Advisory Committee on Fishery Management

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REPORT OF THE WORKING GROUP ON THE ASSESSMENT OF DEMERSAL STOCKS IN THE NORTH SEA AND SKAGERRAK

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11 PLAICE IN DIVISION IIIA

11.1 Trends in Catches and Fisheries

The landing of plaice amounted to 10,930 t in 1995 as compared to 11,300 t in 1994. About 92% of the catch were taken by Denmark.

The annual landings from 1972 to 1995 are given by country and separated on Kattegat and Skagerrak in Table 11.1. In the start of this period most catches were landed in Kattegat but from the mid 1970s Skagerrak have supplied the major proportion of the catch. In recent years more than 80% of the catch derives from Skagerrak. Moreover, most of the catches taken in Kattegat are reported from the northern part of the area.

The landing data for 1983–1988 are considered uncertain and have been adjusted on the assumption that misreporting was a serious source of bias (ICES 1991). In recent years no strong incentive have existed to omit the reporting of plaice catches as the catch quotas have not been restrictive. However, unreported place landings may have resulted in conjunction with non-legal fisheries for other species. Also misreporting by area as well as misreporting of other species as plaice may have taken place.

A directed plaice fishery is carried out by otter trawl, seine and gill-net with some beam trawlers being introduced in recent years. However, most of the catches are taken in mixed human consumption fisheries. A considerable number of vessels have been taken out of the fisheries in recent years (ICES 1995).

11.2 Natural Mortality, Maturity, Age Compositions and Mean Weight at Age

As in previous years catch at age and mean weight at age information are provided by Denmark only. The annual number of Danish market samples and the numbers of plaice measured and aged are presented in Table 11.2.

Serious doubts have been raised on the quality of the Danish age readings at the recent Working Group meetings and for this reason North-Sea age information was used to break down the 1994 Skagerrak catches in last years assessment (ICES 1996). Before the present assessment a thoroughly re-examination of the age readings for the catches taken in Skagerrak in 1994 has been carried out which resulted in an age distribution substantial different to that used in last years assessment. The total international catch at age for 1994 were therefore revised using the new Danish age distribution. The 1995 age distribution for Division IIIa plaice, were similarly derived by raising the Danish age compositions with the international catch by quarter and area (Table 11.3).

The 1994 and 1995 weight at age in the catch were derived from the same data sources as were used for the estimation of the catch at age and are given in Table 11.4. Weight at age in the stock were assumed equal to that of the catch.

A natural mortality of 0.1 per year were assumed for all years and ages. A knife-edge maturity ogive was assumed: Age group 2 was assumed as being immature whereas all age 3 and older plaice were assumed mature.

11.3 Catch, Effort and Research Vessel Data

Three Danish fleets, i.e. trawl , gill-net and seine, are available for tuning. The age disaggregated indices were derived by merging logbook statistics supplying catch weight per market category with the age distribution within these categories available from the market sampling. Only trips where plaice was the most valuable component of the catch were included. The effect of size determined differences in fishing power was reduced by only using data for vessels between 10 and 20 GRT.

IBTS survey data for Kattegat and Skagerrak for the 1st quarter are available since 1984 and for the 2nd, 3rd and 4th quarter since 1991 but these surveys only provide the length frequencies of the catches. To derive catch rates by age the survey length distribution was converted to age groups by applying quarterly age/length keys from the Danish market sampling program. However, the age-length keys from the commercial sampling is restricted to plaice above 25 cm and this implies that age-disaggregated catch rate information can only be derived for plaice at or above an age of 3 years.

11.4 Catch at Age Analysis

The VPA have been tuned by XSA using default F shrinkage and the default three cubic time taper over 20 years. Population shrinkage were applied to age 2 plaice as this age group were poorly represented in all tuning fleets.

Initial XSA runs including tuning information from both the commercial fleets and the quarterly IBTS surveys showed that the catchability of the IBTS surveys were estimated with a very low precision (average "SE log q" found at 0.75 to 1.05 equivalent of CVs above 200%) and that the surveys were given low weights to the estimated numbers of survivors. Trials with XSA tunings excluding the survey data showed very little difference with respect to the estimated numbers of survivors and insignificant differences were seen when comparing the retrospective patterns or SSB and F between the two sets of tuning runs. For this reason the final XSA tuning were carried out by using the commercial fleets only. The catch and effort for the commercial tuning fleets are given in Table 11.5.

The Std. err. on the catchabilites are found at 0.3 to 0.4 in the age span 4 to 7 (equivalent to CVs of 35–50%) with somewhat higher values found for older and younger ages (Table 11.6). Plots of the log catchability residuals (Figure 11.1) show little trends over time.

The VPA results are given in Tables 11.7–11.9. The fishing mortality estimated for 1995 is found similar to what is estimated for the preceding years both with respect to the selection pattern and to the level of the reference F (age 4 to 8). The exploitation pattern show an increase in the fishing mortality until age 6 from where on F remains at a level of about 1 per year. This pattern is different from what is estimated for the North Sea (Section 9) where the fishing mortality reaches a plateau at 0.6 per year at an age of 4. The apparent difference may partly be caused by the larger Skagerrak plaice migrating into the North Sea for spawning.

Retrospective VPA runs are carried back to 1991. (Figure 11.2). Only small differences are seen in the retrospective pattern of SSB and in the F(4–8).

11.5 Recruitment Estimates

No age disaggregated abundance indices are available from the IBTS surveys in Kattegat and Skagerrak and an examination of the survey length distributions did not indicate modes which could be used to proximate the age structure. This may be related to the fact that the young place are found in the shallow areas not covered by the surveys.

11.6 Long-Term Trends

The long-term trends in the fisheries are presented in Tables 11.1 and 11.9 and shown in Figure 11.3.

In the 1970s catches fluctuated between 14,000 and 27,000 t. Since then the catches have declined to the present levels of about 9,000 to 12,000 t. The fishing mortality has remained at a rather stable level of around 0.8 over the period covered by the assessment. The SSB was estimated as high as 60 thousand t in 1978 but has since then fluctuated around 35 thousand t. The recruitment has varied between 25 and 100 million per year without notable trends.

11.7 Biological Reference Points

The yield per recruit analysis has been carried out using the average 1993–1995 exploitation pattern raised to the level of the F(4–8) estimated for 1995. As mean weight at age was used the average weights from 1993–1995. The input data to the yield per recruit analysis are presented in Table 11.10 and the yield per recruit results is given in Table 11.11 and shown in Figure 11.4. F_{max} is found at 0.16 per year and $F_{0.1}$ at 0.08.

No clear relation is found between SSB and recruitment and no apparent decline in recruitment is seen for the lower SSB levels (Figure 11.5). F_{med} is estimated at 0.74 per year which is close to the 1995 level of fishing mortality found at 0.78. F_{high}, corresponding to an SSB per recruit of about 363 gram, is estimated at about 5 per year. The high F_{max} value is caused by the combined effect of a knife edge maturity ogive with full recruitment at age 3 and a insignificant fishing mortality at age 2 (0.026 per year) which makes it virtually impossible to fish down the SSB per recruit to levels below 363 grams.

11.8 Catch Forecast

The inputs used for the predictions are given in Table 11.12. Stock sizes for age 3 and above are taken from the estimated numbers of survivors from the XSA. The age 2 recruitment in 1996, 1997 and 1998 are taken as the geometric average for 1978–1995. The mean weight at age are taken as the average for the years 1993–1995. The exploitation pattern in the prognosis are based on the average exploitation pattern 1993–1995 scaled to F level of 1995.

The *status quo* predictions result in catches of 10,500 and 10,000 t in 1996 and 1997, respectively. The *status quo* estimate of SSB increases from 31,000 t in 1996 to 33,500 t in 1998.

Figure 11.6 show the sensitivity and the sources of variation connected to the various input parameters for the *status quo* catch predictions. The 1997 yield is found most sensitive to the fishing mortality in 1997 and 1996. About 60 percent of the variation associated with the estimated 1997 yield can be attributed to the selectivity towards age 3 plaice (sH3),and the sizes of year class 1992 (N4) and the year class 1994 (N2). The SSB at the start of 1998 is mainly sensitive to the size of the 1994 and 1995 year classes and the weight and proportion mature of the 1992 and 1993 year classes. Of the total variance on the 1998 SSB more than 80 percent can be attributed the recruitment variability in 1996 and 1997.

Figure 11.7 shows the probability profiles for 1997 yield and the 1998 SSB under the *status quo* projection. The plots show that to maintain a catch level similar to that of 1995 a fishing mortality above $F_{status\ quo}$ will must likely be required and that it is unlikely that the SSB fall below the historical minimum SSB found at 24,000 tons.

11.9 Medium-Term Predictions

Medium-term projections were carried out on the *status quo* catch projection for a 10 year period. The recruitment was randomly bootstrapped as no clear relation between SSB and recruitment could be inferred (Figure 11.5). The results of the medium-term analysis are given for yield, SSB, stock biomass and recruitment in Figure 11.8. The trends in all stock measures develops undramatically around the long range values which is to be expected in the lack of a stock-recruitment-relationship.

11.10 Long-Term Considerations

The assessment indicates a relative stability in yield, SSB, fishing mortality and recruitment over the period where the stock have been assessed (1978–1995) The fishing mortality have fluctuated around a value of 0.8 per year which is close to estimated F_{med} of 0.74 per year suggesting that the stock may sustain the present fishing mortality (F estimated at 0.78 per year) without affecting the recruitment prospects.

11.11 Comments on the Assessment

The quality control diagrams are shown in Table 11.14. A face value comparison with the previous years assessments is impeded by the problems associated with the age readings of Skagerrak plaice in 1993 and 1994.

The assessment is based on incomplete catch data in so far as no discard data are available. A programme to estimate the discard levels in Kattegat and Skagerrak have been initiated in autumn 1995.

The plaice catches taken in the quarterly IBTS surveys are not available on an age-disaggregated-aggregated basis. This implies that no fishery independent measures are available for the tuning of the XSA and that no indices of pre-recruit abundance are available to forecast recruitment.

11.12 MBAL Consideration

The establishment of a reliable level of MBAL is impeded by the lack of a clear stock recruitment relationship. Historical lows in the size of the SSB was found in 1989 and 1982 at 24,000 and 27,000 t, respectively. From these levels the stock was able to recover to reach above average SSB levels within few years.

Table 11.1 Plaice landings from the Kattegat and Skagerrak (tonnes) 1972-1995. Official figures, excluding misreported landings in the period 1983–1988. See Anon. (1992).

Year	Denmark		Sweden		Germany		Belgium	Norway	Total	Total	Total
	Kattegat	Skagerrak	Kattegat	Skagerrak	Kattegat	Skagerrak	Skagerrak	Skagerrak	Kattegat	Skagerrak	Div. IIIa
1972	15,504	5,095	348	70					15,852	5,165	21,017
1973	10,021	3,871	231	80					10,252	3,951	14,203
1974	11,401	3,429	255	70					11,656	3,499	15,155
1975	10,158	4,888	369	77					10,527	4,965	15,492
1976	9,487	9,251	271	81					9,758	9,332	19,090
1977	11,611	12,855	300	142					11,911	12,997	24,908
1978	12,685	13,383	368	94					13,053	13,477	26,530
1979	9,721	11,045	281	105					10,002	11,150	21,152
1980	5,582	9,514	289	92					5,871	9,606	15,477
1981	3,803	8,115	232	123					4,035	8,238	12,273
1982	2,717	7.789	201	140					2,918	7,929	10,847
1983	3,280	6,828	291	170			133	14	3,571	7,145	10,716
1984	3,252	7,560	323	356	32		27	22	3,607	7,965	11,572
1985	2,979	9,646	403	296	4		136	18	3,386	10,096	13,482
1986	2,468	10,653	170	215			505	24	2,638	11,397	14,035
1987	2,868	11,370	283	222	104		907	25	3,255	12,524	15,779
1988	1,818	9,781	210	281	3		716	41	2,031	10,819	12,850
1989	1,596	5,387	135	320	4	0	230	33	1,735	5,970.1	7,705
1990	1,831	8,726	201	777	2	1	471	69	2,034	10,043.7	12,078
1991	1,756	5,849	267	472	6	4	315	68	2,029	6,707.9	8,737
1992	2,071	8,522	208	381			537	107	2,279	9,547	11,826
1993	1,289	9,128	287	175			339	78	1,576	9,720	11,296
1994	1,553	8,790	315	227	4	33	325	65	1,872	9,440	11,312
1995	1,555	8,479	132	338	6	42	302	76	1,693	9,237	10,930

Table 11.2 Plaice in Div. IIIa. Samling levels for the Danish port samplings during 1995.

Area	Quarter	# samples	# measured	# aged
Kattegat	1	6	608	561
	2	7	1026	950
	3	3	668	643
	4	3	340	334
Kattegat total		19	2642	2488

Skagerrak	1	9	398	381
	2	3	435	415
	3	3	425	413
	4	7	821	785
Skagerrak total		22	2079	1994

Table 11.3 Plaice in Div. IIIa.International catch at age ('000),1978–1995.

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Run title : Plaice in IIIa (run: XSAHOH02/X02)

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Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE								
2,	503,	1105,	363,	191,	552,	1569,	2184,	1462,
3,	16129,	9791,	4792,	4059,	2168,	10292,	12880,	8990,
4,	40633,	29662,	16421,	13135,	9653,	9143,	12555,	22548,
5,	25613,	20812,	12627,	11001,	11119,	8503,	4590,	6434,
6,	8234,	7648,	6058,	4318,	5825,	2832,	2043,	1767,
7,	637,	2515,	2403,	1431,	1941,	980,	906,	725,
8,	65,	170,	953,	548,	795,	563,	750,	275,
9,	65,	75,	204,	214,	316,	272,	592,	209,
10,	49,	50,	54,	119,	118,	102,	300,	175,
+gp,	62,	55,	50,	97,	50,	112,	107,	164,
0 TOTALNUM,	91990,	71883,	43925,	35113,	32537,	34368,	36907,	42749,
TONSLAND,	26530,	21152,	15477,	12273,	10847,	10716,	11572,	13482,
SOPCOF %,	97,	100,	100,	100,	95,	94,	97,	97,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	395,	592,	100,	1045,	3205,	2363,	934,	1130,	1462,	438,
3,	4479,	4235,	3121,	3977,	8993,	8735,	3995,	3664,	6888,	2268,
4,	15549,	13081,	12374,	7365,	8905,	9602,	12219,	10304,	7903,	6623,
5,	20027,	18620,	14159,	6489,	10042,	4640,	18212,	13486,	9708,	11661,
6,	4915,	10691,	7055,	2813,	3333,	2878,	4493,	7038,	7913,	6662,
7,	680,	2184,	2822,	1215,	1015,	888,	1078,	1707,	2772,	4973,
8,	273,	386,	973,	568,	495,	304,	308,	388,	448,	856,
9,	130,	237,	331,	265,	360,	156,	119,	108,	110,	138,
10,	122,	126,	140,	140,	161,	86,	28,	50,	40,	65,
+gp,	84,	165,	162,	226,	256,	135,	119,	75,	55,	48,
0 TOTALNUM,	46654,	50317,	41237,	24103,	36765,	29787,	41505,	37950,	37299,	33732,
TONSLAND,	14035,	15779,	12850,	7705,	12078,	8737,	11826,	11296,	11312,	10930,
SOPCOF %,	94,	94,	97,	96,	97,	100,	95,	97,	101,	101,

1

Table 11.4 Plaice in Div IIIa. Mean weight at ag (kg), 1978–1995.

Run title : Plaice in IIIa (run: XSAHOH02/X02)

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Table 2 Catch weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE								
2,	.2360,	.2220,	.2610,	.2300,	.2700,	.2850,	.2770,	.2790,
3,	.2480,	.2550,	.2740,	.2630,	.3010,	.2740,	.2930,	.2840,
4,	.2680,	.2670,	.3060,	.2960,	.2860,	.2930,	.3090,	.3070,
5,	.3220,	.2970,	.3450,	.3570,	.3180,	.3560,	.3770,	.3520,
6,	.4170,	.3780,	.4140,	.4320,	.3860,	.4230,	.4200,	.4370,
7,	.5980,	.4510,	.5790,	.5370,	.5440,	.4830,	.4190,	.5470,
8,	.7520,	.6550,	.6400,	.6710,	.7040,	.5310,	.3900,	.6610,
9,	.8180,	.9220,	.7530,	.8130,	.8130,	.6470,	.3600,	.7420,
10,	.9140,	1.0200,	.8110,	.9120,	.9120,	.9860,	.4460,	.7540,
+gp,	.8430,	1.0440,	.9100,	.9990,	.9860,	1.1840,	1.1060,	.9180,
0 SOPCOFAC,	.9729,	.9998,	.9959,	.9972,	.9535,	.9439,	.9656,	.9674,

Table 2 Catch weights at age (kg)

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
2,	.2520,	.3400,	.2490,	.2740,	.2910,	.2630,	.3090,	.2680,	.2750,	.2630,
3,	.2770,	.2850,	.2680,	.2630,	.2880,	.2700,	.3100,	.2730,	.2640,	.3010,
4,	.2840,	.2860,	.2690,	.2820,	.2940,	.2590,	.2730,	.2710,	.2720,	.3030,
5,	.3210,	.3030,	.2900,	.3200,	.3370,	.2740,	.2800,	.2950,	.2890,	.2900,
6,	.3980,	.3740,	.3500,	.3760,	.3970,	.3650,	.3360,	.3380,	.3300,	.3280,
7,	.5380,	.5380,	.4740,	.4660,	.4980,	.4920,	.5000,	.4400,	.3800,	.3680,
8,	.6740,	.7380,	.5670,	.6350,	.6850,	.5860,	.6460,	.5650,	.5140,	.5000,
9,	.7910,	.9440,	.7570,	.7390,	.7740,	.6710,	.8170,	.7150,	.6590,	.7380,
10,	.8620,	1.0230,	.8320,	.8260,	.9570,	.8690,	.8040,	.8020,	.7760,	.7500,
+gp,	1.0260,	1.1180,	1.1920,	1.0100,	1.1520,	1.0110,	.9710,	1.1710,	.9820,	1.0160,
0 SOPCOFAC,	.9366,	.9400,	.9724,	.9619,	.9724,	1.0020,	.9503,	.9714,	1.0075,	1.0093,

1

Table 11.5 Catch and effort information for the fleets used for the XSA tuning of Plaice in Division IIIa.

Plaice in the Kattegat and Skagerrak (Fishing Area IIIa) (run name: XSAHOH02)
103
FLT07: Danish gill-netters (Catch: Unknown) (Effort: Unknown)
1987 1995
1 1 0.00 1.00
2 10

1888	15292.8	122342.4	479552.0	850921.6	650604.8	212777.6	40214.4	24921.6	12838.4
1794	1076.4	80012.4	437556.6	566007.0	386068.8	269997.0	112842.6	47361.6	17222.4
887	8160.4	29537.1	113536.0	120986.8	91538.4	89587.0	74774.1	35213.9	20667.1
471	24256.5	78751.2	85627.8	134564.7	67023.3	30662.1	22089.9	19405.2	10126.5
429	17760.6	93564.9	137408.7	89703.9	104032.5	48691.5	18918.9	7936.5	6864.0
777	27039.6	143745.0	470240.4	711732.0	182595.0	66355.8	24242.4	11033.4	3030.3
1101	19377.6	87969.9	281305.5	554243.4	523305.3	181554.9	37213.8	11450.4	3303.0
2019	23016.6	519690.6	720984.9	926317.2	816079.8	301840.5	49465.5	16555.8	4441.8
1908	8967.6	110282.4	527752.8	1314993.6	678103.2	731527.2	132415.2	17744.4	7250.4

FLT08: Danish trawlers (Catch: Unknown) (Effort: Unknown)
1987 1995
1 1 0.00 1.00
2 10

2551	11479.5	151529.4	542342.6	815554.7	402802.9	52040.4	5612.2	2806.1	1785.7
1572	3301.2	126074.4	565291.2	652851.6	259851.6	63666.0	13519.2	2986.8	1886.4
729	14580.0	52852.5	135885.6	164462.4	65245.5	16839.9	5977.8	2405.7	874.8
1349	113855.6	319443.2	330100.3	335226.5	98342.1	24012.2	8768.5	4047.0	1349.0
1468	75014.8	340429.2	416765.2	203318.0	111127.6	25249.6	8220.8	4991.2	2202.0
1557	27870.3	150250.5	445613.4	728987.4	197116.2	52159.5	13390.2	1712.7	155.7
1511	23873.8	199754.2	628727.1	600018.1	267295.9	55755.9	9821.5	2417.6	1662.1
2578	74246.4	581854.6	737823.6	885285.2	647078.0	159062.6	15468.0	2578.0	773.4
1580	9164.0	70626.0	340016.0	725378.0	323900.0	198764.0	35708.0	3318.0	790.0

FLT12: Danish seiners (Catch: Unknown) (Effort: Unknown)
1987 1995
1 1 0.00 1.00
2 10

3451	33129.6	324048.9	1211646.1	2096137.4	1136069.2	139075.3	18290.3	11043.2	5521.6
2425	8002.5	352595.0	1202557.5	1411592.5	654022.5	203215.0	48257.5	11155.0	4365.0
2220	91908.0	406926.0	717948.0	730602.0	316350.0	119658.0	37962.0	15318.0	7104.0
2625	285600.0	919800.0	940012.5	1055512.5	319462.5	83212.5	27825.0	16537.5	5512.5
2694	256738.2	919462.2	1013752.2	542032.8	359110.2	98331.0	28825.8	12661.8	4041.0
2403	64160.1	322963.2	1335106.8	2032457.4	505591.2	85546.8	17782.2	5526.9	961.2
2510	72539.0	205067.0	609930.0	1019311.0	650090.0	151855.0	30371.0	7028.0	1757.0
2812	328441.6	778361.6	761208.4	968171.6	740962.0	197964.8	23058.4	5061.6	843.6
2612	74442.0	328589.6	726658.4	992821.2	650126.8	408778.0	48583.2	5746.4	3134.4

Table 11.6 Plaice in Div. IIIa. Tuning diagnostics.

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Lowestoft VPA Version 3.1

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 Extended Survivors Analysis

 Plaice in IIIa (run: XSAHOH02/X02)

 CPUE data from file /users/fish/ifad/ifapwork/wgnssk/ple_kask/FLEET.X02

 Catch data for  18 years. 1978 to 1995. Ages  2 to  11.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 FLT07: Danish gill-n,   1987, 1995,   2,     10,    .000,  1.000
 FLT08: Danish trawle,   1987, 1995,   2,     10,    .000,  1.000
 FLT12: Danish seiner,   1987, 1995,   2,     10,    .000,  1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability dependent on stock size for ages <    3

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  3


      Catchability independent of age for ages >=    8


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final    5 years or the   5 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =    .500

      Minimum standard error for population
      estimates derived from each fleet =    .300

      Prior weighting not applied


 Tuning converged after   28 iterations

1


 Regression weights
       ,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000


 Estimated population abundance at 1st Jan 1996

    ,      .00E+00, 3.16E+04, 2.90E+04, 2.41E+04, 1.18E+04, 4.26E+03, 2.25E+03, 4.91E+02, 7.01E+01,

 Taper weighted geometric mean of the VPA populations:

