Advisory Committee on Fishery Management

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PART 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 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 assessment is now made, together with the area for which the TAC is set by the E.U. is shown in Figure 4.1.1. It should be noted, however, 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 the entire management unit is taken from the inshore waters along the Irish coast.

The Study Group on Herring Assessment and Biology in the Irish Sea and Adjacent Areas which met in Belfast early in 1994 proposed a change in the area over which this stock should be assessed (Anon 1994). This proposal to alter the area was endorsed by the Herring Assessment Working Group in 1994 (Anon 1994a). It has not, however, proved possible to establish revised databases for the 1995 meeting of the Herring Assessment Working Group and consequently the current assessment covers the same area as in previous reports.

4.2 The fishery in 1994-1995

4.2.1 Advice and management applicable to 1994 and 1995

In 1994 ACFM considered this stock to be within safe biological limits and concluded that fishing at current levels of fishing mortality would lead to little change in SSB in the immediate future. The catch level suggested by ACFM for 1994 was within the range 20,000 - 24,000 t. The TAC subsequently set by the E.U. for 1994 was 21,000 t, which was the same range as that set each year since 1991. Similarly ACFM did not give a specific recommendation on a catch level for 1995 and the TAC again agreed by the E.U. was 21,000 t. The spawning box closure system was continued during 1994 - the box closed being that in Division VIIj.

4.2.2 The fishery in 1994/1995

The major portion of the catches from this area in 1994/1995 were taken by the Irish fishery during the spawning season which lasted from October to February. As has been the case for a number of years the Irish fishery is directed towards the Japanese roe market. The Irish fishery, therefore, continues to be operated on a seasonal basis and fishing during 1994/1995 was opened on 7 October and closed on 27 February. The total Irish quota was sub-divided into boat quotas on a week by week basis. All vessels participating in the fishery were again regulated by licences which restrict landings to specific ports and to specific times.

As in the 1993/1994 season there appeared to be a severe scarcity of fish during October and November - particularly on the spawning grounds in Division VIIj. This scarcity continued throughout most of December. In January fishing improved and shoals were reported to be abundant on the spawning ground in Divisions VIIa (S) and VIIg. As in recent years considerable fishing took place in the northern part of Division VIIj in January and February and fishermen have reported a continuing increase in the abundance of winter-spawning herring in this area.

The maximum number of Irish boats participating in the fishery during 1994/1995 was 60, compared with 62 in the previous season and 80 in the previous two seasons.

4.2.3 The catch data

The estimated catches from 1985-1994 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 from 1958 to 1994 are shown in Figure 4.2.1. The reported catches, including estimates of discards and unallocated landings, taken during 1994/1995 were about 19,000 t which was very similar to the figure of the previous season. Landings have been reasonably stable for a number of years and have averaged about 21,000 t since 1988. The level of discards in the fishery is believed to have decreased in recent years due to the increased ability of fishermen to avoid herring shoals which are not considered suitable for the "roe" market, and also to an improvement in the markets for "non roe" herring. Observers were again placed on commercial vessels throughout the season as part of an EU funded project. The results of this project are not yet available but preliminary indications confirm that the level of discards in the Irish fishery accepted by the previous Working Groups of 10% is satisfactory.

4.2.4 Quality of catch and biological data

Management authorities are confident that the accuracy of the landing statistics has increased considerably for this fishery in recent years. During 1994/1995 no misreporting of catches to the adjoining Division VIIb took place because of the very poor fishing experienced along the boundary between Divisions VIIb and VIIj. Biological sampling of the catches in

general was satisfactory although the fishery which developed in Division VIIj in January 1995 was not adequately sampled. Details of the sampling data per quarter are shown in Table 4.2.3, while the length distribution of the catches taken by the Irish fleet per quarter are shown in Table 4.2.4.

4.2.5 Catch in number at age

The total catches in numbers at age, including discards, per season are shown in Table 4.2.5 from 1958-1994. The catch for 1994/1995 was dominated by the 1990/1991 year class, i.e. 3-ring fish. This year class, which constituted over 70% of the catches during 1993/1994, constituted nearly 50% of the catches during 1994/1995. Over 88% of the catches in 1994/1995 were composed of 1, 2 and 3-ring fish.

4.3 Mean Weight at Age

As the major portion of the catch from this fishery is taken during the spawning fishery 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 are shown below for the last four seasons and appear to be reasonably stable.

Season	1	2	3	4	5	6	7	8
1991-1992	92	128	168	172	190	206	229	237
1992-1993	96	123	150	177	191	194	212	228
1993-1994	92	129	155	178	201	204	210	225
1994-1995	97	135	168	179	190	210	218	217

4.4 Stock Assessment

4.4.1 Acoustic surveys

Acoustic surveys have been carried out on this stock each year since 1989/1990. Two surveys were again carried out during the 1994/1995 season by the *R.V. Lough Foyle* and the results were presented by Molloy *et al.* (W.D. 1995). The surveys are designed to estimate the size of the autumn and winter-spawning components separately - the combined estimate being considered the size of the total spawning stock. Herring shoals during both surveys appeared less abundant and less dense than those observed during previous surveys. This was particularly so during the November survey when virtually no adult shoals were located. The difficulties encountered during these surveys - e.g. double counting, species mixing, timing, bad weather and area distribution of shoals have been described in previous working group reports. In November there was some evidence from a French research vessel survey that shoals were distributed much further offshore than usual and during 1995 the January survey did not cover Division VIIj where important catches were taken at that time. Nevertheless, the surveys have been carried out consistently and the results obtained from the 1994/1995 survey appear to be consistent with the reports from the fishery. The estimates obtained from the 1994/1995 surveys were: Total stock biomass 51,800 t and Spawning stock biomass 50,600 t. These stock estimates were converted to numbers at age using the method described for this stock by the Working Group in 1994 (Anon 1995a). The stock numbers at age, together with those obtained from previous surveys, are shown in Table 4.4.1.

The acoustic surveys have again indicated the presence of the strong 1990/1991 year class which has been a feature of the fishery since 1991/1992. This year class was, as already mentioned, also abundant in the catches of the commercial vessels. The presence of the year class each season, inspires some confidence in the surveys as an indication of the age structure of the total stock. The low abundance of the 1992/1993 and 1993/1994 year classes in the 1994/1995 surveys may, therefore, be a potential cause for concern.

4.4.2 Results of Assessments

The integrated catch analysis program (ICA) was used, as in 1994, in this assessment to reconstruct the stock size in this area. In the analysis the age-disaggregated data from the acoustic surveys from 1990/1994 to 1994/1995 were used as the only tuning index available. The 0 and 1-ring fish are excluded from the analysis as they are not believed to be fully recruited to the Celtic Sea from Division VIIa (N). The analyses carried out at the 1994 Working Group meeting indicated that using the acoustic surveys as a proportional index of stock abundance provided the best fit to the ICA model. This approach was again adopted and the results of this run are shown in Table 4.4.2 and results from the ICA model are shown in Figures 4.4.1, 4.4.2 and 4.4.3.

The estimated spawning stock size in 1994 from the ICA model is 45,000 t. This is considerably lower than that estimated at the 1994 meeting of the Working Group which calculated that the spawning stock in 1994 would be 59,000 t. There has also been a very dramatic change in fishing mortality and the average level in the three recent years is higher than in any corresponding period since 1976. The 1990/1991 year class which appeared to be very strong when it was first evident in the acoustic surveys as 0 and 1-ring fish does not now appear to be exceptionally abundant. It is difficult to explain the decrease which the ICA model suggests has occurred in the stock. An examination of the residuals about the model fit shows that in 1994 the separable model residuals in 1993 and 1994 contain unusually high numbers of negative values. These negative values are also apparent in the aged index residuals for 1994 which were not present in 1993. This suggests that the numbers at age in the acoustic survey estimates have decreased too rapidly compared with the expected decrease in the numbers at age in the

catch. This in turn suggests that the 1994/1995 acoustic surveys underestimated the stock size or else the catches in the same year were underestimated.

The difficulty in interpreting the survey data has already been mentioned. During November 1994, while the offshore area was extended, it was not possible to include that area in which the French research vessel had reported herring concentrations. In addition the January 1995 survey did not extend into Division VIIj.

Considerable doubts about the accuracy of the catch data for this fishery have been expressed by the Working Group on a number of occasions and major revisions to the catch statistics have been made. Management authorities are confident that the landing statistics have improved in recent years but doubts are still expressed by the Working Group about the accuracy of the total catch.

4.5 Recruitment Estimates

There are no recruitment indices available for this stock which can be used for predictive purposes. In the absence of this information the Working Group in 1994 used the geometric mean value of the numbers of 1-ring fish from 1983 to 1992, excluding the exceptionally strong 1990/1991 year class, for predictions. The results from the acoustic surveys suggest that recent year classes may be below average size. It was, therefore, considered advisable to accept a conservative recruitment level in the 1995 prediction. Accordingly the geometric mean value over the period 1988-1993 was used. This was calculated as 340 million 1-ring fish compared with 517 million used in 1994.

4.6 Short-term Projections

Stock and catch projections were carried out for 1996 and 1997 using the stock in numbers at age at 1 January generated from the ICA model and using the mean geometric recruitment of 340 million 1-ring fish for 1996 and 1997. It was decided because of the uncertainty about the stock size and the lack of information about recruitment that only short-term predictions should be carried out:-

1. A single option prediction in which catches in 1995 to 1997 were fixed at the 1995 TAC of 21,000 t. The results show that the spawning stock will decrease from 42,700 t in 1995 to 35,000 t in 1996 (Table 4.6.1).

2. A prediction with management option tables for 1996 is also shown. If the spawning stock is to be maintained at the 1995 level then catches in 1996 should be restricted to about 10,000 t (Table 4.6.2).

The yield per recruit curve and stock summary diagrams are shown in Figures 4.6.1 and 4.6.2.

4.7 Management Considerations

4.7.1 Evaluation of spawning box closures

The system of rotating closures of selected spawning grounds was first introduced in this fishery during 1989 and has been continued each season since then. The reason why it was thought necessary to introduce this management measure was because of the concern that the development of a "roe" fishery might cause a very high fishing mortality on spawning fish. The selection of the spawning boxes to be closed and the timing of the closures have been described and discussed at a number of Working Group meetings - particularly those of 1989 (Anon 1989), 1991 (Anon 1991) and 1992 (Anon 1992). Apart from some minor changes in the boundaries of the boxes and the timing of the closures the system has remained unaltered since its introduction.

In 1991 ACFM questioned the benefits that may arise from a continuation of this measure and whether it was possible to evaluate them in terms of increases in spawning stock sizes. In 1992 the Working Group examined this question and stated that it was unable to quantify the effects of these measures because only part of the spawning areas were closed each season and because fishing effort may have been transferred to the adjacent areas. However, it was felt that fishermen generally respected the regulations and consider them as a necessary method of conservation.

At present the situation is similar to that of 1992 - i.e. there is no way of determining how effective these spawning box closures are. During 1994 the box closed was that off the southwest of Ireland and during the time of the closure (the first fortnight in November) reports from the acoustic surveys suggested that there were no spawning herring in this area. The benefit of this closure , therefore, was minimal. It has been suggested that the length of the closures (14 days) is too short to ensure any measure of conservation because any change in timing of spawning may mean that shoals may arrive on the spawning beds before or after the spawning closure. It also seems clear that an extension of the closed period or an enlargement of the closed boxes would almost certainly create a diversion of effort to an adjacent area.

In the circumstances the Working Group is reluctant to advise that this conservation measure should be discontinued - particularly in view of the history of stock collapse in the area - without the introduction of some other effective method of effort control. A more effective measure of reducing mortality would possibly be to reduce the number of vessels participating in the

fishery and to ensure that the TAC is taken over a longer period than at present.

4.7.2 Risk Analyses and Medium-term Projection

As there is no method of predicting recruitment for this stock it is not considered realistic to carry out risk analyses and medium-term projections.

4.7.3 Potential for multispecies or multiannual options

In common with other stocks around Ireland the herring in this area are taken in a single species directed fishery species with no by-catch. There is no information from this area about predation on herring by other species. There is, therefore, no potential in considering the stock for multispecies assessment.

The large fluctuations in the stock biomass and similar fluctuations in recruitment and fishing mortality would create difficulties in providing multiannual catch options.

4.7.4 Appropriateness of controls on catch and fishing effort

Most of the catches in this area are taken by the Irish fleet. Landings are controlled by boat quotas, weekend closures, seasonal closures and designated landing places. There are, however, only limited restrictions on the number of vessels participating in the fishery which means that boat quotas are often economically unviable. In these circumstances under-reporting of landings is often possible, unless there is strict surveillance of vessels at sea and ashore. The situation could be improved by limiting the number of vessels licensed to participate in the fishery.

The attempt to control effort by the introduction of spawning box closures has been discussed in Section 4.7.1.

There are no controls on discarding herring at sea and at present this still remains a legitimate practice. Attempts to eliminate this have been introduced by the delayed opening of the season and by the closure of certain areas when no marketable herring were being taken.

Table 4.2.1 Celtic Sea and Division VIIj HERRING landings by calendar year (t), 1985-1994. (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
1985	600	-	11,000	-	-	4,600	3,100	19,300
1986	-	-	13,300	+	-	6,100	3,900	23,300
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[1]	+	-	17,400	1,300	+	-1,300	1,700	19,100

[1] Preliminary

Table 4.2.2 Celtic Sea and Division VIIj herring landings (t) by season (1 April - 31 March). (Data provided by Working Group members).

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
1985/1986	600	-	12,000	-	-	4,500	3,300	20,400
1986/1987	-	-	14,700	+	-	6,100	4,200	25,000
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	+	-	17,400	1,300	+	-1,300	1,900	19,300

Table 4.2.3 Celtic Sea, Division VIIj (1994 - 1995). 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 4.94	12,300	51	1,298	8,763	105	Yes
	Q 1.95	7,100	35	742	5,801	105	Yes
Netherlands	Q 2.94	1,300	1	25	126	19	Yes

Table 4.2.4 Celtic Sea and Division VIIj. Length distribution (including discards) of Irish catches/quarter (thousands).

Length	Division VIIa South		Division VIIg		Division VIIj	
	Q4 94	Q1 95	Q4 94	Q1 95	Q4 94	Q1 95
18		6				
19	27		18			
20	108	18	92			
	261	24	156			203
21	611	48	414			474
	1,222	72	341	29	15	541
22	1,465	269	460	88	37	406
	1,411	436	479	118	59	-
23	1,024	746	534	304	67	-
	943	1,391	469	441	67	68
24	1,375	1,552	672	833	111	406
	1,582	2,262	957	1,029	97	203
25	2,256	2,430	1,390	1,784	171	677
	2,624	2,340	1,951	2,009	579	812
26	3,541	2,895	3,921	2,892	1,590	2,099
	3,334	2,967	4,400	2,911	2,347	1,083
27	2,741	2,364	5,652	3,048	3,654	1,015
	1,492	1,427	3,351	1,568	3,082	135
28	1,096	740	2,246	1,078	2,414	135
	773	221	801	323	1,122	
29	503	101	700	216	966	68
	225	72	312	118	535	
30	108	30	203	49	334	
	36	12	46		134	
31		-	37		22	
	9	-	-		7	
32		-	-		7	
	-					
Total	28,775	22,421	29,604	18,840	17,418	8,326

Table 4.2.5 Herring South and South West of Ireland (Celtic Sea + VIIj) 11:44 Friday, March 31, 1995 1

Catch in Numbers (Thousands)

(CANUM)

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1958	1642	3742	33094	25746	12551	23949	16093	9384	5584
1959	1203	25717	2274	19262	11015	5830	17821	3745	7352
1960	2840	72246	24658	3779	13698	4431	6096	4379	4151
1961	2129	16058	32044	5631	2034	5067	2825	1524	4947
1962	772	18567	19909	48061	8075	3584	8593	3805	5322
1963	297	51935	13033	4179	20694	2686	1392	2488	2787
1964	7529	15058	17250	6658	1719	8716	1304	577	2193
1965	57	70248	9365	15757	3399	4539	12127	1377	7493
1966	7093	19559	59893	9924	13211	5602	3586	8746	3842
1967	7599	39991	20062	49113	9218	9444	3939	6510	6757
1968	12197	54790	39604	11544	22599	4929	4170	1310	4936
1969	9472	93279	55039	33145	12217	17837	4762	2174	3469
1970	1319	37260	50087	26481	18763	7853	6351	2175	3367
1971	12658	23313	37563	41904	18759	10443	4276	4942	2239
1972	8422	137690	17855	15842	14531	4645	3012	2374	1020
1973	23547	38133	55805	7012	9651	5323	3352	2332	1209
1974	5507	42808	17184	22530	4225	3737	2978	903	827
1975	12768	15429	17783	7333	9006	3520	1644	1136	1194
1976	13317	11113	7286	7011	2872	4785	1980	1243	1769
1977	8159	12516	8610	5280	1585	1898	1043	383	470
1978	2800	13385	11948	5583	1580	1476	540	858	482
1979	11335	13913	12399	8636	2889	1316	1283	551	635
1980	7162	30093	11726	6585	2812	2204	1184	1262	565
1981	39361	21285	21861	5505	4438	3436	795	313	866
1982	15339	42725	8728	4817	1497	1891	1670	335	596
1983	13540	102871	26993	3225	1862	327	372	932	308
1984	19517	92892	41121	16043	2450	1085	376	231	180
1985	17916	57054	36258	16032	2306	228	85	173	132
1986	4159	56747	42881	32930	8790	1127	98	29	12
1987	5976	67000	43075	23014	14323	2716	1175	296	464
1988	2307	82027	30962	9398	5963	3047	869	297	86
1989	8260	42413	68399	19601	8205	3837	2589	767	682
1990	2702	41756	24634	35258	8116	3808	1671	695	462
1991	1912	63854	38342	16916	28405	4869	2588	954	593
1992	10410	26752	35019	27591	10139	18061	3021	6285	689
1993	1608	94061	9372	10221	4491	2790	5932	855	508
1994	12130	35768	61737	3289	3025	4773	1713	1705	474

Table 4.4.1 Total stock at age estimated from acoustic surveys (10^6).

W.Rs	1990/1991	1991/1992	1992/1993	1993/1994	1994/1995
0	204.8	213.8	141.8	258.8	41.3
1	131.6	62.6	426.9	217.1	38.0
2	249.0	195.2	117.0	437.9	127.2
3	108.6	94.7	87.8	58.7	160.3
4	152.5	54.0	49.6	63.4	10.5
5	32.4	84.8	22.2	26.0	10.6
6	14.9	22.1	24.2	16.3	6.5
7	6.1	5.3	9.6	24.6	1.6
8	2.5	6.1	1.8	2.3	2.6
9+	1.5	-	1.1	1.7	0.5
Total	1904.9	738.6	882.0	1,106.8	399.1
TSB (000't)	103.0	84.4	88.5	104.0	51.8
SSB (000't)	91.0	77.0	71.0	90.0	50.6

Table 4.4.2 Celtic Sea / VIIj

CATCH NUMBERS AT AGE (Millions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	13.	8.	3.	11.	7.	39.	15.	14.	20.	18.	4.	6.	2.	8.	3.	2.	10.	2.	12.
2	11.	13.	13.	14.	30.	21.	43.	103.	93.	57.	57.	67.	82.	42.	42.	64.	27.	94.	36.
3	7.	9.	12.	12.	12.	22.	9.	27.	41.	36.	43.	43.	31.	68.	25.	38.	35.	9.	62.
4	7.	5.	6.	9.	7.	6.	5.	3.	16.	16.	33.	23.	9.	20.	35.	17.	28.	10.	3.
5	3.	2.	2.	3.	5.	4.	1.	2.	2.	2.	9.	14.	6.	8.	8.	28.	10.	4.	3.
6	5.	2.	1.	1.	2.	3.	2.	0.	1.	0.	1.	3.	3.	4.	4.	5.	18.	3.	5.
7	2.	1.	1.	1.	1.	1.	2.	0.	0.	0.	0.	1.	1.	3.	2.	3.	3.	6.	2.
8	1.	0.	1.	1.	1.	0.	0.	1.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	2.
9	2.	0.	0.	1.	1.	1.	1.	0.	0.	0.	0.	0.	0.	1.	0.	1.	1.	1.	0.

INDICES OF SPAWNING STOCK BIOMASS

0

AGE - STRUCTURED INDICES

INDEX : 1 from 1990 to 1994

	1990	1991	1992	1993	1994
2	.249E+06	.195E+06	.117E+06	.438E+06	.127E+06
3	.109E+06	.947E+05	.878E+05	.587E+05	.160E+06
4	.153E+06	.540E+05	.496E+05	.634E+05	.105E+05
5	.324E+05	.848E+05	.222E+05	.260E+05	.106E+05
6	.149E+05	.221E+05	.242E+05	.163E+05	.650E+04
7	.610E+04	.530E+04	.960E+04	.246E+05	.160E+04
8	.250E+04	.610E+04	.180E+04	.230E+04	.260E+04

FISHING MORTALITY

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	.1062	.0766	.0331	.0780	.0804	.1628	.0373	.0298	.0556	.0585	.0123	.0091	.0094	.0161	.0131	.0185	.0241	.0200	.0278
2	.3034	.2357	.3005	.4013	.5541	.6738	.4816	.6934	.5248	.4015	.4733	.4994	.2847	.4761	.3874	.5470	.7128	.5917	.8247
3	.4481	.4361	.3949	.5400	.7636	1.1662	.7131	.6994	.7282	.4286	.6489	.8905	.4891	.5931	.4826	.6815	.8881	.7371	1.0275
4	.5635	.6492	.5337	.5243	.5874	.9907	.8515	.5982	1.2081	.6714	.8337	.8495	.4596	.6131	.4989	.7044	.9180	.7620	1.0621
5	.4738	.2103	.3609	.5164	.2858	.9009	.7133	.8528	1.1532	.4701	.8651	.9809	.4852	.5520	.4492	.6343	.8266	.6861	.9563
6	.7048	.5839	.2754	.5102	.8405	.5898	1.1615	.2905	1.9646	.2544	.3921	.6357	.4999	.6609	.5378	.7593	.9895	.8214	1.1449
7	.9123	.2842	.2876	.3629	1.0756	.7457	.5652	.6521	.5576	.7672	.1482	.8013	.3781	.8204	.6676	.9426	1.2284	1.0196	1.4212
8	.5287	.3855	.3548	.4704	.6435	.8334	.7257	.6317	.9927	.4777	.5723	.7564	.4220	.5931	.4826	.6815	.8881	.7371	1.0275
9	.5287	.3855	.3548	.4704	.6435	.8334	.7257	.6317	.9927	.4777	.5723	.7564	.4220	.5931	.4826	.6815	.8881	.7371	1.0275

NUMBERS AT AGE (Millions)

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995

Table 4.4.2 Celtic Sea / VIIj (continued)

1	207.	174.	136.	237.	146.	409.	660.	728.	568.	496.	536.	1044.	391.	451.	379.	156.	710.	208.	698.	395.
2	49.	69.	59.	48.	81.	49.	128.	234.	260.	198.	172.	195.	380.	142.	163.	137.	56.	255.	75.	250.
3	22.	27.	40.	32.	24.	34	19.	59.	87.	114.	98.	79.	88.	212.	66.	82.	59.	20.	105.	24.
4	17.	12.	14.	22.	16.	9	9.	7.	24.	34.	61.	42.	27.	44.	96.	33.	34.	20.	8.	31.
5	8.	9.	5.	7.	12.	8.	3.	3.	4.	6.	16.	24.	16.	15.	22.	53.	15.	12.	8.	3.
6	10.	4.	6.	3.	4.	8.	3.	1.	1.	1.	4.	6.	8.	9.	8.	12.	25.	6.	6.	3.
7	3.	4.	2.	4.	2.	2.	4.	1.	1.	0.	1.	2.	3.	4.	4.	4.	5.	9.	2.	2.
8	3.	1.	3.	2.	3.	1.	1.	2.	0.	0.	0.	1.	1.	2.	2.	2.	1.	1.	3.	1.
9	3.	3.	3.	4.	3.	3.	1.	1.	1.	1.	1.	0.	0.	1.	1.	2.	2.	1.	1.	1.

STOCK SUMMARY

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Ref. F Fbar 2- 7
1976	207.	47953.	27054.	9771.	.3612	.5677
1977	174.	45877.	27694.	7833.	.2828	.3999
1978	136.	42725.	27468.	7559.	.2752	.3589
1979	237.	52874.	29282.	10321.	.3525	.4759
1980	146.	45340.	27830.	13130.	.4718	.6845
1981	409.	70245.	31414.	17103.	.5444	.8445
1982	660.	107204.	47451.	13000.	.2740	.7477
1983	728.	140669.	68718.	24981.	.3635	.6311
1984	568.	112678.	62151.	26779.	.4309	1.0227
1985	496.	107641.	61094.	20426.	.3343	.4989
1986	536.	119706.	65511.	25024.	.3820	.5602
1987	1044.	157007.	74574.	26200.	.3513	.7762
1988	391.	114425.	74419.	20447.	.2748	.4328
1989	451.	111941.	66088.	23254.	.3519	.6193
1990	379.	93231.	57498.	18404.	.3201	.5039
1991	156.	66221.	45778.	25562.	.5584	.7115
1992	710.	99563.	44755.	21127.	.4721	.9272
1993	208.	64868.	41231.	18618.	.4515	.7696
1994	698.	100950.	45026.	19300.	.4286	1.0728

PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year

1	1989	.5931	.5204	.6759
2	1990	.4826	.4237	.5498
3	1991	.6815	.6041	.7688

Table 4.4.2 Celtic Sea / VIIj (continued)

4	1992	.8881	.7929	.9947
5	1993	.7371	.6510	.8347
6	1994	1.0275	.8675	1.2169
Separable Model: Selection (S) by age				
7	1	.0271	.0185	.0396
8	2	.8027	.6938	.9286
	3	1.0000	Fixed : Reference age	
9	4	1.0337	.8989	1.1887
10	5	.9307	.8137	1.0646
11	6	1.1143	.9824	1.2638
12	7	1.3832	1.2338	1.5507
	8	1.0000	Fixed : last true age	
Separable Model: Populations in year 1994				
13	1	697641.	283205.	1718554.
14	2	75169.	60578.	93274.
15	3	104531.	88337.	123694.
16	4	8020.	6893.	9333.
17	5	8383.	7253.	9689.
18	6	5602.	4868.	6447.
19	7	2333.	2019.	2696.
20	8	2776.	2325.	3314.
Separable Model: Populations at age 8				
21	1989	1791.7144	1362.3018	2356.4827
22	1990	1770.9797	1448.5704	2165.1477
23	1991	1959.8869	1648.7714	2329.7083
24	1992	1479.8822	1251.7149	1749.6407
25	1993	1395.0805	1172.9536	1659.2724

Age-structured index catchabilities

Age-Structured Index 1

Linear model fitted. Slopes at age:

26	2 Q	.30810E+01	.25809E+01	.36781E+01
27	3 Q	.31605E+01	.26532E+01	.37648E+01
28	4 Q	.31506E+01	.26465E+01	.37507E+01
29	5 Q	.27107E+01	.22745E+01	.32305E+01
30	6 Q	.30123E+01	.25185E+01	.36030E+01
31	7 Q	.31619E+01	.25968E+01	.38500E+01
32	8 Q	.27182E+01	.21724E+01	.34012E+01

RESIDUALS ABOUT THE MODEL FIT

Table 4.4.2 Celtic Sea / VIIj (continued)

Separable Model Residuals
(log(Observed Catch)-log(Expected Catch))
and weights (W) used in the analysis.

Age	1989	1990	1991	1992	1993	1994	
1	.59566E+00	-.14100E+00	.56331E-01	.26214E-01	-.48389E+00	.62982E-13	.10000E+00
2	-.10589E+00	-.92078E-01	.23033E+00	.57053E-01	-.59516E-01	-.39786E-01	.10000E+01
3	-.23851E+00	.72064E-01	.29729E-01	.93395E-01	-.44309E-01	-.19789E-02	.10000E+01
4	.16604E-01	-.21033E-01	.54147E-01	.34180E+00	.82046E-02	-.42637E+00	.10000E+01
5	.28224E+00	.85595E-01	.18191E+00	.23917E+00	-.26317E+00	-.49265E+00	.10000E+01
6	-.86545E-01	.18638E+00	-.26409E+00	.16958E+00	-.12053E+00	.26299E+00	.10000E+01
7	.81909E-01	-.16412E+00	.51168E-01	-.17046E+00	.12812E+00	.51625E-02	.10000E+01
8	-.12599E-13	.69759E-01	.28441E-01	-.28547E+00	.20420E+00	-.35318E-02	.10000E+01
Wts	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	.10000E+01	

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1

Age	1990	1991	1992	1993	1994
2	-.24356E+00	-.20713E+00	.28341E+00	.12973E-01	.15431E+00
3	-.18821E+00	-.41833E+00	-.23032E-01	.53034E+00	.99230E-01
4	-.28280E+00	-.11954E+00	-.88988E-01	.59108E+00	-.99754E-01
5	-.22166E+00	-.29685E-01	.28210E-01	.27812E+00	-.54977E-01
6	-.47049E-01	.47240E-01	-.41683E+00	.53686E+00	-.12022E+00
7	-.26960E+00	-.22017E+00	.33854E+00	.66077E+00	-.50954E+00
8	-.26542E+00	.65849E+00	-.14282E+00	.60141E-01	-.31039E+00

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1989 to 1994
Variance : .0867

Table 4.4.2 Celtic Sea / VIIj (continued)

Skewness test statistic	:	-.3586
Kurtosis test statistic	:	1.4066
Partial chi-square	:	.2346
Probability of chi-square	:	1.0000
Degrees of freedom	:	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	:	2	3	4	5	6	7	8
Variance	:	.0516	.1255	.1154	.0328	.1202	.2330	.1561
Skewness test stat.	:	.0675	.4031	1.1751	.4490	.4932	.3737	.9690
Kurtosis test stat.	:	-.7070	-.3636	.0110	-.2543	-.2493	-.6368	-.1829
Partial chi-square	:	.0173	.0455	.0430	.0129	.0501	.1057	.0775
Prob. of chi-square	:	1.0000	.9997	.9998	1.0000	.9997	.9987	.9993
Number of data	:	5	5	5	5	5	5	5
Degrees of freedom	:	4	4	4	4	4	4	4
Weight in analysis	:	.5714	.5714	.5714	.5714	.5714	.5714	.5714

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

Single option prediction: Input data

Year: 1995								
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	340.000	1.0000	0.5000	0.2000	0.5000	0.094	0.0271	0.094
2	250.000	0.3000	1.0000	0.2000	0.5000	0.129	0.8027	0.129
3	24.000	0.2000	1.0000	0.2000	0.5000	0.160	1.0000	0.160
4	31.000	0.1000	1.0000	0.2000	0.5000	0.177	1.0337	0.177
5	3.000	0.1000	1.0000	0.2000	0.5000	0.193	0.9307	0.193
6	3.000	0.1000	1.0000	0.2000	0.5000	0.204	1.1143	0.204
7	2.000	0.1000	1.0000	0.2000	0.5000	0.217	1.3832	0.217
8	1.000	0.1000	1.0000	0.2000	0.5000	0.227	1.0000	0.227
9+	1.000	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1996								
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	340.000	1.0000	0.5000	0.2000	0.5000	0.094	0.0271	0.094
2	.	0.3000	1.0000	0.2000	0.5000	0.129	0.8027	0.129
3	.	0.2000	1.0000	0.2000	0.5000	0.160	1.0000	0.160
4	.	0.1000	1.0000	0.2000	0.5000	0.177	1.0337	0.177
5	.	0.1000	1.0000	0.2000	0.5000	0.193	0.9307	0.193
6	.	0.1000	1.0000	0.2000	0.5000	0.204	1.1143	0.204
7	.	0.1000	1.0000	0.2000	0.5000	0.217	1.3832	0.217
8	.	0.1000	1.0000	0.2000	0.5000	0.227	1.0000	0.227
9+	.	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1997								
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	.	1.0000	0.5000	0.2000	0.5000	0.094	0.0271	0.094
2	.	0.3000	1.0000	0.2000	0.5000	0.129	0.8027	0.129
3	.	0.2000	1.0000	0.2000	0.5000	0.160	1.0000	0.160
4	.	0.1000	1.0000	0.2000	0.5000	0.177	1.0337	0.177
5	.	0.1000	1.0000	0.2000	0.5000	0.193	0.9307	0.193
6	.	0.1000	1.0000	0.2000	0.5000	0.204	1.1143	0.204
7	.	0.1000	1.0000	0.2000	0.5000	0.217	1.3832	0.217
8	.	0.1000	1.0000	0.2000	0.5000	0.227	1.0000	0.227
9+	.	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

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
1995	0.8632	0.9013	150917	21000	655000	75629	485000	59649	340785	42751
1996	1.1235	1.1731	143376	21000	578155	67008	408155	51028	274976	35064
1997	2.0370	2.1268	144414	21000	189620	27297	189620	27297	117086	16846
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : CELTIC2
Date and time : 03APR95:14:33
Computation of ref. F: Simple mean, age 2 - 7
Prediction basis : TAC constraints

Table 4.6.2

Herring South and South West of Ireland (Celtic Sea + VIIj) 13:59 Monday, April 3, 1995

Prediction with management option table: Input data

Year: 1995								
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	340.000	1.0000	0.5000	0.2000	0.5000	0.094	0.0271	0.094
2	250.000	0.3000	1.0000	0.2000	0.5000	0.129	0.8027	0.129
3	24.000	0.2000	1.0000	0.2000	0.5000	0.160	1.0000	0.160
4	31.000	0.1000	1.0000	0.2000	0.5000	0.177	1.0337	0.177
5	3.000	0.1000	1.0000	0.2000	0.5000	0.193	0.9307	0.193
6	3.000	0.1000	1.0000	0.2000	0.5000	0.204	1.1143	0.204
7	2.000	0.1000	1.0000	0.2000	0.5000	0.217	1.3832	0.217
8	1.000	0.1000	1.0000	0.2000	0.5000	0.227	1.0000	0.227
9+	1.000	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1996								
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	340.000	1.0000	0.5000	0.2000	0.5000	0.094	0.0271	0.094
2	.	0.3000	1.0000	0.2000	0.5000	0.129	0.8027	0.129
3	.	0.2000	1.0000	0.2000	0.5000	0.160	1.0000	0.160
4	.	0.1000	1.0000	0.2000	0.5000	0.177	1.0337	0.177
5	.	0.1000	1.0000	0.2000	0.5000	0.193	0.9307	0.193
6	.	0.1000	1.0000	0.2000	0.5000	0.204	1.1143	0.204
7	.	0.1000	1.0000	0.2000	0.5000	0.217	1.3832	0.217
8	.	0.1000	1.0000	0.2000	0.5000	0.227	1.0000	0.227
9+	.	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1997								
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	340.000	1.0000	0.5000	0.2000	0.5000	0.094	0.0271	0.094
2	.	0.3000	1.0000	0.2000	0.5000	0.129	0.8027	0.129
3	.	0.2000	1.0000	0.2000	0.5000	0.160	1.0000	0.160
4	.	0.1000	1.0000	0.2000	0.5000	0.177	1.0337	0.177
5	.	0.1000	1.0000	0.2000	0.5000	0.193	0.9307	0.193
6	.	0.1000	1.0000	0.2000	0.5000	0.204	1.1143	0.204
7	.	0.1000	1.0000	0.2000	0.5000	0.217	1.3832	0.217
8	.	0.1000	1.0000	0.2000	0.5000	0.227	1.0000	0.227
9+	.	0.1000	1.0000	0.2000	0.5000	0.240	1.0000	0.240
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Prediction with management option table

Year: 1995					Year: 1996					Year: 1997	
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
0.8632	0.9013	75629	42751	21000	0.0000	0.0000	67008	40916	0	80306	53548
.	.	.	.	.	0.2000	0.2088	.	39784	5352	74856	47025
.	.	.	.	.	0.4000	0.4176	.	38693	9851	70310	41732
.	.	.	.	.	0.6000	0.6265	.	37642	13640	66512	37421
.	.	.	.	.	0.8000	0.8353	.	36628	16837	63337	33897
.	.	.	.	.	1.0000	1.0441	.	35650	19541	60679	31002
.	.	.	.	.	1.2000	1.2529	.	34708	21832	58451	28614
.	.	.	.	.	1.4000	1.4617	.	33799	23780	56580	26631
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : CELTIC1
Date and time : 03APR95:14:48
Computation of ref. F: Simple mean, age 2 - 7
Basis for 1995 : TAC constraints

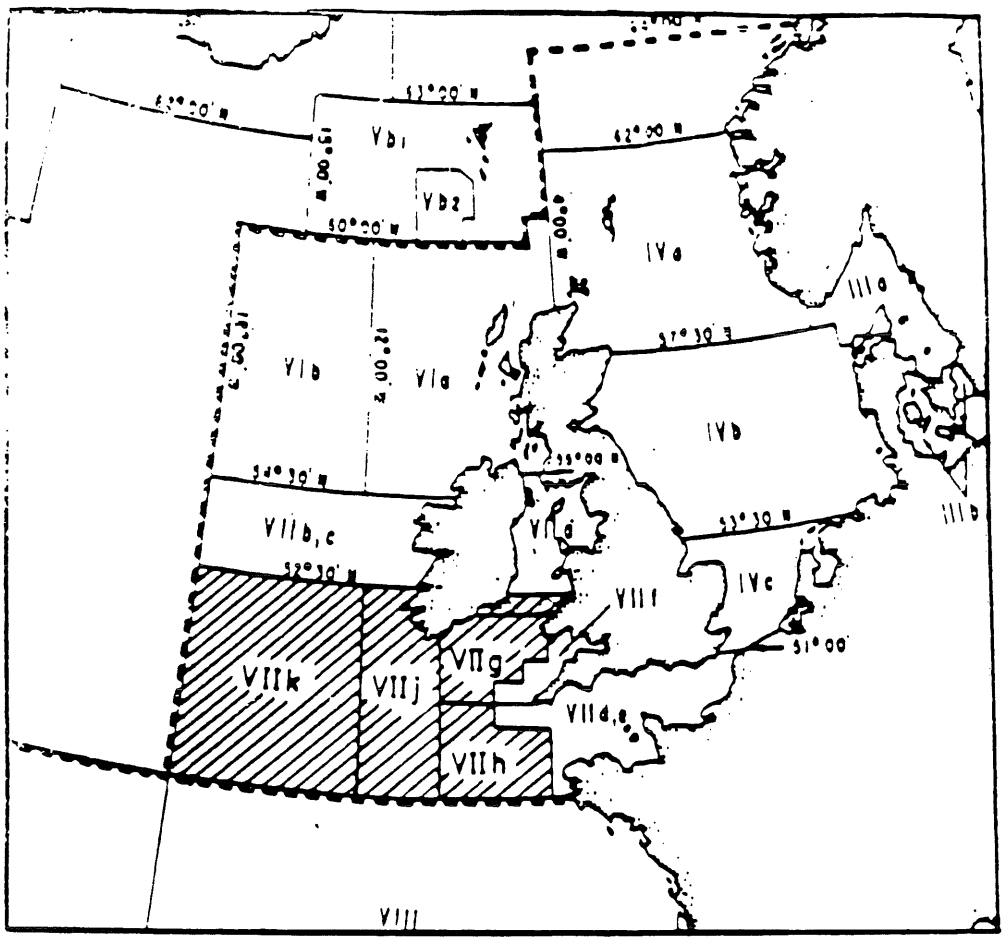


Figure 4.1.1 The assessment covers the area Divisions VIIj and VIIg and that part of Division VIIa below 52°30. TAC is set by EC for Divisions VIIg-k and that section of Division VIIa below 52°30.

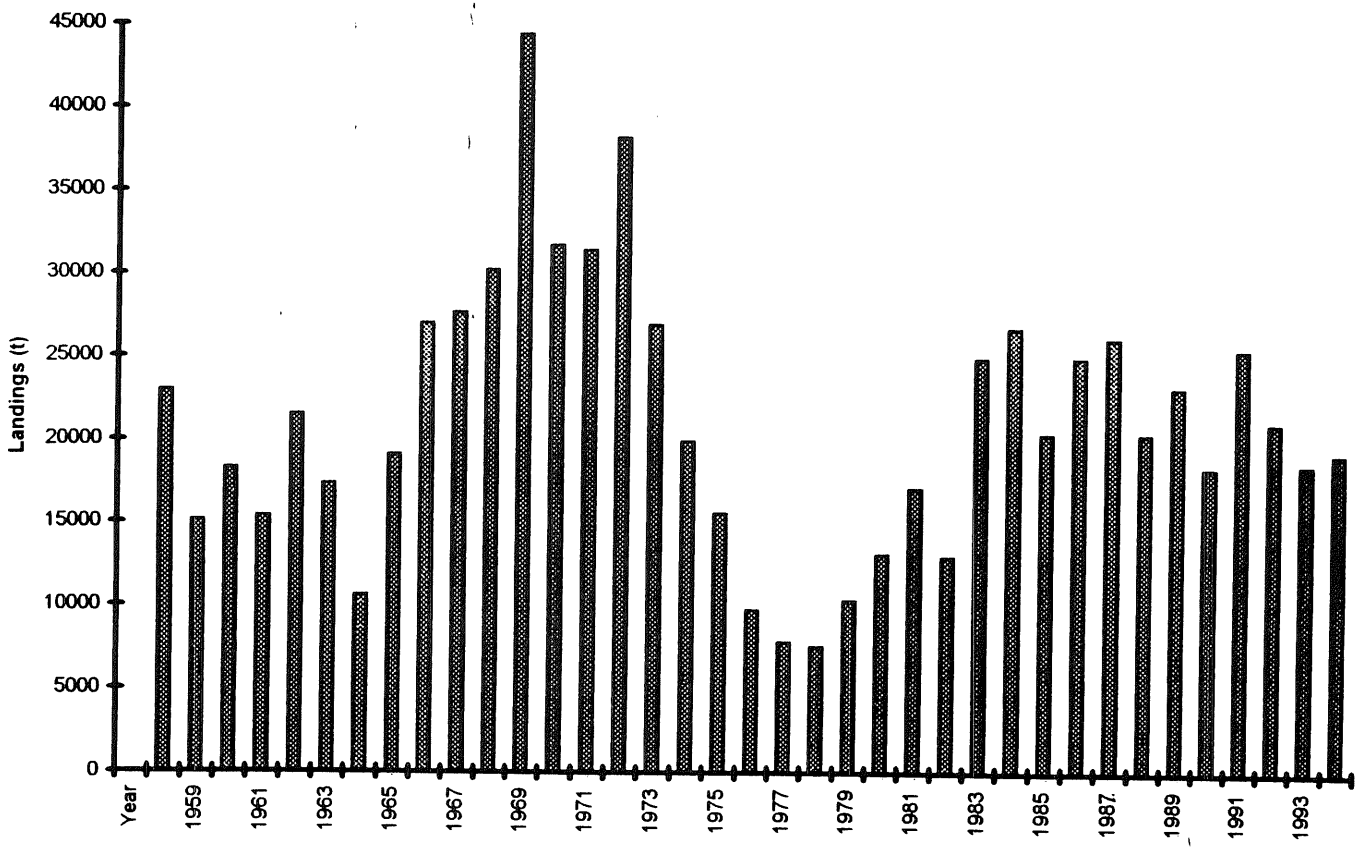


Figure 4.2.1 **Herring: Landings from the Celtic Sea and Division VIIj for the period 1958 to 1994**

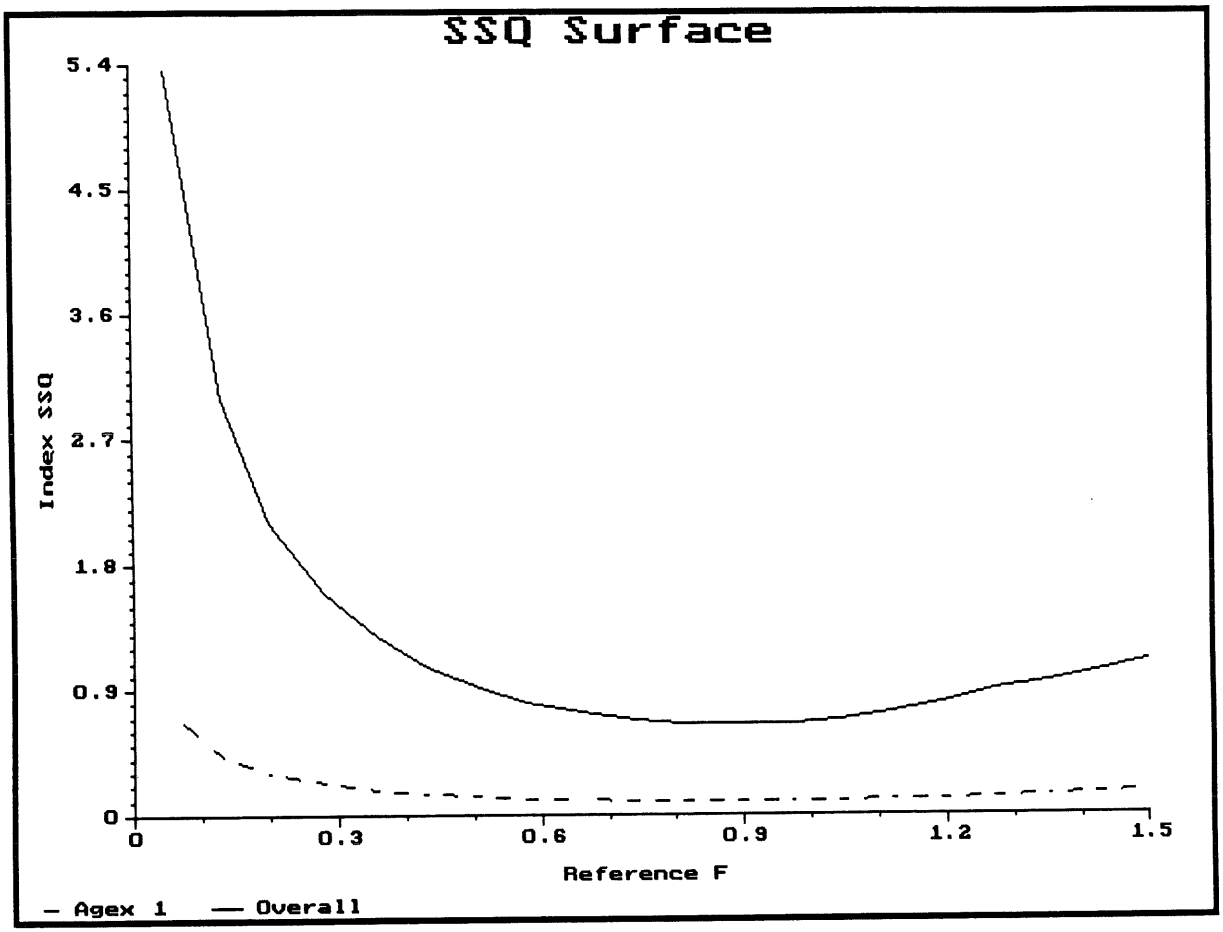


Figure 4.4.1 **Celtic Sea / VIIj**

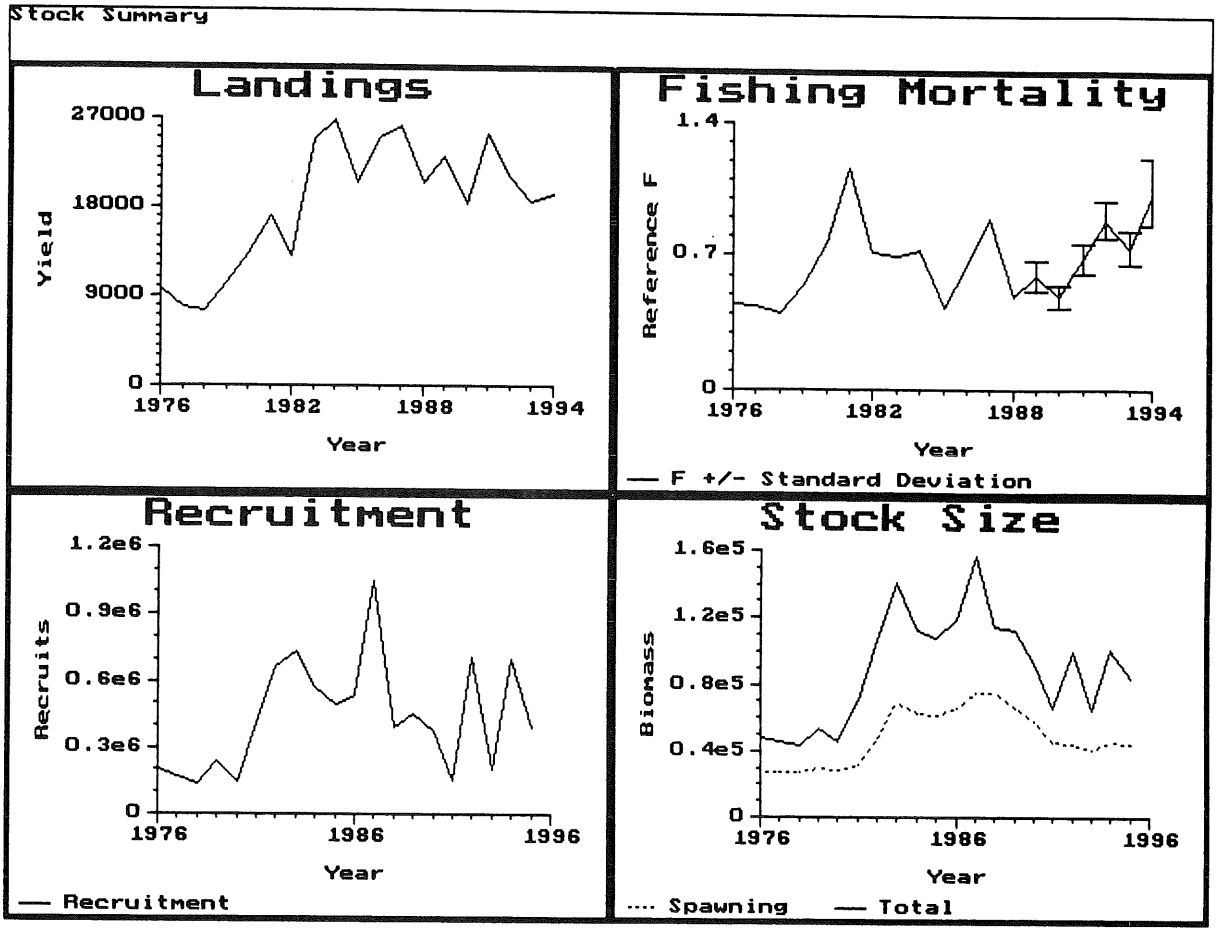


Figure 4.4.2 **Celtic Sea / VIIj**

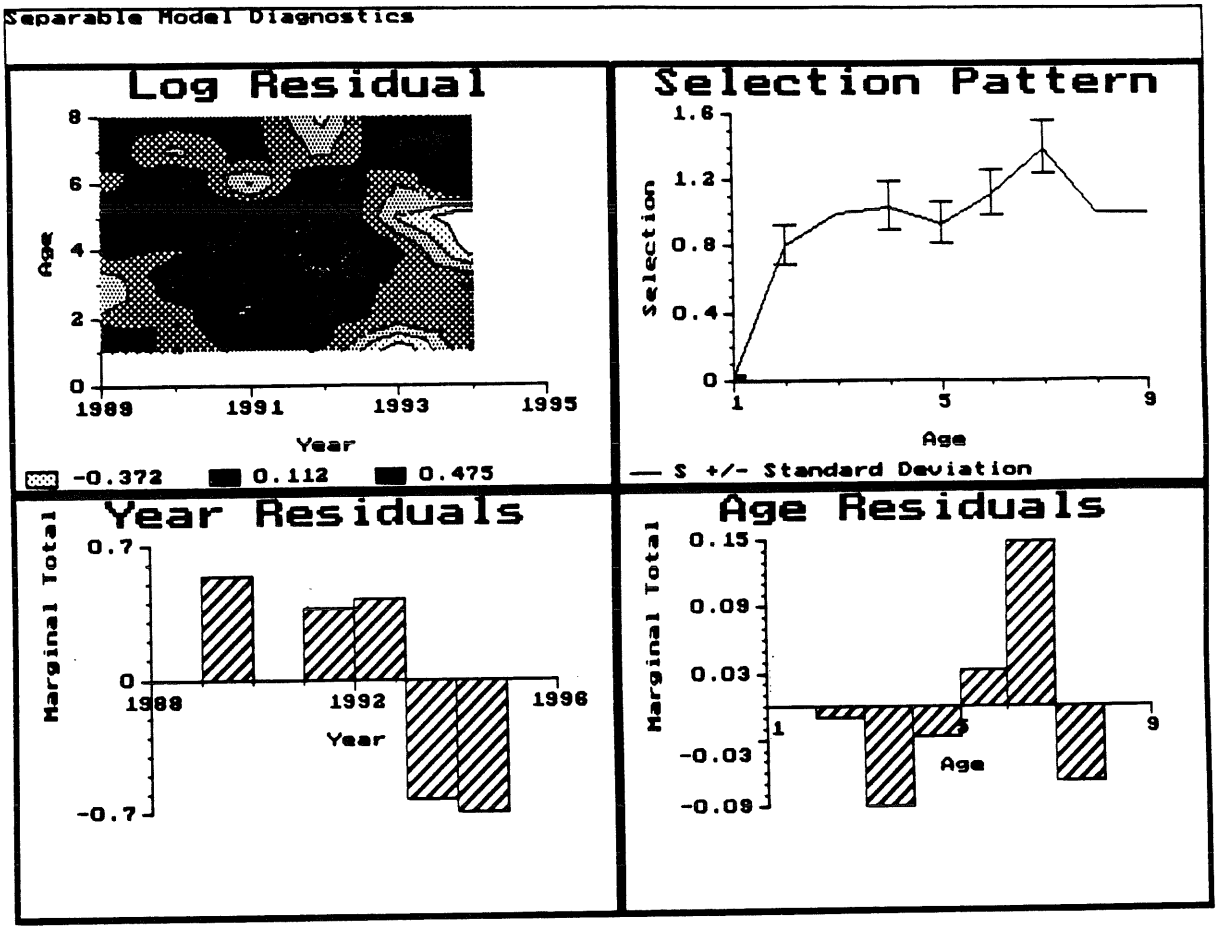


Figure 4.4.2 (continued)