    ,     4.84E+04, 4.41E+04, 3.55E+04, 2.09E+04, 8.11E+03, 2.72E+03, 9.32E+02, 3.74E+02, 1.60E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .3174,     .3188,     .3194,     .4183,     .4992,     .5170,     .4317,     .5595,     .6956,
1
```

Table 11.6 (Continued)

Log catchability residuals.

Fleet : FLT07: Danish gill-n

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	.16	-.60	-.45	.01	.30	.28	.06	.17	.00
3	-.22	-.53	-.77	.17	.39	.55	-.28	.92	-.37
4	-.07	.27	-.46	.01	-.19	.41	-.13	.17	-.02
5	-.08	.09	-.50	.10	-.27	.48	-.25	.01	.37
6	-.20	-.09	-.31	.01	.47	.07	.26	-.31	.03
7	-.57	-.19	.03	-.15	.49	-.01	.42	-.29	.15
8	-1.09	-.19	.27	.34	.46	.22	.08	-.28	.02
9	-.61	-.14	.31	.52	.76	.28	.17	-.38	-.09
10	-.31	.16	.74	.70	.69	.53	-.27	-.29	-.17

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

Age	3	4	5	6	7	8	9	10
Mean Log q	-5.9335	-4.6137	-3.6144	-3.0564	-2.6002	-2.5670	-2.5670	-2.5670
S.E(Log q)	.5607	.2615	.3150	.2611	.3329	.4487	.4457	.5141

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	.31	1.617	9.98	.46	9	.33	-8.23

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.42	2.255	8.67	.70	9	.19	-5.93
4	.76	.824	6.02	.64	9	.20	-4.61
5	.69	1.625	5.59	.81	9	.20	-3.61
6	1.20	-.861	1.83	.73	9	.32	-3.06
7	1.26	-.944	1.21	.67	9	.42	-2.60
8	1.67	-1.021	-.23	.26	9	.75	-2.57
9	1.09	-.242	2.17	.53	9	.50	-2.46
10	.77	1.050	2.93	.77	9	.36	-2.37

1

Table 11.6 (Continued)

Fleet : FLT08: Danish trawle

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	-.10	-.29	-.30	.07	.28	-.01	-.06	.36	-.02
3	-.42	-.06	-.11	.40	.33	-.22	.10	.67	-.75
4	-.24	.66	-.09	.31	-.31	-.33	.36	-.05	-.27
5	-.22	.56	.21	.16	-.48	.01	-.28	-.07	.16
6	-.34	.28	.18	-.02	-.06	.09	-.10	-.15	.11
7	-.94	-.16	-.11	-.11	-.06	.39	.26	.16	.37
8	-1.59	-.41	-.30	.14	.17	.70	.20	.08	.67
9	-1.33	-1.00	-.40	-.33	.84	-.51	.07	-.71	.20
10	-.81	-.15	-.46	-.60	.09	-1.37	.50	-.51	-.43

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

Age	3	4	5	6	7	8	9	10
Mean Log q	-5.8139	-4.6162	-3.8147	-3.6893	-3.9369	-4.3363	-4.3363	-4.3363
S.E(Log q)	.4437	.3535	.3092	.1826	.3927	.6638	.7348	.6961

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	.31	2.227	9.90	.61	9	.24	-7.95

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.49	2.108	8.29	.72	9	.18	-5.81
4	8.34	-2.055	-38.15	.01	9	2.47	-4.62
5	1.11	-.316	3.12	.55	9	.37	-3.81
6	1.21	-1.343	2.57	.86	9	.21	-3.69
7	.98	.064	4.01	.68	9	.41	-3.94
8	2.41	-1.008	.91	.07	9	1.60	-4.34
9	3.71	-1.748	1.70	.06	9	2.13	-4.66
10	.84	.560	4.76	.65	9	.48	-4.75

1

Table 11.6 (Continued)

Fleet : FLT12: Danish seiner

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	-.24	-.65	-.28	.05	.35	-.15	-.13	.70	.21
3	-.39	.12	.39	.37	.29	-.31	-.80	.45	-.13
4	.01	.73	.21	.44	-.28	.08	-.43	-.36	-.27
5	.13	.62	.30	.36	-.39	.32	-.55	-.35	-.31
6	-.03	.34	.22	.07	.08	.17	-.14	-.53	-.12
7	-.75	.08	.25	-.02	.20	-.03	.27	-.19	.10
8	-1.16	-.02	-.01	.18	.37	.10	.38	-.05	.03
9	-.71	-.56	-.11	-.03	.71	-.22	.18	-.57	-.21
10	-.44	-.20	.08	-.30	-.36	-.43	-.40	-.96	.00

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

Age	3	4	5	6	7	8	9	10
Mean Log q	-5.3933	-4.3630	-3.5317	-3.2643	-3.4489	-3.8887	-3.8887	-3.8887
S.E(Log q)	.4383	.3923	.4194	.2586	.3006	.4326	.4679	.4716

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	.42	1.052	9.26	.33	9	.43	-7.19

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.76	.498	6.65	.40	9	.35	-5.39
4	25.39	-2.001	******	.00	9	8.42	-4.36
5	1.28	-.507	1.74	.34	9	.56	-3.53
6	1.53	-2.261	.17	.73	9	.32	-3.26
7	1.19	-.783	2.61	.73	9	.37	-3.45
8	1.68	-1.077	1.94	.28	9	.72	-3.89
9	1.52	-1.085	3.16	.40	9	.66	-4.04
10	.79	1.571	4.35	.90	9	.22	-4.23

1

Table 11.6 (Continued)

Terminal year survivor and F summaries :

Age 2 Catchability dependent on age and year class strength

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	31595.,	.360,	.000,	.00,	1,	.205,	.013
FLT08: Danish trawle,	30995.,	.300,	.000,	.00,	1,	.294,	.013
FLT12: Danish seiner,	39179.,	.452,	.000,	.00,	1,	.130,	.011
P shrinkage mean ,	44092.,	.32,,,,				.264,	.009
F shrinkage mean ,	11368.,	.50,,,,				.107,	.036

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
31610.,	.16,	.19,	5,	1.182,	.013

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	29634.,	.301,	.237,	.79,	2,	.274,	.070
FLT08: Danish trawle,	29912.,	.253,	.509,	2.01,	2,	.390,	.070
FLT12: Danish seiner,	37527.,	.334,	.416,	1.25,	2,	.226,	.056
F shrinkage mean ,	14447.,	.50,,,,				.110,	.139

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
28982.,	.16,	.20,	7,	1.236,	.072

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	27022.,	.214,	.210,	.98,	3,	.341,	.210
FLT08: Danish trawle,	24135.,	.210,	.238,	1.13,	3,	.340,	.232
FLT12: Danish seiner,	23553.,	.256,	.216,	.84,	3,	.233,	.237
F shrinkage mean ,	15997.,	.50,,,,				.086,	.332

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
24077.,	.13,	.11,	10,	.881,	.232

Table 11.6 (Continued)

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	14844.,	.183,	.100,	.55,	4,	.333,	.558
FLT08: Danish trawle,	12521.,	.179,	.052,	.29,	4,	.345,	.634
FLT12: Danish seiner,	8006.,	.224,	.127,	.57,	4,	.218,	.869
F shrinkage mean ,	10708.,	.50,,,,				.104,	.711

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
11828.,	.11,	.08,	13,	.707,	.662

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	4454.,	.171,	.076,	.44,	5,	.308,	.885
FLT08: Danish trawle,	4713.,	.169,	.080,	.48,	5,	.314,	.852
FLT12: Danish seiner,	3582.,	.198,	.096,	.48,	5,	.249,	1.019
F shrinkage mean ,	4167.,	.50,,,,				.128,	.924

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4258.,	.11,	.05,	16,	.443,	.912

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	2256.,	.174,	.115,	.66,	6,	.287,	1.130
FLT08: Danish trawle,	2310.,	.175,	.124,	.71,	6,	.258,	1.114
FLT12: Danish seiner,	2000.,	.187,	.139,	.74,	6,	.279,	1.214
F shrinkage mean ,	2630.,	.50,,,,				.175,	1.029

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2254.,	.12,	.06,	19,	.529,	1.131

1

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	479.,	.233,	.094,	.40,	7,	.266,	.994
FLT08: Danish trawle,	598.,	.246,	.137,	.56,	7,	.183,	.859
FLT12: Danish seiner,	459.,	.233,	.057,	.24,	7,	.278,	1.020
F shrinkage mean ,	473.,	.50,,,,				.274,	1.001

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
491.,	.17,	.05,	22,	.285,	.978

Table 11.6 (Continued)

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1986

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	65.,	.291,	.077,	.27,	8,	.254,	1.102
FLT08: Danish trawle,	79.,	.360,	.070,	.19,	8,	.127,	.981
FLT12: Danish seiner,	65.,	.291,	.073,	.25,	8,	.244,	1.107
F shrinkage mean ,	74.,	.50,,,,				.374,	1.018

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
70.,	.22,	.04,	25,	.165,	1.056

1

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 1985

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT07: Danish gill-n,	25.,	.286,	.073,	.25,	9,	.237,	1.231
FLT08: Danish trawle,	23.,	.383,	.126,	.33,	9,	.126,	1.320
FLT12: Danish seiner,	27.,	.282,	.106,	.37,	9,	.254,	1.186
F shrinkage mean ,	39.,	.50,,,,				.383,	.952

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
30.,	.22,	.07,	28,	.301,	1.119

Table 11.7 Plaice in Div. IIIa. Fishing mortality 1978–1995 as estimated from XSA.

Run title : Plaice in IIIa (run: XSAHOH02/X02)

At 11-Oct-96 14:39:08

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE								
2,	.0086,	.0252,	.0108,	.0075,	.0112,	.0170,	.0317,	.0307,
3,	.2390,	.2048,	.1306,	.1442,	.0991,	.2632,	.1691,	.1582,
4,	.7713,	.7954,	.5469,	.5492,	.5239,	.6650,	.5207,	.4407,
5,	1.0916,	1.0731,	.8482,	.7742,	1.1542,	1.1100,	.7424,	.4893,
6,	1.0360,	1.0586,	.9651,	.7026,	1.1521,	.9447,	.7769,	.6319,
7,	.6060,	.9512,	1.0604,	.5521,	.7056,	.5151,	.8116,	.6175,
8,	.2900,	.2819,	1.0946,	.6457,	.6022,	.3984,	.8437,	.5444,
9,	.4958,	.5605,	.5656,	.6800,	.8632,	.3745,	.8411,	.5243,
10,	.7070,	.7888,	.9115,	.6738,	.9001,	.6714,	.8070,	.5637,
+gp,	.7070,	.7888,	.9115,	.6738,	.9001,	.6714,	.8070,	.5637,
0 FBAR 4- 8,	.7590,	.8321,	.9030,	.6448,	.8276,	.7266,	.7390,	.5447,

Table 8 Fishing mortality (F) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	FBAR 93-95
AGE											
2,	.0109,	.0177,	.0031,	.0162,	.0469,	.0493,	.0200,	.0240,	.0396,	.0131,	.0256,
3,	.1116,	.1397,	.1096,	.1463,	.1693,	.1564,	.0993,	.0917,	.1783,	.0718,	.1139,
4,	.3969,	.4797,	.6617,	.3599,	.4940,	.2455,	.3033,	.3531,	.2599,	.2324,	.2818,
5,	.7843,	1.0350,	1.3334,	.7846,	1.0574,	.4588,	.8751,	.5661,	.5815,	.6616,	.6030,
6,	.7612,	1.2125,	1.4276,	.9504,	1.1281,	.9042,	.9754,	.9102,	.6806,	.9116,	.8342,
7,	.4696,	.8216,	1.1679,	.9241,	1.0018,	.9553,	.9379,	1.1833,	1.0395,	1.1309,	1.1179,
8,	.4393,	.4716,	.9870,	.6787,	1.1526,	.8449,	.9495,	.9633,	1.0699,	.9776,	1.0036,
9,	.4748,	.7535,	.8465,	.7065,	1.1407,	1.4046,	.8544,	.9520,	.7086,	1.0555,	.9054,
10,	.5882,	1.0526,	1.3244,	.9738,	1.1696,	.8257,	.9409,	.9858,	1.0531,	1.1191,	1.0526,
+gp,	.5882,	1.0526,	1.3244,	.9738,	1.1696,	.8257,	.9409,	.9858,	1.0531,	1.1191,	
0 FBAR 4- 8,	.5703,	.8041,	1.1155,	.7395,	.9668,	.6817,	.8082,	.7952,	.7263,	.7828,	

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Table 11.8 Plaice in Div. IIIa. Stock numbers 1978–1995 as estimated from XSA.

Run title : Plaice in IIIa (run: XSAHOH02/X02)

At 11-Oct-96 14:39:08

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE								
2,	61955,	46640,	35490,	26889,	52254,	97852,	73685,	50822,
3,	79773,	55581,	41151,	31767,	24149,	46756,	87048,	64596,
4,	79462,	56839,	40978,	32676,	24883,	19788,	32517,	66512,
5,	40532,	33249,	23215,	21459,	17072,	13333,	9208,	17480,
6,	13417,	12311,	10288,	8994,	8952,	4871,	3976,	3966,
7,	1474,	4308,	3865,	3546,	4031,	2559,	1714,	1654,
8,	271,	727,	1506,	1211,	1847,	1801,	1384,	689,
9,	175,	184,	496,	456,	575,	915,	1094,	538,
10,	102,	96,	95,	255,	209,	219,	569,	427,
+gp,	128,	105,	87,	207,	88,	239,	202,	398,
0 TOTAL,	277289,	210041,	157171,	127461,	134060,	188335,	211397,	207081,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	GMST 78-93	AMST 78-93
AGE													
2,	38161,	35540,	34056,	68191,	73482,	51600,	49579,	50195,	39568,	35393,	0,	50088,	52900,
3,	44595,	34154,	31594,	30720,	60708,	63441,	44442,	43973,	44343,	34412,	31610,	46053,	49028,
4,	49897,	36090,	26875,	25619,	24013,	46376,	49095,	36413,	36303,	33571,	28982,	37591,	40502,
5,	38734,	30358,	20213,	12547,	16175,	13258,	32829,	32800,	23146,	25331,	24077,	21223,	23279,
6,	9696,	15998,	9757,	4821,	5181,	5084,	7582,	12382,	16850,	11709,	11828,	7805,	8580,
7,	1908,	4098,	4306,	2118,	1686,	1517,	1862,	2587,	4509,	7719,	4258,	2494,	2702,
8,	807,	1079,	1631,	1212,	761,	560,	528,	660,	717,	1443,	2254,	926,	1042,
9,	362,	471,	609,	550,	556,	217,	218,	185,	228,	223,	491,	410,	475,
10,	288,	203,	201,	236,	245,	161,	48,	84,	65,	101,	70,	180,	215,
+gp,	198,	264,	229,	379,	386,	251,	204,	125,	88,	74,	52,		
0 TOTAL,	184646,	158255,	129471,	146393,	183195,	182465,	186388,	179401,	165817,	149977,	103622,		

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Table 11.9 Plaice in Div. IIIa. Stock summary 1978–1995.

Run title : Plaice in IIIa (run: XSAHOH02/X02)

At 11-Oct-96 14:39:08

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 8,
1978,	61955,	75776,	61155,	26530,	.4338,	.7590,
1979,	46640,	57029,	46675,	21152,	.4532,	.8321,
1980,	35490,	49077,	39814,	15477,	.3887,	.9030,
1981,	26889,	39285,	33100,	12273,	.3708,	.6448,
1982,	52254,	41616,	27508,	10847,	.3943,	.8276,
1983,	97852,	56588,	28701,	10716,	.3734,	.7266,
1984,	73685,	63233,	42823,	11572,	.2702,	.7390,
1985,	50822,	63277,	49097,	13482,	.2746,	.5447,
1986,	38161,	54741,	45124,	14035,	.3110,	.5703,
1987,	35540,	51270,	39186,	15779,	.4027,	.8041,
1988,	34056,	37321,	28841,	12850,	.4456,	1.1155,
1989,	68191,	42557,	23872,	7705,	.3228,	.7395,
1990,	73482,	55906,	34523,	12078,	.3499,	.9668,
1991,	51600,	49813,	36243,	8737,	.2411,	.6817,
1992,	49579,	55926,	40606,	11826,	.2912,	.8082,
1993,	50195,	51042,	37590,	11296,	.3005,	.7952,
1994,	39568,	47080,	36199,	11312,	.3125,	.7263,
1995,	35393,	44903,	35594,	10930,	.3071,	.7828,
Arith. Mean ,	51186,	52024,	38147,	13255,	.3468,	.7760,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 11.10 The SAS System 18:34 Friday, October 11, 1996

Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	1.000	0.1000	0.0000	0.0000	0.0000	0.269	0.0261	0.269
3	.	0.1000	1.0000	0.0000	0.0000	0.279	0.1161	0.279
4	.	0.1000	1.0000	0.0000	0.0000	0.282	0.2872	0.282
5	.	0.1000	1.0000	0.0000	0.0000	0.291	0.6145	0.291
6	.	0.1000	1.0000	0.0000	0.0000	0.332	0.8502	0.332
7	.	0.1000	1.0000	0.0000	0.0000	0.396	1.1393	0.396
8	.	0.1000	1.0000	0.0000	0.0000	0.526	1.0228	0.526
9	.	0.1000	1.0000	0.0000	0.0000	0.704	0.9227	0.704
10	.	0.1000	1.0000	0.0000	0.0000	0.776	1.0727	0.776
11+	.	0.1000	1.0000	0.0000	0.0000	1.056	1.0727	1.056
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDHOH02
Date and time: 11OCT96:18:47

Table 11.11

The SAS System 18:34 Friday, October 11, 1996

Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)

Yield per recruit: Summary table

						1 January		Spawning time	
F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.0000	0.0000	0.000	0.000	10.508	6931.036	9.508	6662.370	9.508	6662.370
0.0500	0.0391	0.255	179.139	7.966	4425.043	6.966	4156.376	6.966	4156.376
0.1000	0.0783	0.379	238.446	6.720	3265.201	5.720	2996.534	5.720	2996.534
0.1500	0.1174	0.454	258.467	5.973	2613.102	4.973	2344.436	4.973	2344.436
0.2000	0.1566	0.505	263.185	5.470	2203.642	4.470	1934.975	4.470	1934.975
0.2500	0.1957	0.542	261.623	5.106	1927.158	4.106	1658.492	4.106	1658.492
0.3000	0.2348	0.570	257.606	4.828	1730.424	3.828	1461.757	3.828	1461.757
0.3500	0.2740	0.592	252.851	4.609	1584.690	3.609	1316.023	3.609	1316.023
0.4000	0.3131	0.610	248.135	4.429	1473.187	3.429	1204.521	3.429	1204.521
0.4500	0.3523	0.625	243.793	4.279	1385.554	3.279	1116.888	3.279	1116.888
0.5000	0.3914	0.638	239.948	4.151	1315.090	3.151	1046.424	3.151	1046.424
0.5500	0.4305	0.649	236.618	4.041	1257.300	3.041	988.634	3.041	988.634
0.6000	0.4697	0.659	233.776	3.944	1209.077	2.944	940.410	2.944	940.410
0.6500	0.5088	0.668	231.373	3.858	1168.216	2.858	899.550	2.858	899.550
0.7000	0.5480	0.676	229.356	3.781	1133.120	2.781	864.453	2.781	864.453
0.7500	0.5871	0.683	227.672	3.711	1102.607	2.711	833.940	2.711	833.940
0.8000	0.6262	0.689	226.273	3.648	1075.789	2.648	807.123	2.648	807.123
0.8500	0.6654	0.695	225.117	3.590	1051.989	2.590	783.322	2.590	783.322
0.9000	0.7045	0.701	224.167	3.536	1030.681	2.536	762.014	2.536	762.014
0.9500	0.7437	0.706	223.391	3.487	1011.454	2.487	742.787	2.487	742.787
1.0000	0.7828	0.711	222.762	3.441	993.982	2.441	725.315	2.441	725.315
1.0500	0.8219	0.715	222.259	3.398	978.003	2.398	709.336	2.398	709.336
1.1000	0.8611	0.719	221.861	3.357	963.307	2.357	694.640	2.357	694.640
1.1500	0.9002	0.723	221.553	3.319	949.719	2.319	681.053	2.319	681.053
1.2000	0.9394	0.727	221.321	3.284	937.098	2.284	668.432	2.284	668.432
1.2500	0.9785	0.730	221.154	3.250	925.326	2.250	656.659	2.250	656.659
1.3000	1.0176	0.733	221.043	3.217	914.302	2.217	645.635	2.217	645.635
1.3500	1.0568	0.737	220.978	3.187	903.944	2.187	635.277	2.187	635.277
1.4000	1.0959	0.740	220.953	3.158	894.180	2.158	625.513	2.158	625.513
1.4500	1.1351	0.743	220.962	3.130	884.950	2.130	616.283	2.130	616.283
1.5000	1.1742	0.745	221.001	3.103	876.201	2.103	607.534	2.103	607.534
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDHOH02
Date and time : 11OCT96:18:47
Computation of ref. F: Simple mean, age 4 - 8
F-0.1 factor : 0.1034
F-max factor : 0.2059
F-0.1 reference F : 0.0809
F-max reference F : 0.1612
Recruitment : Single recruit

Table 11.12

Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)

Prediction with management option table: Input data

Year: 1996								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	50088.000	0.1000	0.0000	0.0000	0.0000	0.269	0.0261	0.269
3	31610.000	0.1000	1.0000	0.0000	0.0000	0.279	0.1161	0.279
4	28982.000	0.1000	1.0000	0.0000	0.0000	0.282	0.2872	0.282
5	24077.000	0.1000	1.0000	0.0000	0.0000	0.291	0.6145	0.291
6	11828.000	0.1000	1.0000	0.0000	0.0000	0.332	0.8502	0.332
7	4258.000	0.1000	1.0000	0.0000	0.0000	0.396	1.1393	0.396
8	2254.000	0.1000	1.0000	0.0000	0.0000	0.526	1.0228	0.526
9	491.000	0.1000	1.0000	0.0000	0.0000	0.704	0.9227	0.704
10	70.000	0.1000	1.0000	0.0000	0.0000	0.776	1.0727	0.776
11+	52.000	0.1000	1.0000	0.0000	0.0000	1.056	1.0727	1.056
Unit	Thousands	-	-	-	-	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
2	50088.000	0.1000	0.0000	0.0000	0.0000	0.269	0.0261	0.269
3	.	0.1000	1.0000	0.0000	0.0000	0.279	0.1161	0.279
4	.	0.1000	1.0000	0.0000	0.0000	0.282	0.2872	0.282
5	.	0.1000	1.0000	0.0000	0.0000	0.291	0.6145	0.291
6	.	0.1000	1.0000	0.0000	0.0000	0.332	0.8502	0.332
7	.	0.1000	1.0000	0.0000	0.0000	0.396	1.1393	0.396
8	.	0.1000	1.0000	0.0000	0.0000	0.526	1.0228	0.526
9	.	0.1000	1.0000	0.0000	0.0000	0.704	0.9227	0.704
10	.	0.1000	1.0000	0.0000	0.0000	0.776	1.0727	0.776
11+	.	0.1000	1.0000	0.0000	0.0000	1.056	1.0727	1.056
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1998								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
2	50088.000	0.1000	0.0000	0.0000	0.0000	0.269	0.0261	0.269
3	.	0.1000	1.0000	0.0000	0.0000	0.279	0.1161	0.279
4	.	0.1000	1.0000	0.0000	0.0000	0.282	0.2872	0.282
5	.	0.1000	1.0000	0.0000	0.0000	0.291	0.6145	0.291
6	.	0.1000	1.0000	0.0000	0.0000	0.332	0.8502	0.332
7	.	0.1000	1.0000	0.0000	0.0000	0.396	1.1393	0.396
8	.	0.1000	1.0000	0.0000	0.0000	0.526	1.0228	0.526
9	.	0.1000	1.0000	0.0000	0.0000	0.704	0.9227	0.704
10	.	0.1000	1.0000	0.0000	0.0000	0.776	1.0727	0.776
11+	.	0.1000	1.0000	0.0000	0.0000	1.056	1.0727	1.056
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANHOH03
Date and time: 11OCT96:19:00

Table 11.13

The SAS System 18:34 Friday, October 11, 1996

Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)

Prediction with management option table

Year: 1996					Year: 1997					Year: 1998	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.7828	44728	31271	10532	0.5000	0.3914	45771	32314	5737	51654	38197
.	.	.	.	.	0.6000	0.4697	.	32314	6687	50631	37174
.	.	.	.	.	0.7000	0.5480	.	32314	7583	49670	36213
.	.	.	.	.	0.8000	0.6262	.	32314	8429	48767	35310
.	.	.	.	.	0.9000	0.7045	.	32314	9228	47917	34460
.	.	.	.	.	1.0000	0.7828	.	32314	9984	47116	33659
.	.	.	.	.	1.1000	0.8611	.	32314	10700	46360	32903
.	.	.	.	.	1.2000	0.9394	.	32314	11380	45646	32189
.	.	.	.	.	1.3000	1.0176	.	32314	12025	44970	31514
.	.	.	.	.	1.4000	1.0959	.	32314	12638	44331	30874
.	.	.	.	.	1.5000	1.1742	.	32314	13222	43725	30268
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANHOH03
Date and time : 11OCT96:19:00
Computation of ref. F: Simple mean, age 4 - 8
Basis for 1996 : F factors

Table 11.14 Quality Control diagrams for Plaice in Division IIIa

Assessment Quality Control Diagram 1

Average F(4-8 ,u)									
Date of assessment	Year								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
1989									
1990									
1991									
1992									
1993									
1994	-	-	-	-	-	-	-		
1995	0.80	1.11	0.73	0.92	0.60	0.68	0.86	0.64	
1996	0.80	1.12	0.74	0.97	0.68	0.81	0.80	0.73	0.78

Remarks: No analytical assesment carried out in 1994. In 1995 the catch at age was derived by using age information taken from the North Sea

Table 11.14 (Cont'd) Stock: Plaice in Division IIIa

Assessment Quality Control Diagram 2

Recruitment (age 2) Unit: millions									
Date of assessment	Year class								
	1986	1987	1988	1989	1990	1991	1992	1993	1994
1989	25.3	-							
1990	73.7	-	-						
1991	38.6	81.4	47.5	-					
1992	26.0	41.8	69.3	104.2	-				
1993	34.2	81.2	104.0	53.6	78.8	-			
1994	-	-	-	-	-	-	-		
1995	34.8	67.3	55.8	34.6	39.2	99.5	46.0	47.3	
1996	34.0	68.2	73.5	51.6	49.6	50.2	39.6	35.4	50.1

Remarks: No analytical assesment carried out in 1994. In 1995 the catch at age was derived by using age information taken from the North Sea

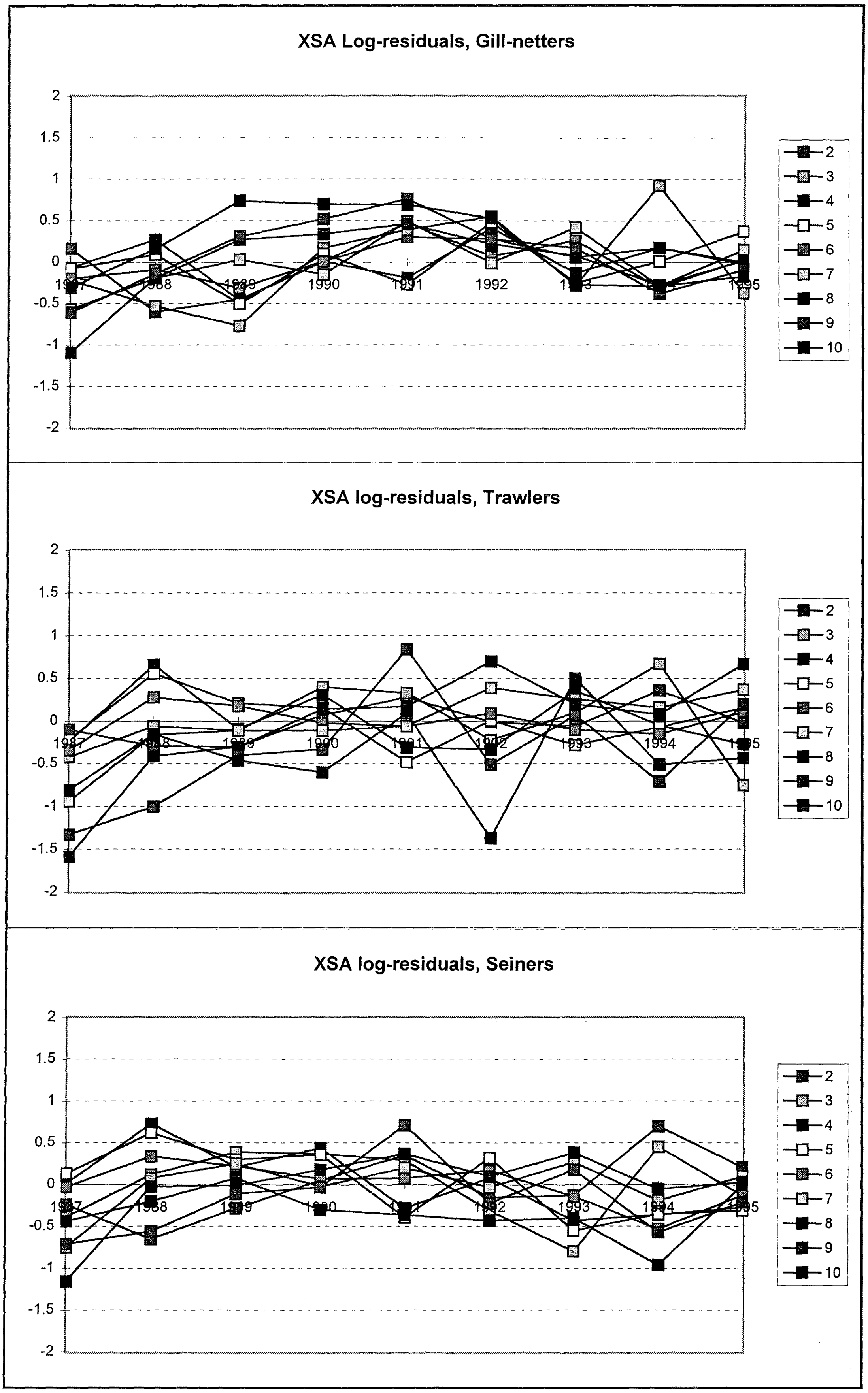
Table 11.14 (Cont'd) **Assessment Quality Control Diagram 3**

Spawning stock biomass ('000 t)											
Date of assessment	Year										
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989	36.6	-	-[1]	-[1]							
1990	40.7	43.0	-	-[1]	-[1]						
1991	31.3	27.2	42.3	62.0	-[1]	-[1]					
1992	27.8	20.9	24.9	28.0	23.4	24.3[1]	24.8[1]				
1993	29.1	24.3	38.2	46.8	51.1	56.9	50.7[1]	46.4[1]			
1994	-	-	-	-	-	-	-	-1	-1		
1995	29.2	24.4	34.8	32.3	32.3	27.8	40.7	47.3	47.3	47.3	
1996	28.8	23.9	34.5	36.2	40.6	37.6	36.2	35.6	31.3	32.3	33.7

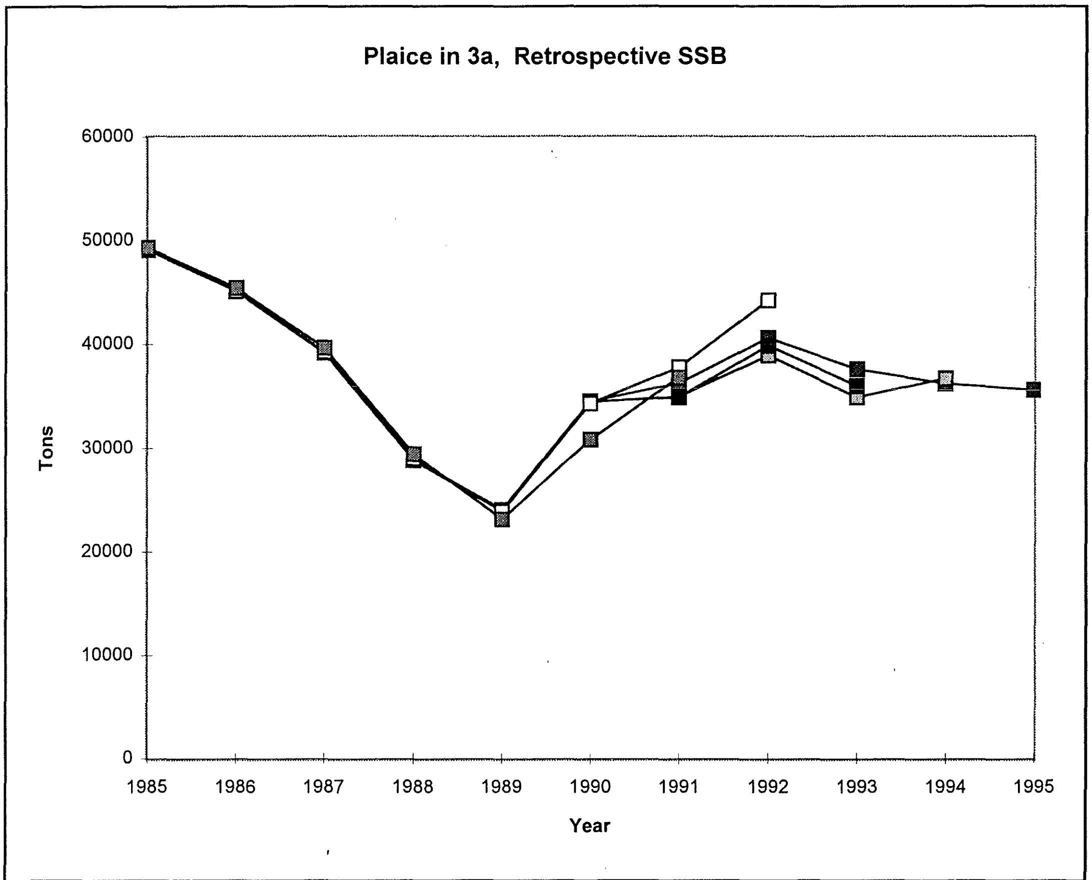
[1]Forecast.

Remarks **No analytical assesment carried out in 1994. In 1995 the catch at age was derived by using age information taken from the North Sea**

Figure 11.1 XSA Residuals for plaice in Division IIIa



E:\acfm\wgnssk97\F-11-1.xls


Plaice in 3a, Retrospective SSB
Tons
60000
50000
40000
30000
20000
10000
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
Year

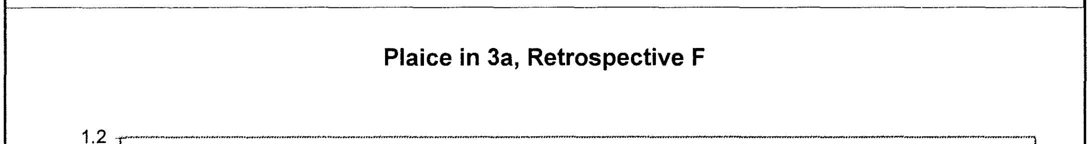

Plaice in 3a, Retrospective F
F(4-8)
1.2
1
0.8
0.6
0.4
0.2
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
Year

Figure 11.3

Fish Stock Summary
Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)
11-10-1996

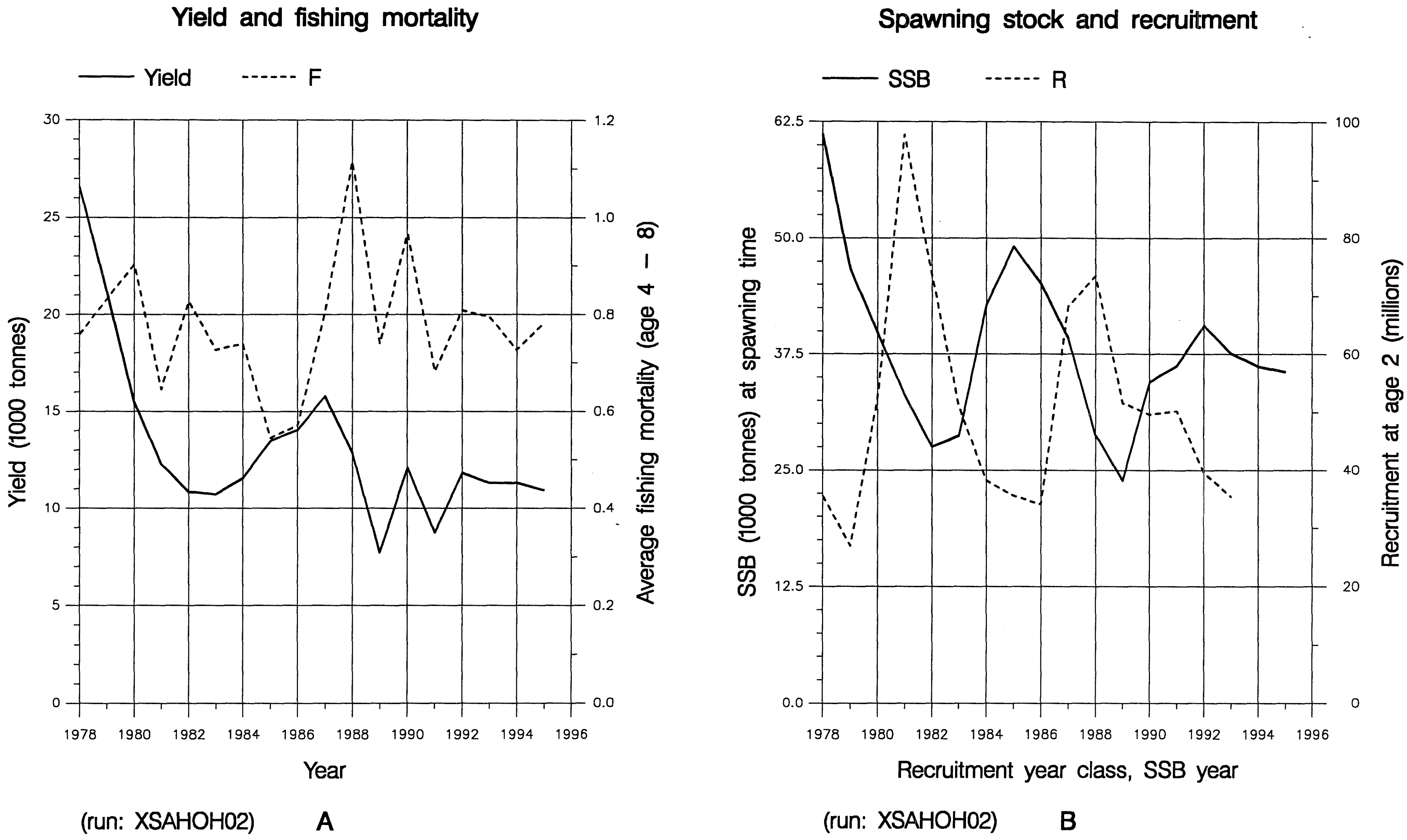
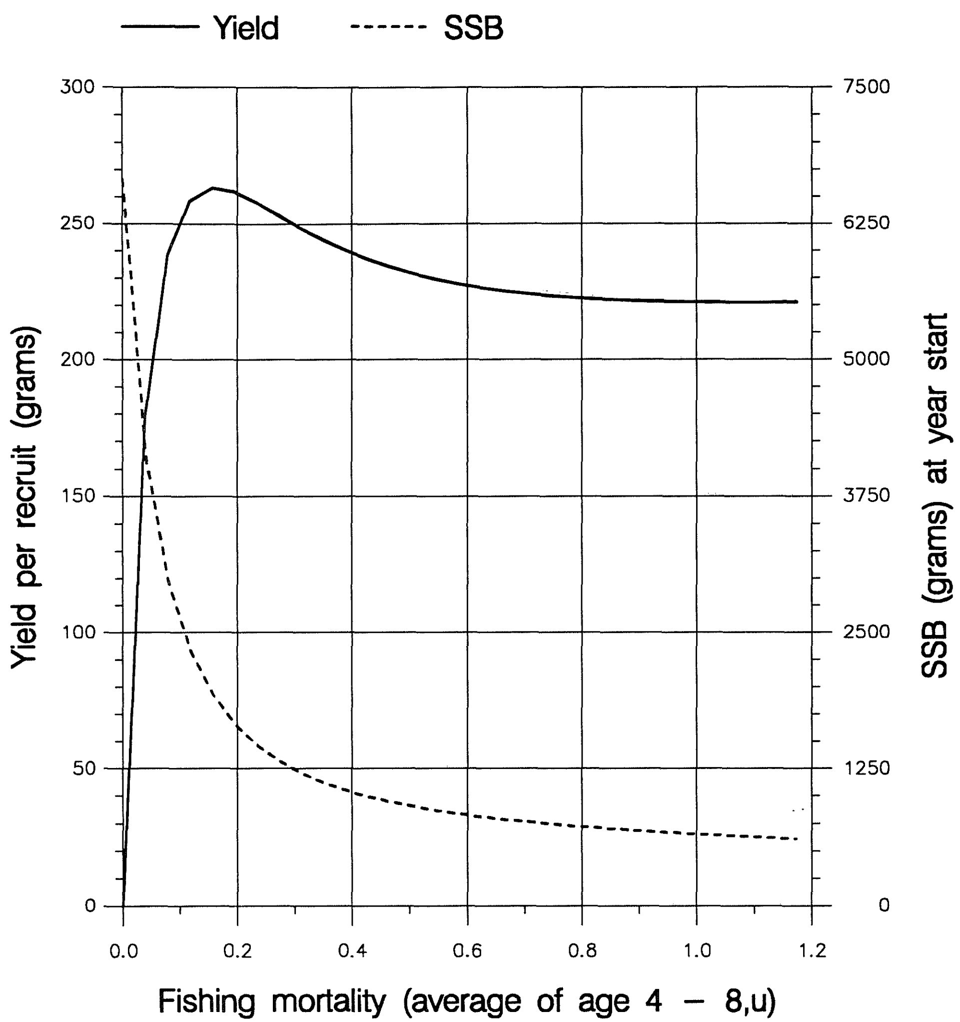


Figure 11.4

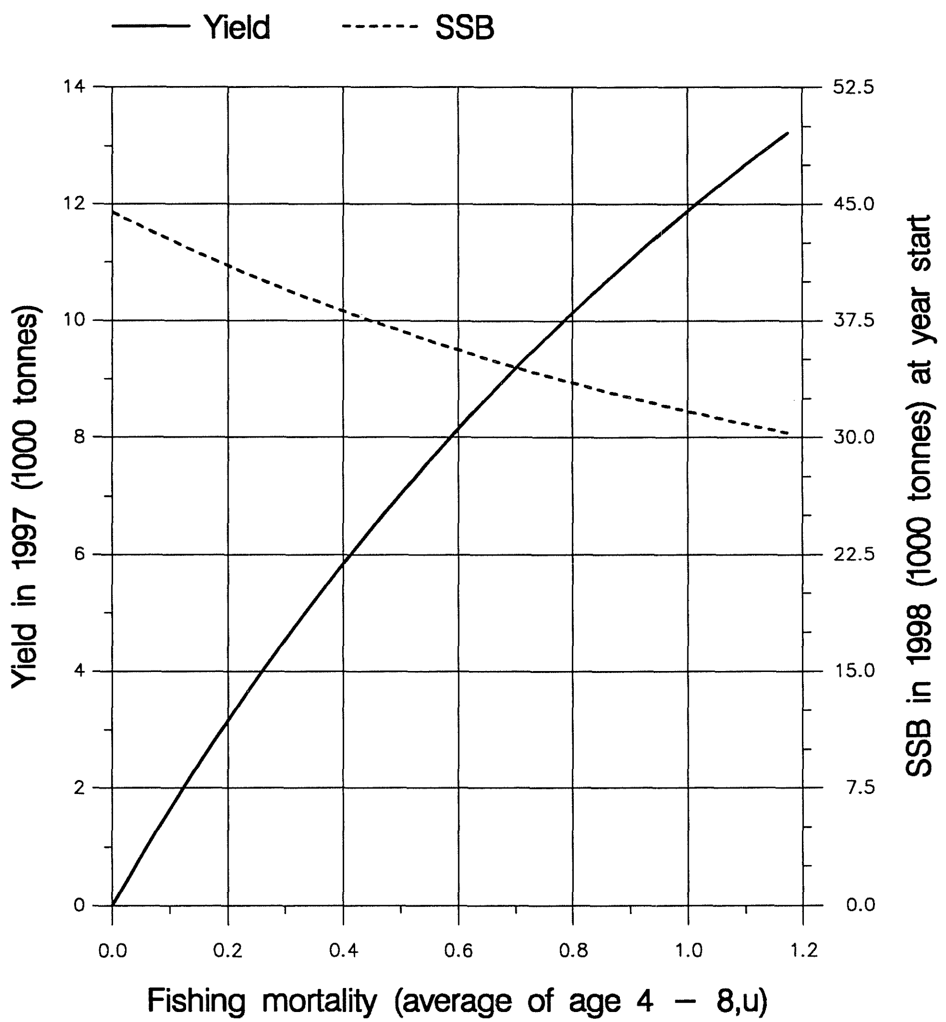
Fish Stock Summary
Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)
11–10–1996

Long term yield and spawning stock biomass



(run: YLDHOH02) C

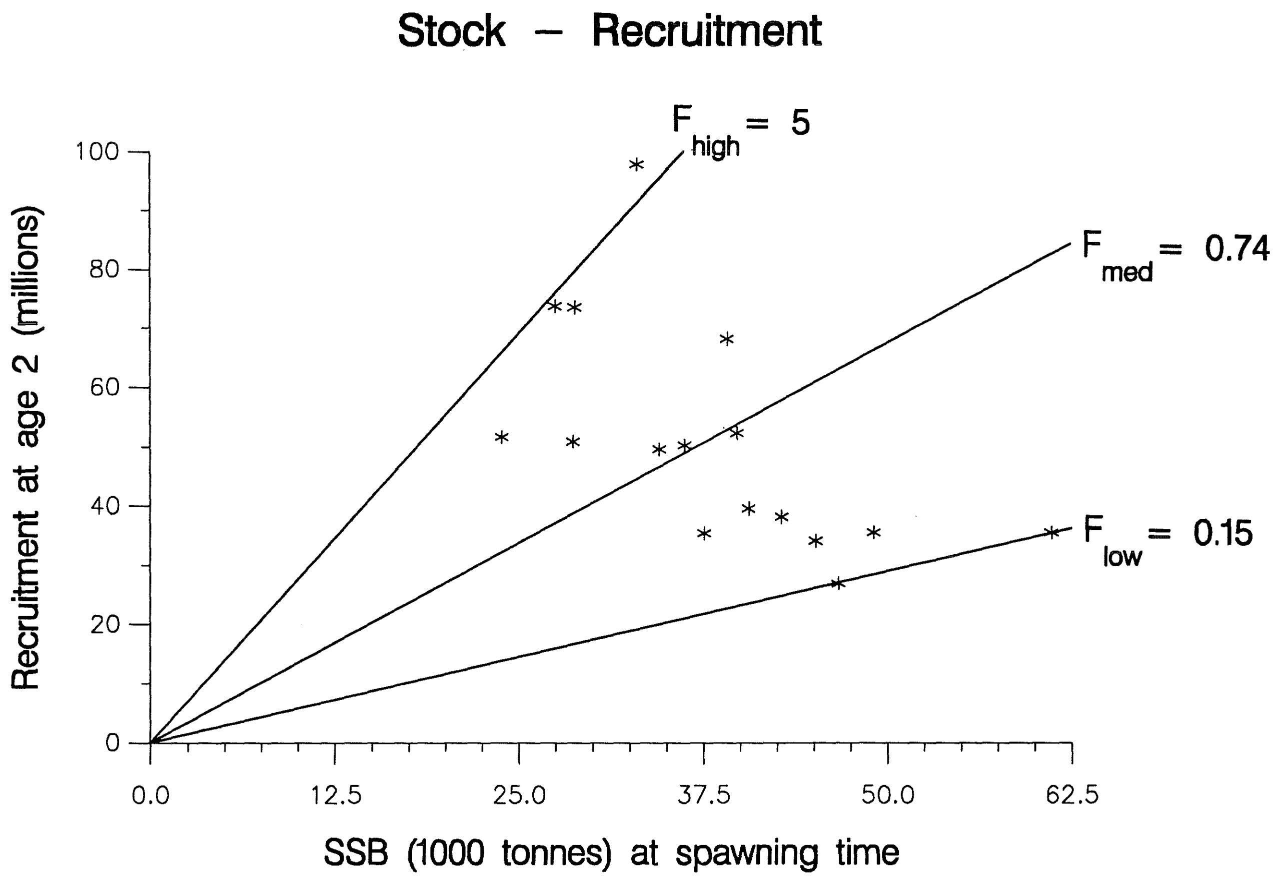
Short term yield and spawning stock biomass



(run: MANHOH03) D

Plaice in the Kattegat and Skagerrak (Fishing Area IIIa)

Figure 11.5 11–10–1996



(run: XSAHOH02)

Figure 11.6

Figure Plaice,Kattegat and Skagerr. Sensitivity analysis of short term forecast.

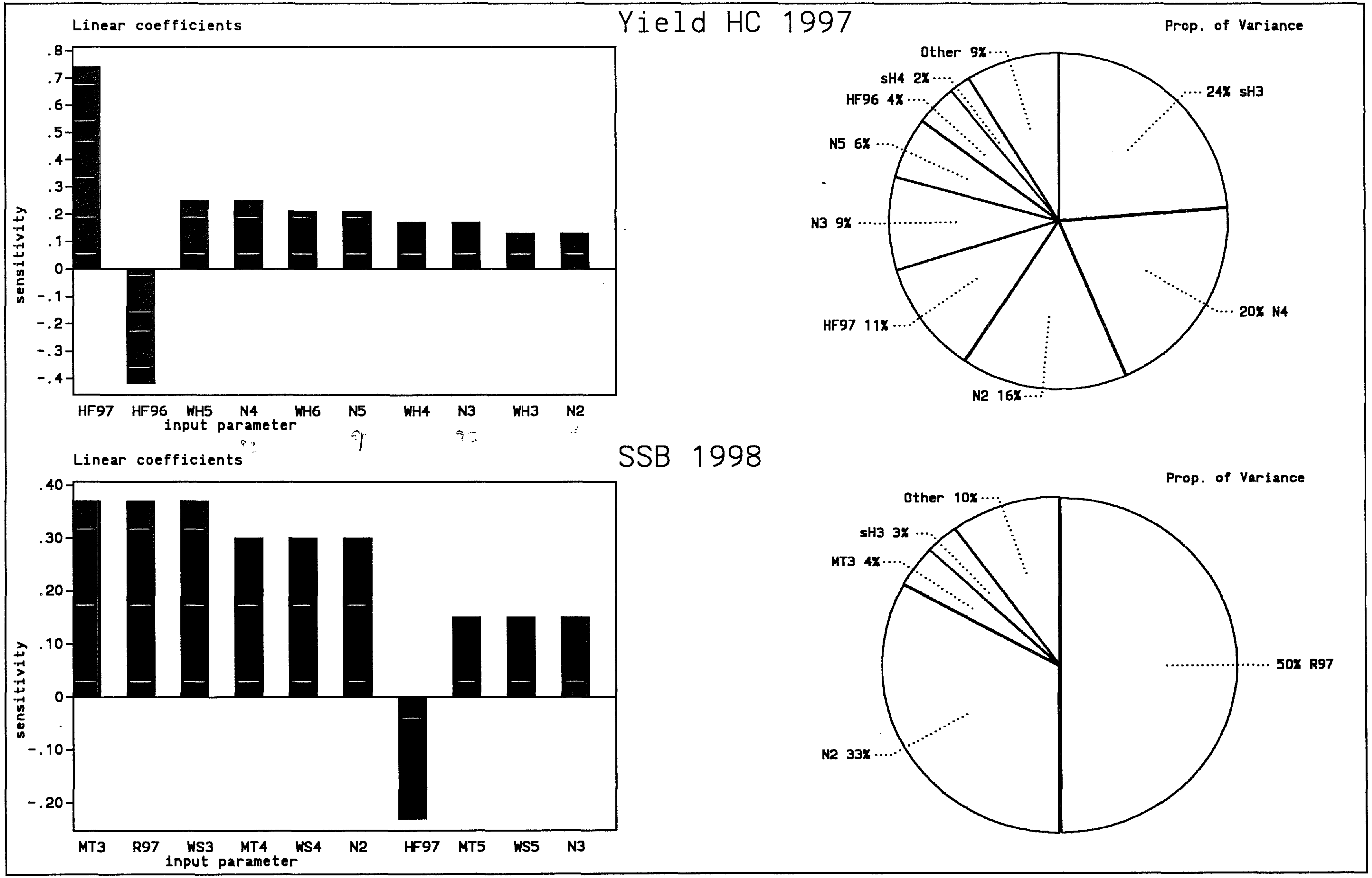
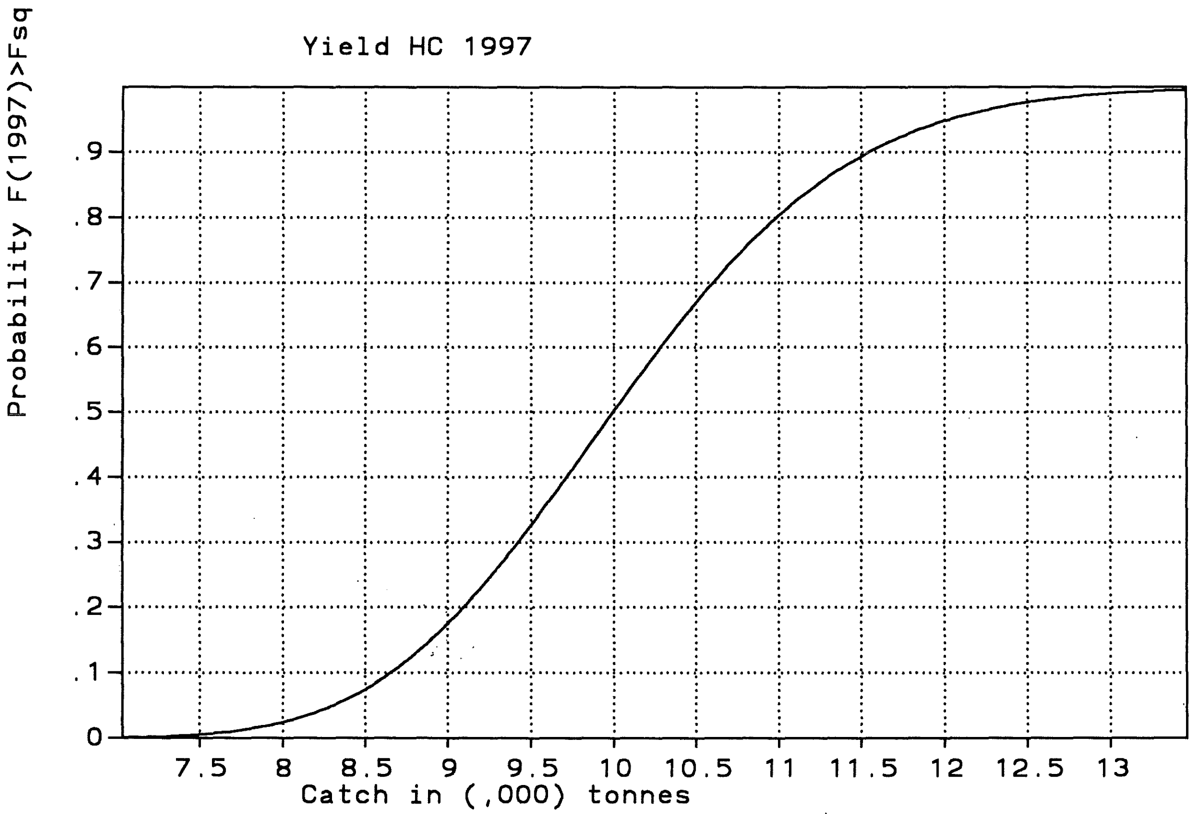


Figure 11.7 Plaice,Kattegat and Skagerr. Probability profiles for short term forecast.



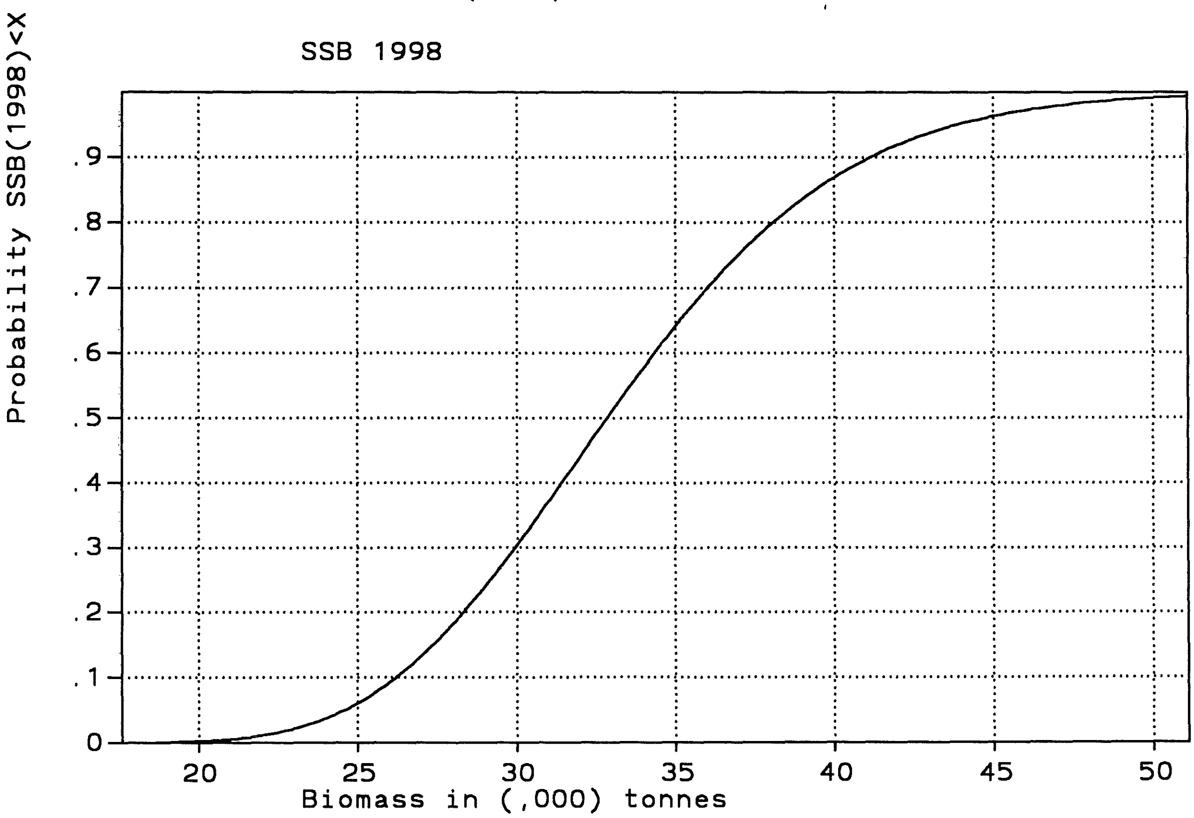
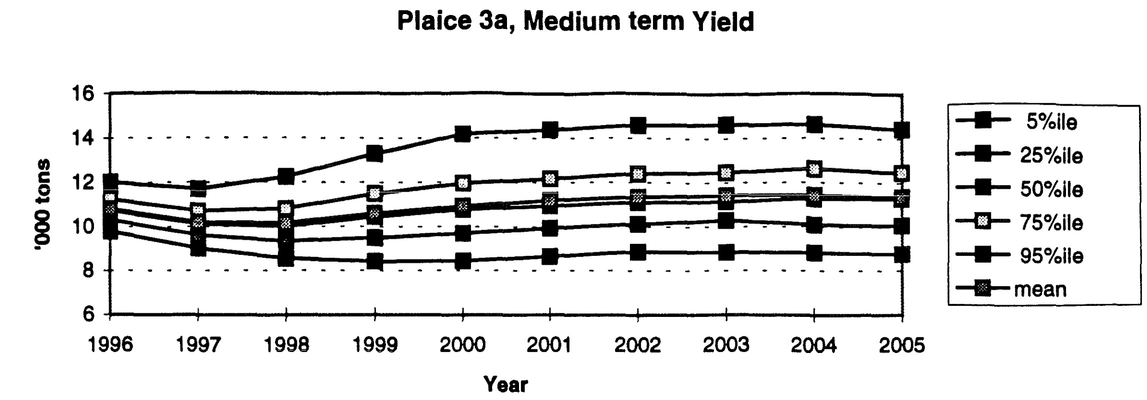
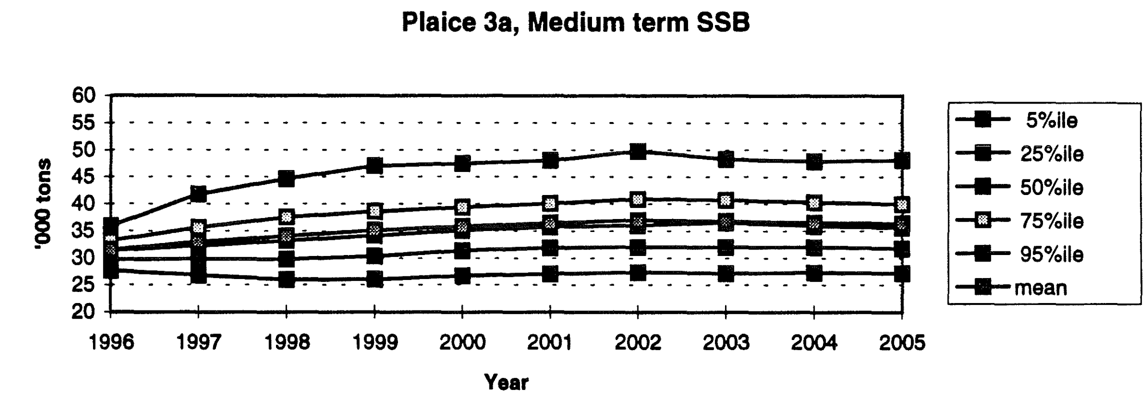
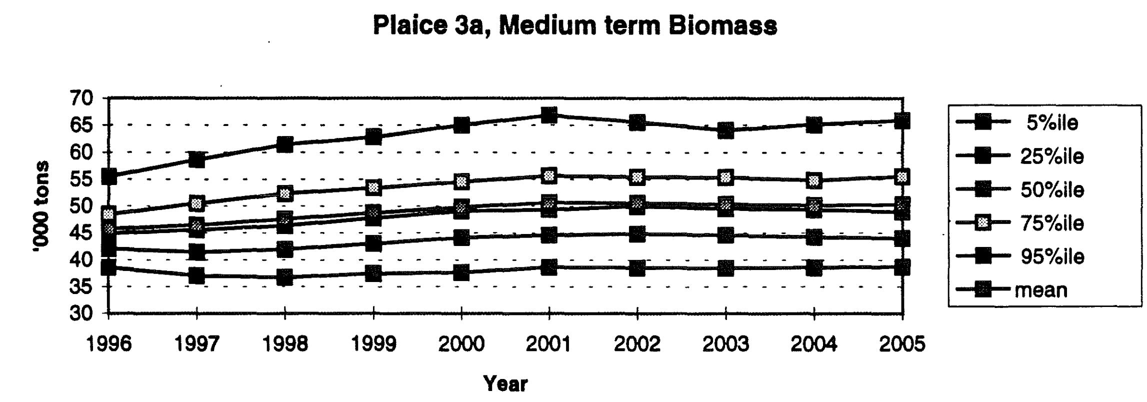
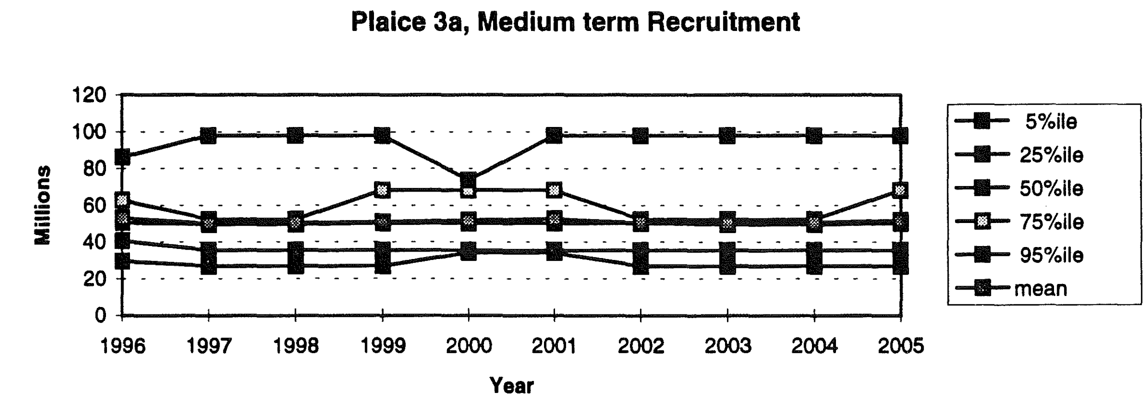


Fig.11-8. Plaice in 3a. Medium term projections









12 NORWAY POUT IN SUB-AREA IV AND DIVISION IIIA

12.1 Catch Trends

Annual landings as provided by Working Group members are shown in Table 12.1.1. The table now includes landings from IIIa. The total landings in 1995 of 241,000 t are larger than last year's landings probably because of the strong 1994 year class. Most of the increase is due to very high catches in IIIa. Plots of total yield is shown in Figure 12.6.1.

The landings by month and country are shown in Table 12.1.2. The seasonal distribution of the landings in 1995 are the same as in recent years. The Danish landings decrease in the second quarter of the year, while the Norwegian landings are more evenly distributed over the year.

12.2 Natural Mortality, Maturity, Age Composition, Mean Weight at Age

Age compositions were available from Norway and Denmark, Table 12.2.1. Note that catches in 1990 are estimated catches. The catches of 1-group fish in 1995 suggest that the 1994 year class is strong. Mean weight at age in the catch was estimated as a weighted average of Danish and Norwegian data, Table 12.2.2. There is no weight at age in catch data available for 1990 and these data are modelled in the same way as in previous years. Mean weight at age in the stock, maturity ogive and natural mortality were the same as used in previous years, Table 12.2.3.

12.3 Catch, Effort and Research Vessel Data

The assessment uses the combined catch and effort data from Danish and Norwegian commercial fishery. See also Section 1.3.2 for an overview of the available data sources. The following subsections give a description of the commercial fishery tuning series and lists the survey indices series used.

12.3.1 Danish data

1) Information is collected from Danish fishing trips with a share of Norway pout and blue whiting exceeding 70% on the number of fishing days, the GRT of the vessel and the total landings.

2) The data are grouped in 7 GRT classes (5-50, 50-100, ...250-300, >300). For each class the following values are calculated by quarter: sum of fishing days, mean catch per fishing day (CPUE).

3) The total number of fishing days in each size class is adjusted to correct for the relative differences in fishing power between the size classes. Therefore the summed fishing days in each class (i) and quarter are multiplied with the yearly $CPUE_i$ of the this particular class divided by the yearly $CPUE_{175}$ of the 150-200GRT class (midpoint 175GRT). This standardises the number of fishing days in each class to the equivalent number of fishing days of a 175GRT vessel (standardised 175GRT-fishing days).

12.3.2 Norwegian data

Here the situation is complicated by the fact, that the vessels perform a mixed fishery mainly aiming at Norway pout. The landing figures of the trips contain mostly Norway pout (NP) but also a variety of other species (among the blue whiting being most important).

1) From the individual trips the following information is recorded: the number of fishing days ($fd_{NP+other}$), the total landings of Norway pout + other ($L_{NP+other}$), the GRT of the vessel and a sample of the catch from which the species composition of the mixed landings is derived. The number of fishing days is not available for years after 1992 and is for these years estimated from a regression relating the number of fishing days with the number of trips, the GRT and the landings.

   The linear regression applied was of the form:

   $$fd = 273.7 + 2.437 \cdot \text{Trips} + 2.258 \cdot \text{mean(GRT)} + 8.283 \cdot \text{Catch('000}t)$$

   All variables contributed significantly to the model, while the quarter effect was not significant.

2) The information on the species composition is used to split the total landings into landings of Norway pout (L_{NP}) and other (L_{other}).

3) From the mixed landings a first estimate of the $CPUE_{NP+other}$ is derived as $\frac{L_{NP+other}}{fd_{NP+other}}$.

4) The total landings of Norway pout (L_{NP}) are divided by the first estimate of the CPUE of the mixed fishery ($CPUE_{NP+other}$) to give the number of fishing days directed at Norway pout (fd_{NP}).

5) The total number of fishing days directed at Norway pout (fd_{NP}) are also standardised to a vessel size of 175GRT. From the individual GRT values involved in the Norwegian fishery a mean GRT_{avN} is calculated, weighted by the number of fishing days related to each GRT value. The total number of fishing days is now adjusted to the vessel size 175GRT. This adjustment is, however based on a regression model, which is derived from data of the Danish fishery (this is due to the fact, that only the Danish data are available by size class). The regression model used is a power function of the type $\mathrm{CPUE} = a \cdot (\mathrm{GRT} - 50)^b$. (The function was shifted by 50GRT on the axis to give a better fit to the data). The adjustment factor is the defined as $\left(\frac{GRT_{avN} - 50}{175 - 50}\right)^b$ the total number of fishing days multiplied with this factor give the Norwegian standardised 175GRT-fishing days for Norway pout.

12.3.3 Combination of Danish and Norwegian data

The total standardised 175GRT-fishing days are the sum of the two national estimates.

More details and the coefficients of the different regression models used can be found in the two previous reports of the then Working Group on the Assessment of Norway Pout and Sandeel (CM 1994/Assess:7, CM 1995/Assess:5).

12.3.4 Research vessel data

Survey indices were available from the IBTS, the EGFS (English Ground Fish Survey) and the SGFS (Scottish Ground Fish Survey), Table 12.3.3. All surveys indicated a strong 1994 year class.

12.4 Catch-at-Age Analysis

The SXSA was used to estimate quarterly stock numbers and fishing mortalities (For details concerning the SXSA see Appendix 1 in CM 1994/Assess:7). Tuning was performed over the period 1983 to 1996 producing averaged logged residual stock numbers and survivor estimates, where the contributions from the various age groups to the survivor estimates were weighted in proportion to the inverse of their variance. The three surveys and the commercial fleet were all used in the tuning. As in previous years the catch at age in 1990 was extrapolated from the estimated catchabilities and stock sizes, under the constraint that the quarterly SOP should be in accordance with observed landings. Table 12.4.1 contains the options used as well as the estimated stock numbers, fishing mortalities and additional output from the analysis. The log residual stock numbers are plotted in Figure 12.4.2. As expected they are least variable for 1 and 2 year old fish. There is no apparent trend in the residuals with time. The log residual stock numbers for the commercial fishery in the 2nd quarter have a very high negative value for all age groups in 1996. In Figure 12.4.4 the SSQ Residuals are shown. This figure indicates large yearly variations with large residuals for commercial fishery in 1992 (3rd quarter), 1993 (4th quarter) and 1995 (3rd quarter). The sum of squared residuals looks better for the survey series, but with the English Ground Fish Survey giving slightly higher residuals and with 1992 as a peak.

Average fishing mortality for ages 1–2 was at a level of around 1.0 in the early 1980's but then declined to the present level of app. 0.7 with an estimated drop below 0.4 in 1995. The 1991 year class was strong, while the 1992 and 1993 year classes was of intermediate strength. The fishery in 1995 and also in 1996 concentrated on the very strong 1994 year class. Spawning stock biomass decreased in the mid 1980s, but has since slowly increased again with a smaller drop in 1994 and 1995. The 1996 spawning biomass is estimated to more than 300,000 t, but as seen on Figure 12.4.1 there is retrospectively a tendency to overestimate the spawning biomass in the current year. No confidence should be given to the observed drop in average fishing mortality for 1- and 2-

group in 1995. The fishery is mainly targeting the 1-group and the yearly fishing mortality of this group is estimated to be on a stable level. The estimated fishing mortality of 2-group has been drastically reduced and that is contributing to the low (unweighted) average of the 2 Fs. See also Figure 12.6.2 showing the separate mortalities. The estimated low fishing mortality of 2-group could possibly be explained by a) the proportion of 2-group in the catches are very low and this proportion is estimated with a higher CV. The estimated proportion of 2-group in the catches is less than 4% in 1995, b) age reading problems can further increase the uncertainty and c) changes in distribution of fishing effort could have lead to reduction in effort targeted at the 2-group.

The weights in the tuning process in the base run (constant catchability) were reasonably distributed over the different CPUE series with most weight given to the CPUE data from the commercial fishery (CF). Most weight are given to CF age 1 season 3, CF age 1 season 4, CF age 2 season 1 and CF age 2 season 2. See also Figure 12.4.3. In the survey series most weight were given to IYFS age 2 season 1, IYFS age 1 season 1, SGFS age 3 season 3 and SGFS age 1 season 3.

A retrospective analysis was done for recruitment and SSB. These are shown in Figure 12.4.1. The analysis revealed a general tendency to overestimate SSB and recruitment values in the last year. In most cases the estimates converged rapidly, but the estimate of the 1991 year class was gradually revised downward in three successive years to end at approx. 60% of the initial estimate. The 1994 year class estimate was revised drastically down from the 1994 assessment to the 1995 assessment. The 1996 assessment increases the estimate again.

12.5 Recruitment Estimates

The 0- and 1-group indices of the EGFS and SGFS surveys were used to estimate the stock numbers in the 3rd quarter in 1996 of the 0- and 1-group. This was done by regressing the VPA estimates of the 0- and 1-group in the 3rd quarter against the mentioned indices. The RCT3 method was used for the period 1983 to 1994. The standard options selected and the results are given Tables 12.5.1 and 12.5.2. Estimated values of the 0- and 1-group in the 3rd quarter in 1996 were 130 and 22 billions respectively. These values are both a little above the averages (1983–1994) of 96 and 17 billions respectively.

The correlation between The SGFS 0-group index and the 0- and 1-group VPA estimates seem to poor, which is indicated by low values of R square and weights given in the predictions. The Figures 12.5.1 and 12.5.2 show VPA estimates vs. the survey indices.

12.6 Historical Stock Trends

The landings of Norway pout for the period 1975–1995 are presented in Table 12.6.1. In addition the estimated average fishing mortality for 1- and 2-group, the trends in the Spawning Stock Biomass (SSB) and the recruitment trends for the period 1974–1995/1996 are shown in Table 12.6.1. These results are also presented in Figure 12.6.1.

After several years up to 1986 with fishing mortalities fluctuating around 1.0, the fishing mortality was reduced to a level around 0.7. This reduction of F and in addition good recruitment in 1991 and 1994 has given an increase in SSB in the years 1989–1996. As mentioned in Section 12.4 there should be no confidence in the estimate of the average fishing mortality for 1- and 2-group in 1995.

12.7 Short-Term Forecasts, Medium-Term Predictions and Long-Term Considerations

It was the intention to produce similar predictions as for the sandeel during the meeting, but there was not enough time available. Quite some time was spent discussing the strong variability in the pattern of log residual stock numbers.

12.8 MBAL Considerations

MBAL has been defined using the stock recruitment plot, Figure 12.10.1 and ACFM's definition no 1, see Section 15. MBAL is estimated to 120,000 t of SSB.

12.9 Biological Reference Points

F_{med} and F_{high} was in the last assessment (ICES CM 1996/Assess:6 part II) estimated to be 0.99 and 3.90.

In this year's assessment F_{med} and F_{hig}h was estimated to 1.24 and 1.88 using mean weights and fishing mortalities from 1993–1995. Quite large changes, but so is also the changes in the estimated fishing mortalities for the 1993–1995 period in this assessment compared to the fishing mortalities of 1992–1994 used in the previous assessment. In addition this assessment now includes Skagerrak.

12.10 Comments on the Assessment

The MBAL considerations suggests a minimum SSB of 120,000 t. In the historical times series of SSBs the stock has been below this limit 1989–1990 and in 1994. The SSB was above 300,000 t in both 1983 and 1984. Medium recruitment and low recruitment lead to a medium sized SSB in 1985. The total effort was high in the period 1982–1986 with average fishing mortalities well above 1. From Figure 12.6.1 it seems that the fishery responded to the lower CPUE by reducing effort in 1987. Good recruitment in 1991 and 1994 lead to an increase in SSB.

Table 12.1.1 Norway pout annual landings ('000 t) in the North Sea and Division IIIa, by countries in 1958–1995. (Data provided by Working Group members).

Year	Denmark		Faroes	Norway	Sweden	UK (Scotland)	Others	Total
	North Sea	Div. IIIa						
1957	-	-	-	0.2	-	-	-	0.2
1958	-	-	-	-	-	-	-	-
1959	61.5	-	-	7.8	-	-	-	69.3
1960	17.2	-	-	13.5	-	-	-	30.7
1961	20.5	-	-	8.1	-	-	-	28.6
1962	121.8	-	-	27.9	-	-	-	149.7
1963	67.4	-	-	70.4	-	-	-	137.8
1964	10.4	-	-	51.0	-	-	-	61.4
1965	8.2	-	-	35.0	-	-	-	43.2
1966	35.2	-	-	17.8	-	-	+	53.0
1967	169.6	-	-	12.9	-	-	+	182.6
1968	410.8	-	-	40.9	-	-	+	451.8
1969	52.5	-	19.6	41.4	-	-	+	113.5
1970	142.1	-	32.0	63.5	-	0.2	0.2	238.0
1971	178.5	-	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	-	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	-	51.2	63.0	2.9	13.0	0.6	345.9
1974	464.5	-	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	-	63.6	218.9	2.3	22.7	1.0	559.7
1976	244.9	-	64.6	108.9	+	17.3	1.7	435.4
1977	232.2	-	50.9	98.3	2.9	4.6	1.0	389.9
1978	163.4	-	19.7	80.8	0.7	5.5	-	270.1
1979	219.9	9.0	21.9	75.4	-	3.0	-	329.2
1980	366.2	11.6	34.1	70.2	-	0.6	-	482.7
1981	167.5	2.8	16.6	51.6	-	+	-	238.5
1982	256.3	35.6	15.4	88.0	-	-	-	395.3
1983	301.1	28.5	24.5	97.3	-	+	-	451.4
1984	251.9	38.1	19.1[1]	83.8	-	0.1	-	393.0
1985	163.7	8.6	9.9	22.8	-	0.1	-	205.1
1986	146.3	4.0	6.6	21.5	-	-	-	178.4
1987	108.3	2.1	4.8	34.1	-	-	-	149.3
1988	79.0	7.9	1.5	21.1	-	-	-	109.5
1989	95.6	5.4	0.8	65.3	-	0.1	0.3	172.5
1990	61.5	12.1	0.9	77.1	-	-	-	151.6
1991	85.0	38.3	1.3	68.3	-	-	+	192.9
1992	146.9	44.7	2.6	105.5	-	0	0.1	299.8
1993	97.3	7.8	n/a	76.7	-	-	-	181.8
1994	97.9	6.6	n/a	74.2	-	-	-	178.7
1995	138.4	50.3	8.8	43.1	-	-	-	240.6

Table 12.1.2 Norway Pout, North Sea. National landings (t) by month, 1992-1995. (Data provided by Working Group members.)

Month	Denmark	Norway	Faroes	Total[1]
1993				
Jan	5,678	2,578		8,256
Feb	10,871	7,460		18,331
Mar	6,654	2,558		9,212
Apr	0	4,128		4,128
May	79	12,585		12,664
Jun	1,419	10,171		11,590
Jul	9,646	10,713		20,359
Aug	10,686	7,866		18,552
Sep	12,609	7,358		19,967
Oct	20,741	4,168		24,909
Nov	10,650	3,995		14,645
Dec	8,296	3,092		11,388
Total	97,329	76,672	N/A	174,001
1994				
Jan	8,600	3,425		12,025
Feb	9,579	4,146		13,725
Mar	4,603	3,478		8,101
Apr	681	5,126		5,807
May	0	4,209		4,209
Jun	0	5,340		5,340
Jul	312	9,653		9,965
Aug	4,763	13,524		18,287
Sep	13,697	8,629		22,326
Oct	17,750	8,435		26,185
Nov	21,538	4,706		26,244
Dec	16,335	3,501		19,836
Total	97,858	74,192	N/A	172,050
1995[1]				
Jan	6,501	1,195		7,696
Feb	6,501	8,966		15,467
Mar	8,345	5,360		13,705
Apr	3,448	2,646		6,074
May	6,695	5,326		12,021
Jun	7,191	2,667		9,858
Jul	19,833	1,671		21,504
Aug	11,620	471		12,091
Sep	32,529	3,648		36,177
Oct	39,772	6,837		46,609
Nov	31,378	2,578		33,956
Dec	14,675	1,716		16,391
Total	188,488	43,117	8,800	231,605

[1] IV + IIIa

Table 12.2.1 NORWAY POUT in the North Sea. Catch in numbers at age by quarter (millions). + represents less than half a million. Data for 1990 only partly available and therefore not included.

Year	1978				1979				1980			
Age	1	2	3	4	1	2	3	4	1	2	3	4
0	0	0	304	1,225	0	0	997	890	0	0	25	660
1	2,931	1,181	2,385	1,400	5,231	3,368	4,371	2,219	5,196	2,664	7,942	4,038
2	1,371	650	786	322	968	256	786	172	1,107	710	2,019	527
3	93	194	30	6	175	28	50	11	61	30	19	6
4+	4	0	0	0	3	1	0	0	2	5	0	0
Age Year	1981				1982				1983			
0	0	0	78	36,926	0	0	156	1,090	0	0	446	2,671
1	2,245	1,083	1,329	1,048	5,425	3,349	6,773	3,108	4,207	1,826	5,825	4,296
2	1,705	627	953	304	427	283	444	47	1,297	1,234	1,574	379
3	77	78	17	3	222	24	64	0	15	10	17	7
4+	6	2	0	0	0	0	0	0	0	2	0	0
Age Year	1984				1985				1986			
0	0	0	1	2,231	0	0	6	678	0	0	0	5,572
1	2,759	2,252	5,290	3,492	2,264	857	1,400	2,991	396	260	1,186	1,791
2	1,375	1,165	1,683	734	1,364	145	793	174	1,069	87	245	39
3	143	269	8	0	192	13	19	0	72	3	6	0
4+	0	0	0	0	1	0	0	0	3	0	0	0
Age Year	1987				1988				1989			
0	0	0	8	227	0	0	741	3,146	0	0	151	4,854
1	2,687	1,075	1,627	2,151	249	95	183	632	1,736	678	1,672	1,741
2	401	60	171	233	700	73	250	405	48	133	266	93
3	12	0	0	5	20	0	0	0	6	6	5	13
4+	1	0	0	0	0	0	0	0	0	0	0	0
Age Year	1990				1991				1992			
0	0	0	22	1,591	0	0	734	3,486	0	0	879	954
1	1,548	1,689	964	1,017	1,501	636	1,519	1,048	3,556	1,522	3,457	2,784
2	662	617	188	133	1,336	404	215	187	1,086	293	389	267
3	24	22	7	5	93	19	22	18	118	20	1	2
4+	7	0	0	0	6	0	0	0	3	0	0	0
Age Year	1993				1994				1995			
0	0	0	96	1,175	0	0	647	4,238	0	0	728	1,758
1	1,942	813	1,147	1,050	1,975	372	1,029	1,148	4,148	1,980	2,645	3,480
2	699	473	912	445	591	285	421	134	249	266	48	62
3	15	58	19	2	56	29	71	0	6	33	3	3
4+	0	0	0	0	0	0	0	0	0	0	0	0

Table12.2.2 Norway pout. North Sea and Division IIIa 1986-1995. Mean weight at age by quarter. Danish and Norwegian catches combined (grams).

		Age Group				
Year	Quarter	0	1	2	3	4
1986	1	-	6.7	29.7	44.0	82.5
	2	-	14.5	42.9	55.4	-
	3	-	28.8	43.4	47.6	-
	4	7.2	27.1	44.1	-	-
1987	1	-	8.1	28.3	52.9	63.1
	2	-	12.6	31.5	-	-
	3	5.8	20.4	35.0	-	-
	4	7.4	23.5	37.5	46.6	-
1988	1	-	9.23	27.3	38.4	69.5
	2	-	11.5	32.7	-	-
	3	8.3	26.5	39.8	-	-
	4	7.9	30.6	43.3	-	-
1989	1	-	8.0	26.7	39.9	-
	2	-	13.5	28.7	44.4	-
	3	7.4	26.6	33.3	31.2	-
	4	6.7	26.8	34.7	46.5	-
1990	1	-	6.5	25.5	37.7	68.0
	2	-	13.7	25.3	40.3	-
	3	6.4	20.3	32.9	39.4	-
	4[1]	6.7	21.7	38.9	52.9	-
1991	1	-	7.8	20.5	35.4	44.3
	2	-	12.4	28.7	49.9	-
	3	6.3	30.8	44.7	50.0	-
	4	7.1	30.6	43.1	59.9	-
1992	1	-	8.2	25.8	41.9	43.9
	2	8.0	12.9	32.5	49.5	-
	3	3.5	25.6	42.6	50.0	-
	4	7.2	27.5	44.3	50.3	-
1993	1	-	9.3	24.9	46.5	-
	2	-	15.1	30.6	48.7	-
	3	3.7	25.1	35.5	55.4	-
	4	7.7	26.2	36.5	70.8	-
1994	1		8.6	25.91	42.09	-
	2		15.2	29.27	46.88	-
	3	4.0	29.3	38.91	53.95	-
	4	7.8	31.2	49.59	-	-
1995	1		7.7	24.7	50.8	-
	2		11.0	22.9	37.7	-
	3	5.0	25.4	33.4	45.6	-
	4	6.6	16.8	26.1	41.2	-

[1]Mean of 1989 and 1991 values.

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Table 12.2.3 Norway pout. Mean weight at age in the stock, proportion mature and natural mortality.

Age	w(g)				Matprop	M (per quarter)
	Q1	Q2	Q3	Q4		
0	-	-	4	6	0	0.4
1	7.0	15.0	25.0	23.0	0.1	0.4
2	22.0	34.0	43.0	42.0	1.0	0.4
3	40.0	50.0	60.0	58.0	1.0	0.4
4	56.0	56.0	-	-	1.0	0.4

Table 12.3.1.a Norway pout. Danish CPUE data (tonnes/day fishing) by vessel category for 1983-1994.

Vessel GRT	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
51-100	11.37	12.53	11.60	10.83	11.73	20.26	14.64	9.68	12.56	-	-	-	29.63
101-150	24.51	21.35	17.98	19.49	20.70	19.83	19.93	18.21	24.14	26.43	23.72	26.45	39.81
151-200	29.00	24.17	20.76	22.97	22.20	23.91	24.06	25.62	28.22	34.20	27.36	31.43	42.77
201-250	32.71	27.82	24.80	25.20	27.51	30.50	27.43	25.34	29.45	37.50	28.44	40.70	39.60
251-300	32.05	26.59	22.86	25.12	25.58	24.03	26.10	21.87	28.15	31.90	32.05	37.94	37.91
301-	31.81	37.47	26.86	26.63	31.10	40.09	28.92	25.91	36.73	41.84	35.10	46.09	59.11

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Table 12.3.1.b Days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1982-1992.

		q1	q2	q3	q4
1982	Effort	528	1578	1043	616
	Ave GRT	178.8	142.0	178.0	187.1
1983	Effort	293	1168	2039	552
	Ave GRT	167.6	168.4	159.9	171.7
1984	Effort	509	1442	1576	315
	Ave GRT	178.5	141.6	161.2	212.4
1985	Effort	363	417	230	250
	Ave GRT	166.9	169.1	202.8	221.4
1986	Effort	429	598	195	222
	Ave GRT	184.3	148.2	197.4	226.0
1987	Effort	412	555	208	334
	Ave GRT	199.3	170.5	158.4	196.3
1988	Effort	296	152	73	590
	Ave GRT	216.4	146.5	191.1	202.9
1989	Effort	132	586	1054	1687
	Ave GRT	228.5	113.7	192.1	178.7
1990	Effort	369	2022	1102	1143
	Ave GRT	211.0	171.7	193.9	187.6
1991	Effort	774	820	1013	836
	Ave GRT	196.1	180.0	179.4	187.7
1992	Effort	847	352	1030	1133
	Ave GRT	206.3	181.3	202.2	199.8
1993[1]	Effort	640	1098	1150	682
	Ave GRT	227.5	206.6	217.8	219.8
1994[1]	Effort	533	600	1230	641
	Ave Grt	226.5	223.5	212.0	211.4
1995[1]	Effort	646	514	1108	739
	Ave Grt	223.6	233.8	221.7	218.1
1996[1]	Effort	561	823		
	Ave Grt	213.6	219.9		

[1] estimated values

Table 12.3.2 Combined Danish and Norwegian fishing effort on Norway pout.

		q1	q2	q3	q4	
1982	Norway	534	1404	1052	638	3629
	Denmark	1922	502	3929	2234	8587
	Total	2456	1906	4981	2872	12216
1983	Norway	286	1144	1942	546	3919
	Denmark	2318	505	3725	3620	10168
	Total	2604	1649	5667	4166	14087
1984	Norway	514	1015	1507	348	3385
	Denmark	1887	454	3783	4433	10557
	Total	2401	1469	5290	4781	13942
1985	Norway	354	409	248	282	1293
	Denmark	2177	232	2044	3340	7793
	Total	2531	641	2292	3622	9086
1986	Norway	441	546	208	253	1447
	Denmark	3198	126	2025	5835	11184
	Total	3639	672	2233	6088	12631
1987	Norway	441	547	197	355	1539
	Denmark	1169	7	1333	1946	4455
	Total	1610	554	1530	2301	5994
1988	Norway	330	138	76	637	1181
	Denmark	910	3	464	1957	3334
	Total	1240	141	540	2594	4515
1989	Norway	148	471	1099	1703	3421
	Denmark	565	76	1323	2009	3973
	Total	713	547	2422	3712	7394
1990	Norway	401	2005	1153	1179	4738
	Denmark	574	616	446	1167	2803
	Total	975	2621	1599	2346	7541
1991	Norway	814	830	1024	863	3532
	Denmark	979	18	517	1524	3038
	Total	1793	848	1541	2387	6570
1992	Norway	911	358	1098	1201	3568
	Denmark	1682	101	1213	1264	4260
	Total	2593	459	2311	2465	7828
1993	Norway	708	1171	1252	745	3876
	Denmark	1210	35	1527	1650	4422
	Total	1918	1206	2979	2395	8298
1994	Norway	614	686	1367	711	3378
	Denmark	1106	27	452	1283	2868
	Total	1720	713	1819	1994	6246
1995	Norway	689	555	1180	783	3207
	Denmark	686	78	571	1561	2896
	Total	1375	633	1751	2344	6103
1996	Norway	598	885			
	Denmark	596	158			
	Total	1194	1043			

Table 12.3.3 Research vessel indices for NORWAY POUT

Year Class	IYFS[1] February			EGFS[2] August				SGFS[3] August			
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	0-group	1-group	2-group	3-group
1968	-	6	-	-	-	-	-	-	-	-	-
1969	35	22	-	-	-	-	-	-	-	-	-
1970	1,556	653	-	-	-	-	-	-	-	-	-
1971	3,425	438	-	-	-	-	-	-	-	-	-
1972	4,207	399	-	-	-	-	-	-	-	-	-
1973	25,626	2,412	-	-	-	-	-	-	-	-	-
1974	4,242	385	-	-	-	-	25		-	-	-
1975	4,599	334	-	-	-	239	25		-	-	-
1976	4,813	1,215	-	-	770	119	-		-	-	-
1977	1,913	240	-	1,388	314	20	7		-	-	12.0
1978	2,690	611	-	1,209	600	60	25		-	346.0	9.0
1979	4,081	557	-	-	-	-	38.98		1,928.0	127.0	22.0
1980	1,375	403	9	-	-	46.43	3.99		185.0	43.9	1.0
1981	3,315	663	58		2,491.13	101.91	9.48		991.3	90.8	8.5
1982	2,331	802	71	6,362	1,808.18	325.29	6.51	8.0	489.5	68.8	5.4
1983	3,925	1,423	23	5,255	3,528.42	259.48	61.68	13.3	615.1	173.1	8.9
1984	2,109	384	65	560	1,050.92	163.54	0.86	1.9	635.7	53.8	1.1
1985	2,043	469	13	478	765.61	142.73	10.12	4.7	388.7	22.6	4.4
1986	3,023	760	178	380	532.93	120.16	16.72	38.4	337.9	209.2	14.3
1987	127	260	46	8	89.86	535.6	29.83	7.4	38.2	21.4	1.5
1988	2,079	773	129	157	1,224.85	158.53	7.97	13.7	381.7	51.0	6.2
1989	1,320	677	33	1,399	922.88	412.6	157.01	1.5	206.2	42.3	24.0
1990	2,497	902	259	2,194	562.93	1,069.14	0	57.9	731.7	221.3	20.4
1991	5,121	2,644	67	1,402	6,192.89	1,715.06	6.63	9.7	1,714.6	329.1	5.8
1992	2,681	375	77	2,885	3,277.52	111.73	14.44	12.2	580.4	106.3	20.8
1993	1,868	785	234	5,699	1,305.06	387	2.43	1.7	387.2	233,5	7.8
1994	5,941	2,635		7,764	6,174.48	302.62		136.0	2,438,2	321.0	
1995	912			7,546	1,262.07			36.2	411.7		
1996				3,274				127.0			

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3.
[3]Scottish groundfish surveys, arithmetic mean catch no./h.`
[4]Preliminary.
[5]GOV adjusted to Granton trawl by dividing by 3.3.

Table 12.4.1 SURVIVORS ANALYSIS OF: Norway Pout in the North Sea and Skagerak

The following parameters were used:

Year range:	1983 - 1996
Seasons per year:	4
The last season in the last year is season :	2
Youngest age: 0; Oldest age: 3; (Plus age: 4)	
Recruitment in season:	3
Spawning in season:	1

The following fleets were included:

Fleet 1:	Commercial fishery
Fleet 2:	IYFS
Fleet 3:	EGFS
Fleet 4:	SGFS

The following options were used:

1: Inv. catchability: (1: Linear; 2: Log; 3: Cos. filter)	2
2: Indiv. shats: (1: Direct; 2: Using z)	2
3: Comb. shats: (1: Linear; 2: Log.)	2
4: Fit catches: (0: No fit; 1: No SOP corr; 2: SOP corr.)	0
5: Est. unknown catches: (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)	2
6: Weighting of rhats: (0: Manual)	0
7: Weighting of shats: (0: Manual; 1: Linear; 2: Log.)	2
8: Handling of the plus group: (1: Dynamic; 2: Extra age group)	1

Data were input from the following files:

Catch in numbers:	canum.qrt
Weight in catch:	weca.qrt
Weight in stock:	west.qrt
Natural mortalities:	natmor.qrt
Maturity ogive:	matprop.qrt
Tuning data (CPUE):	tuning.xsa
Weighting for rhats:	rweigh.xsa
Unknown catches:	uc90

Weighting factor (Inv. catchabilities at oldest age):	0.00000
Min. value for the survivor number :	1.00000

Table 12.4.1 (Cont'd)

Stock numbers (at start of season)

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	153972.	102845.	*	*	79115.	53031.	*	*	57259.	38377.
1	108903.	69555.	45129.	25482.	66752.	42486.	26635.	13523.	33721.	20750.	13208.	7707.
2	13665.	8098.	4417.	1672.	13564.	7967.	4387.	1563.	6206.	3043.	1921.	639.
3	117.	66.	37.	11.	810.	426.	65.	37.	446.	142.	84.	41.
4+	6.	3.	0.	0.	1.	1.	1.	0.	25.	16.	11.	7.
SSN	24679.				21050.				10050.			
SSB	381916.				377600.				179403.			
TSN	122691.	77722.	203555.	130010.	81127.	50879.	110203.	68154.	40399.	23952.	72484.	46771.
TSB	1068002.	1322117.	1936259.	1274013.	798138.	929482.	1174893.	697010.	391847.	422753.	646923.	436726.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	112232.	75231.	*	*	32411.	21719.	*	*	91296.	60591.
1	25169.	16547.	10879.	6321.	45867.	28546.	18254.	10904.	14373.	9431.	6244.	4036.
2	2717.	946.	563.	177.	2771.	1529.	976.	514.	5549.	3146.	2049.	1169.
3	286.	132.	86.	53.	87.	48.	32.	21.	154.	87.	58.	39.
4+	32.	19.	13.	9.	41.	27.	18.	12.	18.	12.	8.	6.
SSN	5552.				7486.				7158.			
SSB	90634.				98853.				139318.			
TSN	28205.	17645.	123773.	81791.	48767.	30150.	51691.	33171.	20094.	12676.	99655.	65840.
TSB	249201.	288059.	750287.	607274.	387817.	484084.	629893.	403960.	229869.	253468.	612864.	507705.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	103604.	69318.	*	*	96594.	64733.	*	*	166736.	111166.
1	38040.	24077.	15584.	9078.	42492.	26976.	16625.	10349.	42579.	27313.	17788.	10679.
2	2188.	1427.	848.	350.	4660.	2646.	1305.	724.	5970.	2909.	1619.	909.
3	452.	298.	195.	127.	159.	90.	44.	25.	390.	185.	109.	54.
4+	30.	20.	13.	9.	80.	46.	31.	20.	27.	13.	9.	6.
SSN	6473.				9148.				10645.			
SSB	94497.				143103.				178258.			
TSN	40709.	25822.	120244.	78882.	47390.	29757.	114599.	75851.	48966.	30420.	186261.	122815.
TSB	334149.	425698.	852161.	646752.	410800.	501650.	860796.	658250.	446506.	518578.	1187777.	953958.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	76709.	50699.	*	*	67004.	44835.	*	*	216862.	144838.
1	71663.	45125.	29002.	16610.	33204.	20667.	13188.	7901.	29092.	17884.	11683.	6989.
2	6301.	3334.	1995.	1019.	8855.	5364.	3208.	1404.	4436.	2490.	1436.	618.
3	456.	210.	124.	82.	464.	299.	153.	87.	577.	341.	205.	79.
4+	26.	15.	10.	7.	58.	39.	26.	17.	68.	46.	31.	21.
SSN	13949.				12698.				7991.			
SSB	208478.				239877.				144864.			
TSN	78446.	48684.	107840.	68418.	42581.	26369.	83579.	54244.	34173.	20760.	230216.	152544.
TSB	659954.	801549.	1125116.	733800.	449061.	509507.	744849.	514733.	328143.	372521.	1233536.	1060308.

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	42236.	27716.	*	*
1	93617.	59357.	38168.	23419.	17139.	10988.
2	3745.	2306.	1328.	850.	12850.	7989.
3	304.	199.	107.	69.	520.	337.
4+	67.	45.	30.	20.	57.	38.
SSN	13478.				15140.	
SSB	163840.				318671.	
TSN	97734.	61908.	81867.	52074.	30565.	19353.
TSB	753630.	981246.	1186618.	744648.	426646.	455450.

Table 12.4.1 (Cont'd)

Catch in numbers for fleet: 1
Commercial fishery

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	446.	2671.	*	*	1.	2231.	*	*	6.	678.
1	4207.	1826.	5825.	4296.	2759.	2252.	5290.	3492.	2264.	857.	1400.	2991.
2	1297.	1234.	1574.	379.	1375.	1165.	1683.	734.	1364.	145.	793.	174.
3	15.	10.	17.	7.	143.	269.	8.	0.	192.	13.	19.	0.
4+	0.	2.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.
SOP	58587.	69964.	216106.	131207.	56790.	56532.	152291.	110942.	57464.	15509.	62489.	92017.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.	5572.	*	*	8.	227.	*	*	741.	3146.
1	396.	260.	1186.	1791.	2687.	1075.	1627.	2151.	249.	95.	183.	632.
2	1069.	87.	245.	39.	401.	60.	171.	233.	700.	74.	250.	405.
3	72.	3.	6.	0.	12.	0.	0.	5.	20.	0.	0.	0.
4+	3.	0.	0.	0.	1.	0.	0.	0.	0.	0.	0.	0.
SOP	37889.	7657.	45085.	89993.	33894.	15435.	38729.	60847.	22181.	3559.	21793.	61762.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	159.	4854.	*	*	20.	993.	*	*	734.	3486.
1	1736.	678.	1672.	1741.	1840.	1780.	971.	1181.	1501.	636.	1519.	1048.
2	48.	133.	266.	93.	584.	572.	185.	116.	1336.	404.	215.	187.
3	6.	6.	5.	13.	20.	19.	6.	4.	93.	19.	22.	18.
4+	0.	0.	0.	0.	10.	0.	0.	0.	6.	0.	0.	0.
SOP	15379.	13234.	55066.	82880.	28283.	39730.	26158.	45253.	42776.	20786.	62518.	64380.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	879.	954.	*	*	96.	1175.	*	*	647.	4238.
1	3556.	1522.	3457.	2784.	1942.	813.	1147.	1050.	1975.	372.	1029.	1148.
2	1086.	293.	389.	267.	699.	473.	912.	445.	591.	285.	421.	134.
3	118.	20.	1.	2.	15.	58.	19.	2.	56.	29.	71.	0.
4+	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SOP	64224.	27973.	114122.	96177.	36206.	29291.	62290.	53470.	34575.	15373.	53799.	79838.

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	728.	1758.	*	*
1	4148.	1980.	2645.	3480.	611.	560.
2	249.	266.	48.	62.	762.	344.
3	6.	33.	3.	3.	14.	15.
4+	0.	0.	0.	0.	0.	0.
SOP	38390.	29118.	72498.	100852.	22711.	16067.

Table 12.4.1 (Cont'd)

Partial fishing mortality for fleet: 1
Commercial fishery

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.004	0.032	*	*	0.000	0.052	*	*	0.000	0.022
1	0.048	0.032	0.169	0.225	0.051	0.066	0.271	0.365	0.085	0.051	0.137	0.599
2	0.122	0.202	0.538	0.315	0.130	0.193	0.590	0.769	0.303	0.059	0.647	0.390
3	0.165	0.189	0.751	1.354	0.238	1.173	0.161	0.000	0.682	0.119	0.318	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.035	0.000	0.000	0.000
F (1- 2)	0.085	0.117	0.353	0.270	0.091	0.130	0.430	0.567	0.194	0.055	0.392	0.494

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.094	*	*	0.000	0.013	*	*	0.010	0.065
1	0.019	0.019	0.141	0.407	0.073	0.047	0.114	0.268	0.021	0.012	0.036	0.208
2	0.609	0.117	0.694	0.304	0.191	0.049	0.235	0.732	0.164	0.029	0.159	0.520
3	0.356	0.027	0.088	0.000	0.183	0.000	0.012	0.325	0.171	0.000	0.000	0.000
4+	0.119	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.314	0.068	0.417	0.355	0.132	0.048	0.174	0.500	0.093	0.021	0.097	0.364

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.088	*	*	0.000	0.019	*	*	0.005	0.039
1	0.057	0.035	0.138	0.260	0.054	0.083	0.073	0.148	0.044	0.029	0.109	0.126
2	0.027	0.119	0.461	0.377	0.163	0.298	0.186	0.214	0.309	0.182	0.174	0.281
3	0.016	0.025	0.029	0.132	0.163	0.298	0.186	0.214	0.333	0.132	0.282	0.487
4+	0.000	0.000	0.000	0.000	0.163	0.000	0.000	0.000	0.307	0.000	0.000	0.000
F (1- 2)	0.042	0.077	0.300	0.319	0.109	0.190	0.130	0.181	0.177	0.105	0.141	0.203

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.014	0.023	*	*	0.002	0.032	*	*	0.004	0.036
1	0.062	0.042	0.155	0.224	0.073	0.049	0.111	0.174	0.086	0.026	0.112	0.219
2	0.231	0.112	0.265	0.372	0.100	0.112	0.409	0.465	0.174	0.148	0.424	0.299
3	0.365	0.122	0.010	0.030	0.039	0.263	0.162	0.028	0.124	0.108	0.520	0.000
4+	0.151	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.146	0.077	0.210	0.298	0.087	0.081	0.260	0.320	0.130	0.087	0.268	0.259

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	0.021	0.080	*	*
1	0.055	0.041	0.087	0.196	0.044	0.064
2	0.084	0.150	0.045	0.091	0.074	0.053
3	0.023	0.221	0.036	0.056	0.033	0.055
4+	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.069	0.095	0.066	0.144	0.059	0.059

Table 12.4.1 (Cont'd)

Log inverse catchabilities, fleet no: 1
Commercial fishery

Season	1	2	3	4
AGE				
0	*	*	15.620	11.498
1	10.473	10.186	9.927	9.434
2	9.364	8.910	8.992	9.065
3	9.364	8.910	8.992	9.065

Log inverse catchabilities, fleet no: 2
IYFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.797	*	*	*
2	1.719	*	*	*
3	1.719	*	*	*

Log inverse catchabilities, fleet no: 3
EGFS

Season	1	2	3	4
AGE				
0	*	*	4.200	*
1	*	*	2.369	*
2	*	*	1.449	*
3	*	*	1.449	*

Log inverse catchabilities, fleet no: 4
SGFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	3.378	*
2	*	*	2.595	*
3	*	*	2.595	*

Log residual stocknr. (nhat/n), fleet no: 1
Commercial fishery

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	1.270	-0.338	*	*	-4.039	0.064	*	*	-1.088	-0.549
1	-0.488	-0.712	-0.554	-0.448	-0.290	0.169	0.036	-0.056	0.147	0.732	0.179	0.706
2	-0.666	-0.156	-0.329	-0.484	-0.468	-0.038	-0.120	0.320	0.315	-0.398	0.800	-0.092
3	-0.360	-0.221	0.005	0.975	0.135	1.767	-1.419	*	1.126	0.301	0.091	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	0.391	*	*	0.173	-0.632	*	*	1.269	0.836
1	-1.678	-0.643	0.255	-0.238	0.470	0.802	0.394	0.372	-0.515	0.691	0.316	0.002
2	0.666	-0.113	0.916	-0.919	0.316	-0.430	0.176	0.999	0.434	0.382	0.861	0.549
3	0.130	-1.587	-1.153	*	0.276	*	*	0.201	0.447	*	*	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	-1.612	0.824	*	*	0.029	-0.134	*	*	0.781	0.178
1	1.025	0.543	-0.265	-0.021	0.395	-0.005	0.029	-0.134	-0.161	-0.527	-0.040	-0.433
2	-0.818	0.573	0.128	-0.160	0.395	-0.005	0.029	-0.134	0.699	0.448	-1.271	0.011
3	-1.167	-1.010	*	-1.201	0.395	-0.005	0.029	-0.134	0.772	0.145	-2.344	0.522

Table 12.4.1 (Cont'd)

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.343	-0.820	*	*	-0.845	0.058	*	*	1.297	0.490
1	-0.232	0.456	0.034	0.076	0.302	0.038	-0.286	-0.102	0.551	0.025	0.284	0.341
2	0.021	0.350	-0.127	0.214	-0.496	-0.329	0.157	0.524	0.189	0.507	0.632	0.281
3	0.491	0.669	-3.460	-2.082	-1.510	0.518	-0.757	-2.413	-0.140	0.190	0.876	*

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	2.421	-0.370	*	*
1	0.347	-0.157	-0.380	-0.065	0.128	-1.412
2	-0.343	0.386	-1.853	-1.110	-0.243	-1.179
3	-1.619	0.777	-1.904	-1.594	-1.009	-0.892

Log residual stocknr. (nhat/n), fleet no: 2
IYFS

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	-0.832	*	*	*	0.180	*	*	*	0.256	*	*	*
2	-1.060	*	*	*	-0.858	*	*	*	0.569	*	*	*
3	-0.582	*	*	*	-0.622	*	*	*	0.343	*	*	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	0.488	*	*	*	0.304	*	*	*	-1.729	*	*	*
2	0.200	*	*	*	0.219	*	*	*	-0.003	*	*	*
3	-0.457	*	*	*	1.705	*	*	*	-0.485	*	*	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	0.109	*	*	*	-0.457	*	*	*	0.174	*	*	*
2	-0.205	*	*	*	0.188	*	*	*	-0.133	*	*	*
3	0.989	*	*	*	0.746	*	*	*	0.947	*	*	*

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	0.380	*	*	*	0.507	*	*	*	0.283	*	*	*
2	0.068	*	*	*	0.748	*	*	*	-0.482	*	*	*
3	-0.561	*	*	*	1.347	*	*	*	-0.185	*	*	*

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	*	*	*	*
1	0.258	*	*	*	0.077	*
2	0.388	*	*	*	0.361	*
3	0.548	*	*	*	1.130	*

Table 12.4.1 (Cont'd)

Log residual stocknr. (nhat/n), fleet no: 3
EGFS

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	1.017	*	*	*	-0.557	*	*	*	-0.392	*
1	*	*	-0.581	*	*	*	0.656	*	*	*	0.091	*
2	*	*	-1.908	*	*	*	-0.724	*	*	*	-0.105	*
3	*	*	-0.282	*	*	*	-0.271	*	*	*	-0.714	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	-1.295	*	*	*	-3.913	*	*	*	-1.968	*
1	*	*	-0.029	*	*	*	-0.921	*	*	*	-1.661	*
2	*	*	0.682	*	*	*	-0.177	*	*	*	-1.126	*
3	*	*	1.350	*	*	*	-1.828	*	*	*	-0.119	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.089	*	*	*	0.609	*	*	*	-0.383	*
1	*	*	0.080	*	*	*	-0.296	*	*	*	-0.843	*
2	*	*	1.373	*	*	*	-0.382	*	*	*	0.352	*
3	*	*	-0.783	*	*	*	1.331	*	*	*	-0.846	*

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	1.119	*	*	*	1.930	*	*	*	1.065	*
1	*	*	1.086	*	*	*	1.219	*	*	*	0.420	*
2	*	*	1.132	*	*	*	1.186	*	*	*	-0.733	*
3	*	*	1.882	*	*	*	*	*	*	*	-1.522	*

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	2.680	*	*	*
1	*	*	0.779	*	*	*
2	*	*	0.430	*	*	*
3	*	*	-0.372	*	*	*

Log residual stocknr. (nhat/n), fleet no: 4
SGFS

Year	1983				1984				1985			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	-0.878	*	*	*	-0.082	*	*	*	0.598	*
2	*	*	-0.876	*	*	*	-1.127	*	*	*	0.638	*
3	*	*	-0.522	*	*	*	0.757	*	*	*	0.096	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	0.302	*	*	*	-0.368	*	*	*	-1.515	*
2	*	*	0.717	*	*	*	-0.858	*	*	*	0.575	*
3	*	*	0.566	*	*	*	-0.682	*	*	*	0.111	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	-0.077	*	*	*	-0.787	*	*	*	0.429	*
2	*	*	-0.720	*	*	*	-0.373	*	*	*	-0.788	*
3	*	*	0.169	*	*	*	-0.231	*	*	*	0.013	*

Table 12.4.1 (Cont'd)

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	0.811	*	*	*	0.496	*	*	*	0.213	*
2	*	*	0.701	*	*	*	0.681	*	*	*	0.358	*
3	*	*	1.150	*	*	*	0.824	*	*	*	-0.530	*

Year	1995				1996	
Season	1	2	3	4	1	2
AGE						
0	*	*	*	*	*	*
1	*	*	0.859	*	*	*
2	*	*	1.073	*	*	*
3	*	*	1.180	*	*	*

Weighting factors for computing survivors:
Fleet no: 1
Commercial fishery

Season	1	2	3	4
AGE				
0	*	*	0.560	1.796
1	1.490	1.498	3.272	2.997
2	1.927	1.983	1.189	1.636
3	1.101	1.064	0.563	0.635

Weighting factors for computing survivors:
Fleet no: 2
IYFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.571	*	*	*
2	1.877	*	*	*
3	1.082	*	*	*

Weighting factors for computing survivors:
Fleet no: 3
EGFS

Season	1	2	3	4
AGE				
0	*	*	0.555	*
1	*	*	1.136	*
2	*	*	0.984	*
3	*	*	0.825	*

Weighting factors for computing survivors:
Fleet no: 4
SGFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	1.346	*
2	*	*	1.216	*
3	*	*	1.435	*

Table 12.5.1 Recruitment analysis of Norway pout in IV and IIIa, age 0 in 3'th quarter