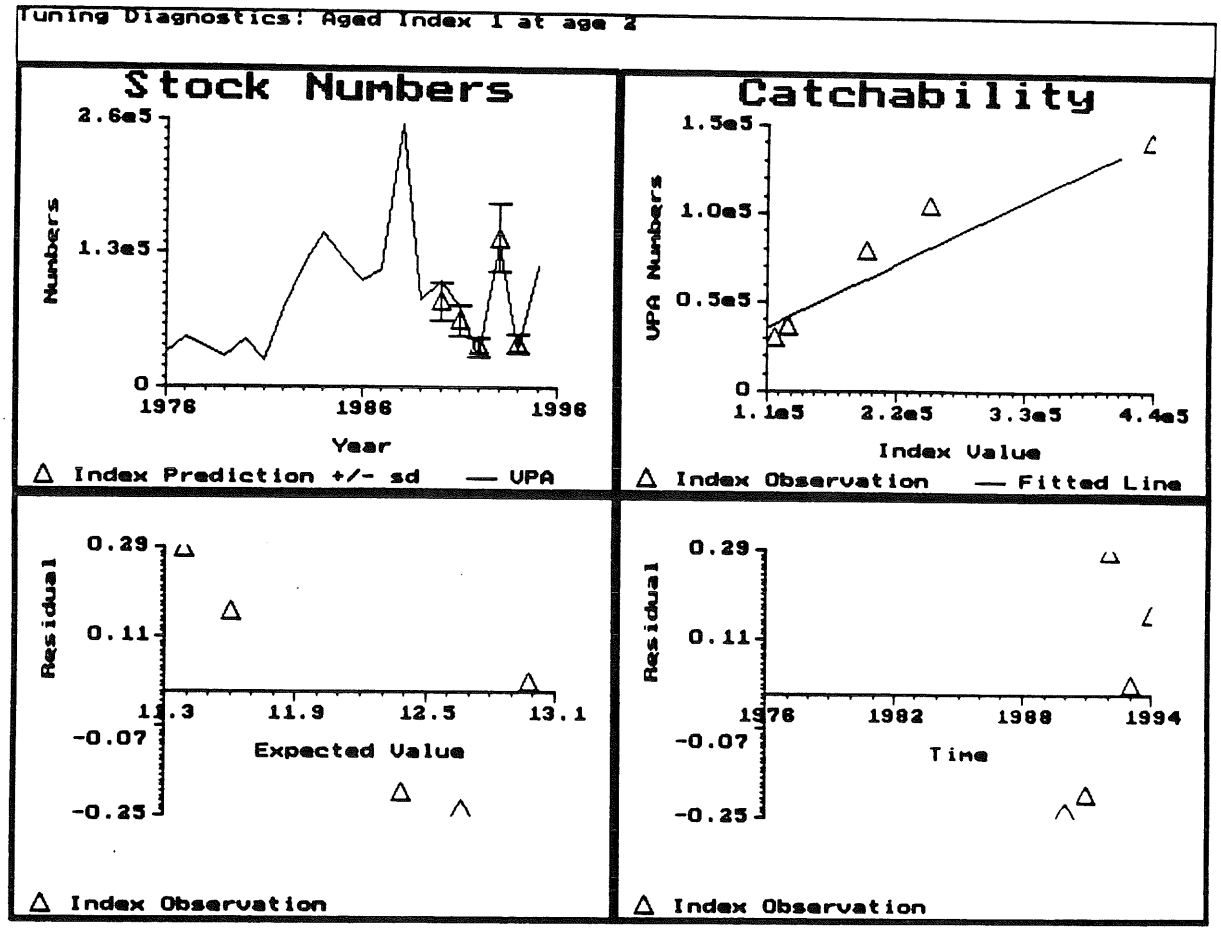

Tuning Diagnostics: Aged Index 1 at age 2
Stock Numbers
2.6e5
1.3e5
0
Numbers
1978
1988
1998
Year
Index Prediction +/- sd
VPA
Catchability
1.5e5
1.0e5
0.5e5
0
VPA Numbers
1.1e5
2.2e5
3.3e5
4.4e5
Index Value
Index Observation
Fitted Line
0.29
0.11
-0.07
-0.25
Residual
11.3
11.9
12.5
13.1
Expected Value
Index Observation
1976
1982
1988
1994
Time
Index Observation

Figure 4.4.3

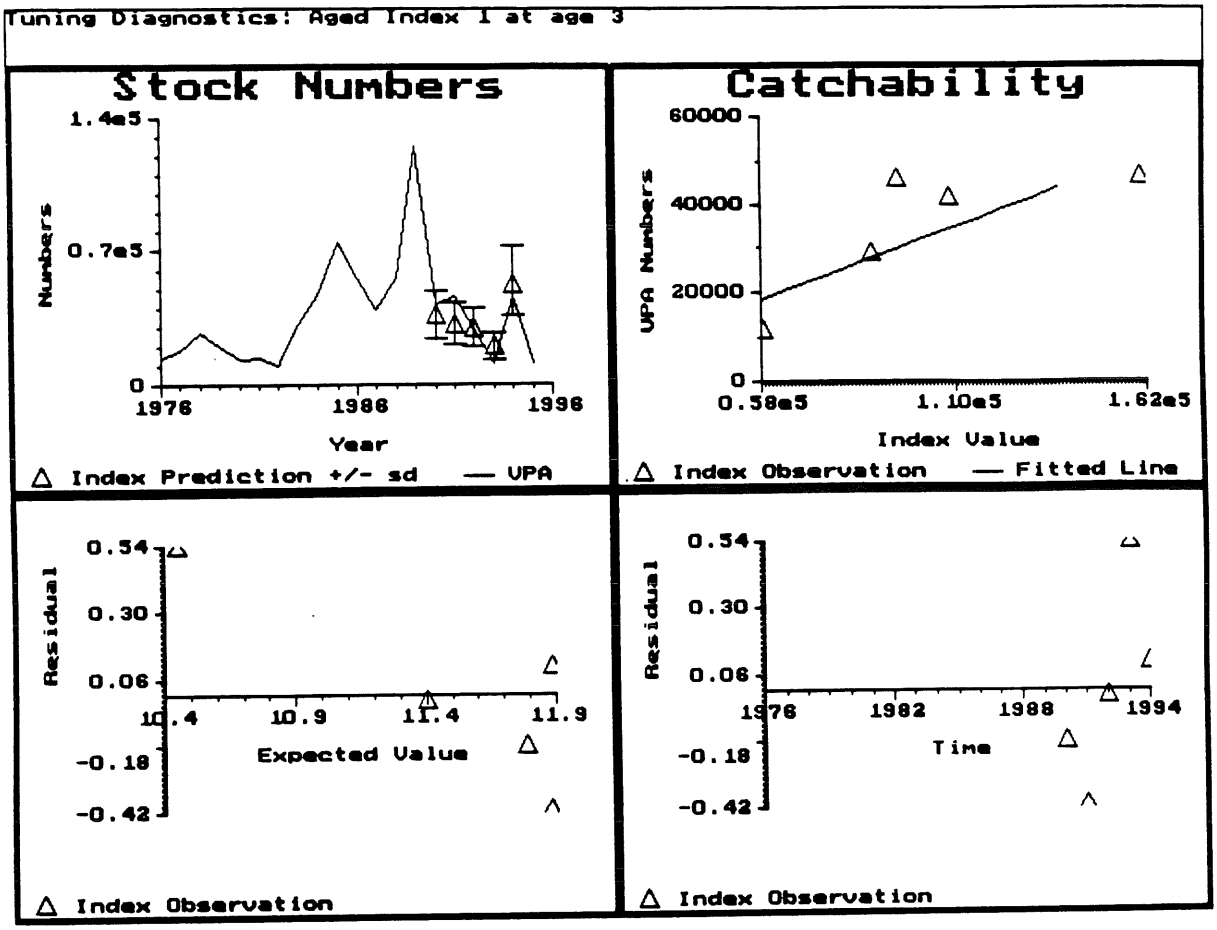
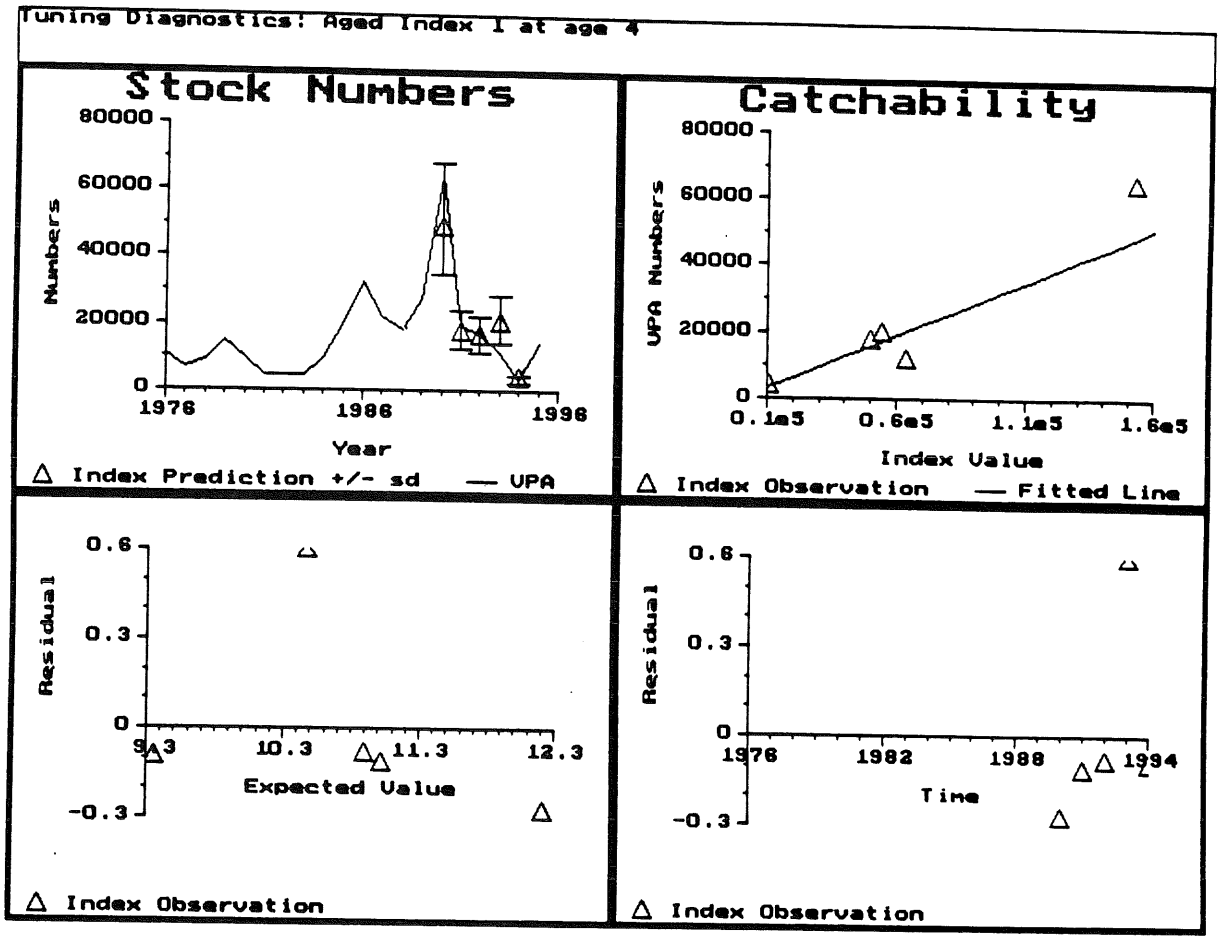


Figure 4.4.3 (continued)



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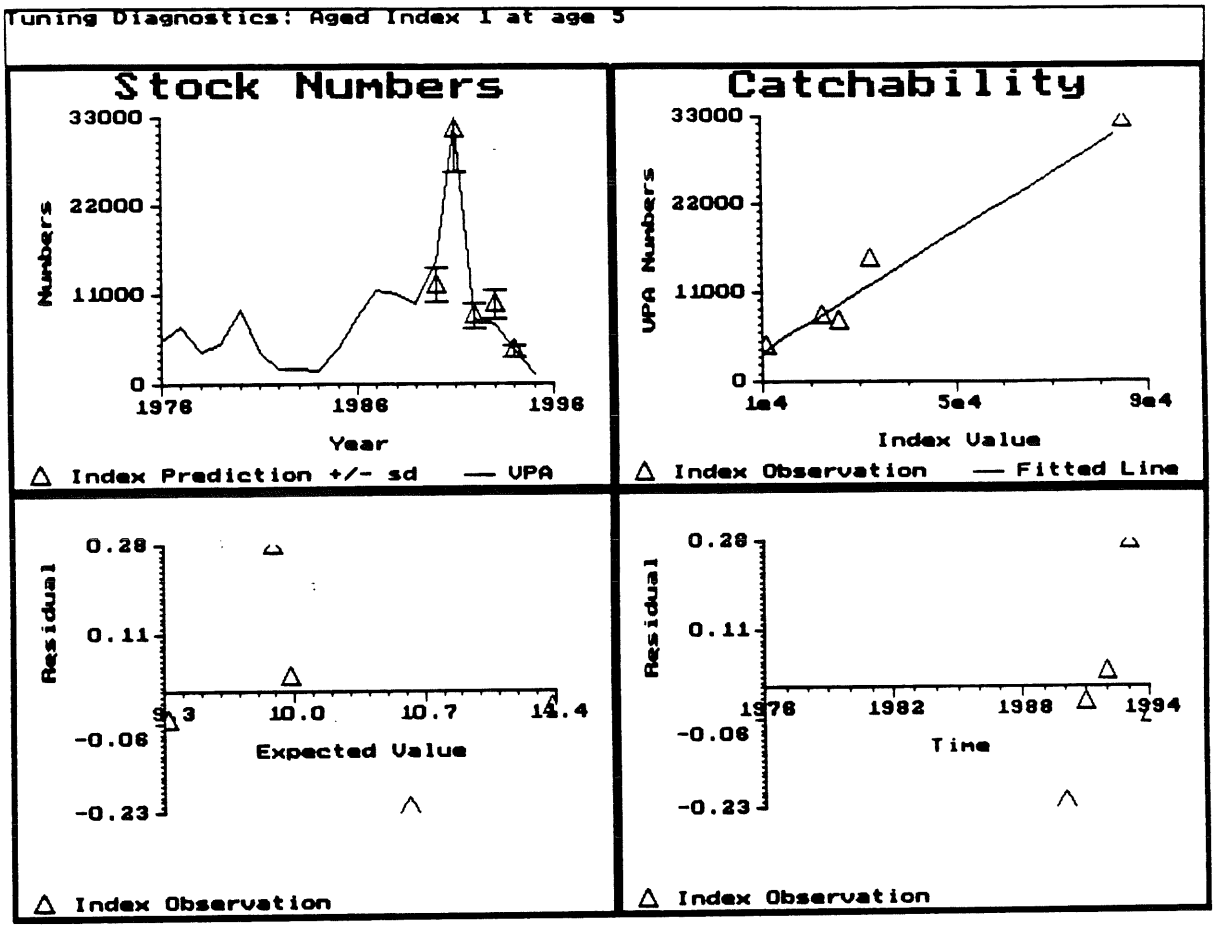


Figure 4.4.3 (continued)

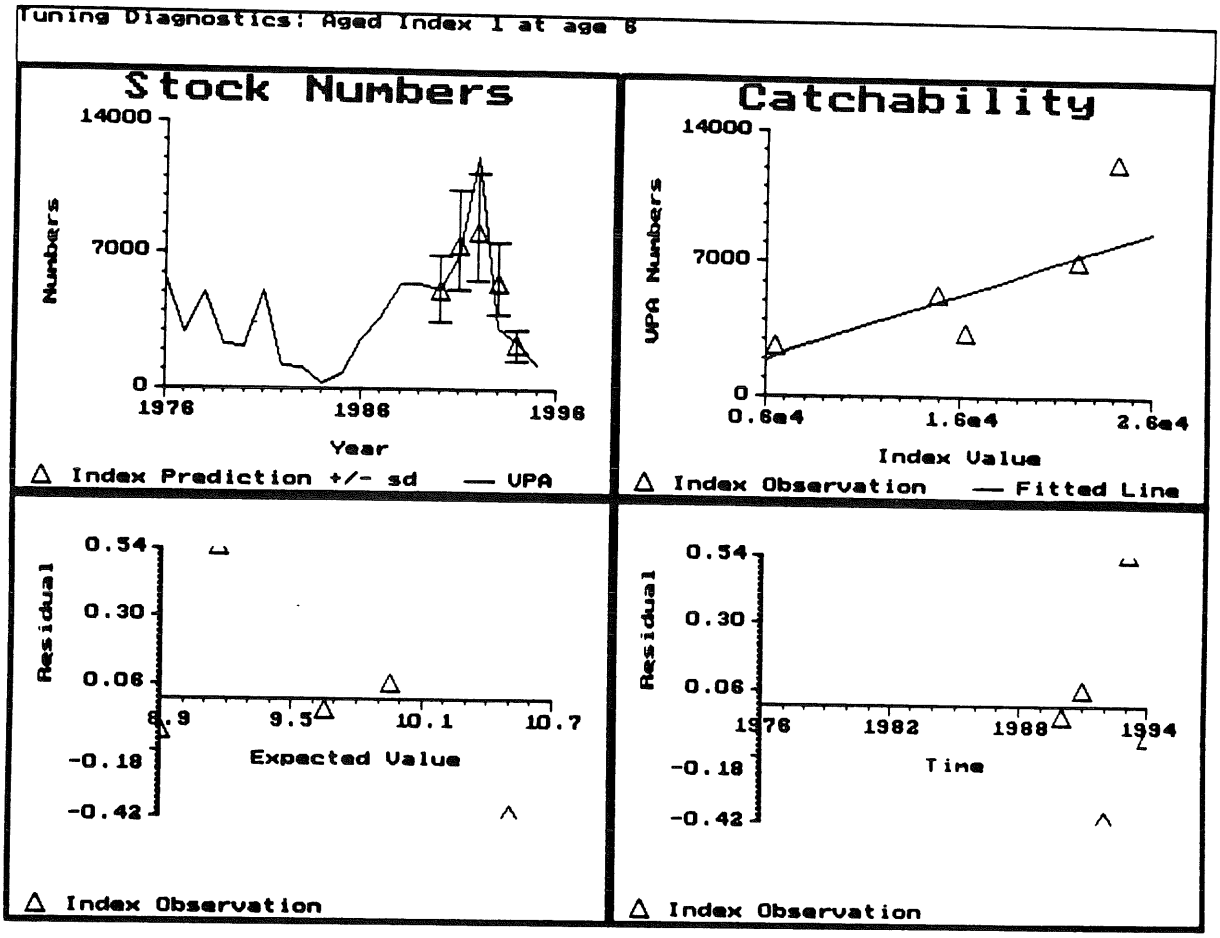


Figure 4.4.3 (continued)

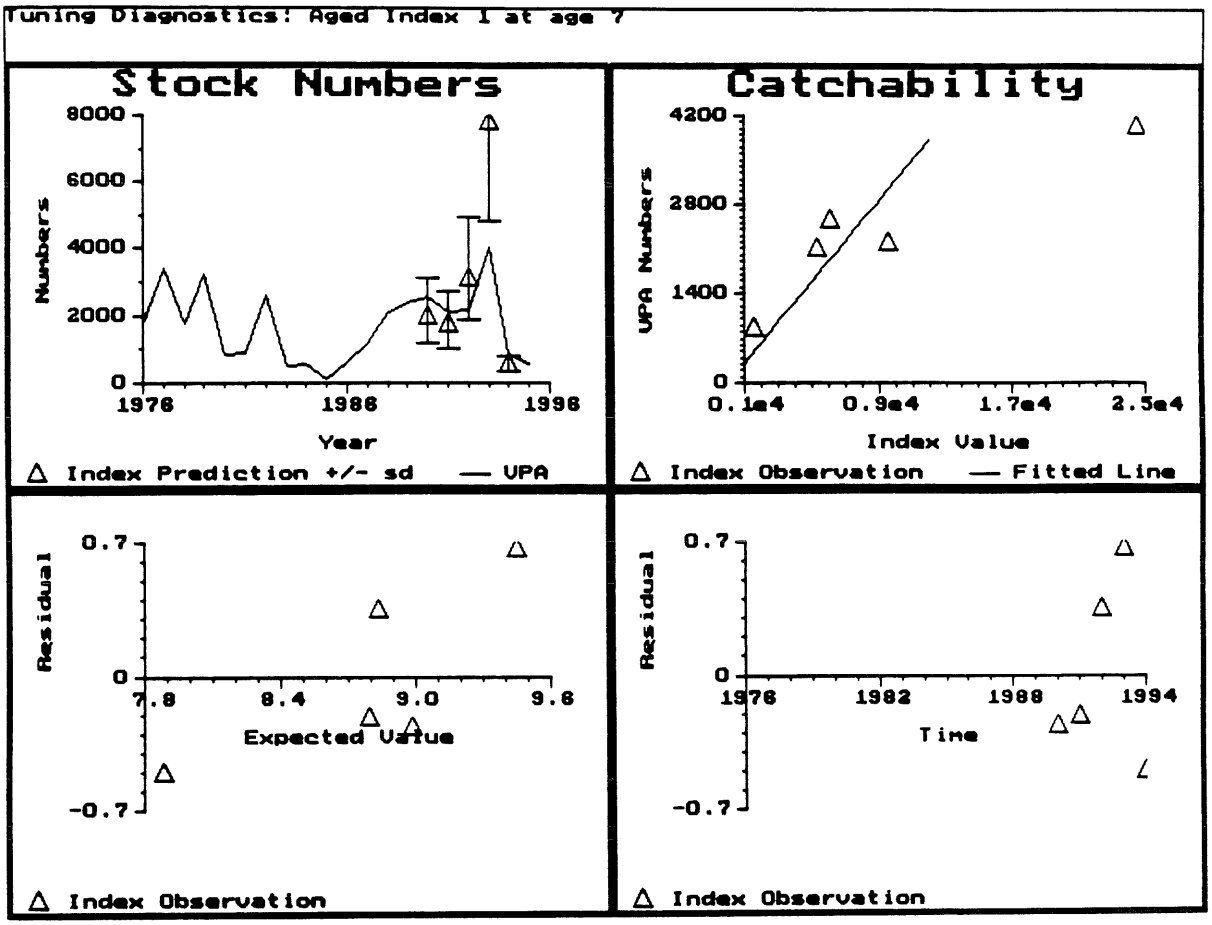


Figure 4.4.3 (continued)

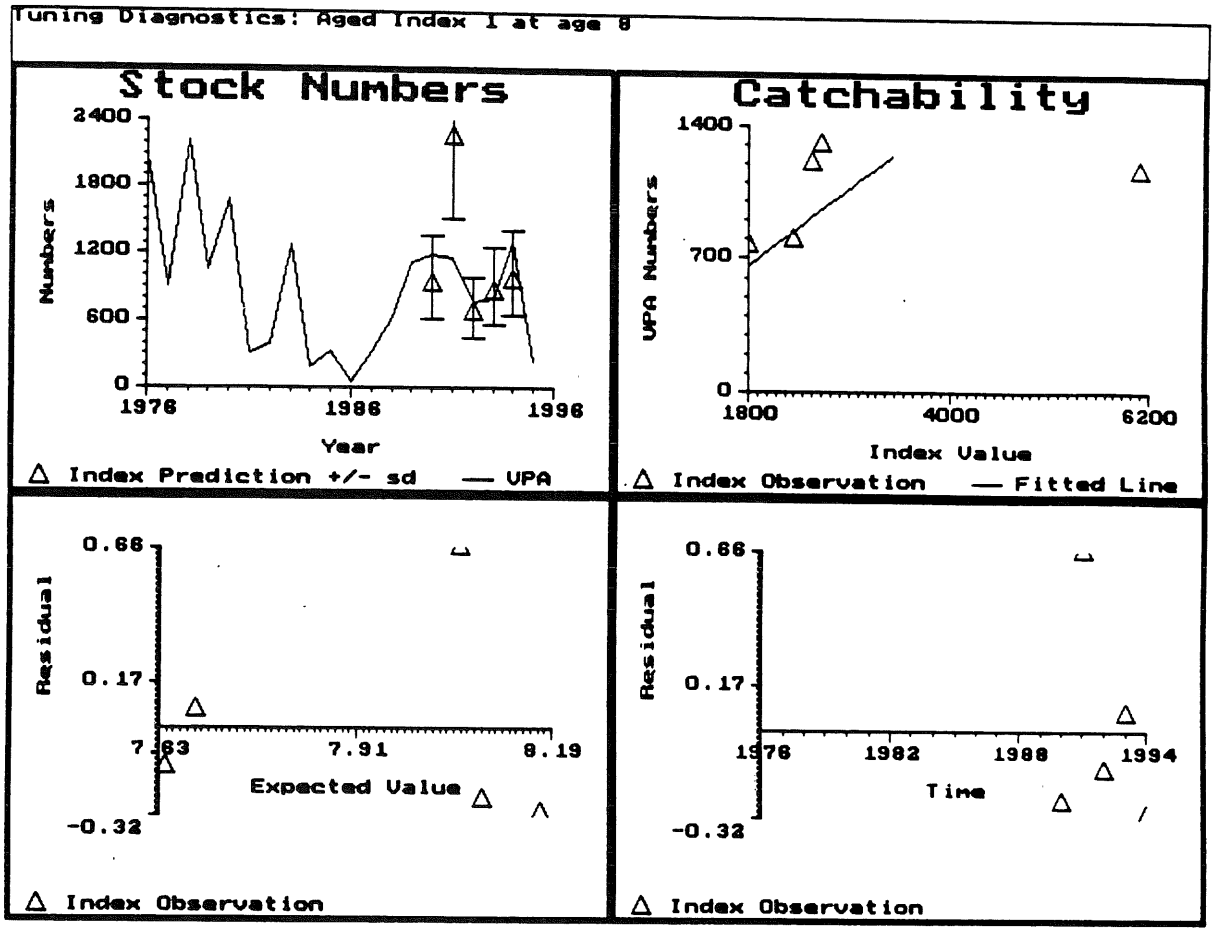


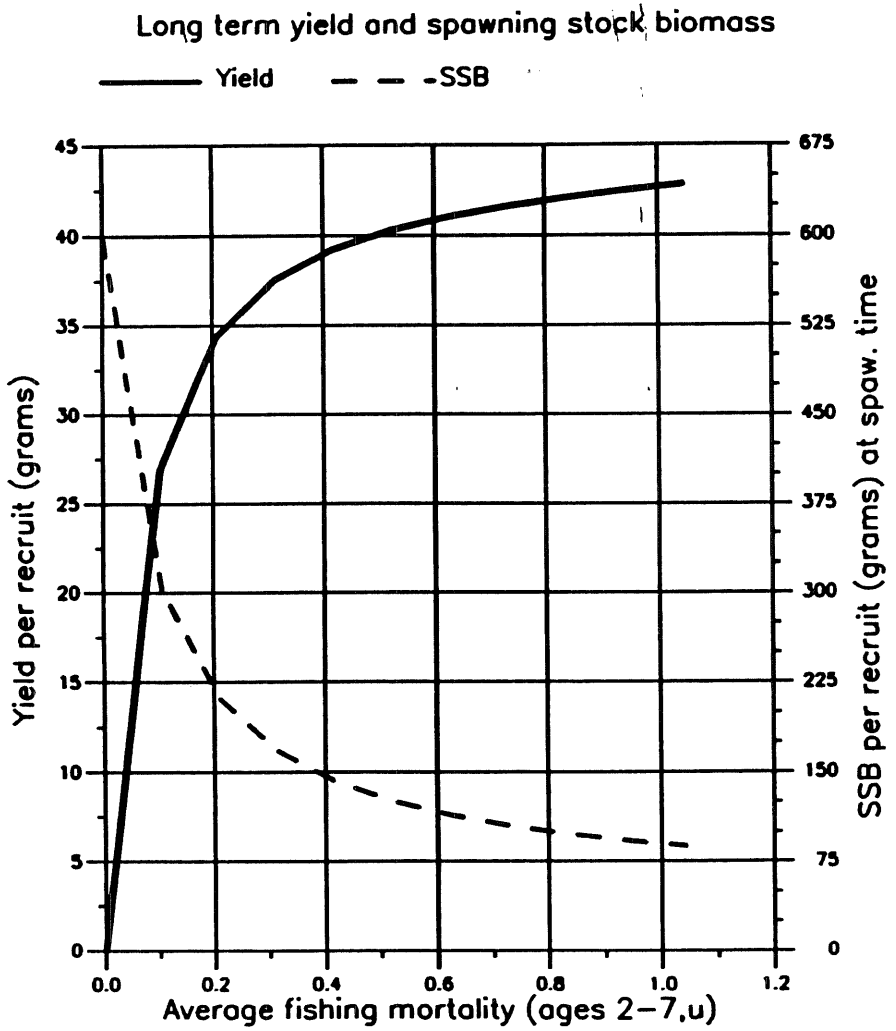
Figure 4.4.3 (continued)

Figure 4.6.1

FISH STOCK SUMMARY

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

3–4–1995



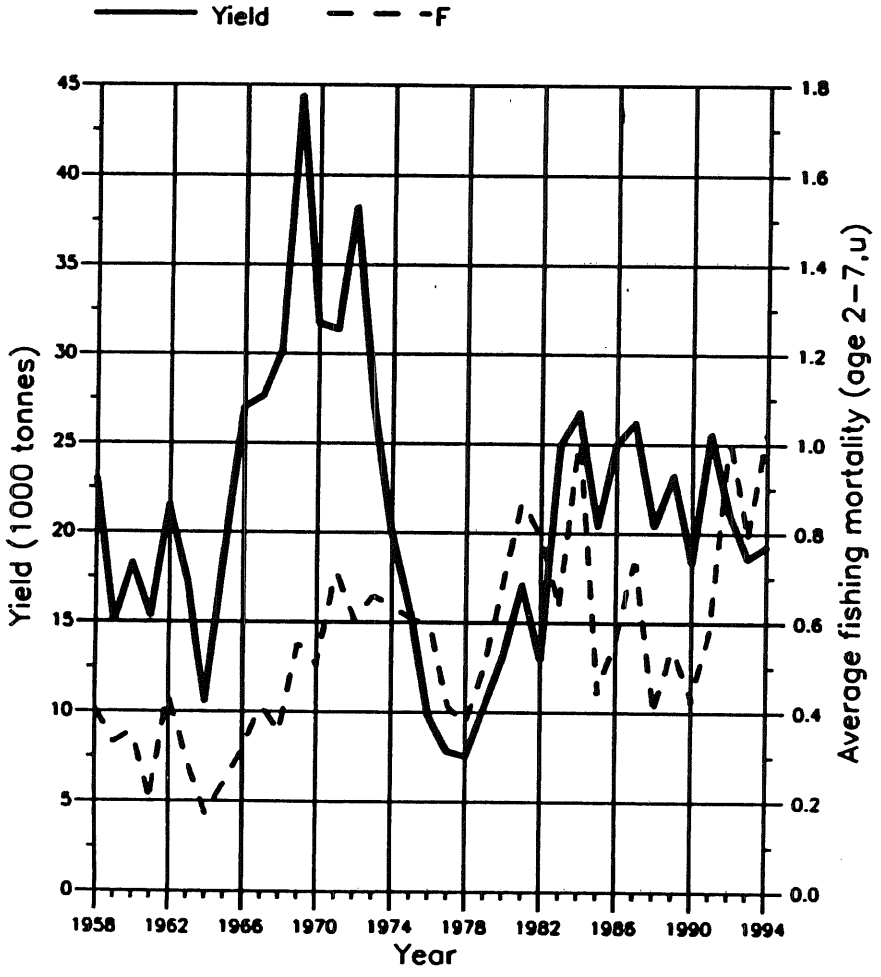
(run: CELTFIN)

C

Figure 4.6.2

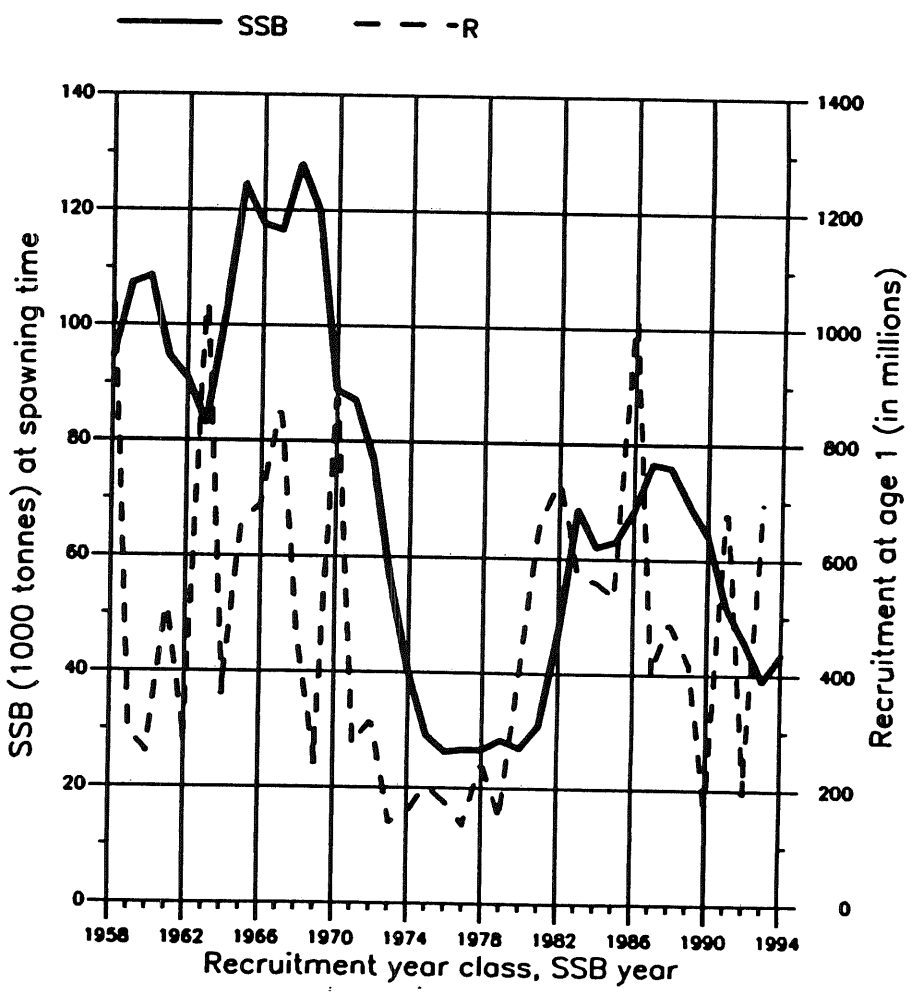
FISH STOCK SUMMARY
STOCK: Herring South and South West of Ireland (Celtic Sea + VIIj)
3–4–1995

Trends in yield and fishing mortality (F)



(run: CELTFIN) **A**

Trends in spawning stock biomass (SSB) and recruitment (R)



(run: CELTFIN) **B**

5 WEST OF SCOTLAND HERRING

5.1 Division VIa (North)

5.1.1 ACFM Advice applicable to 1994 and 1995

In 1994 ACFM regarded this stock to be within safe biological limits. For this stock no MBAL level has been defined. The projected catch for 1994 corresponding to fishing at 1993 levels of fishing mortality was 60 000t. The agreed TAC for 1995 is 77 000t.

5.1.2 The fishery

Estimated catches by participating nations are given in Table 5.1.1. The total catch for 1994 was estimated at 54 708 t including discards and unallocated catches, compared with the agreed TAC of 62 400t. This is the sixth year in succession in which the TAC was not reached. Estimates of discards were available for one fleet and estimates of unallocated catches were available for three fleets. Negative unallocated landings arise because of misreporting of catches taken in adjacent areas.

Fishing in late winter was on large fish on the edge of the continental shelf and on smaller, winter-spent fish closer inshore. In summer the fleets tended to target North Sea herring in preference to the West Coast stock, then moving onto the western herring thereafter. However this pattern of fishing was not entirely successful due to low catches at the start of the North Sea season and later spawning of the West Coast herring. Fleets may reverse their pattern of activity in 1995, exploiting the West Coast herring first and then moving on to the North Sea stock later.

The Faroese fishery in Sub-area V caught approximately 1,500 t of herring in 1993. No Faroese catches were reported to the Working Group for 1994. Although Faroese catches may be taken from Division VIa(N) herring stock, it was shown in the 1992 assessment that the impact of including these catches is small. The analysis will not again be repeated with the inclusion of these catches.

5.1.3 Catch in numbers at age

Age composition data for 1994 were available from Scotland (first, third and fourth quarters), the Netherlands (second and third quarters) and Norway (in the second quarter). As the UK fleets have a more inshore distribution of effort, Scottish sampling data was used to allocate unsampled catches by England and Wales by ages. Unsampled Scottish catches in the second quarter of the year were allocated by interpolation between the first and the third quarter.

Unsampled catches in the first and second quarters by all fleets other than Scotland and England and Wales were allocated to ages using an age distribution calculated by taking a mean (weighted by the number of samples taken) of the Netherlands and Norwegian age distributions for the first and second quarters. Unsampled catches in the third and fourth quarters were assumed to have the age distribution recorded in the Netherlands samples in the third quarter.

The sampling effort used to derive the catch in numbers is summarised in Table 5.1.2., and the estimated catches in numbers at age are given in Table 5.1.3, including historical data back to 1970. Sampling was unevenly distributed over the quarters, and sampling was well below the recommended level

5.1.4 Larvae surveys

Larvae surveys for this stock have been discontinued and no new information is available since 1994. As the larval survey indices of abundance are again used in the assessment the available information has been reproduced in Table 5.1.4. for convenience. Details of the survey are given in the 1994 report of the Working Group (Anon. 1994a).

5.1.5 Acoustic survey

Historical acoustic survey information as available and as documented in Anon. (1994a) have been used. The time series has been updated to include information from the most recent survey (Table 5.1.5).

An acoustic survey of Division VIa (N) was completed from 9 July to 29 July 1994 using a chartered purse-seine fishing vessel. Previous surveys of this area had detected regions of markedly higher abundances of herring, and in order to improve survey precision a stratified survey design was introduced. Areas expected to have high densities of herring were surveyed with a track spacing of 7.5 nautical miles (n.m.), compared with a spacing of 15 n.m. for the other areas. A systematic track design with random starting point was used. Forty-one successful trawl hauls were shot on the echotraces, of which 22 captured

sufficient herring to provide adequate samples. 3 and 7-ringers predominated in the samples: the age-structure of the stock is consistent with that observed in the 1992 and 1993 surveys.

Echo-traces were allocated among the following categories, where the percentage in brackets indicates the contribution of each category to the stock size estimate.

(1) Herring (57.3%)
(2) Likely to be herring (31.2%)
(3) Unlikely to be herring (0 %)
(4) Herring mixed with large (ca. 16cm) Norway Pout (3.4%)
(5) Herring mixed with small (ca. 6cm) Norway Pout (7.9%)
(6) Herring mixed with sprat or mackerel (0.2 %)

The two sizes of Norway Pout were rarely mixed in trawl catches. Had all the fish traces seen been scored as herring, this would have resulted in a total stock size estimate of 953 000t. This figure may be considered an upper bound on the likely size of the stock. The spawning biomass of the stock was estimated to be 600 430 t, compared with 893 600t in 1993. However, it is thought that the 1993 survey returned an exceptionally high stock estimate, possibly on account of a strongly contagious distribution.

In fitting the age-structured model to the survey data it was again assumed that 40% of annual mortality had been incurred before the surveys. This figure was calculated by assuming that natural mortality is constant throughout the year, and that fishing mortality can be apportioned in the ratio of seasonal catches in 1993.

5.1.6 Recruitment

The acoustic index is still not usable as an index of recruitment because the time series is too short. The few data available seem to coincide well with the fitted populations, however, suggesting that it may be feasible to use this measure of cohort strength in future years.

No index of recuitment from the Scottish groundfish surveys is presently available for 1995. 1994 survey data have now been calculated and are presented together with earlier data in Table 5.1.6. The index is an arithmetic unweighted mean of the catch rate per hours' trawling in statistical rectangles 47E4-E6, 46E4-E6 and 44E3-E4.

5.1.7 Mean weight at age, maturity ogive and natural mortality

Weight at age data from the 1994 fishery were available from Scotland, Norway and the Netherlands (Table 5.1.7). In previous assessments a historical mean weight at age in the stock has been used. Beginning in 1992 however, reasonably good estimates of these quantities are available from the acoustic surveys. It was decided, to begin using these estimates rather than historical means. For prediction purposes mean weights at age in the last three years of the catches and of the acoustic surveys have been calculated. These are given in the last columns of Table 5.1.7. Assumed values of maturity and natural mortality are also included. The same maturity ogive as used in previous assessments has been continued for consistency. For future assessments it is suggested that the maturity ogives as estimated from data from acoustic surveys should be used.

5.1.8 Description of the assessment method

The assessment method is an integrated catch-at-age analysis as described in the Appendix to Anon. (1994a).

In order to provide consistency with previous assessments, a separable model was fitted over the last six years of the assessment with terminal selection set = 1.2 relative to reference age 3-rings.

As in the previous year's assessment, a variety of model formulations were tested in order to assess the importance of the form of the assumed prior relationship of the indices of abundance to the resulting stock size estimate. For simplicity the acoustic and larval survey components were tested separately. The following model choices were tested:

Larval Survey
- 10% Trimmed mean, linear relationship assumed
- 10% Trimmmed mean, power relationship assumed
- Larval abundance index, linear relationship assumed
- Larval abundance index, power relationship assumed
- Larval production estimate, linear relationship assumed
- Larval production estimate, power relationship assumed

Acoustic Survey

Age-disaggregated index, absolute relationship assumed

Age-disaggregated index, linear relationship assumed.

Eight model fits were completed to assess the predicted fishing mortality from each model component. Estimates of fishing mortality at reference age from each model fit are given in Figure 5.1.1. It was again found infeasible to fit the LPE or 10% trimmed mean of the larval indices as power indices of abundance as the sums of squares surface did not have minima in the range of fishing mortality at reference age from 0.05 to 1.0. Results of the six remaining model fits are given in Figure 5.1.1, which show that in all cases fishing mortality estimates were below 0.2. It is again very difficult to estimate such low fishing mortalities.

A model was fitted with a formulation exactly corresponding to that used in the previous year's assessment of this stock:

$$\sum_{a,y}(\log(C_{a,y}) - \log(C_{a',y}))^2 +$$
$$\sum_{y}(\log(K_{LAI}\,SSB_y^{Q_{LAI}}) - \log(LAI_y))^2 +$$
$$\lambda_a \sum_{a,y}(\log(Q_{ACU,a}\,N^*_{a,y}) - \log(ACOUST_{a,y}))^2 +$$
$$0.01\sum_{y}(\log(N_{1,y+2}) - \log(\frac{a\,SSB_y}{b+SSB_y}))^2$$

where a and y suffices indicate year and age, Q_{LAI}, K_{LAI} and $Q_{ACU,a}$ are the coefficients relating the indices and the acoustic abundance estimates to the stock size; lambda is a weighting value set at 0.1 for age 1 and at 1 for all other ages; $N^*_{a,y}$ are population sizes calculated for the time of the acoustic survey; LAI_y are the values of the larval abundance index in each year; $ACOUST_{a,y}$ are the values of the acoustic survey for each year and age. Lastly a and b are the parameters of the Beverton and Holt stock-recruit relationship.

Consideration was given to including the 2-ringer index of recruitment in the model. The recruitment index was compared with the fitted populations and an apparently good correspondence obtained (Correlation coefficient = 0.69 %). It was concluded that there existed sufficient indication of a relationship between the recruitment index and the fitted populations to warrant the inclusion of this index in the model. As an approximately linear relationship was relation was assumed. The objective function was therefore expanded to include the 2-ringer index:

$$\sum_{a,y}(\log(C_{a,y}) - \log(C_{a',y}))^2 +$$
$$\sum_{y}(\log(K_{LAI}\,SSB_y^{Q_{LAI}}) - \log(LAI_y))^2 +$$
$$\lambda_a \sum_{a,y}(\log(Q_{ACU,a}\,N^*_{a,y}) - \log(ACOUST_{a,y}))^2 +$$
$$0.01\sum_{y}(\log(N_{1,y+2}) - \log(\frac{a\,SSB_y}{b+SSB_y}))^2$$

where K_{rec} and Q_{rec} are parameters of the catchability relationship for the 2-ringer recruitment index, and REC_y are observations of the index in each year. The relationship between the 2-ringer index and the fitted populations was found to be strongly nonlinear with $Q \approx 4.0$. The index was found to be a very poor predictor of population sizes, and its inclusion in the model was rejected on this account.