```
Analysis by RCT3 ver3.1 of data from file :

npout.rct

Norway pout IV+IIIa. Age 0 in 3th quarter, 10.10 1996

Data for    4 surveys over   14 years :  1983 - 1996

Regression type = C
Tapered time weighting applied
power =     3 over  20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of    3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass =    1995

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope   Inter-   Std  Rsquare  No.   Index Predicted   Std     WAP
Series           cept    Error          Pts   Value   Value    Error   Weights

EGFS0     .41   8.65    .61   .444     12    8.93   12.28     .750     .106
EGFS1     .53   7.64    .41   .639     12    7.14   11.44     .478     .262
SGFS0     .71   8.11    .94   .253     12    5.91   12.33    1.130     .047
SGFS1     .57   6.62    .35   .711     12    8.32   11.37     .406     .363

                                       VPA Mean =   11.45     .518     .223

Yearclass =    1996

         I-----------Regression----------I  I-----------Prediction---------I

Survey/  Slope   Inter-   Std  Rsquare  No.   Index Predicted   Std     WAP
Series           cept    Error          Pts   Value   Value    Error   Weights

EGFS0     .41   8.59    .63   .432     12    8.09   11.95     .756     .287
EGFS1
SGFS0     .70   8.16    .93   .259     12    7.15   13.18    1.241     .107
SGFS1

                                       VPA Mean =   11.45     .520     .606

Year     Weighted      Log     Int      Ext      Var      VPA      Log
Class     Average      WAP     Std      Std     Ratio              VPA
         Prediction           Error    Error