5.1.9 Baseline Assessment

Using the criteria defined in the foregoing section a baseline assessment has been calculated. No reweighting procedure was used on account of the possibility of overfitting the model. Instead, all observations were given equal weight in the assessment, with the exception that the acoustic estimate of 1-ringers was downweighted to 10% on account of a perception that the survey is a poor indicator of this year-class. Values so estimated are given in Table 5.1.8 and in Figures 5.1.2.- 5.1.15. Salient points of the assessment are:

1. Fishing mortality in 1994 was low, and in the range 0.098 to 0.26 (Parameter 95% C.I.s).
2. The catches at age are reasonably consistent with the separable model, except for the 1-ringers.
3. 1-ringers are highly variable in the acoustic index.
4. 3-ringers are unusually abundant.
5. Assumptions of lognormality in the index observations are not demonstrably violated.
6. The estimate of fishing mortality in 1993 has changed from 0.144 in the 1994 assessment to 0.183 in the present assessment (95% C.I. 0.12 to 0.28). However, the assessments are consistent as last year's estimate falls within the confidence interval calculated in the present assessment.

7. Fishing mortality in 1994 is estimated to have fallen to 0.16 from 0.18 in 1993. The change may not be significant (the confidence intervals for F in 1993 and 1994 overlap widely) and does not necessarily indicate a fall in true fishing mortality.

5.1.10 Short-term projections

For reasons described in section 5.1.15.3, the Working Group considered that a calculation of projected catches from the baseline stock assessment is not meaningful and should not be presented.

5.1.11 Risk Analysis and Medium-Term Projections

Given the large uncertainty in the assessment which is introduced by the apparently high levels of misreporting of catches, the Working Group considered that it would be misleading to present such calculations as part of an assessment. A calculation of risk in the medium term based on the baseline assessment for this stock is presented in Section 1.7.4, solely for the purpose of demonstrating the application of a method.

5.1.12 Appropriateness of controls on catch and fishing effort

Given the well-known lack of a dependable relationship between fishing mortality and fishing effort in pelagic fisheries, it is not considered appropriate to attempt management of this fishery through regulation of fishing effort. Catch controls are thought to be more appropriate, but in the case of this stock there are serious doubts about their effectiveness (see Section 5.1.15.3).

5.1.13 Potential for multispecies or multiannual catch options

Herring in Division VIa(N) is caught in a single-species directed fishery with little by-catch. No information is available about interactions with other species in the area. Consequently there is not at present thought to be substantive potential for considering multispecies catch options that include this stock.

A trial calculation comparing the effectiveness of constant catches *versus* constant F over a three-year period is given in Section 1.7.4.6. This calculation is based on the assessment which is considered unreliable and the relationship between future catches and future stock size should not be used for management purposes. However, the general conclusion from this calculation is that if fishing mortality remains low, then a constant catch strategy is almost as good at protecting the spawning biomass as is a constant F strategy. Conversely, if fishing mortality is high (ca. 0.6) then a constant F strategy is markedly better at keeping the stock size at a higher level, for similar amounts of catches over the three-year period. This conclusion is likely to be generally applicable.

Management comment on this comparison of options is invited.

5.1.14 Long-term Yield

A conventional yield-per-recruit analysis was repeated with the updated population estimates (Figure 5.1.16). $F_{0.1}$ was estimated at 0.139 compared with 0.136 in the previous assessment. F_{max} was undefined.

5.1.15 Uncertainties in the Assessment.

5.1.15.1 Uncertainty in Model Formulation

Figure 5.1.2. shows that the estimated fishing mortality is somewhat different depending on the tuning index used and on the way in which it is treated in the model. There is no *a priori* objective criterion for making such a model choice; hence uncertainty is introduced due to lack of prior knowledge as to which model formulation is correct. On this basis, estimates of current year fishing mortalities could lie in the range 0.083 to 0.163 depending on the tuning index used, the way in which it is calculated, and the relationship it is assumed to hold to stock abundance. The highest upper 95% confidence interval of terminal-year fishing mortality was below 0.4. The range of estimates is generally consistent and below the assumed natural mortality.

5.1.15.2 Parametric Uncertainty

As an indicator of uncertainty in the baseline assessment, simple separable VPAs were initiated with terminal Fs corresponding to the estimated F +/- 1.96 * estimated parameter standard deviation, in order to approximate 95% confidence bands. The estimated time series of biomass together with the upper and lower confidence bands are given in Figure 5.1.17.

5.1.15.3 Misreporting and Discarding

Reports of catches by ICES statistical rectangle were available for three fleets. Of these, in two

cases the catches were largely concentrated in an area at the eastern maritime edge of Division VIa, in statistical rectanges 46E5 to 50E5 (here termed the E5 rectangles). Although there are substantial reports of catches around the Shetland Islands, there are very few catch reports from the rectangles along the eastern edge of the boundary between Divisions VIa and IVa. The catches from these two fleets in the E5 rectangles accounted for 65% of the total international catch (including unallocated catches). For the two fleets individually 82% and 99% of the national catches were taken from the E5 rectangles. In contrast, from the acoustic survey reports, only 2.9% of the estimated spawning biomass of herring in Division VIa(N) was distributed in the E5 rectangles (Simmonds pers.comm. 1995).

The discrepancy cannot easily be explained in terms of the seasonality of the fishery. The acoustic survey was completed between 9 and 29 July. For the first fleet mentioned, 21% of the catch was taken in July and a further 38% in August. In the case of the other fleet, 33 % was taken in July and 30% in August. Most of the remaining catches were taken in September. It seems most unlikely that a rapid migration of fish could have occurred from the areas of distribution reported from the acoustic survey as being West and South of the Hebrides, into the E5 rectangles but not moving into Division IVa. Instead, the Working Group considered that this distribution of catches is most probably an indication of substantial misreporting.

The Working Group considered that it would be feasible to reallocate catches on the basis of this perception of misreporting for 1994. However, it appears likely that the problem is not a new one and has existed to a variable extent in recent years. Reallocating catches only in 1994 would therefore be an inconsistent treatment of the data. Instead, the **Working Group recommends that an objective criterion for the reallocation of misreported catches and associated samples over at least the last five years be defined and implemented by next year's Working Group meeting.**

As an interim measure to explore the scale of the problem a population model was fitted in which the catches by the two fleets mentioned above in the E5 rectangles over the previous ten years were removed from the analysis. Catches reported by the two fleets in the E5 rectangles were assumed to be misreported, and the proportion of misreported catches relative to the total catch (as used by the Working Group in previous years) was calculated (Table 5.1.9.). The international catch in number matrix was decremented by the proportion of the misreported catches. Results of a stock assessment calculation based on this adjusted catch-at-age matrix are presented in Figure 5.1.18 for comparison with the baseline assessment, with all model parameters specified as in section 5.1.8. This 'adjusted' assessment shows an approximately two-thirds reduction in spawning stock size and a fishing mortality that is only slightly lower. The overall trends in the populations are generally similar. There was no significant difference in the goodness of fit of the two assessments (variance = 0.1415 for the baseline assessment and 0.1216 for the adjusted assessment, F = 1.163 for 75, 75 d.f.; P(F)= 26%).

A calculation of $F_{status\ quo}$ TAC for 1995 [defining $F_{status\ quo}$ as the mean F from 1992-1994], based on the adjusted assessment is 35 630 t compared with the estimate of 51 460 t based on the baseline assessment. This comparative assessment indicates that allowing for estimated misreporting has a substantial effect on the calculation of the stock size and of the $F_{status\ quo}$ TAC for 1995. However, the estimate of fishing mortality is slightly lower. The general perception of the stock as being lightly exploited, with decreasing fishing mortality and a spawning stock size close to the highest recorded level is little changed.

5.1.15.4 Changes in Selection

The analytic method used here assumes, as has that used in recent years, that selection pattern was constant over the six most recent years of the fishery. It is difficult to discriminate changes in selection from a time-trend in recruitment. For example, increased catches of smaller fish can be due either to an increase in recruitment or to an increase in selection on younger ages; the model cannot discriminate between the two without external information. In an attempt to investigate any such possible changes, a model fit was repeated with very high weights (10.0) forced on the tuning indices, so that the selection pattern of the commercial fleets could be examined for consistency against the populations tuned on the survey data alone. This affords a simple test of the validity of the separable assumption. Figure 5.1.19 shows some indication of increasing selection on ages 1 and 2 in 1994. The mortality exerted on these year classes may therefore have been underestimated.

5.1.15.5 Uncertainty for Management

This assessment is predicated on the assumption that the reported catches are taken from the same

population of fish as are being measured by the acoustic and larval surveys. If this is not so, as points mentioned in Section 5.1.13.3 appear to suggest, then the assessment is invalid. It is not known to what extent information on catches used in the assessment correspond to the actual removals from the assessed stock, either in quantity or in age-structure. The calculation of a comparative assessment with an adjustment for misreporting appears to confirm the finding that fishing mortality is low, but the stock size estimate is much more sensitive to assumptions made about misreporting. Possible misreporting is clearly identified as the most important cause of uncertainty in the estimate of stock size.

5.1.15.6. Consistency of Assessments

It is not possible to calculate an informative retrospective analysis for this stock, as the assessments are heavily dependent on a short time series of acoustic survey data. Thus, deleting recent data leaves a data set which is too small for a comparable analysis to be calculated. Recent assessments have been calculated using a variety of assumptions about survey indices, but in general the assessments have been relatively stable considering the low fishing mortality in this stock and also the uncertainty introduced by having few and variable survey indices. A summary of estimates of fishing mortality made in recent assessments is given as Figure 5.1.20. Recent estimates of F have fluctuated in a narrow band around F =0.2.

Table 5.1.1. HERRING in Division VIa (North). Catch in tonnes by country 1982-1994. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1982	1983	1984	1985	1986	1987
Denmark	-	-	96	-	-	-
Faroes	74	834	954	104	400	-
France	2 069	1 313	-	20	18	136
FDR	8 453	6 283	5 564	5 937	2 188	1 711
Ireland	-	-	-	-	6 000	6 800
Netherlands	11 317	20 200	7 729	5 500	5 160[2]	5 212[1]
Norway	10 018	7 336	6 669	4 690	4 799	4 300
UK England	90	-	-	-	-	-
UK Scotland	38 381	31 616	37 554	28 065	25 294	26 810
Unallocated	18 958	-4 059	16 588	502	37 840[1]	18 038[1]
Discards	-	-	-	-	-	-
Total	92 360	63 523	75 154	43 814	81 699	63 007

Country	1988	1989	1990	1991	1992	1993
Denmark	-	-	-	-	-	-
Faroes	-	-	326	482	-	-
France	44	1342	1287	1168	119	818
FDR	1 860	4 290	7 096	6 450	5 640	4 693
Ireland	6 740	8 000	10 000	8 000	7 985	8 236
Netherlands	6 131	5 680	7 693	7 979	8 000	6 132
Norway	456	-	1 607	3 318	2 389	7 447
UK Eng. & Wales	1 892	1 977	2 376	2 998	3 327	2 965
UK Scotland	25 002	27 897	35 877	29 630	29 403	29 637
Unallocated	5 229[1]	2 123[1]	2 397	-10 597	-5 485	-3 753
Discards	-	1 550	1 300	1 180	200	820
Total	47 354	53 039	69 959	50 606	51 585	56 175

Country	1994
Denmark	0
Faroes	0
France	1 362
FDR	5 087
Ireland	7 938
Netherlands	6 093
Norway	8 183
UK Eng. & Wales	3 511
UK Scotland	27 165
Unallocated	-4 675
Discards	700
Total	54 708

[1]Including discards.
Discards are included in national catches.

Table 5.1.2 HERRING in Division VIa (North), 1994. Sampling intensity of commercial catches.

Country	Catch in tonnes	No. of samples	No. of age readings	No. of fish measured	Estimate of discards
France	274	0	0	0	NONE
FDR	5087	0	0	0	NONE
Netherlands	6093	18	450	1976	700
Norway	8183	2	200	200	NONE
UK (Eng. and Wales	3555	0	0	0	NONE
UK (Scotland)	25399	15	1310	2203	NONE

Table 5.1.3. Estimated catches at age of herring in Area VIa(N).

Rings	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	238738	169947	801663	51170	309016	172879	69053	34836	22525	392
2	205454	372615	804097	235627	124944	202087	319604	47739	46284	225
3	359711	560348	219502	808267	151025	89066	101548	95834	20587	122
4	139718	357745	63069	131484	519178	63701	35502	22117	40692	31
5	53320	113391	85920	63071	82466	188202	25195	10083	6879	21
6	203462	54571	37341	54642	49683	30601	76289	12211	3833	12
7	29141	181592	13377	18242	34629	12297	10918	20992	2100	7
8	32860	18042	100938	6506	22470	13121	3914	2758	6278	2
9+	30651	36395	20465	32223	21042	13698	12014	1486	1544	0

Rings	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	12867	36740	13304	81923	2961	45663	38943	27645	2273	9690
2	1335	77961	250010	77810	253291	77063	178714	93679	158832	57305
3	452	105600	72179	92743	66857	166112	99264	64575	55529	170687
4	246	61341	93544	29262	46963	19269	137077	45488	37815	29497
5	62	21473	58452	42535	20057	17027	21723	71188	26292	28228
6	43	12623	23580	27318	15250	7422	20759	11973	37993	11830
7	40	11583	11516	14709	12478	7731	2973	10378	4327	23400
8	3	1309	13814	8437	5940	3720	16177	4982	2956	2529
9+	1	1326	4027	8484	2629	2450	2273	8498	3140	5463

Rings	1990	1991	1992	1993	1994
1	22374	46826	9346	41169	3863
2	75241	40824	43538	147513	81712
3	63832	44755	44344	30400	89846
4	116270	50048	42228	18642	13428
5	41512	66554	38818	24045	16616
6	20826	24007	60262	27464	18109
7	15463	13449	11301	36129	23505
8	33585	12226	7681	8839	27178
9+	8644	7904	9805	13825	22814

Table 5.1.4. 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 5.1.5. HERRING in Division VIa (North). Estimates of abundance from Scottish acoustic surveys. Thousands of fish at age.

Age	1987	1991	1992	1993	1994
1	249 100	338 312	74 310	2 760	494 150
2	578 400	294 484	503 430	750 270	542 080
3	551 100	327 902	210 980	681 170	607 720
4	353 100	367 830	258 090	653 050	285 610
5	752 600	488 288	414 750	544 000	306 760
6	111 600	176 348	240 110	865 150	268 130
7	48 100	98 741	105 670	284 110	406 840
8	15 900	89 830	56 710	151 730	173 740
9	6 500	58 043	63 440	156 180	131 880

Table 5.1.6. HERRING in Division VIa(North). Scottish bottom trawl survey indices of 2-ringed herring catch rates. Mean catches per hour's trawling.

Trawl survey Year	Number of Trawls	2-ringer index
1981	9	1 237
1982	10	2 361
1983	12	11
1984	12	12 456
1985	17	98
1986	12	359
1987	15	40
1988	19	15 770
1989	15	1 435
1990	16	46
1991	18	1 242
1992	14	38
1993	13	836
1994	18	343

Table 5.1.7. HERRING in Division VIa (North). Mean weights at age (g), maturity ogive and assumed natural mortality.

Age	Weight in the catch											
(Age, Rings)	1982-1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Mean 92-94
1	90	69	113	73	80	82	79	84	91	89	83	88
2	140	103	145	143	112	142	129	118	122	128	142	131
3	175	134	173	183	157	145	173	160	172	158	167	166
4	205	161	196	211	177	191	182	203	194	197	190	194
5	231	182	215	220	203	190	209	211	216	206	195	206
6	253	199	230	238	194	213	224	229	224	228	201	218
7	270	213	242	241	240	216	228	236	236	223	244	234
8	284	223	251	253	213	204	237	261	251	262	234	249
9+	295	231	258	256	228	243	247	271	258	263	266	262

	Weight in the stock						
	Historical	1992	1993	1994	Mean 92-94	Maturity	Natural Mortality
1	90	68	75		52	0	1.0
2	164	152	162	150	155	1	0.3
3	208	186	196	192	191	1	0.2
4	233	206	206	220	211	1	0.1
5	246	232	226	221	226	1	0.1
6	252	252	234	233	240	1	0.1
7	258	271	254	241	255	1	0.1
8	269	296	260	270	275	1	0.1
9	292	305	276	296	292	1	0.1

Table 5.1.8. HERRING in Division VIa(N). Results of baseline assessment.

CATCH NUMBERS AT AGE (Millions)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	173.	69.	35.	23.	0.	13.	37.	13.	82.	3.	46.	39.	28.	2.	10.	22.	47.	9.	31.	4.
2	202.	320.	48.	46.	0.	1.	78.	250.	78.	253.	77.	179.	94.	159.	57.	75.	41.	44.	168.	82.
3	89.	102.	96.	21.	0.	0.	106.	72.	93.	67.	166.	99.	65.	56.	171.	64.	45.	44.	33.	90.
4	64.	36.	22.	41.	0.	0.	61.	94.	29.	47.	19.	137.	45.	38.	29.	116.	50.	42.	19.	13.
5	188.	25.	10.	7.	0.	0.	21.	58.	43.	20.	17.	22.	71.	26.	28.	42.	67.	39.	23.	17.
6	31.	76.	12.	4.	0.	0.	13.	24.	27.	15.	7.	21.	12.	38.	12.	21.	24.	60.	26.	18.
7	12.	11.	21.	2.	0.	0.	12.	12.	15.	12.	8.	3.	10.	4.	23.	15.	13.	11.	34.	24.
8	13.	4.	3.	6.	0.	0.	1.	14.	8.	6.	4.	16.	5.	3.	3.	34.	12.	8.	8.	27.
9	14.	12.	1.	2.	0.	0.	1.	4.	8.	3.	2.	2.	8.	3.	5.	9.	8.	10.	13.	23.

INDICES OF SPAWNING STOCK BIOMASS

1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
.878E+03	.189E+03	.787E+03	.332E+03	.107E+04	.144E+04	.215E+04	.189E+04	.668E+03	.213E+04	.271E+04	.304E+04	.412E+04	.595E+04	.432E+04	.653E+04	.443E+04	MISSING	.294E+04

AGE - STRUCTURED INDICES

INDEX : 1 from 1987 to 1994

	1987	1988	1989	1990	1991	1992	1993	1994
1	.249E+06				.338E+06	.743E+05	.276E+04	.494E+06
2	.578E+06				.294E+06	.503E+06	.750E+06	.542E+06
3	.551E+06				.328E+06	.211E+06	.681E+06	.608E+06
4	.353E+06				.368E+06	.258E+06	.653E+06	.286E+06
5	.753E+06		MISSING		.488E+06	.415E+06	.544E+06	.307E+06
6	.112E+06				.176E+06	.240E+06	.865E+06	.268E+06
7	.481E+05				.987E+05	.106E+06	.284E+06	.407E+06
8	.159E+05				.898E+05	.567E+05	.152E+06	.174E+06
9	.650E+04				.580E+05	.634E+05	.156E+06	.132E+06

FISHING MORTALITY

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	.1374	.1900	.0884	.0373	.0004	.0214	.0329	.0228	.0342	.0032	.0428	.0425	.0122	.0020	.0169	.0263	.0249	.0181	.0190	.0165
2	.7389	.7708	.3420	.2803	.0008	.0028	.2993	.5937	.3100	.2400	.1783	.4130	.2322	.1503	.1285	.1996	.1891	.1378	.1447	.1255
3	.8955	1.2240	.6018	.2578	.0011	.0020	.3272	.5364	.4934	.5133	.2605	.3899	.2733	.2228	.1621	.2518	.2385	.1738	.1825	.1584
4	.8600	1.1253	.9560	.5276	.0005	.0026	.3700	.5098	.4103	.4737	.2566	.3370	.2947	.2416	.1432	.2223	.2106	.1535	.1612	.1399
5	.9219	.9054	1.0600	.8010	.0004	.0011	.2881	.6357	.4071	.4846	.2786	.4525	.2615	.2472	.1834	.2849	.2699	.1967	.2065	.1792
6	1.0231	1.1308	1.5378	1.5585	.0024	.0009	.2971	.5182	.6142	.2224	.2949	.5655	.4286	.1941	.1833	.2846	.2697	.1965	.2063	.1790
7	1.1160	1.2092	1.0178	1.1919	.0077	.0088	.3118	.4284	.6306	.5593	.1504	.1649	.5450	.2409	.1759	.2732	.2589	.1886	.1980	.1719
8	1.1099	1.2770	1.0701	.8787	.0024	.0037	.3857	.6555	.5666	.4986	.2843	.4689	.4025	.2596	.1945	.3021	.2862	.2086	.2190	.1900
9	1.1099	1.2770	1.0701	.8787	.0024	.0037	.3857	.6555	.5666	.4986	.2843	.4689	.4025	.2596	.1945	.3021	.2862	.2086	.2190	.1900

Table 5.1.8. (contd.)

NUMBERS AT AGE (Millions)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	2107.	622.	646.	969.	1528.	961.	1789.	932.	3841.	1483.	1717.	1476.	3611.	1837.	1319.	1041.	1207.	2019.	2306.	391.	1277.
2	440.	676.	189.	218.	344.	562.	346.	637.	335.	1366.	544.	605.	520.	1312.	675.	477.	373.	433.	729.	832.	141.
3	164.	156.	232.	100.	122.	254.	415.	190.	261.	182.	796.	337.	297.	306.	837.	439.	289.	229.	280.	468.	544.
4	115.	55.	37.	104.	63.	100.	208.	245.	91.	130.	89.	502.	187.	185.	200.	582.	280.	187.	157.	191.	327.
5	326.	44.	16.	13.	55.	57.	90.	130.	133.	55.	73.	62.	324.	126.	131.	157.	422.	205.	145.	121.	150.
6	50.	117.	16.	5.	5.	50.	51.	61.	62.	80.	30.	50.	36.	226.	89.	99.	107.	291.	152.	107.	92.
7	19.	16.	34.	3.	1.	5.	45.	35.	33.	30.	58.	21.	26.	21.	168.	67.	67.	74.	217.	112.	81.
8	20.	6.	4.	11.	1.	1.	4.	30.	20.	16.	16.	45.	16.	14.	15.	128.	46.	47.	55.	161.	85.
9	18.	11.	4.	3.	5.	5.	6.	6.	17.	19.	19.	24.	39.	33.	33.	36.	109.	106.	112.	122.	211.

STOCK SUMMARY

Year	Recruits x10^6	Total B tonnes	Spawn B tonnes	Landings tonnes	Yld/SSB	Ref. F Fbar 3- 6
1975	2107.	430957.	119683.	111922.	.9352	.9251
1976	622.	261298.	94298.	93642.	.9930	1.0964
1977	646.	165376.	61085.	41341.	.6768	1.0389
1978	969.	176923.	59807.	22176.	.3708	.7862
1979	1528.	250893.	97790.	60.	.0006	.0011
1980	961.	284539.	170891.	306.	.0018	.0017
1981	1789.	402233.	171923.	51420.	.2991	.3206
1982	932.	351162.	161399.	92361.	.5723	.5500
1983	3841.	543518.	130607.	63523.	.4864	.4813
1984	1483.	477036.	237167.	75154.	.3169	.4235
1985	1717.	480594.	242882.	43814.	.1804	.2727
1986	1476.	471614.	232286.	82280.	.3542	.4362
1987	3611.	626732.	222579.	63007.	.2831	.3145
1988	1837.	593903.	327436.	47354.	.1446	.2264
1989	1319.	561696.	351690.	53039.	.1508	.1680
1990	1041.	524638.	329594.	69959.	.2123	.2609
1991	1207.	487623.	291787.	50606.	.1734	.2472
1992	2019.	490488.	283136.	51585.	.1822	.1801
1993	2306.	546122.	294681.	56175.	.1906	.1891
1994	391.	435003.	330982.	54708.	.1653	.1641

Table 5.1.8. (contd.)

```
PARAMETER ESTIMATES +/- SD

Separable Model: Reference F by year
 1   1989            .1621            .1358            .1935
 2   1990            .2518            .2122            .2987
 3   1991            .2385            .1994            .2854
 4   1992            .1738            .1435            .2104
 5   1993            .1825            .1480            .2250
 6   1994            .1584            .1241            .2020
Separable Model: Selection (S) by age
 7      1            .1043            .0844            .1291
 8      2            .7927            .6583            .9547
        3           1.0000              Fixed : Reference age
 9      4            .8831            .7476           1.0432
10      5           1.1317            .9636           1.3291
11      6           1.1305            .9653           1.3241
12      7           1.0852            .9228           1.2761
        8           1.2000              Fixed : last true age
 Separable Model: Populations in year      1994
13    1          390773.          250746.          608995.
14    2          832391.          602338.         1150309.
15    3          467523.          364603.          599495.
16    4          190750.          150362.          241987.
17    5          121263.           97189.          151300.
18    6          106621.           86061.          132092.
19    7          112173.           90524.          139000.
20    8          160830.          129983.          198997.
Separable Model: Populations at age  8
21   1989        15072.1864       10672.5223       21285.5777
22   1990       127787.1197       98818.9731      165247.0922
23   1991        46147.8533       36452.9852       58421.1237
24   1992        47016.0061       37556.6466       58857.8863
25   1993        55316.6505       44550.2206       68684.9982

 SSB Index catchabilities
 26  1    Power Model : Q      .47452E+01       .40790E+01       .55204E+01
 27  1    Power Model : K     -.11324E+02      -.13134E+02      -.95144E+01


 Age-structured index catchabilities
     Age-Structured Index    1

 Linear model fitted. Slopes at age:
28  1 Q      .96148E-01      .25828E-01      .35792E+00
29  2 Q      .11156E+01      .72012E+00      .17284E+01
30  3 Q      .16899E+01      .10969E+01      .26035E+01
31  4 Q      .20715E+01      .13472E+01      .31852E+01
32  5 Q      .25020E+01      .16297E+01      .38410E+01
33  6 Q      .26156E+01      .17017E+01      .40203E+01
34  7 Q      .20811E+01      .13499E+01      .32085E+01
35  8 Q      .17053E+01      .11003E+01      .26427E+01
36  9 Q      .69658E+00      .44333E+00      .10945E+01


 Parameters of the B.-H. stock-recruit relationship
37      a       .2403350E+07     .4321812E+06     .1336498E+08
38      b       .1056475E+06     .9955917E+03     .1121081E+08

  RESIDUALS ABOUT THE MODEL FIT
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 Separable Model Residuals
 (log(Observed Catch)-log(Expected Catch))
 and weights (W) used in the analysis.
 -------------------------------------------------

  Age          1989          1990          1991          1992          1993          1994
   1     -.36793E+00     .26847E+00     .91263E+00    -.89923E+00     .12863E+00    -.48248E-01     .10000E+01
   2     -.20717E+00     .41717E-02    -.31265E+00    -.10462E+00     .68186E+00    -.40763E-01     .10000E+01
   3      .40570E+00    -.33261E+00    -.22212E+00     .28993E+00    -.24852E+00     .36733E+00     .10000E+01
   4      .14781E+00     .49112E-01    -.11870E-01     .51196E+00    -.14050E+00    -.56895E+00     .10000E+01
   5      .29710E+00     .11150E+00    -.35800E+00     .10661E+00    -.94031E-01    -.13210E+00     .10000E+01
   6     -.18256E+00    -.11510E+00    -.33204E-02     .19551E+00    -.34419E-01     .83546E-01     .10000E+01
   7     -.10095E+00     .11648E-01    -.84885E-01    -.67910E-01    -.89928E-01     .33110E+00     .10000E+01
   8     -.42110E-02     .54946E-01     .10954E+00    -.93948E-01    -.21964E+00     .24090E-01     .10000E+01

 Wts      .10000E+01     .10000E+01     .10000E+01     .10000E+01     .10000E+01     .10000E+01
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Table 5.1.8. (contd.)

Biomass Index Residuals: log(Observed Index) - log(Expected Index) : LARVAL ABUNDANCE INDEX

1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
-.10504E+00	-.12697E+01	.83286E+00	.26733E-02	.40824E+00	-.16769E+00	.22839E+00	.19601E+00	-.51441E+00	-.28236E+00	-.80021E-01	.10336E+00	.47457E+00	.24078E+00	-.19013E+00	.32330E+00

1991	1992	1993
.12578E+00	MISSING	-.29924E+00

Aged Index Residuals: log(Observed Index) - log(Expected Index)

Aged Index 1: Acoustic Survey

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	.72830E-01				.14797E+01	-.55289E+00	-.39786E+01	.29832E+01
2	.20925E+00				-.15061E+00	.21587E+00	.96741E-01	-.36811E+00
3	.28419E+00				-.22440E+00	-.45635E+00	.51865E+00	-.11908E+00
4	.66135E-01				-.33013E+00	-.30290E+00	.79869E+00	-.22869E+00
5	.69192E-01		MISSING		-.62303E+00	-.93788E-01	.52867E+00	.12271E+00
6	.38241E+00				-.31254E+00	-.10367E+01	.89756E+00	.72308E-01
7	.14655E+00				-.20623E+00	-.25885E+00	-.34273E+00	.66420E+00
8	-.32311E+00				.28682E+00	-.22285E+00	.60289E+00	-.34050E+00
9	-.12320E+01				-.11632E+00	-.24618E-01	.82078E+00	.55798E+00

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1989 to 1994

Variance	:	.1867
Skewness test statistic	:	.6895
Kurtosis test statistic	:	2.7056
Partial chi-square	:	.4166
Probability of chi-square	:	1.0000
Degrees of freedom	:	23

Table 5.1.8. (contd)

DISTRIBUTION STATISTICS FOR ln (LARVAL ABUNDANCE INDEX)

Power catchability relationship assumed.
Last age is a plus-group.

Variance	:	.2183
Skewness test statistic	:	-1.6017
Kurtosis test statistic	:	1.5728
Partial chi-square	:	.5242
Probability of chi-square	:	1.0000
Number of observations	:	18
Degrees of freedom	:	16
Weight in the analysis	:	1.0000

DISTRIBUTION STATISTICS FOR ln (ACOUSTIC SURVEY)

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6	7	8	9
Variance	:	6.8073	.0645	.1556	.2238	.1741	.5324	.1724	.1789	.6292
Skewness test stat.	:	-.4793	-.5169	.2262	1.0458	-.3258	-.2400	.8190	.5342	-.5852
Kurtosis test stat.	:	-.3392	-.5785	-.6333	-.1451	-.2908	-.4458	-.3368	-.6312	-.3409
Partial chi-square	:	2.4298	.0194	.0484	.0706	.0526	.1644	.0564	.0637	.2411
Prob. of chi-square	:	.6573	1.0000	.9997	.9994	.9997	.9968	.9996	.9995	.9933
Number of data	:	5	5	5	5	5	5	5	5	5
Degrees of freedom	:	4	4	4	4	4	4	4	4	4
Weight in analysis	:	.0111	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111

ANALYSIS OF VARIANCE

Total weighted SSQ is : 9.122499245759684

Unweighted Residuals About the Model fit

	Start SSQ	End SSQ	df	Variance	IV Wt
Separable model:	4.7840	4.2934	23	.1867	5.35709
Biomass idx 1	3.4242030	3.4929487	16	.2183	.85507
Aged index 1	43.7442655	35.7532116	36	.9931	.18796

Partition of the weighted residuals

Catch at Age Matrix : .4293E+01 for 48 observations.

SSB Index 1 3.492949 for 18 observations

Aged Index 1

Age:	1	2	3	4	5	6	7	8	9
Wted SSQ:	.3025E+00	.2866E-01	.6917E-01	.9948E-01	.7737E-01	.2366E+00	.7663E-01	.7953E-01	.2797E+00
No data:	5	5	5	5	5	5	5	5	5

Table 5.1.9 HERRING in VIa(N). Catches that are assumed misreported in rectangles 46E5-50E5, as a proportion of the total catch from Division VIa(N), as used by the Working Group in previous years. Where available, the proportion of the stock distributed in the E5 rectangles (as estimated from the acoustic survey) are also given.

Year	Proportion of Catch Reported in E5 rectangles	Proportion of Stock Reported in E5 rectangles
	(%)	(%)
1984	15	*
1985	11	*
1986	13	*
1987	30	*
1988	25	*
1989	36	*
1990	36	*
1991	36	9.8
1992	44	11.8
1993	43	1.1
1994	55	2.9

* - Not available

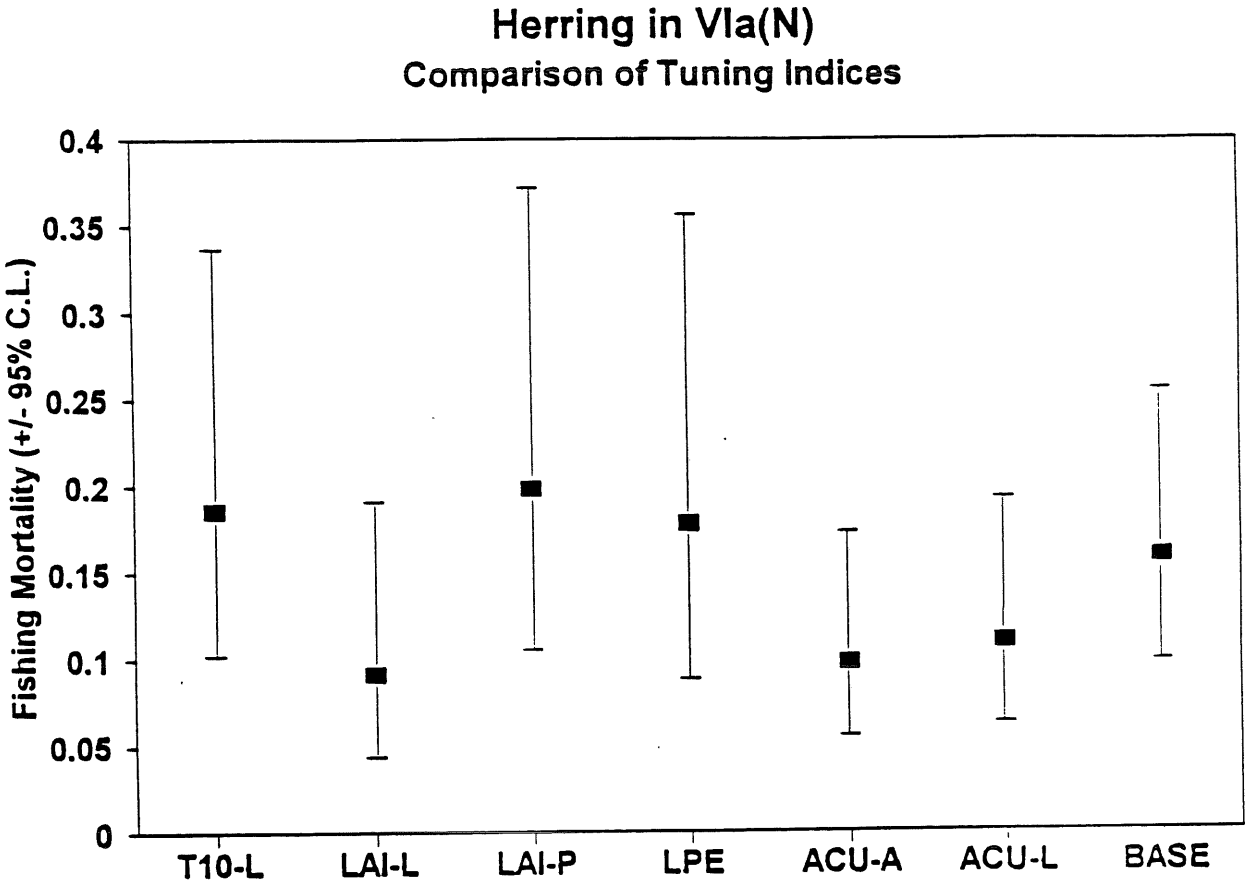


Figure 5.1.1. Herring in VIa(N). Estimates of fishing mortality at age 3 in population models fitted to the 10% trimmed mean of larval abundances (T10), the conventional larval abundance index (LAI-L, proportionate model; LAI-P, power model), the larval production estimate (LPE, in proportionate model), the acoustic survey used as an absolute estimator of abundance (ACU-A) and the acoustic survey used as a proportionate measure of abundance (ACU-L). In these independent model fits, the indices were given a high weight (=5) relative to the catch-at-age observations. Lastly, the estimate from the baseline fit in which the LAI and the acoustic survey (used as a proportionate measure of abundance) are given equal weight to observations of catches at age (LAI+ACU-L).

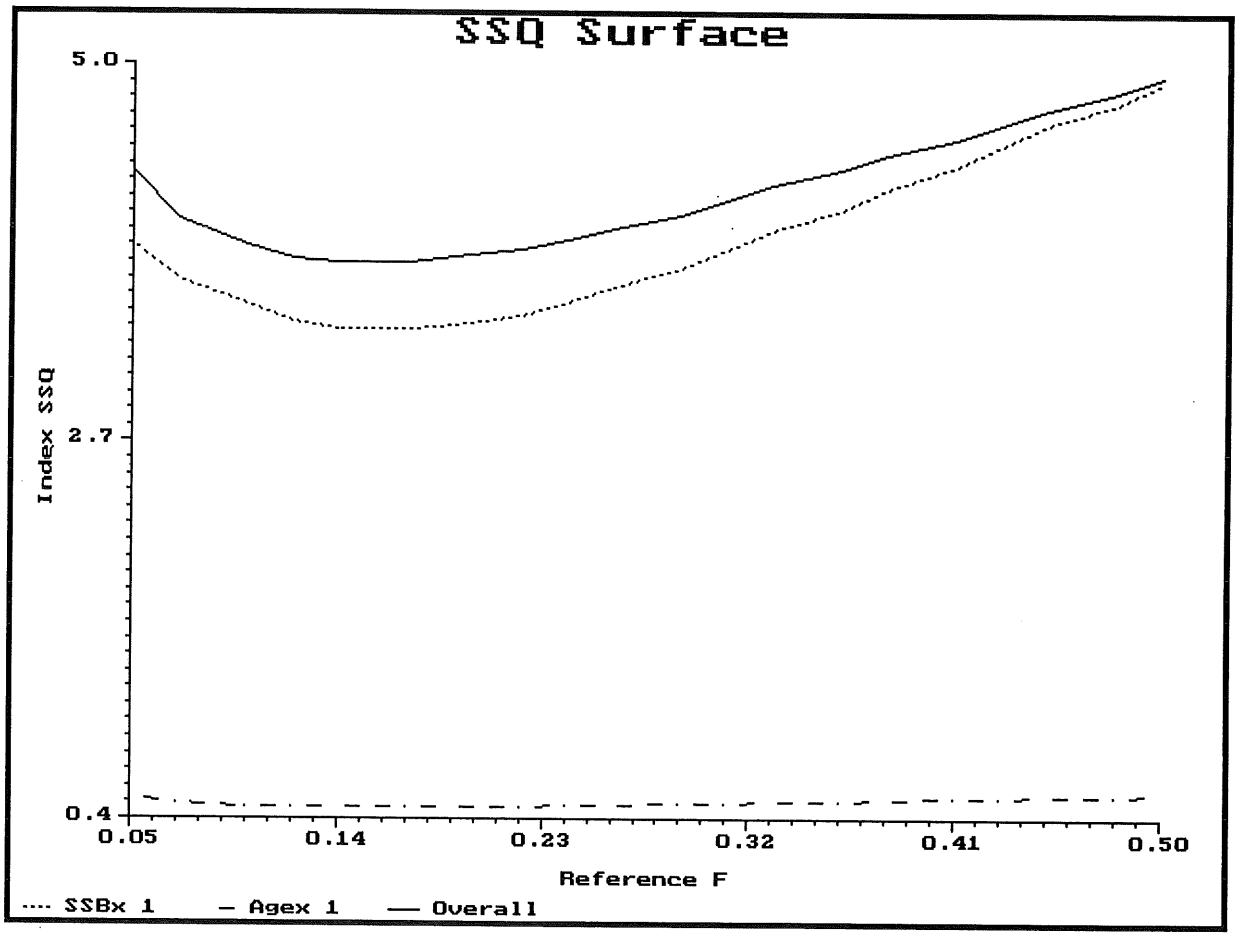


Figure 5.1.2. Herring in VIa(N). Sums of squares surface for the baseline model fit. Twenty independent conventional separable VPAs have been fitted to the catch at age data with a range of values of fishing mortality at age 3 from 0.05 to 0.5. For each calculated time series of larval survey (SSBx) and acoustic survey (Agex 1), a simple double-logarithmic regression of LAI on SSB was fitted. Sums of squared residuals of these regressions are plotted above, showing that the model has a reasonably well-defined minimum in the region of F= 0.16. The plot is for illustrative purposes only as the model is fitted with a multidimensional mimimisation algorithm.

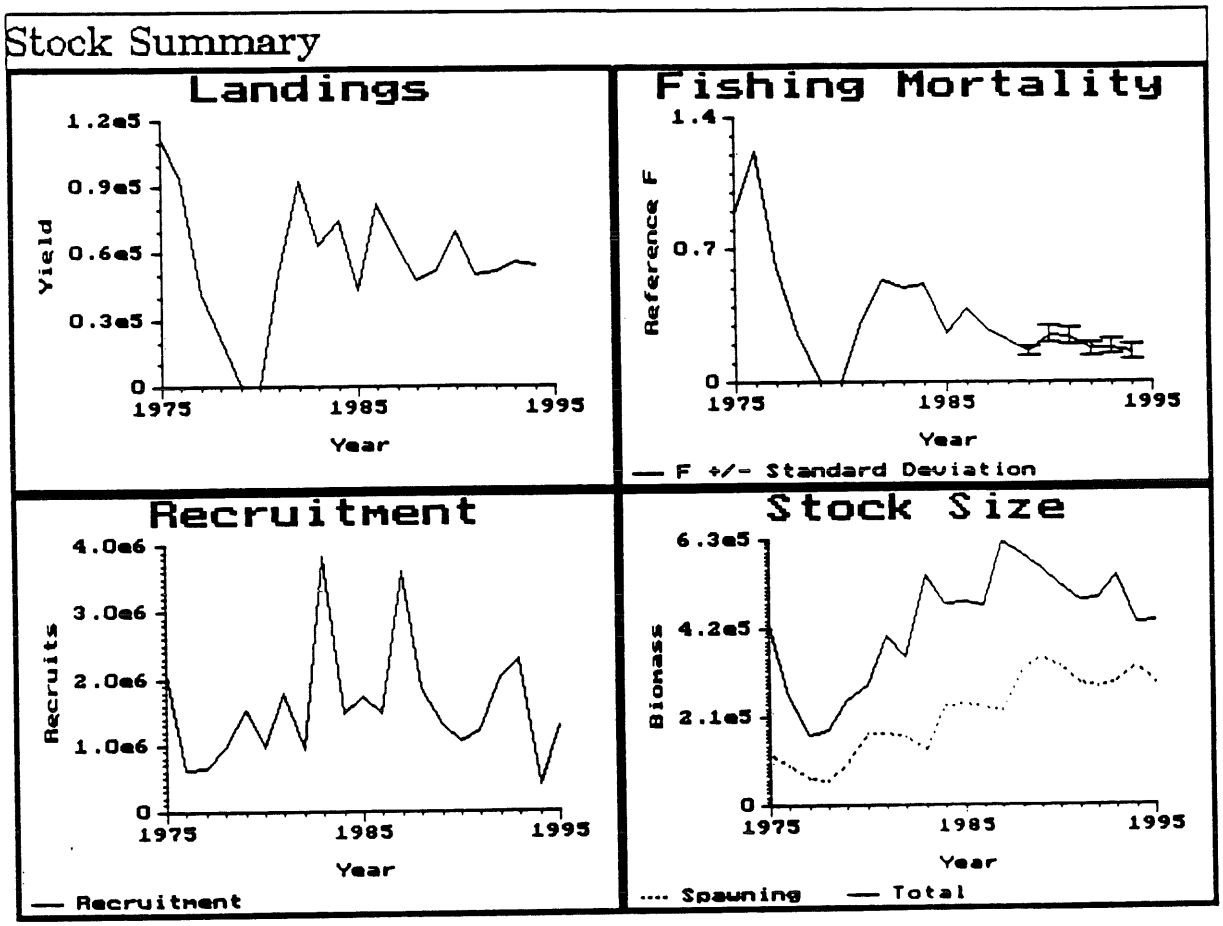


Figure 5.1.3. Herring in VIa(N). Results of baseline assessment. Summary of estimates of landings, fishing mortality at age 3, recruitment at age 1, stock size on 1 January and spawning stock size at spawning time.

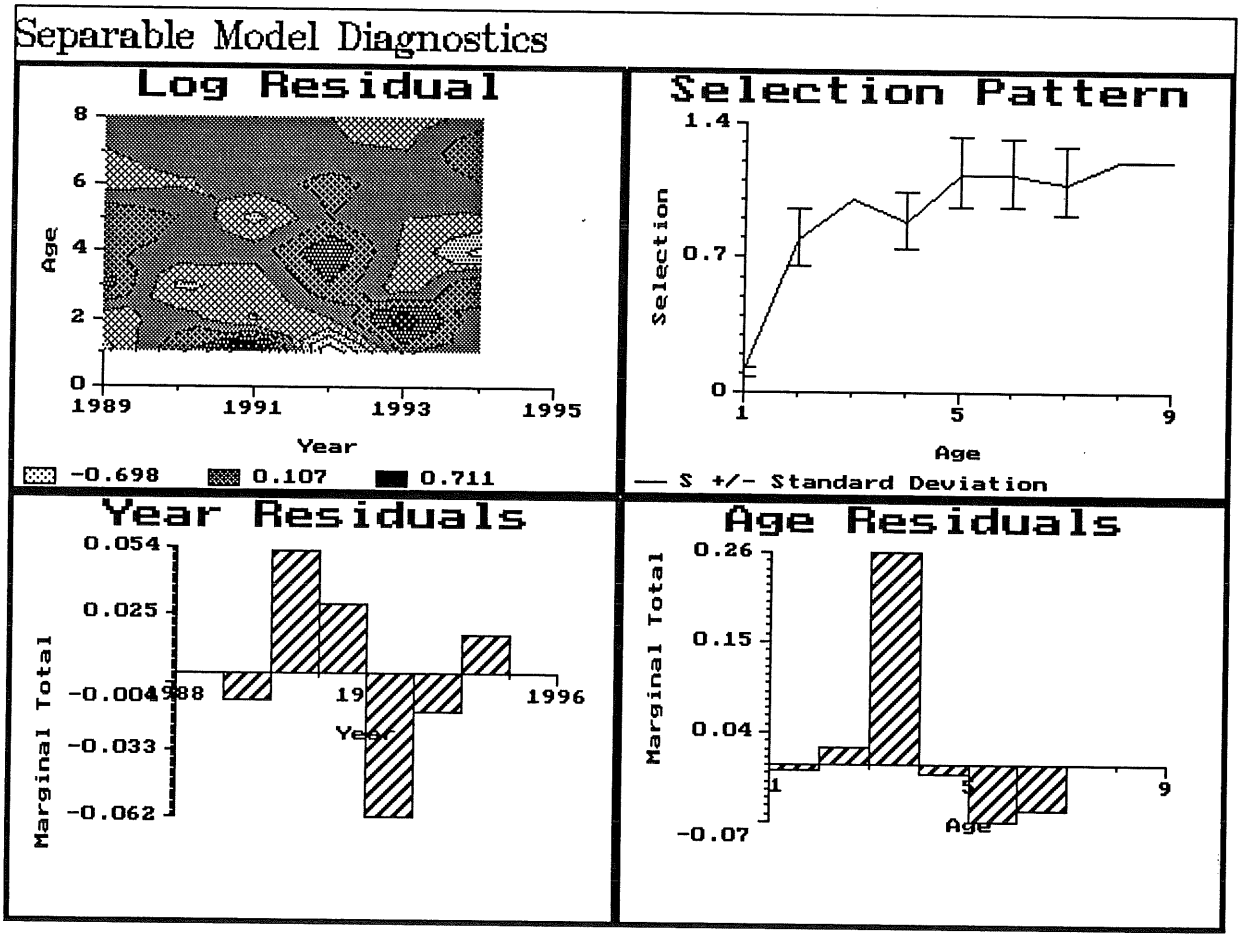


Figure 5.1.4. Herring in VIa(N). Results of baseline assessment. Selection pattern diagnostics. Top left, contour plot of selection pattern residuals. Top right, estimated selection (relative to age 3) +/- standard deviation. Bottom, marginal totals of residuals by year and age.

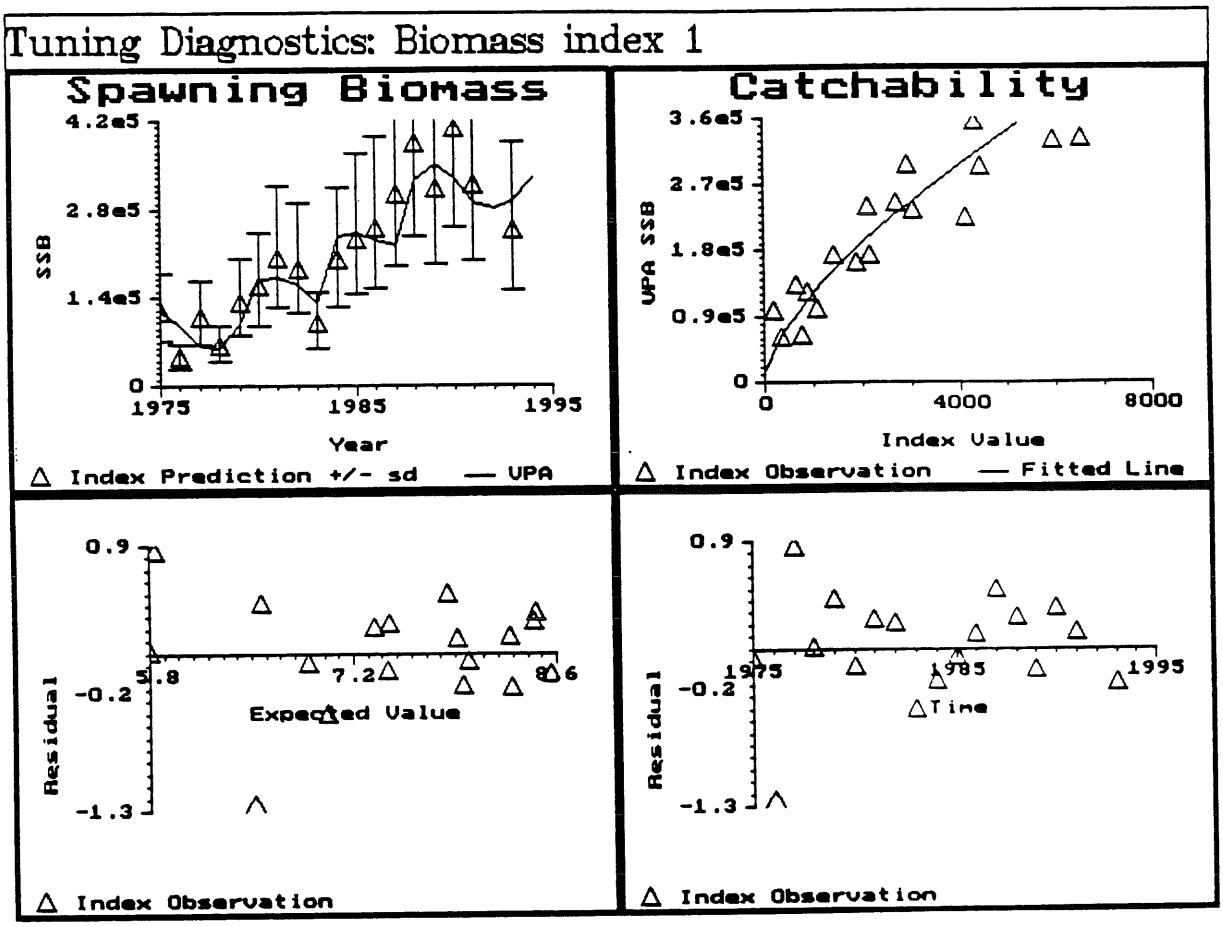


Figure 5.1.5. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the larval abundance index against the estimated spawning biomass. Top left, spawning biomass from the fitted populations (line), and predictions of spawning biomass in each year made from the index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of spawning biomass from the fitted populations and larval survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

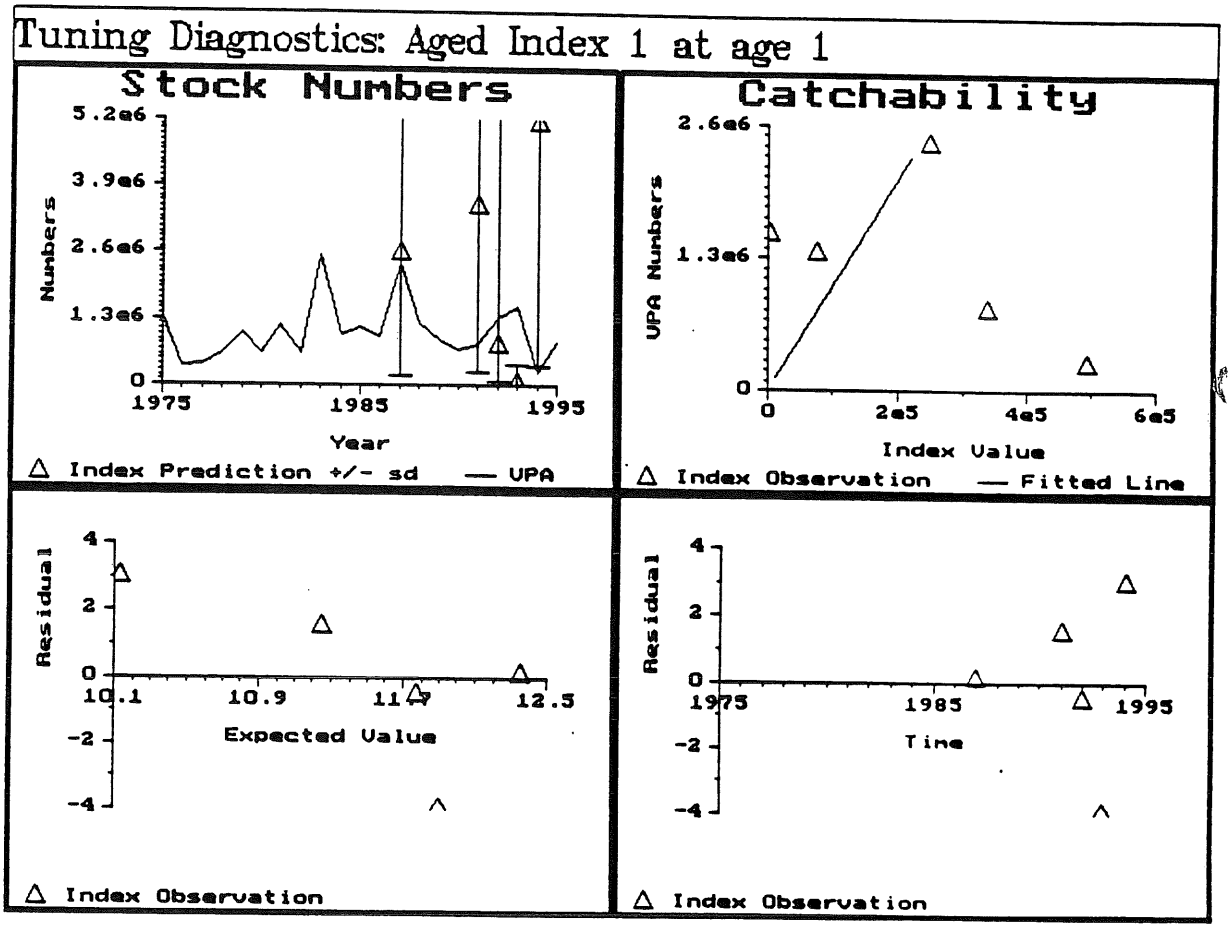


Figure 5.1.6. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 1. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

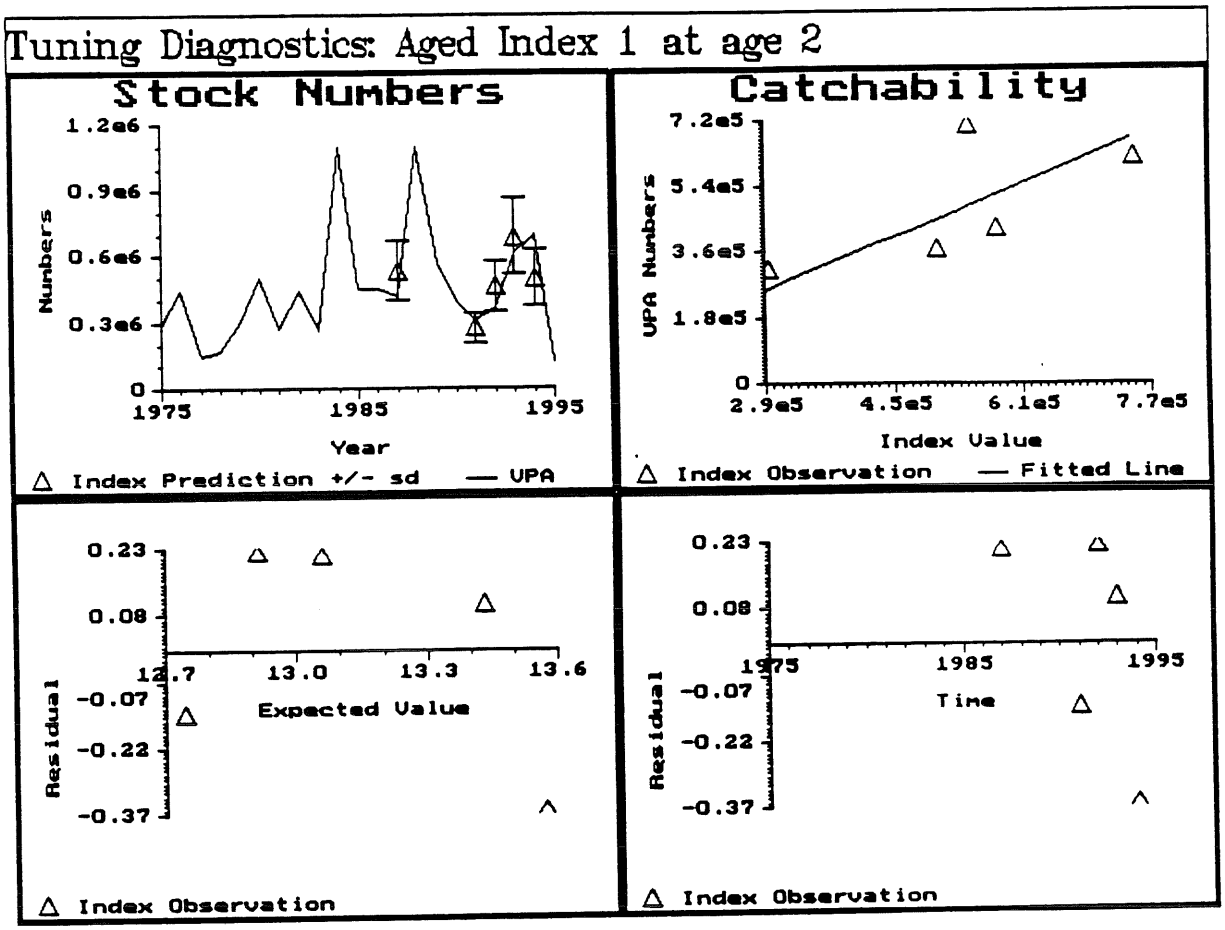


Figure 5.1.7. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 2. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

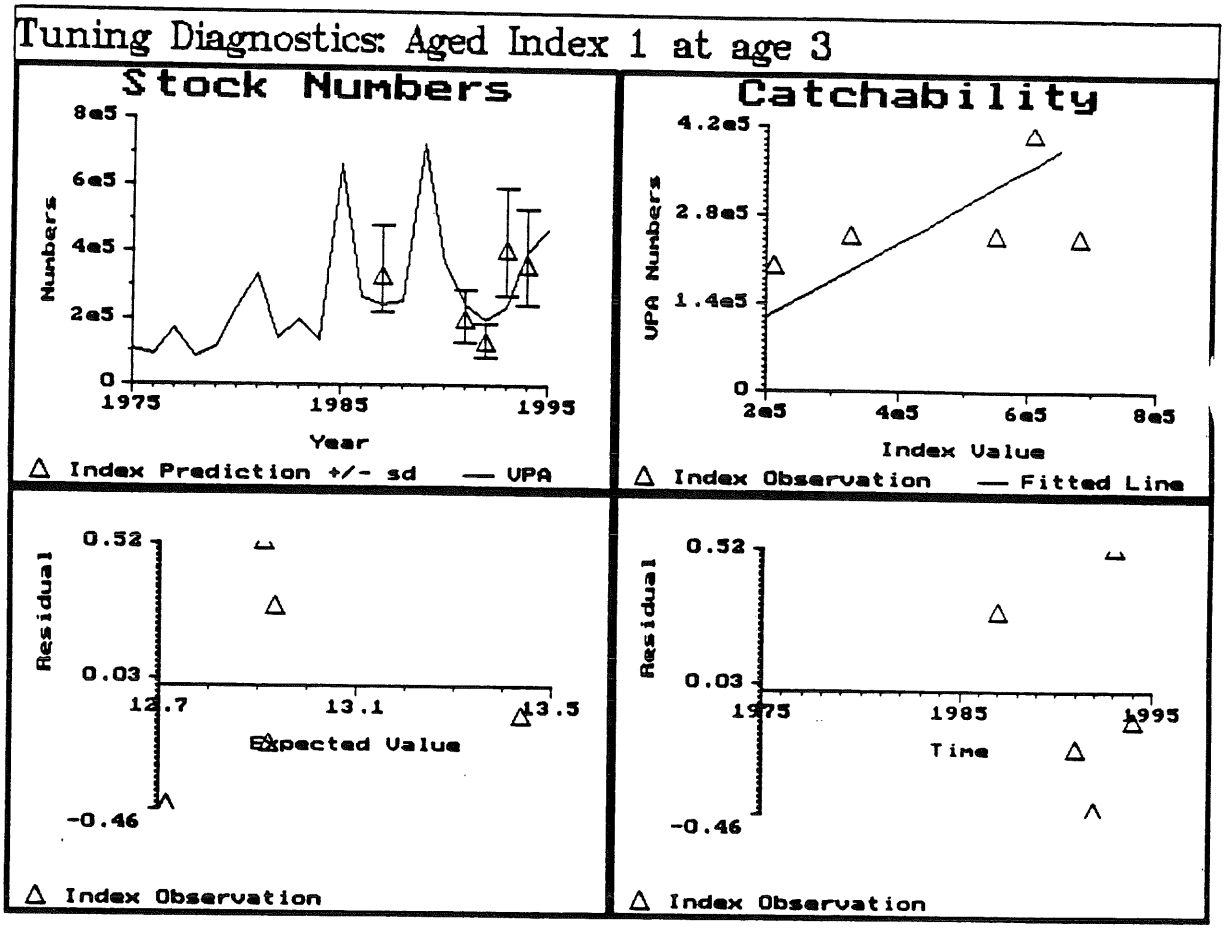


Figure 5.1.8. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 3. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

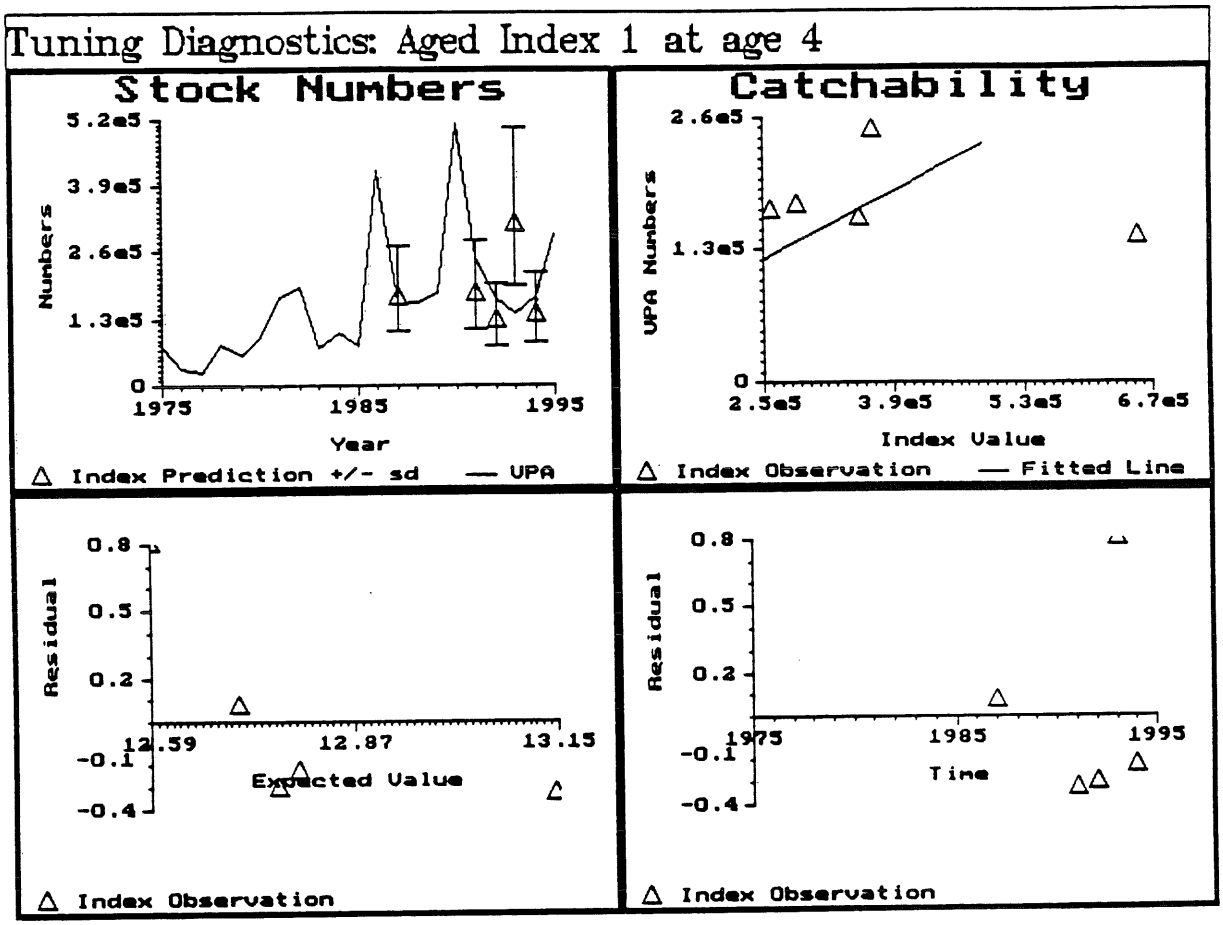


Figure 5.1.9. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 4. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

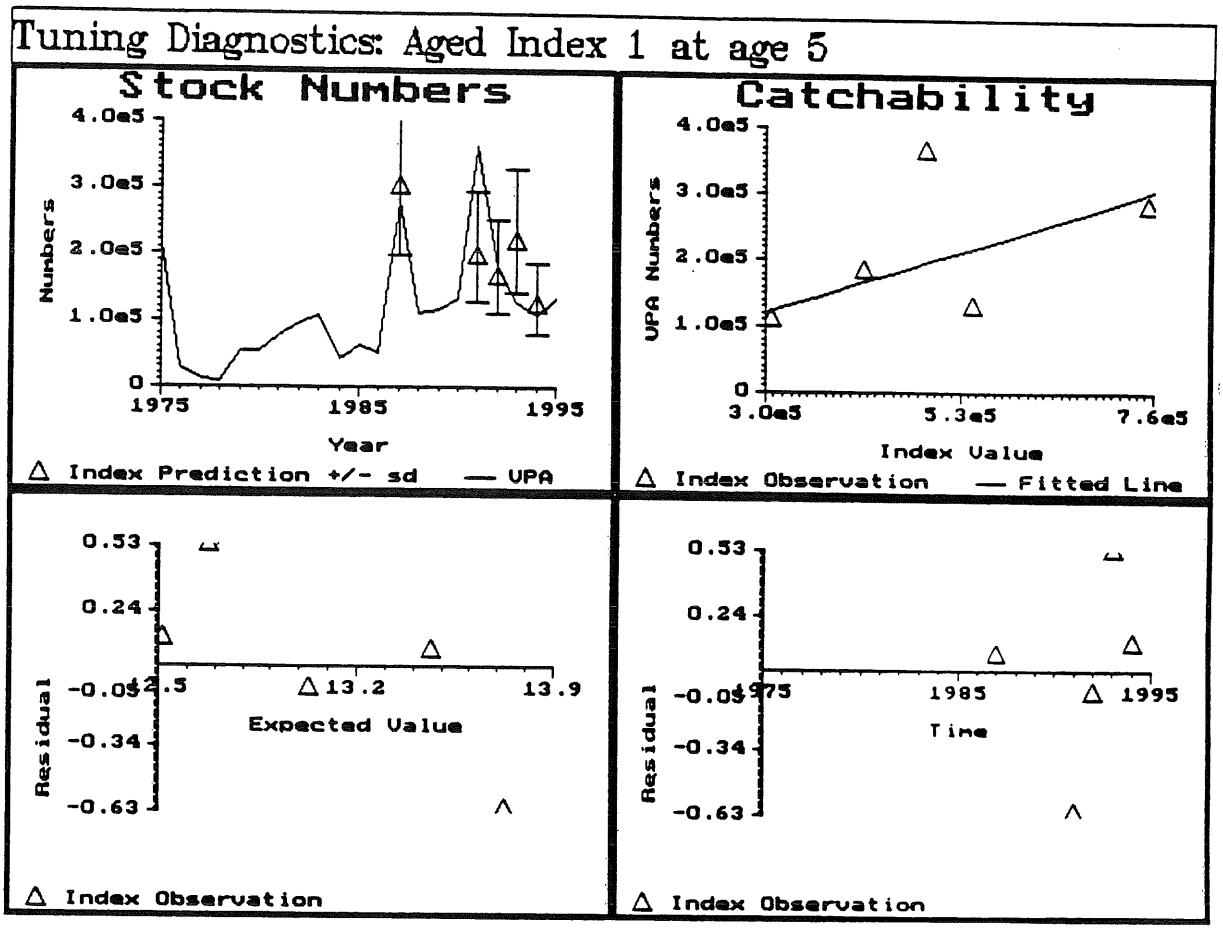


Figure 5.1.10. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 5. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

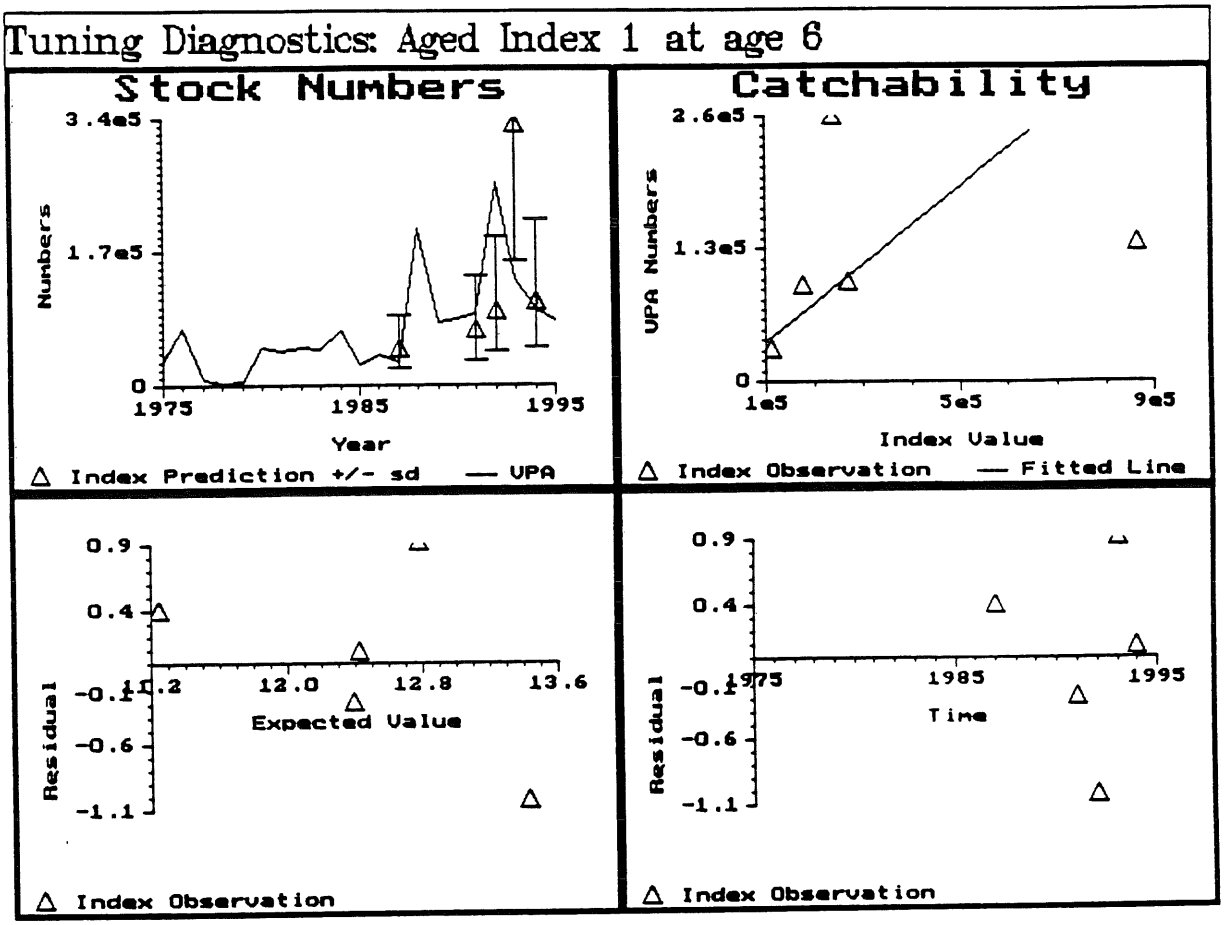


Figure 5.1.11. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 6. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

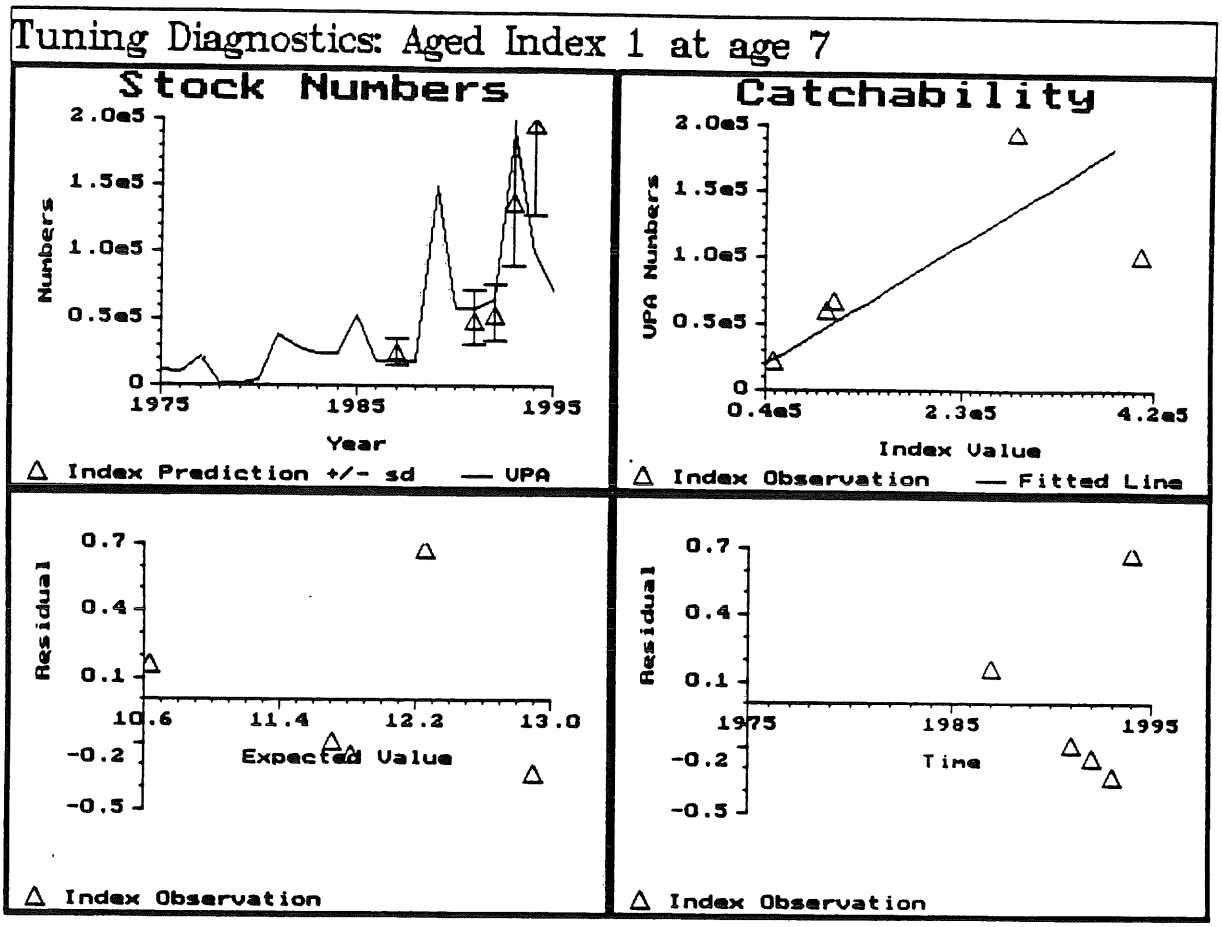


Figure 5.1.12. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 7. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

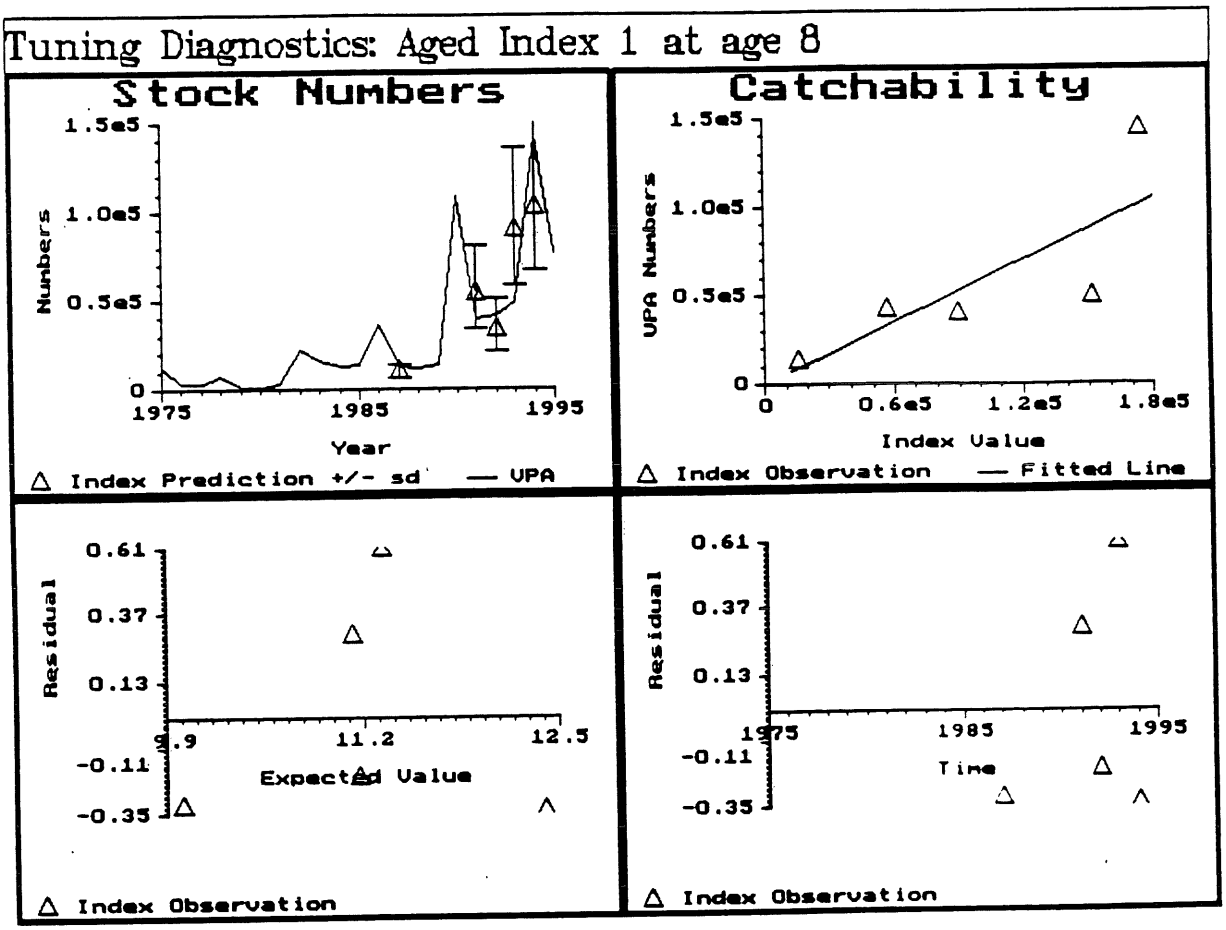


Figure 5.1.13. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index against the estimated populations at age 8. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

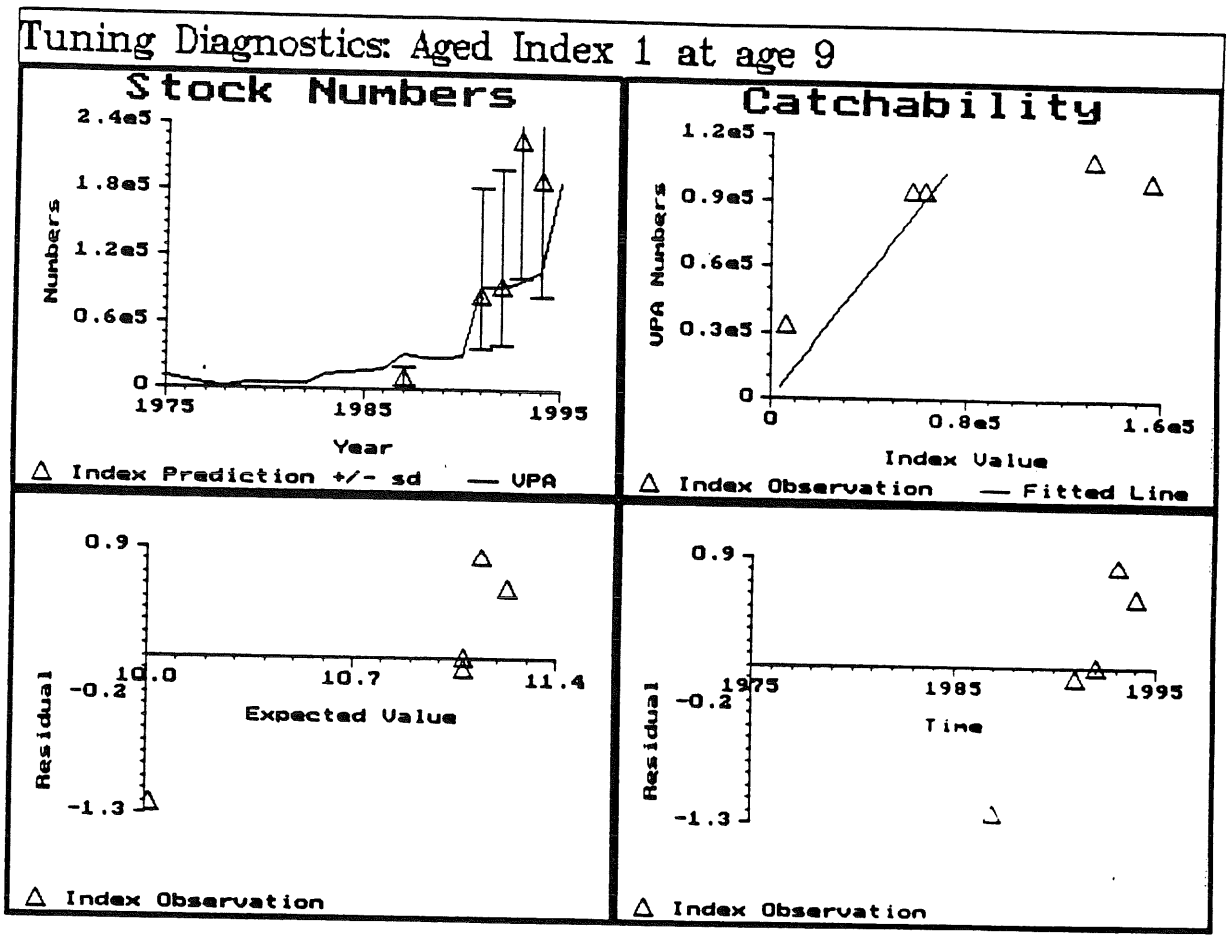


Figure 5.1.14. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the acoustic index at age 9 against the estimated populations at age 9. Top left, fitted populations (line), and predictions of abundance in each year made from the acoustic index observations and the estimated catchability (triangles +/- standard deviation), plotted by year. Top right, scatterplot and fitted relationship of the fitted populations and acoustic survey index observations. Bottom, residuals, as (ln(observed index) - ln(expected index) plotted against expected values and against time.

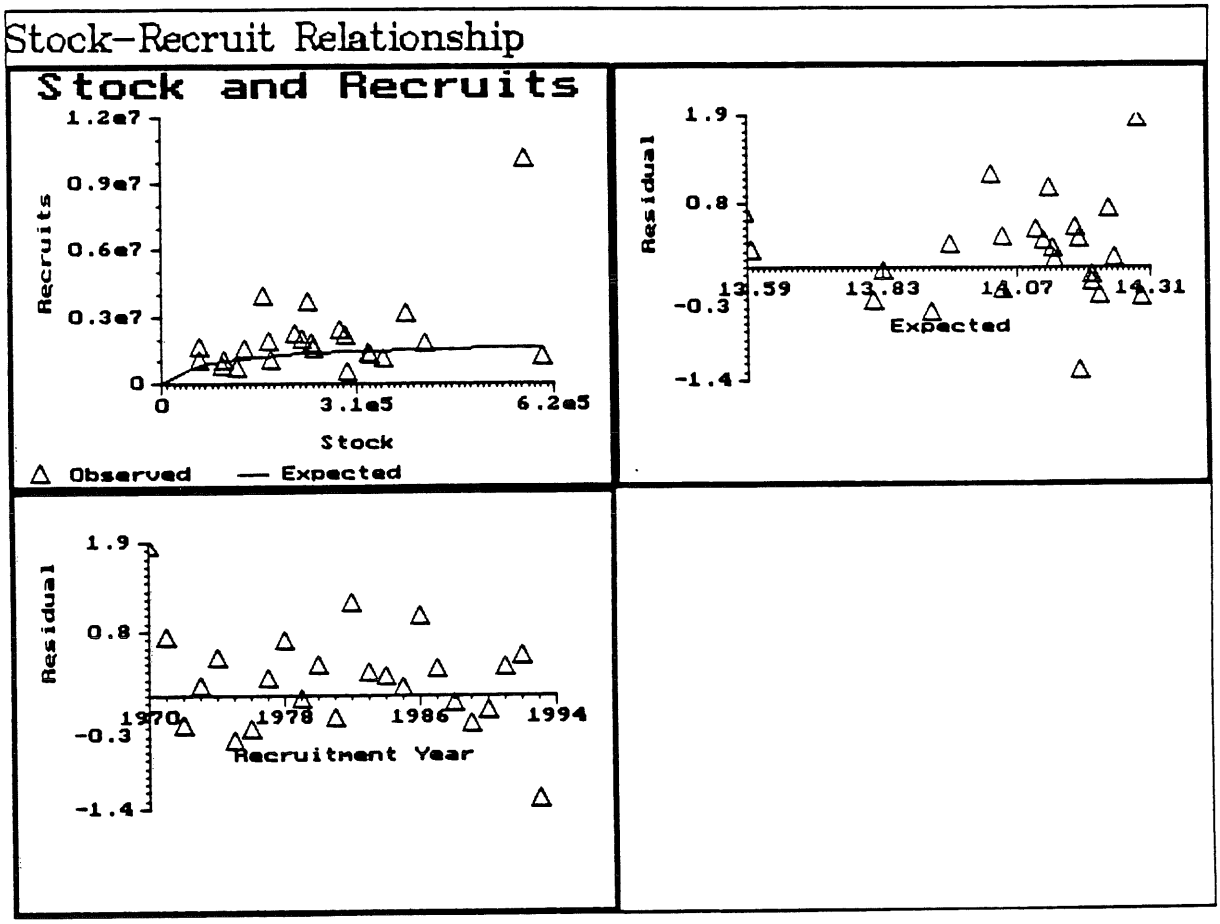


Figure 5.1.15. Herring in VIa(N). Results of the baseline assessment. Diagnostics of the fit of the Beverton-Holt Stock-recruit relationship. Top left, spawning stock size and corresponding recruitment; top right, residuals as ln(observed recruitment) -ln(expected recruitment) plotted against ln(expected recruitment); and lastly residuals plotted by year.

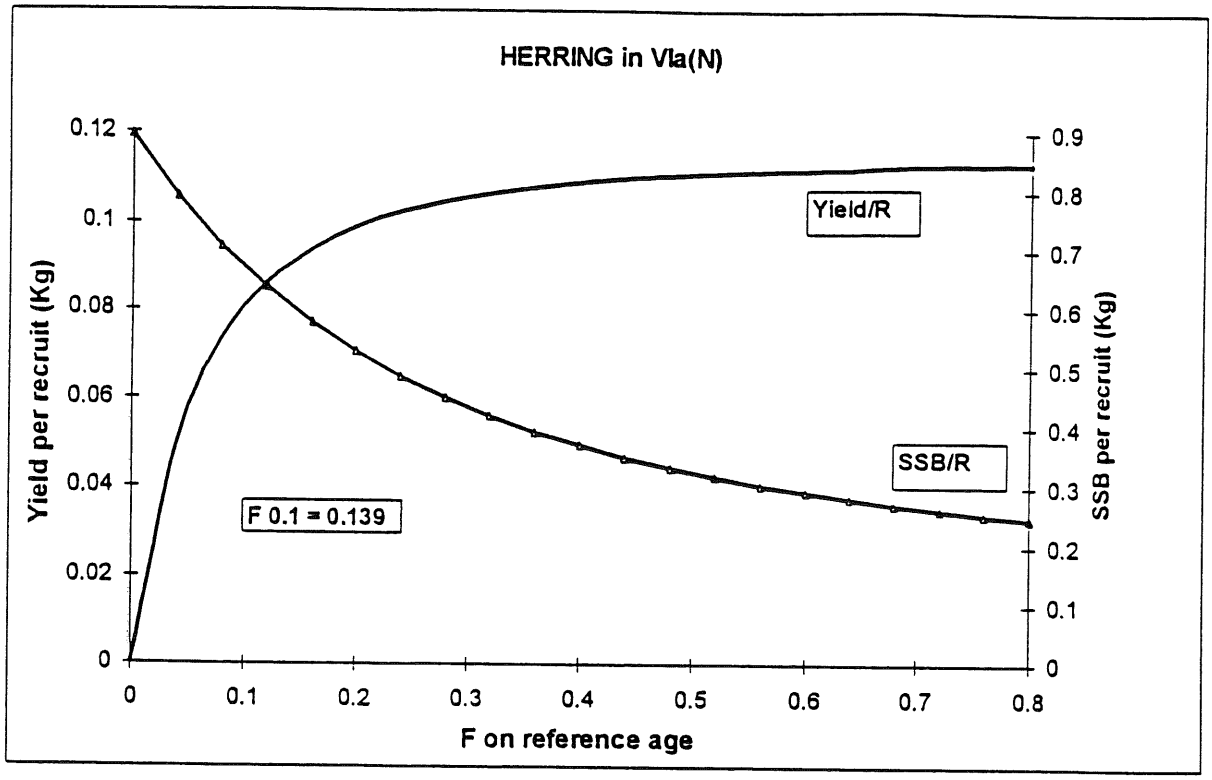


Figure 5.1.16. Herring in VIa(N). Yield per recruit analysis. Yield (Kg/recruit) and spawning stock biomass (Kg/recruit) calculated for a range of values of fishing mortality on reference age 3.

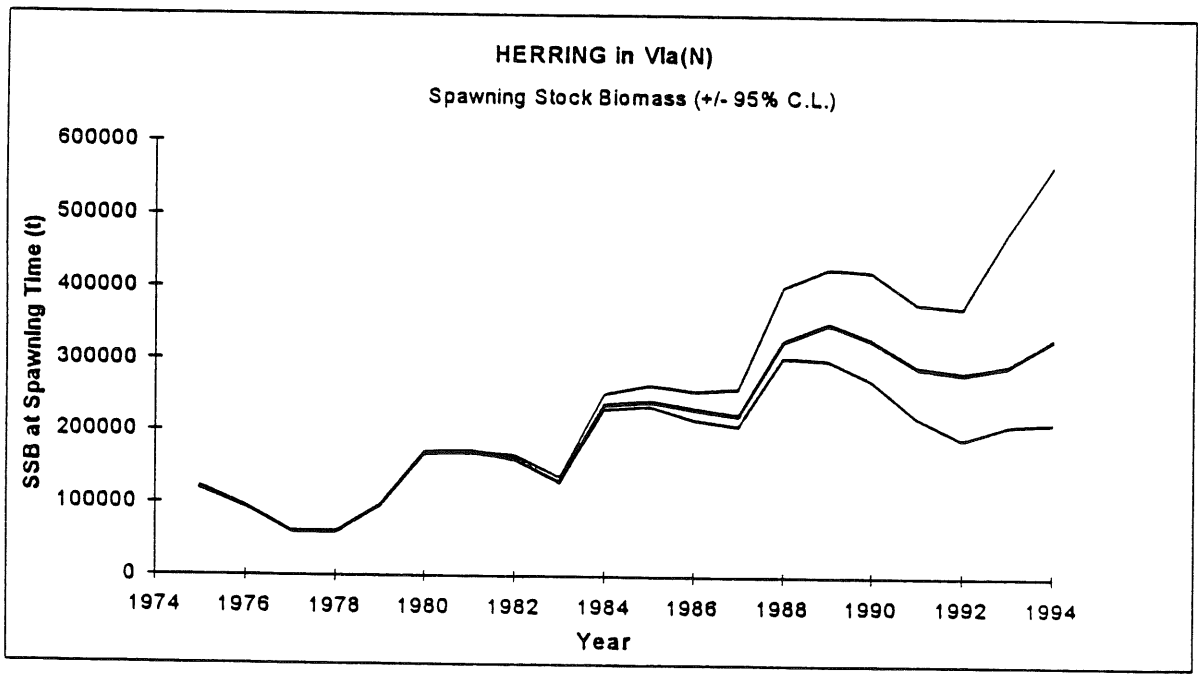
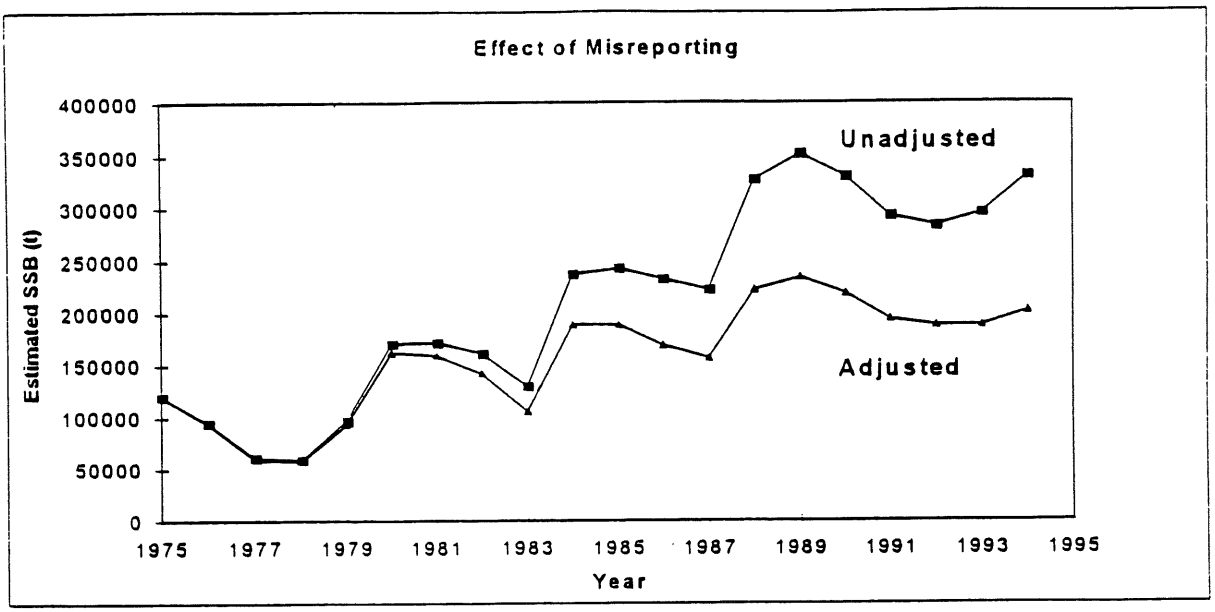


Figure 5.1.17. Herring in VIa(N). Estimated spawning stock biomass, +/- estimates of the 95% confidence interval.



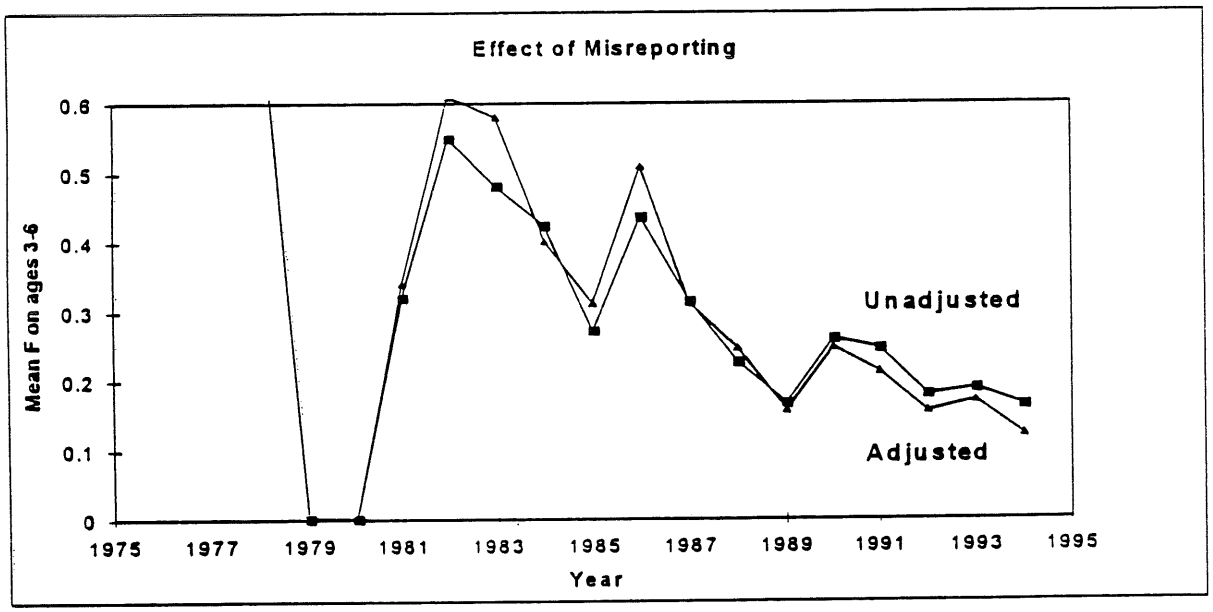
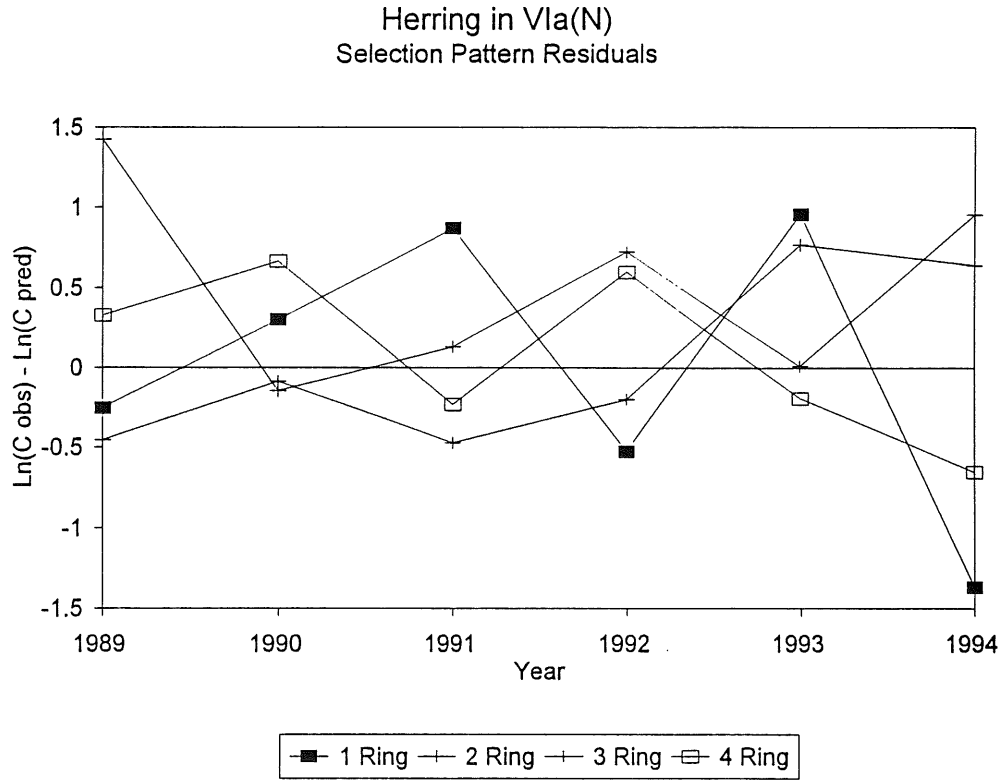


Figure 5.1.18. Herring in VIa(N). Comparison of the baseline assessment (**unadjusted**) with one in which catches in rectangles 46E5 to 50E5 from 1984 to 1994 have been assumed to be misreported North Sea catches, and the catches at age reduced in proportion (**adjusted**). Spawning stock biomass and unweighted mean F on ages 3-6.



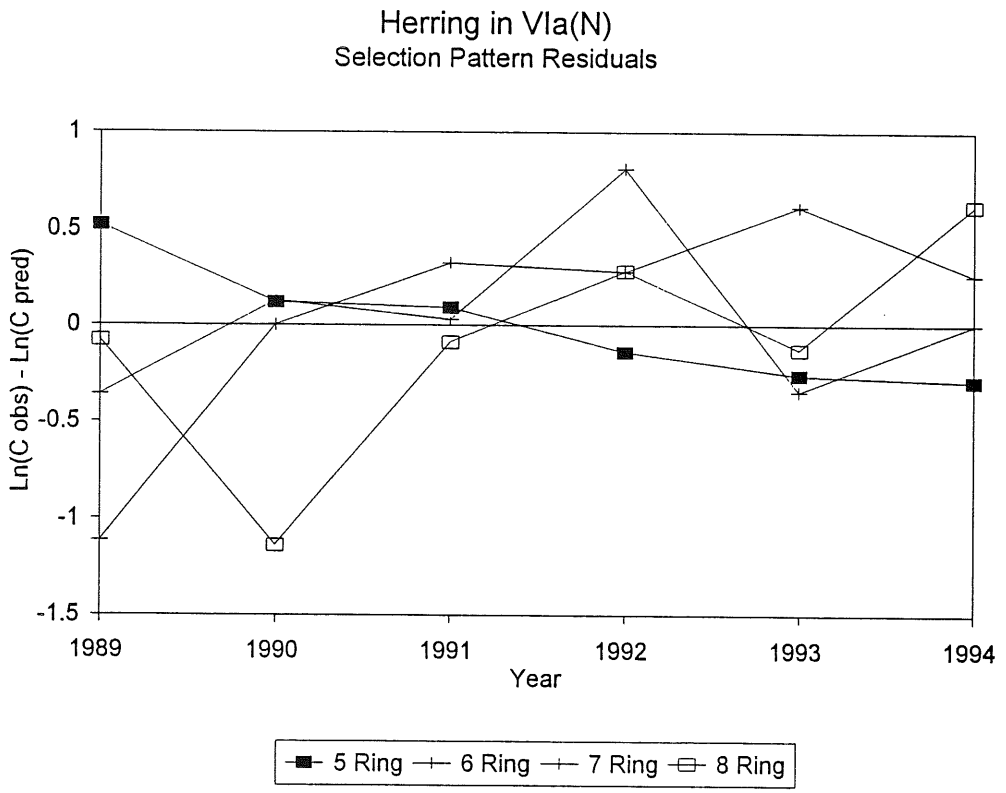


Figure 5.1.19. Herring in VIa(N). Selection pattern residuals for the catches at age against a model fit that was heavily driven by the survey indices.

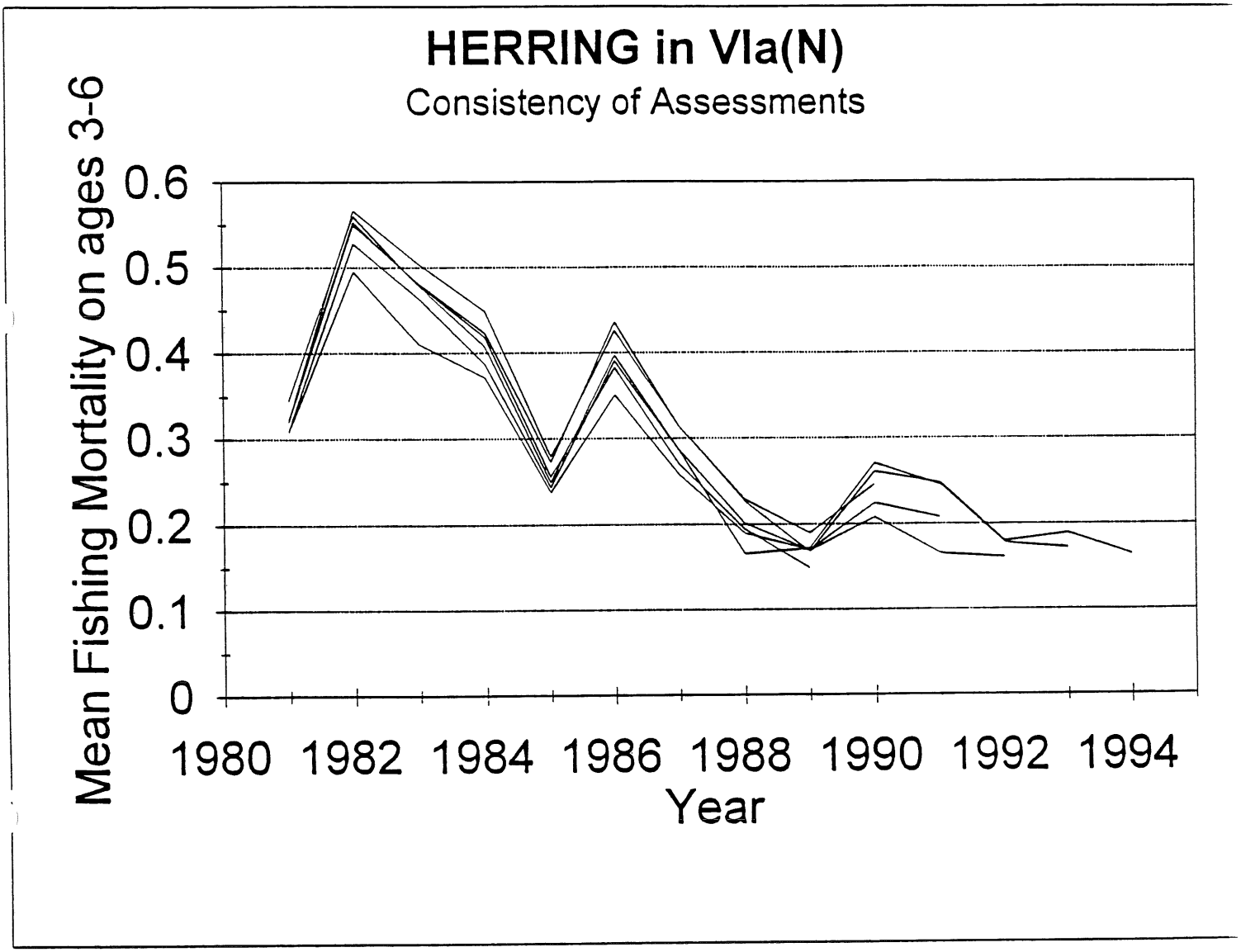


Figure 5.1.20. Herring in VIa(N). Estimates of fishing mortality (Arithmetic unweighted mean over ages 3 to 6) as made by the Herring Assessment Working Group in meetings from 1989 to date.

5.2 Clyde Herring

5.2.1 Advice and management applicable to 1993 and 1994.

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 TAC has been maintained at 1000t in 1993, 1994 and 1995. The ban on herring fishing to protect the indigenous spring-spawners, initiated in 1990 and extended in 1992 from 1 January until 30 April was continued for 1994 and 1995. Other fishing activities were allowed a 200 t maximum by-catch during the closed season. In addition the spawning grounds at Ballantrae bank were closed to all forms of active fishing from 1 February to 1 April in order to prevent disturbance to spawning shoals and to the demersal eggs themselves.

5.2.2 The fishery in 1994

Landings up to 1994 are presented in Table 5.2.1. Total landings were estimated to be 608 t compared with 852 t in 1993. Both estimates were below the TAC of 1 000t. Of the total landings, 572t were reported taken by pair trawlers in the directed fishery between July and December, and 36t were taken as a by-catch in demersal trawl fisheries in all months. Sampling levels in the fishery are given in Table 5.2.2 and are well above recommended levels.

An index of effort has been calculated by raising the number of days absence from port by pair trawlers by the ratio of pair trawl to total landings. Values are given in Table 5.2.3. Effort in 1994 was half the recorded level in 1993 and much lower than the lowest recorded level of 1992. The proportion of spring/autumn spawners in the catches could not be estimated.

5.2.3 Weight at age and stock composition

Problems in age-readings of Clyde herring in 1992 were addressed and commented on in the 1994 report (Anon, 1994a). In 1993 the anomalous age distribution, and in particular the marked high catch of 5-ring fish, was still evident. The catch at age in 1994 (Table 5.2.4) shows that this anomaly is no longer as evident as in previous years. The catches at age for the younger year classes, 1 to 4-ringers, have increased indicating possible improved recruitment to the fishery.

Weights at length have been assigned using the weight-length relationship observed in 1991 and assigned to ages accordingly. These are given in Table 5.2.5. As mean weights in the stock are not available from research vessel surveys for 1994, the weights in the stock used are simply the weights at age in the catches Weights at age in previous years are as used by the Working Group in 1994. Once again no attempt has been made to apportion catches between spring and autumn-spawning stocks for 1993. The landings data show that the fishery has been directed at aggregations of autumn-spawning fish, with 70% of the catch taken in the last quarter and virtually all of the remainder from July to September.

5.2.4 Surveys

No demersal egg surveys on the Ballantrae Bank and Brown Head spawning sites were carried out in 1994. The egg survey estimates of SSB up to 1993 are presented in Table 5.2.6. No acoustic surveys have been conducted in the Clyde since 1992. Historical survey data are presented in Table 5.2.7. The spring trawl surveys are no longer carried out but the historical data on the proportion of fish by age are presented in Table 5.2.8 .

5.2.5 Stock Assessment

Because of uncertainty about stock structure no formal analytical stock assessment has been attempted. No joint-stock VPA will be calculated on account of the known extensive migrations of autumn-spawners in and out of the area.

5.2.6 Stock and catch projections

As no analytical estimates of the stock have been calculated, no new stock projections can be provided.

5.2.7 Management considerations

The management of this fishery continues to be problematic due to the mixed-stock nature of the fishery and the absence of current fishery-independent survey data. Further research is required to improve our understanding of the Clyde stock structure. Suitable management objectives for the spring-spawners and autumn-spawners are necessarily distinct. The spring-spawning stock supported a strong and locally-important fishery from 1955 to 1974 at catch levels ranging from 4,000 t to 15,000 t. Catches then declined but increased again in the 1980's. A TAC of 3,000 t was set in 1984 but was exceeded in that year and the following three years. Since then catches have steadily declined and the stock shows no signs of recovering to its former level. However, the appearance of increased numbers of 1,2 and 3-ringers in the catches in 1994 may indicate some improved recruitment. Nevertheless, the stock is still at a very low level and current management measures should remain in force in order to protect it. Consequently, if

the objective is to restore the spring-spawning stock the catches should be reduced to as low a level as possible and the technical measures to protect the spring-spawning stock should remain in place.

5.2.8 Future research requirements

Provision of some fishery-independent survey data for this area is imperative if an analytical assessment for the stock is to be provided.

Table 5.2.1. Catches of HERRING from the Firth of Clyde. Spring and autumn-spawners combined. Catch in tonnes by country, 1955-1994.

Tonnes.

Year	Scotland	Other UK	Unallocated	Discards	Total used by WG	Agreed TAC
1955					4 050	
1956					4 848	
1957					5 915	
1958					4 926	
1959					10 530	
1960					15 680	
1961					10 848	
1962					3 989	
1963					7 073	
1964					14 509	
1965					15 096	
1966					9 807	
1967					7 929	
1968					9 433	
1969					10 594	
1970					7 763	
1971					4 088	
1972					4 226	
1973					4 715	
1974					4 061	
1975					3 664	
1976					4 139	
1977					4 847	
1978					3 862	
1979					1 951	
1980					2 081	
1981					2 135	
1982	2 506	-	262	1 253	4 021	
1983	2 530	273	293	1 265	4 361	
1984	2 991	247	224	2 308	5 770	3 000
1985	3 001	22	433	1 3443	4 800	3 000
1986	3 395	-	576	6793	4 650	3 100
1987	2 895	-	278	4394	3 612	3 500
1988	1 568	-	110	2454	1 923	3 200
1989	2 135	-	208	-2	2 343	3 200
1990	2 184	-	75	-2	2 259	2 600
1991	713	-	18	-2	731	2 900
1992	929	-	-	-	926	2 300
1993	852	-	-	-	852	1 000
1994	608	-	-	-	608	1 000

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 1988-1994

Year	Reported catch	No. of samples	No. of fish measured	No. of fish aged	Discards
1988	1,568	41	5,955	2,574	Based on local reports
1989	2,135	45	8,368	4,152	" "
1990	2,184	37	5,926	3,803	" "
1991	713	29	4,312	2,992	No information
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

Table 5.2.3 Effort on Clyde HERRING. Number of days' absence from port by pair trawlers in the Firth of Clyde, 1974 to 1992, and estimated total effort in pair trawl units.

Year	Days absent (pair trawl)	Raised to total landings
1974	3 376	3 376
1975	3 209	3 209
1976	3 016	3 016
1977	4 186	4 186
1978	4 379	4 379
1979	2 933	2 933
1980	1 982	1 982
1981	1 529	1 529
1982	1 755	1 755
1983	1 644	1 644
1984	1 401	1 401
1985	1 688	1 688
1986	1 375	1 375
1987	850	998
1988	540	626
1989	582	639
1990	388	429
1991	169	254
1992	137	165
1993	194	224
1994	104	111

Table 5.2.4 Clyde HERRING catch in numbers at age. Spring and autumn spawners combined. Thousands of fish.

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
1	716	42	145	3	399
2	1004	615	411	418	964
3	839	472	493	261	964
4	7533	703	385	268	358
5	576	1908	1305	1305	534
6	359	169	333	327	319
7	329	92	91	78	76
8	119	113	69	111	57
9	49	22	32	38	16
9+	16	9	10	0	17

Table 5.2.5 HERRING in the Firth of Clyde. Mean weights at age in the catch and stock (g).

Age (rings)	Weight in the stock (Spr spawn)		Weight in the catch									
			1970-81	1982-85	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	-	-	225	149	166	149	156	149	170	143	141	141	92
3	171	173	270	187	199	194	194	174	186	163	187	174	157
4	195	218	290	228	224	203	207	203	202	188	188	198	184
5	210	215	310	253	253	217	211	221	216	192	216	213	212
6	210	245	328	272	265	225	222	227	237	198	227	216	249
7	234	-	340	307	297	236	230	235	234	210	206	229	248
8	-	-	345	291	298	247	225	237	234	222	218	261	240
9	-	-	350	300	298	255	244	219	257	200	201	233	249
10+	-	-	350	300	321	258	230	254	272	203	221	254	294

Table 5.2.6 Clyde HERRING. Estimates of stock biomass from egg surveys on Ballantrae Bank and Brown Head in April and from fish in acoustic surveys in July, except for acoustic surveys in 1985 and 1986 in June. Tonnes of spawning fish Year

	1986	1987	1988	1989	1990	1991	1993
Egg survey :							
Spring-spawners							
Ballantrae			760	5 200	4 843	2 984	1 730
Brown Head					1 187	3 976	1 344
Total					6 730	6 960	3 074
Acoustic survey							
Total (2+ ringers)	6 600	9 000	16 100	12 400	18 400	11 900	

Table 5.2.7 Proportions of fish by age in the trawl surveys carried out in spring. These represent almost entirely spring-spawners.

Age (Rings)	1985	1986	1987	1988	1989	1990	1991	1993
1	5.8	11.3	10.4					
2	7.9	3.3	18.8	0.7	1.1		0.25	0.6
3	31.8	36.1	32.7	23.5	93.0	0.9	0.75	19.0
4	25.4	24.0	12.9	35.6	2.6	97.5	3.99	9.3
5	14.6	16.3	7.0	16.4	1.9	1.2	93.02	54.4
6	5.9	3.6	7.2	10.7	0.4	0.3	1.75	13.9
7	4.3	2.5	3.7	7.8	0.7		0.25	0.7
8	2.9	1.9	4.1	4.0				0.6
9	0.7	0.8	1.4	1.0	0.4			
10	0.5	0.3	1.6					
11+	0.2		0.6	0.2				

Table 5.2.8. Estimates of Clyde HERRING abundance at age from acoustic surveys.

Age (Rings)	1985	1986	1987	1988	1989
2	3 200	20 500	11 500	67 400	9 500
3	9 900	12 500	9 200	6 200	80 300
4	10 600	9 300	11 500	4 800	6 700
5	3 000	3 400	5 700	5 500	2 400
6	3 200	3 200	3 000	3 600	1 800
7	800	1 200	1 200	2 800	1 100
8	700		700	1 500	300

6. HERRING IN DIVISIONS VIa (SOUTH) AND VIIb,c

6.1 The Fishery

6.1.1 Advice and management applicable in 1994 and 1995

The TAC set for the area for 1994 was 28,000 tonnes. This was a precautionary TAC and was the same as that set for 1993 and 1992. The total catch estimated by the Working Group to have been taken from the stock in this area during 1994 was about 33,900 tonnes compared with 36,800 tonnes in 1993. The total catch therefore, as it has been every year since 1982, was considerably higher than the recommended level. ACFM in 1994 did not give any specific scientific advice for this stock for 1995 as it has not been possible to carry out an analytical assessment for a number of years. It did advise, however, that catches should not exceed the recent catch level of 36,000 tonnes, which was about the average level from 1990–1993. The TAC subsequently set by the EU for 1995 was again 28,000 tonnes.

6.1.2 Catch data

As has now been the position for a number of years the main catches from this area in 1994 were again taken by the Irish fleet.

The total amount of "unallocated" catches in 1994 amounted to about 6,200 tonnes. This total consisted of approximately 8,000 tonnes which were reported as having been taken in Division VIa (North) but which were in fact taken in Division VIa (South) and a negative unallocated catch of 1,800 tonnes.

The catches and landings taken by each country fishing in this area from 1985–1994 are shown in Table 6.1.1 and the total catch from 1970 is shown in Figure 6.1.1

The catches for 1994 are preliminary. It has not been found necessary to make any alterations to the 1993 data. Even though a substantial roe fishery has been developed in the area in recent years by the Irish fleet the quantities of herring discarded are believed to be very small. Estimates of herring discarded by the Dutch fleet are provided but catches by this fleet have in recent years been very small.

The pattern of the Irish fishery in 1994 was similar to that of 1992 and 1993, i.e. herring appeared to be distributed more northerly than in the years prior to 1992. As indicated in the 1994 Working Group report catches taken in the first quarter of 1993 and 1994 contained large numbers of full and spawning fish (40%). These fish were again present in the catches during January–March 1995. Throughout most of 1994 herring shoals were reported to be very scarce - particularly throughout Division VIIb. Catches in this area were very poor and shoals appeared to be almost completely absent from the traditional spawning areas. This scarcity of herring from west of Ireland was also reported by the Dutch fleet.

The composition of the Irish fleet in 1994 was very similar to that in 1993 and has been stable at about 18 vessels for a number of years. Landings were again regulated in weekly quotas and a closed season was again introduced during June and July.

6.1.3 Catch in numbers at age

The catches in numbers at age for this fishery since 1970 are shown in Table 6.1.2. These data are based mainly on samples from the Irish fishery, together with a small sample from the Dutch fishery. For a long period the age compositions of the catches from this fishery were similar to those from that in Division VIa (North). However in 1993 and 1994 considerable difference became apparent and this was particularly evident in 1994. The strong 1985 year class constituted 16% of the catches in Divisions VIa (South) and VIIb compared with 9% in Division VIa (North) while the 1990 year class which constituted 15% of the catches in Divisions VIa (South), VIIb constituted 30% of the catches in the northern area. The 1991 year class constituted 28% of the Irish catches. This year class was particularly apparent in the catches taken during the fourth quarter and the percentage age composition over the period 1970–1994 indicates that this year class may be the strongest to recruit to the fishery for some time.

6.1.4 Quality of the catch and biological data.

Although there have been reports of underreporting of the landings from this area management authorities in general seem confident of the accuracy of the figures in recent years. The scarcity of herring throughout 1994 did not put pressure on skippers to under-report to any great extent. Misreporting of catches to Division VIa (North) did, however, continue but it was possible to reallocate these catches using information from the fisheries. There was no misreporting of catches between Divisions VIIj and VIIb during 1994 because of the very poor fishing reported around the boundary line 52°30'N.

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. Although samples have been obtained throughout the year there is a relatively low sampling intensity during quarter 4 when catches are high compared to that of quarter 2 when catches are rather low.

6.2 Mean Weight at Age

The mean weights (g) at age in the catches in 1994 are based on a combination of Irish and some Dutch data and are shown below together with those for 1992 and 1993.

Year	Age							
	1	2	3	4	5	6	7	8
1992	95	141	147	157	165	171	180	194
1993	112	138	153	170	181	184	186	229
1994	81	141	164	177	189	187	191	204

The mean weights are again higher than those of 1993 which were in turn higher than those of 1992. These increases may be due to the increased catches taken during the fourth quarter and the increased numbers of full and spawning fish taken during the first quarter.

The 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. These mean weights are shown below, together with those for 1992 and 1993.

Year	Age							
	2	3	4	5	6	7	8	8+
1992	144	167	182	194	197	214	218	242
1993	166	196	205	214	220	223	242	258
1994	156	192	209	216	223	226	230	247

The mean weights of the spawning stock for 1994 are very similar to those of 1993

6.3 Young Fish Surveys

Young fish surveys were carried out during November in Divisions VIa (South) and VIIb. Over 60 stations were again sampled, as in a similar survey in 1993. These surveys have only been carried out for two years and it is not yet possible to use the results to provide an index of recruitment to the herring stock in the area.

6.4 Acoustic Surveys

An acoustic survey, designed to obtain an estimate of the total herring stock size in this area was carried out during July 1994. The vessel used was the R/V Lough Foyle and the results were presented in a working paper (Molloy and Fernandes, 1995.W.D.), and were also reported in the report of the 1994 Coordinated Acoustic Survey (Simmonds *et al.*, 1994.W.D.). The total stock size estimated from the survey was 350,000 t. However, this estimate was not accepted by the Working Group as an accurate estimate of stock size because it was based on extremely limited biological information and very poor verification of observed fish traces. During the survey extreme difficulty was experienced in relocating observed herring shoals and in actually catching herring. In fact throughout the survey no samples of adult herring were obtained. The estimate was, however, consistent with total stock sizes indicated from tentative VPAs for the area in recent years. Although it was not possible to use this survey as an indication of stock size it is considered extremely important that these surveys should be continued and that every effort should be made to improve the sampling techniques employed – a possible solution is the use of nets with much larger mouth openings than those used during the 1994 survey and/or the use of chartered commercial vessels. The Working Group therefore recommends that the surveys should be continued and that every effort should be made to ensure that sufficient biological data are obtained to enable proper stock estimates to be made.

6.5 State of the Stock

No analytical assessment has been carried out on this stock in recent years because of the absence of any fishery-independent data. Although an acoustic survey was carried out in 1994 the stock estimate was not considered sufficiently reliable on which to base an assessment. It was decided therefore that no assessment would again be carried out for the purpose of providing management advice.

As mentioned in the 1994 report the landings in this area in recent years have been very stable and there has been little change in the composition of the fleets. In general, recent working groups, on the basis of available information, have suggested that the stock did not appear to be heavily exploited. It was pointed out, however, that the stock was declining each year as the strong 1985 year class passed through the fishery and came to the end of its natural life span and because it had not been replaced by any other year class of similar strength. During 1994 there have been continuous reports from fishermen about a scarcity of herring throughout the area – particularly in Division VIIb.

In the absence of any data necessary for assessments, it was decided to adopt the same procedure as that adopted at recent Working Group meetings. A VPA was therefore carried out in order to study the development of the stock in recent years. A separable VPA was carried out using the updated data and a terminal S value of 1.2 and downweighted prior to 1989 to 0.001. Using a reference age of 4 the exploitation pattern rose sharply on age 7. This sharp rise was also apparent in similar separable VPAs carried out in 1993 and 1994. The results of the separable VPA are shown in Table 6.5.1. As in 1994 the terminal populations from the separable VPA using an input F value = 0.30 were used to carry out a traditional VPA. This value was again selected to be consistent with that selected in 1993 and 1994 and to reflect the apparent stability of effort in the area. The

summary results from this VPA are shown in Table 6.5.2. For comparative purposes VPAs were also carried out using input F values of 0.2, 0.4 and 0.5. The resulting spawning stock estimates are shown in Figure 6.5.1.

The results from the VPA indicate that the spawning stock was at its maximum level of 268,000 t in 1988 when it was boosted by the recruitment of the exceptionally strong 1985 year class. This year class appears to have been the strongest one to recruit to the fishery since 1970. Since 1988 the stock has declined each year as the 1985 year class progressed through the fishery. Fishing mortality appears to have been rather stable. The VPA would suggest that in 1990 the spawning stock may have been between 150,000 t and 200,000 t. Since then the spawning stock has declined but the present level is not known.

6.6 Management Considerations

Although it has not been possible to carry out an assessment for this stock or to carry out any predictions it is important for management authorities to be aware that the stock has declined in recent years. This decline will not be reversed until another strong year class enters the fishery. There are some indications from the age composition of the 1994 catches that the 1991 year class may be above average size but this is by no means certain. It is therefore extremely important that every effort should be made to ensure that the 1995 catches are restricted to the advised level of 28,000 t. In this respect it is also important to ensure that no misreporting of catches from Division VIa (North) takes place.

6.7 Risk Analysis and Projections

As no assessment has been carried out on this stock for a number of years and because no recruitment indices are available it is not possible to carry out risk analyses or to make projections

6.8 Appropriateness of Controls on Catch and Fishing Effort

In this area the main catches in recent years have been taken by the Irish fleet. The total national quota is administered by a local management committee which divides it throughout the year according to market requirements. The quota is further divided into boat quotas per week according to boat categories. Enforcement of boat quotas is carried out by local fishery officers. While the controls on catch are in theory appropriate to ensure that landings are restricted to the permitted level the actual enforcement of control measures has proved difficult, unless there is intense and consistent monitoring of landings at port level. In addition area misreporting of catches cannot be detected unless there is continuous surveillance of fleets while at sea.

6.9 Potential for Multispecies or Multiannual Catch Options

As in Division VIa (North) herring in this area is caught in a single species directed fishery with little by-catch. There is no information available about interactions with other species in the area. There does not appear to be any possibility of carrying out multispecies assessments in the near future.

At present, as it is not possible to carry out stock predictions it is not possible to provide multiannual catch options.

Table 6.1.1 Estimated Herring catches in tonnes in Divisions VIa (South) and VIIb,c, 1985–1994. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

Country	1985	1986	1987	1988	1989
France	-	-	-	-	-
Germany, Fed.Rep.	-	-	-	-	-
Ireland	13,900	15,540	15,000	15,000	18,200
Netherlands	1,270	1,550	1,550	300	2,900
UK (N.Ireland)	-	-	5	-	-
UK (England + Wales)	-	-	51	-	-
UK Scotland	-	-	-	-	+
Unallocated	8,204	11,785	31,994	13,800	7,100
Total landings	23,374	28,785	48,600	29,100	28,200
Discards	-	-	-	-	1,000
Total catch	23,374	28,785	48,600	29,100	29,200

Country	1990	1991	1992	1993[1]	1994[1]
France	+	-	-	-	-
Germany, Fed.Rep.	-	-	250	-	-
Ireland	25,000	22,500	26,000	27,600	24,400
Netherlands	2,533	600	900	2,500	2,500
UK (N.Ireland)	80	-	-	-	-
UK (England + Wales)	-	-	-	-	50
UK (Scotland)	-	+	-	200	-
Unallocated	13,826	11,200	4,600	6,250	6,250
Total landings	41,439	34,300	31,750	36,550	33,200
Discards	2,530	3,400	100	250	700
Total catch	43,969	37,700	31,850	36,800	33,900

[1]Provisional

Table 6.1.2 Herring West of Ireland and Porcupine Bank and lower part of VIa (fish catch in numbers).

12:21 Wednesday, March 29, 1995

Catch in Numbers (Thousands)

(CANUM)

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	3784	1130
1991	0	675	34437	27810	12420	100444	17921	14865	11311	7660
1992	0	2592	15519	42532	26839	12565	73307	8535	9203	6286
1993	0	191	20562	22666	41967	23379	13547	67265	7571	6013
1994	0	11709	56156	31225	16877	21772	13644	8597	31729	10093

Table 6.1.3 Divisions VIa (South) and VIIb. Sampling intensity of catches in 1994

Country	Q	Catch[1]	No. of samples	No. of age readings	No. of fish measured	Aged per 1000 t.	Estimate of discards
Ireland	1	5000	6	298	1634	60	No
	2	5000	15	692	2942	138	No
	3	700	3	150	150	214	No
	4	21700	16	794	3956	37	No
Netherlands	3	1300	3	75	307	236	Yes
	4	+	-	-	-	-	
UK (England & Wales)	4	+	-	-	-	-	No

[1] Including Division VIa (North)

Table 6.1.4 Divisions VIa(S) and VIIb. Length distributions of Irish catches (pelagic trawlers) per quarter (10^3) in 1994.

Length	1st quarter	2nd quarter	3rd quarter	4th quarter
18.0				
18.5				63
19.0		11		316
19.5		11		726
20.0	21	33		1105
20.5	42	45		1926
21.0	83	67		1516
21.5	63	67		947
22.0	229	212		789
22.5	334	323		884
23.0	626	680	23	1074
23.5	584	735	23	1579
24.0	584	1404	-	2368
24.5	563	1136	69	3757
25.0	1022	1638	207	7042
25.5	1147	1270	229	9758
26.0	1564	1437	275	12853
26.5	1460	1582	275	9537
27.0	2336	2150	367	9158
27.5	3900	3130	436	8116
28.0	6423	5158	551	10327
28.5	5526	5091	436	12253
29.0	4171	4133	413	14148
29.5	1814	1727	69	7326
30.0	980	624	69	5179
30.5	250	100		1295
31.0	271	-		537
31.5	42	11		221
32.0	42			126
32.5				
Total	34077	32775	3442	124926

Table 6.5.1 Herring west of Ireland and Porcupine Bank and lower part of Division VIa..

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At 29-Mar-95  14:40:18

Separable analysis
from 1970 to 1994 on ages  1 to  8
with Terminal F of  .400 on age  4 and Terminal S of 1.200

Initial sum of squared residuals was   457.259 and
  final sum of squared residuals is     70.650 after 114 iterations

Matrix of Residuals
```