1996      130368      11.78     .41      .37      .85
```

Table 12.5.2 Recruitment analysis of Norway pout in IV and IIIa, age 1 in 3'th quarter

Analysis by RCT3 ver3.1 of data from file :

npout1.rct

Norway pout IV+IIIa. Age 1 in 3th quarter, 11.10 1996

Data for 4 surveys over 14 years : 1983 - 1996

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1995

	I----------Regression---------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
EGFS0	.39	7.01	.59	.437	12	8.93	10.51	.727	.097
EGFS1	.51	6.06	.40	.636	12	7.14	9.70	.460	.243
SGFS0	.62	6.78	.79	.302	12	5.91	10.47	.955	.056
SGFS1	.53	5.18	.31	.739	12	8.32	9.62	.361	.394
					VPA Mean =		9.70	.495	.210

Yearclass = 1996

	I----------Regression---------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
EGFS0	.40	6.94	.62	.424	12	8.09	10.18	.735	.272
EGFS1									
SGFS0	.61	6.83	.79	.309	12	7.15	11.22	1.050	.134
SGFS1									
					VPA Mean =		9.71	.498	.594

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1996	22884	10.04	.38	.36	.87		

Table 12.6.1 Trends in Yield, Average fishing mortality for 1- and 2-group, SSB and Recruitment for Norway Pout in the North Sea and Skagerak[1].

Year	Yield ('000 tonnes)	$F_{av(1-2)}$	SSB ('000 tonnes)	Recruitment ('000 millions)
1974	735.8	1.84	171	176
1975	559.7	1.206	208	212
1976	435.4	1.204	200	198
1977	389.9	0.835	242	102
1978	270.1	0.907	241	201
1979	329.2	1.006	198	233
1980	482.7	1.233	332	61
1981	238.5	0.777	278	306
1982	395.3	1.016	174	238
1983	451.4	0.825	382	154
1984	392.0	1.218	378	79
1985	205.1	1.135	179	57
1986	178.4	1.154	91	112
1987	149.3	0.575	99	32
1988	109.5	0.575	139	91
1989	172.5	0.738	94	104
1990	151.6	0.610	143	97
1991	192.9	0.626	178	167
1992	299.8	0.731	208	77
1993	181.8	0.748	240	67
1994	178.7	0.744	145	217
1995	240.6	0.374	164	42
1996			319	

[1] The estimates before 1983 are based on previous assessment runs which does not include data from Skagerak

Figure: 12.2.1 **Mean weight at age in stock**

Norway pout in the North Sea and Skagerak

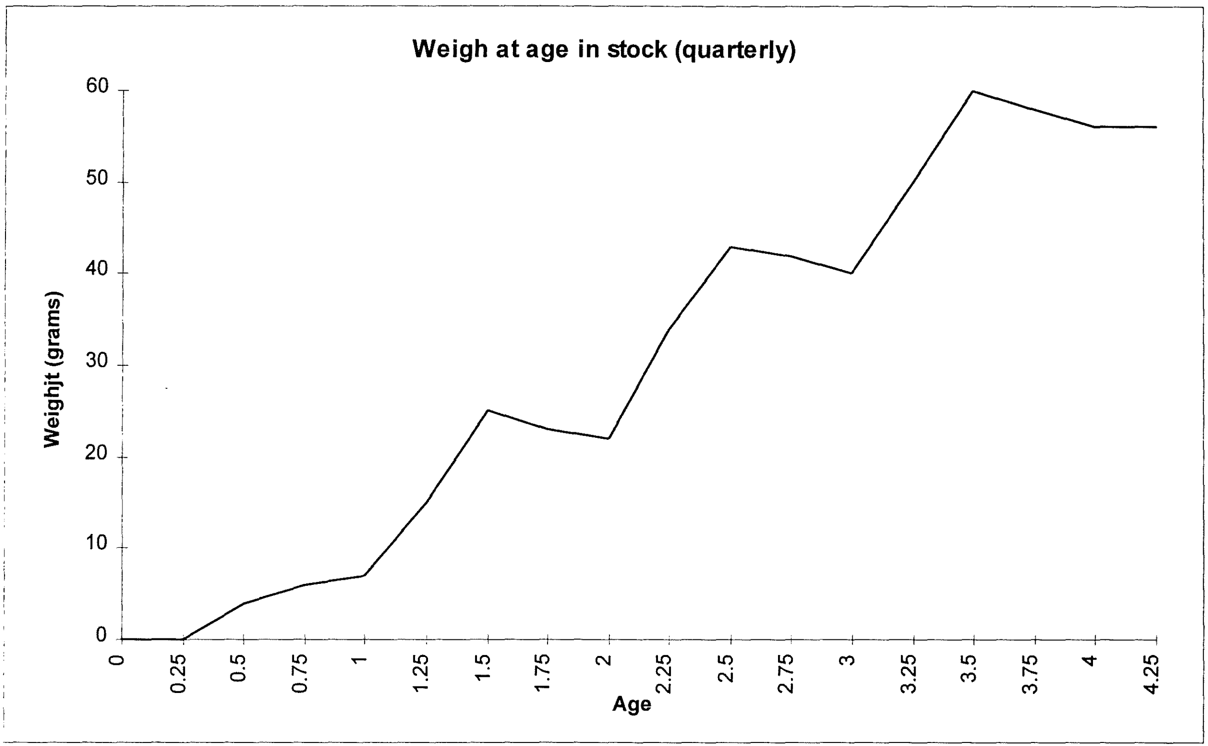
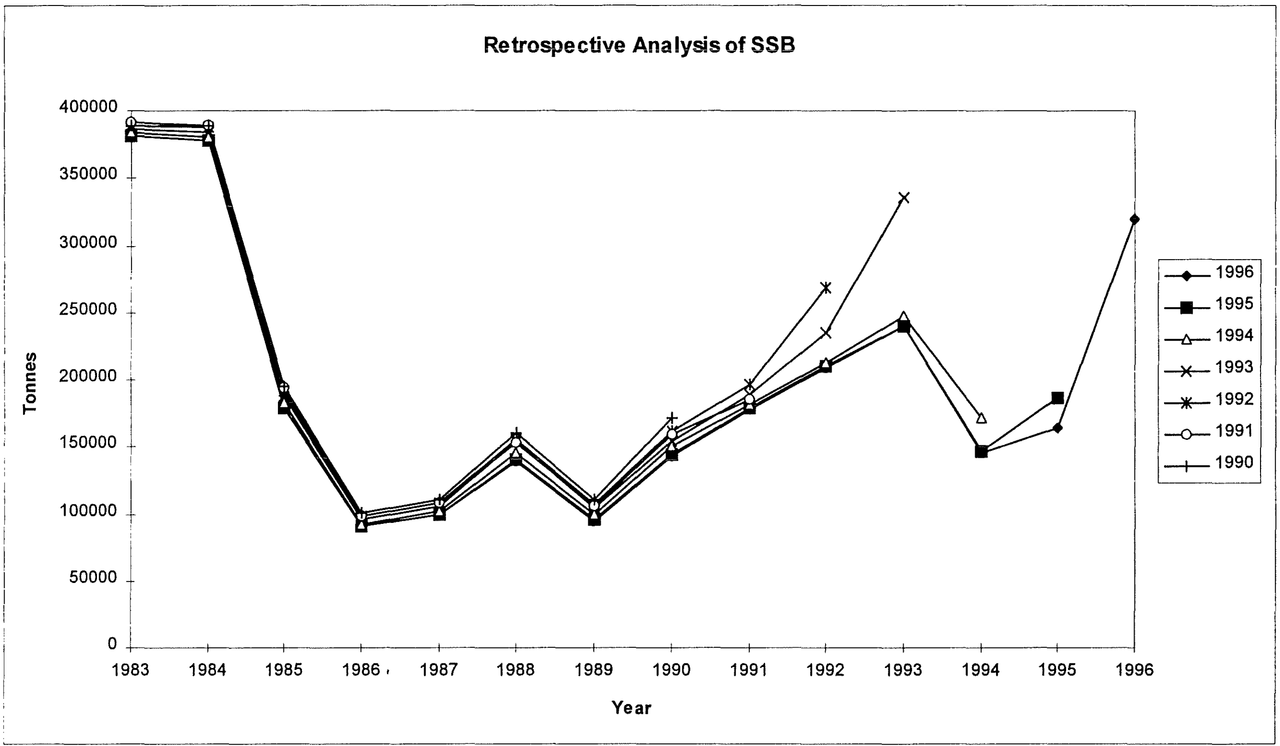


Figure: 12.4.1 Retrospective analysis of SSB and Recruitment

SXSA - Norway pout in the North Sea and Skagerak



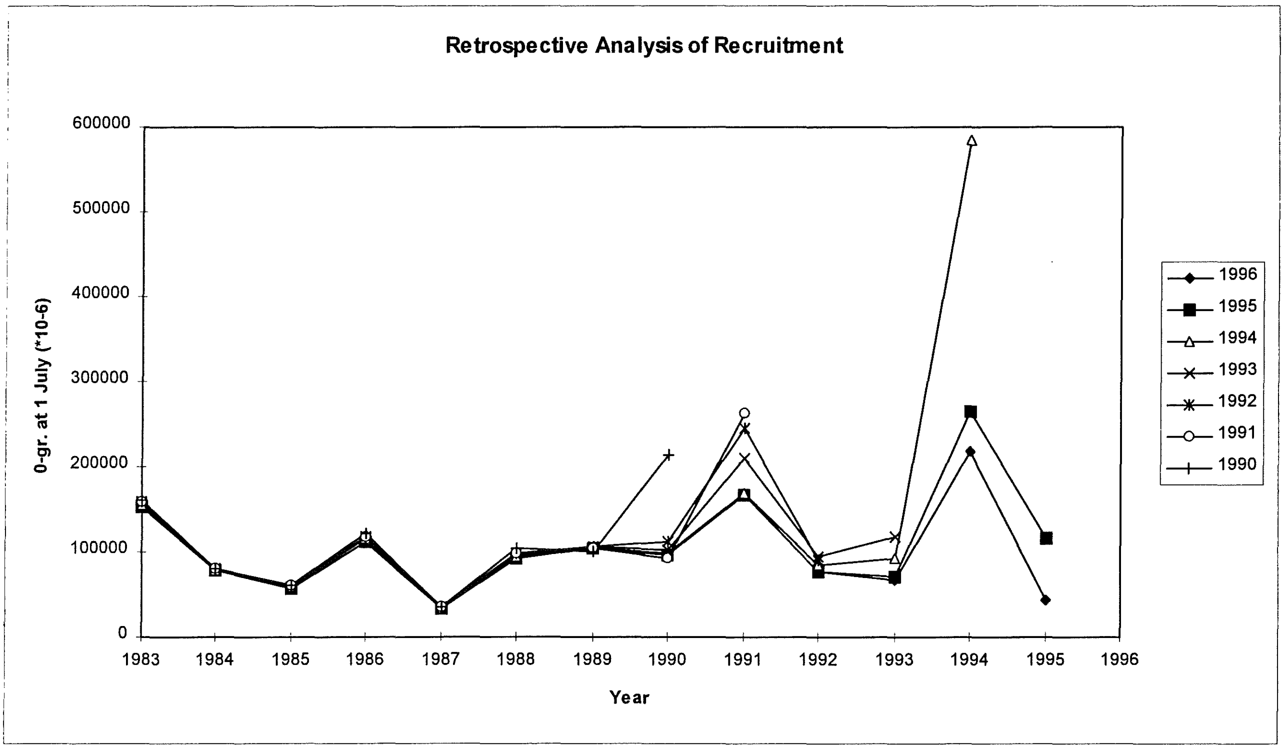


Figure: 12.4.2 Log residual stocknumbers by fleet and season

SXSA - Norway pout in the North Sea and Skagerak

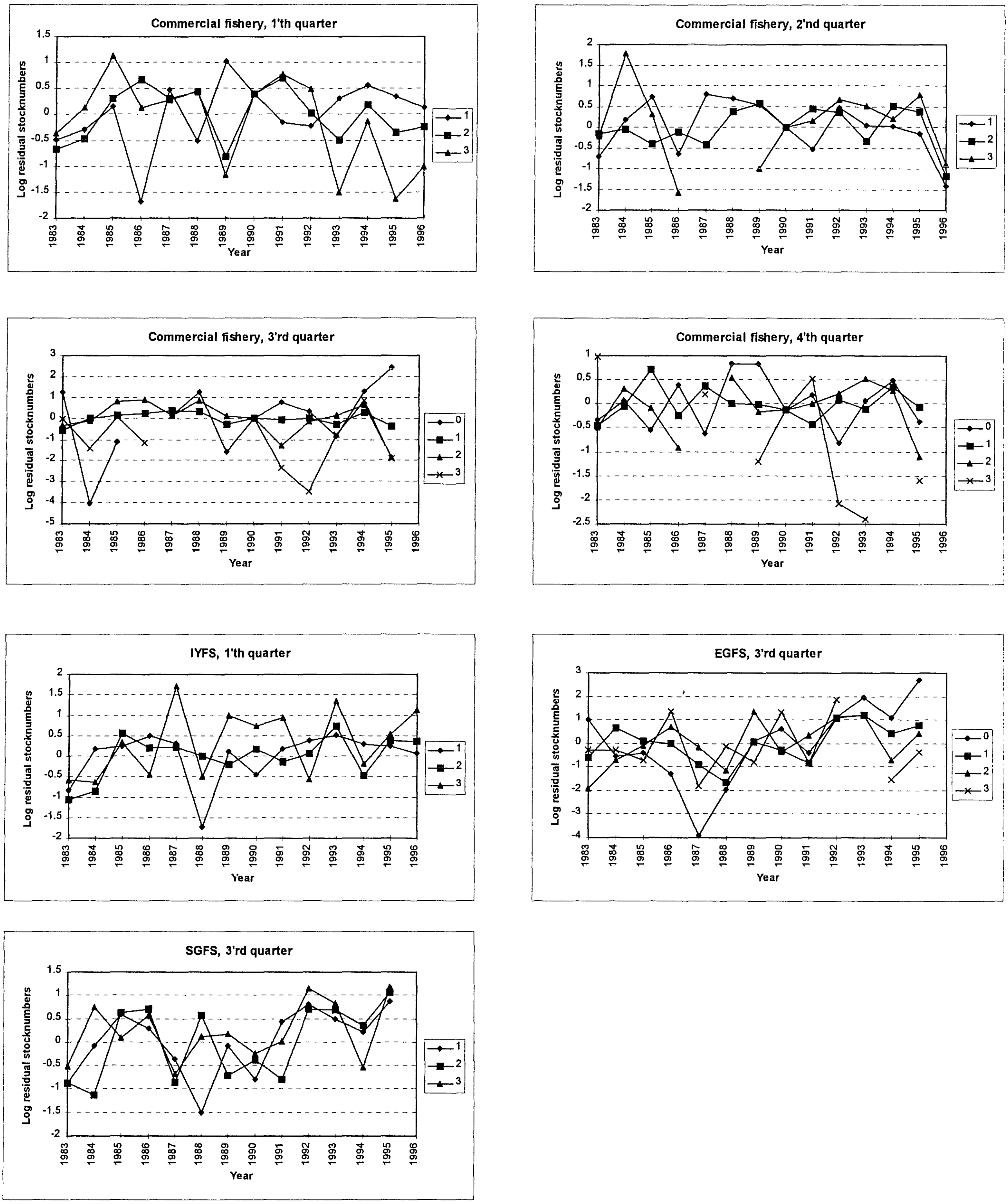


Figure: 12.4.3 Weighting factors for computing survivors

Commercial fishery (CF), IYFS, EGFS and SGFS

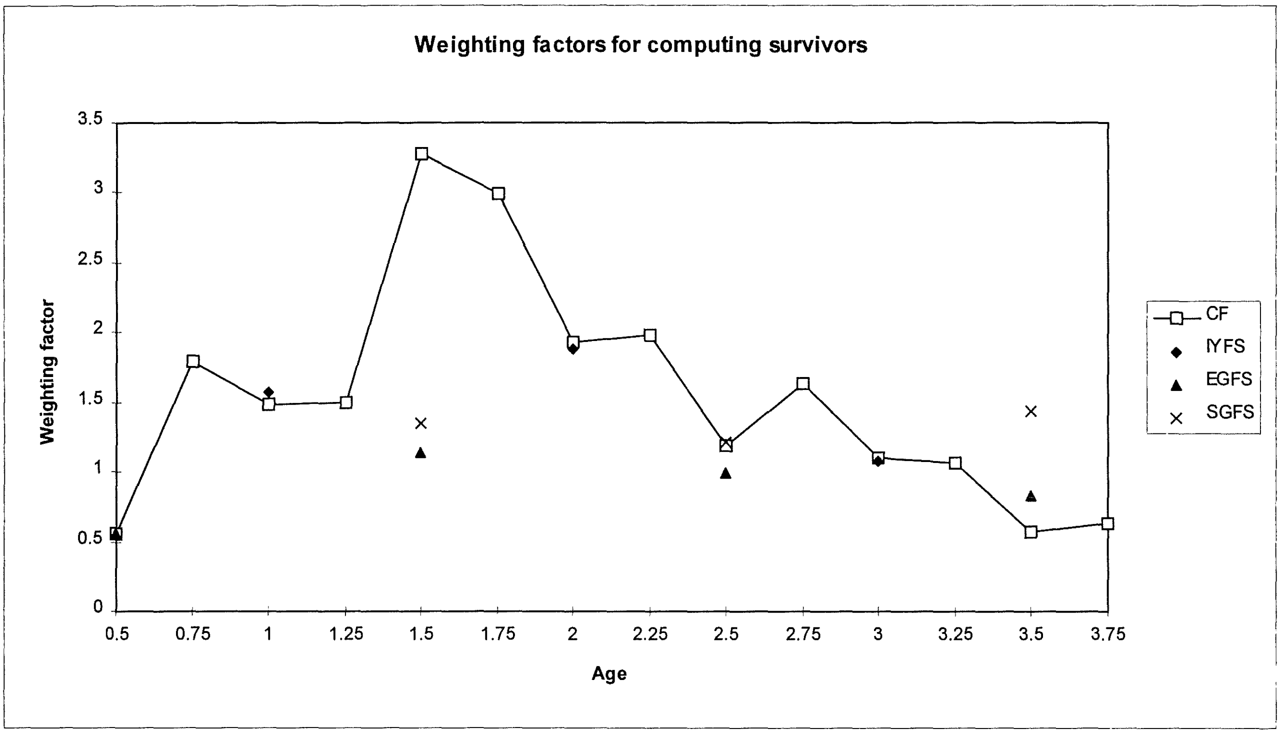
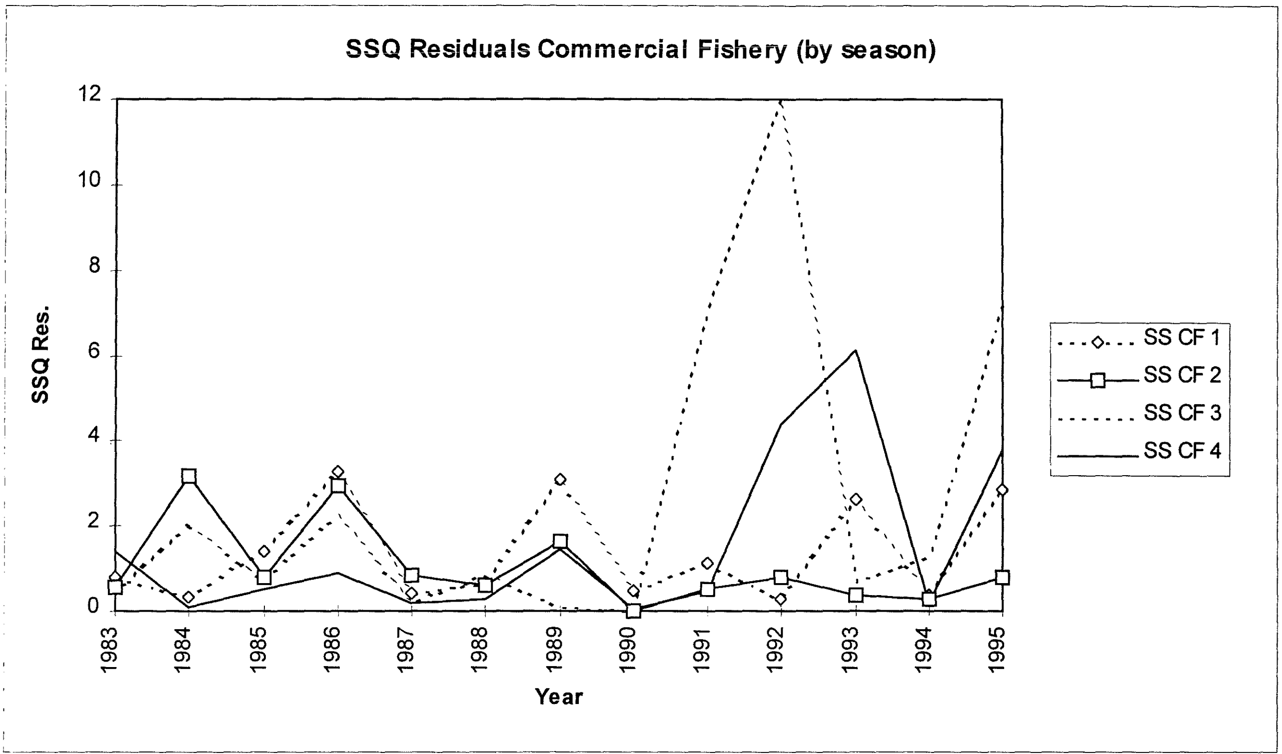


Figure: 12.4.4 **SSQ Residuals for commercial fishery (by season) and for the survey series**

Commercial fishery (CF), IYFS, EGFS and SGFS



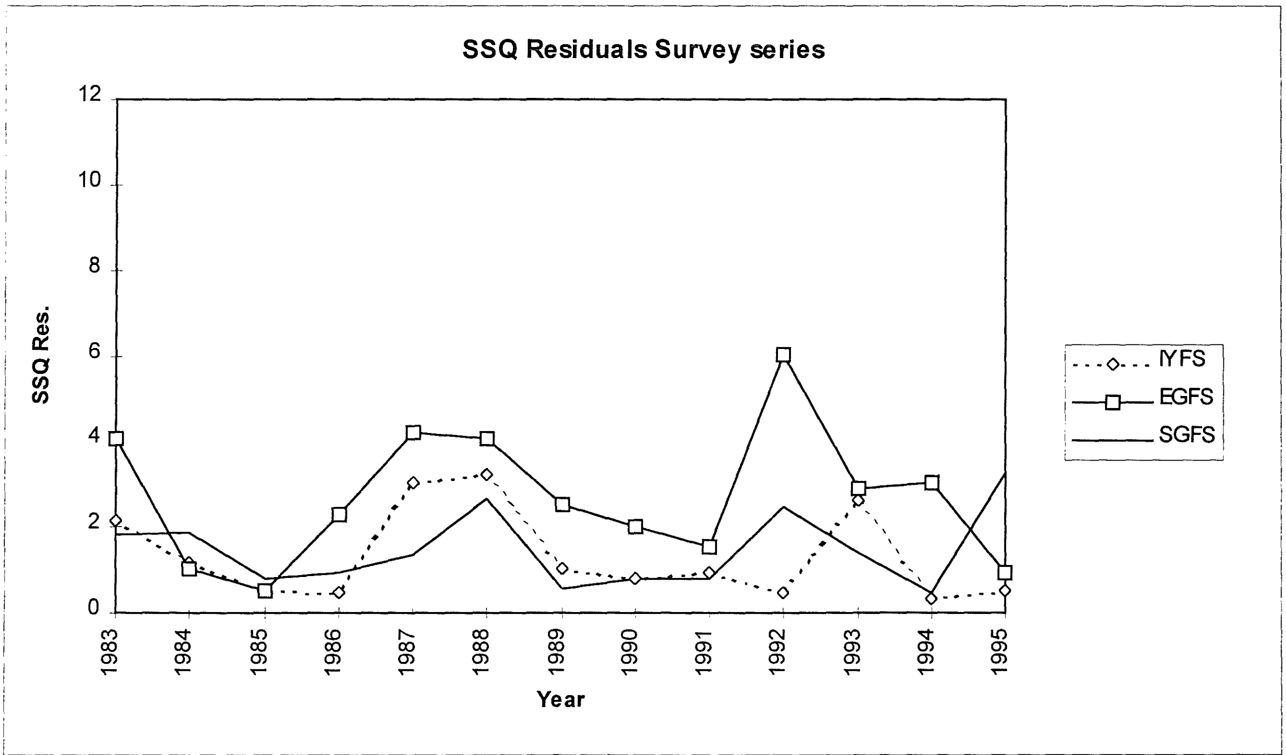
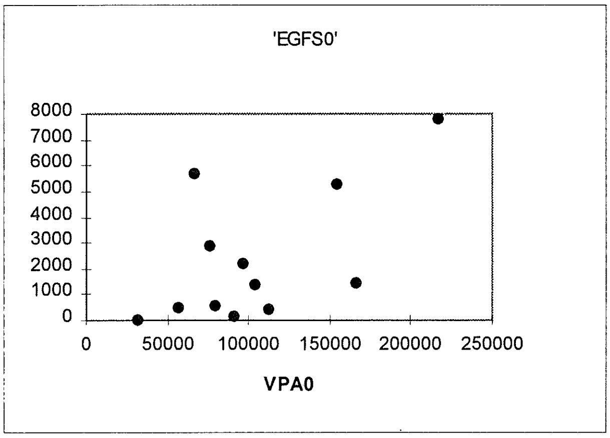
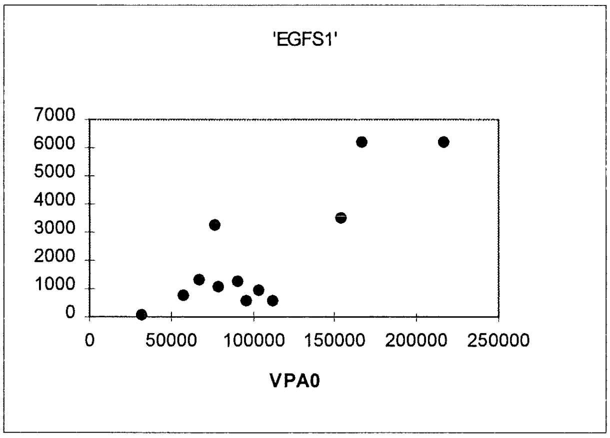
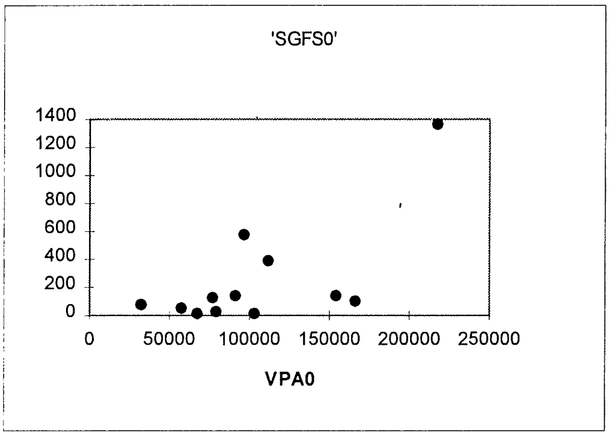


Figure: 12.5.1 **Recruitment indices vs VPA stocknumbers of age 0 in 3'rd quarter**

Norway pout in the North Sea and Skagerak







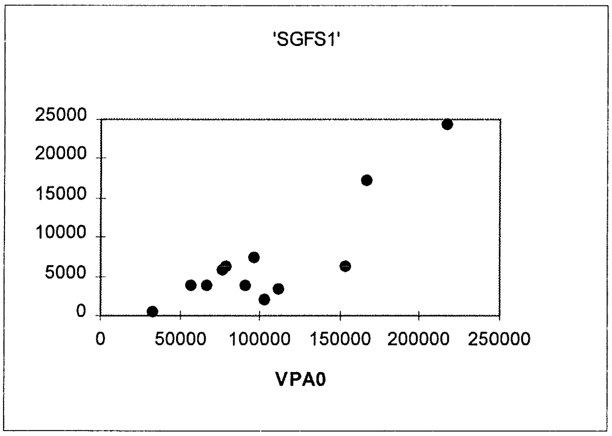


Figure: 12.5.2 **Recruitment indices vs VPA stocknumbers of age 1 in 3'rd quarter**

Norway pout in the North Sea and Skagerak

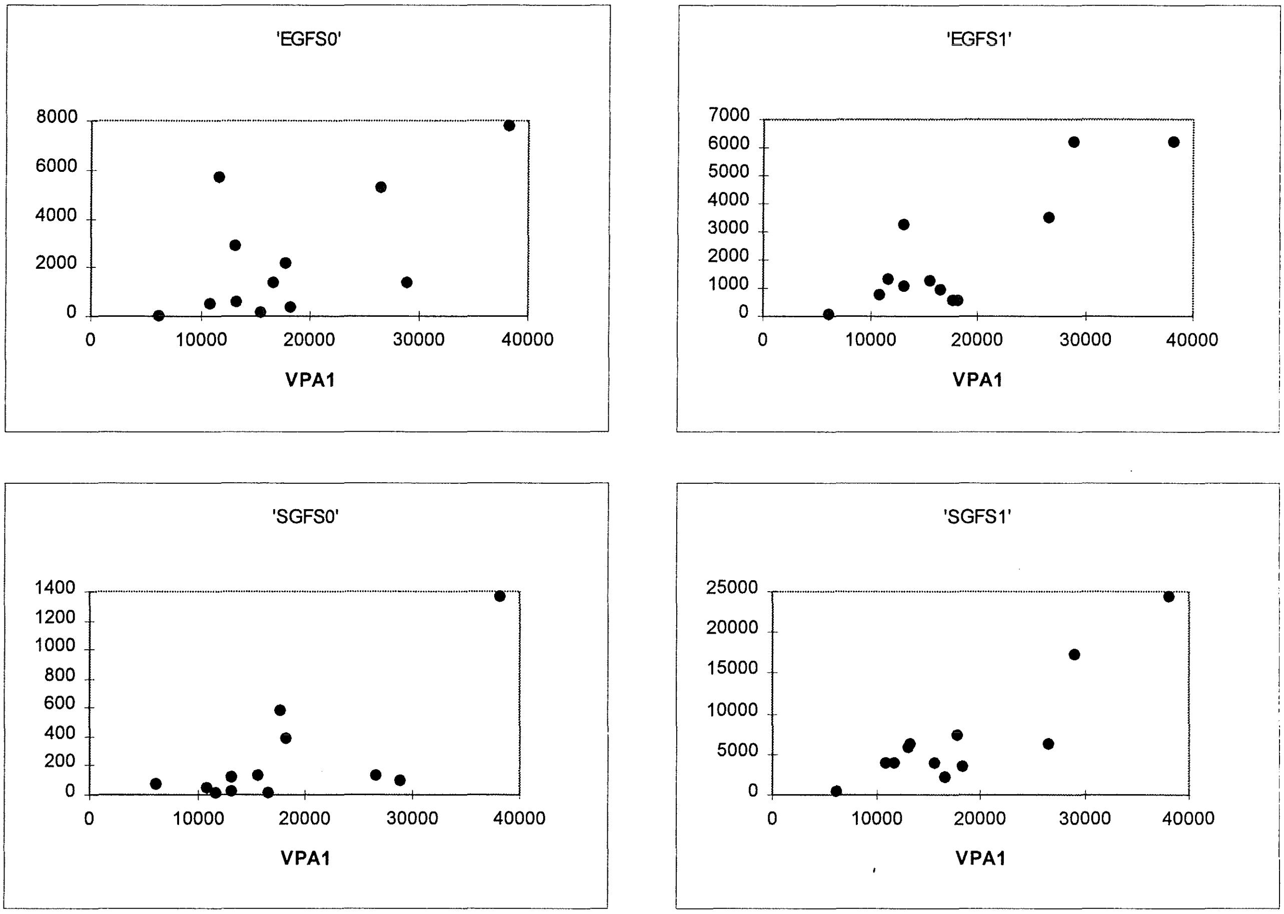
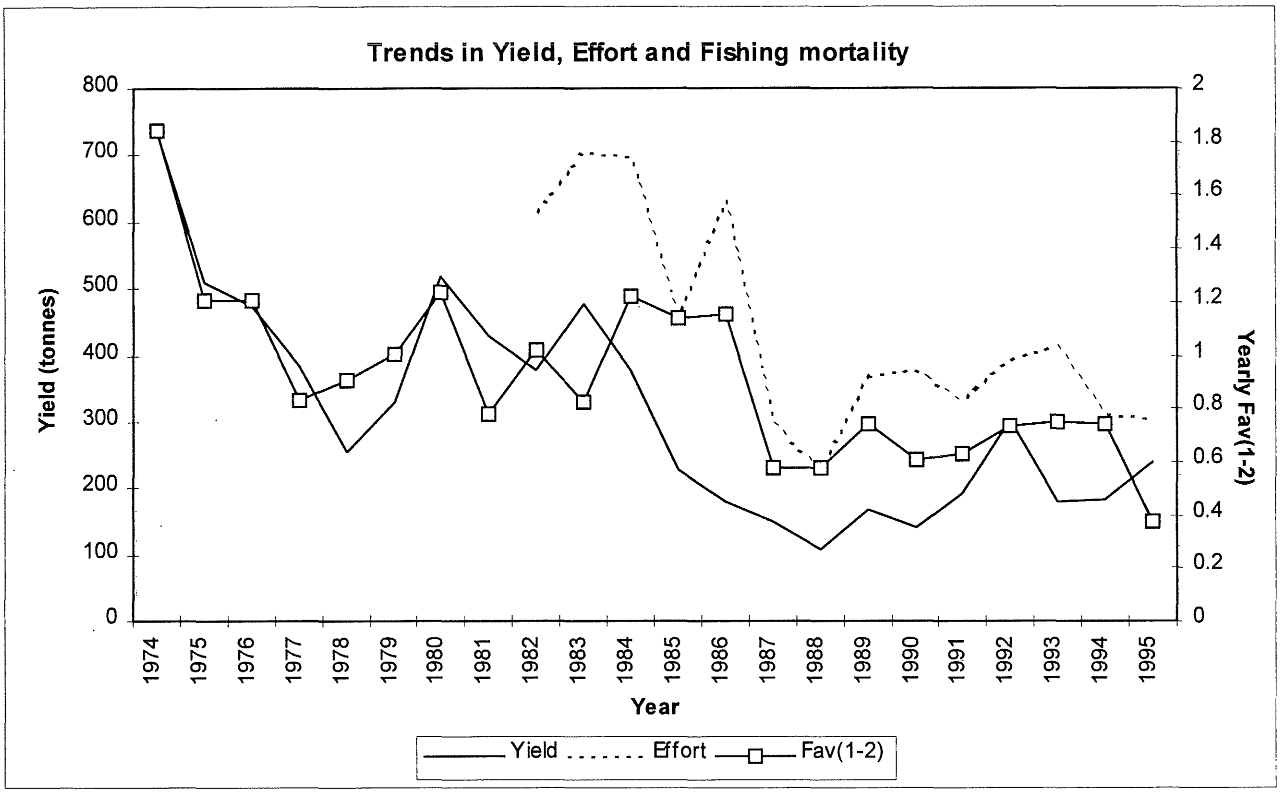
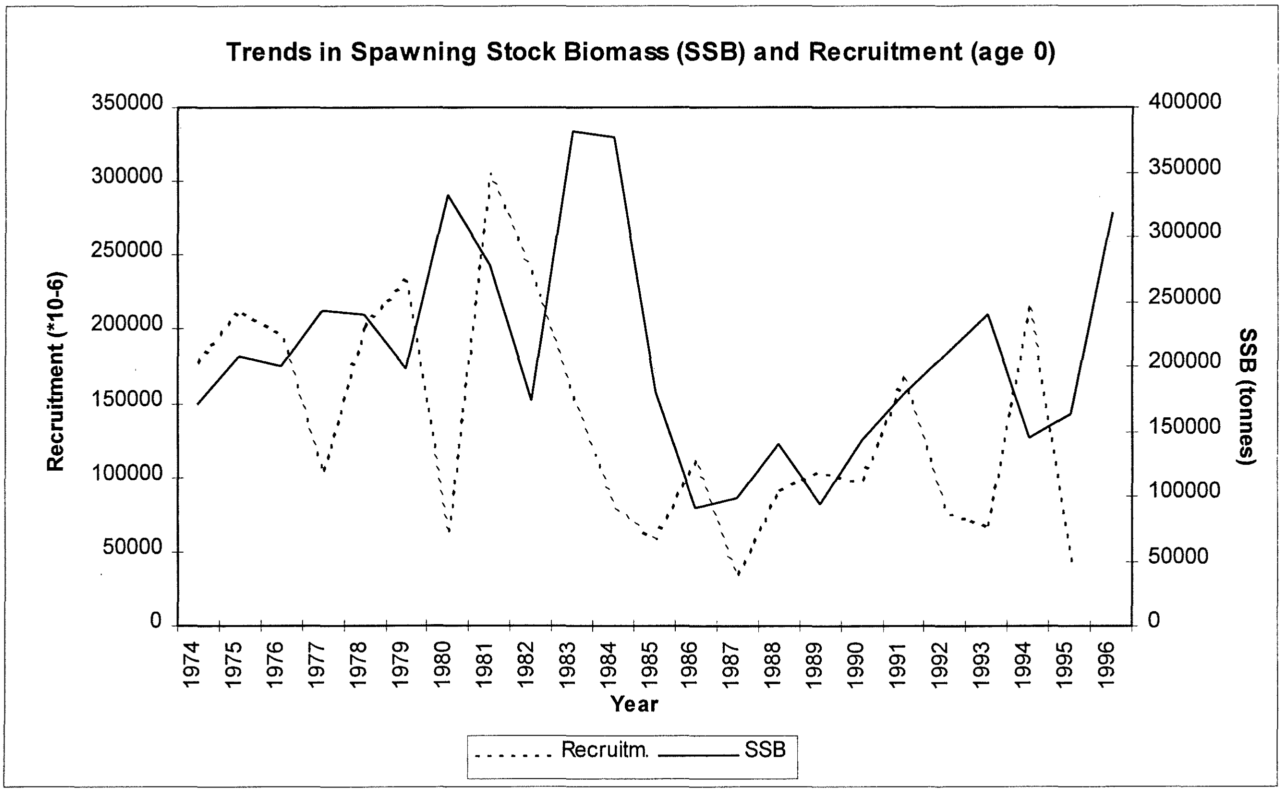


Figure: 12.6.1 **Historical trends in Yield, Effort, Average fishing mortality for 1- and 2-group, SSB and Recruitment**

Norway pout in the North Sea and Skagerak[1]





[1] Results and data previous to 1983 do not include Skagerak

Figure: 12.6.2 **Historical trends in fishing mortality for 1- and 2-group**

Norway pout in the North Sea and Skagerak

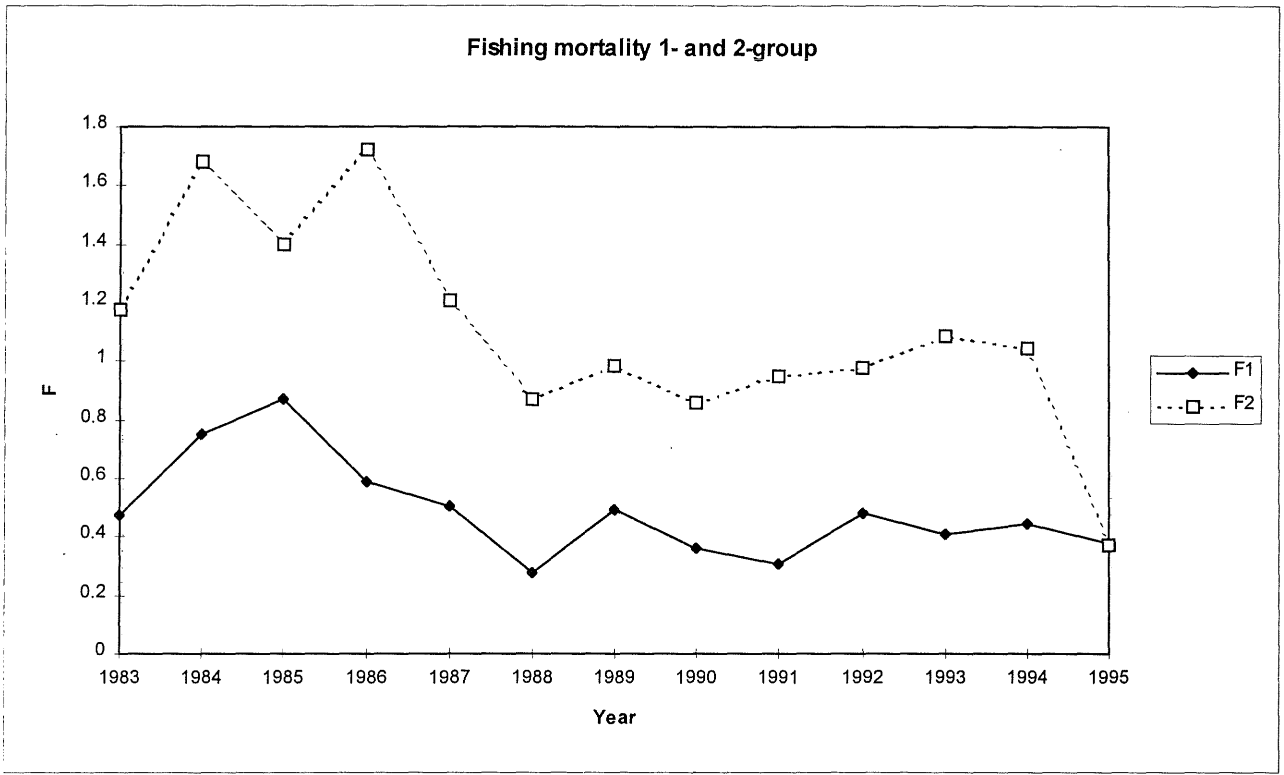


Figure: 12.9.1 Recruitment/SSB plot used to calculate F_{med} and F_{high}

Norway pout in the North Sea and Skagerak

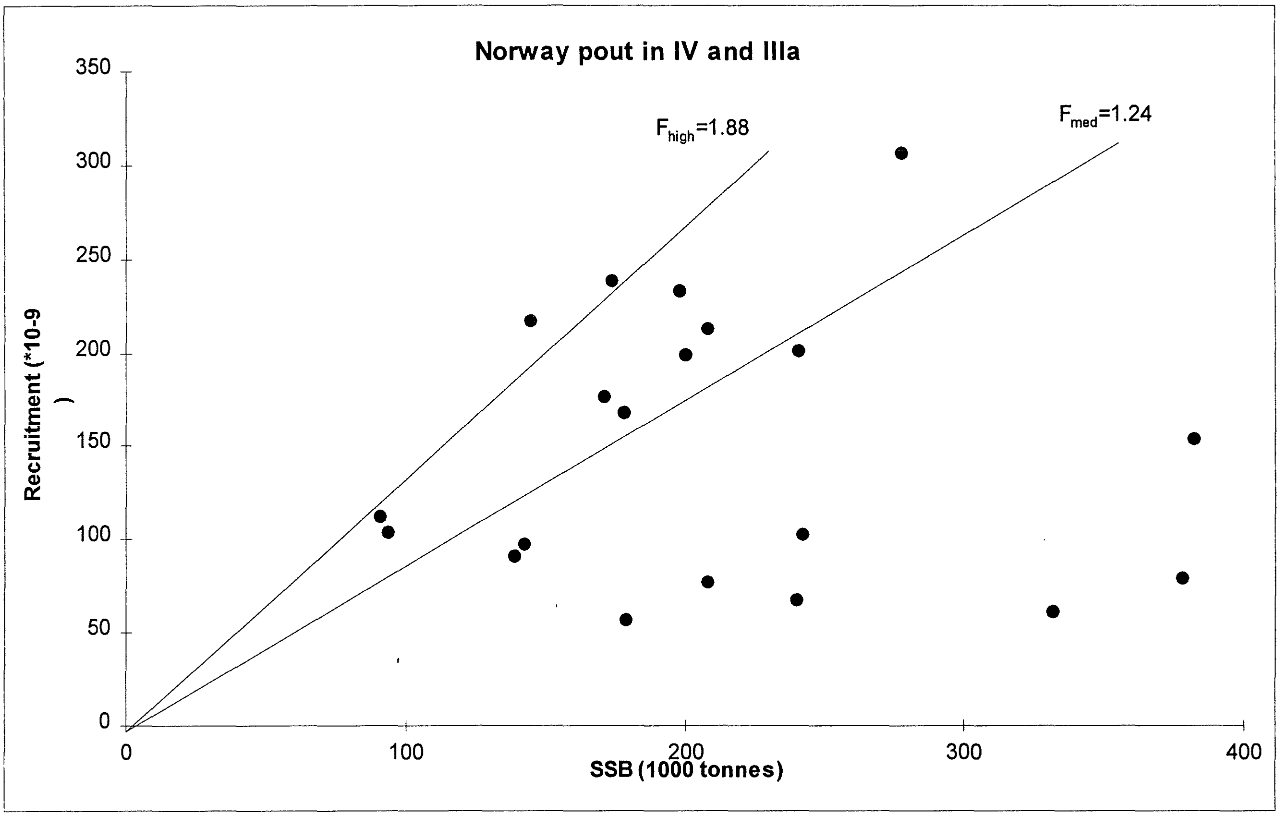
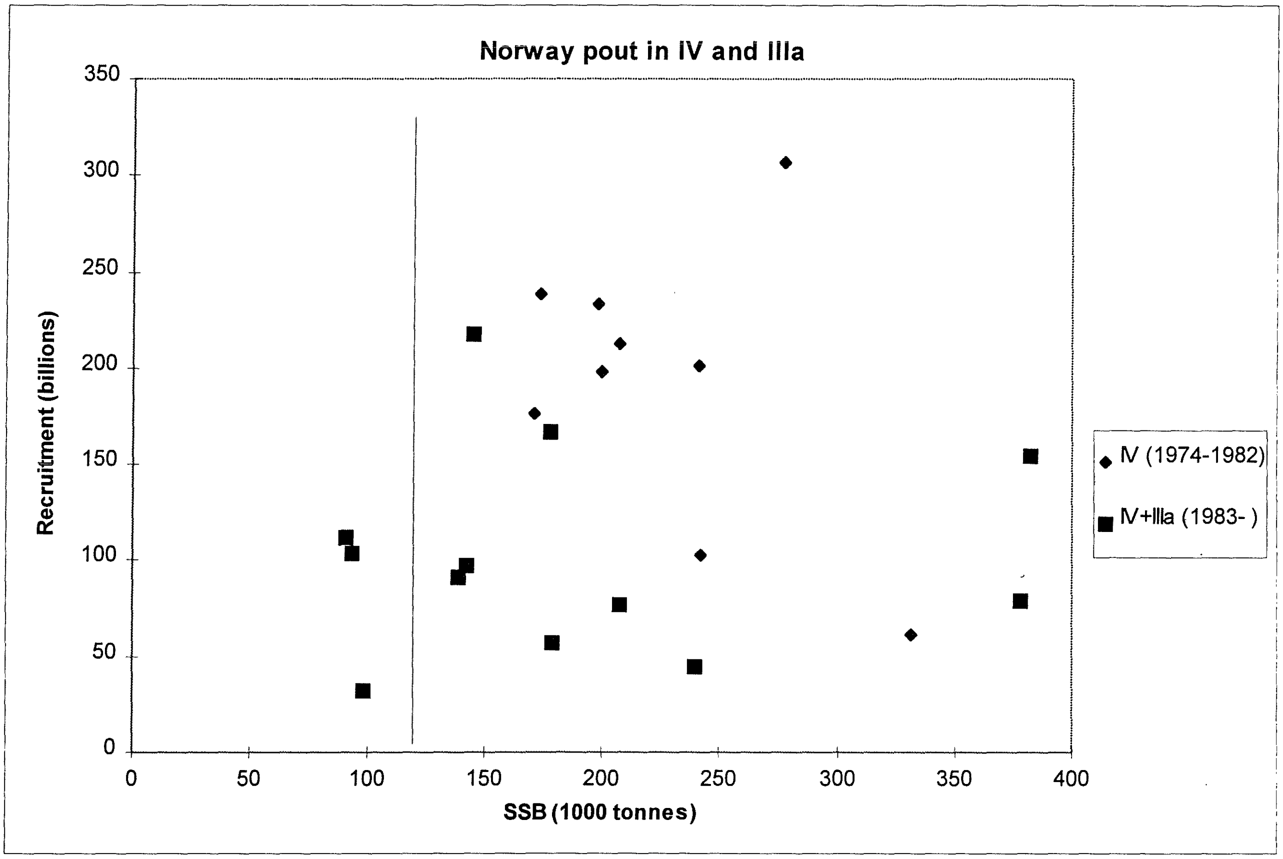


Figure: 12.10.1 Recruitment vs SSB

Norway pout in the North Sea and Skagerak[1]



[1] Results and data previous to 1983 do not include Skagerak

13 SANDEEL

13.1 Sandeel in Sub-area IV and Division IIIa

The Working Group discussed whether it would be feasible to combine the data for Sub-area IV and Division IIIa in the assessment. As stated in last years report biological samples are only available from 1992 onwards and do not allow a separate assessment for sandeel in Division IIIa to be carried out. Furthermore, the biological samples show that unlike the landings from the North Sea, which consist almost entirely of *Ammodytes marinus* the landings from Division IIIa consist of a mixture of *A. marinus*, *A. tobianus*, *Hyperoplus lanceolatus* and *Gymnoammodytes semisquamatus*. There are no data available prior to 1992 which can be used to estimate the species composition of the landings from Division IIIa. It was therefore decided not to include Division IIIa in the assessment of the North Sea sandeel stock.

13.1.1 Catch trends

The overall landings of sandeel increased from 765,000 t in 1994 to 918,000 t in 1995, of which 71% was landed by the Danish fishery, Table 13.1.1.1. The landings by sandeel area, Tables 13.1.1.3 and 13.1.1.4, show how the spatial distribution of the fishery has changed. Figure 13.1.1.1 shows the location of the sandeel areas used in the tables.

In the northern North Sea a fishery developed in April 1995 on the Viking Bank increasing the landings from area 1C from almost nil in 1994 to 147,000 t in 1995, which is the highest on record for this area. At the same time landings from the traditionally important grounds along the Norwegian deep (areas 2B and 3) declined. Overall the landings from the northern North Sea therefore exhibited a slight decline compared to 1994. In the southern North Sea landings increased by 78% compared to 1994. The increase was due to an substantial increase in the landings from the north eastern part of the Dogger bank (area 1A), while the landings from the Firth of Forth declined compared to 1994. Figure 13.1.1.2, which is based on fishermen's logbooks, shows the distribution of the catches by quarter and ICES statistical rectangle for 1995 and the first half of 1996.

The main fishing season started later than usually in 1996, Table 13.1.1.2. The landings from the first half of 1996 amounted to 482,000 t, which represents a 38% decrease compared to the first half of 1995. Most of the decrease was due to a reduction in the landings from the Viking and Dogger bank areas compared to the first half of 1995, Tables 13.1.1.3 and 13.1.1.4.

From 1976 onwards landings have fluctuated around a long term mean without any particular trend, Fig. 13.1.5.1.

13.1.2 Natural mortality, maturity, age composition, mean weight at age

Values of natural mortality and maturity at age were the same as used at previous meetings, Table 13.1.2.1.

The catch and weight at age data for the southern and northern North Sea were worked up separately. The catch and weight at age data from the northern North Sea were constructed by combining Danish and Norwegian data. In June 1996 the Norwegian samples from area 3 were reported to contain an unknown proportion of Greater sandeel and the length samples from the fishery showed that a proportion of the fish were unexpectedly large. For this reason the Danish samples from area 3 were used to estimate the proportion of Greater sandeel in the Norwegian landings by comparing the size distribution of the samples and subtracting the proportion of the fish in the Norwegian length samples which were larger than the fish in the Danish samples from the Norwegian catch. Finally the Danish samples were used to estimate the age composition of the Norwegian landings of lesser sandeel from area 3. The catch in numbers at age in 1995 and 1996 suggest that the 1994 year class is strong, Table 13.1.2.2.

The weight at age in the catch is shown in Table 13.1.2.3. The catch and weight at age for the southern North Sea were based on Danish samples, Tables 13.1.2.4 and 13.1.2.5. As for the northern North Sea the numbers caught at age suggest that the 1994 year class is strong. The mean weight at age in the stock by half-year was constructed as a weighted average of the mean weight at age in the catch in the northern and southern North Sea, Table 13.1.2.1.

13.1.3 Catch, effort and research vessel data

13.1.3.1 Calculation of the total international effort in the sandeel fishery

The data from the southern and northern North Sea were treated as two independent fleets. The fleet fishing in the southern North Sea consisting only of Danish vessels and the fleet in the northern North Sea being a mixture of Danish and Norwegian vessels.

13.1.3.2 Danish data

The number of fishing days by vessel category were estimated by counting the number of days where the logbook indicated that sandeel constituted more than 70% of the total daily catch. A total of 7 GRT categories (5-50, 50-100, 250–300, >300) were used. The corresponding total catch of sandeel for each vessel category was estimated as the sum of the logbook estimate of the sandeel catch. In each vessel category the mean catch per fishing day, season and year was estimated, Tables 13.1.3.1 and 13.1.3.2. In order to account for differences in fishing power the following model was fitted to the data:

$$\ln(\text{CPUE year, season}) = a_{\text{year,season}} + b_{\text{year,season}} * \ln(\text{Av. GRT})$$

This model was used to estimate the CPUE of a 200 GRT vessel in a particular year and season, Table 13.1.3.3.

In the southern North Sea the total number of standardised fishing days in each size class was subsequently calculated by dividing the total international catch by the CPUE of a 200 GRT vessel as estimated above, Table 13.1.3.4.

In the northern North Sea the Danish CPUE was combined with the standardised Norwegian CPUE to produce an overall standardised measure of CPUE. This CPUE was then divided into the total international catch in order to estimate total effort.

13.1.3.3 Norwegian data

In the Norwegian fleet effort is measured in number of fishing trips. In order to combine the Norwegian data with the Danish effort was converted from number of trips to number of fishing days. The following linear regressions were used:

$$fd_1 = 23.255 + 5.3713 \cdot \text{Trips} - 13.459 \cdot \text{Catch('}000t\text{)}$$
$$fd_2 = 67.626 + 4.1068 \cdot \text{Trips} + 9.955 \cdot \text{Catch('}000t\text{)}$$

where fd_1 and fd_2 are the number of fishing days in the first and second half of the year, respectively. The model showed significant effects of number of trips, catch and season and provided the estimates of Norwegian fishing days shown in Table 13.1.3.5.

Finally effort was standardised to a vessel size of 200 GRT by applying the model linking GRT and CPUE in the Danish data to the Norwegian data. The mean GRT (GRTavN) of the Norwegian vessels was estimated in the same way as for Norway pout. The model used to standardise effort was described above. Assuming the fishing power of the Norwegian vessels to be related to GRT in the same way as the Danish the factor to standardise the Norwegian effort data is equal to $(GRT_{avN}/200)^b$.

13.1.3.4 Combination of Danish and Norwegian data (only northern North Sea)

The Danish and Norwegian effort data for the northern North Sea were combined by dividing the catch corresponding to the effort by the total standardised number of fishing days of each fleet. A standardised CPUE for the entire fleet was then calculated as a weighted mean of the CPUE of each fleet. Total effort was estimated by dividing the total international catch by the standardised CPUE, Table 13.1.3.6.

13.1.3.5 Research vessel data

There are no appropriate survey data available for this species.

13.1.4 Catch-at-age analysis

The Seasonal XSA (SXSA) developed by Skagen (1993) was used to estimate fishing mortalities and stock numbers at age. As in last years assessment half yearly manual weighting factors were applied to the catchabilities in order to downweight the influence of older fish and estimates from the second half of the year, both of which were expected to suffer from higher sampling variance, Table 13.1.4.1.

Catchability was assumed to remain constant over the time period considered (1983–1996) and used to estimate the missing catch at age data for 1990 under the constraint that the estimated SOP in 1990 should equal the observed landings. The analysis resulted in large log stock number residuals, but did not suggest a trend in catchability with time, (Figure 13.1.4.2), thus justifying the constant catchability assumption. A plot of fishing mortality versus effort show a good correlation ($r^2 = .88$) between effort and average fishing mortality for ages 1 and 2, Figure 13.1.4.3.

The retrospective analysis, Figure 13.1.4.1, indicates that the SXSA estimates of sandeel SSB converge rapidly and show no sign of a consistent bias in the most recent estimates. Sandeel recruitment, however, tends to be overestimated by the method.

As in last year's assessment the results indicate that fishing mortality has decreased in the most recent years. Recruitment in 1994 is estimated to be the second highest since 1983. Because the weight at age of the 0-group in the stock has been set equal to the weight at age in the catch the estimate of total stock biomass in the second half of the year is likely to be an overestimate and should hence be treated with caution.

13.1.5 Historical stock trends

Average fishing mortality, recruitment at age 0 and SSB are shown in Table 13.1.5.1 and Figure 13.1.5.1 for the period 1976 to 1995.

Fishing mortality has been fluctuating around the long term average, but appears to have decreased since 1991 to a value below the long-term average of 0.58.

Recruitment has been fluctuating with a pattern of alternating strong and weak year classes. The 1994 year class is estimated to be the second largest in the time series and has only been exceeded by the 1985 year class. The 1995 year class is estimated to be among the lowest on record, but the estimate should be treated with caution due to the generally high log stock number residuals of the SXSA and the limited number of catch observations available to estimate its strength.

The spawning stock biomass has fluctuated around a level of 1 million t. After declining to 477,000 t in 1991 it has been increasing in recent years and is presently estimated to be close to the long-term average.

13.1.6 Catch predictions

The catch prediction was made by non-parametric bootstrapping a seasonal version of the Lowestoft XSA modified written specially for the working group. Although the estimates of terminal Ns given by the Lowestoft version of XSA (Table 13.1.6.1) and the Skagen version of XSA used in the key run (Table 13.1.4.1) are not identical due to differences in the tuning algorithms the differences were not significant.

The input data to XSA are modelled as random variables and the assessment rerun 100 times to produce a distribution of population estimates. The estimates of terminal Ns obtain at the end of each run are then passed on to a prediction program. The method thus allows the terminal Ns to be modelled by an empirical rather than a parametric distribution.

Only results from a run where CPUE was bootstrapped in the assessment and the total international catch at age data adjusted accordingly are presented here. In the prediction no trends were modelled in any of the population parameters. The expected values of growth and natural mortality used were five year averages of the input values to the assessment. Other runs combining the bootstrapped estimates of N with uncertainty in biological parameters to allow uncertainty in the reference points to estimated were made but the results are not presented.

There are four tuning fleets for sandeel, comprising the catch at age and effort data from the northern and southern North Sea in each half of the year, each modelled as i.e.:

$$\log(CPUE_{fleet,age,year}) = \log(q_{\ fleet,age}) + \log(N_{age,year}) + \varepsilon_{\ fleet,age}$$

allowing the expected CPUE and their residuals to be estimated and the new tuning data used in consecutive runs to be constructed as:

$$CPUE = E(CPUE)*\exp\{\varepsilon_i\}$$

where the residual ε_i is selected at random from the estimated residuals. Since the sum of the tuning fleet catches is equal to the total landings the international catch at age data has also to be adjusted. This assumes that all the error is in the catch at age data which is consistent with the XSA model assumptions. Alternative CPUE models could be fitted by including them in the XSA. However, this would also mean that the key run would also have to be re run and this was not feasible.

The prediction for recruited ages was:

$$N_{y,a-1} \begin{cases} N_{y,a-1}\, e^{-M_{y,a-1}+F_{y,a-1}} & 1 \le a \le m \\ N_{y,m-1}\, e^{-M_{y,m-1}+F_{y,m-1}} + N_{y,m}\, e^{-M_{y,m-1}+F_{y,m-1}} & a = m \end{cases} \qquad (1)$$

assuming recruitment at age 0.

Recruitment was modelled by simple geometric mean for recruitment when SSB is above the lowest SSB seen in the time series from the assessment and otherwise as a line between the origin and the point corresponding to the lowest SSB and the mean recruits. The historic low is in 1982 and the stock has recovered from this level so MBAL is set as the SSB in this year. The level of recruits were also constrained by setting a threshold on the recruit:SSB ratio so that it was always below the highest value of the ratio seen in the time series generated during each iteration of the assessment. Figure 13.1.6.1 shows the stock recruitment data with the fitted relationship contrasted with a Ricker curve. The residual are plotted in Figure 13.1.6.2. A strong negative autocorrelation can be seen and were modelled as a first order autoregressive process, i.e.:

$$\varepsilon_{t+1} = \rho\varepsilon_t + \upsilon_{t+1}$$

There is not much difference between the fitted Ricker and the constrained geometric, however since the constrained geometric mean will generate lower recruitments at low SSBs, it was preferred as it was considered the more precautionary.

Catch at age data were available from the first half of 1996 and these were included in the assessment. The prediction started in the second half of 1996 was continued to 2001, i.e. five and a half years. Since no recruit indices were available the short-term prediction for 1997 is given by the medium-term prediction.

The selectivity at age was estimated during each iteration of XSA and the selectivities used in the prediction were randomly selected from these. Natural mortality and growth were estimated by a five year average for the most recent years. The prediction was run for F multipliers of 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3.

The results from the runs are presented as time trends in Figure 13.1.6.3 in the form of time trends in yield and SSB for various F-multipliers and as plots showing the probability of falling below a particular level of SSB in Figure 13.1.6.4. The reference points estimated from the runs are tabulated in Table 13.1.6.4.

The bootstrapped XSA represents an important step forward in the development of tools to predict the short- and medium-term yield and SSB of short-lived species. For these species sequential population analysis is likely to suffer from high uncertainty due to high values of natural mortality relative to the level of fishing mortality.

Short-term predictions will furthermore depend strongly on the strength of the incoming year classes and deterministic predictions of yield and SSB are therefore of little or no use in setting TACs.

There appears, however, still to be problems with the present version of the bootstrapped XSA, and the preliminary results should therefore be treated with caution. Model estimates of numbers and biomasses were close the ones produced by the SXSA of Skagen (1993), but the output revealed discrepancies between observed and predicted yield in the retrospective analysis. These discrepancies might to some extend be due to the very large coefficients of variance of the estimated log(CPUE)s, which could present problems for the bootstrap approach because the residuals followed a Gamma distribution, rather than the lognormal distribution assumed by XSA. Secondly, the model probably overestimates the CV of the log(CPUE)s for individual age group/year/season combinations since it did not include the correlation between age group due for instance to errors in age readings. Finally, there are large SOP discrepancies in the data and time did not allow a thorough investigation of their influence on the result. Despite the model is still in its development phase it has pointed to the inadequacy of the constant catchability assumption of XSA for this stock. It has become clear that more work should be undertaken in order to understand and model the relationship between commercial CPUE and population abundance for sandeel.

13.1.7 MBAL considerations

SXSA estimates of recruitment and SSB are plotted in Figure 13.11.1. There are no clear indications of a reduction in recruitment at lower levels of SSB in the available time series. It was therefore decided to use the lowest observed SSB as an estimate of MBAL. Using this approach MBAL equals 427,000 t which is the lowest value of SSB estimated by the SXSA over the time period from 1976 to 1995.

The above definition of MBAL assumes that the sandeel stock can be treated as a unit stock. If sandeel in the North Sea consist of a number of smaller self-sustained stocklets the use of a MBAL for the entire North Sea is inappropriate.

The results from the bootstrapped XSA produced minimum estimates of SSB with a median of 237,000 t over the same period. Note, however, that the 90th percentile does not include the SXSA estimate of the minimum SSB and that the results therefore should be treated with caution.

13.1.8 Biological reference points

Table 13.1.6.4 contains a selection of reference points. F_{med}, F0.1 and F30%$_{max}$ are all expressed relative to values found in the second half of 1995, first half of 1996. The median of the estimates of F_{med} is slightly above the present level of fishing mortality, while the median of F0.1 is app. 50% above.

13.1.9 Comments on the assessment

1. A basic problem in the assessment of the sandeel stock in the North Sea is the lack of information on the abundance of sandeel outside the main fishing areas. The catch at age data will only represent the exploited part of the population and methods based on analysis of catch at age data are therefore likely to underestimate the total stock size. Another problem is the changes in the spatial distribution of the fishery. Assuming adult sandeel to be stationary the fishery will exploit different stock components in different years, and it is therefore unlikely that catch at age data will reflect the changes in the age composition of the entire North Sea population.

2. The estimates of recruitment from the SXSA for the most recent years are subject to large log stock number residuals, and thus very uncertain. As an example the 1993 year class was estimated to be among the highest on record by last year's assessment. This year's assessment produced an estimate of the 1993 year class close to the long-term average which is almost half the estimate from the previous assessment, Table 13.1.9.1.

13.2 Sandeel at Shetland

13.2.1 Catch trends

The sandeel population around Shetland is regarded as a separate stock to the main North Sea populations, the fish at Shetland being slower growing and longer-lived than elsewhere. It is known that in some years much of the recruitment to the Shetland stock-unit originates from spawning areas to the south and west of Shetland, but once recruited to the Shetland area, fish are thought to be rather sedentary. Thus the adult population is probably a discrete stock unit, although there is some interchange of larvae between areas.

The fishery at Shetland is also rather different to the main North Sea fisheries in that it consists of small boats operating close inshore. The sandeel population at Shetland is also important for the large concentration of breeding seabirds at Shetland, which also forage in these inshore areas. A series of years of poor sandeel recruitment at Shetland in the mid-late eighties led to poor seabird breeding success and to a low level of sandeel SSB. This led to the introduction of seasonal closures to restrict effort on the stock. The fishery was closed during the second half of 1989 and 1990, and then closed completely over 1991 to 1994. The fishery was re-opened during the first half of 1995 and 1996, subject to restrictive licensing conditions and a precautionary TAC of three thousand t. In 1995, landings amounted to 1,164 t, and provisional data for 1996 indicate that 1,042 t were taken. These landings are very low compared to the landings recorded in the early-eighties. Annual landings for 1974-1996 are given in Table 13.2.1 and Figure 13.2.1.

The fishery is well sampled, with samples obtained from virtually every landing in 1996. Sampling indicates that the fishery is very clean,.with typically at least 95% of the catches consisting of *Ammodytes marinus*.

13.2.2 Commercial catch-effort data and research vessel surveys

Commercial effort data are available for the boats prosecuting this fishery. Previous assessments, have used standardised effort data. However, it was not possible to calculate standardised effort data for 1995 and 1996 in advance of the Working Group meeting. Nominal effort figures for the two most recent years are given in Table 13.2.2, along with standardised effort data for previous years. It should be noted that the composition of the fleet fishing for sandeel at Shetland has changed completely since the closure of the fishery in 1990, and that now access is limited to licensed vessels up to 20m long.

A sandeel survey has been conducted at Shetland in every August since 1984, although there was no survey in 1987 or 1995. Indices from this survey are given in Table 13.3.3.

13.2.3 Age compositions and mean weights at age

Catch-at-age data by half-year for 1984–1996 are given in Table 13.2.4. Catches in both 1995 and 1996 were dominated by 1-gp fish. Long-term mean weights-at-age from the catch, which are used to calculate biomass totals, are given in Table 13.2.5.

13.2.4 Natural mortality and maturity at age

The natural mortality values used for the assessment of this stock are the same as those used in the main North Sea assessment, and originate from MSVPA. The values are given in Table 13.2.6, along with the maturity ogive.

13.2.5 Stock assessment