Years,	1970/71	1971/72	1972/73	1973/74
1/ 2,	-.675,	.153,	-.143,	2.125,
2/ 3,	1.838,	-.488,	.103,	.633,
3/ 4,	.686,	.420,	.352,	.230,
4/ 5,	.011,	.060,	-.246,	-.123,
5/ 6,	-.366,	-.009,	-.142,	-.232,
6/ 7,	-.416,	-.007,	-.013,	-.011,
7/ 8,	-.432,	-.364,	.385,	-.523,
TOT ,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,

Years,	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84
1/ 2,	.814,	2.054,	1.853,	.865,	1.734,	1.679,	.973,	.630,	-.325,	-1.336,
2/ 3,	.446,	.468,	.575,	.579,	1.106,	.338,	-.015,	.352,	-.243,	.096,
3/ 4,	.111,	-.224,	.046,	-.390,	.204,	-.154,	.256,	.011,	-.104,	.217,
4/ 5,	.142,	-.292,	-.234,	-.161,	.025,	-.220,	-.045,	-.071,	-.051,	.212,
5/ 6,	.024,	.017,	-.072,	.208,	-.068,	.083,	-.154,	-.133,	.081,	-.117,
6/ 7,	-.182,	.167,	-.120,	.147,	-.396,	.004,	.011,	.475,	.199,	.018,
7/ 8,	-.726,	-.338,	-.086,	-.573,	-.701,	-.239,	-.162,	-.894,	-.060,	-.208,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	TOT,	WTS,
1/ 2,	1.520,	2.267,	.059,	1.959,	-3.053,	1.145,	-.402,	.162,	1.488,	-2.407,	.000,	.114,
2/ 3,	.473,	-.113,	-.113,	-.183,	-.744,	-.423,	.206,	.133,	.209,	-.130,	.000,	.300,
3/ 4,	.664,	-.028,	.009,	.063,	.387,	-.481,	.312,	-.071,	.138,	.099,	.000,	.567,
4/ 5,	.105,	-.389,	-.094,	-.272,	.247,	.032,	.052,	-.340,	.037,	.221,	.000,	.887,
5/ 6,	-.382,	.127,	.291,	-.047,	.077,	.054,	-.028,	.013,	-.156,	.118,	.000,	1.000,
6/ 7,	-.043,	.025,	-.197,	-.114,	.181,	-.155,	-.099,	.373,	-.069,	-.049,	.000,	.793,
7/ 8,	-.906,	-.028,	-.073,	.426,	-.216,	.761,	-.325,	-.062,	-.327,	-.041,	.000,	.407,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	12.805,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1970,	1971,	1972,	1973,	1974,					
F-values,	.2182,	.1851,	.2594,	.3389,	.4980,					
,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
F-values,	.5306,	.6406,	.4147,	.3307,	.3451,	.4787,	.3710,	.2893,	.4656,	.2419,
,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
F-values,	.2196,	.2191,	.4233,	.2661,	.2367,	.3081,	.3003,	.3017,	.4000,	.4000,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,	8,
S-values,	.0062,	.3483,	.7396,	1.0000,	1.0826,	1.2488,	1.4151,	1.2000,

Table 6.5.2 Herring West of Ireland and Porcupine Bank (VIa South).

At 30-Mar-95 17:28:43

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- 7,
1970,	392543,	175110,	103480,	20306,	.1962,	.8968,	.2175,
1971,	791759,	199635,	93623,	15044,	.1607,	.8707,	.1983,
1972,	709049,	214289,	102677,	23474,	.2286,	.8975,	.2708,
1973,	511738,	249742,	136736,	36719,	.2685,	1.0162,	.3259,
1974,	560842,	201061,	89142,	36589,	.4105,	.9762,	.4933,
1975,	382650,	192294,	91883,	38764,	.4219,	1.1237,	.5242,
1976,	645460,	184642,	65004,	32767,	.5041,	1.0472,	.6212,
1977,	537098,	171525,	72265,	20567,	.2846,	1.0778,	.3906,
1978,	962299,	216474,	71140,	19715,	.2771,	1.0161,	.3131,
1979,	885332,	248286,	98610,	22608,	.2293,	1.0664,	.3528,
1980,	477547,	196684,	97513,	30124,	.3089,	.9636,	.5053,
1981,	613379,	208512,	96519,	24922,	.2582,	1.0312,	.3864,
1982,	644853,	210525,	100026,	19209,	.1920,	1.0301,	.2941,
1983,	2024491,	382533,	94390,	32988,	.3495,	1.0042,	.4767,
1984,	890989,	311328,	157095,	27450,	.1747,	.9688,	.2507,
1985,	1133971,	309138,	154930,	23343,	.1507,	.9846,	.2362,
1986,	893031,	327718,	189730,	28785,	.1517,	1.0002,	.2355,
1987,	3205761,	525533,	159249,	48600,	.3052,	.9488,	.4644,
1988,	439644,	389501,	268222,	29100,	.1085,	.9992,	.3307,
1989,	713556,	349554,	200125,	29210,	.1460,	1.0010,	.2629,
1990,	940080,	333545,	172724,	43969,	.2546,	1.0006,	.3087,
1991,	471880,	261246,	161972,	37700,	.2328,	.9971,	.2917,
1992,	796433,	249766,	128180,	31856,	.2485,	.9951,	.2767,
1993,	871348,	283195,	131170,	36763,	.2803,	1.0060,	.3786,
1994,	10722298,	1220260,	126689,	33908,	.2676,	.9980,	.3172,
Arith. Mean ,	1248721,	304484,	126524,	29779,	.2564		.3489,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

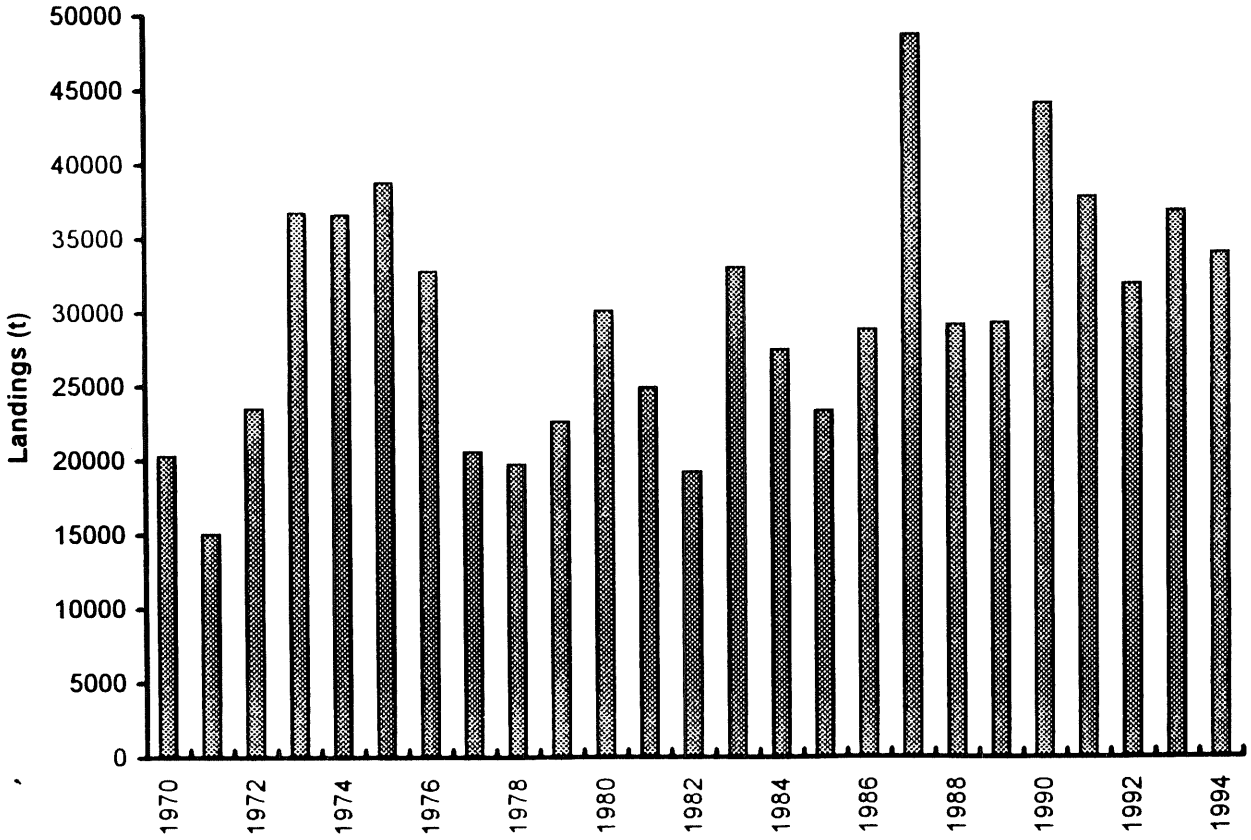

Figure 6.1.1 Herring: Landings from Divisions Via (S) and VIIb for the period 1970 to 1994.

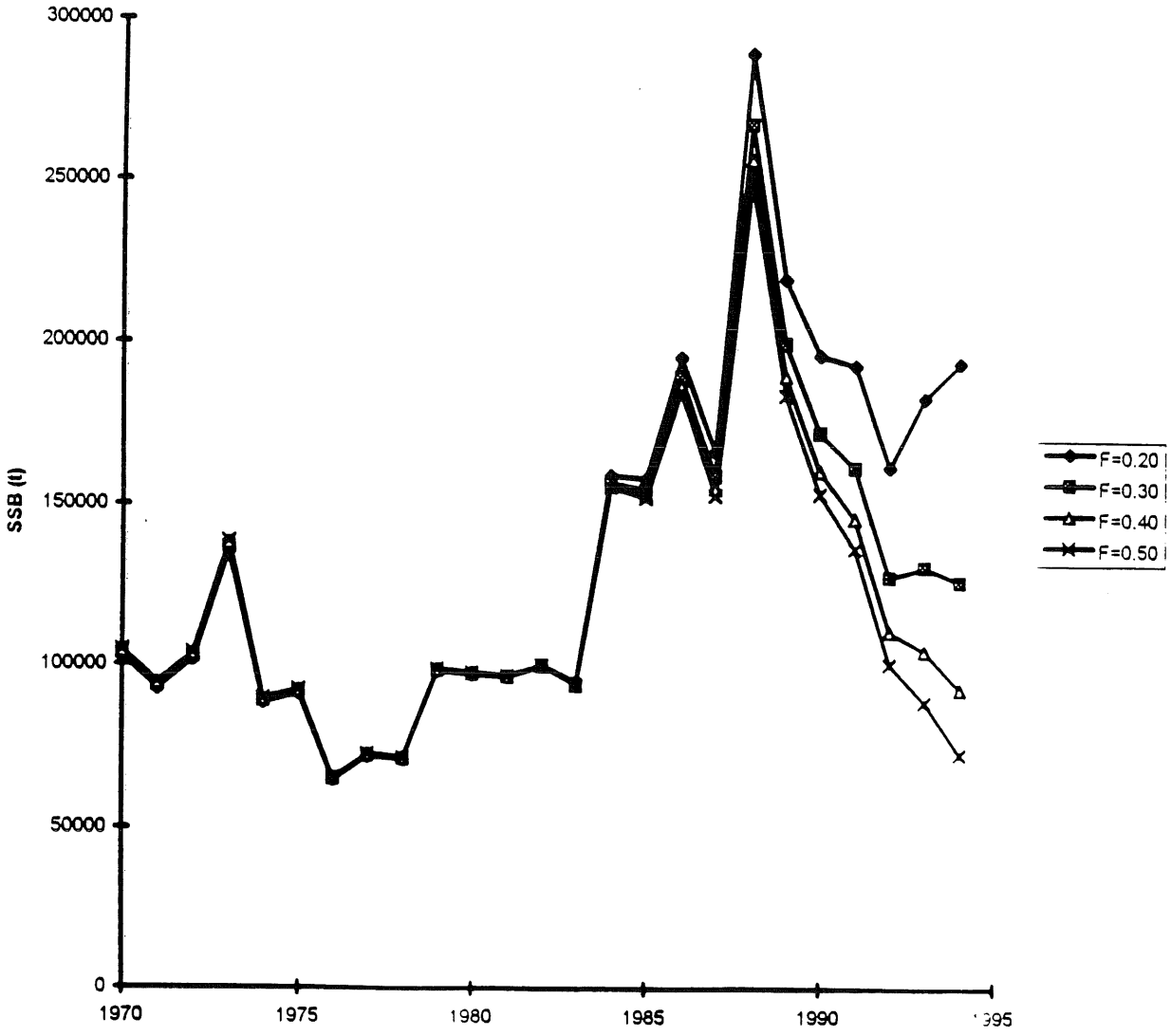

Figure 6.5.1 Divisions Via (S) and VIIb. SSB levels arising from different input levels of F in 1995.

7. IRISH SEA HERRING (DIVISION VIIa, NORTH)

7.1. The Fishery

7.1.1. Advice and management applicable to 1994 and 1995

In 1993 no analytical assessment was undertaken due to continued uncertainty about the fishing mortality and level of SSB. It was suggested that there would be a slight reduction in SSB if current catch levels were maintained or the TAC of 7,000t was taken. ACFM recommended a catch of approximately 5,300t for 1994. The EU subsequently adopted a TAC of 7,000t for 1994. This was partitioned as 1,820 t to the Republic of Ireland and 5,180 t to the UK. The spawning and nursery closures were maintained. However, the EU in conjunction with the Northern Irish authorities sanctioned limited exploitation (for scientific purposes) within the spawning closed area to the east of the Isle of Man.

The UK fishery started in the third week of June. The area to the east of the Isle of Man (encompassing the Douglas Bank spawning ground) was closed on 21 September. Two sets of pair trawlers undertook fishing operations within the closed area between 26 and 30 September and again between 19 and 20 October. The Mourne skiff fishery opened in September and closed in November. Fishing by the Republic of Ireland opened in the second week of August but no catches were recorded.

In 1994, ACFM concluded that the present state of the stock is not known. Consequently ACFM advice was that if a precautionary TAC is required for 1995 it should not exceed the recent catch levels of 5,100 t (average over the period 1990-1993). A TAC of 7,000 t was subsequently adopted for 1995 and again partitioned as 1,820 t to the Republic of Ireland and 5,180 t to the UK. ACFM also considered a request by the UK (Northern Ireland) for amendment of the spawning closure to the east of the Isle of Man. Due to not being able to assess the state of Division VIIa(N) stock and uncertainty about its present status ACFM stated that it was not possible to evaluate on scientific grounds the effect of the current closure or of the proposed amendments.

7.1.2. The fishery in 1994

The catches reported from each country for the period 1981 to 1994 are given in Table 7.1.1. Again there has been no estimate of discarding or slipping. The total catch of 4,828 t was again below the recommended TAC of 7,000 t. The catches reported here also include 718 t from the 'experimental fishery' in the spawning closed area, which was not put against quota. The Republic of Ireland did not take any herring in Division VIIa(N) because of difficulties in obtaining markets for non-roe herring. The Northern Ireland fleet took 71% of their catch in the 2nd and 3rd quarters and the remainder in the 4th quarter.

7.1.3. Quality of catch and biological data

The quality of landings data is probably quite good. However, there are still no estimates of discarding or slippage.

Biological sampling in this fishery remains fairly high with approximately one sample per 81 t landed (Table 7.1.2). Coverage in the 4th quarter could still be improved. The question of potential ageing problems with the Isle of Man data was resolved in 1995 with a small workshop involving otolith readers from Northern Ireland, the Republic of Ireland and the Isle of Man.

7.1.4. Catch in number at age

Catches in numbers at age are given in Table 7.1.3 for the years 1972 to 1994. The predominant age group in 1994 was the 3-ringers (1990 year class) which was prevalent in the 1993 fishery as 2-ringers. This year class constituted approximately 39% of the total catch in numbers. The last above-average year class (1985) also constituted 39% of the catch in numbers at 3-ringer age. There was a fairly even representation of 4, 5, 6 and 8+ ringers. The catch in numbers at length is given in Table 7.1.4 for 1988 to 1994. The distribution of lengths was similar to the preceding year with a low abundance of fish over 30cm. The progression of the 1990 year class from 1992 to 1994 is clear in the length frequency distribution.

7.2. Mean length, weight and maturity at Age

Mean lengths at age were calculated for the 3rd quarter using the Northern Ireland data and are given for the years 1985 to 1994 in Table 7.2.1. In general mean lengths have remained fairly stable since 1988.

Mean weights at age in the stock are given in Table 7.2.2. Mean weights at age in 1994 were comparable to those in 1993. The weight at age in the stock (WEST) file again uses third quarter mean weights.

The maturity ogive used in 1994 (Anon. 1994) 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.

7.3. Research surveys and scientific experiments

7.3.1. Acoustic surveys

Acoustic surveys were undertaken both over the whole north Irish Sea (Division VIIa(N)) (Northern Ireland)

and on Douglas Bank (Isle of Man). The Division VIIa(N) survey was undertaken between 28 August and 8 September (slightly later than in previous years) (Armstrong 1995a WD). This year an EK500, split-beam system was used. Coverage of the area was complete; in some areas survey lines were only 2NM apart. There are some problems with reconciling the output data between two software packages and as such the estimates can only be considered as preliminary. Estimates of variance have also not been computed. The preliminary results suggest a total stock biomass of between 29,000 and 35,000t (Table 7.3.1).

The acoustic survey on the spawning aggregation (22-24 September 1994) on Douglas Bank was undertaken using a single beam EY500. The same software problems were also encountered as with the Northern Irish survey. Again preliminary estimates of the spawning aggregation are of the same order of magnitude as the Northern Irish survey. It is hoped that the problems can be resolved for both surveys and the data can then be made available by the next Working Group meeting.

7.3.2. Larvae surveys

Larvae surveys were again undertaken by Northern Ireland (whole of Division VIIa(N)) and the Isle of Man (Douglas Bank and northeast of the Isle of Man). The Douglas Bank survey (the 6th in the series) was undertaken between 12 and 14 October over the usual 5nm grid centred on Douglas Bank (see Nash & Hughes 1995a WD). The numbers of larvae at 6mm and the average number per m^2 was higher than the previous year (Table 7.3.2). The distribution of spawning dates, back-calculated from the length at capture, suggested that the majority of the larvae in the area were spawned around 30 September. This is consistent with previous years, the acoustic survey on Douglas Bank and the experimental fishing experiment (see below).

The larvae survey to the northeast of the Isle of Man (the 3rd in the series) indicated that the numbers of larvae produced, based on back-calculation to 6mm, was higher than in the previous year but still an order of magnitude less than in 1992 (Table 7.3.2). An examination of the length frequencies and estimated spawning dates (Nash & Hughes 1995b WD) suggests that there is probably a sampling problem with this survey. The Isle of Man utilizes a 50 cm, 20 cm aperture Gulf III and it is possible that the larger larvae have not been properly represented in the 1993 and 1994 surveys. This may lead to the large variability seen in this index which was commented on by ACFM. In 1995 the Isle of Man will utilize a 76 cm, 30cm aperture Gulf III (identical to the one utilized by Northern Ireland).

The Northern Irish survey covered the majority of Division VIIa(N) in 1994 and the 1993 survey results were also made available (Dickey-Collas 1995 WD, Table 7.3.1). These surveys indicated an increase in larvae produced between 1993 and 1994. However, the results appear more consistent than the Isle of Man results. The length frequencies and estimated spawning dates were more realistic than the Isle of Man data. These surveys also suggested that peak spawning could have been up to one week later in 1994 than 1993. The 1994 survey also suggested that the number of larvae at 6mm produced by the Mourne component was two orders of magnitude less than the Manx component.

7.3.3. Commercial fishing experiment in the spawning closed area

An experimental commercial fishing experiment was started on the herring spawning grounds to the east of the Isle of Man on 26 September (one week after the closure of the spawning grounds) (see Armstrong 1995b WD). The objectives were:

1. To improve the scientific understanding of distribution, population structure, biological parameters and behaviour of spawning herring on the Douglas Bank spawning ground over the entire spawning period.

2. To provide information allowing optimum design of scientific acoustic surveys of the spawning aggregations.

3. To investigate the likely nature of fishing operations on the spawning aggregations and the potential risk to the stock caused by discarding or slipping of unwanted catches if the spawning ground was open to fishing.

Objectives 1 and 2 related to scientific studies and objective 3 related to the impact of a commercial fishery operating at this time.

The initial design of the experiment was to allow two pairs of Northern Irish vessels to fish inside the closed box for two 24h periods each during a week. They were also required to return to port to offload their catches. An observer accompanied each trip and maintained a detailed log of all operations. A sample of fish was taken from each haul for biological parameters. The experiment was terminated after the first week due to the large catches taken (718 t) and was not resumed until a new protocol could be agreed between the Isle of Man and UK authorities. Poor weather delayed the restart of the experiment until 19 October. The new protocols for the experiment were that fishing could take place only over two 24h periods, the catch per trip would be limited to 100t between the two vessels and there was an overall limit of 700t for the remainder of the experiment.

During the experiment (four days of fishing) the four vessels landed 663t and slipped a further 55t. The catch levels indicate that these four vessels could remove approximately 400 t in a 24h period. It is obvious that

with only four vessels operating substantial catches could be taken from this relatively short time period during the spawning season. Information from when the experiment restarted (19 October) and the larvae surveys suggest that the spawning aggregation is mainly present from 21 September to around the second week in October, i.e. approximately 3 weeks.

The results from the commercial fishing experiment, which were reported to the Working Group, have not provided any new information from which an assessment can be undertaken.

7.4. Stock Assessment

7.4.1. Estimation of fishing mortality and trends in abundance

There was no information available to tune a VPA; therefore no new analytical assessment could be undertaken. Acoustic surveys estimated a stock size of about 28,000 t and therefore for illustrative purposes only a separable VPA with a terminal F of 0.15 was chosen to reflect this perception (Table 7.4.1).

Natural mortality 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.

7.4.2. Exploitation pattern

Age 3-ring herring were chosen as the reference age for the exploitation pattern generated by the separable VPA and unweighted mean Fs were generated for age classes 2-6-ring fish. This is consistent with analyses in previous years. The separable VPA output with a terminal F of 0.15 is given in Table 7.4.1. The exploitation pattern was essentially flat topped.

7.4.3. Results of VPA

There is considerable doubt as to the stock level as there are still no reliable fishery-independent data. The VPA with an input F of 0.15 is given to illustrate the trends in fishing mortality, landings, SSB and recruitment (Figure 7.4.1). The outputs for F=0.15 are given in Tables 7.4.2 to 7.4.4. This VPA suggests a slow decline in SSB from 1988 onwards with a sharp increase in 1993, primarily due to the strong 1990 year class. Due to the uncertainties in the assessment a number of plausible input Fs (0.1-0.3) are also presented (Figure 7.4.2). A similar pattern of change in SSB is seen over the range of Fs.

7.5. Stock and Catch Projection

The Working Group is very unsure of the SSB level and fishing mortality so no catch projections were undertaken for this stock. However, there was an increase in SSB in 1993 as the strong 1990 year class entered the adult phase. This year class will form a significant portion of the stock for at least the next three years. The stock also contains a wide range of year classes with the strong 1985 year class still present as 8+ ringers.

7.6. Management considerations

7.6.1. Management Advice

It appears that maintaining current catch levels (approximately 5,000 t) will not harm this stock. More detailed advice, including risk analysis, medium-term projections and the potential for mutispecies or multiannual catch options cannot be given until reliable fishery-independent data are available.

7.6.2. Spawning and Juvenile Fishing Area Closures

Due to the uncertainty about the size of this stock and because a large proportion of the Manx stock aggregates in a small area for spawning, the closure of the spawning areas should be maintained for 1996. The closure of the existing nursery areas should also be maintained.

7.7. Research and Data Requirements

There is still an urgent need to provide information on the extent of mixing of adults in Dision VIIa(N) with adults from adjoining areas - e.g. Divisions VIa North and South and the Clyde. There is also a need to establish the extent of emigration of 1-ring herring each year from the Irish Sea to the Celtic Sea. This could be established by a series of tagging experiments. The Irish Sea wide and north-east sector larvae surveys should be continued and inconsistencies in sampling strategy resolved. The acoustic surveys should be continued. Estimates of discarding and slippage in this fishery should be made.

Table 7.1.1. Irish Sea HERRING (Division VIIa(N)). Catch in tonnes by country, 1981-1994. These figures do not in all cases correspond to the official statistics and cannot be used for mangement purposes.

Country	1981	1982	1983	1984	1985	1986	1987
France	-	-	48	-	-	-	-
Ireland	283	300	860	1,084	1,000	1,640	1,200
UK	4,094	3,375	3,025	2,982	4,077	4,376	3,290
Unallocated	-	1,180	-	-	4,110	1,424	1,333
Total	4,377	4,855	3,933	4,066	9,187	7,440	5,823

Country	1988	1989	1990	1991	1992	1993	1994
France	-	-	-	-	-	-	-
Ireland	2,579	1,430	1,699	80	406	0	0
UK	7,593	3,532	4,613	4,318	4,864	4,408	4,828
Unallocated	-	-	-	-	-	-	-
Total	10,172	4,962	6,312	4,398	5,270	4,408	4,828

Table 7.1.2 HERRING. Sampling intensity of commercial landings for Division VIIa (N) in 1994.

Quarter	Country	Landings (t)	No. samples	No. fish measured	No. fish aged	Estimation of discards
1	Ireland	0	-	-	-	-
	UK (N.Ireland)	+	0	0	0	No
	UK (Isle of Man)	0	-	-	-	-
	UK (England and Wales)	0	-	-	-	-
2	Ireland	0	-	-	-	-
	UK (N.Ireland)	11	0	0	0	No
	UK (Isle of Man)	81	1	409	47	No
	UK (England and Wales)	0	-	-	-	-
3	Ireland	0	2*	569	100	No
	UK (N.Ireland)	2,600	35	2,819	975	No
	UK (Isle of Man)	635	13	3,315	567	No
	UK (England and Wales)	157	0	0	0	No
4	Ireland	0	-	-	-	-
	UK (N.Ireland)	1,345	8	872	200	No
	UK (Isle of Man)	0	-	-	-	-
	UK (England and Wales)	0	-	-	-	-

* Samples from NI landings

Table 7.1.3 Herring in the North Irish Sea (Manx plus Mourne herring, Division VIIa(N)).

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

Catch in Numbers (Thousands)

(CANUM)

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

Table 7.1.4 HERRING in Division VIIa (North). Catch at length for 1988-1994. Numbers of fish in thousands.

Length	1988	1989	1990	1991	1992	1993	1994
14	1						
	1						
15	1				95		
	10				169		
16	13		6		343		
	16		6	2	275		
17	29		50	1	779		84
	44	24	7	4	1,106		59
18	46	44	224	31	1,263		69
	85	43	165	56	1,662		89
19	247	116	656	168	1,767	39	226
	306	214	318	174	1,189	75	241
20	385	226	791	454	1,268	75	253
	265	244	472	341	705	57	270
21	482	320	735	469	705	130	400
	530	401	447	296	597	263	308
22	763	453	935	438	664	610	700
	1,205	497	581	782	927	1,224	785
23	2,101	612	2,400	1,790	1,653	2,016	1,035
	3,573	814	1,908	1,974	1,156	2,368	1,473
24	5,046	1,183	3,474	2,842	1,575	2,895	2,126
	5,447	1,656	2,818	2,311	2,412	2,616	2,564
25	5,276	2,206	4,803	2,734	2,792	2,207	3,315
	4,634	2,720	3,688	2,596	3,268	2,198	3,382
26	4,082	3,555	4,845	3,278	3,865	2,216	3,480
	4,570	3,293	3,015	2,862	3,908	2,176	2,617
27	4,689	2,847	3,014	2,412	3,389	2,299	2,391
	4,124	2,018	1,134	1,449	2,203	2,047	1,777
28	3,406	1,947	993	922	1,440	1,538	1,294
	2,916	1,586	582	423	569	944	900
29	2,659	1,268	302	293	278	473	417
	1,740	997	144	129	96	160	165
30	1,335	801	146	82	70	83	9
	685	557	57	36	36	15	27
31	563	238	54	12	2	4	
	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

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

Table 7.3.1 Herring: Summary of acoustic survey information for Division VIIa(N) for the period 1989-1995.

Year	Location		Dates of surveys	Adult herring (t)	Sprat (t)
	Douglas Bank	VIIa(N)			
1989	Spawning aggregation		25-26th September	18,000	
1990	Spawning aggregation		26-27th September	26,600	
1991		Mainly west of IoM	26th July-8th August	10,300	66,000
1992		Mainly west of IoM	20th-31st July	10,400	41,200
1993	Spawning aggregation		22nd-25th September	*	
1994		Total	28th August-8th September	25,000-35,000[a]	
	Spawning aggregation		22nd-26th September	*	
1995		Total	11th-22nd September[b]		
	Spawning aggregation		21st-26th September[b]		
	Spawning aggregation		23rd-26 September[b]		

* data not supplied to the WG

[a] Preliminary estimate only

[b] Projected dates

Table 7.3.2 HERRING larval production (10^{11}) indices for the Manx component of Division VIIa(N

Year	Douglas Bank	North east of the Isle of Man	
		Northern Ireland	Isle of Man
1989	3.39		
1990	1.92		
1991	1.56		
1992	15.64		128.86
1993	4.81	34.7	1.10
1994	7.30	52.5	12.50

Table 7.4.1 HERRING in the North Irish Sea (Manx + Mourne herring).

```
Title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: NIRS-FIRST)

At 28-Mar-95  18:27:04

Separable analysis
from 1972 to 1994 on ages  1 to  7
with Terminal F of  .150 on age  3 and Terminal S of 1.000

Initial sum of squared residuals was   146.951 and
  final sum of squared residuals is     20.172 after  80 iterations

Matrix of Residuals
```

Years, Ages	1972/73	1973/74
1/ 2,	1.529,	.966,
2/ 3,	-.634,	-.398,
3/ 4,	-.026,	.195,
4/ 5,	-.150,	-.100,
5/ 6,	.140,	.089,
6/ 7,	.019,	-.322,
TOT ,	-.001,	-.001,
WTS ,	.001,	.001,

Years,	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84
1/ 2,	1.111,	.900,	1.117,	.987,	.464,	.609,	-.313,	-.004,	.227,	-.332,
2/ 3,	-.088,	-.029,	-.219,	-.074,	-.448,	-.220,	.465,	.127,	.172,	.128,
3/ 4,	.117,	.012,	-.077,	-.007,	.184,	.053,	.258,	-.531,	-.204,	-.030,
4/ 5,	.030,	-.004,	.087,	.218,	.237,	-.122,	-.291,	1.295,	.765,	-.076,
5/ 6,	-.256,	.089,	-.064,	.000,	-.456,	-.078,	.116,	-.166,	-1.242,	-.203,
6/ 7,	-.389,	-.458,	-.153,	-.513,	.173,	.038,	-.622,	-.126,	.519,	.296,
TOT ,	.000,	.000,	.000,	.001,	.001,	.002,	.004,	.007,	.005,	.002,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	TOT,	WTS,
1/ 2,	.310,	-.441,	.220,	-.099,	.093,	-.573,	-.169,	.549,	.899,	-.714,	-.001,	.276,
2/ 3,	-.189,	-.326,	.200,	.165,	-.484,	-.018,	-.071,	.205,	-.050,	-.063,	.000,	.651,
3/ 4,	-.092,	.054,	.178,	.017,	-.041,	.068,	-.035,	-.176,	-.094,	.236,	.000,	1.000,
4/ 5,	-.027,	.512,	.072,	-.175,	.347,	.209,	.001,	-.234,	.029,	-.009,	.000,	.482,
5/ 6,	.378,	.195,	-.205,	.010,	.255,	.014,	.182,	-.153,	-.147,	.106,	.000,	.532,
6/ 7,	-.091,	-.111,	-.467,	-.028,	.044,	-.009,	.049,	.135,	-.093,	-.079,	.000,	.628,
TOT ,	.001,	.001,	.001,	.001,	.000,	.000,	.000,	.000,	.000,	-.001,	4.571,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1972,	1973,	1974,
F-values,	.6129,	.5241,	.9693,

,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
F-values,	.8779,	1.0195,	.9706,	.8375,	.8694,	.9590,	.4271,	.2794,	.1639,	.1470,

,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
F-values,	.3647,	.3080,	.2233,	.4186,	.2281,	.2944,	.2096,	.2535,	.1459,	.1500,

Selection-at-age (S)

,	1,	2,	3,	4,	5,	6,	7,
S-values,	.0809,	.8899,	1.0000,	1.0105,	1.0677,	1.0844,	1.0000,

Table 7.4.2 HERRING in the North Irish Sea (Manx + Mourne herring).

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: NIRS-FIRST)

At 28-Mar-95 18:27:34

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age YEAR,	1972,	1973,	1974,
AGE			
1,	.1667,	.1042,	.2139,
2,	.3621,	.3456,	.8237,
3,	.5340,	.6154,	1.0211,
4,	.5480,	.4337,	1.0084,
5,	.6444,	.5508,	.8085,
6,	.6704,	.4609,	.8767,
7,	.6108,	.5191,	1.0615,
+gp,	.6108,	.5191,	1.0615,
FBAR 2- 6,	.5518,	.4813,	.9077,

Table 8 Fishing mortality (F) at age YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
1,	.1525,	.2291,	.1566,	.1024,	.1408,	.0601,	.0377,	.0337,	.0087,	.0138,
2,	.7521,	.7948,	.8536,	.5299,	.7404,	1.0465,	.4026,	.2769,	.1773,	.1189,
3,	.9044,	.9759,	1.0028,	.9147,	.8465,	1.2654,	.3583,	.2618,	.1554,	.1611,
4,	.8415,	1.0923,	.9936,	.9293,	.8123,	.8342,	.5622,	.4119,	.1907,	.1443,
5,	.9627,	.9565,	1.0510,	.6653,	.7990,	1.0330,	.4939,	.1042,	.1243,	.2020,
6,	.7849,	1.0175,	.8327,	.9419,	.9905,	.8189,	.4079,	.4169,	.1960,	.1334,
7,	1.0457,	1.4013,	1.0004,	1.0725,	.7281,	1.0249,	.5932,	.2698,	.1411,	.1202,
+gp,	1.0457,	1.4013,	1.0004,	1.0725,	.7281,	1.0249,	.5932,	.2698,	.1411,	.1202,
FBAR 2- 6,	.8491,	.9674,	.9467,	.7962,	.8377,	.9996,	.4450,	.2944,	.1687,	.1519,

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: NIRS-FIRST)

At 28-Mar-95 18:27:34

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	FBAR 92-
AGE											
1,	.0253,	.0390,	.0114,	.0316,	.0094,	.0225,	.0291,	.0425,	.0073,	.0121,	.0206,
2,	.2705,	.3818,	.2585,	.2449,	.1698,	.2321,	.2112,	.2247,	.1101,	.1706,	.1685,
3,	.4052,	.3525,	.2770,	.4934,	.2266,	.2403,	.1949,	.2351,	.1532,	.1330,	.1738,
4,	.4666,	.3393,	.2210,	.5666,	.3055,	.2726,	.1705,	.2857,	.1488,	.1246,	.1864,
5,	.3876,	.2540,	.2465,	.5434,	.2501,	.3591,	.1998,	.2691,	.1728,	.1635,	.2018,
6,	.3494,	.2645,	.2182,	.4700,	.2455,	.3256,	.2211,	.2836,	.1845,	.1639,	.2106,
7,	.3235,	.2948,	.2792,	.3758,	.2278,	.2947,	.2037,	.2104,	.1677,	.1962,	.1915,
+gp,	.3235,	.2948,	.2792,	.3758,	.2278,	.2947,	.2037,	.2104,	.1677,	.1962,	
FBAR 2- 6,	.3759,	.3184,	.2442,	.4636,	.2395,	.2860,	.1995,	.2596,	.1539,	.1511,	

Table 7.4.3 HERRING in the North Irish Sea (Manx + Mourne herring).

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: NIRS-FIRST)

At 28-Mar-95 18:27:34

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year)				Numbers*10**-3
YEAR,	1972,	1973,	1974,	
AGE				
1,	412935,	668013,	349103,	
2,	176204,	128579,	221427,	
3,	71232,	90883,	67419,	
4,	32678,	34189,	40214,	
5,	30257,	17093,	20050,	
6,	14461,	14373,	8917,	
7,	6084,	6693,	8203,	
+gp,	3820,	6718,	2596,	
TOTAL,	747672,	966542,	717929,	

Table 10 Stock number at age (start of year)							Numbers*10**-3			
YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
1,	368092,	263464,	326262,	250420,	140186,	157600,	215079,	242543,	237755,	134357,
2,	103693,	116256,	77079,	102627,	83156,	44800,	54595,	76193,	86266,	86706,
3,	71979,	36210,	38899,	24319,	44757,	29380,	11655,	27040,	42794,	53525,
4,	19883,	23854,	11172,	11684,	7977,	15717,	6786,	6669,	17039,	29993,
5,	13274,	7755,	7240,	3743,	4174,	3203,	6175,	3500,	3997,	12740,
6,	8082,	4586,	2696,	2290,	1741,	1699,	1032,	3410,	2853,	3194,
7,	3358,	3336,	1500,	1061,	808,	585,	678,	621,	2033,	2122,
+gp,	2635,	1751,	1846,	554,	586,	374,	561,	1685,	470,	4439,
TOTAL,	590995,	457213,	466696,	396697,	283384,	253358,	296561,	361660,	393209,	327077,

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: NIRS-FIRST)

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Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year)							Numbers*10**-3					
YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	AMST
AGE												
1,	153767,	185249,	309479,	132195,	195673,	164015,	110191,	459673,	140889,	258379,	0,	2607
2,	48748,	55157,	65544,	112557,	47118,	71312,	58994,	39376,	162060,	51454,	93907,	883
3,	57031,	27554,	27894,	37496,	65273,	29454,	41887,	35384,	23300,	107541,	32140,	443
4,	37303,	31138,	15858,	17312,	18744,	42607,	18963,	28222,	22901,	16366,	77082,	222
5,	23491,	21168,	20068,	11503,	8889,	12495,	29353,	14469,	19191,	17857,	13074,	130
6,	9420,	14426,	14857,	14192,	6045,	6263,	7895,	21749,	10003,	14608,	13721,	78
7,	2529,	6010,	10019,	10808,	8026,	4279,	4092,	5727,	14821,	7526,	11220,	42
+gp,	2745,	3600,	7191,	14088,	10070,	6632,	4638,	2167,	5762,	11725,	14316,	
TOTAL,	335034,	344302,	470910,	350151,	359839,	337056,	276013,	606766,	398926,	485457,	255460,	

Table 7.4.4 HERRING in the North Irish Sea (Manx + Mourne herring).

Run title : Herring in the North Irish Sea (Manx plus Mourne herring) (run name: NIRS-FIRST),

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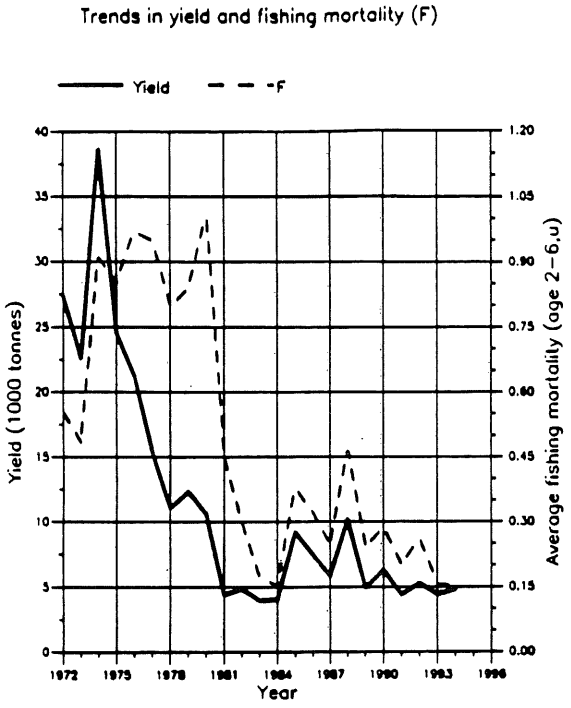
Table 17 Summary (with SOP correction)

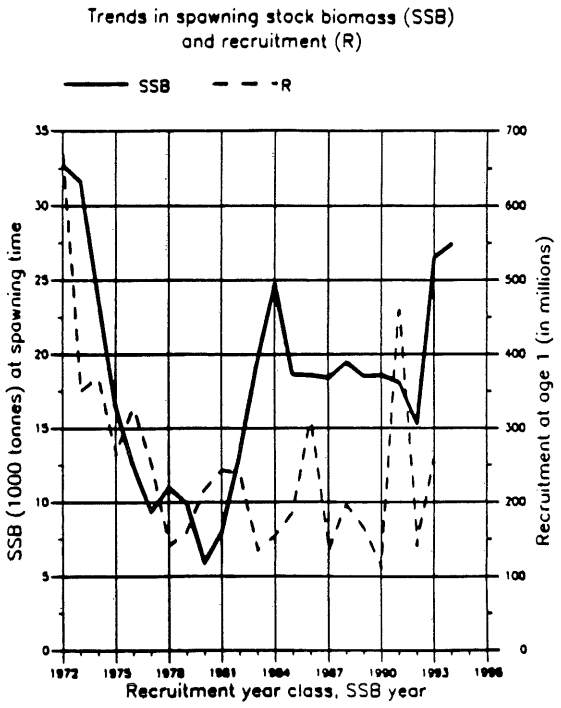
Traditional vpa Terminal populations from weighted Separable populations

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 2- 6,
1972,	412935,	103265,	36649,	27350,	.7463,	1.1200,	.5518,
1973,	668014,	106513,	31854,	22600,	.7095,	1.0073,	.4813,
1974,	349103,	91446,	23655,	38640,	1.6335,	.9958,	.9077,
1975,	368092,	70184,	16822,	24500,	1.4564,	1.0260,	.8491,
1976,	263464,	53704,	12316,	21250,	1.7254,	.9927,	.9674,
1977,	326262,	47100,	8938,	15410,	1.7240,	.9538,	.9467,
1978,	250419,	40310,	10152,	11080,	1.0914,	.9243,	.7962,
1979,	140186,	33015,	9211,	12338,	1.3395,	.9296,	.8377,
1980,	157600,	28329,	5721,	10613,	1.8552,	.9701,	.9996,
1981,	215079,	27421,	7297,	4377,	.5998,	.9092,	.4450,
1982,	242543,	38155,	12902,	4855,	.3763,	.9837,	.2944,
1983,	237755,	44606,	19104,	3933,	.2059,	.9838,	.1687,
1984,	134357,	42566,	23861,	4066,	.1704,	.9623,	.1519,
1985,	153767,	44222,	19014,	9187,	.4832,	1.0202,	.3759,
1986,	185249,	40188,	18157,	7440,	.4098,	.9767,	.3184,
1987,	309479,	46254,	19097,	5823,	.3049,	1.0382,	.2442,
1988,	132195,	44812,	20468,	10172,	.4970,	1.0521,	.4636,
1989,	195673,	42058,	18562,	4949,	.2666,	1.0034,	.2395,
1990,	164015,	40941,	18834,	6312,	.3351,	1.0130,	.2860,
1991,	110191,	33012,	18062,	4398,	.2435,	1.0006,	.1995,
1992,	459673,	49486,	15475,	5270,	.3405,	1.0111,	.2596,
1993,	140889,	50647,	26906,	4409,	.1639,	1.0133,	.1539,
1994,	258379,	56164,	28120,	4828,	.1717,	1.0249,	.1511,
Arith. Mean	255449,	51061,	18312,	11470,	.7326		.4821,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

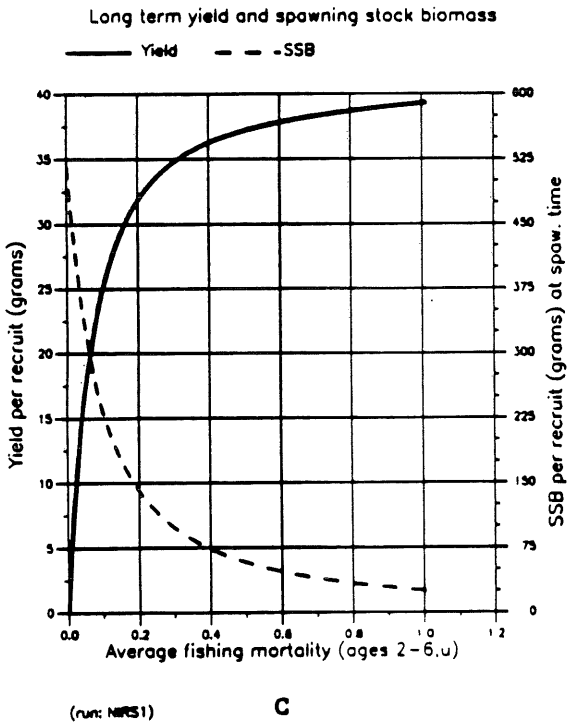
Figure 7.4.1

FISH STOCK SUMMARY
STOCK: Herring in the North Irish Sea (Manx plus Mourne herring)
28–3–1995





FISH STOCK SUMMARY
STOCK: Herring in the North Irish Sea (Manx plus Mourne herring)
30–3–1995



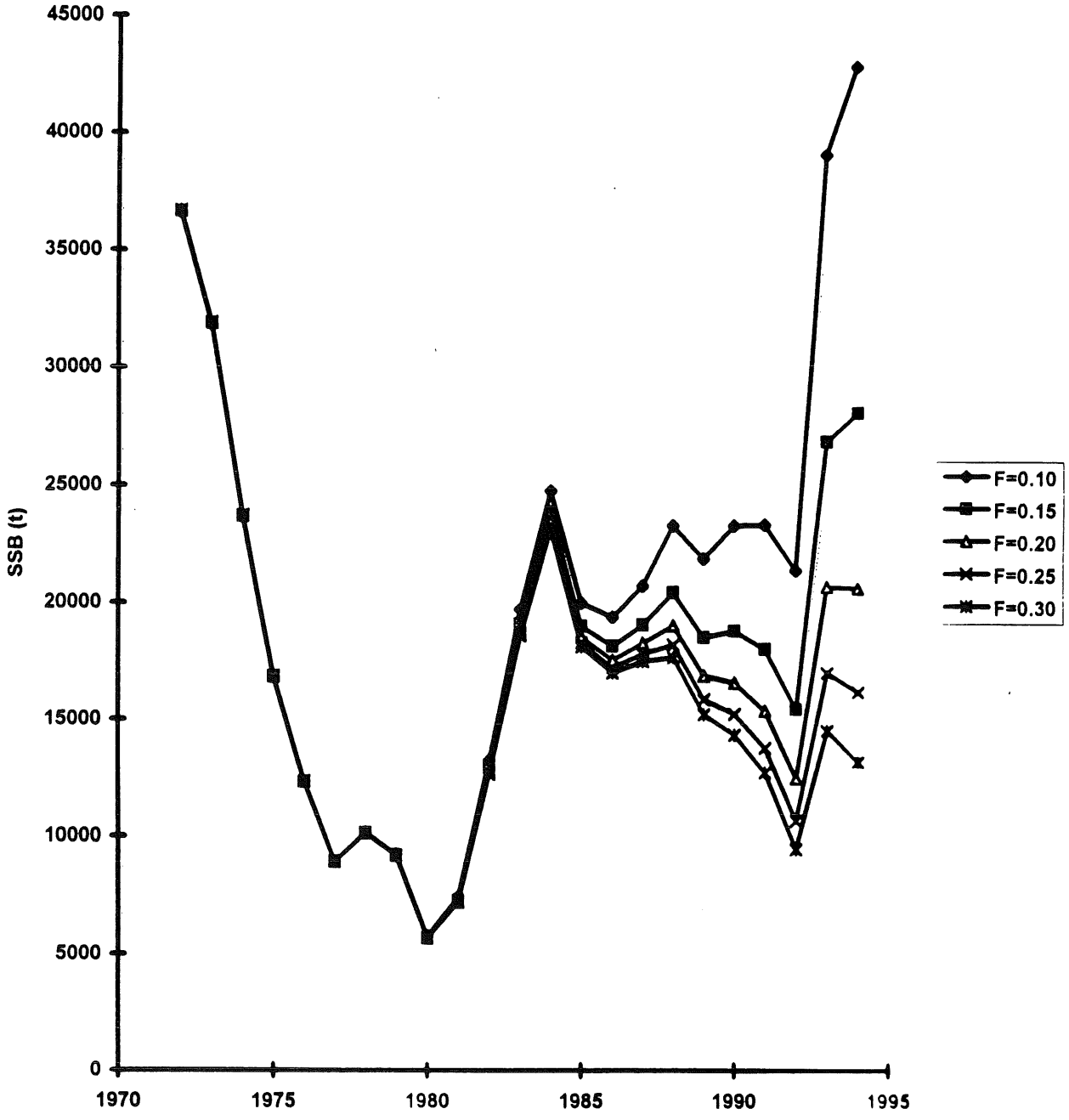


Figure 7.4.2 Division VIIa (N) HERRING (Manx + Mourne). Trends in SSB estimated by VPA for a number of terminal Fs.

8 SPRAT IN THE NORTH SEA

8.1 The Fishery

8.1.1 ACFM advice applicable for 1994 and 1995

No ACFM advice on a sprat TAC has been given for recent years. The TAC set by the management bodies was 83,000 t for 1993 and 114,000 t for 1994 [Subarea IV(EU zone) + Division IIa (EU zone)]. The agreed TAC for 1995 is 175,000 t.

8.1.2 Catches in 1994

Landing statistics for sprat for the North Sea by area and country are presented in Table 8.1.1 for 1983-1994. The monthly and annual distribution of catches by rectangle for Sub-area IV is shown in Figures 8.1.1-8.1.13. As in previous years, sprat from the fjords of western Norway were not included in the landings for the North Sea. While there remains uncertainty concerning the sprat stock identity, landings from the fjords are considered separately. Norwegian catches in the western fiords for 1983-1994 are presented in Table 8.1.2.

Preliminary sprat landing figures for Denmark, Norway and UK (England) indicate that 323,700 t were harvested from the North Sea in 1994. This represents a 60 % increase in landings from 1993. Danish landings increased by 86 % while the Norwegian catches decreased slightly between 1993 and 1994. Catches by Denmark, which represent nearly 90 % of the North Sea sprat landings, continued their upward trend started in 1990 and were the largest reported in the period. English catches accounted for only 1% and were at the same level as in 1993. Catches by Norway in the western fjords increased and were the highest since 1987.

Landings by area and quarter are shown in Table 8.1.3. As in previous years, the largest component of the catch was reported from Division IVb, predominantly Division IVb (E) in the third quarter. Significant catches from this division were also made during the fourth quarter.

8.1.3 Fleets

Fleet descriptions were provided in the report of the Industrial Fisheries Working Group (IFWG) in 1992 (Anon., 1992c).

8.2 Catch Composition

8.2.1 Catches in number

Uncertainties in the reliability and/or absence of quarterly aged samples have prevented the IFWG from running a VPA since 1984. A historical perspective of the problems associated with estimates of catch in numbers at age by previous groups until 1992 are described in the Working Group report of 1993 (Anon. 1993).

The estimated quarterly catch-at-age in numbers is presented in Table 8.2.1. Age composition data for commercial landings for 1994 were provided by Denmark and Norway. The sampling intensity is given in Table 8.2.2. Although the number of samples presented to the Working Group has increased, the sampling was far below the recommended level. The Working Group concluded that the data were poor and unsuitable for catch-at-age estimation.

8.2.2 Mean weight at age

The mean weights (g) at age in catches taken in 1994 are provided by quarter in Table 8.2.3. Weights were estimated from Danish and Norwegian commercial samples data as provided by Working Group members.

8.2.3 Quality of catch and biological data

In 1994 the sampling of Danish landings for industrial purposes was continued with the intensity and coverage largely unchanged compared to the previous years. A total of 724 samples were analysed for species composition of which 73 samples were analyzed for age and weight at age. From the Norwegian purse seine landings 17 samples were analysed for age and weight at age. There were no sprat reported in the Norwegian industrial fishery. For details of the sampling for biological data see Table 8.2.2.

8.3 Recruitment

8.3.1 Abundance

In 1993 it was decided to break from the traditional presentation of indices for the North Sea (all ages), Division IVb (1-group) and Division IVb E (1-group) and concentrate on Division IVb only, as Division IVb is considered the IBTS standard area applicable for North Sea sprat assessment. These revised IBTS (no./hr) sprat indices from 1981 to 1994 are presented in Table 8.3.1 for age groups 1-4 and 5+. Data in the

old format can be found in the 1992 IFWG report (Anon., 1992c).
The 1994 IBTS-Fbruary data indicate that all indices for age groups 1-3 have decreased after a 3- year period with increasing indices in these age groups. For age groups 4+ the indices have increased. The total 1995 abundance index decreased compared with 1994 but is higher than in 1993. The IBTS data are provided by rectangle in Figure 8.3.1 for age groups 1, 2 and 3+ and show the abundance of the 1-group to be concentrated in the central-eastern areas of Divisions IVb and IVc. The mean lengths of age group 1 by rectangle are presented in Figure. 8.3.2.

8.4 Acoustic Survey

No acoustic estimates were available to the Working Group for 1994.

8.5 State of the Stock

8.5.1 Catch-Survey Data Analysis

The IBTS survey has difficulties following strong and weak cohorts. This is illustrated by the text table below which is extracted from Table 8.3.1. The 1-group:2-group ratio varies between 0.34 (1987 year class) and 7.62 (1988 year class).

Year class	1-group	2-group	1-gr/2-gr
1980	941.46	501.87	1.88
1981	295.82	754.08	0.39
1982	210.04	387.05	0.54
1983	382.37	297.67	1.28
1984	660.12	102.75	6.42
1985	71.36	74.33	0.96
1986	803.37	1436.80	0.56
1987	148.49	441.86	0.34
1988	4245.98	557.41	7.62
1989	176.81	116.08	1.52
1990	1121.06	340.17	3.30
1991	1560.54	422.47	3.69
1992	1754.61	1294.30	1.36
1993	4013.40	834.84	4.81

8.6 Projections of Catch and Stock

As discussed in the 1994 report (Anon 1994a) a regression of catch and IBTS(February) indices in the same year showed a reasonable relationship but is very dependent on the 1989 and 1994 observations (Figure 8.6.1). The 1989 observation now appears to be an outlier but the regression is largely driven by the 1994 observation. The 1995 (February) index is 2830 which, when applied in the regression, indicates a 1995 catch of 189,000 t when excluding the 1989 index (r^2=0.84). There are indications in the current fishery that this estimate is on the low side.

The assumption behind the above regression is that the exploitation level is fairly constant over the years i.e. that the variability in abundance is greater than that of the exploitation.

An attempt was made to improve this analysis by including a model for stock development: the biomass dynamic model

$$B(t+1) = B(t) + r*[1- B(t)/K] - C(t)$$

$$I(t) = q* B(t)$$

where B(t) is the biomass at time t, C(t) is the catch and I(t) the total abundance IBTS index. r, K and q are parameters of the model. This model was fitted using the CEDA program (see Anon 1993b). The data were total catch and IBTS(February) abundance data for 1978 to 1994 (see Figure 8.6.2). The initial state of the stock in 1978 was assumed to be that the biomass was 0.8 of the carrying capacity K. The 1989 observation is again clearly an outlier. The model suggests that the biomass will decrease after 1994. However, this is an extrapolation of the 1995 IBTS(February) observation.

Predictions made by the simple regression model (catch vs. abundance indices) can be done with CV ~ 25 % while the biomass dynamic model provides projections with approximately twice this CV.

There is no predictor available to indicate the 1996 catch.

8.7 Management Considerations

The stock does not show signs of overexploitation as both catch and biomass appear to be high at present. There are no indications of a re-direction of effort from other areas to this stock. There are therefore no reasons, so far as the sprat stock is concerned, for any severe management constraints on the current fishery.

8.8 Prelimary Analysis of the 1991-1994 Quarterly IBTS Indices

The indices are shown in Figure 8.8.1 in which the data for the 2nd, 3rd and 4th quarters are preliminary. Even so, Figure 8.8.1 demonstrates large differences between quarters. Apparently the index for the 4th quarter is much higher than that for the other three quarters. This is caused by a large 1-group index observed in the 4th quarter which disappeared from the surveys between November and February. This

seems difficult to explain by fishing and there is no obvious biological explanation. Concerning the 0-group in November and the corresponding 1-group in February the data appear fairly consistent with only a minor mortality. Therefore, a preliminary conclusion could be that the 0-group index from the 4th quarter may suffice for prediction of the fishery in the following year. This may be of some help to management when setting a TAC in November-December.

8.9 Research Recommendations

The Working Group considered the research required to improve the quality of the sprat assessment and identified three tasks which should be addressed before the next meeting of the Working Group.

1) The acoustic surveys should include an estimate of sprat abundance. The survey data should be revisited to obtain these estimates for as many years as possible.

2) There are no biological samples taken from the landings for human consumption, either from the North Sea or from Division IIIa. Such samples are required for an adequate description of the age composition of the total fishery. Samples from Division IIIa are particularly needed.

3) MIK is appropriate for sampling of sprat larvae. However MIK is not used in the IBTS (4th quarter). IBTS should be expanded by MIK sampling during the 4th quarter survey. Whenever MIK samples are taken the analysis should include identification of sprat larvae.

Table 8.1.1. Sprat catches in the North Sea ('000 t) 1983-1994. Catch in tonnes by country. Catches 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 official statistics and cannot be used for management purposes.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994[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	+	+	+	-	-	-	+	+
Norway	-	-	-	-	-	-	-	-	-	0.54	2.5	+
Sweden	-	-	-	-	-	-	-	+[5]	2.5	-	-	-
Total	-	-	+	0.2	+	+	+	+	2.5	0.64	2.5	+
Division IVb West												
Denmark	32.6	5.6	1.8	0.4	3.4	1.4	2.0	10.0	9.4	19.9	13.0	19.0
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-
Norway	0.9	0.5	-	-	-	3.5	0.1	1.2	4.4	18.4	16.8	12.6
UK (England)	-	+	-	-	-	-	-	-	-	0.48	0.5	-
UK (Scotland)	+	+	-	-	0.1	-	-	-	-	-	0.5	-
Total	33.5	6.1	1.8	0.4	3.5	4.9	2.1	11.2	13.8	38.26	30.5	31.6
Division IVb East												
Denmark	39.2	62.1	36.6	10.3	28.0	80.7	59.2	59.2	67.0	66.56	136.2	251.7
Germany	-	0.6	0.6	0.6[3]	-	-	-	-	-	-	-	-
Norway	10.8	3.1	-	-	-	0.6	-	0.6	25.1	9.5	24.1	19.1
Sweden	-	-	-	-	-	-	-	+[2]	+[2]	-	-	-
Total	50.0	65.8	37.2	10.9	28.0	81.3	59.2	59.8	92.1	76.49	160.3	270.8
Division IVc												
Belgium	-	-	+	+	+	-	+[2]	+[2]	+[2]	-	-	-
Denmark	1.0	0.5	+	0.1	+	0.1	0.5	1.5	1.7	2.49	3.5	-
France	-	-	-	+	-	-	+[2]	-	+[2]	-	+	+
Netherlands	-	0.1	-	-	-	0.4	0.4[2,3]	-	+[2,3]	-	-	-
Norway	0.5	3.4	-	-	-	-	-	-	-	-	0.4	4.6
UK (England)	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.12[1]	2.0	2.9
Total	5.1	4.9	3.4	4.3	0.7	1.1	1.8	1.7	3.5	8.61	5.9	21.2
Total North Sea												
Belgium	-	-	+	+	+	-	+	+[2]	+[2]	-	-	-
Denmark	72.6	68.1	39.5	11.7	31.7	82.3	61.9	69.2	78.1	89.1	153.3	284.4
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	+	-	-	+	-	+[2,3]	-	+	-
Germany	-	0.6	-	0.6	-	-	-	-	-	-	-	-
Netherlands	-	0.1	0.6	-	0.5	0.4	0.4	-	+[2,3]	-	-	-
Norway	12.0	7.0	6.1	-	-	4.1	0.1	1.8	29.6	28.5	43.8	36.3
Sweden	-	-	-	-	-	-	-	+[2]	+[2]	-	0.1	-
UK (England)	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8	6.6	2.6	2.9
UK (Scotland)	+	+	-	+	0.2	-	-	+	-	-	0.5	0.1
Total	88.4	76.7	49.6	16.4	33.1	87.4	63.3	71.2	109.5	124.2	200.3	323.7

[1]Preliminary. [2]Official statistics. [3]Includes Divisions IVa-c. [5]Includes Division IVb East.

+ = less than 0.1. - = magnitude known to be nil.

Table 8.1.2 Sprat catches ('000 t) in the fjords of western Norway, 1983-1994. The catches for 1988 are to be included and the value is 5.3.

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994[2]
3.2	4.4	7.1	2.2	8.3	-[1]	2.4	2.7	3.2	3.8	1.9	5.3

[1]Not available.

[2]Preliminary.

Table 8.1.3 Sprat catches (t) in the North Sea by quarter in 1986, 1987, 1988 (Denmark and the UK), 1989 (Denmark, Norway and the UK), 1990 (Denmark and Norway), and 1991, 1992 (Denmark, Norway and the UK) 1993 (Denmark, Norway, Sweden and UK) and 1994 (Denmark and Norway). Catches in fjords of western Norway excluded

Year	Quarter	Area					Total
		IVa West	IVa East (North Sea stock)	IVb West	IVb East	IVc	
1986	1	282	123	104	2,899	4,134	7,542
	2	5	39	206	5,048	22	5,320
	3	3	10	6	389	9	417
	4	373	63	80	2,005	51	2,571
Total		663	235	396	10,341	4,216	15,851
1987	1	70	10	148	17	564	809
	2	-	7	118	3,297	57	3,479
	3	-	6	65	6,999	46	7,116
	4	98	-	3,191	16,456	17	19,762
Total		168	23	3,522	26,769	684	31,166
1988	1	-	-	5	206	529	740
	2	-	-	229	682	28	949
	3	-	11	4,682	72,317	73	77,083
	4	55	-	651	7,529	31	8,266
Total		55	11	5,567	80,734	621	87,028
1989	1	-	39	1,127	14,702	1,231	17,099
	2	-	-	241	242	14	497
	3	31	-	784	43,190	110	44,115
	4	10	-	2	1,092	101	1,205
Total		41	39	2,154	59,226	1,456	62,916
1990	1	-	-	222	4,896	-	5,118
	2	-	-	426	320	39	785
	3	-	-	6,759	31,054	10	37,823
	4	-	-	3,812	23,565	1,420	28,797
Total		-	-	11,219	59,835	1,469	72,523
1991	1	-	-	31	899	1,117	2,047
	2	-	-	55	87	1	143
	3	144	-	9,038	58,312	-	67,494
	4	-	-	4,821	33,389	-	38,210
Total		144	-	13,945	92,687	1,118	107,894
1992	1	1	-	19	404	5,234	5,658
	2	-	-	164	2,223	4	2,391
	3	252	-	26,736	62,248	869	90,105
	4	8	635	11,370	11,586	2,500	26,099
Total		261	635	38,289	76,461	8,607	124,253
1993	1	1	2,478	22,448	18,246	3,916	47,089
	2	5	-	278	4,280	10	4,573
	3	682	-	9,926	65,410	991	77,009
	4	-	-	8,014	60,887	1,964	70,865
Total		688	2,478	40,666	148,823	6,881	199,536
1994	1	-	42	2,616	17,227	16,091	35,976
	2	-	-	242	10,857	2	11,101
	3	-	-	10,479	184,747	3,572	198,798
	4	97	-	18,224	57,959	1,325	77,605
Total		97	42	31,561	270,790	20,990	323,480

Table 8.2.1 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1994 by Denmark and Norway.