Recent assessments of this stock have used a semi-annual separable VPA (SSV; Cook, 1992) This can use both commercial catch and effort data and survey data, and can also handle missing years of data (Cook and Reeves, 1993). However, this method could not be used with the current data. The program was unable to fit the model to the data. Similarly, other methods using only the survey data were also unsuccessful. It is likely that this is due, at least partially, to the sparseness of the data; catches for almost 50% of the half-year intervals within the assessment period are zero, and there are also two years for which no survey data are available, including 1995. This problem may also be exacerbated by the complete change in the fleet composition between 1990 and 1995. Thus it was not possible to do an analytical assessment for this stock.

In the absence of an analytical assessment, some indications of recent trends in the stock may be obtained from the survey data (Table 13.2.3). The index of the 1996 year class at age 0 indicates that this year class may be comparable with the 1993 year class in strength. The most recent assessment (Anon. 1995/Assess:5), indicates that the 1993 year class is relatively strong, so the 1996 year class is also like to be strong. No 0-group index is available for the 1995 year class, but the 1-group index of this year class falls between those of the 1992 and 1989 year classes, indicating that the 1995 year class may be around average strength.

13.2.6 MBAL considerations

In the absence of an analytical assessment, only tentative conclusions can be made concerning the current state of this stock. The survey data indicate that most recent year-classes have been of at least average strength. In addition, recent catches have been very low, so fishing mortality is likely to be at a similarly low level. Thus the indications are that this stock is within safe biological limits.

With regard to setting a MBAL for this stock, the closure of the fishery in 1991 followed concern that the spawning stock at Shetland had fallen below the level required to produce a strong year-class. However, subsequent research (Wright and Bailey, 1993) has indicated that the recruitment of strong year classes to the Shetland stock is more dependent upon advection and survival of sandeel larvae spawned from areas to the south and west of Shetland than on the strength of the local spawning stock at Shetland. This means that the setting of a minimum level of spawning stock may not be appropriate in this case. The absence of an analytical assessment further compounds this problem. However, the management regime in place for the Shetland stock (a low, precautionary TAC, seasonal closure and limited access) is intended to limit the level of exploitation of this stock, and thus ensure that the fishery does not have an adverse impact on the availability of sandeels to Shetland's seabird populations. These measures should also ensure that the stock stays well within safe biological limits.

Table 13.1.1.1 Landings ('000 t) of sandeel from the North Sea, 1952-1995. (Data provided by Working Group members.)

Year	Denmark	Germany	Faroes	Netherlands	Norway	Sweden	UK	Total
1952	1.6	-	-	-	-	-	-	1.6
1953	4.5	+	-	-	-	-	-	4.5
1954	10.8	+	-	-	-	-	-	10.8
1955	37.6	+	-	-	-	-	-	37.6
1956	81.9	5.3	-	+	1.5	-	-	88.7
1957	73.3	25.5	-	3.7	3.2	-	-	105.7
1958	74.4	20.2	-	1.5	4.8	-	-	100.9
1959	77.1	17.4	-	5.1	8.0	-	-	107.6
1960	100.8	7.7	-	+	12.1	-	-	120.6
1961	73.6	4.5	-	+	5.1	-	-	83.2
1962	97.4	1.4	-	-	10.5	-	-	109.3
1963	134.4	16.4	-	-	11.5	-	-	162.3
1964	104.7	12.9	-	-	10.4	-	-	128.0
1965	123.6	2.1	-	-	4.9	-	-	130.6
1966	138.5	4.4	-	-	0.2	-	-	143.1
1967	187.4	0.3	-	-	1.0	-	-	188.7
1968	193.6	+	-	-	0.1	-	-	193.7
1969	112.8	+	-	-	-	-	0.5	113.3
1970	187.8	+	-	-	+	-	3.6	191.4
1971	371.6	0.1	-	-	2.1	-	8.3	382.1
1972	329.0	+	-	-	18.6	8.8	2.1	358.5
1973	273.0	-	1.4	-	17.2	1.1	4.2	296.9
1974	424.1	-	6.4	-	78.6	0.2	15.5	524.8
1975	355.6	-	4.9	-	54.0	0.1	13.6	428.2
1976	424.7	-	-	-	44.2	-	18.7	487.6
1977	664.3	-	11.4	-	78.7	5.7	25.5	785.6
1978	647.5	-	12.1	-	93.5	1.2	32.5	786.8
1979	449.8	-	13.2	-	101.4	-	13.4	577.8
1980	542.2	-	7.2	-	144.8	-	34.3	728.5
1981	464.4	-	4.9	-	52.6	-	46.7	568.6
1982	506.9	-	4.9	-	46.5	0.4	52.2	610.9
1983	485.1	-	2.0	-	12.2	0.2	37.0	536.5
1984	596.3	-	11.3	-	28.3	-	32.6	668.6
1985	587.6	-	3.9	-	13.1	-	17.2	621.8
1986	752.5	-	1.2	-	82.1	-	12.0	847.8
1987	605.4	-	18.6	-	193.4	-	7.2	824.6
1988	686.4	-	15.5	-	185.1	-	5.8	892.8
1989	824.4	-	16.6	-	186.8	-	11.5	1039.1
1990	496.0	-	2.2	0.3	88.9	-	3.9	591.3
1991	701.4	-	11.2	-	128.8	-	1.2	842.6
1992	751.1	-	9.1	-	89.3	0.5	4.9	855.0
1993	482.2	-	-	-	95.5	-	1.5	579.2
1994	603.5	-	10.3	-	165.8	-	5.9	765.5
1995	647.8	-	-	-	263.4	-	6.7	917.9

+ = less than half unit.
- = no information or no catch.

Table 13.1.1.2 Sandeel North Sea. Monthly landings (t) by country, 1988-1996. (Data provided by Working Group members.

Year	Month	Denmark	Faroes	Norway	Scotland	Total[1]
1988	Mar	48,766		21,582	4	70,352
	Apr	147,839		27,181	1,518	186,538
	May	246,852		65,160	2,481	314,493
	Jun	169,526		32,995	744	203,265
	Jul	33,120	n/a	104	633	33,857
	Aug	21,155		5,212	198	26,565
	Sep	9,224		9,111	181	18,516
	Oct	9,885		13,709	36	23,630
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	686,367	15,531	185,054	5,795	877,216[1]
1989	Mar	62,927		23,117	106	86,150
	Apr	164,296		27,953	1,345	193,594
	May	300,524		61,764	4,912	376,200
	Jun	235,779	n/a	59,079	5,124	299,982
	Jul	31,670		187	-	31,857
	Aug	6,533		9,581	-	16,114
	Sep	22,705		5,086	-	27,791
	Oct	-		65	-	65
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	824,434	16,612	186,832	11,487	1,022,753[1]
1990	Mar	24,700		11,542	-	36,242
	Apr	94,670		13,673	906	109,249
	May	181,582		35,394	2,184	219,160
	Jun	121,981	n/a	6,660	797	129,438
	Jul	17,307		1,101	-	18,408
	Aug	48,992		17,519	-	66,511
	Sep	6,793		2,541	-	9,334
	Oct	-		474	-	474
	Nov	-		-	-	-
	Total	496,025	2,230	88,904	3,887	588,816[1]
1991	Mar	23,454		7,349	-	30,803
	Apr	78,374		12,582	30	90,986
	May	204,894	n/a	50,110	1,124	256,519
	Jun	217,334		13,176	-	230,509
	Jul	129,548		8,267	-	137,815
	Aug	43,024		16,955	-	59,979
	Sep	4,801		16,153	-	20,955
	Oct	-		4,242	-	4,242
	Nov	-		-	-	-
	Total	701,429		128,834	1,154	831,808[1]

[1]Excluding the Faroes.

continued

Table 13.1.1.2 (continued)

Year	Month	Denmark	Faroes	Norway	Scotland	Total[1]
1992	Mar	22,686		3,490	392	26,269
	Apr	148,866		10,998	2,975	160,256
	May	242,170		29,149	1,469	274,294
	Jun	265,879		44,197	-	311,545
	Jul	64,910	n/a	1,464	-	66,374
	Aug	6,574		-	-	6,574
	Sep	1		-	-	1
	Oct	16		-	-	16
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	751,102	9,139	89,298	4,836	854,462
1993	Mar	18,374		8,006	0	26,830
	Apr	49,794		22,169	0	71,963
	May	134,695		19,213	0	153,908
	Jun	186,936		17,242	204	204,382
	Jul	56,049	n/a	2,883	0	58,932
	Aug	10,552		8,017	0	18,569
	Sep	4,474		6,421	0	10,895
	Oct	13,145		9,392	0	22,537
	Nov	8,163		2,150	0	10,313
	Total	482,182		95,463	204	577,869
1994	Mar	79		1,919	0	1,998
	Apr	98,123		18,887	0	117,010
	May	243,826		69,048	607	313,481
	Jun	222,409		48,228	4,755	275,392
	Jul	84,191	n/a	22,060	559	106,810
	Aug	2,320		7,922	0	10,242
	Sep	7,425		5,137	0	12,562
	Oct	9		599	0	608
	Nov	0		0	0	0
	Total	658,381		173,800	5,921	838,103
1995	Mar	12,980		5,646	0	18,626
	Apr	106,606		43,423	0	150,425
	May	210,966		71,961	397	284,572
	Jun	230,302		89,119	1,645	324,095
	Jul	69,777	n/a	6,112	4,674	75,889
	Aug	15,372		37,389	0	52,761
	Sep	705		2,916	0	3,621
	Oct	1,127		6,842	0	7,969
	Nov	0		0	0	0
	Total	647,835		263,408	6,716	917,958
1996	Mar	1,588		829		2,417
	Apr	34,005		8,614		42,619
	May	145,272		45,628	n/a	190,900
	Jun	196,324		50,162		246,486
1st half	Total	377,189		105,233		482,422

[1]Excluding the Faroes.

Table 13.1.1.3 Monthly landings of sandeels (t) from each area in Figure 13.1, 1993–1996 1st half.

Month	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland
1993											
Mar	222	131	0	0	25,069	0	928	30	0	0	0
Apr	14,927	11,121	0	2,287	38,170	0	4,496	747	55	160	0
May	47,453	1,490	0	7,546	35,118	0	34,186	17,192	685	10,238	0
Jun	125,991	3,038	23	7,550	21,544	148	13,509	5,018	1,879	25,682	0
Jul	7,942	4,494	65	6,894	18,563	116	6,871	3,608	1,258	9,121	0
Aug	0	1,573	0	703	7,863	0	5,744	0	0	2,686	0
Sept	0	0	0	186	7,127	0	3,501	0	0	81	0
Oct	0	0	0	899	9,296	0	11,807	0	0	535	0
Nov	0	20	0	112	2,150	0	7,803	0	0	228	0
Total	196,535	21,867	88	26,177	164,900	264	88,845	26,595	3,877	48,731	0
1994											
Mar	79	0	21	168	1730	0	0	0	0	0	0
Apr	10512	41080	0	9700	33383	2249	17145	318	0	113	0
May	47346	36777	6	21386	78640	281	83588	1064	10	2314	0
Jun	85405	29250	0	23947	47986	38	41184	10087	2572	16450	0
Jul	13679	1483	0	4966	27474	0	27813	4521	267	23164	0
Aug	0	0	0	1	7794	128	174	0	0	5	0
Sep	0	0	0	1487	5845	0	5048	0	0	0	0
Oct	0	0	0	0	522	0	79	0	0	0	0
Nov	0	0	0	0	0	0	0	0	0	0	0
Total	157,021	108,590	,021	61,655	203,374	2,696	175,031	15,990	2,849	42,046	0
1995											
Mar	0	3,769	0	317	14,428	0	94	0	0	18	
Apr	64,640	29,155	17,990	10,529	26,818	248	123	751	0	171	
May	105,246	9,646	25,901	62,345	47,201	340	27,795	2,267	293	3,539	
Jun	139,864	1,308	68,056	3,874	58,920	369	16,343	12,261	4,424	18,676	
Jul	12,612	0	104	8,811	9,605	0	7,541	11,301	367	25,548	
Aug	0	0	34,151	867	3,242	0	6,507	0	193	7,801	
Sep	0	0	1,234	4	1,683	0	615	0	0	85	
Oct	0	0	0	0	7,555	0	410	0	0	4	
Total	322,361	43,878	147,436	86,747	169,452	957	59,428	26,580	5,277	55,842	1,160
1996											
Mar	0	28	10	0	2,379	0	0	0	0	0	
Apr	8,792	35	1,551	3,944	21,184	0	6,332	247	0	534	
May	78,847	13,217	4,595	13,739	54,993	611	18,870	2,509	455	3,064	
Jun	112,059	217	20,441	12,692	32,264	489	24,330	7,097	1,711	35,186	
Total	199,698	13,497	26,597	30,375	110,820	1,100	49,532	9,853	2,166	38,784	1,040

Table 13.1.1.4 Annual landings ('000 t) of Sandeels by area of the North Sea (Denmark, Norway and UK (Scotland)). Data provided by Working Group members (Figure 13.1).

	Area										Assessment areas[1]		
Year	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Northern	Southern
1972	98.8	28.1	3.9	24.5	85.1	0.0	13.5	58.3	6.7	28.0	0.0	130.6	216.3
1973	59.3	37.1	1.2	16.4	60.6	0.0	8.7	37.4	9.6	59.7	0.0	107.6	182.4
1974	50.4	178.0	1.7	2.2	177.9	0.0	29.0	27.4	11.7	25.4	7.4	386.6	117.1
1975	70.0	38.2	17.8	12.2	154.7	4.8	38.2	42.8	12.3	19.2	12.9	253.7	156.5
1976	154.0	3.5	39.7	71.8	38.5	3.1	50.2	59.2	8.9	36.7	20.2	135.0	330.6
1977	171.9	34.0	62.0	154.1	179.7	1.3	71.4	28.0	13.0	25.3	21.5	348.4	392.3
1978	159.7	50.2		346.5	70.3		42.5	37.4	6.4	27.2	28.1	163.0	577.2
1979	194.5	0.9	61.0	32.3	27.0	72.3	34.1	79.4	5.4	44.3	13.4	195.3	355.9
1980	215.1	3.3	119.3	89.5	52.4	27.0	90.0	30.8	8.7	57.1	25.4	292.0	401.2
1981	105.2	0.1	42.8	151.9	11.7	23.9	59.6	63.4	13.3	45.1	46.7	138.1	378.9
1982	189.8	5.4	4.4	132.1	24.9	2.3	37.4	75.7	6.9	74.7	52.0	74.4	479.2
1983	197.4	-	2.8	59.4	17.7	-	57.7	87.6	8.0	66.0	37.0	78.2	419.[illegible]
1984	337.8	4.1	5.9	74.9	30.4	0.1	51.3	56.0	3.9	60.2	32.6	91.8	532.8
1985	281.4	46.9	2.8	82.3	7.1	0.1	29.9	46.6	18.7	84.5	17.2	79.7	513.5
1986	295.2	35.7	8.5	55.3	244.1	2.0	84.8	22.5	4.0	80.3	14.0	375.1	457.4
1987	275.1	63.6	1.1	53.5	325.2	0.4	5.6	21.4	7.7	45.1	7.2	395.9	402.8
1988	291.1	58.4	2.0	47.0	256.5	0.3	37.6	35.3	12.0	102.2	4.7	384.8	487.6
1989	228.3	31.0	0.5	167.9	334.1	1.5	125.3	30.5	4.5	95.1	3.5	492.4	526.3
1990	141.4	1.4	0.1	80.4	156.4	0.6	61.0	45.5	13.8	85.5	2.3	219.5	366.7
1991	228.2	7.1	0.7	114.0	252.8	1.8	110.5	22.6	1.0	93.1	+	372.9	458.9
1992	422.4	3.9	4.2	168.9	67.1	0.3	101.2	20.1	2.8	54.4	0	176.7	668.6
1993	196.5	21.9	0.1	26.2	164.9	0.3	88.0	26.6	3.9	48.7	0	276.0	301.9
1994	157.0	108.6	-	61.7	203.4	2.7	175.0	16.0	2.8	42.0	0	489.7	279.5
1995	322.4	43.9	147.4	86.7	169.5	1.0	59.4	26.6	5.3	55.8	1.2	421.2	496.8
1996[2]	199.7	13.5	26.6	30.4	110.8	1.1	49.5	9.9	2.2	38.8	1.0	201.5	280.9

[1]Assessment areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

[2]Only January–June included.

Table 13.1.2.1 Sandeel in the North Sea. Natural mortality, maturity and stock weight at age.

Age	Weight at age in the stock			Maturity	Natural Mortality	
	1995 Jan-Jun	1995 Jul-Dec	1996 Jan-Jun		Jan-Jun	Jul-Dec
0	0.00	5.08	0.00	0.0		0.8
1	7.13	10.14	6.86	0.0	1.0	0.2
2	15.41	13.66	9.80	1.0	0.4	0.2
3	20.02	17.96	14.44	1.0	0.4	0.2
4	19.87	20.86	23.97	1.0	0.4	0.2
5	25.30	21.68	23.65	1.0	0.4	0.2

Table 13.1.2.2 Sandeels in the northern North Sea. Catch in numbers, half-year (millions).

Age group	1977		1978		1979		1980		1981	
	1	2	1	2	1	2	1	2	1	2
0	3,686	3,067	-	7,820	-	44,203	17	8,349	17	9,128
1	24,307	2,856	6,127	1,001	2,335	1,310	13,394	1,173	5,505	346
2	2,351	913	2,338	307	1,328	433	8,865	214	4,109	94
3	516	142	573	39	242	66	1,050	19	904	14
4	124	99	78	1	5	10	645	4	128	6
5+	20	43	66	1	7	-	183	4	46	-

Age group	1982		1983		1984		1985		1986	
	1	2	1	2	1	2	1	2	1	2
0	2	6,530	-	7,911	-	-	1	349	7	7,105
1	3,518	65	5,684	303	11,692	1,207	2,688	109	23,934	7,077
2	2,132	-	1,215	316	1,647	121	3,292	239	2,600	473
3	556	-	89	19	153	43	1,002	89	200	-
4	76	-	8	-	5	-	377	7	-	-
5+	9	-	4	-	-	-	103	4	-	-

Age group	1987		1988		1989		1990[1]		1991	
	1	2	1	2	1	2	1	2	1	2
0	-	455	2,453	13,196	6,163	3,380	1,599	18,293	-	13,616
1	26,236	5,768	9,855	1,283	57,002	4,038	10,551	-	41,855	866
2	10,855	198	25,922	340	2,233	274	1,481	-	2,342	28
3	350	-	1,319	119	3,406	-	232	-	908	8
4	107	-	26	17	-	-	-	-	225	3
5+	48	-	-	-	-	-	-	-	93	-

Age group	1992		1993		1994		1995		1996
	1	2	1	2	1	2	1	2	1
0	137	6,797	-	26,960	398	456	-	4,046	-
1	9,871	48	15,768	1,004	28,490	829	36,140	3,374	8,454
2	4,056	3	2,635	112	7,225	1,211	3,360	338	6,280
3	486	-	1,023	34	5,954	396	1,091	26	1,061
4	195	-	207	8	1,579	12	116	2	524
5+	110	-	439	14	577	12	29	-	154

[1]Based on Norwegian data only.
Note: 1 = Jan-Jun.
2 = Jul-Dec.

Table13.1.2.3 SANDEEL, North Sea. Northern area. Mean weight at age (g) in the catch for 1993, 1994, 1995 and 1996 first half. Data from Denmark and Norway.

1993	Half-year	
Age	1	2
0	0.92	2.71
1	5.97	10.37
2	20.62	19.22
3	24.92	20.28
4	19.65	20.27
5+	23.31	22.00
1994	Half-year	
Age	1	2
0	1.10	6.58
1	6.43	22.75
2	13.70	30.20
3	15.08	58.07
4	18.18	59.30
5+	21.47	85.00
1995	Half-year	
Age	1	2
0	-	5.08
1	6.95	13.46
2	19.75	14.20
3	24.90	21.00
4	23.01	19.00
5+	31.47	-
1996	Half-year	
Age	1	2
0	-	
1	7.30	
2	11.65	
3	22.65	
4	33.91	
5+	43.70	

Table 13.1.2.4 SANDEELS in the Southern North Sea. Catch in numbers, half-year (millions).

Age groups	1976		1977		1978		1979		1980		1981		1982	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
0	4	-	-	13,263	922	41,224	181	1,947	62	72	415	43,420	242	5,039
1	16,308	249	19,500	269	58,839	2,774	16,018	5,210	33,269	4,738	13,394	407	56,545	4,718
2	14,505	2,358	5,596	27	16,948	385	22,737	2,085	12,472	840	11,719	1,892	6,224	490
3	1,522	392	6,300	8	1,793	124	4,487	138	3,794	575	2,466	115	3,277	344
4	1,234	102	965	8	1,006	97	1,265	110	375	9	774	36	1,813	36
5	171	20	445	3	114	26	441	30	63	-	353	3	94	4
6	72	58	239	3	21	26	244	-	50	-	84	-	24	-
7+	1	16	159	-	39	9	35	-	+	-	21	-	8	-

Age groups	1983		1984		1985		1986		1987		1988		1989	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
0	955	9,298	20	-	6,573	11,940	-	112	-	298	1,420	-	29	1
1	2,232	240	62,517	9,423	7,790	1,896	43,629	5,350	4,351	3,095	2,349	-	44,444	1,619
2	35,029	2,806	2,257	92	39,301	3,229	7,333	293	22,771	6,664	10,074	234	405	165
3	934	513	13,272	577	2,490	2,234	1,604	241	1,158	196	17,914	2,084	957	35
4	234	2	267	44	233	163	30	9	141	45	1,920	63	3,350	122
5	122	-	109	-	18	77	-	9	24	6	617	5	18	1
6	25	-	66	-	7	30	-	-	-	-	146	-	-	-
7+	6	-	-	-	7	28	-	-	-	-	86	-	-	-

Age groups	1990		1991		1992		1993		1994		1995		1996
	1	2	1	2	1	2	1	2	1	2	1	2	1
0			-	12,115	2	134	-	838	-	-	-	-	-
1			20,058	11,411	60,337	3,903	3,581	1,037	24,697	4,093	39,683	3,166	8,448
2			9,224	344	10,021	382	14,659	953	2,594	322	6,607	2,789	14,841
3			1,320	111	1,002	157	3,707	266	2,654	198	1,555	307	5,705
4			454	-	427	25	451	60	447	116	988	93	601
5			-	-	69	2	375	17	268	21	217	41	449
6					103	5	186	10	61	-	21	20	71
7+					22	2			31	-		3	29

Note: 1 = January-June
2 = July-December

Table 13.1.2.5 SANDEEL, North Sea. Southern area. Mean weight at age (g) in the catch for 1993, 1994, 1995 and 1996 first half.

1993	Half-year	
Age	1	2
0	-	3.08
1	6.08	10.13
2	11.54	15.66
3	15.09	17.04
4	19.18	21.84
5	20.02	22.43
6	22.46	23.10
7+	23.63	21.89
1994	**Half-year**	
Age	1	2
0		
1	6.07	8.56
2	11.01	17.16
3	13.46	19.50
4	16.17	23.29
5	17.90	26.25
6	18.49	
7	19.15	
1995	**Half-year**	
Age	1	2
0	-	-
1	7.30	6.60
2	13.20	13.60
3	16.60	17.70
4	19.50	20.90
5	25.00	21.30
6	20.00	21.20
7+	-	30.00
1996	**Half-year**	
Age	1	2
0	-	
1	6.42	
2	9.02	
3	12.91	
4	15.29	
5	18.24	
6	17.70	
7	15.50	

Table 13.1.3.1 Sandeel. Northern North Sea. Danish CPUE data.

Year	Vessel size (GRT)						
	5-50	50-100	100-150	150-200	200-250	250-300	>300
				First half year			
1982	11.2	17.2	31.8	26.7	47.6	40.8	25.8
1983	11.1	17.1	23.6	23.9	31.6	36.4	41.3
1984	14.6	24.8	33.4	32.1	44.4	55.5	19.7
1985	12.1	17.2	35.7	51.2	57.9	67.2	55.8
1986	21.0	32.0	45.5	50.2	63.9	57.4	71.8
1987	23.7	37.8	67.0	66.5	78.6	79.9	113.0
1988	19.0	25.6	34.4	42.5	48.0	47.8	75.3
1989	16.3	25.2	36.7	41.0	49.6	51.4	76.2
1990	14.5	21.6	27.3	27.8	29.5	27.4	39.7
1991	16.7	25.5	38.4	42.5	47.6	47.5	72.2
1992	16.6	24.6	36.3	34.7	60.6	46.9	76.9
1993	14.9	19.3	33.6	36.5	47.2	51.1	51.8
1994	26.9	32.0	53.9	61.8	75.0	87.9	102.5
1995	19.6	29.5	49.5	57.8	61.0	66.9	73.6
1996	16.5	21.1	35.9	39.1	36.7	40.0	56.2
				Second half year			
1982	-	17.7	33.6	46.7	19.9	-	-
1983	17.9	25.7	31.0	32.9	44.5	34.3	57.1
1984	113.2	22.0	21.5	35.2	-	28.3	24.0
1985	21.6	23.5	25.8	39.6	60.7	33.3	-
1986	17.1	27.5	50.2	50.0	77.9	74.0	80.7
1987	21.3	31.8	23.9	24.3	42.6	25.4	46.3
1988	16.8	21.3	30.0	32.4	38.0	33.1	43.9
1989	16.6	22.3	23.6	27.3	28.3	35.6	25.0
1990	17.6	32.5	29.4	34.1	40.4	32.6	53.3
1991	15.1	26.3	40.8	44.8	54.4	51.3	72.5
1992	20.4	25.4	35.2	38.2	53.6	50.9	52.1
1993	18.5	21.4	26.5	27.5	38.8	47.9	59.0
1994	24.3	31.5	42.7	53.5	59.8	65.8	74.6
1995	21.9	34.6	46.1	53.8	58.6	62.7	68.6

Table 13.1.3.2 Sandeel. Southern North Sea. Danish CPUE data.

Year	Vessel size (GRT)						
	5-50	50-100	100-150	150-200	200-250	250-300	>300
				First half year			
1982	16.1	26.9	43.1	47.2	59.2	53/2	59.6
1983	17.0	20.6	36.3	44.4	49.1	51.2	50.9
1984	19.9	26.3	42.6	50.4	60.9	56.4	60.1
1985	13.8	21.2	35.5	43.4	49.8	49.1	56.3
1986	23.2	31.4	41.1	49.8	58.9	58.4	69.4
1987	23.9	33.9	53.9	67.4	76.1	76.4	115.5
1988	19.2	26.8	42.9	52.3	60.0	56.6	82.8
1989	19.4	24.5	43.3	52.3	58.9	55.2	74.3
1990	20.0	20.8	30.4	33.7	39.8	35.7	49.1
1991	27.0	30.0	49.5	50.3	62.8	60.7	92.8
1992	18.4	23.4	53.1	63.2	83.8	82.4	115.9
1993	17.2	18.1	38.1	40.2	58.6	60.9	89.5
1994	24.6	29.0	59.1	59.5	75.2	78.9	96.6
1995	23.6	33.2	63.7	63.5	68.0	80.0	00.8
1996	23.4	25.3	40.9	48.4	58.8	56.4	84.1
				Second half year			
1982	-	20.3	37.5	40.5	-	27.9	-
1983	15.1	21.3	25.1	32.4	45.4	34.0	34.7
1984	12.7	16.4	26.9	34.2	36.5	40.2	40.9
1985	13.2	19.5	26.0	35.8	36.2	38.2	39.4
1986	18.4	25.2	32.5	44.5	45.8	51.8	55.5
1987	16.2	22.6	41.4	45.8	49.3	45.6	75.4
1988	18.8	29.3	29.9	31.1	38.6	31.1	44.0
1989	26.7	26.2	27.0	38.3	38.0	29.3	40.4
1990	27.9	32.8	36.4	41.3	48.3	45.2	42.7
1991	21.4	26.8	41.8	49.4	65.1	53.7	98.3
1992	21.3	28.7	36.7	42.6	44.8	39.1	58.3
1993	20.2	22.7	30.8	35.6	45.3	39.3	51.8
1994	28.6	38.9	50.4	54.3	60.7	56.9	65.2
1995	28.6	42.2	50.2	53.3	72.4	60.8	73.9

Table 13.1.3.3. Danish CPUE data. Parameter estimates from regressions of ln(CPUE) versus ln(Av. GRT) together with estimates of standardized CPUE (200GRT).

Northern North Sea

	Jan-Jun				Jul-Dec			
Year	SLOPE	INTERCEPT	R-square	CPUE	SLOPE	INTERCEPT	R-square	CPUE
1987	0.57	3.60	0.98	75.2	0.20	11.22	0.58	31.9
1988	0.48	3.58	0.95	46.4	0.36	5.06	0.96	33.9
1989	0.55	2.54	0.98	47.5	0.23	8.11	0.87	27.3
1990	0.33	5.13	0.95	29.4	0.33	6.37	0.89	37.3
1991	0.52	2.99	0.97	46.5	0.58	2.31	0.99	49.4
1992	0.55	2.55	0.94	47.0	0.41	5.05	0.96	43.7
1993	0.54	2.40	0.97	40.9	0.43	3.86	0.90	37.4
1994	0.54	4.02	0.96	70.3	0.45	5.20	0.98	56.1
1995	0.54	3.36	0.99	57.8	0.45	5.15	1.00	55.5
1996	0.44	3.74	0.95	38.9				

Southern North Sea

	Jan-Jun				Jul-Dec			
Year	SLOPE	INTERCEPT	R-square	CPUE	SLOPE	INTERCEPT	R-square	CPUE
1987	0.58	3.28	0.97	71.7	0.55	2.54	0.95	47.4
1988	0.55	3.00	0.97	54.7	0.27	8.17	0.91	34.4
1989	0.53	3.18	0.96	52.6	0.15	15.33	0.69	33.7
1990	0.34	5.93	0.92	35.8	0.20	14.18	0.94	41.8
1991	0.45	5.54	0.93	58.8	0.54	3.23	0.93	56.3
1992	0.74	1.41	0.96	70.6	0.34	6.85	0.95	42.5
1993	0.64	1.67	0.93	51.0	0.37	5.56	0.94	38.5
1994	0.55	3.60	0.96	67.8	0.32	10.23	0.99	55.6
1995	0.55	3.71	0.97	69.6	0.36	8.88	0.97	60.1
1996	0.48	4.14	0.93	53.3				

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Table 13.1.3.4 SANDEEL Southern North Sea. Standardized CPUE, based on Danish data.

Year	Half-year	CPUE (t/day)	Total international Catch ('000 t)	Total Int'l fishing effort ('000 days) Half-year
1982	1	48.2	426.5	8.9
	2	35.7	52.6	1.5
1983	1	42.8	359.8	8.4
	2	33.9	59.3	1.8
1984	1	50.5	461.1	9.1
	2	32.9	71.1	2.2
1985	1	41.9	417.1	10.0
	2	33.6	110.6	3.3
1986	1	53.7	386.4	7.2
	2	44.1	75.5	1.7
1987	1	71.7	297.7	4.2
	2	47.4	105.1	2.2
1988	1	54.7	462.0	8.5
	2	34.4	33.4	1.0
1989	1	52.6	506.1	9.6
	2	33.7	18.5	0.5
1990	1	35.8	341.7	9.5
	2	41.8	24.0	0.6
1991	1	58.8	326.6	5.6
	2	56.3	132.3	2.4
1992	1	70.6	621.1	8.8
	2	42.5	73.0	1.7
1993	1	51.0	267.7	5.3
	2	38.5	34.2	0.9
1994	1	67.8	226.4	3.3
	2	55.6	47.6	0.9
1995	1	69.6	429.2	6.2
	2	60.1	67.6	1.1
1996	1	53.3	280.9	5.3

Table 13.1.3.5 Sandeel northern North Sea. Norwegian effort data.

Year	Fishing days		Mean gross register tonnage (GRT)	
	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec
1976	595	-	198.8	-
1977	2,212	457	172.3	184.9
1978	1,747	806	203.4	203.7
1979	1,407	1,720	213.8	188.9
1980	2,642	1,099	215.5	210.3
1981	1,740	404	216.6	190.9
1982	1,206	-	209.1	-
1983	304	66	254.6	191.1
1984	145	-	182.6	-
1985	366	-	219.5	-
1986	1,562	567	201.1	187.4
1987	2,123	1,584	218.8	200.9
1988	3,571	925	203.3	198.2
1989	4,292	588	192.3	202.1
1990	2,275	731	207.9	189.2
1991	1,749	958	199.7	194.1
1992	1,202	23	204.5	212.7
1993[1]	1,411	716	224.7	198.6
1994[1]	1,547	434	216.3	224.2
1995	1,775	700	215.7	223.3
1996	1,963	-	217.6	-

[1]Av. GRT pr. trip

Table 13.1.3.6 Fishing effort indices for SANDEEL in the Northern North Sea (days fishing multiplied by scaling factors for each vessel category to represent days fishing for a vessel of 200 GRT).

Year	Norwegian			Danish		Mean CPUE (t/day)	Total Intnat. catch ('000 t)	Derived Intnat. effort ('000 days)
	Standardized fishing days	Catch sampled for fishing effort (;000 t)	CPUE (t/day)	Catch sampled for fishing effort ('000 t)	CPUE (t/day)			
				First half of year				
1976	593	11.1	18.7	-	-	18.7	110.3	5.9
1977	2,061	50.4	24.4	-	-	24.5	276.0	11.2
1978	1,761	44.9	25.5	-	-	25.5	109.7	4.3
1979	1,451	29.6	20.4	-	-	20.4	47.7	2.3
1980	2,733	112.8	41.3	-	-	41.3	220.9	5.4
1981	1,804	42.8	23.7	-	-	23.7	93.3	3.9
1982	1,231	26.9	21.9	13.5	34.9	26.2	62.3	2.4
1983	338	8.7	25.7	17.4	28.9	27.8	54.5	2.0
1984	139	3.5	25.2	54.1	41.2	40.2	74.1	1.8
1985	382	8.7	22.8	47.4	46.7	43.0	69.9	1.6
1986	1,565	60.4	38.6	154.1	54.7	50.2	221.3	4.4
1987	2,235	122.9	55.0	213.2	75.2	67.8	360.9	5.3
1988	3,599	143.8	40.0	158.1	46.4	43.3	332.0	7.7
1989	4,200	146.9	35.0	267.3	47.5	43.1	435.2	10.1
1990	2,304	58.6	25.4	94.9	29.4	27.9	148.7	5.3
1991	1,748	67.7	38.7	210.6	46.5	44.6	282.2	6.3
1992	1,217	53.7	44.1	124.0	47.0	46.1	151.2	3.3
1993	1,524	70.7	46.4	133.8	40.8	43.0	189.0	4.4
1994	1,638	130.1	79.4	299.6	70.3	73.1	413.4	5.7
1995	1,849	208.6	112.8	143.2	57.8	90.5	348.5	3.9
1996	2,061	101.0	49.0	106.9	38.9	43.8	201.5	4.6
				Second half of year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.4
1977	445	11.8	26.5	-	-	26.5	110.0	4.2
1978	811	22.5	27.6	-	-	27.8	53.3	1.9
1979	1,688	52.2	30.9	-	-	30.9	147.7	4.8
1980	1,117	33.1	29.6	-	-	29.5	71.1	2.4
1981	398	7.9	19.6	-	-	19.9	44.9	2.3
1982	-	-	-	1.8	32.3	33.0	12.0	0.4
1983	65	2.4	36.9	12.3	36.6	37.3	23.7	0.6
1984	-	-	-	10.7	29.6	30.2	17.7	0.6
1985	-	-	-	16.4	38.0	38.8	16.8	0.4
1986	555	21.8	39.3	96.1	60.2	57.4	153.8	2.7
1987	1,585	68.1	43.0	5.5	31.9	42.1	76.9	1.8
1988	922	26.9	29.2	41.5	33.9	32.0	71.4	2.2
1989	589	11.5	19.5	44.9	27.3	25.7	57.2	2.2
1990	718	22.8	31.8	65.8	37.3	35.9	70.8	2.0
1991	942	30.3	32.2	96.0	49.4	45.3	90.7	2.0
1992	24	1.5	63.6	48.0	43.7	44.3	25.5	0.6
1993	714	30.7	43.0	59.4	37.4	39.3	87.0	2.2
1994	459	35.7	77.8	90.8	56.1	62.2	76.4	1.2
1995	727	53.3	73.3	77.6	55.5	62.7	72.6	1.2

Table 13.1.4.1

SURVIVORS ANALYSIS OF:
Sandeel in the North Sea

The following parameters were used:

Year range:	1983 - 1996
Seasons per year:	2
The last season in the last year is season :	1
Youngest age: 0; Oldest age: 4; (Plus age: 5)	
Recruitment in season:	2
Spawning in season:	1

The following fleets were included:
Fleet 1: Fishery in the Northern North Sea
Fleet 2: Fishery in the Southern North Sea

The following options were used:

1: Inv. catchability:	2
(1: Linear; 2: Log; 3: Cos. filter)	
2: Indiv. shats:	2
(1: Direct; 2: Using z)	
3: Comb. shats:	2
(1: Linear; 2: Log.)	
4: Fit catches:	0
(0: No fit; 1: No SOP corr; 2: SOP corr.)	
5: Est. unknown catches:	2
(0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)	
6: Weighting of rhats:	0
(0: Manual)	
7: Weighting of shats:	0
(0: Manual; 1: Linear; 2: Log.)	
8: Handling of the plus group:	1
(1: Dynamic; 2: Extra age group)	

Data were input from the following files:

Catch in numbers:	canum5.hyr
Weight in catch:	weca5.hyr
Weight in stock:	west5.hyr
Natural mortalities:	natmor.hyr
Maturity ogive:	matprop.hyr
Tuning data (CPUE):	tuning5.xsa
Weighting for rhats:	tweq.new
Weighting for shats:	twred.xsa
Unknown catches:	uc5.90

Weighting factor	
(Inv. catchabilities at oldest age):	0.00000
Min. value for the survivor number :	1.00000

Table 13.1.4.1 (Cont'd)

Stock numbers (at start of season)

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	859255.	*	244081.	*	1240523.	*	643080.	*	271076.	*	738600.
1	82243.	25454.	374553.	92780.	109673.	33991.	549165.	161048.	284117.	85969.	121297.	37221.
2	88331.	29536.	20349.	10444.	66344.	9599.	26015.	9306.	120610.	53317.	62366.	12334.
3	3037.	1198.	21357.	3325.	8359.	2744.	4721.	1688.	6926.	3408.	37443.	9352.
4	405.	73.	500.	112.	2161.	949.	145.	72.	1164.	577.	2613.	158.
5+	192.	0.	58.	0.	52.	0.	624.	418.	385.	199.	589.	0.
SSN	91965.		42264.		76917.		31505.		129085.		103011.	
SSB	1204462.		639937.		1050915.		440213.		1690316.		1577889.	
TSN	174208.	915517.	416817.	350743.	186589.	1287807.	580670.	815612.	413202.	414545.	224308.	797666.
TSB	1618144.	1714686.	2175603.	1512668.	1510445.	2061255.	2735724.	3002354.	3025664.	2186894.	2111597.	1852830.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	350322.	*	660931.	*	776184.	*	339763.	*	662767.	*	978345.
1	323029.	57512.	155144.	34251.	288089.	68430.	331514.	79374.	148020.	42718.	279167.	70440.
2	29313.	14127.	41969.	8930.	24947.	7253.	44917.	18583.	61411.	27006.	33127.	14166.
3	9579.	2866.	11169.	2048.	6655.	2637.	5602.	2537.	14866.	6093.	21147.	7128.
4	5664.	1054.	2315.	425.	1363.	358.	2051.	866.	1935.	758.	4717.	1503.
5+	57.	24.	771.	0.	283.	113.	383.	8.	686.	0.	559.	0.
SSN	44612.		56223.		33248.		52953.		78898.		59550.	
SSB	687858.		812272.		477025.		731806.		1076674.		834083.	
TSN	367641.	425905.	211367.	706585.	321337.	854975.	384467.	441131.	226918.	739341.	338717.	1071582.
TSB	2109186.	1360411.	1473184.	1452307.	1712927.	1753167.	2084383.	1702408.	1742762.	1927495.	2581667.	7960521.

Year	1995		1996
Season	1	2	1
AGE			
0	*	302662.	*
1	439292.	115618.	133283.
2	53218.	27513.	88742.
3	10211.	4678.	19696.
4	5298.	2648.	3529.
5+	1115.	529.	2457.
SSN	69842.		114424.
SSB	1158000.		1296776.
TSN	509135.	453647.	247707.
TSB	4290154.	3236427.	2211095.

Catch in numbers for fleet: 1
Fishery in the Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	7911.	*	0.	*	349.	*	7105.	*	455.	*	13196.
1	5684.	303.	11692.	1207.	2688.	109.	23934.	7077.	26236.	5768.	9855.	1283.
2	1215.	316.	1647.	121.	3292.	239.	2600.	473.	10855.	198.	25922.	340.
3	89.	19.	153.	43.	1002.	89.	200.	0.	350.	0.	1319.	119.
4	8.	0.	5.	0.	377.	7.	0.	0.	107.	0.	26.	17.
5+	4.	0.	0.	0.	103.	4.	0.	0.	48.	0.	0.	0.
SOP	50871.	37464.	91792.	20871.	106277.	12946.	174378.	128325.	305979.	83202.	430970.	71479.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	3380.	*	12538.	*	13616.	*	6797.	*	26960.	*	457.
1	56661.	4038.	14992.	1691.	41855.	866.	9871.	48.	15768.	1004.	28490.	829.
2	2219.	274.	4339.	288.	2342.	28.	4056.	3.	2635.	112.	7225.	1211.
3	3385.	0.	998.	107.	908.	8.	486.	0.	1023.	34.	5954.	396.
4	0.	0.	207.	22.	225.	3.	195.	0.	207.	8.	1579.	12.
5+	0.	0.	138.	0.	93.	0.	110.	0.	439.	14.	577.	12.
SOP	437540.	57222.	183721.	73237.	374466.	55404.	115957.	38189.	188262.	86785.	413543.	83223.

Table 13.1.4.1 (Cont'd)

Year	1995		1996
Season	1	2	1
AGE			
0	*	4046.	*
1	36140.	3374.	8454.
2	3360.	338.	6280.
3	1091.	26.	1061.
4	116.	2.	524.
5+	29.	0.	154.
SOP	348281.	71351.	183406.

Catch in numbers for fleet: 2
Fishery in the Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	9298.	*	0.	*	11940.	*	112.	*	298.	*	0.
1	2232.	240.	62517.	9423.	7790.	1896.	43629.	5350.	4351.	3095.	2349.	0.
2	35029.	2806.	2257.	92.	39301.	3229.	7333.	293.	22771.	6664.	10074.	234.
3	934.	513.	13272.	577.	2490.	2234.	1604.	241.	1158.	196.	17914.	2084.
4	234.	2.	267.	44.	233.	163.	30.	9.	141.	45.	1920.	63.
5+	153.	0.	175.	0.	32.	135.	0.	9.	24.	6.	849.	5.
SOP	380559.	61745.	556795.	80581.	472950.	114930.	335960.	47286.	296759.	105111.	464842.	40004.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	1.	*	719.	*	12115.	*	134.	*	838.	*	0.
1	44444.	1619.	22637.	1730.	20058.	11411.	60337.	3903.	3581.	1037.	24697.	4093.
2	4525.	165.	19114.	438.	9224.	344.	10021.	382.	14659.	953.	2594.	322.
3	957.	35.	5645.	240.	1320.	111.	1002.	157.	3707.	266.	2654.	198.
4	3350.	122.	1170.	50.	454.	0.	427.	25.	451.	60.	447.	116.
5+	18.	1.	2098.	117.	0.	0.	194.	9.	561.	27.	268.	21.
SOP	309832.	22244.	479982.	32428.	345866.	123092.	618474.	47520.	267431.	34453.	226320.	47671.

Year	1995		1996
Season	1	2	1
AGE			
0	*	0.	*
1	39683.	3166.	8448.
2	6607.	2789.	14841.
3	1555.	307.	5705.
4	988.	93.	601.
5+	238.	64.	549.
SOP	427820.	67591.	280841.

Partial fishing mortality for fleet: 1
Fishery in the Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.014	*	0.000	*	0.000	*	0.016	*	0.002	*	0.026
1	0.116	0.013	0.056	0.015	0.041	0.004	0.075	0.051	0.157	0.078	0.137	0.039
2	0.022	0.012	0.110	0.013	0.093	0.034	0.153	0.059	0.129	0.004	0.739	0.031
3	0.044	0.023	0.013	0.016	0.189	0.064	0.065	0.000	0.070	0.000	0.060	0.016
4	0.036	0.000	0.016	0.000	0.250	0.009	0.000	0.000	0.126	0.000	0.020	0.161
5+	0.046	*	*	*	*	*	0.000	0.000	0.168	0.000	*	*
F (1- 2)	0.069	0.013	0.083	0.014	0.067	0.019	0.114	0.055	0.143	0.041	0.438	0.035

Table 13.1.4.1 (Cont'd)

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.014	*	0.028	*	0.026	*	0.029	*	0.061	*	0.001
1	0.345	0.082	0.180	0.057	0.265	0.015	0.054	0.001	0.183	0.027	0.183	0.013
2	0.105	0.022	0.181	0.037	0.153	0.004	0.132	0.000	0.062	0.005	0.316	0.100
3	0.571	0.000	0.161	0.063	0.203	0.003	0.123	0.000	0.101	0.006	0.440	0.064
4	0.000	0.000	0.161	0.063	0.276	0.009	0.138	0.000	0.160	0.012	0.532	0.009
5+	0.000	0.000	*	*	0.488	0.000	0.618	*	*	*	*	*
F (1- 2)	0.225	0.052	0.181	0.047	0.209	0.010	0.093	0.000	0.123	0.016	0.250	0.057

Year	1995		1996
Season	1	2	1
AGE			
0	*	0.020	*
1	0.146	0.033	0.109
2	0.085	0.014	0.099
3	0.151	0.006	0.081
4	0.030	0.001	0.218
5+	0.036	0.000	0.090
F (1- 2)	0.116	0.024	0.104

Partial fishing mortality for fleet: 2
Fishery in the Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.016	*	0.000	*	0.014	*	0.000	*	0.002	*	0.000
1	0.046	0.011	0.301	0.119	0.119	0.064	0.136	0.038	0.026	0.042	0.033	0.000
2	0.621	0.111	0.150	0.010	1.111	0.458	0.433	0.036	0.271	0.148	0.287	0.021
3	0.458	0.616	1.152	0.212	0.469	1.617	0.522	0.170	0.230	0.065	0.809	0.281
4	1.044	0.031	0.926	0.540	0.155	0.209	0.284	0.147	0.167	0.090	1.510	0.598
5+	1.761	*	*	*	*	*	0.000	0.024	0.084	0.034	*	*
F (1- 2)	0.333	0.061	0.226	0.065	0.615	0.261	0.284	0.037	0.148	0.095	0.160	0.011

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	0.000	*	0.002	*	0.023	*	0.001	*	0.002	*	0.000
1	0.270	0.033	0.272	0.059	0.127	0.203	0.332	0.056	0.042	0.027	0.159	0.067
2	0.214	0.013	0.798	0.057	0.602	0.054	0.327	0.023	0.343	0.040	0.114	0.027
3	0.161	0.014	0.911	0.142	0.295	0.048	0.254	0.071	0.367	0.049	0.196	0.032
4	1.064	0.136	0.911	0.142	0.556	0.000	0.303	0.032	0.348	0.092	0.150	0.089
5+	0.462	0.048	*	*	0.000	0.000	1.090	*	*	*	*	*
F (1- 2)	0.242	0.023	0.535	0.058	0.365	0.128	0.329	0.039	0.192	0.034	0.136	0.047

Year	1995		1996
Season	1	2	1
AGE			
0	*	0.000	*
1	0.160	0.031	0.109
2	0.168	0.119	0.233
3	0.215	0.075	0.433
4	0.256	0.040	0.251
5+	0.298	0.143	0.322
F (1- 2)	0.164	0.075	0.171

Log inverse catchabilities, fleet no: 1
Fishery in the Northern North Sea

Season	1	2
AGE		
0	*	4.924
1	3.506	4.201
2	3.500	4.638
3	3.617	4.104
4	3.617	4.104

Table 13.1.4.1 (Cont'd)

Log inverse catchabilities, fleet no: 2
Fishery in the Southern North Sea

Season	1	2
AGE		
0	*	6.959
1	4.108	3.354
2	3.032	3.394
3	2.899	2.476
4	2.899	2.476

Log residual stocknr. (nhat/n), fleet no: 1
Fishery in the Northern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	1.133	*	*	*	-1.956	*	-0.194	*	-1.678	*	0.495
1	0.661	0.391	0.041	0.530	-0.153	-0.495	-0.571	0.223	-0.016	1.066	-0.522	0.162
2	-1.031	0.766	0.703	0.796	0.655	2.170	0.144	0.808	-0.216	-1.378	1.156	0.381
3	-0.209	0.834	-1.295	0.459	1.480	2.278	-0.597	*	-0.715	*	-1.245	-0.818
4	-0.410	*	-1.133	*	1.762	0.308	*	*	-0.120	*	-2.315	1.491

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	-0.126	*	0.652	*	0.582	*	1.909	*	1.333	*	-2.553
1	0.128	0.908	0.105	0.652	0.338	-0.665	-0.602	-2.574	0.328	-0.214	0.068	-0.288
2	-1.065	0.021	0.105	0.652	-0.219	-1.487	0.284	-3.474	-0.769	-1.517	0.608	2.153
3	0.744	*	0.105	0.652	0.181	-2.265	0.329	*	-0.156	-1.748	1.055	1.175
4	*	*	0.105	0.652	0.488	-1.268	0.445	*	0.300	-1.089	1.244	-0.735

Year	1995		1996
Season	1	2	1
AGE			
0	*	0.809	*
1	0.219	0.613	-0.237
2	-0.321	0.216	-0.341
3	0.366	-1.134	-0.428
4	-1.251	-3.149	0.569

Log residual stocknr. (nhat/n), fleet no: 2
Fishery in the Southern North Sea

Year	1983		1984		1985		1986		1987		1988	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	2.231	*	*	*	1.501	*	-1.847	*	-0.267	*	*
1	-1.107	-1.788	0.700	0.439	-0.319	-0.596	0.140	-0.441	-0.978	-0.604	-1.453	*
2	0.427	0.608	-1.071	-2.022	0.834	1.419	0.220	-0.452	0.289	0.694	-0.356	-0.448
3	-0.011	1.403	0.832	0.138	-0.161	1.762	0.274	0.175	-0.004	-1.040	0.547	1.205
4	0.813	-1.602	0.614	1.072	-1.269	-0.283	-0.335	0.025	-0.329	-0.724	1.171	1.961

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	-4.735	*	1.032	*	2.317	*	-1.024	*	0.790	*	*
1	0.538	0.629	0.533	1.032	0.323	0.885	0.830	-0.064	-0.738	-0.135	1.074	0.750
2	-0.770	-0.248	0.533	1.032	0.801	-0.404	-0.261	-0.912	0.293	0.275	-0.338	-0.127
3	-1.187	-1.132	0.533	1.032	-0.045	-1.445	-0.646	-0.706	0.228	-0.426	0.076	-0.861
4	0.699	1.174	0.533	1.032	0.590	*	-0.470	-1.486	0.175	0.191	-0.189	0.162

Year	1995		1996
Season	1	2	1
AGE			
0	*	*	*
1	0.436	-0.210	0.223
2	-0.593	1.170	-0.091
3	-0.476	-0.207	0.395
4	-0.307	-0.851	-0.153

Table 13.1.4.1 (Cont'd)

Weighting factors for computing survivors:
Fleet no: 1
Fishery in the Northern North Sea

Season	1	2
AGE		
0	*	0.020
1	1.000	0.100
2	1.000	0.100
3	1.000	0.100
4	0.200	0.020

Weighting factors for computing survivors:
Fleet no: 2
Fishery in the Southern North Sea

Season	1	2
AGE		
0	*	0.020
1	1.000	0.100
2	1.000	0.100
3	1.000	0.100
4	0.200	0.020

Table 13.1.5.1. North Sea sandeel. Average fishing mortality, recruitment and SSB, 1976-95			
Year	Mean F age 1 to 2	Recruits age 1 (billions)	SSB ('000t)
1976	0.55	115	780
1977	0.54	215	546
1978	0.68	284	701
1979	0.64	206	881
1980	0.68	213	841
1981	0.68	90	706
1982	0.62	407	427
1983	0.48	82	1204
1984	0.39	375	640
1985	0.96	110	1051
1986	0.49	549	440
1987	0.43	284	1690
1988	0.64	121	1578
1989	0.54	323	688
1990	0.82	155	812
1991	0.71	288	477
1992	0.46	332	732
1993	0.37	148	1077
1994	0.49	279	834
1995	0.38	439	1158
Average	0.58	251	863

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Table 13.1.6.1 Estimates of N given by the Lowestoft version of XSA used in the bootstrap

Year		1992	1992	1993	1993	1994	1994	1995	1995	1996
Season		1	2	1	2	1	2	1	2	1
Age	0	783659	352121	1520534	683220	2263222	1016931	733016	329365	0
	1	328712	81357	153702	45481	288917	76159	456638	124911	145355
	2	48965	21532	63044	28378	35395	15845	57914	30777	96366
	3	7087	3552	17281	7787	22273	8069	11591	5640	22379
	4	3445	1808	2766	1325	6105	2472	6071	3179	4317
	5+	1323	204	3344	1064	2009	454	1069	1084	2130

Table 13.1.6.4 Reference points estimated from the bootstrapped assessment for XSA using VPA and Cohort Analysis

	VPA			Cohort Analysis		
	90th Percentile	Median	10th Percentile	10th Percentile	Median	90th Percentile
Fmed	0.66	1.09	1.78	0.64	1.06	1.78
F0.1	1.21	1.50	1.79	1.22	1.50	1.79
F that gives 30% of the maximum SSB per recruit	1.08	1.22	1.34	1.08	1.22	1.36
1O th percentile of the SSB per recruit ratio	0.86	0.95	1.05	0.87	0.97	1.06
5O th percentile of the SSB per recruit ratio	1.75	1.87	2.02	1.77	1.91	2.07
9O th percentile of the SSB per recruit ratio	3.30	3.55	4.00	3.38	3.65	4.13
Geometric mean recruits	12.75	12.85	13.01	12.74	12.85	13.03
Maximum Recruit to SSB ratio	4.63	5.33	6.22	4.82	5.51	6.46
Minimum SSB	201048	236556	267055	194603	229168	261544

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Table 13.1.9.1 Assesment Quality Control Diagrams for Sandeel in the North Sea

Assessment Quality Control Diagram 1

Average F(1-2,u)									
Date of assessment	Year								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
1989									
1990									
1991									
1992									
1993									
1994 b	0.44	0.66	0.52	0.83	0.36	0.54	0.46		
1995 b	0.42	0.64	0.54	0.78	0.70	0.43	0.32	0.35	
1996 b	0.43	0.64	0.54	0.82	0.71	0.46	0.37	0.49	0.38

Assessment Quality Control Diagram 2

Recruitment (age 1) Unit: millions									
Date of assessment	Year class								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
1989									
1990									
1991									
1992									
1993									
1994 a[1]	93	321	128	287	385	111			
b	125	332	138	273	287	134			
1995 b	118	329	146	292	362	160	502		
1996 b	121	323	155	288	332	148	279	439	133

[1] a) Sum of separate assesments for the Northern North Sea and the Southern North Sea. b) Combined assessment total North Sea

Table 13.1.9.1 cont.

Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)											
Date of assessment	Year										
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989 a	2266										
1990 a	1909	655	1913								
1991											
1992											
1993 a	1786	711	804	498	647	2020					
1994 a	1170	687	789	524	755	1299					
b	1538	677	844	452	657	859					
1995 b	1593	685	829	490	755	1209	962				
1996 b	1578	688	812	477	732	1077	834	1158			

Table 13.2.1, Sandeel at Shetland
Landings ('000 t) 1974-1996

Year	Landings
1974	7.4
1975	12.9
1976	20.2
1977	21.5
1978	28.1
1979	13.4
1980	25.4
1981	46.7
1982	52
1983	37
1984	32.6
1985	17.2
1986	14
1987	7.2
1988	4.7
1989	3.5
1990	2.3
1991	0
1992	0
1993	0
1994	0
1995	1.16
1996	1.04 *

* Provisional

Table 13.2.2, Sandeel at Shetland
Standardised Effort, (days absent), by half-year, 1984-1996.
UK (Scotland) data.

Year	1	2
1984	852	539
1985	358	302
1986	404	157
1987	180	98
1988	200	72
1989	168	0
1990	102	0
1991	0	0
1992	0	0
1993	0	0
1994	0	0
1995*	149	0
1996*	133	0

* Nominal effort

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Table 13.2.3, Sandeel at Shetland

Survey indices, Mean No. fish per 30 minute tow 1984-1996.

Year	Age 0	1	2	3	4	5	6	7
1984	345774	47590	34613	9921	3999	1369	856	258
1985	121905	74509	38843	23455	10872	1959	962	119
1986	681869	49816	11399	15376	7049	2893	1210	191
1987	-	-	-	-	-	-	-	-
1988	73371	898	7189	4843	4612	3031	1619	20
1989	813752	9059	977	3820	3893	2017	462	86
1990	90148	30118	3771	1346	1736	1142	444	329
1991	1009024	10001	1925	1694	750	53	21	5
1992	199301	465958	1215	347	168	43	10	12
1993	635331	18180	73176	2176	361	150	72	23
1994	98653	135158	14272	41299	3369	296	12	17
1995	-	-	-	-	-	-	-	-
1996	589368	23056	12513	1836	1185	1387	524	72

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Table 13.2.4, Sandeel at Shetland
Commercial catch at age, (millions), 1984-1996.

	1984		1985		1986		1987	
	1	2	1	2	1	2	1	2
0	1940	4833	153	2039	898	1328	19	400
1	1843	481	1076	252	522	94	873	111
2	1064	154	313	157	352	25	53	16
3	501	36	166	83	327	24	35	10
4	134	10	55	20	141	11	38	8
5	38	9	17	11	58	3	16	7
6	14	1	6	3	14	1	4	1
7	9	1	2	1	6	0	1	0

	1988		1989		1990		1991	
	1	2	1	2	1	2	1	2
0	52	478	33	0	14	0	0	0
1	30	3	8	0	162	0	0	0
2	151	3	7	0	22	0	0	0
3	107	1	199	0	14	0	0	0
4	48	1	96	0	60	0	0	0
5	26	2	34	0	29	0	0	0
6	15	0	14	0	5	0	0	0
7	4	0	4	0	6	0	0	0

	1992		1993		1994		1995	
	1	2	1	2	1	2	1	2
0	0	0	0	0	0	0	43	0
1	0	0	0	0	0	0	185	0
2	0	0	0	0	0	0	23	0
3	0	0	0	0	0	0	11	0
4	0	0	0	0	0	0	6	0
5	0	0	0	0	0	0	2	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0

	1996	
	1	2
0	31	0
1	169	0
2	52	0
3	4	0
4	2	0
5	3	0
6	0	0
7	0	0

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Table 13.2.5, Sandeel at Shetland
Mean Weights at age (g) in catch by half-year, 1974-1990.

Age	1	2
0	0.746	1.618
1	3.095	5.053
2	5.409	7.87
3	8.585	10.483
4	11.143	13.255
5	13.705	15.787
6	15.605	19.472
7	21.254	24.482

Table 13.2.6, Sandeel at Shetland
Natural Mortality and proportion mature at age.

Age	Natural Mortality		Proportion Mature
	1	2	
0	0	0.8	0
1	1	0.2	0
2	0.4	0.2	1
3	0.4	0.2	1
4	0.4	0.2	1
5	0.4	0.2	1
6	0.4	0.2	1
7	0.4	0.2	1

Figure 13.1.1.1 Danish SANDEEL areas and assessment areas used by the Working Group.

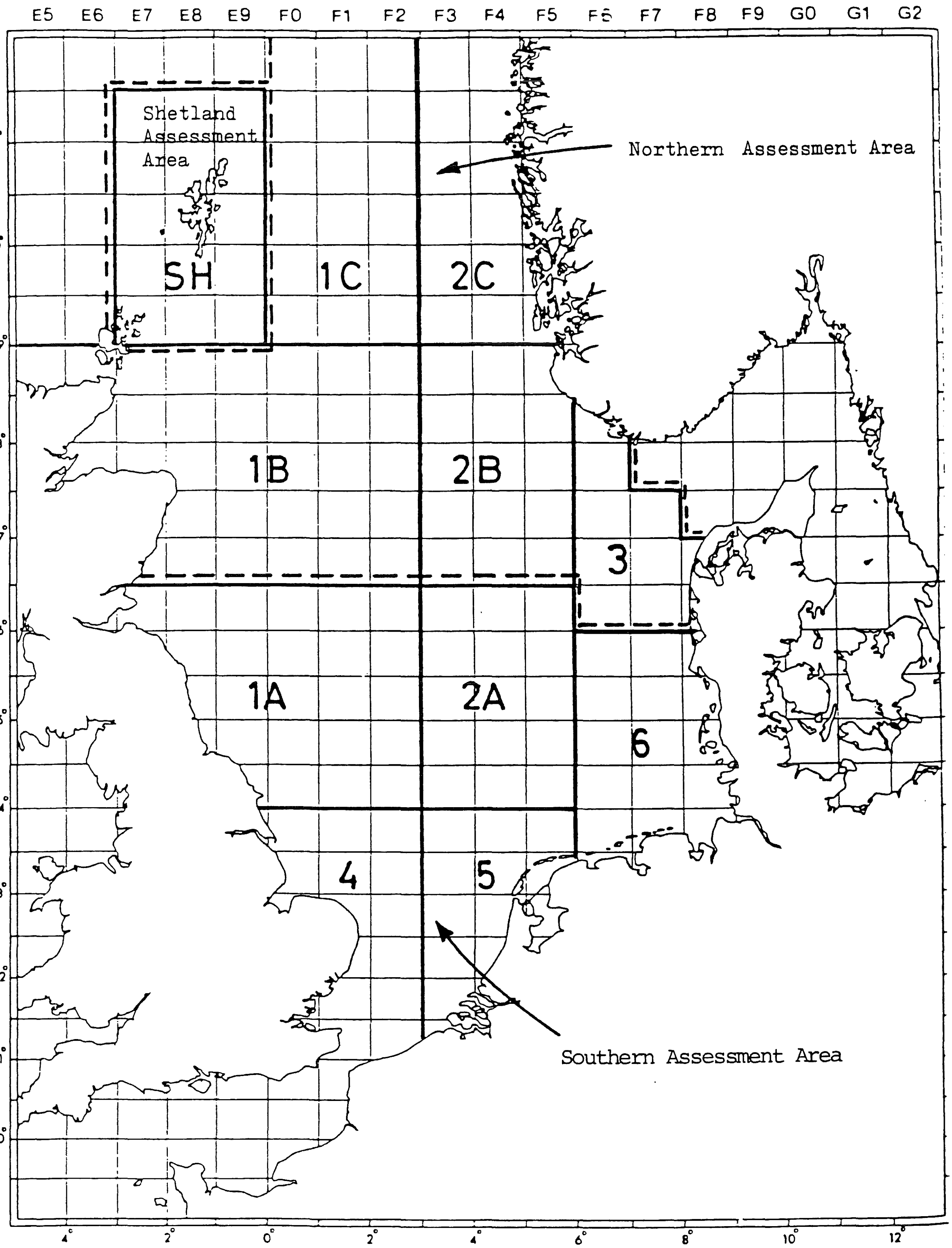


Figure 13.1.1.2 Sandeel landings in 1995 and 1996 (1st half) by ICES Statistical rectangle and quarter. Data from Denmark, Norway and UK.

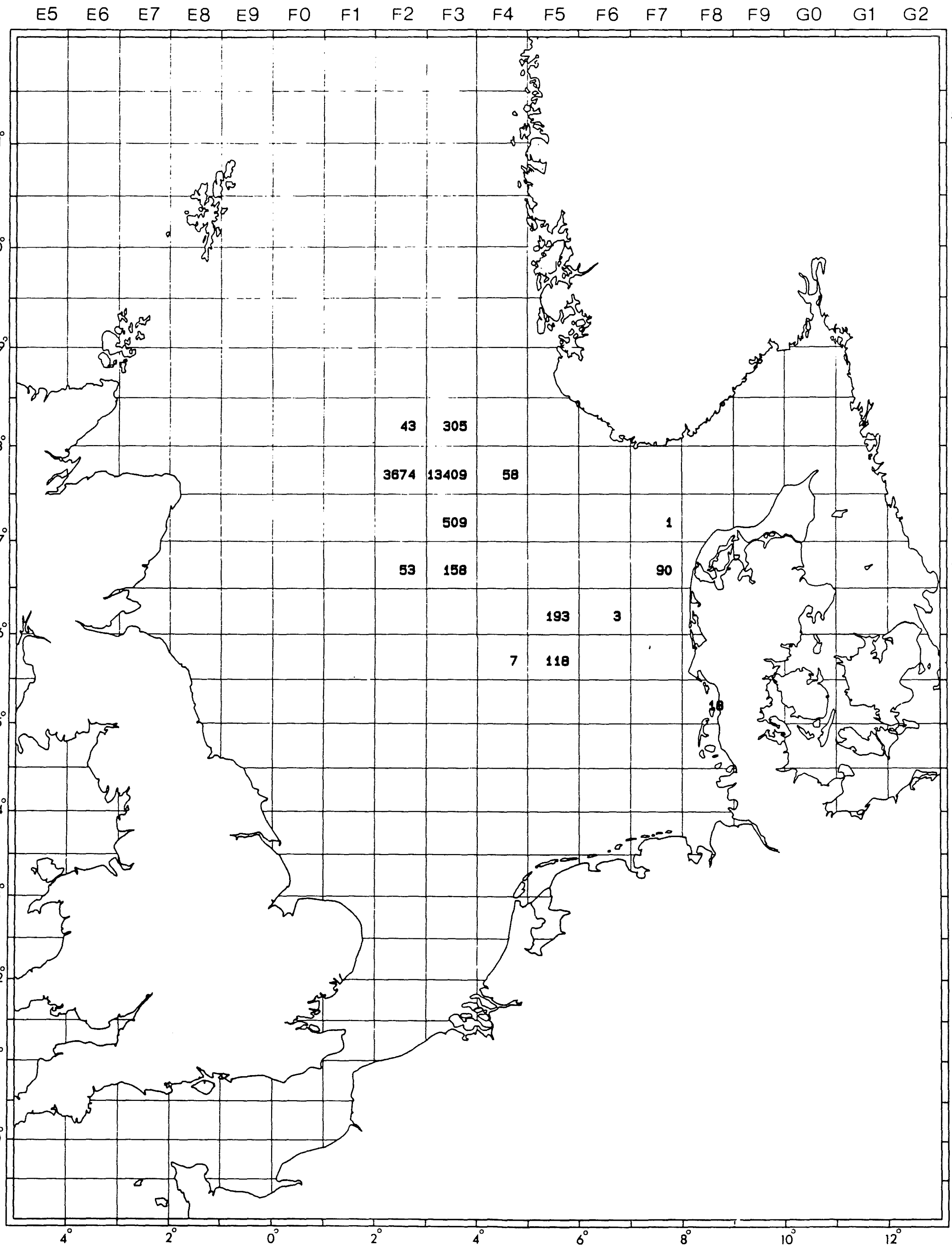


Figure 13.1.1.2 (Cont'd)

Sandeel Landings 1995 Q2

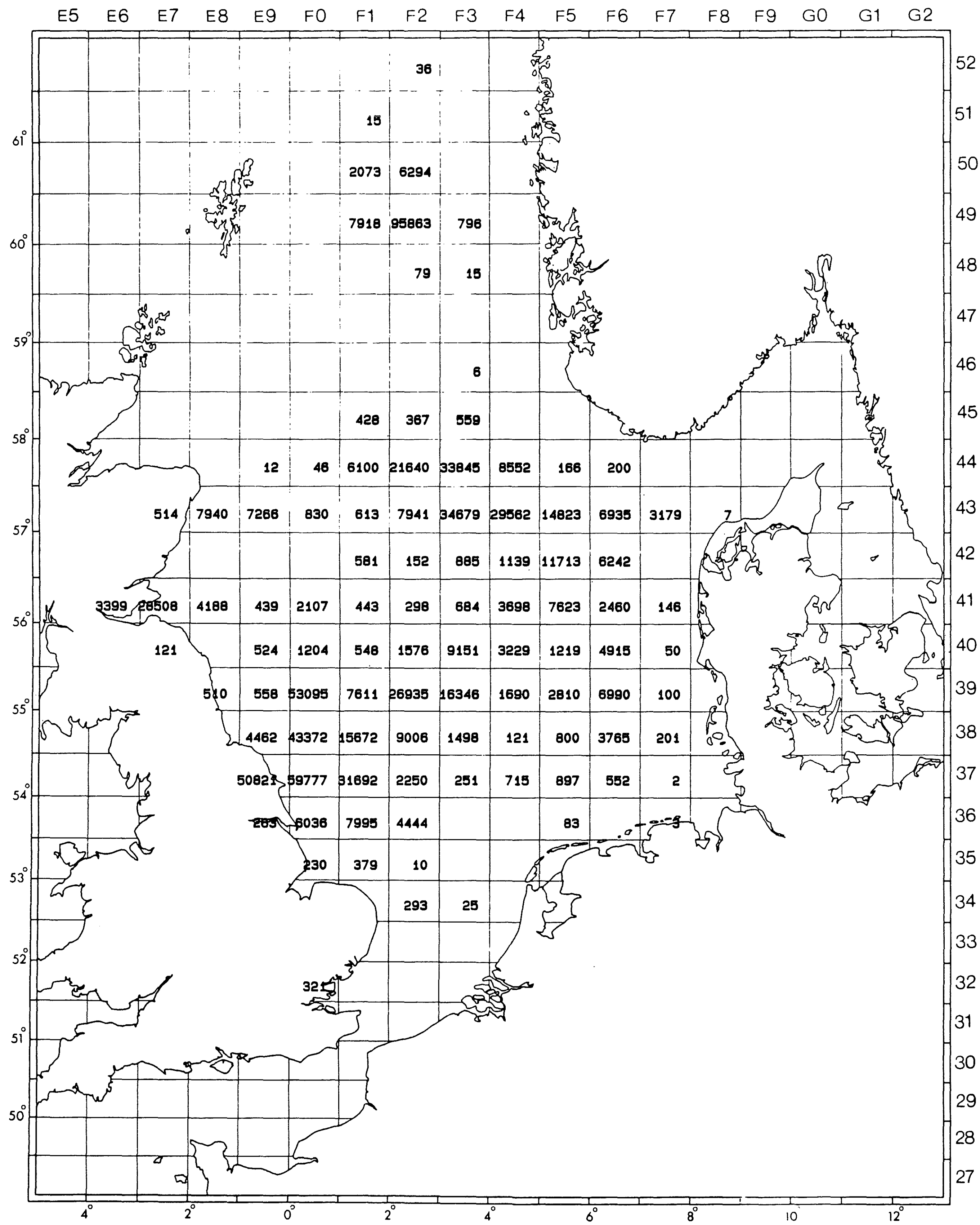


Figure 13.1.1.2 (Cont'd)

Sandeel Landings 1995 Q3

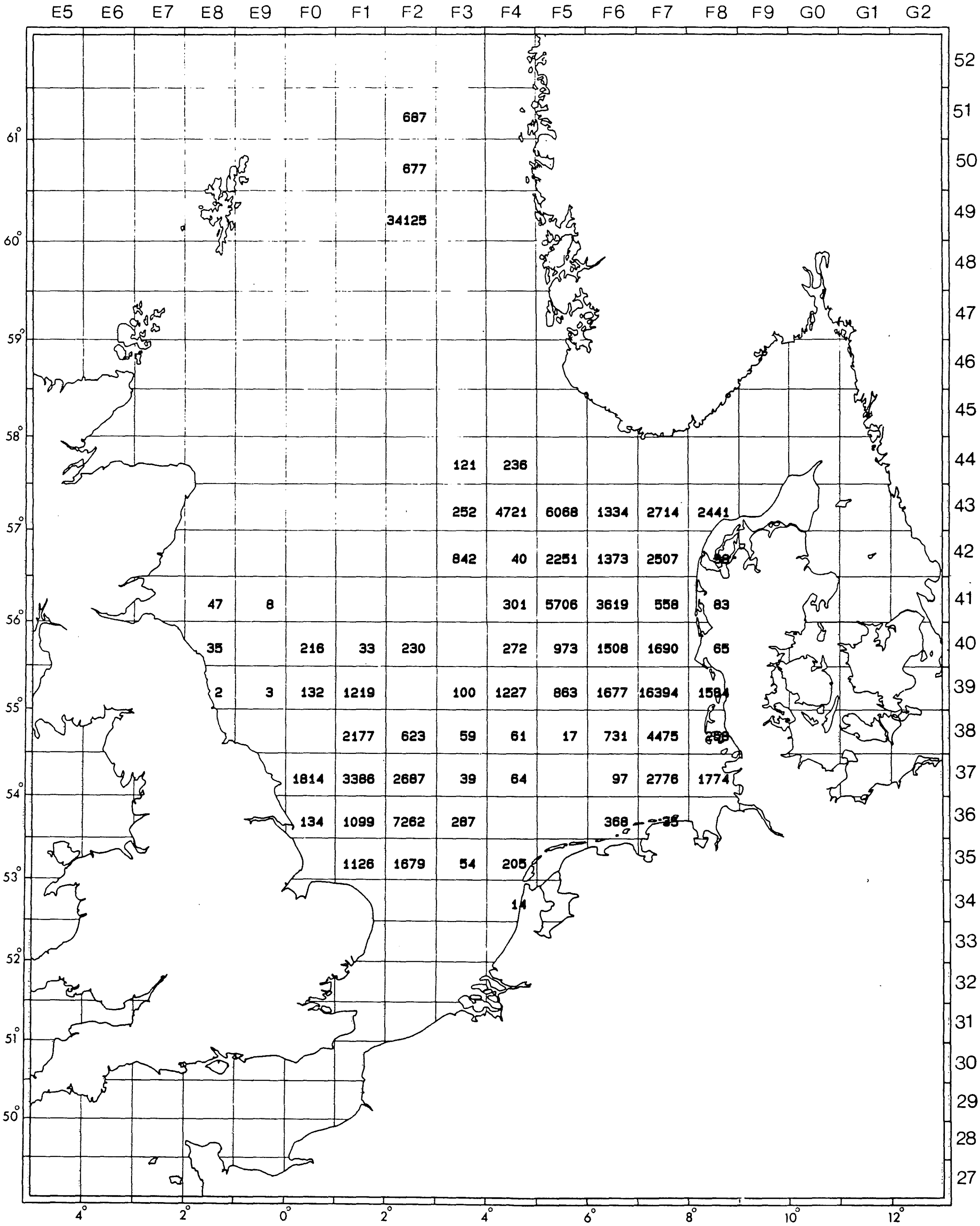


Figure 13.1.1.2 (Cont'd)

Sandeel Landings 1995 Q4

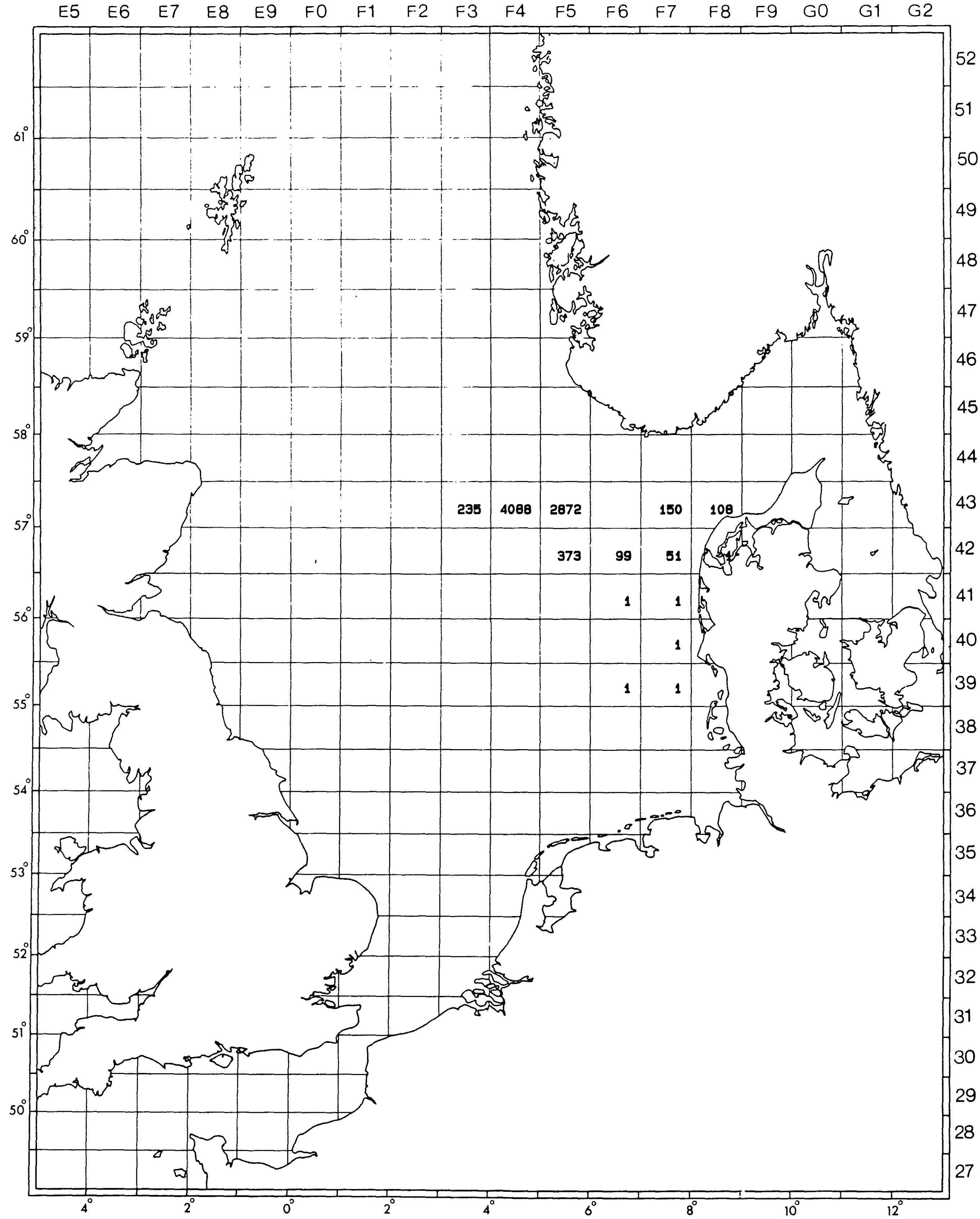


Figure 13.1.1.2 (Cont'd)

Sandeel Landings 1996 Q1

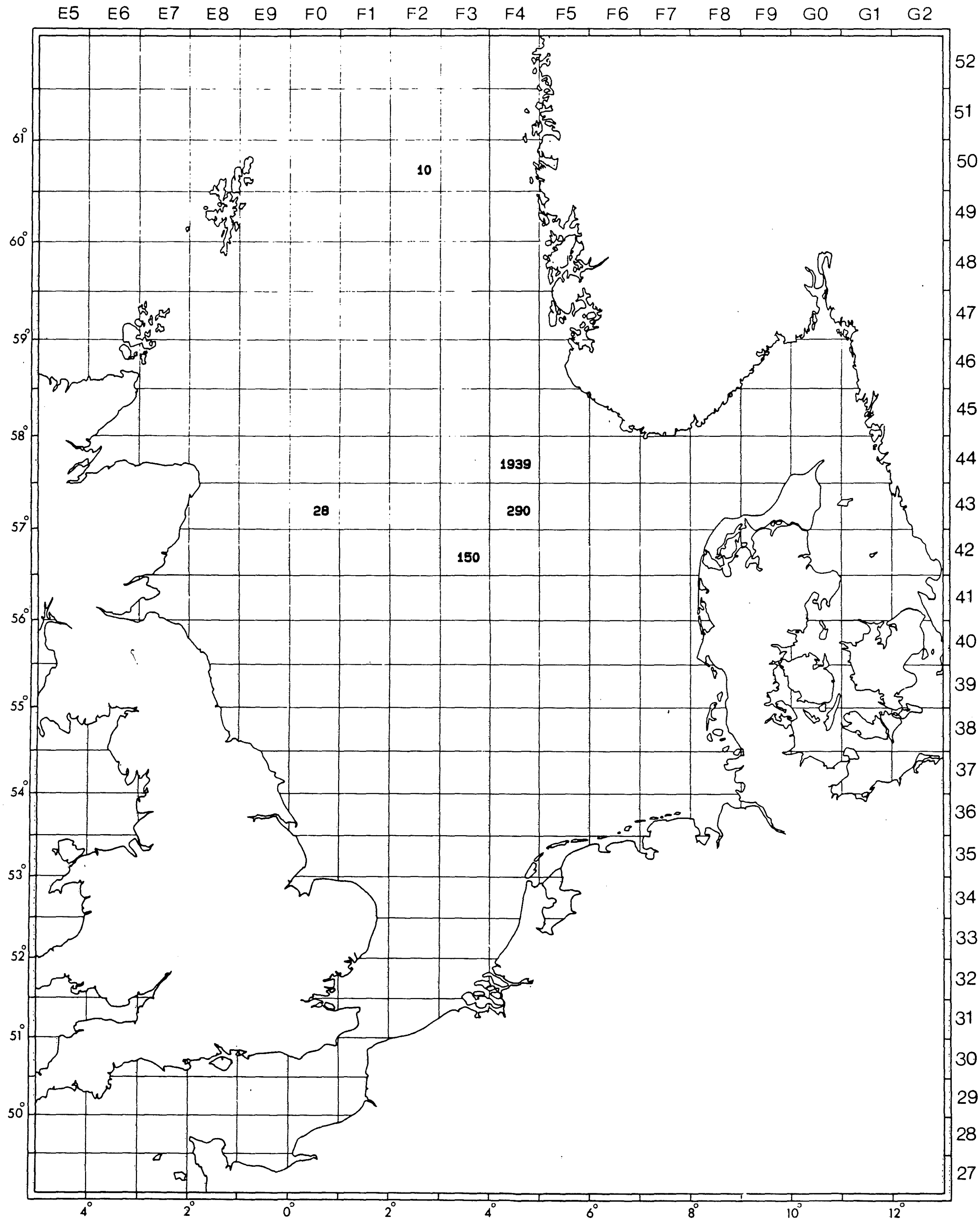


Figure 13.1.1.2 (Cont'd)

Sandeel Landings 1996 Q2

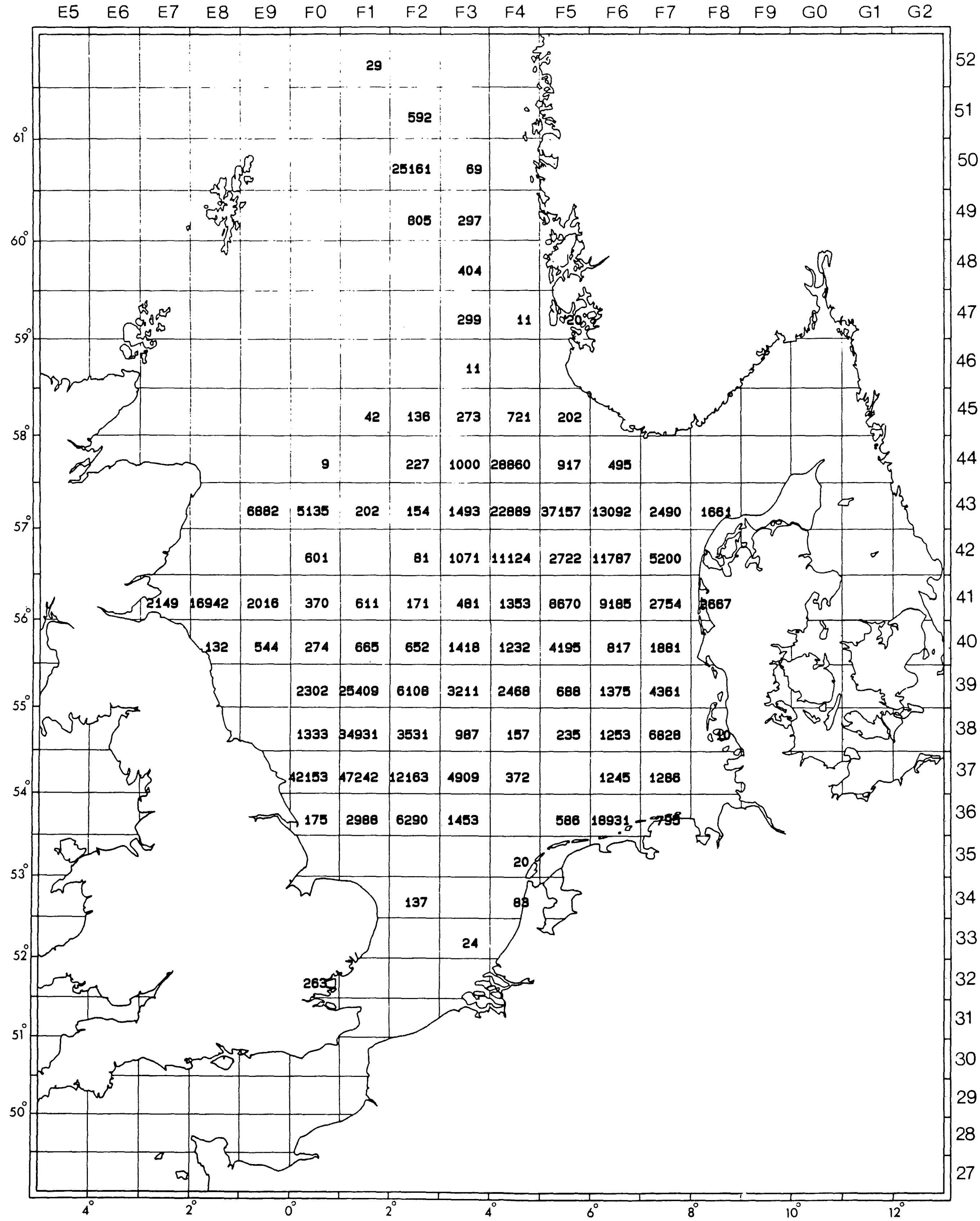
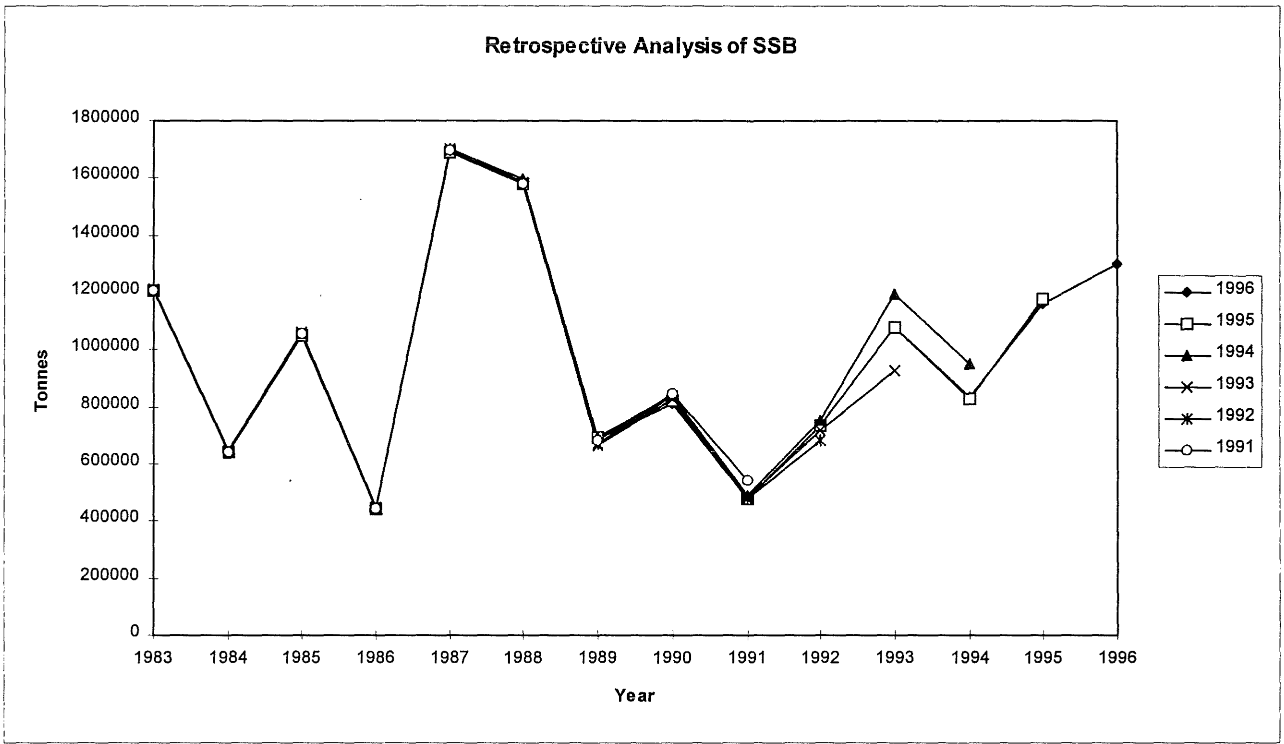
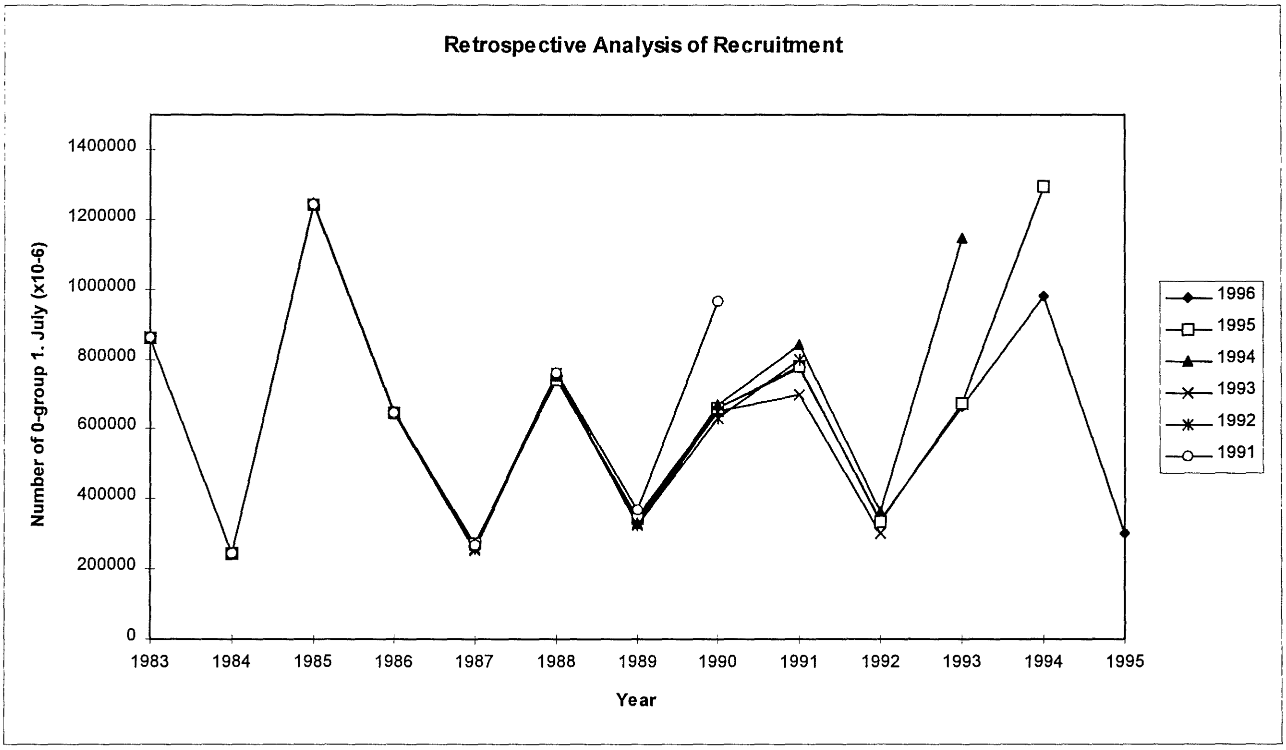


Figure: 13.1.4.1 Retrospective analysis of SSB and Recruitment[1]

SXSA - Sandeel in the North Sea





[1] Only estimnated recruitment for the year previous to the assesment year is shown

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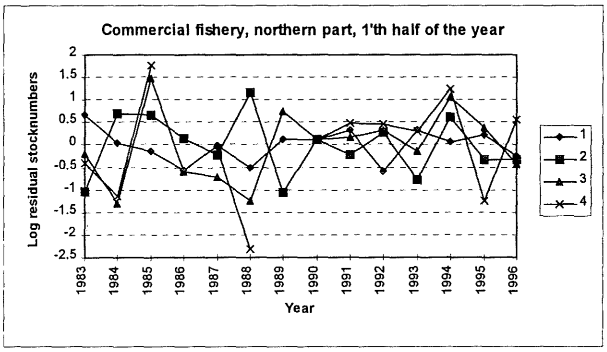
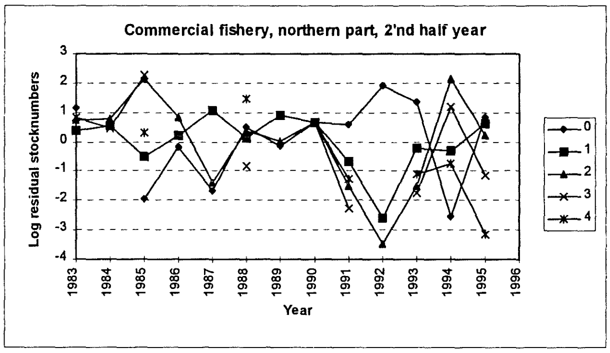
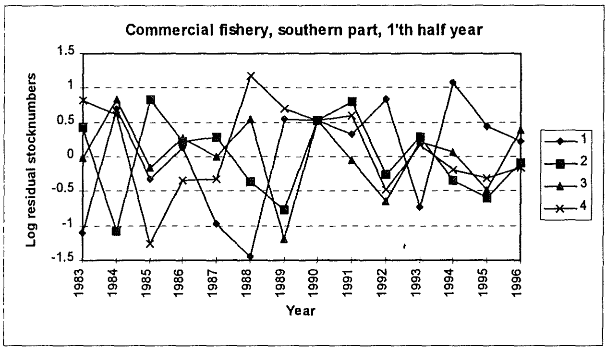
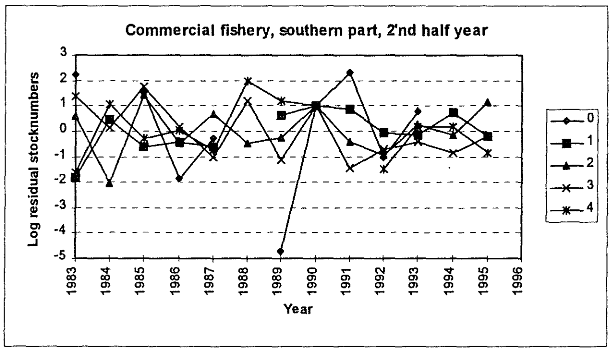
Figure: 13.1.4.2 Log residual stocknumbers by fleet and season

SXSA - Sandeel in the North Sea









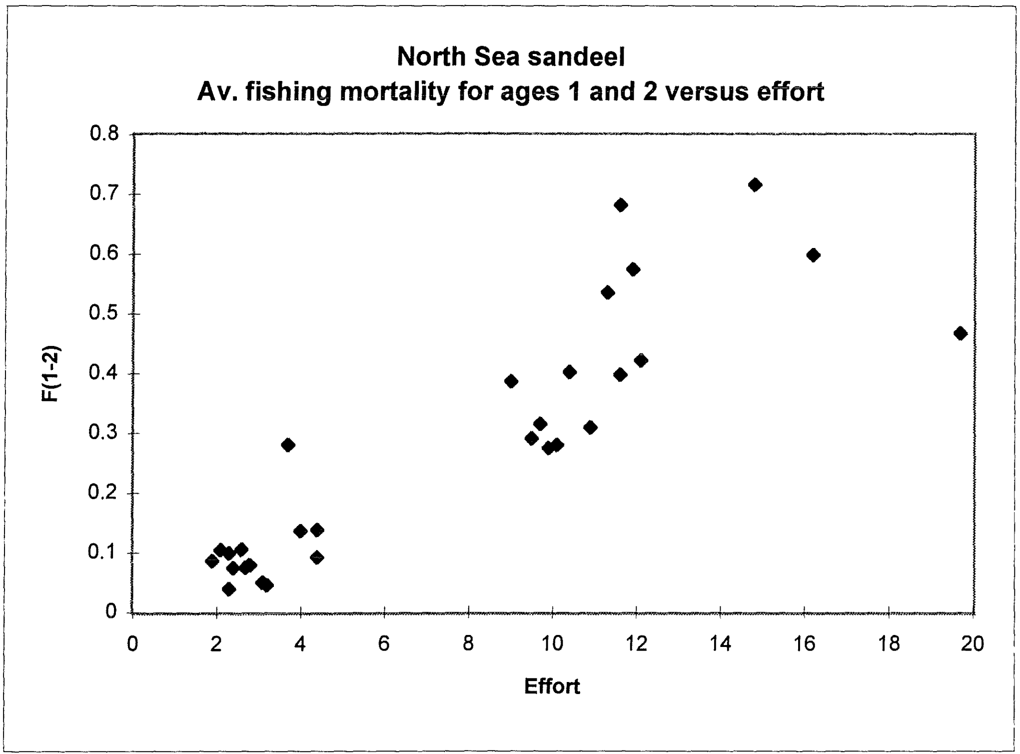


Fig. 13.1.4.3. North Sea sandeel . Average fishing mortality for ages 1 and 2 versus fishing effort

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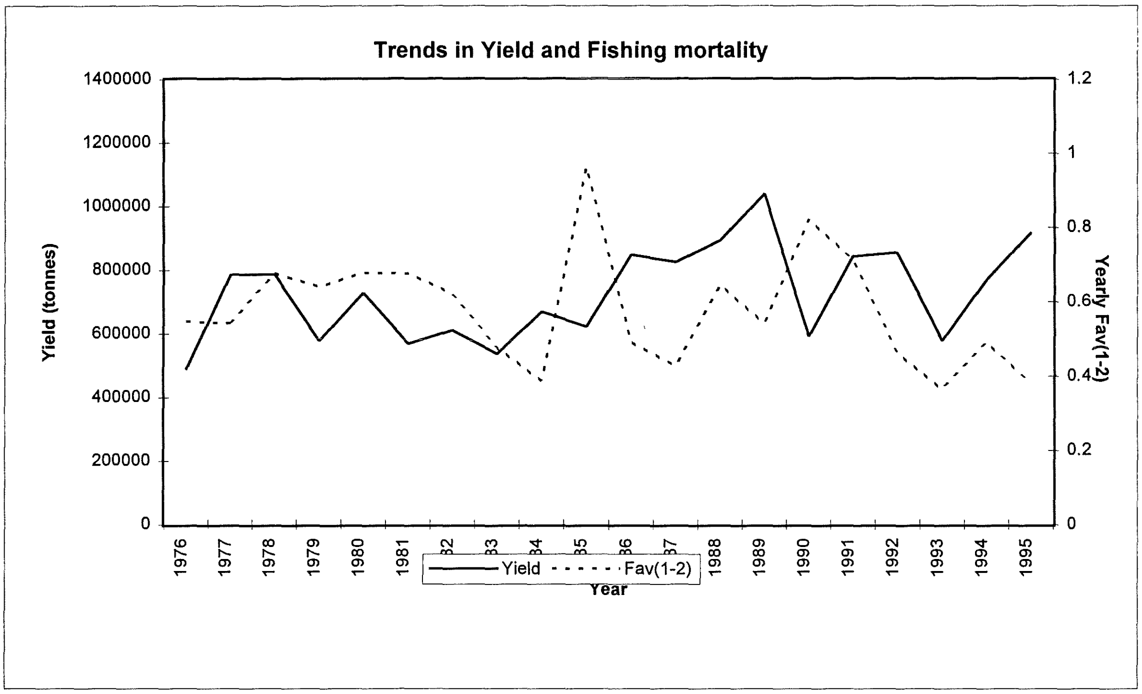

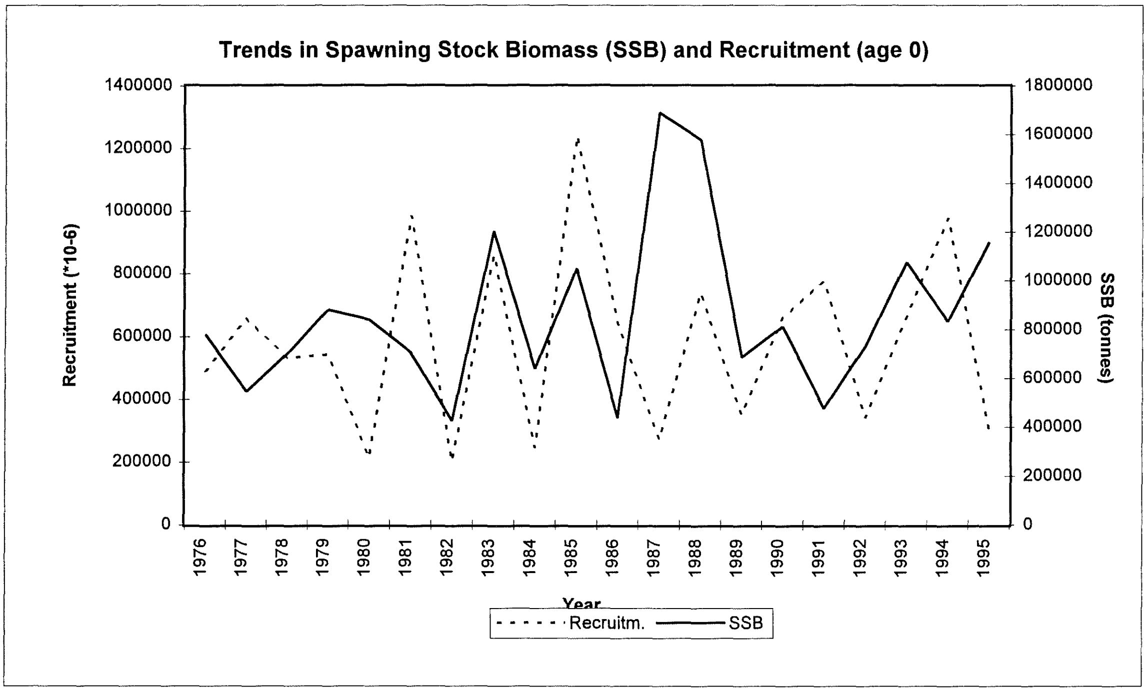

Fig. 13.1.5.1 Trends in yield, fishing mortality (F_{av}1-2), SSB and Recruitment

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Figure 13.1.6.1 Fitted Stock recruitment relationships

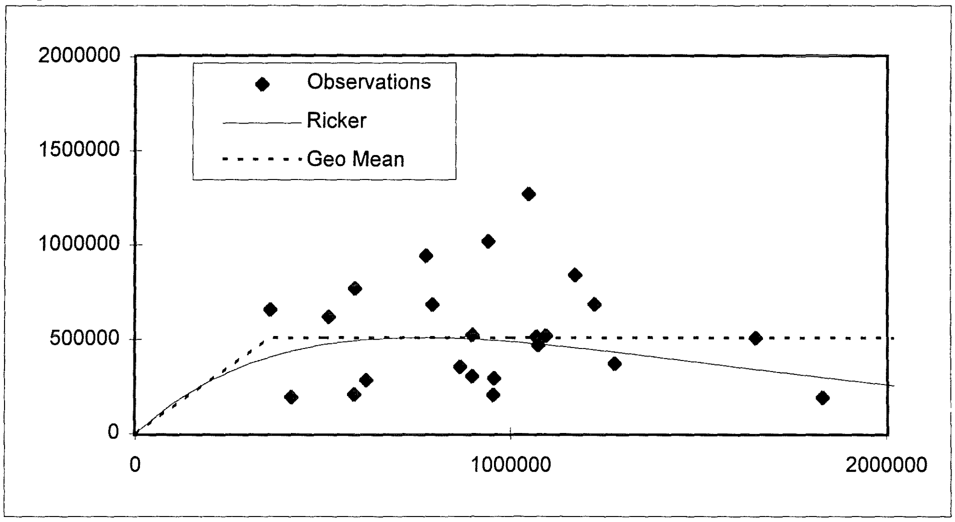


Figure 13.6.1.2. Residual plot for geometric mean recruits

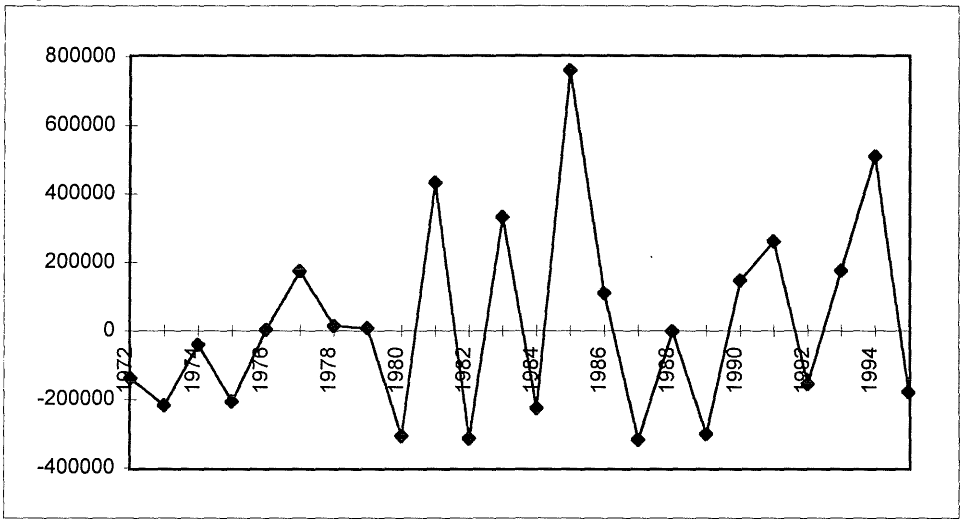
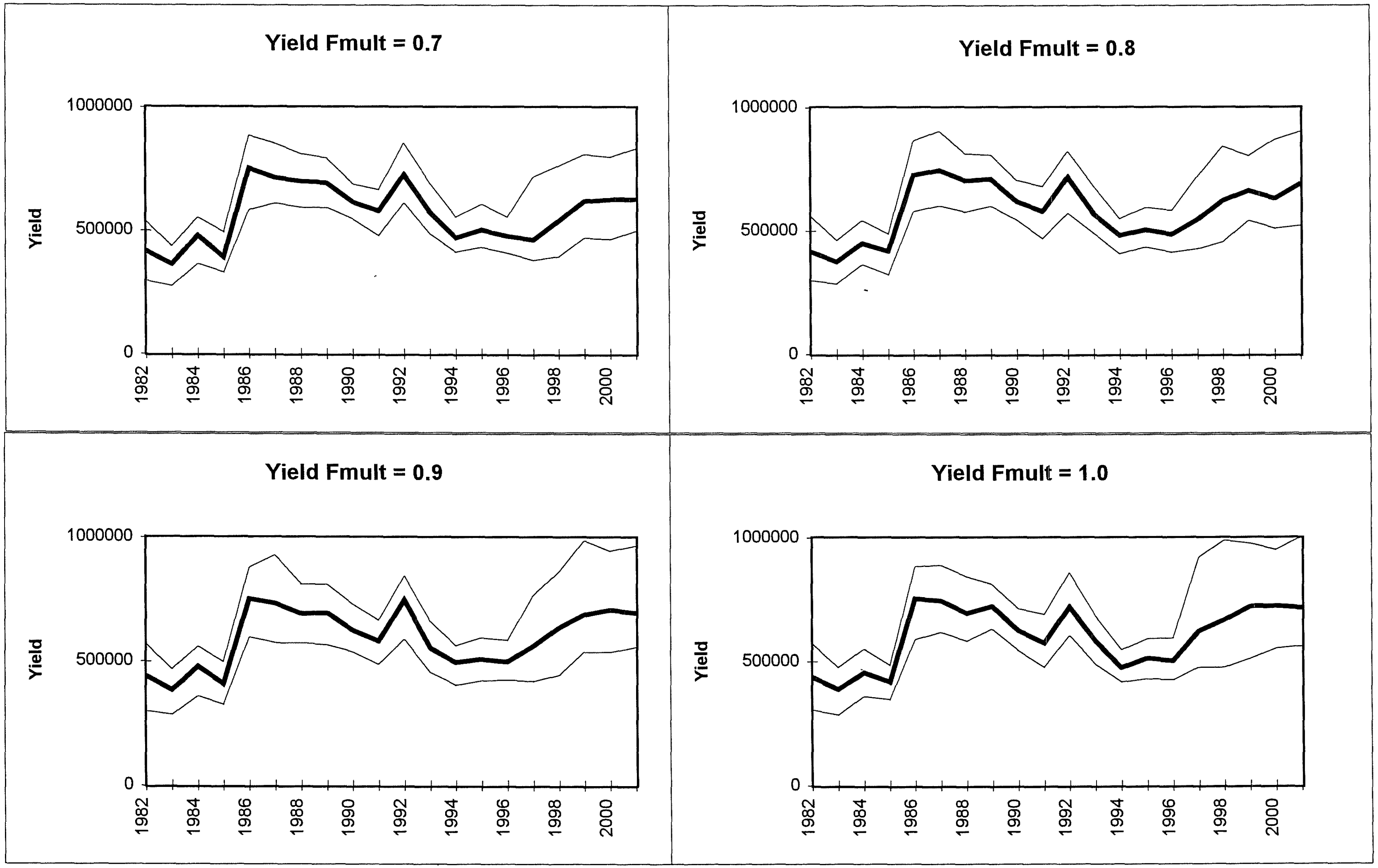


Figure 13.1.6.3a



Lines show the median and 10th and 90th percentiles

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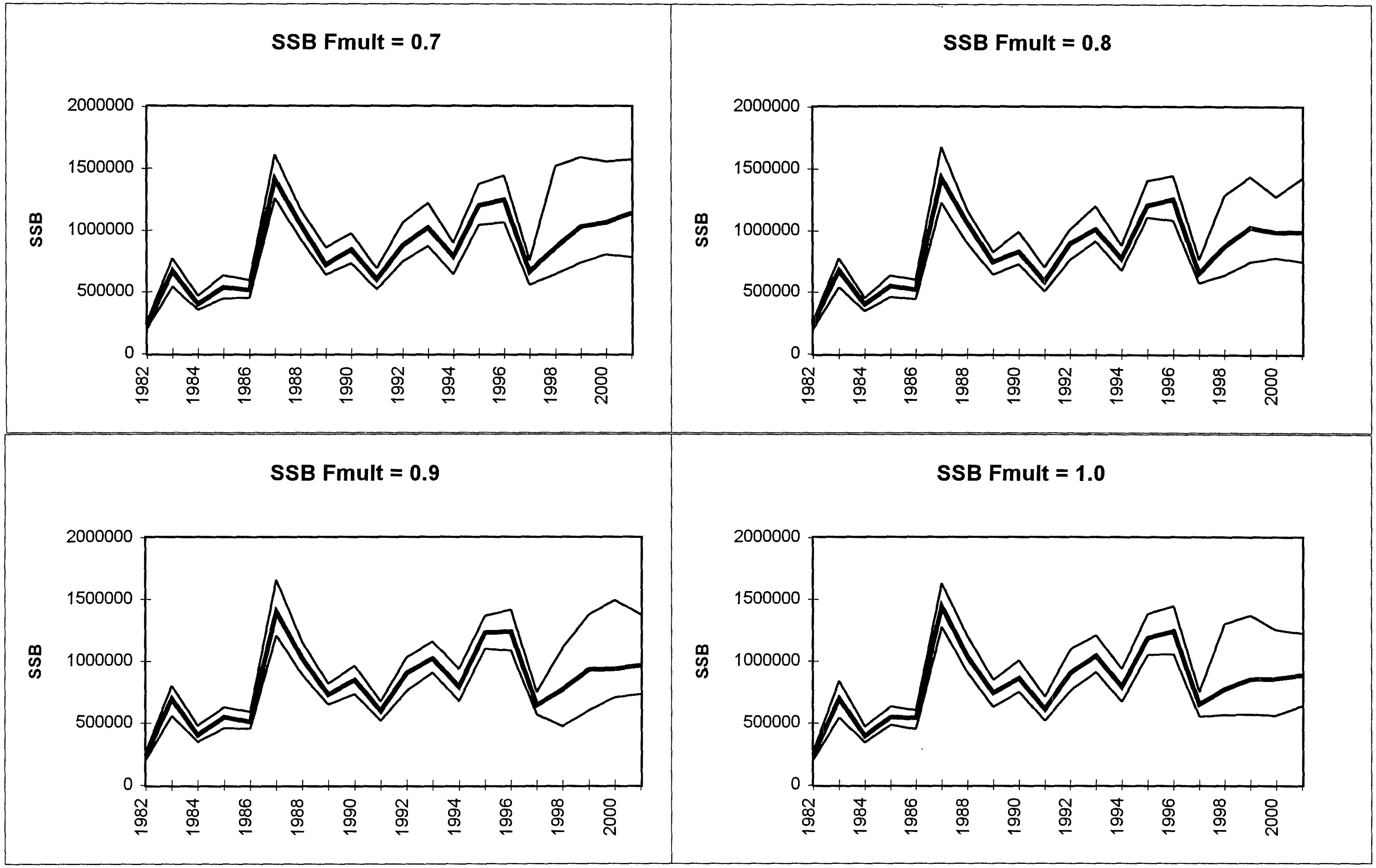
Figure 1.3.1.6.3b.Trends in SSB in the assessment and prediction



Lines show the median and 10th and 90th percentiles

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Figure 13.1.6.4 The 95th, 90th and 80th percentiles of SSB for in the prediction plotted against

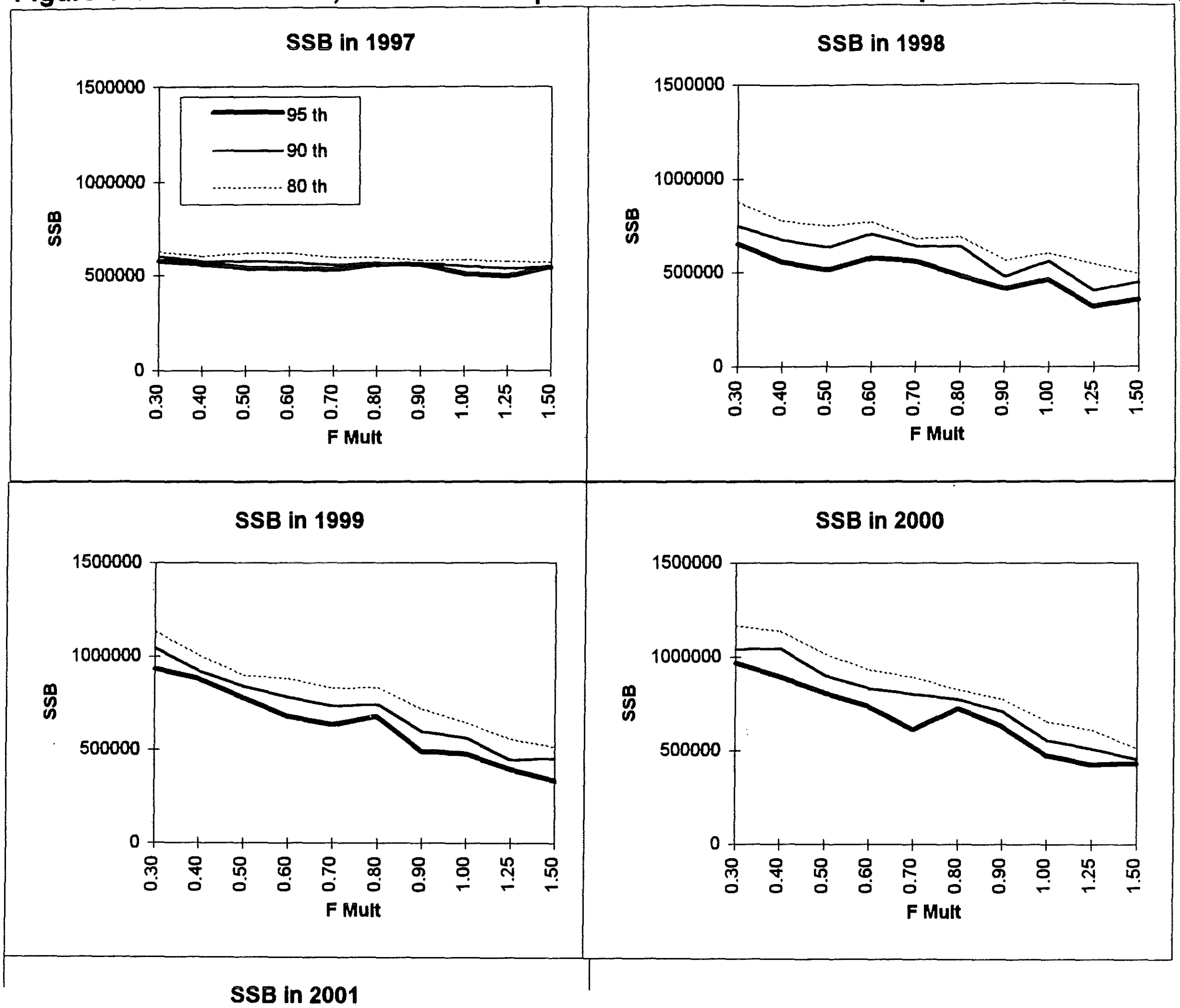
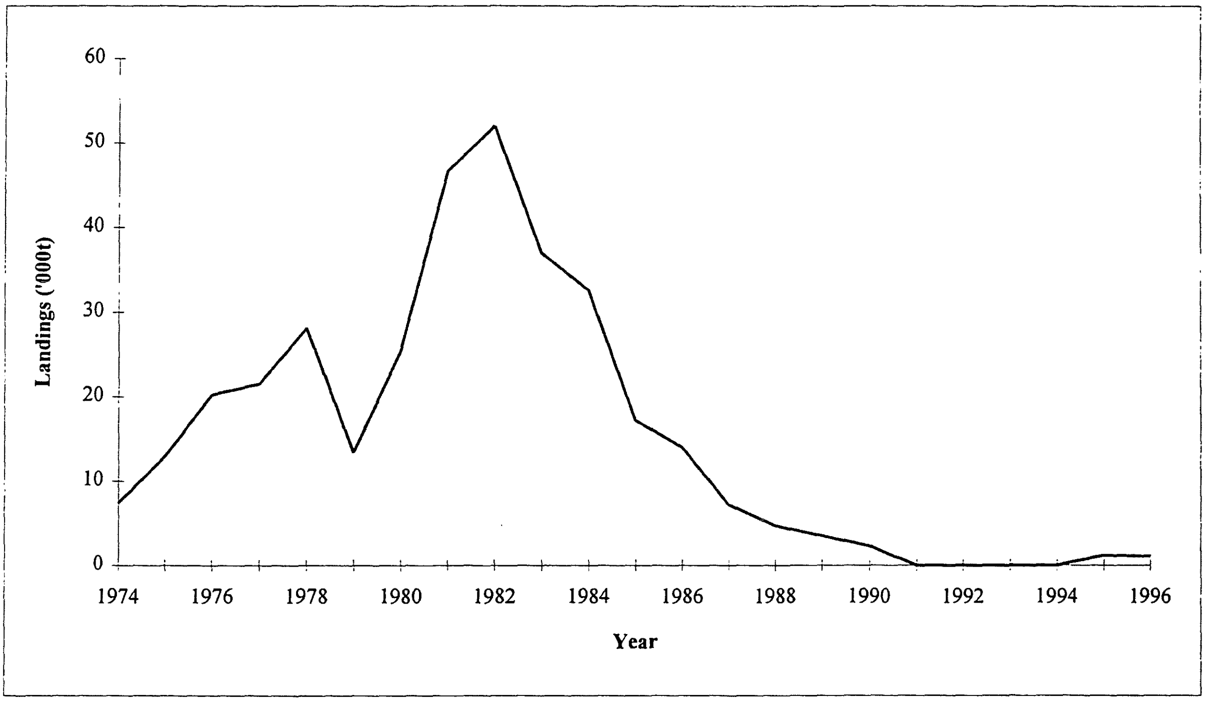


Figure 13.2.1; Sandeel at Shetland
Trends in landings



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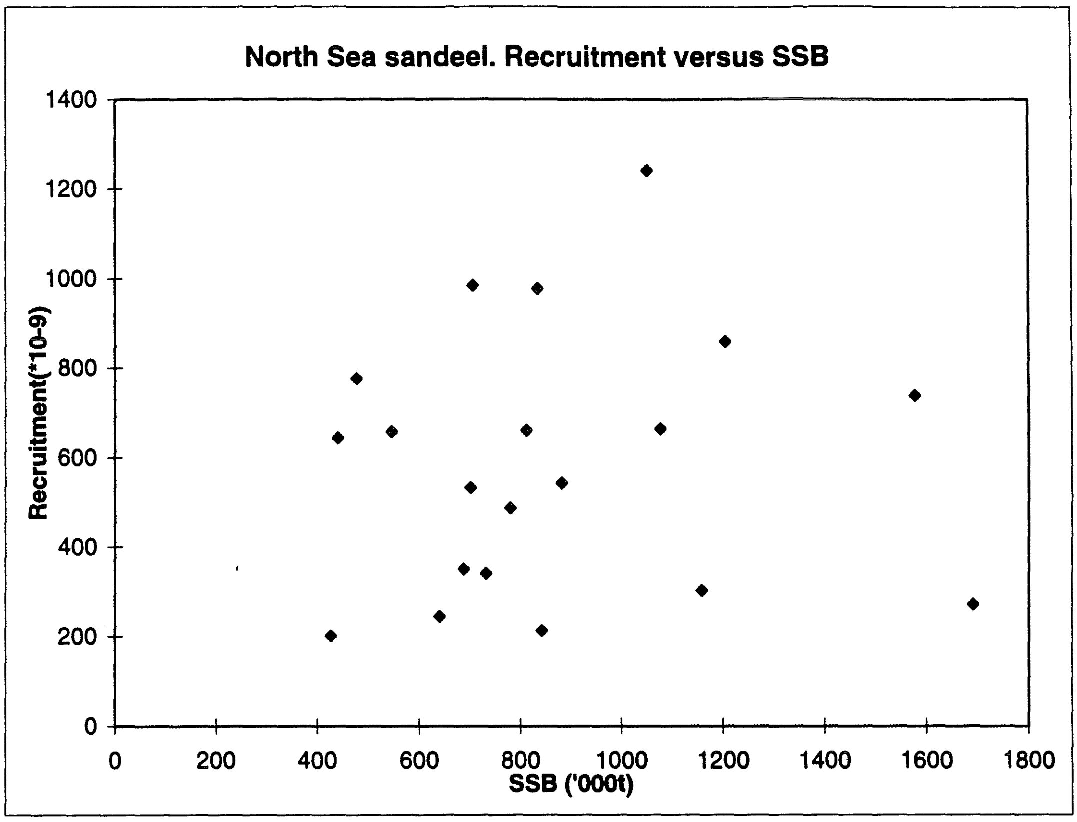

Fig. 13.11.1. North Sea sandeel. Recruitment versus SSB

14 NORWAY POUT AND SANDEEL IN DIVISION VIA

14.1 Overview of Industrial Fisheries in Division VIa

There are two distinct industrial fisheries operating in Division VIa; a Norway pout fishery and a sandeel fishery. The Norway pout fishery is predominately Danish, whereas the sandeel fishery is almost exclusively Scottish and operates in more inshore areas. No information is available on by-catches in the Norway pout fishery. The sandeel fishery has a small by-catch of other species; information from the 1995 and 1996 catches indicates that in excess of 97% of the catch consisted of *Ammodytes marinus,* with the by-catch consisting mostly of other species of sandeel. Landings from both fisheries are small compared to the fisheries in the North Sea.

14.2 Norway Pout in Division VIa

Landings of Norway Pout from Division VIa as reported to ICES are given in Table 14.2.1. Landings in 1995 were 24,439 t, which is the highest figure since 1989, and is above the series average of 12,650 t. No data are available on by-catches in this fishery. In addition, no age composition dates are available so there are insufficient data available to assess this stock.

Table 14.2.1 Norway Pout. Annual landings (t) in Division VIa. (Data officially reported to ICES).

Country	1974	1975	1976	1977	1978	1979	1980	1981
Denmark	-	193	-	-	4,443	15,609	13,070	2,877
Faroes	1,581	1,524	6,203	2,177	18,484	4,772	3,530	3,540
Germany	179	-	8	-	-	-	-	-
Netherlands	-	322	147	230	21	98	68	182
Norway	144[3]	-	82[3]	-	-	-	-	-
Poland	75	-	-	-	-	-	-	-
UK (Scotland)[2]	4,702	6,614	6,346	2,799	302	23	1,202	1,158
Russia	40	2	7,147	-	-	-	-	-
Total	6,721	8,655	19,933	5,206	23,250	20,502	17,870	7,757

Country	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	751	530	4,301	8,547	5,832[4]	37,714[5]	5,849[5]	28,180[5]
Faroes	3,026	6,261	3,400	998	-	-	376	11
Germany	-	-	70	-	-	-	-	-
Netherlands	548	1,534	-	139	-	-	-	-
Norway	-		-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-
UK (Scotland)[2]	586	-	23	13	-	553	517	5
Russia	-	-	-	-	-	-	-	-
Total	4,911	8,325	7,794	9,697	5,832	38,267	6,742	28,196

Country	1990	1991	1992	1993	1994	1995[1]
Denmark	3,316[5]	4,348	5,147	7,338	14,147	24,431
Faroes	-	-	-	-	-	-
Germany	-	-	-	-	-	1
Netherlands	-	-	10	-	-	7
Norway	-	-	-	-	-	-
Poland	-		-	-	-	-
UK (Engl.& Wales)	-	-	2	-	1	-
UK (Scotland)	+	-	-	-	+	-
Russia	-	-	-	-	-	-
Total	3,316	4,348	5,159	7,338	14,148	24,439

[1]Preliminary.
[2]Amended using national data.
[3]Including by-catch.
[4]Includes Division VIb.
[5]Included in Division IVa.

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14.3 Sandeel in Division VIa

14.3.1 Catch trends

Landings of sandeel in Division VIa as officially reported to ICES are given in Table 14.3.1, and trends in landings are given in Figure 14.3.1. Landings in 1995 amounted to 7,111 t, which is a decrease compared to the 1994 figure of 10,627 t, and well below the overall average of 13,250t. Provisional figures for 1996 indicate that landings increased to around 13,300 t. This increase in landings in 1996 reflects an increase in effort relative to 1995. In 1995 all landings were taken between June and early August from grounds at North Rona, the North Minch and the Outer Hebrides. In 1996 landings came from a wider area, but from within a similarly limited season.

14.3.2 Natural mortality, maturity, age composition and mean weight at age

The assessment of this stock uses the same natural mortalities and maturities at age as the North Sea stocks. These are given in Table 14.3.2.

Semi-annual catch-at-age data for 1983 to 1996 are given in Table 14.3.4. Catches in 1995 and 1996 were dominated by fish from the 1994 year class. Over 1995 and 1996 most landings into Scotland were sampled, and samples were obtained from all month/area combinations. A small proportion of the catch , particularly in the late season, is landed into the Faroes. No samples were obtained from these landings.

Biomass totals are calculated using mean weights at age from the catch. These are given in Table 14.3.4.

14.3.3 Catch/effort data

Nominal effort data are available for all vessels landing into Scotland. For use in the catch-at-age analysis these data are raised to the total catches. The effort data are given in Table 14.3.5.

14.3.4 Catch-at-age analysis

Recent assessments of this stock have used a semi-annual separable VPA (SSV, Cook 1992), and this method has again been used in the current assessment. In the SSV catches at age 0 were given a weighting of 0.1 relative to older ages, and effort data were given equal weight to the catch data. These settings follow previous practice. Initial exploratory runs used the full year-range of catch and effort data, but the diagnostics from these runs showed a strong trend in the year-season effect residuals, with residuals for the earliest years being all positive, then becoming all negative in the middle of the year range, then all positive in the later years. This trend presumably reflected trends in catchability. To address this problem, another run was made using only data from 1989 onwards. This removed the trend in the residuals and also resulted in trends in F which corresponded more closely to trends in fishing effort, so the run based on the reduced year-range of data was adopted as the final run. Diagnostics from this run are given in Table 14.3.6. The time series of F and population estimates was extended back to 1983, by using the existing catch data in a semi-annual VPA, which used the SSV estimates of population numbers at the start of 1989 as terminal population estimates.

Estimates of fishing mortality and stock numbers from the SSV are given in Tables 14.3.7 and 14.3.8. The full time series of recruitment, mean F and SSB, including the years prior to those included in the SSV, is given in Table 14.3.9.

14.3.5 Historical stock trends

Long-term trends in landings, Mean F, SSB and recruitment are given in Table 14.3.9 and Figure 14.3.1. Landings and fishing mortality peaked in the late 1980s after which both declined until 1992 since when they have increased slightly. Spawning stock has followed a similar trend, with SSB at the start of 1996 estimated to be close to the highest value observed. This follows strong recent recruitment; the 1991 and 1994 year classes appear to be the largest observed.

14.3.6 Catch forecast

This is a stock where F is low relative to M and assessments are liable to large changes in level from year to year (see Section 14.3.8). This means that the assessment is subject to high uncertainty and is probably best regarded as an indication of overall trends in the stock. In addition, the current estimate of the strength of the 1996 year class is considered unreliable. So there is no information on the strength of the year class which will form an important component of the 1997 catch. In view of this a short-term catch forecast is considered inappropriate. A precautionary TAC of 12,000 t has been set for the 1997 fishery (see Section 4.3.10).

14.3.7 Long-term considerations

Two recent strong year classes, together with a low level of exploitation have resulted in SSB increasing to a high level. Precautionary management measures are in place to limit the level of exploitation which should ensure that future stock trends will be determined largely by recruitment.

14.3.8 Comments on the assessment

The assessment quality control diagrams for this assessment are given in Table 14.3.10. It can be seen that this assessment is prone to large changes in level from year to year. Thus the assessment is probably best regarded as an indication of overall trends in the stock rather than the absolute level of the stock. In addition, the estimate of the 1996 year class at age 0 is based only on a small 0-group catch, which due to seasonal restrictions on the fishery is unlikely to reflect true 0-group abundance. This means that the estimate of the strength of this year class can not be considered reliable.

14.3.9 MBAL considerations

The stock-recruitment scatter plot from the current assessment is given in Figure 14.3.2. The time series is relatively short, but it does not show any evidence of diminished recruitment at low SSBs. This stock unit is less well studied than that at Shetland, but it is possible that as in the latter area, some recruits may originate from areas not exploited by the fishery. Given this possibility, and the large changes in level which this assessment is prone to, it would seem inadvisable to set MBAL in terms of an absolute level of SSB for this stock. As at Shetland, precautionary management measures are in place to limit exploitation of this stock. These consist of a precautionary TAC of 12,000 t; seasonal closure from 1 August each year, and access restricted to licensed vessels.

Table 14.3.1, Sandeel, Division VIa
Landings (tonnes), 1981-1995, as officially reported to ICES,

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Denmark	-	-	-	-	-	-	-	-	-	-
UK, Scotla	5972	10786	13051	14166	18586	24469	14479	24465	18785	16515
Total	5972	10786	13051	14166	18586	24469	14479	24465	18785	16515

Country	1991	1992	1993	1994	1995*
Denmark	-	-	80	-	-
UK, Scotla	8532	4935	6156	10627	7111
Total	8532	4935	6236	10627	7111

* Preliminary

Table 14.3.2, Sandeel, Division VIa
Natural Mortality and proportion mature at age.

Age	Natural Mortality		Proportion Mature
	1	2	
0	0	0.8	0
1	1	0.2	0
2	0.4	0.2	1
3	0.4	0.2	1
4	0.4	0.2	1
5	0.4	0.2	1
6	0.4	0.2	1
7	0.4	0.2	1

Table 14.3.3, Sandeel, Division VIa
Mean weights at age in catch (g)

Age	1	2
0	1.33	1.51
1	4.21	5.33
2	7.80	8.50
3	10.72	11.76
4	12.94	14.02
5	15.83	15.98
6	16.73	16.70
7	18.40	19.49

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Table 14.3.4, Sandeel, Division VIa
Semi-annual catch-at-age, 1983-1996.

		1983		1984		1985		1986
	1	2	1	2	1	2	1	2
0	391	2253	186	1751	53	3207	368	2702
1	521	106	863	99	139	13	859	996
2	136	29	226	67	437	163	140	68
3	86	21	138	115	181	117	171	219
4	111	18	67	38	139	73	58	103
5	29	3	28	26	55	28	38	40
6	12	3	8	8	27	12	9	12
7	2	1	1	3	7	1	6	6

		1987		1988		1989		1990
	1	2	1	2	1	2	1	2
0	105	595	795	173	185	284	21	588
1	521	676	187	72	211	21	602	158
2	97	232	1216	548	136	64	229	6