Country	Fishing area	Quarter	Age					
			0	1	2	3	4	5+
1994								
Denmark	Division IVa)	4	0.54	2.13	0.61	0.06		
Denmark	(Division IVb)	1		485.02	670.18	268.1		
		2		2983.51	15			
		3		24541.4	272.95			
		4	887.11	4528.93	1289.6	144.85	2.97	5.38
Norway	(Division IVb)	1			794.57	172.58	12.82	
Denmark	(Division IVc)	1		22.74	673.41	150.43	27.99	
		2		0.27				
		4	1.26	85.25	23.6	4.12	0.23	

Table 8.2.2. North Sea Sprat. Sampling of commercial landings in 1993 and 1994

1993								
Country	Quarter	Total catch		No. samples		No. aged		No. meas
		('000 t)						
Denmark		153.3		81		1209		6832
Norway		43.8		3		100		315
Sweden		0.1						
UK(England)		2.6						
UK(Scotland)		0.5						
Total		200.3		84		1309		7147
1994								
Country	Quarter	Total catch		No. samples		No. aged		No. meas
		('000 t)						
Denmark	1	18.7		13		839		1565
	2	11.1		4		191		194
	3	174.8		23		1479		2639
	4	76.3		33		1776		3619
Total		280.9		73		4285		8017
Norway	1	14.5		17		707		1870
	3	20.4		0		0		0
	4	1.5		0		0		0
Total		36.4		17	0	707	0	1870
UK(England)		6		0		0		0
UK(Scotland)		0.1		0		0		0
Grand		323.4		90		4992		9887

Table 8.2.3 North Sea Sprat quarterly mean weight (g) at age in the landings in 1994. Weight were estimated from data provided by Working group members

			Age			
Quarter		0	1	2	3	4
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	13.9	18.1

Table 8.3.1 North Sea Sprat. Abundance indices from IBTS for the standard area for sprat (Division IVb).

Year	No. of rectangles sampled	1-Group	2-Group	3-Group	4-Group	[3]5-Group	Total
1981	72	941.46	1,379.85	333.286	4.0259	0.3016	2658.93
1982	69	295.82	501.87	123.141	5.5884	0.1884	926.61
1983	81	210.04	754.08	188.451	8.1393	0.8710	1,161.59
1984	82	382.37	387.05	46.427	6.5030	0.4008	822.75
1985	81	660.12	297.67	37.306	4.2101	0.8770	1000.18
1986	81	71.36	102.75	29.041	1.3109	0.2519	204.71
1987	80	803.37	74.33	24.179	3.5246	0.2014	905.61
1988	80	148.49	1,436.80	107.168	8.5611	0.0000	1,701.01
1989	80	4,245.98	441.86	315.169	4.0471	13.2736	5,020.33
1990	80	176.81	557.41	146.421	30.0234	0.5748	911.24
1991	80	1,121.06	116.08	27.898	2.3144	1.2079	1,268.56
1992	80	1,560.54	340.17	37.831	5.4531	0.4430	1,944.44
1993	81	1,754.61	422.47	71.163	3.2936	0.0370	2,251.57
1994	80	4,013.40	1,294.30	129.300	2.4000	0.0600	5,439.58
1995	78	1,906.48	834.84	84.88	3,210	0.47	2,829.88

Figure 8.1.1 North Sea and Division VIId,e sprat catches in tonnes for January 1994

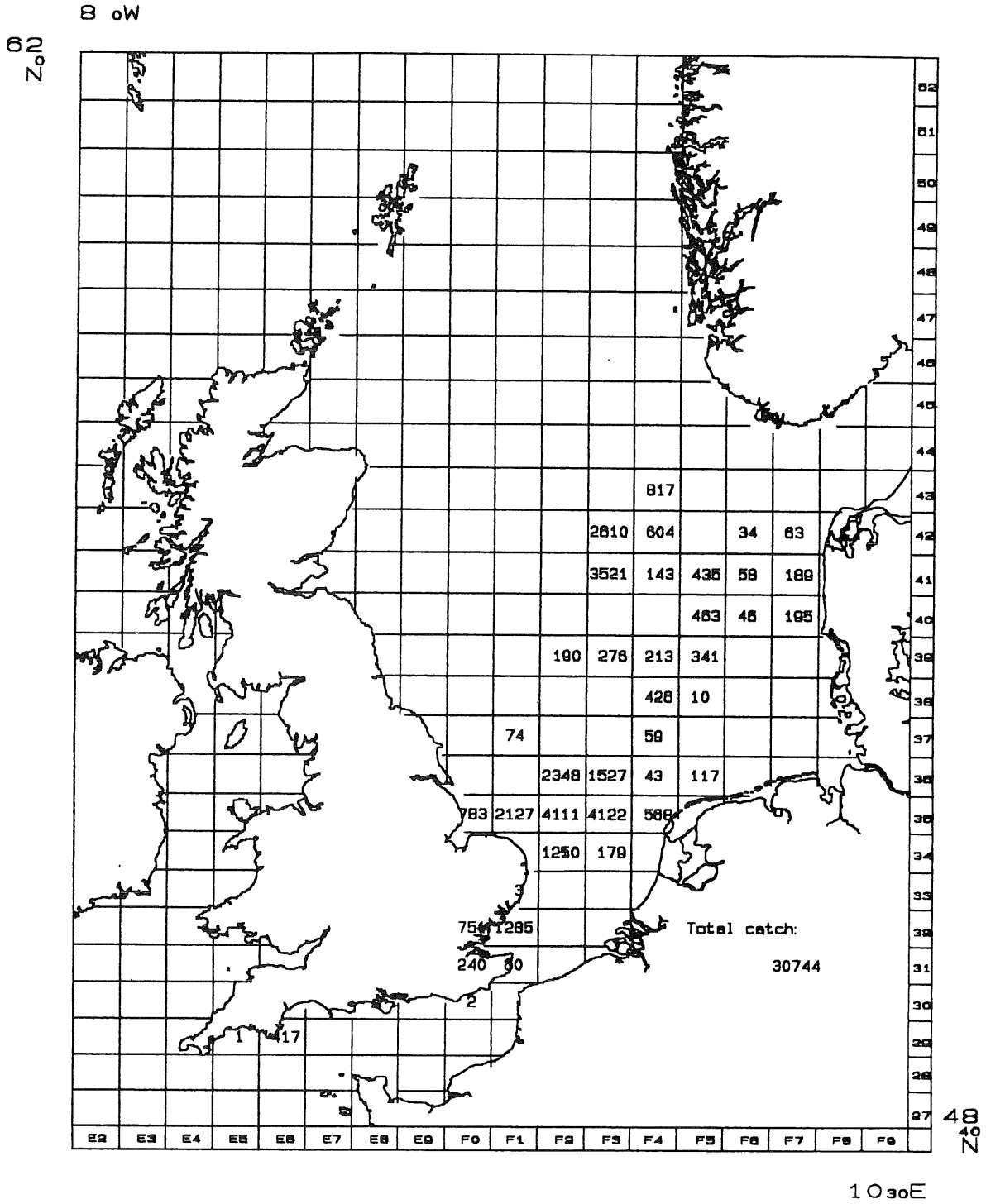


Figure 8.1.2. North Sea and Division VIId,e sprat catches in tonnes for February 1994

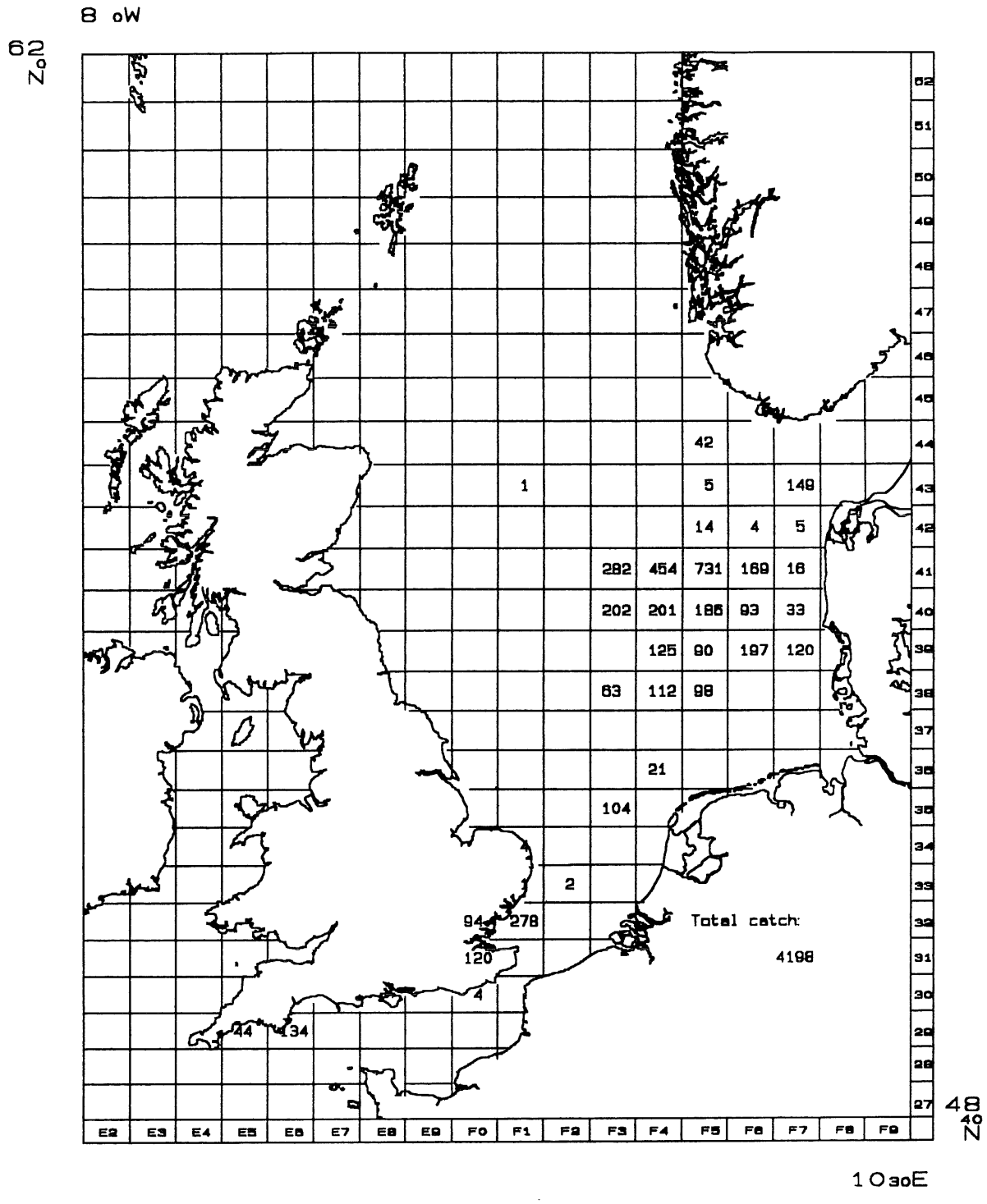


Figure 8.1.3. North Sea and Division VIId,e sprat catches in tonnes for March 1994.

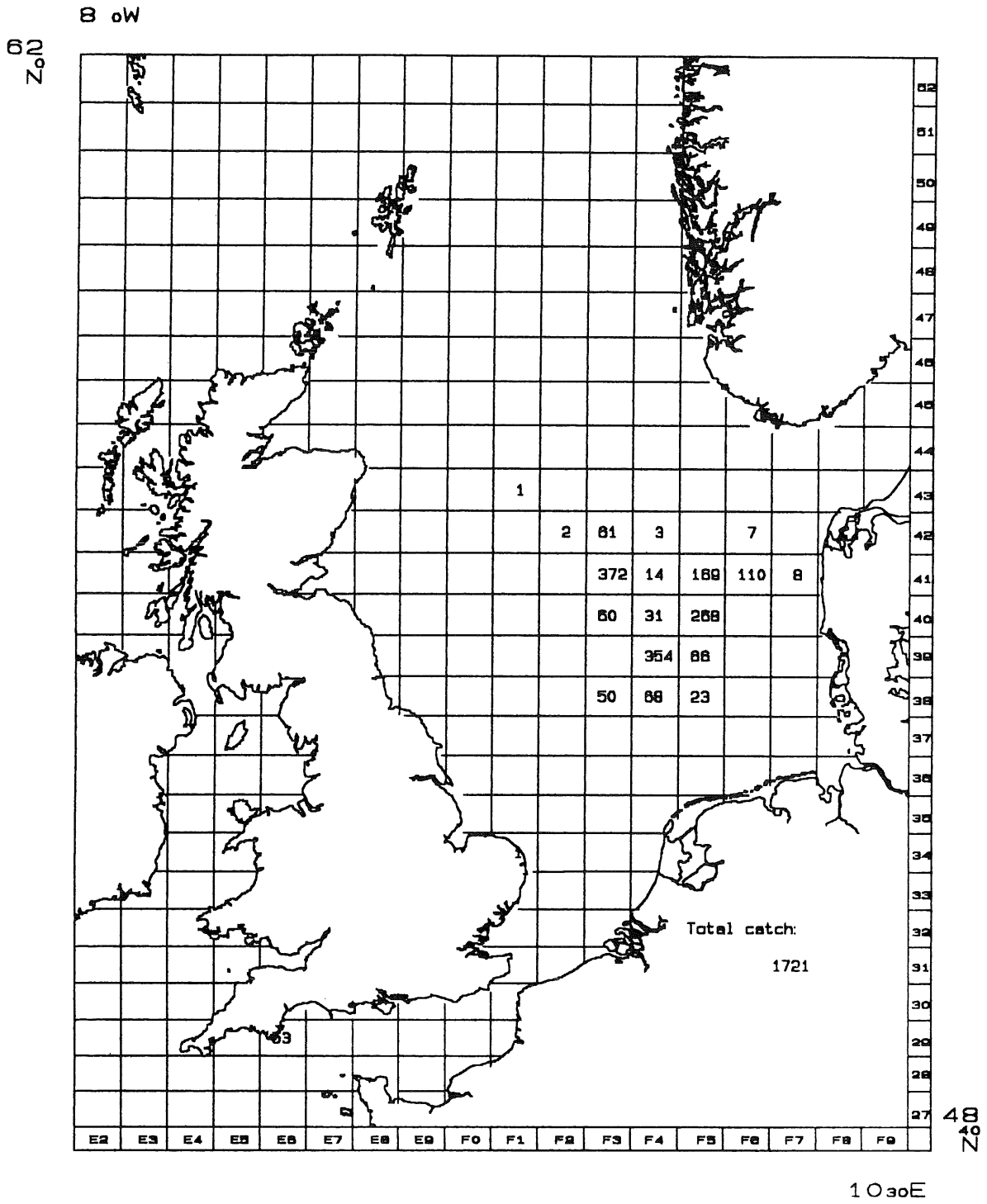


Figure 8.1.4. North Sea and Division VIId,e sprat catches in tonnes for April 1994.

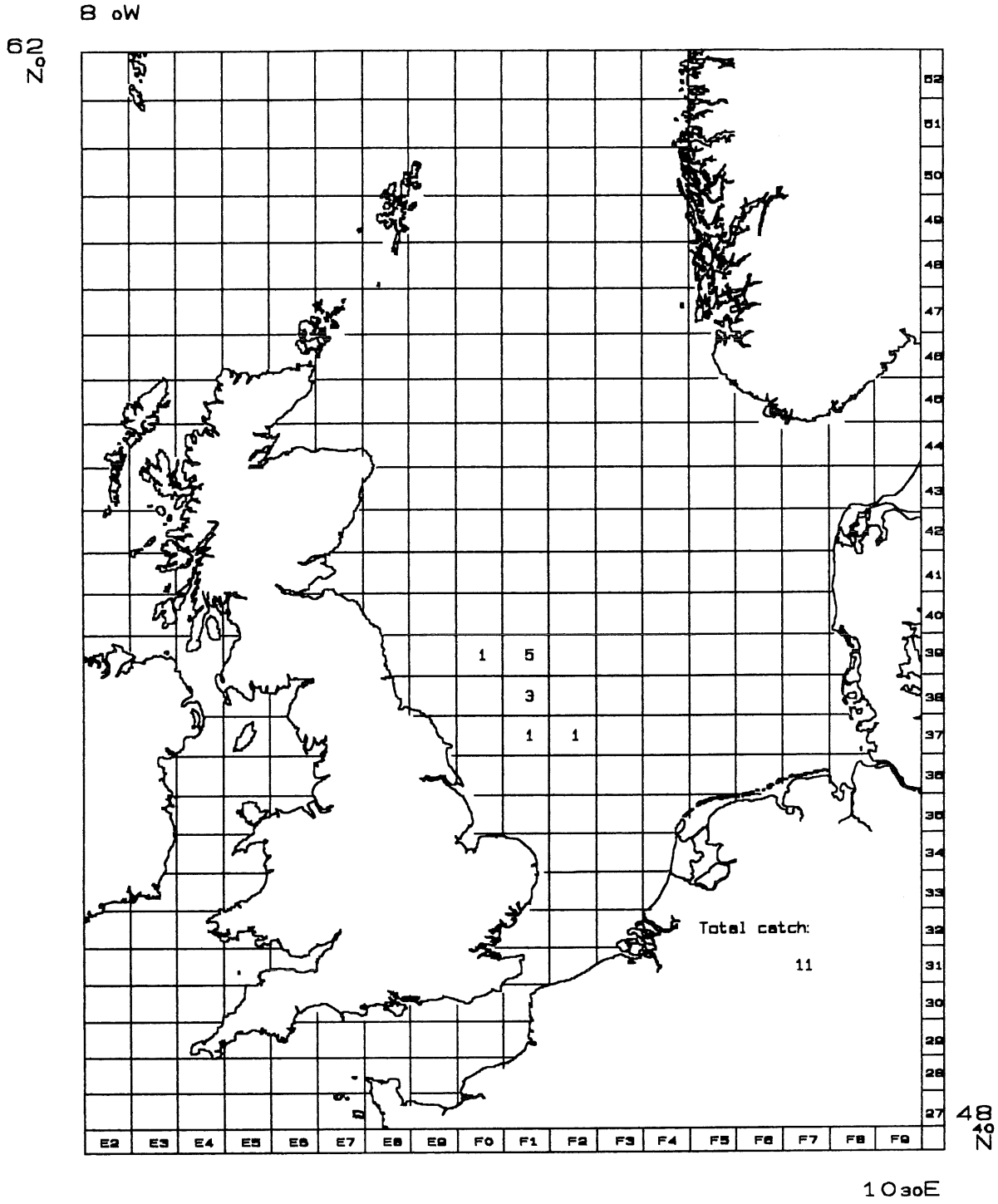


Figure 8.1.5. North Sea and Division VIId,e sprat catches in tonnes for May 1994.

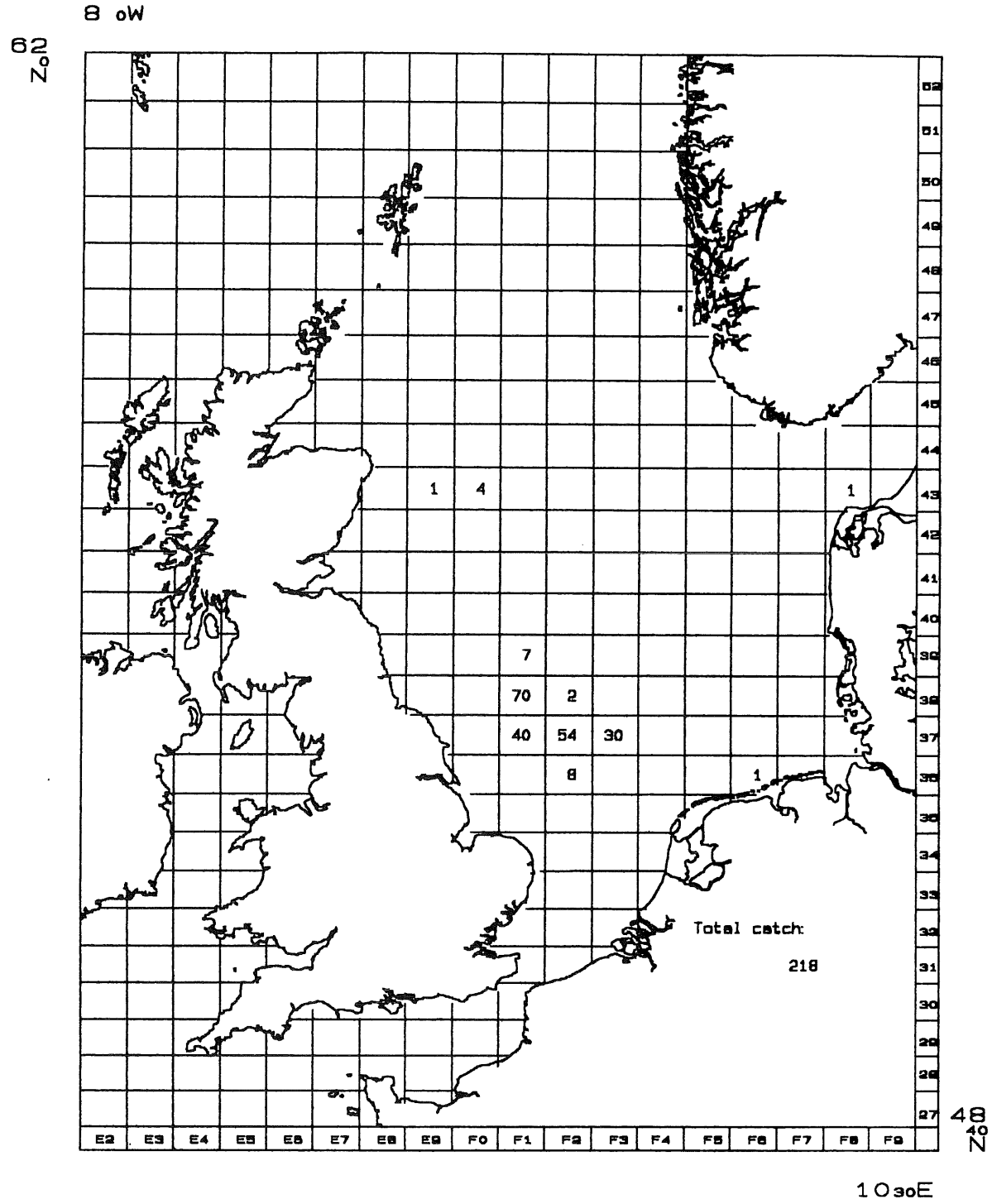


Figure 8.1.6. North Sea and Division VIId,e sprat catches in tonnes for June 1994.

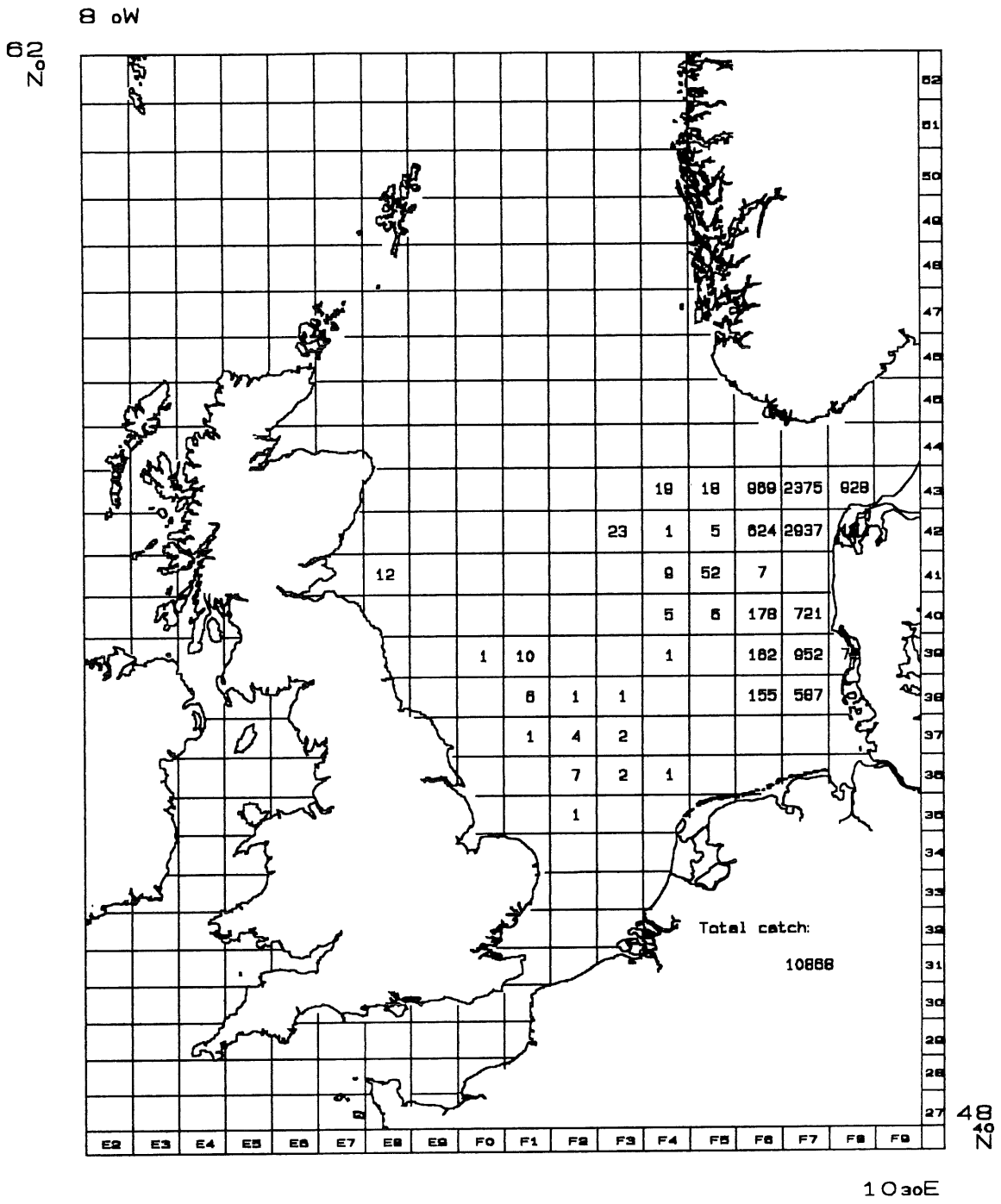


Figure 8.1.7. North Sea and Division VIId,e sprat catches in tonnes for July 1994.

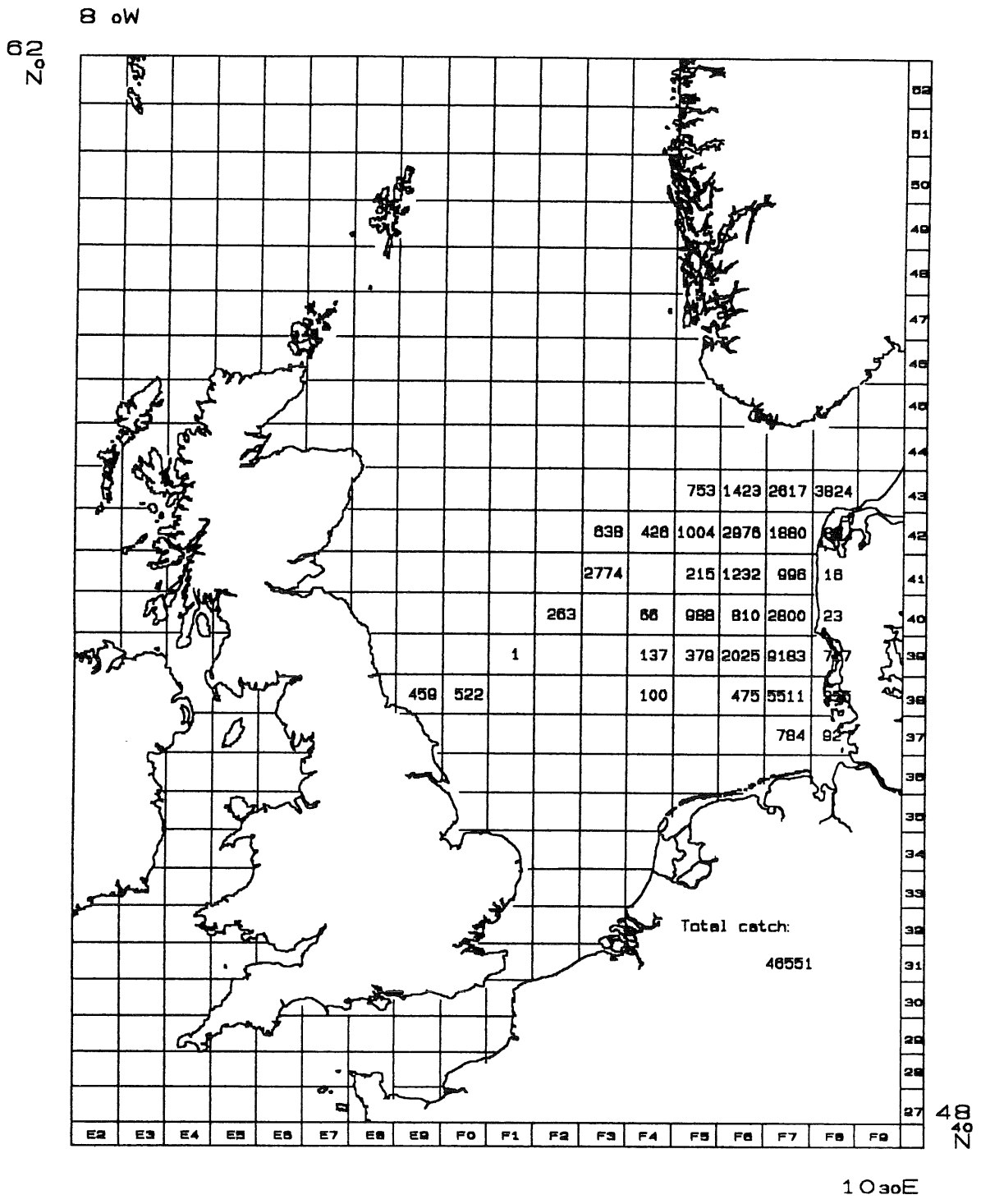


Figure 8.1.8. North Sea and Division VIId,e sprat catches in tonnes for August 1994.

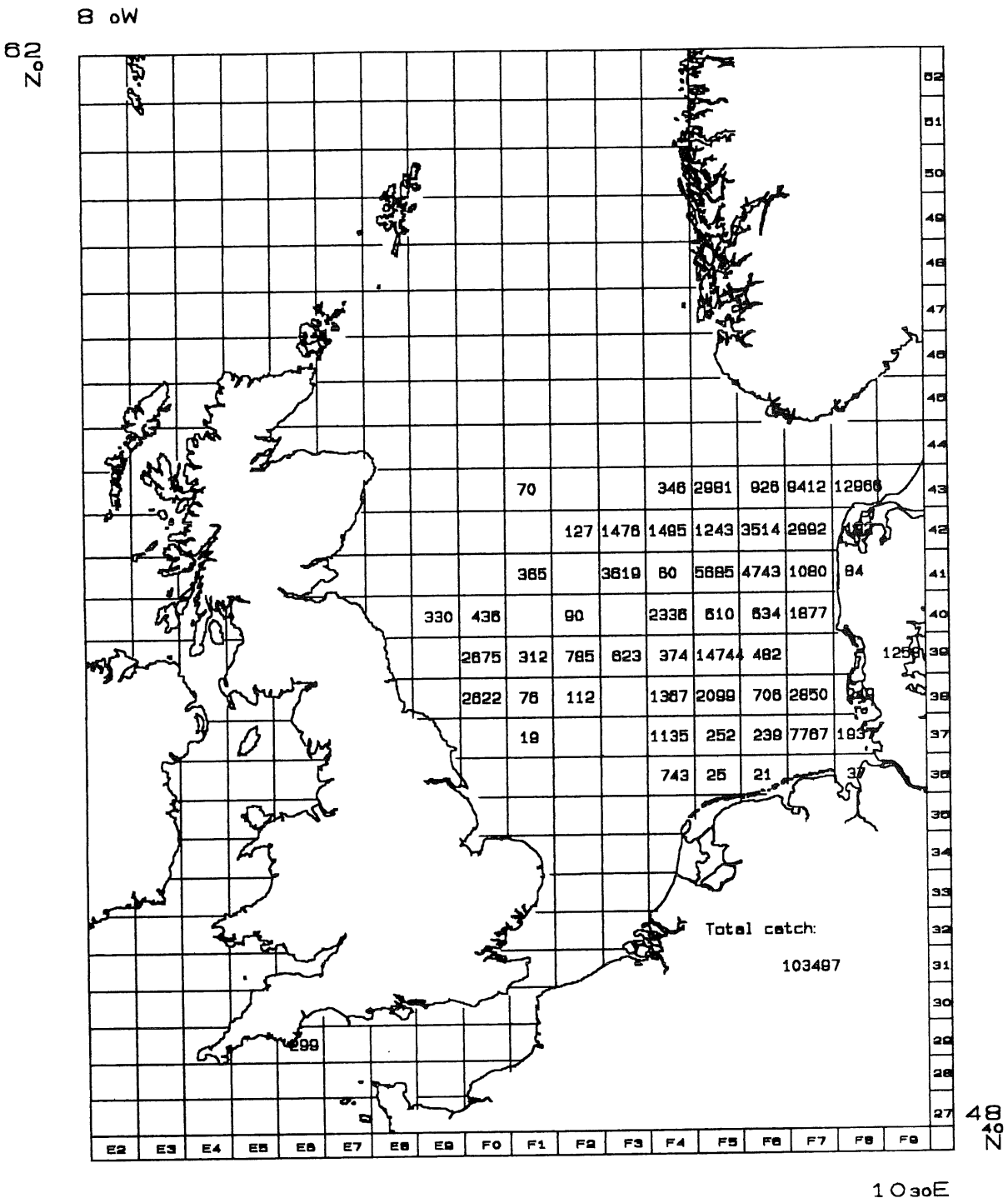


Figure 8.1.9. North Sea and Division VIId,e sprat catches in tonnes for September 1994.

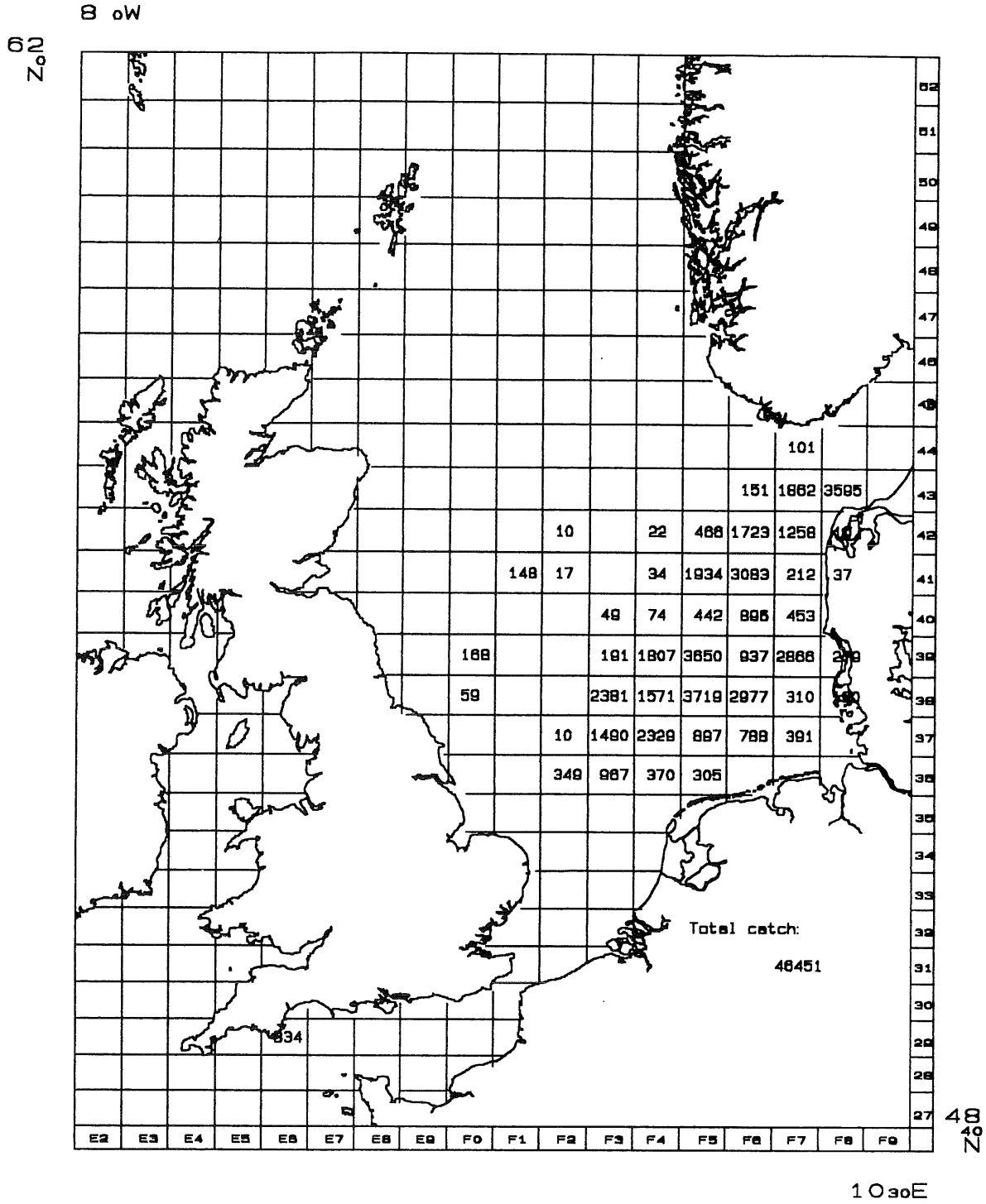


Figure 8.1.10. North Sea and Division VIId,e sprat catches in tonnes for October 1994.

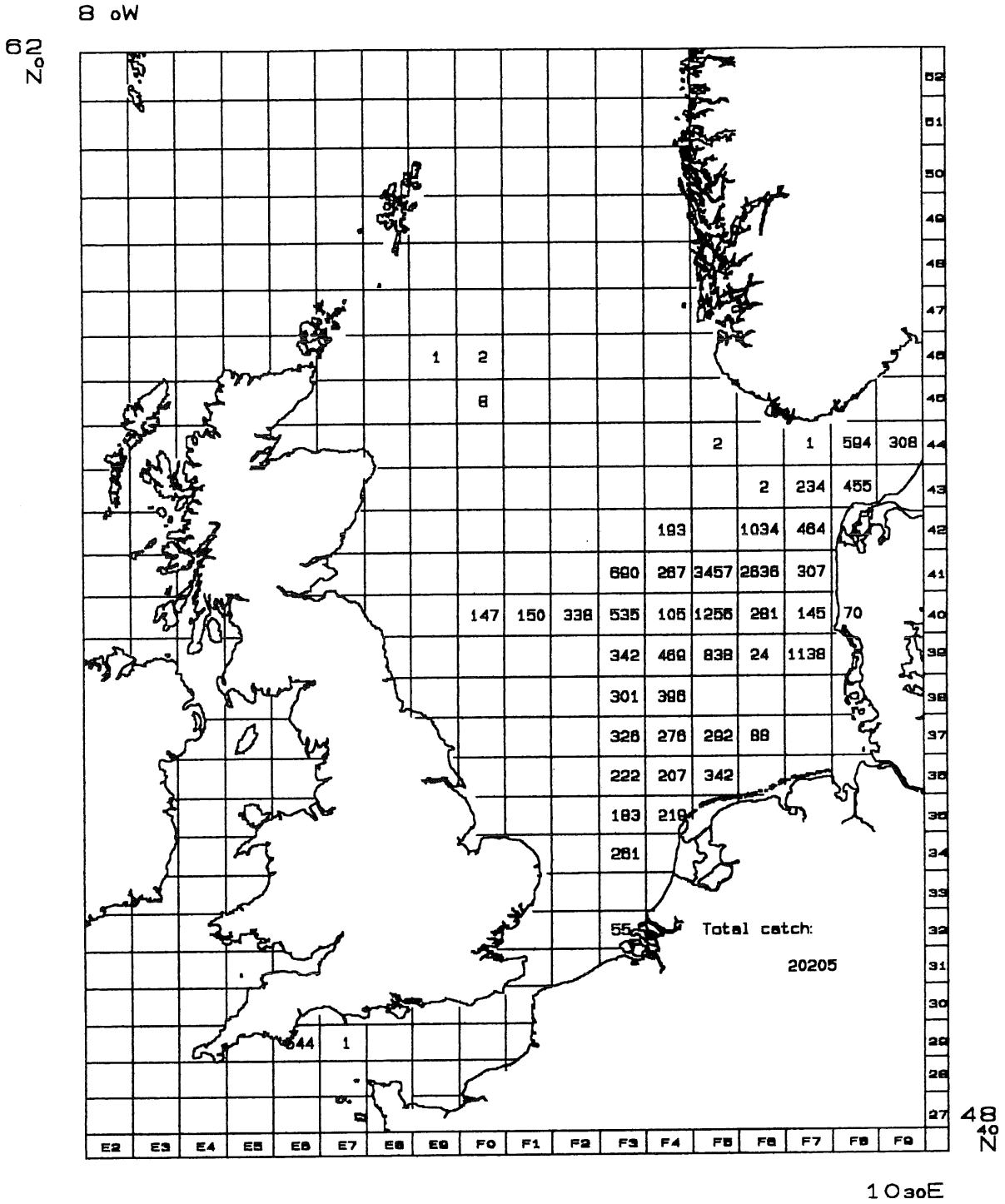


Figure 8.1.11. North Sea and Division VIId,e sprat catches in tonnes for November 1994.

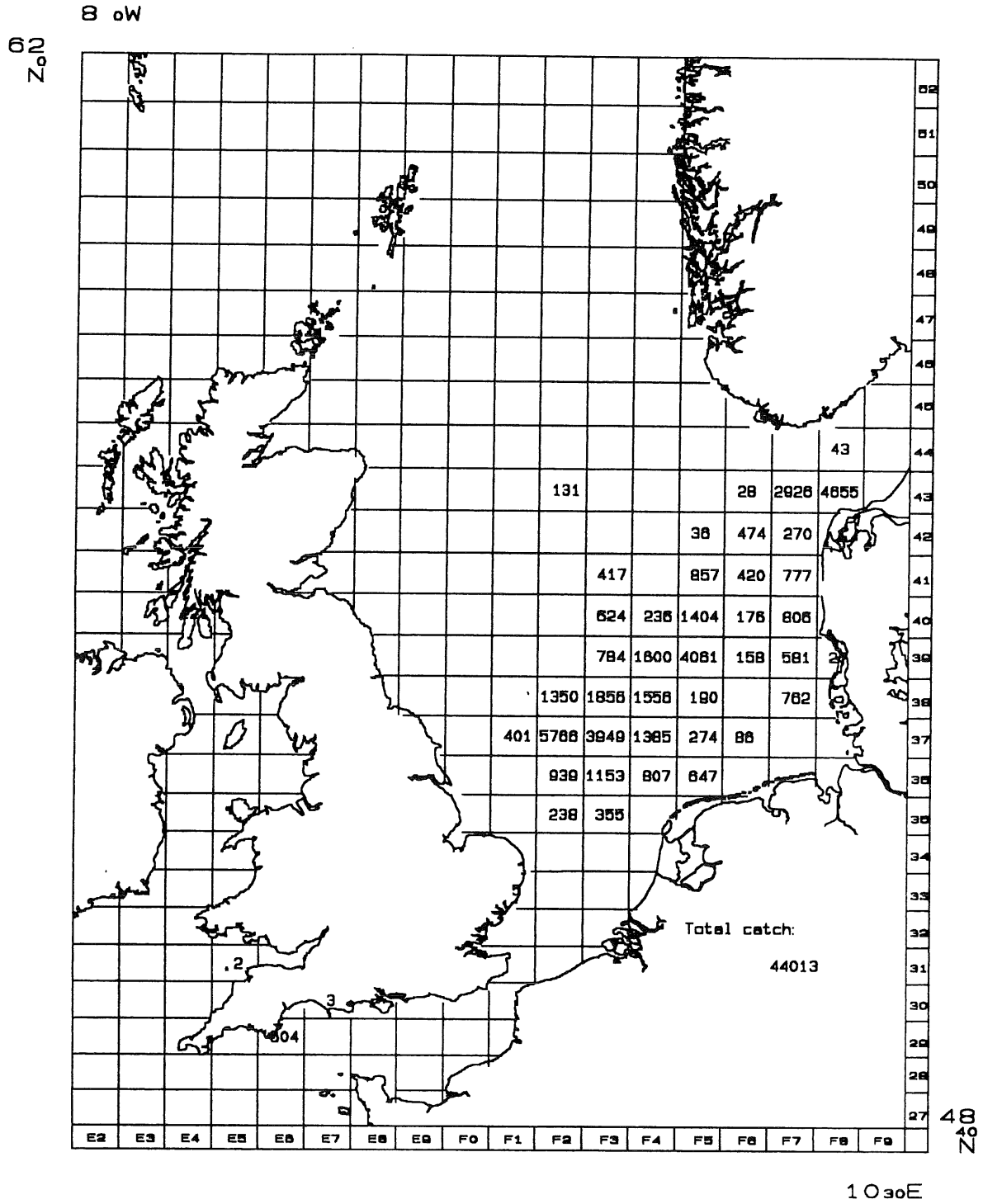


Figure 8.1.12. North Sea and Division VIId,e sprat catches in tonnes for December 1994.

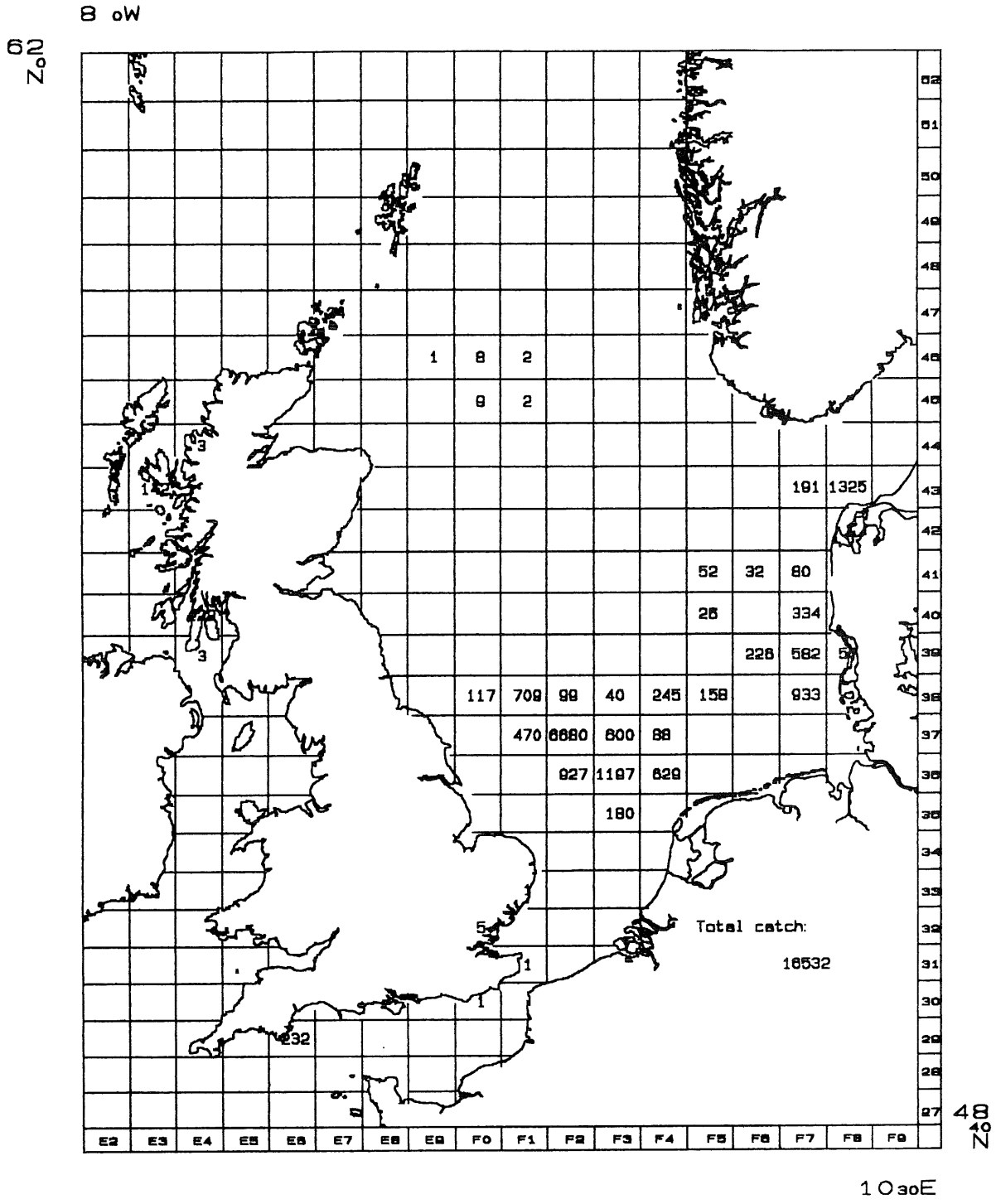
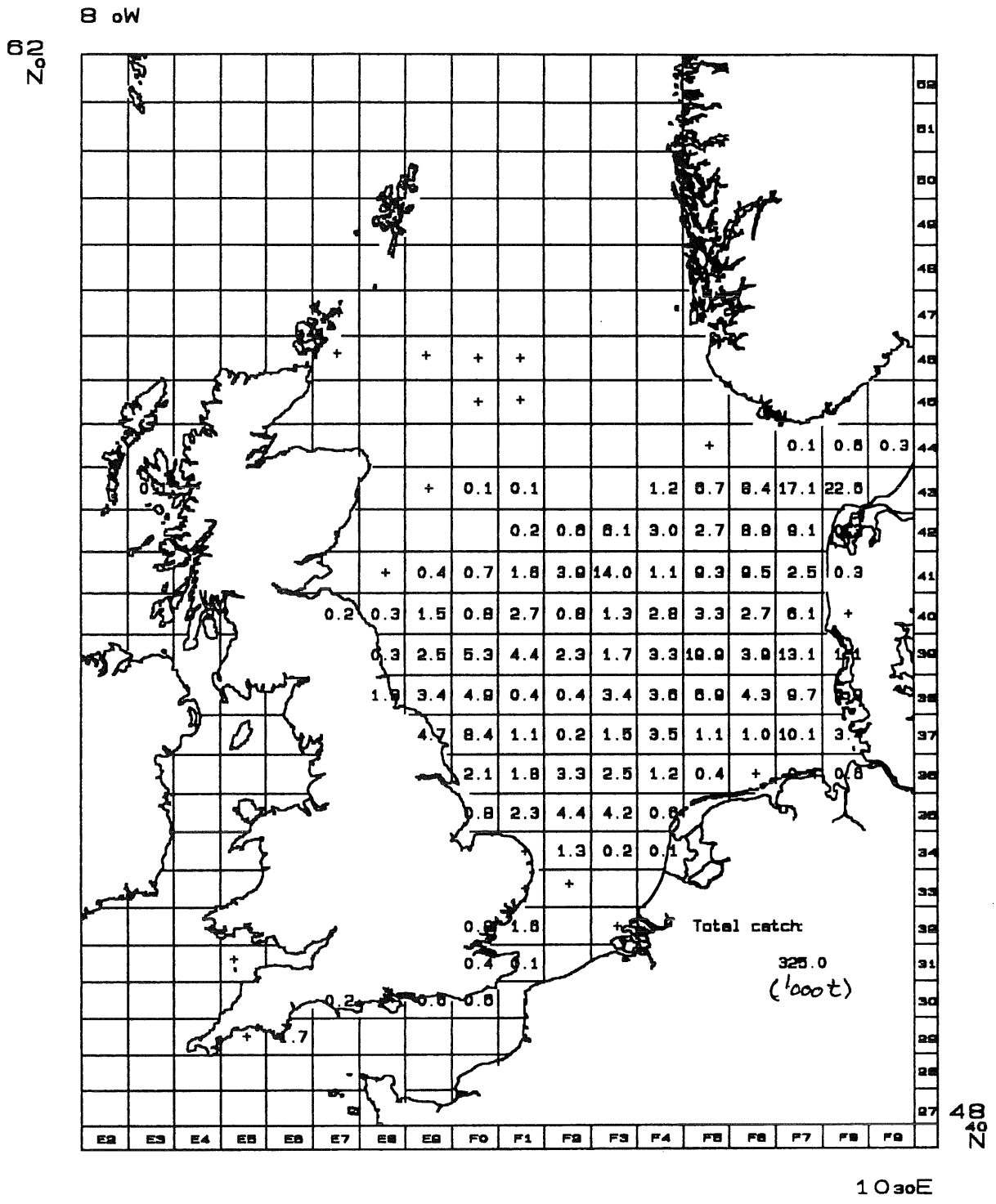
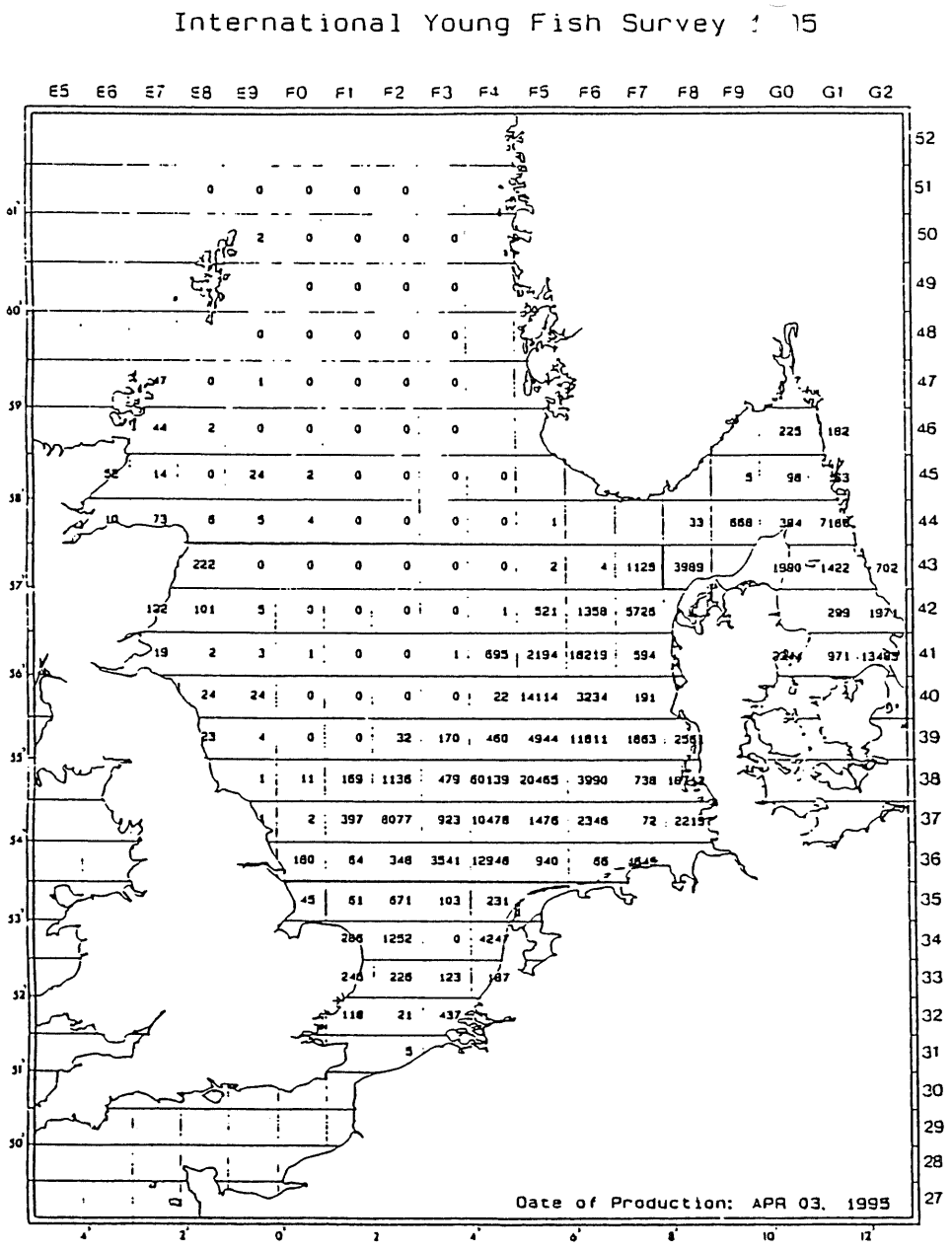


Figure 8.1.13. North Sea and Division VIId,e sprat catches in tonnes for the year 1994.
(in '000 tonnes. + is less than 1).





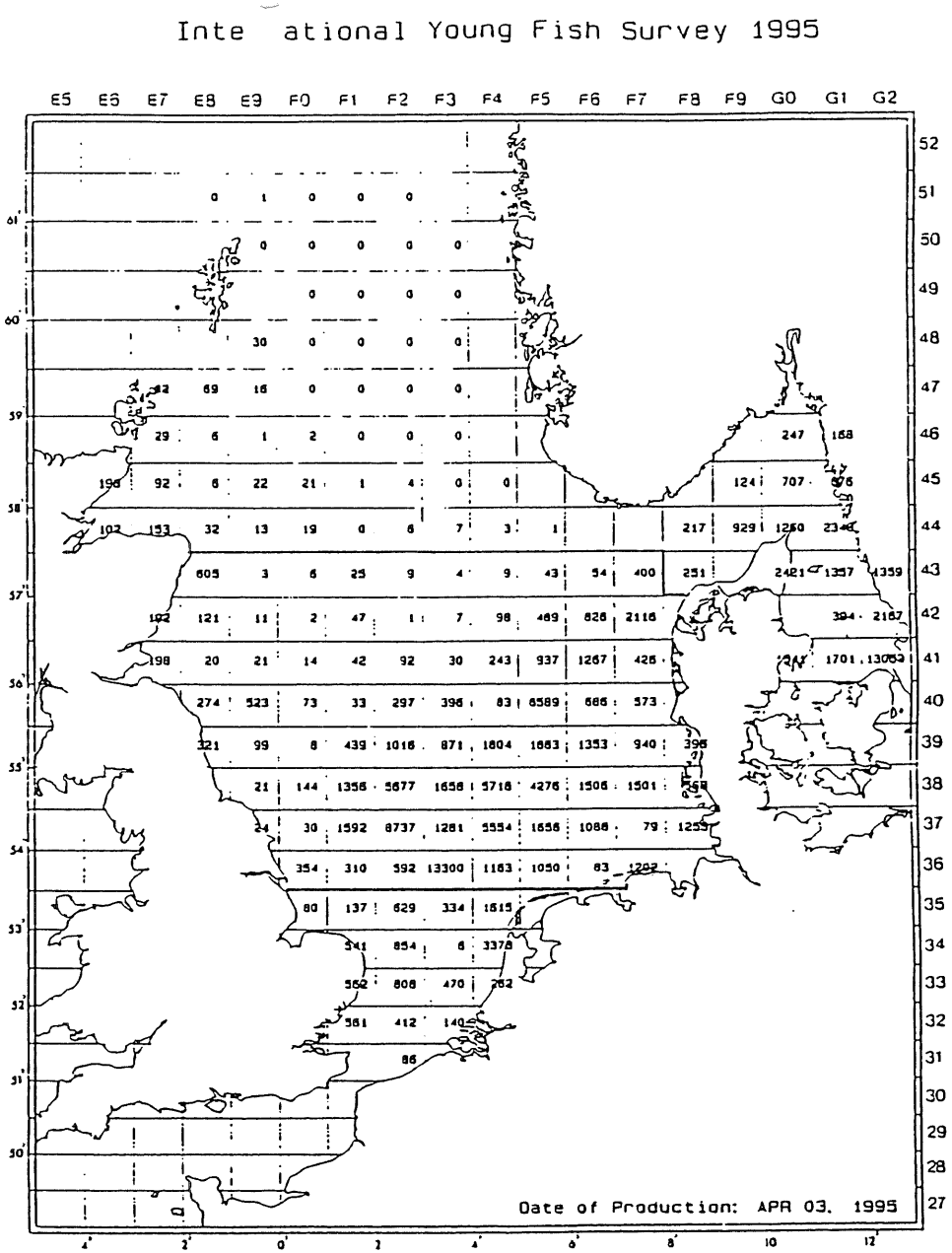
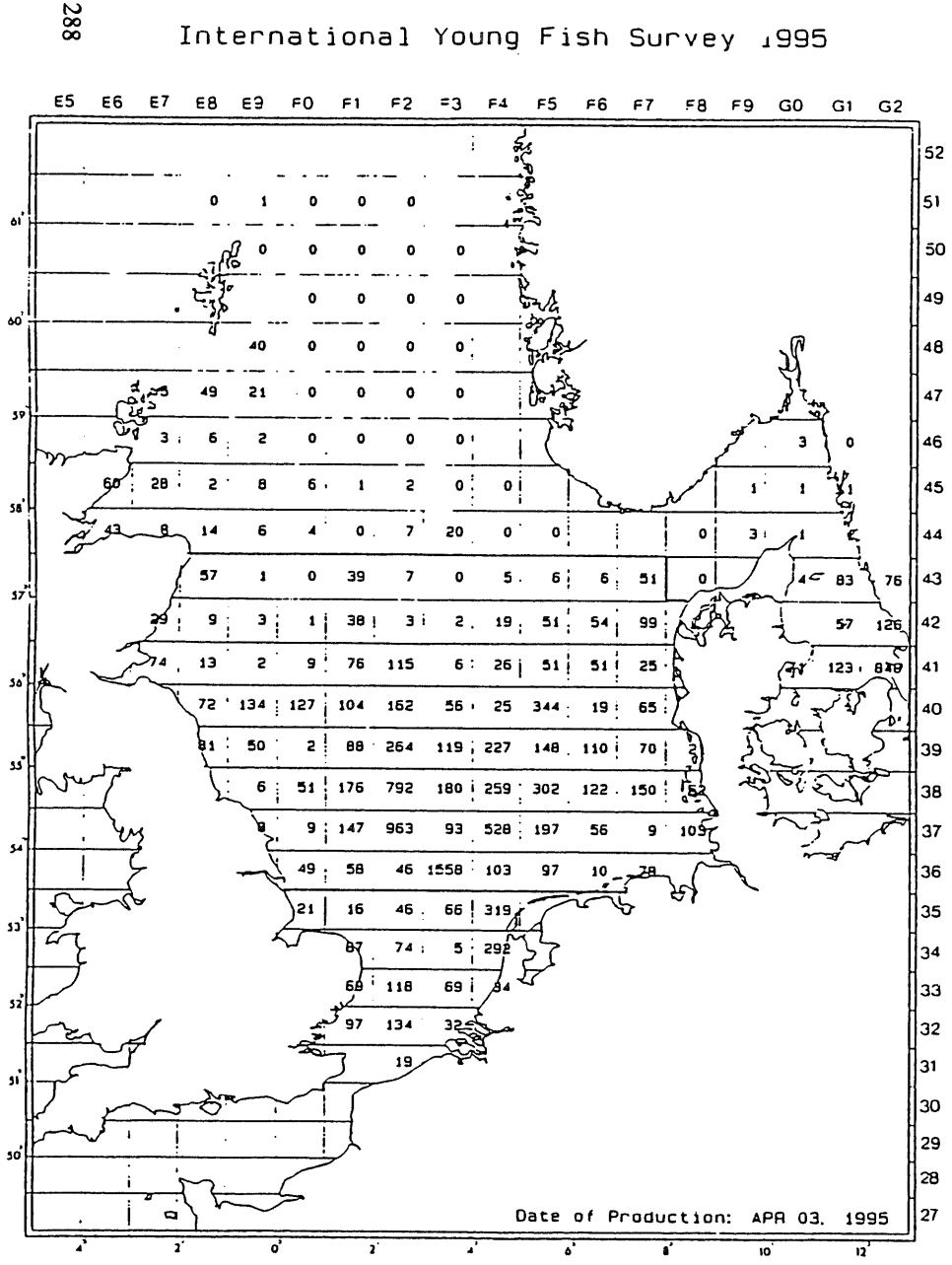
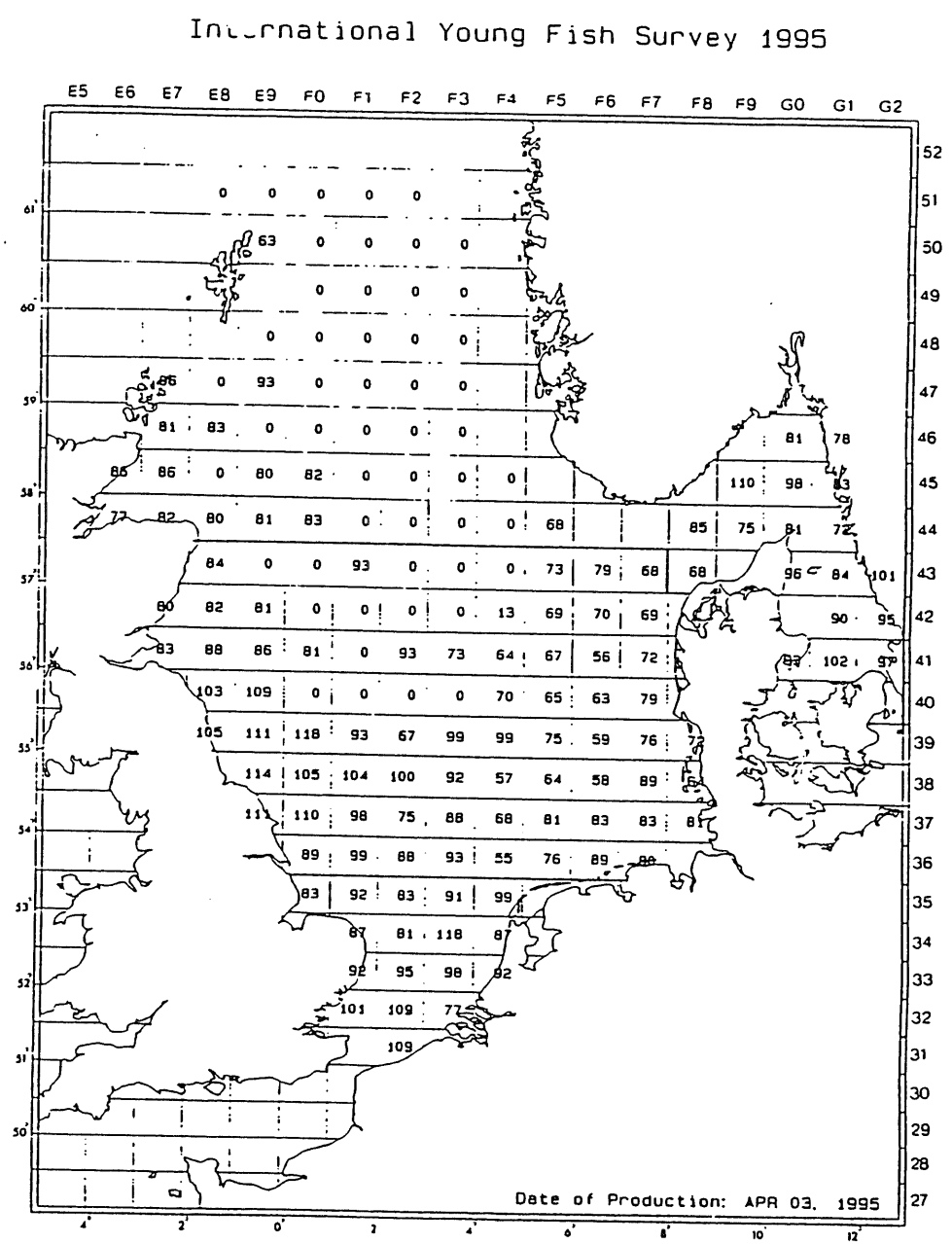


Figure 8.3.1 SPRAT. Distribution by age group in the IBTS (February) 1994, in the North Sea and Division IIIa.



Sprat. SPRA SPR
Number per Hour. Age Group 3+.

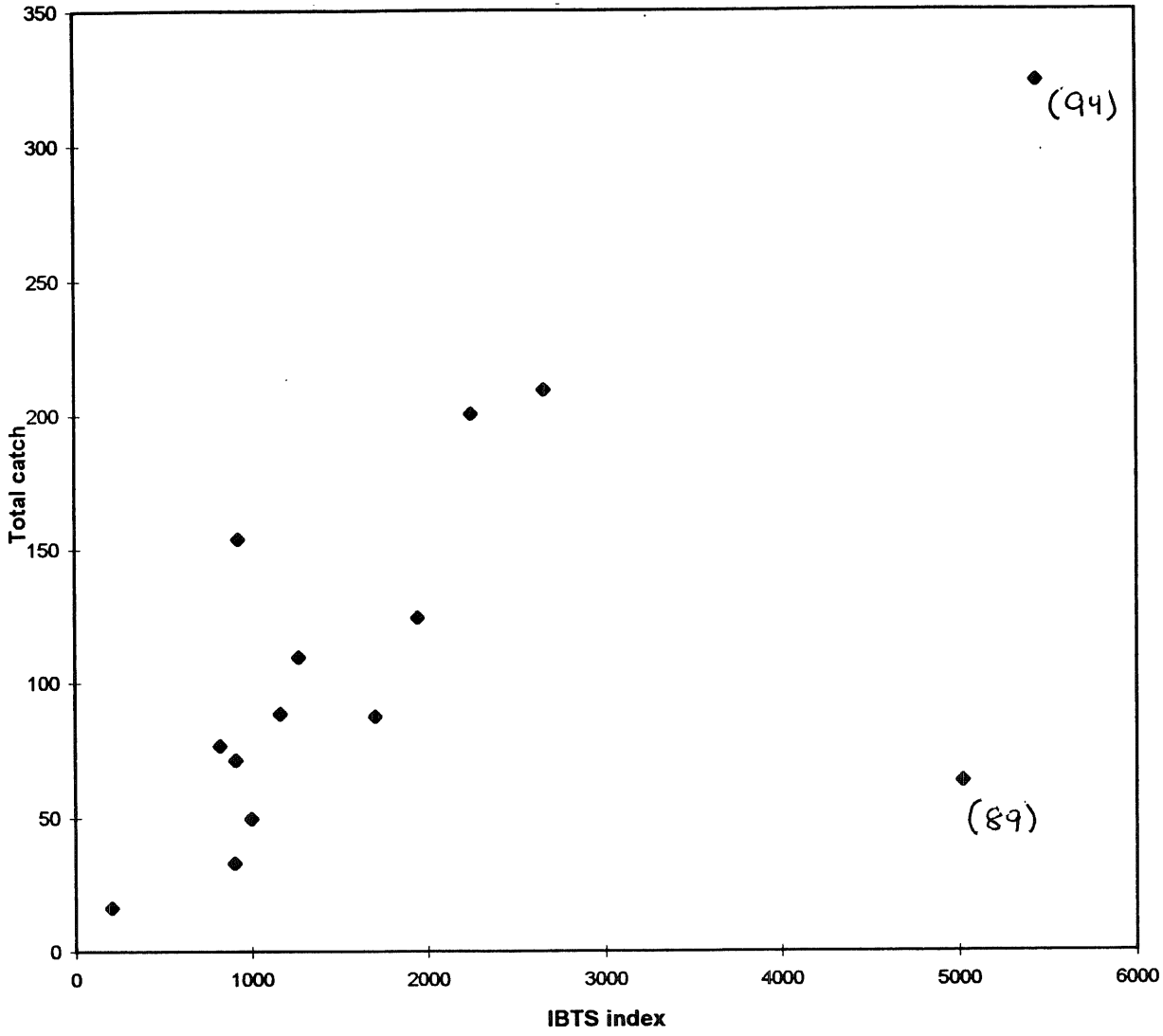
Figure 8.3.1 (continued)



Sprat. SPRA SPR
Mean Length. Age Group 1.

Figure 8.3.2 SPRAT Mean length of age group 1 (mm), in the IBTS (February)

Figure 8.6.1 North Sea sprat. IBTS total indices *vs* total catches in 1981-1995.



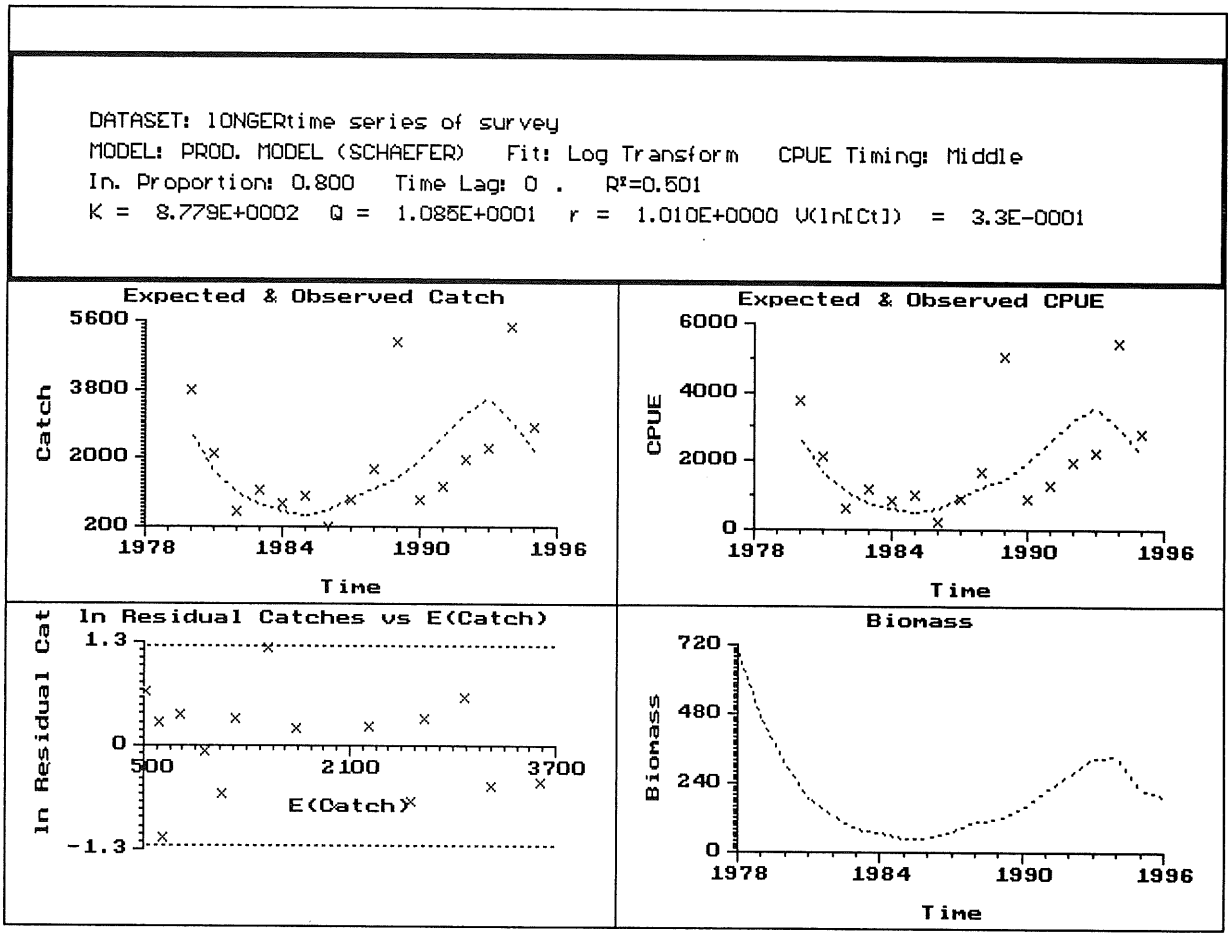
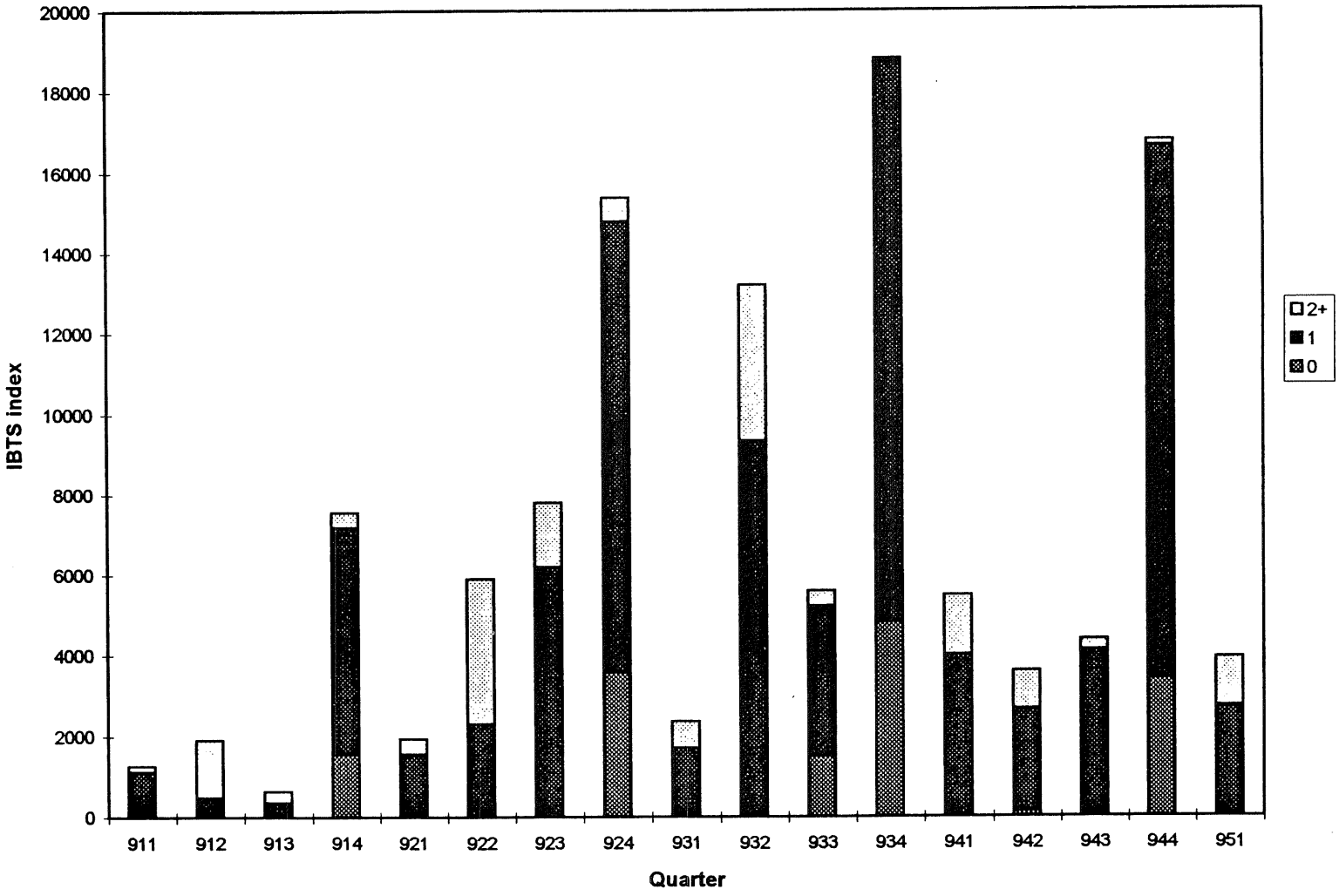


Figure 8.6.2 Biomass *vs* year for the North Sea sprat, 1978-1994.

Figure 8.8.1 North Sea sprat. Quarterly IBTS total indices 1991-1995.



9 SPRAT IN DIVISIONS VIId,e

9.1 The Fishery

The nominal landings are shown in Table 9.1.1. Table 9.1.2 shows monthly catches for the Lyme Bay fishery. Monthly and annual distributions of catches by rectangle are shown in Figures 8.1.1-8.1.13. The landings from the western Channel increased in 1994.

9.2 Catch Composition

No data were available to the Working Group on catch composition in the commercial landings in the fishing season 1994/95. Tables 9.2.1 and 9.2.2 show catch compositions and mean weights for the fishing seasons 1991/92 to 1993/94.

10 SPRAT IN DIVISION IIIa

10.1 Fishery

10.1.1 ACFM advice applicable for 1994 and 1995

ACFM advice on a sprat TAC has not been provided in recent years. Sprat is landed under the TAC for the mixed clupeoid fishery, including catches of all species taken in this fishery. The mixed clupeoid fishery at present mainly consists of herring but the proportion of sprat increased substantially between 1993 and 1994. In 1994 there was for the first time in several years a directed sprat fishery for industrial purposes in the Skagerrak and the northern part of the Kattegat. The TACs for this fishery, as adopted by the management bodies, were 45,000 t in 1993 and 43,000 t in 1994. The TAC set for 1995 was 43,000 t.

10.1.2 Catches in 1994

The total annual landings for Division IIIa by area and country in 1974-1994 are given in Table 10.1.1. The Norwegian and Swedish catches include the coastal and the fjord fishery. The total landings in 1994 as estimated by the Working Group were 96,000 t, the highest reported since 1975. The increase was reported in the Danish and Swedish landings. Of the total landings 2 % were taken for consumption, 600 t by Norway and 1,170 t by Sweden, all in the Skagerrak.

Landings by quarter for all three countries in 1994 are shown in Table 10.1.2. Nearly all the landings were taken in the third and last quarters.

10.1.3 Fleet

The sprat fishery in Division IIIa is conducted by fleets from Denmark, Norway and Sweden. These were described by the Herring Assessment Working Group in 1993 (Anon. 1993b).

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 1992-1994 data were supplied by Denmark, and in 1994 also by Sweden. The numbers and the mean weights by age in the Danish and Swedish industrial landings in 1992-1994 are presented in Tables 10.2.1 and Table 10.2.2, respectively, representing 96 % of the total sprat landings in Division IIIa.

10.2.2 Quality of catch and biological data

In 1994 the sampling was extended to cover the Swedish landings for industrial purposes . About 100 samples were analyzed for species composition and 45 samples for age and mean weight at age. The Danish sampling intensity and coverage of the landings in the "mixed clupeoid" fishery were largely unchanged compared to previous years. A total of 187 samples were analysed for species composition of which 80 samples were analysed for age and weight at age. In 1993, the landings of sprat made up about 6 % in weight of the total landings in the "mixed clupeoid" fishery while in 1994 the estimate increased to 40 %. There were as in previous years no samples taken from the fisheries for human consumption. Further details of 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 have been revised for 1993-1995 based on data in the IBTS database. Indices before that time are as given in previous IFWG reports (see Anon., 1992c). Sprat occurs mainly in the upper 150 m and only hauls taken between 10 and 150 m depth were included in the calculations. The 1993-1995 indices were calculated as mean cpue (#/hr) weighted by the area with water depths between 10 and 150 m in the rectangle (see Table 10.3.1). The rectangle area used for weights are presented in Table 10.3.2. The difference between the revised index and the index previously presented is in the assumption of

the density in unsampled rectangles. The old index included a standard set of rectangles (12 out of 15 rectangles in the Skagerrak and 8 in the Kattegat, (see Anon 1993, Table 10.3. 1) and if these rectangles were not sampled they were allocated zero density. The new index assumes that the rectangles sampled are representative of the entire stock, i.e. rectangles not sampled had the average density estimated by the survey allocated to them. The 1995 survey sampled 10 rectangles in the Skagerrak and 7 in the Kattegat. The age structure in the survey is rather variable as demonstrated in the text table below. The 1993 and 1994 comparison, particularly appears out of line with the other data.

Year class	1-group	2-group	1-gr/2-gr
1982	5818	2426	0.42
1983	2402	1934	1.24
1984	670	2219	0.30
1985	2234	5527	0.40
1986	950	1012	0.94
1987	435	243	1.79
1988	510	468	1.09
1989	659	634	1.03
1990	5897	4620	1.28
1991	177	116	1.52
1992	1121	340	3.30
1993	1561	422	3.69

The IBTS (February) index increased slightly between 1994 and 1995 (see Table 10.3.1).

The quarterly IBTS indices were not available for analysis.

10.4 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.

10.5 Projection of Catch and Stock

Figure 10.5.1 shows the IBTS (February) index plotted vs the catch in the same year. The 1994 observation is apparently an outlier. Ignoring this observation the projection for 1995 is 10-20,000 t. which seems low taking the current fishery into account.

10.6 Management Considerations

The recruitment variation between years does not appear to be driven directly by fishing. The sprat stock has in recent years been mainly fished together with herring except in 1994. The human consumption fishery is only a minor part of the total catch. There are no indications of overexploitation but the data available are quite variable.

10.7 Research Recommendations

For research recommenadations see Section 8.9.

Table 9.1.1 Nominal catch of sprat in Divisions VIId,e, 1983-1994.

Country	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994[1]
Belgium	3	-	-	-	-	-	-	-	-	-	-	-
Denmark	638	1,417	-	15	250	2,529	2,092	608	-	-	-	-
France	60	47	14	-	23	2	10	-	-	35	2	1
Germany	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	1,454	589	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl.& Wales	4,756	2,402	3,771	1,163	2,441	2,944	1,319	1,508	2,567	1,790	1,798	3,132
Total	6,911	4,455	3,785	1,178	2,714	5,475	3,421	2,116	2,567	1,825	1,800	3,133

[1]Preliminary

Table 9.1.2 Lyme Bay area fishery monthly catches (t) (UK vessels only).

Season	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1991/92	0	0	205	450	952	60	358	258	109	51	2443
1992/93	0	0	302	472	189	294	248	284	158	78	1719
1993/94	8	0	156	82	302	529	208	417	134	53	1889
1994/95	0	0	299	834	545	608	232				

[1]Provisional.

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	15.70	1.95	0.58
1994/95			No data			

[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.

Table 9.2.2 Lyme Bay area SPRAT. 1991-1993 mean weight at 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
	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
1994/95				No data				

[1]Based on November samples only.

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[1]	47.7	32.2	1.8	11.7	2.6	-	96.0

[1]Preliminary.

Table 10.1.2 Sprat in Division IIIa. Landings of sprat ('000 t) by quarter by the three countries. (Data provided by the Working Group).These figures do not in all cases correspond to the official statistics and cannot be used for management purposes.

1992	Quarter	Denmark	Norway	Sweden	**Total**
	1	1.9	0.0	2.3	4.2
	2	0.8	-	0.7	1.5
	3	0.6	0.2	0.1	0.9
	4	0.1	0.3	3.5	3.9
	Total	3.0	0.5	6.6	10.5
1993	Quarter	Denmark	Norway	Sweden	**Total**
	1	0.7	0.1	1.3	2.1
	2	0.2	-	0.4	0.6
	3	0.3	0.2	0.8	1.3
	4	0.2	1.0	3.8	5.0
	Total	1.4	1.3	6.3	9.0
1994	Quarter	Denmark	Norway	Sweden	**Total**
	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

Table 10.2.1 Division IIIa sprat. Landed numbers (millions) of sprat by age groups in the industrial fishery.

Country	Fishing area	Quarter	Age					
			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	-	-	-
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	-
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	-	-
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

Table 10.2.2 Mean weights (g) at age of sprat in Division IIIa 1994 (Danish and Swedish data)

	Age					
Quarter	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

Table 10.2.3 Division IIIa Sprat. Sampling of industrial landings in 1994.

1993

Country	Total catch ('000 t)	No. samples	No. aged	No. measured
Denmark	0.6	30	98	654
Norway	1.3			
Sweden	4.7			

1994

Country	Total catch ('000 t)	No. samples	No. aged	No. measured
Denmark	59.4	80	3420	6564
Norway	1.8	1		96
Sweden	34.8	45	687	3719

Table 10.3.1 Div. IIIa Sprat. Revised indices of sprat from IBTS 1993-1995.
(mean no/hr per rectangle weighted by area. Only hauls taken in depths of 10-150 m are included)

		Age			
Year	No hauls	1	2	3+	Total
1993	41	1789.72	4623.66	1475.42	7888.8
1994	43	1546.82	614.21	1327.87	3488.9
1995	45	2282.86	1828.81	89.29	4200.96

Table 10.3.2 Division IIIa. Areas (sq. n.m.) used for weighting IBTS indices

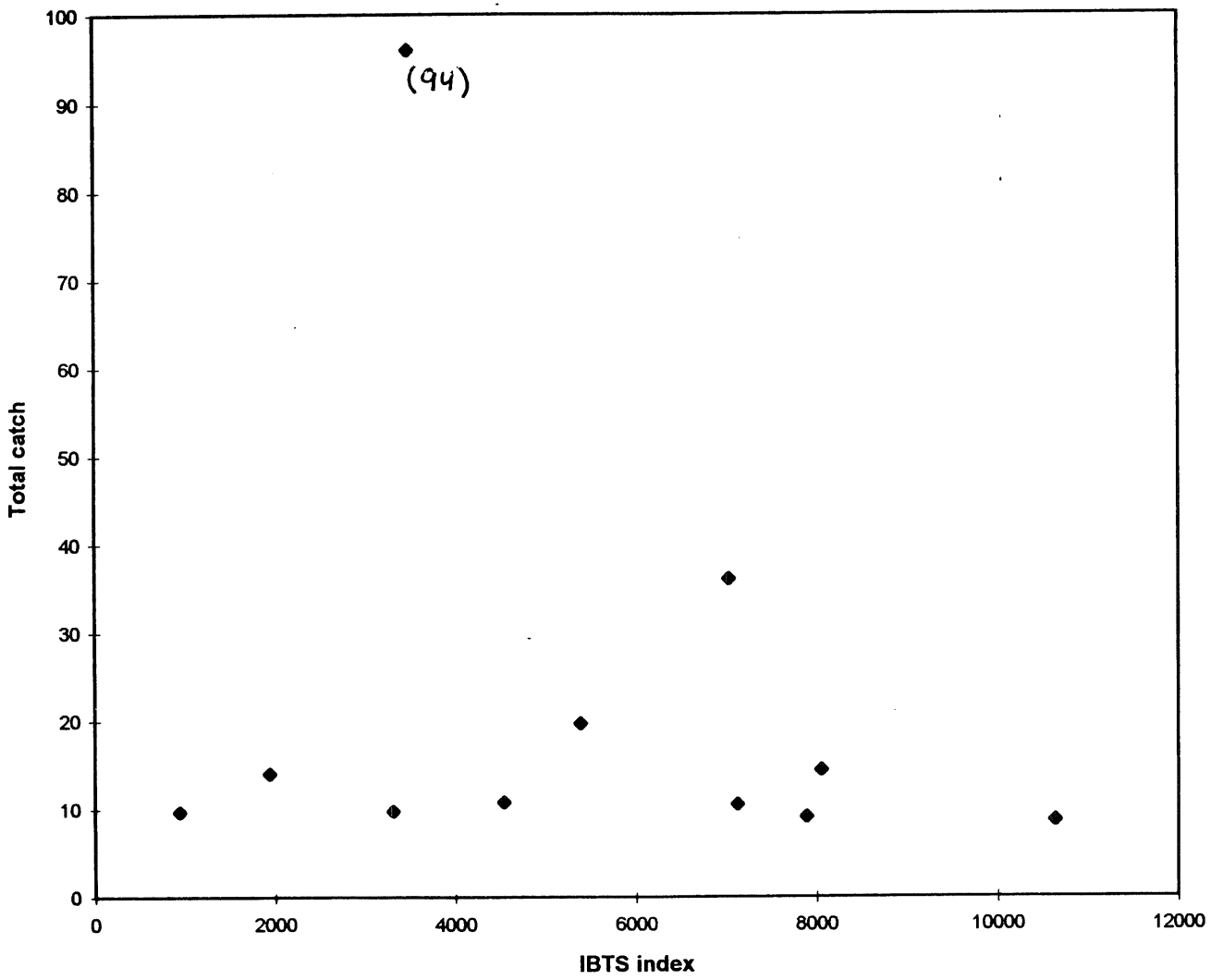
Skagerrak

Rectangle	Total	Area 0-9 m	> 150 m	10-150 m weight of cpue used in the index calculations
47G0	900.0	0.0	300.0	600.0
46G0	933.7	21.1	422.5	490.1
46G1	400.0	0.0	120.0	280.0
45F9	950.6	0.0	933.7	16.9
45F8	950.6	0.0	950.6	0.0
45G0	950.6	0.0	722.9	227.7
45G1	527.0	237.3	0.0	289.7
44F8	967.2	0.0	721.3	245.9
44F9	967.2	25.1	170.7	771.4
44G0	967.2	174.1	53.3	739.8
44G1	957.4	380.3	0.0	577.1
43F8	904.8	103.5	0.0	801.3
43F9	904.3	535.3	0.0	369.0

Kattegat

Rectangle	Total	Area 0-9 m	> 150 m	10-150 m weight of cpue used in the index calculations
43G0	973.5	768.6	0.0	204.9
43G1	973.5	289.7	0.0	683.8
43G2	325.2	227.0	0.0	98.2
42G0	879.0	595.6	0.0	283.4
42G1	993.9	110.8	0.0	883.1
42G2	958.9	341.7	0.0	617.2
41G1	1000.7	33.6	0.0	967.1
41G2	965.6	450.7	0.0	514.9

Figure 10.5.1 Division IIIa sprat. IBTS total indices *vs* total catches 1984-1995.



11. REFERENCES

Aglen, A. and Simmonds, E.J. 1988. Report on the Herring Acoustic Surveys in the Northern and Central North Sea during summer 1988. ICES C.M. 1988 /H: 31.

Anon. 1989a.Report of the Planning Group for Acoustic Surveys in Sub-division IV and Division IIIa. ICES C.M. 1989/H:3.

Anon. 1989b. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1989/Assess:15.

Anon. 1990. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1990/Assess:14.

Anon. 1991. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1991/Assess:15

Anon. 1992a. Manual for the International Bottom Trawl Survey. Addendum to ICES Doc. C.M. 1992/H:3

Anon. 1992b. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1992/Assess:11.

Anon. 1992c. Report of the Industrial Working Group. ICES Doc. C.M. 1992/Assess:9.

Anon. 1992d. Report of the Workshop on Methods of Forecasting Herring Catches in Division IIIa and the North Sea. ICES C.M. 1992/ H: 5.

Anon. 1993a. Report of the Working Group on the Assessment of Pelagic Stocks in the Baltic. ICES C.M. 1993/Assess: 17.

Anon. 1993b. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1993/Assess:15.

Anon. 1994a. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES, Doc. C.M.1994/Assess:13.

Anon. 1994b. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES C.M. 1994/ Assess: 6.

Anon. 1994c. Report of the Study Group on Herring Assessments and Biology in the Irish Sea and Adjacent Areas. Belfast, Northern Ireland, February 1994.

Anon 1994d. Report of the Planning Group for Herring Surveys. ICES C.M. 1994/H:3

Anon. 1995. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. ICES C.M. 1995/ Assess: 2.

Degnbol, P., Jensen, T.F., Lundgren, B. and Vinther, M. 1990. ECHOANN - An analyser for echosounder signals. ICES, Doc. C.M. 1990/B:10 Sess.R.

Fournier, P. and Archibald, C.P. 1982. A general theory for analysing catch at age data. Can. J. Fish. Aquat. Sci. 39: 1195-1207.

Gislason, H. 1991. The influence of variation in recruitment on Multi-species yield prediction in the North Sea. ICES Marine Science Symposia. 193: 50-59.

Gislason, H. 1993. The effect of changes in recruitment levels on multi-species long-term predictions. Can. J. Fish. Aquat. Sci.

12 WORKING DOCUMENTS

Anon. 1994. Report of The Planning Group for Herring Surveys. Bergen, 24-27 May 1994.

Armstrong, M.J. 1995a. Preliminary results of a hydro-acoustic survey of herring in the Irish Sea (area VIIa) during August - September 1994.

Armstrong, M.J. 1995b. Results of experimental commercial fishing on the Manx herring spawning grounds during September and October 1994.

Dickey-Collas, M. 1995. Results of larval herring surveys in the north Irish Sea(area VIIa (N)) in November 1993 and November 1994.

Heessen, H., Hagstrøm, O. and Sparholt, H. 1994. Suggestion for revisions of herring IBTS indices.

Molloy, J. and Fernandes, P. 1995. Acoustic survey off the West coast of Ireland, 1994.

Molloy, J., Fernandes, P. and Reid, D. 1995. Acoustic Surveys in the Celtic Sea andDiv. VIIj 1994/95.

Munk, P. 1995a. The catch of larval Downs herring during the IBTS (MIK-sampling).

Munk, P. 1995b. Distribution of 0-ringed and 1-ringed herring during the IBTS, year-classes 1977-1992. Predicting the distribution pattern of the 1-ringed herring.

Nash, R.D.M. 1995. A comparison of the Isle of Man and Northern Ireland larval surveys on the Manx component of the VIIa (N) stock.

Nash, R.D.M. and Hughes, G. 1995a. A survey of Manx stock herring larvae north-east of the Isle of Man in November 1994.

Nash, R.D.M. and Hughes, G. 1995b. Herring larvae over the Douglas Bank spawning ground (Area VIIa (N) Manx stock) in October 1994.

Patterson, K.R. 1995a. North Sea Autumn-Spawning Herring Stock Assessment Update.

Patterson, K.R. 1995b. Programmers Reference for the Integrated Catch-at-Age Programmes. Version 1.2.

Patterson, K.R. 1995c. Technical Reference for the Integrated Catch-at-Age Programmes. Version 1.2.

Patterson, K.R. and Beveridge, D. 1995. Report of the Herring Larvae Surveys in the North Sea and Adjacent Waters in 1993/1994.

Patterson, K.R. and Melvin, G.D. 1995. Integrated Catch at Age Analysis. Version 1.2. Users' Manual.

Simmonds, E.J., Toresen, R., Corten, A., Pedersen, J. and Reid, D.G. 1994. 1994 ICES coordinated acoustic survey of ICES Divisions IVa, IVb and VIa.

Skagen, D.W. 1995. Prevalence at age of *Ichthyophonus hoferi* disease in the North Sea 1991-94. Norwegian data from surveys and commercial catches.

Sparre, P. 1995a. On the medium term management.

Sparre, P. 1995b. VPA by Excel Spread Sheet ("PERS_VPA.XLS").

Sparre, P. 1995c. Short-term and medium-term prediction by spread-sheet (Excel 5).