3	17	37	235	131	569	294	122	11
4	45	31	41	28	135	76	324	52
5	23	20	52	45	228	23	75	19
6	4	7	21	24	19	12	18	1
7	1	4	3	8	6	8	2	1

		1991		1992		1993		1994
	1	2	1	2	1	2	1	2
0	673	94	122	578	552	814	0	309
1	423	52	226	177	134	76	38	54
2	158	66	29	26	186	67	60	105
3	10	39	8	22	31	5	31	363
4	15	23	5	10	21	16	2	61
5	27	37	1	5	8	2	2	18
6	10	12	4	7	5	1	0	2
7	1	0	1	3	5	1	0	3

		1995		1996
	1	2	1	2
0	53	67	33	46
1	281	469	218	11
2	22	66	341	188
3	17	116	47	43
4	7	72	58	99
5	1	9	31	161
6	0	0	4	42
7	0	0	1	5

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Table 14.3.5, Sandeel, Division VIa
Nominal effort (days absent) by half-year, 1983-1996
UK (Scotland) data (Figures for 1989 to 1995 are raised to total landings)

Year	I	II	Total
1983	245	202	447
1984	258	188	446
1985	262	213	475
1986	228	302	530
1987	104	186	290
1988	252	203	455
1989	173	142	315
1990	187	94	281
1991	67	49	116
1992	24	59	83
1993	55	79	134
1994	14	148	162
1995	21	110	131
1996*	65	174	239

* Provisional

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Table 14.3.6, Sandeel, Division VIa
Diagnostics from semi-annual Separable VPA (SSV)

weight for effort data = 1.0000
RMS for catch data = .4795
RMS for effort data = .3478

IFAIL on exit from E04FDF = 5
IFAIL on exit from E04YCF = 0

Number of observations = 137
Number of parameters = 45

Initial sum of squares = 335.6648
Final sum of squares = 30.4947
Residual mean square = .3315

Coefficient of determination = .9092
Adj. Coeff. of determination = .8657

Selectivities at age

age	1	2
0	0.0075	0.0279
1	0.1303	0.0554
2	0.2489	0.1053
3	0.1932	0.2402
4	0.2542	0.3731
5	0.3334	0.4467
6	0.4666	0.4867
7	0.1932	0.2402

Year/season effects

			residuals	
year	1	2	1	2
1989	1.2009	1.0184	-0.183	-0.2157
1990	1.4001	0.3995	-0.2587	0.3074
1991	0.4513	0.7052	-0.1531	-0.9122
1992	0.1323	0.4166	0.0478	-0.2
1993	0.37	0.2195	-0.1517	0.7328
1994	0.07	0.736	0.1449	0.1505
1995	0.0701	0.5716	0.5491	0.1066
1996	0.374	0.9754	0.0046	0.0307

Log catch residuals

		1989		1990		1991		1992
	1	2	1	2	1	2	1	2
0	-0.0261	-0.0426	-0.2161	0.1661	0.1028	-0.2151	0.1006	0.0646
1	-0.483	-0.856	-0.4082	1.2779	0.7319	-0.1046	-0.0909	0.1928
2	-0.4694	0.3126	0.4775	-0.5428	0.2914	0.2265	0.093	0.0344
3	0.2883	0.1131	0.515	-0.3643	-0.3972	0.7253	-0.4652	-0.4578
4	-0.3902	-0.5451	0.4301	0.0327	0.172	0.2523	0.6944	0.247
5	1.3926	-0.3045	-0.046	0.18	-0.1824	-0.0806	-0.6352	-0.0552
6	-0.0681	0.4274	-0.0714	-0.9987	-0.1342	0.1302	-0.1765	-0.3791
7	-0.1989	0.5739	-0.7779	0.0557	-0.2677	0	0.4815	0.5759

		1993		1994		1995		1996
	1	2	1	2	1	2	1	2
0	0.2264	0.2405	-0.5176	-0.1357	0.2613	-0.0018	0.0694	-0.0694
1	-1.1799	0.4636	-0.0191	-0.3418	0.4057	0.4939	1.1063	-1.1323
2	-0.5125	0.2082	0.4549	-0.1324	0.213	0.4105	-0.2688	-0.5655
3	0.079	-1.078	0.2919	0.5721	0.1388	0.1148	0.2543	-0.5635
4	-0.0452	0.2098	-0.5721	0.5459	-0.6791	-0.4219	0.2068	-0.0832
5	0.6954	-0.0494	-0.2604	-0.2441	-0.6429	-0.4057	-0.2556	0.7061
6	0.4995	-0.1876	0	-0.4959	0	0	-0.3178	1.6419
7	0.4918	-0.4501	0	-0.1122	0	0	-0.5216	0.3589

Table 14.3.7, Sandeel, Division VIa
Fishing mortalities from SSV

		1989		1990		1991		1992
	1	2	1	2	1	2	1	2
0	0.009	0.028	0.01	0.011	0.003	0.02	0.001	0.012
1	0.156	0.056	0.182	0.022	0.059	0.039	0.017	0.023
2	0.299	0.107	0.348	0.042	0.112	0.074	0.033	0.044
3	0.232	0.245	0.271	0.096	0.087	0.169	0.026	0.1
4	0.305	0.38	0.356	0.149	0.115	0.263	0.034	0.155
5	0.4	0.455	0.467	0.178	0.15	0.315	0.044	0.186
6	0.56	0.496	0.653	0.194	0.211	0.343	0.062	0.203
7	0.232	0.245	0.271	0.096	0.087	0.169	0.026	0.1
Fbar (1-3)	0.229	0.136	0.267	0.053	0.086	0.094	0.025	0.056

		1993		1994		1995		1996
	1	2	1		1	2	1	2
0	0.003	0.006	0.001	0.02	0.001	0.016	0.003	0.027
1	0.048	0.012	0.009	0.041	0.009	0.032	0.049	0.054
2	0.092	0.023	0.017	0.078	0.017	0.06	0.093	0.103
3	0.071	0.053	0.014	0.177	0.014	0.137	0.072	0.234
4	0.094	0.082	0.018	0.275	0.018	0.213	0.095	0.364
5	0.123	0.098	0.023	0.329	0.023	0.255	0.125	0.436
6	0.173	0.107	0.033	0.358	0.033	0.278	0.174	0.475
7	0.071	0.053	0.014	0.177	0.014	0.137	0.072	0.234
Fbar (1-3)	0.070	0.029	0.013	0.099	0.013	0.076	0.071	0.130

Table 14.3.8, Sandeel, Division VIa
Fitted populations from SSV

	1989		1990		1991		1992	
	1	2	1	2	1	2	1	2
0	0	26621	0	17307	0	71170	0	45058
1	3395	1304	7794	2918	5155	2184	21019	9283
2	967	531	554	290	1282	849	944	677
3	2370	1392	354	200	206	140	584	422
4	871	475	807	419	134	89	87	63
5	197	98	241	112	267	170	51	36
6	54	23	46	18	69	42	92	64
7	41	24	21	12	18	12	28	20
SSB (t)	48987		23525		19650		17607	

	1993		1994		1995		1996		1997
	1	2	1	2	1	2	1	2	1
0	0	20685	0	101348	0	7406	0	5884	0
1	13415	5744	6192	2757	29906	13315	2195	939	2573
2	4076	2754	2550	1856	1189	866	5797	3913	728
3	480	331	1994	1457	1273	930	604	416	2890
4	283	191	232	169	904	658	601	405	270
5	40	26	130	94	95	69	394	258	230
6	22	14	17	13	50	36	40	25	137
7	51	35	33	24	19	14	28	19	13
SSB (t)	42526		47206		37300		66871		46311

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Table 14.3.9, Sandeel, Division VIa
Trends in landings, Mean F, SSB and recruitment

Year	Landings ('000 t)	Mean F (1-3)	SSB (tonnes)	Recruits (millions)
1983	13	0.090	52936	33949
1984	14.2	0.159	62617	17569
1985	18.6	0.179	64750	46437
1986	24.5	0.295	48133	60022
1987	14.5	0.113	57047	9200
1988	24.5	0.289	87216	7814
1989	18.8	0.365	48987	26621
1990	16.5	0.320	23525	17307
1991	8.5	0.180	19650	71170
1992	4.9	0.081	17607	45058
1993	6.2	0.100	42526	20685
1994	10.6	0.112	47206	101348
1995	7.1	0.090	37300	7406
1996	13.3	0.202	66871	5884 *
1997			*46311*	

* Value set aside

Table 14.3.10 Stock: Sandeel in Division VIa

Assessment Quality Control Diagram 1

Average F(1-3,u)									
Date of assessment	Year								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
1989[1]	0.129	0.279							
1990[2]	0.071	0.124	0.115						
1991[2]	0.09	0.16	0.11	0.08					
1992[3]	0.09	0.18	0.14	0.09	0.05				
1993[3]	0.08	0.15	0.16	0.10	0.04	0.01			
1994[3]	0.05	0.09	0.10	0.07	0.03	0.01	0.01		
1995[3]	0.10	0.20	0.24	0.18	0.08	0.03	0.04	0.04	
1996[3]	0.11	0.29	0.37	0.32	0.18	0.08	0.1	0.11	0.09

[1]"Hand" tuned. [2]*Ad hoc* tuned. [3]Separable

Remarks:

Assessment Quality Control Diagram 2

Recruitment (age 0) Unit: '000 million									
Date of assessment	Year class								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
1989	15.1	4.3							
1990	24.4	8.7	14.0						
1991	22.8	27.0	50.1	-					
1992	35.0	23.9	66.2	42.8	-				
1993	33	29	95	96	397	-			
1994	26	21	60	45	203	140	-		
1995	23	17	47	37	193	130	92	-	
1996	9.2	7.8	26.6	17.3	71.2	45.1	20.7	101.3	7.4

Remarks:

Table 14.3.10 (Cont'd) Stock: Sandeel in Division VIa

Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)											
Date of assessment	Year										
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1989	81.1		[1]	[1]							
1990	150.0	122.9	85.1	[1]	[1]						
1991	77.5	144.6	112.6	91.3	[1]	[1]					
1992	114	82	55	61	78	[1]	[1]				
1993	132	95	63	79	98		[1]	[1]			
1994	108	73	45	51	54	136		[1]	[1]		
1995	100	66	38	40	42	122	150	193	[1]	[1]	
1996	87	49	24	20	18	43	47	37	67	46	

[1]Forecast.

Remarks:

Figure 14.3.1, Sandel in Division VIa
Stock Summary

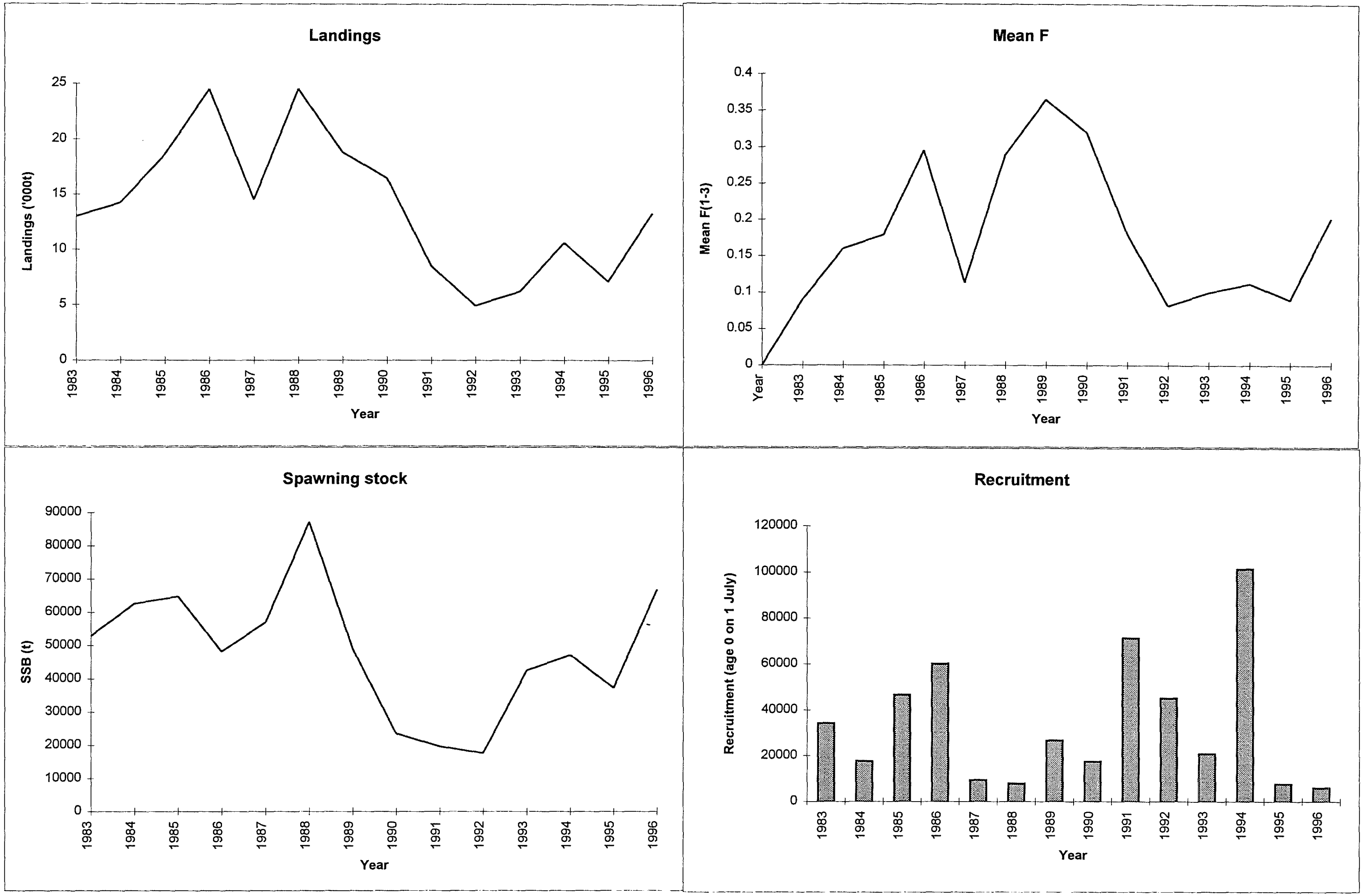

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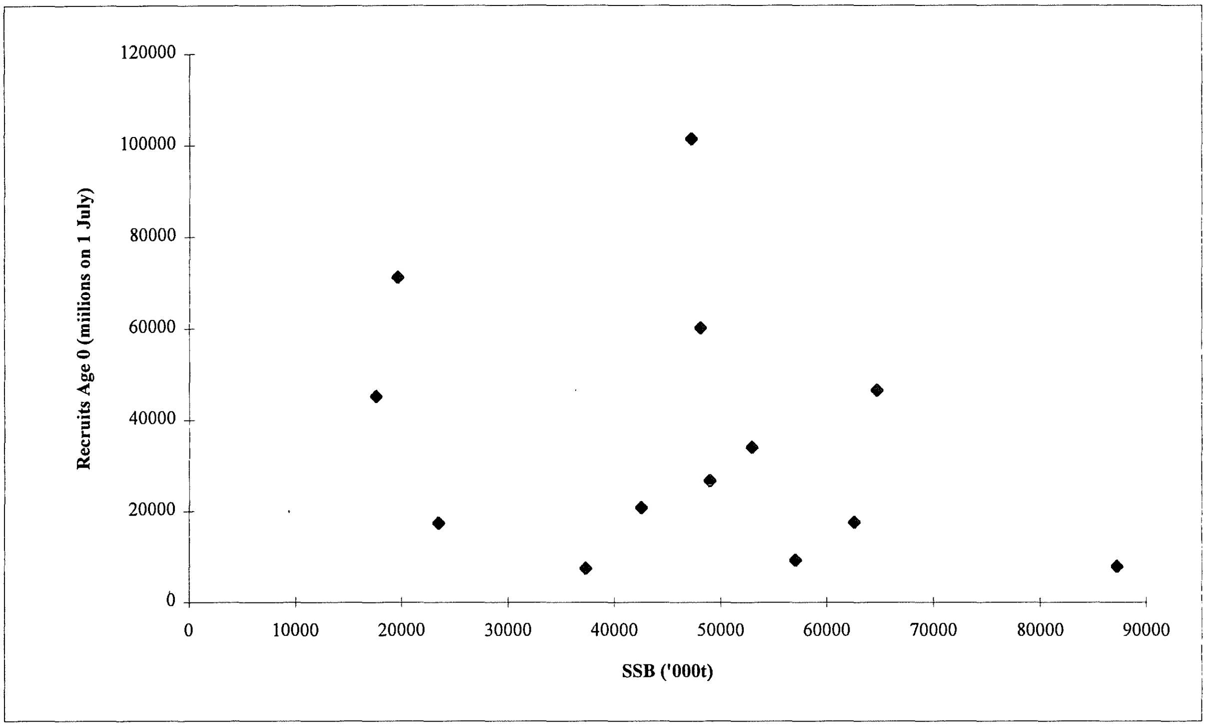
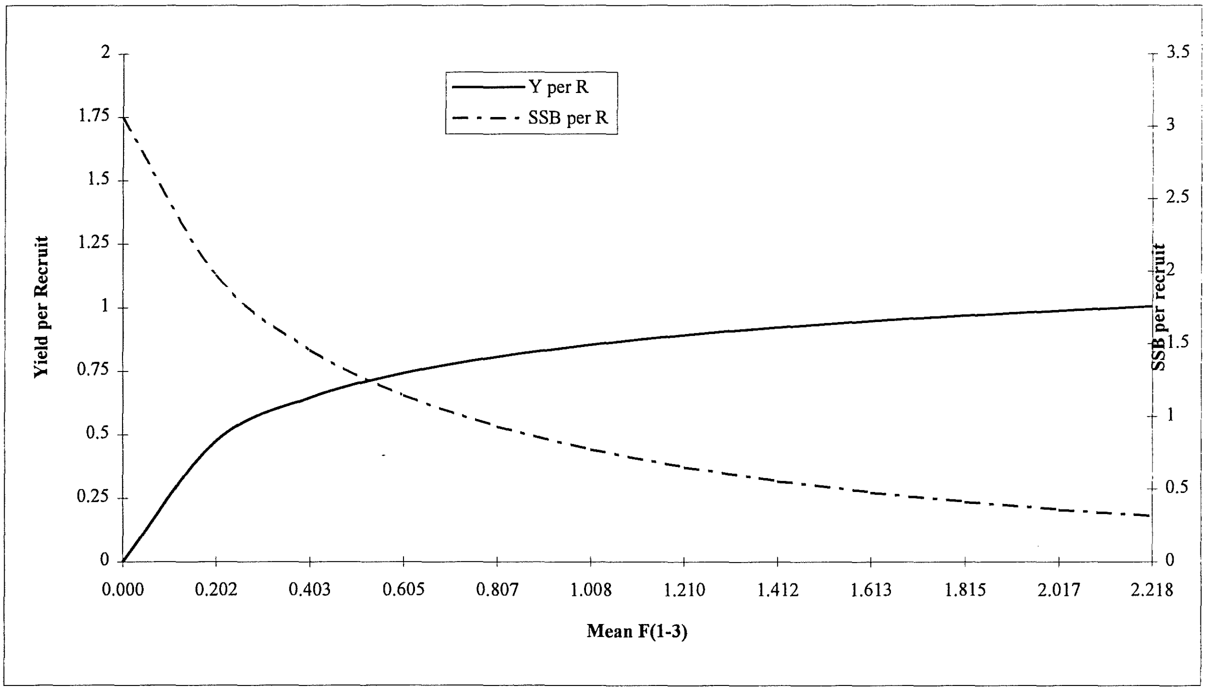
Figure 14.3.2
Sandeel in Division VIa, Spawning stock and recruitment



Sandeel in Division VIa, Yield and SSB per Recruit



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15 MBAL ESTIMATES

The Working Group has been requested to provide estimates of the minimum biologically acceptable level of spawning stock biomass (MBAL) for as many stocks as possible, with an explanation of the basis on which the estimates are obtained.

In its 1991 report (Anon. 1991) ACFM defined the MBAL concept as it is presently used. It was stated that there is likely to be a level of spawning stock below which the probability of poor recruitment increases as spawning stock size decreases - some idea of the bounds within which it may lie can be obtained by examining historic variation in recruitment at different levels of spawning stock. For the present purposes this is named the minimum biologically acceptable level (MBAL).

Guidance on the estimation of MBAL was given for two cases: 1) in stocks for which there is adequate information on historic stock and recruitment, the MBAL can be defined by the level of spawning stock below which the data indicate that the probability of poor recruitment increases as spawning stock size decreases and 2) in stocks for which information is limited, it is safest to assume that the MBAL is equal to the lowest level of spawning stock so far recorded. Even though there may be no evidence that recruitment is depressed at this level of spawning stock, it must be assumed that the MBAL level of spawning stock defined above may lie at any level below that so far observed.

The present Working Group has had difficulties in applying the second definition for some stocks. Several of the stocks dealt with have been in a declining state where each year represents a new historic minimum. If the second definition is applied strictly as it is worded, every year would thus represent a new MBAL, the effect being that it would be impossible for any stocks to which definition 1) does not apply to have SSBs below MBAL. Since recruitment in the last data year is poorly estimated the second definition may thus lead to estimates of MBAL which will later be demonstrated to be below the level for which recruitment has increased probability of being reduced. The Working Group has therefore chosen to interpret the second definition of MBAL as the lowest level of spawning stock so far recorded *from which recruitment at or above average has been demonstrated.*

Another variant of this approach, which in earlier reports has been used by this Working Group, is to look for *the lowest historic level from which the stock has been seen to recover.* This criterion is more conservative than the first approach in requiring observations of stock recovery and not just recruitment. This raises the question whether the sequence of events in stock collapse and recovery should be included as part of the basis for determining MBAL. This is also relevant to the first ACFM criterion There are several historic cases of stock-recruitment relationships being different in the collapse and the recovery phase, and this should be taken into account when judging the dangers of collapse or the possibilities for recovery in a specific situation. However, on the basis of the present MBAL definition as presented by ACFM is seems most consistent to base the MBAL determination on stock-recruitment plots without regard to the underlying event sequence.

The Working Group on Methods of Fish Stock Assessment addressed the issue of MBAL determination in its 1993 meeting (Anon. 1993). It was suggested that MBALs should be determined on the basis of a maximum likelihood fit of a recruitment function. MBAL could then be determined as the SSB at 50% of maximum recruitment or - if this estimate is judged to be unacceptable - as 20% of the virgin biomass estimated from SSB/R analysis and either a fitted stock-recruitment relationship or from average recruitment. The proposal of the Methods Working Group included various supplementary criteria to exclude insensible estimates and to emphasise estimates with properties similar to the ACFM definition. These criteria are based on judging the differences between various means and slopes on either side of an estimate.

The Methods Working Group approach is not entirely consistent with the MBAL definition of ACFM. The choice of 20% of virgin biomass is rather arbitrary and is not directly associated with a criterion based on reduction in recruitment. A value of SSB equivalent to 50% of maximum recruitment seems to be similarly arbitrary and would result in MBALs well into the range of reduced recruitment if the recruitment model is considered to represent any realism. The main asset of these approaches seems to be that a model based estimate using all data points will be less sensitive to new observations than an approach directly on the ACFM criteria. Furthermore, the procedure proposal of the Methods Working Group has never been adopted by ACFM and developed into an established approach to be used by Working Groups.

Since these definitions of MBAL were put forward the precautionary approach has been established as a criterion of guidance in future fisheries management. The choice of MBAL according to ACFM's definition 1), where a single low observation is chosen, may not be in accordance with a precautionary approach. However, there is as yet no new guidance on how to incorporate precautionary approach considerations in MBAL estimations.

In view of this the Working Group has decided to adhere to the criteria of ACFM, 1991, with the necessary extension needed to handle recent values of historic low SSB found in some stocks. The criteria are thus:

a) in stocks for which there is adequate information on historic stock and recruitment, the MBAL is defined by the level of spawning stock below which the data indicate that the probability of poor recruitment increases as spawning stock size decreases.

b) in stocks for which information is limited or for which no reduction in recruitment is apparent for low SSBs MBAL is assumed equal to the lowest level of spawning stock so far recorded. However, historically low SSBs in recent years, for which only shaky recruitment estimates are available, are not considered to be useable MBAL estimates.

For illustrative purposes the values which would result from the Methods Working Group approach has been calculated for some stocks. These estimates and the present MBAL estimates based on ACFM's (1991) criteria are presented in Table 15.1. The estimates based on the Methods Working Group approach are:

1) The SSB at 50% of maximum recruitment on the fitted stock recruitment relationship.

2) 20% of the virgin biomass as estimated from SSB/R for F=0 and average recruitment.

Stock recruitment relationships are modelled as described for each stock in the sections on a medium-term prognosis. SSB/R values at F=0 are taken from Y/R analysis output.

Table 15.1 MBAL estimates in 000 t. The estimates by the Working Group are presented in the MBAL column, based on ACFM (1991) criteria. na = not available due to lack of SSB and R estimates. For illustration the estimates resulting from some of the criteria of the Methods Working Group (1993) are included. The criteria a), b), 1), 2) are described in the text.

Stock	ACFM 1991criteria		Virgin biomass and recruitment		Recruitment model				MBAL, Meth.WG 1993 criteria	
	MBAL	Criterion	SSB/R for F=0, kg	Average R *10-6	Type	Parameters			1)	2)
Cod in IV, VIId and Skagerrak	150	a)	12.7	400	1)	-	-	-	-	1016
Haddock in IV and IIIa	65	b)	.072	46600						671.04
Whiting in IV and VIId	250	b)	.030	48300						289.8
Saithe in IV and IIIa	150	a)	11.2	223						499.52
Sole in IV	25	b)	3.76	139						104.528
Sole in VIId	7	b)	3.65	22.9						16.717
Plaice in IV	300	b)	5.69	459						522.342
Plaice in VIId	6	b)	5.4	27						29.16
Plaice in IIIa	25	b)	6.7	52.9						70.886
Norway pout in IV and IIIa	120	a)	0.0033	142000						93.72
Sandeel in IV	430	b)		584000						0
Sandeel in IIIa	na									0
Sandeel, Shetland	na									0

[1]Shepherd curve with moving average.

16 THE PRECAUTIONARY APPROACH

16.1 The Precautionary Approach and Biological Reference Points

The Comprehensive Fishery Evaluation (COMFIE) Working Group (ICES 1996/Assess:20) has reviewed the various international declarations and agreements relating to the precautionary approach and fisheries and has attempted to set up a hierarchy of biological reference points which may be used in this context. In brief, the main declarations and agreements are the Rio Declaration on Environment and Development (1992), the Code of Conduct for Responsible Fisheries (1995) and the agreement on Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. It is established that the precautionary approach shall be applied and that this shall not be compromised by short-term considerations or lack of information. States shall in this context establish reference points, which are of two types:

- Target reference points, which shall meet management objectives,
- Limit reference points which are boundaries.

The texts can be interpreted such, that the criteria in terms of biomass and fishing mortality are:

- Limit points : Prob($B<B_{lim}$) and Prob($F>F_{lim}$) must be low,
- Target points : Prob($B<B_{target}$) and Prob($F>F_{target}$) < 0.5.

The various texts are reasonably explicit with regards to limit points in stating that management shall maintain stocks at levels capable of producing MSY, that fishing effort should not exceed sustainable use and that the fishing mortality rate which generates maximum sustainable yield should be regarded as a minimum standard for limit reference points. The COMFIE Working Group gives an interpretation of these statements in terms of reference points:

Limit reference points are:

- F_{crash} (which can be substituted with F_{med} if F_{crash} is not available),
- F_{MSY} (which may be substituted with F_{max} or $F_{0.1}$ if not available),
- B_{MSY}.

Definitions of target reference points are difficult to establish on basis of the texts. It should in this context be noted that the clear statement that an equivalent of F_{MSY} is a minimum standard for *limit* reference points has far-reaching implications. The expectation on basis of the thinking in classical mainstream fisheries biology would be that F_{MSY} type reference points could be considered in relation to target reference points.

Within the ICES advisory framework there has been a development towards an approach which basically is based on the same line of thoughts as the precautionary approach. This has taken place in two stages: first the introduction of the MBAL concept as the basis for the advice from 1991 and later the medium-term considerations, where the risk of the SSB falling below MBAL on the medium-term has been analysed from a probabilistic point of view. The concept of medium-term probabilities of SSB falling below MBAL is much in line with the approach above, that Prob($B < B_{lim}$) should be low.

As an extension to this approach there are now signs that clients start to request advice on fishing mortality levels which - if these are not exceeded - should be associated with a high probability of maintaining stock levels above a threshold level.

The Working Group has therefore tried to illustrate this understanding of the precautionary approach in the context of concepts already developed within the ICES advisory framework. For several stocks presented in this report results from medium term analysis are presented, where the levels of fishing mortalities associated with 80, 90 and 95% probability of SSB staying above MBAL has been interpolated (F(MBAL,0.8), F(MBAL,0.9) and F(MBAL,0.95) respectively (Figure 16.1). These levels of fishing mortality would be F_{lim} levels if MBAL is accepted as a B_{lim} reference.

However, if MBAL is to be replaced by B_{MSY} as B_{lim} this analysis will result in different F_{lim} levels which are expected to be higher.

16.2 A Sustainability Reference Point Based on the Precautionary Approach

16.2.1 Introduction

A fundamental limit reference point required by the Precautionary Approach is that fishing mortality should be sustainable; i.e. less than F_{crash}. It is usually not possible to estimate F_{crash} with any degree of precision since this requires a well estimated stock-recruitment function in the region close to the origin of the stock-recruitment plot. This section attempts to address this problem by taking the precautionary view that there always exists a stock-recruitment relationship and that it is near to linear below the lowest observed spawning stock sizes. This assumption allows the definition of replacement lines which will lead to the stock remaining above the lowest observed spawning stock size and hence fishing mortalities which should have a high probability of being sustainable.

16.2.2 Theory

The sustainability of harvesting is largely determined by two factors, the relationship between the size of spawning stock (SSB) and the annual number of offspring (the recruits) produced, and the subsequent survival of the recruits on entering the fishery. This is illustrated in Figure 16.2 which shows a theoretical stock-recruitment curve and a recruit survivorship line. Where the two lines intersect is an equilibrium point to which the population is attracted (Beverton & Holt, 1957) . If the survivorship line lies above the stock recruitment curve there is no non-zero equilibrium point and the population is attracted to the origin. The slope of the survivorship line is affected by the fishing mortality rate. The more heavily the stock is exploited, the steeper the slope. This line is also called the replacement line since it defines the survivorship needed to replace the spawning stock in the future. It is important to note the distinction between the replacement line and fishing mortality. The replacement line (referred to as G below) is dependent on a number of biological parameters including growth, maturity and natural mortality. Thus a unique value of F can give a variety of replacement lines if the biological parameters vary.

With perfect information of the type in Figure 16.2 it is easy to define conditions of sustainability and collapse but this pays no regard to estimation errors or the limitations of real data. Crucial to our goal is the need to establish a criterion related to sustainability which is estimable. Consider the stock recruitment data illustrated in Figure 16.3. This shows the typical problem where data are scattered and are inadequate to define the left hand part of the stock-recruitment curve (the broken line). If we knew the stock recruitment curve we could define the slope of the line, G_{crash}, the replacement line for the fishing mortality which results in stock collapse. However, the best we can do is to define G_{loss}, the replacement line which corresponds to the lowest observed spawning stock (LOSS). Although this is not the replacement line we seek it has certain value because;

a) G_{loss} is a minimum estimate of G_{crash},

b) any fishing mortality which corresponds to a replacement line to the right of G_{loss} should be sustainable and,

c) any fishing mortality which corresponds to a replacement line to the left of G_{loss} should result in an equilibrium stock size below the lowest observed value or stock collapse.

Given these properties we wish to know if the present level of fishing mortality is greater than G_{loss}. Clearly we wish to establish a fishing mortality rate which is below G_{crash} with some degree of confidence. To do this requires;

i. the estimation of the uncertainties in replacement lines calculated for any fishing mortality rate,

ii. the estimation of the uncertainties in G_{loss} and,

iii. how close G_{loss} is to G_{crash}.

16.2.3 Methods

In order to calculate equilibrium yield and biomass curves it is necessary to describe a stock-recruitment relationship. There are many parametric stock recruitment which can be used to summarise the data. Although some of these are quite flexible in shape the choice of function to use is usually stock-dependent. To avoid the need to choose a particular function a non-parametric approach has been used here. Non-parametric methods have been used before (Rice and Evans) and have the advantage that the data determine the shape of the curve. The particular method used here is to fit a lowest curve (a smoothing method assuming local linearity). The equilibrium yield, Y_e, and equilibrium spawning stock, S_e, can then be calculated simply by multiplying the fitted recruitment value, by the appropriate yield per recruit value, $y(\theta)$, or spawning stock biomass per recruit value, $s(\theta)$ i.e.;

$$Y_e = \overline{R} y(\theta) \quad \mathbf{(1)}$$

$$S_e = \overline{R} s(\theta) \quad \mathbf{(2)}$$

The parameters, θ, are the standard vital quantities of weight at age, maturity, fishing mortality rate and natural mortality rate.

The replacement line, G_{loss}, can be defined as the line joining the origin of the stock-recruitment plot to the point given by the fitted recruitment value, $\overline{R}_{loss}$, at the lowest observed spawning stock biomass, S_{loss}. The slope of this line is simply calculated from;

$$G_{loss} = \frac{\overline{R}_{loss}}{S_{loss}} \quad \mathbf{(3)}$$

Equations 1–3 enable the calculation of equilibrium yield and biomass and the replacement line corresponding to G_{loss}. These calculations are all deterministic and take no account of the uncertainties in the data. Of particular concern is the uncertainty in G_{loss} replacement line and the uncertainty in the replacement lines which correspond to any given fishing mortality rate. Uncertainty in the G_{loss} can be considered by calculating a frequency distribution of the estimate in equation (3). This can be achieved by bootstrapping the lowest fit to the stock recruitment data. It has been done here by adding a random residual, obtained from the initial fit, to the fitted recruitment values.

The position of the G_{loss} is determined directly from the stock-recruitment data. The calculation of replacement lines for given fishing mortality rates can be done from the standard "per recruit" formulae. The slope, G_F, of the replacement line for a particular value of fishing mortality rate, F, is simply $1/s(\theta)$ i.e.;

$$G_F = \frac{1}{s(\theta)} \quad \mathbf{(4)}$$

The parameters, θ, are generally measured with error or are by their nature variable quantities. Growth, for example would be expected to vary from year to year leading to different annual mean weights at age. These sources of error need to be considered when calculating a frequency distribution of G_F. The calculation of such a frequency distribution has been achieved here by simulation. A mean and variance for each parameter was specified with an associated distribution. The quantity G_F was then calculated repeatedly by drawing parameter values at random from the specified distributions.

Given the estimated distributions of the replacement lines it is simple to calculate the probability that the present fishing mortality rate, F_t, has a replacement line above G_{loss}. This probability is given by;

$$pr\left(G_{F_t} \geq G_{loss}\right) = \sum_i pr\left(G_{loss} = G_{F_i}\right) * pr\left(G_{F_t} \geq G_{F_i}\right) \quad \mathbf{(5)}$$

Alternatively one might consider the distribution of the ratio G_{loss}/G_F. This ratio will be centred on one if $G_{loss}=G_F$. If $G_{loss}<G_F$, then the ratio will be less than one. Hence the probability we seek is simply the probability that this ratio is less than or equal to one.

Given the definition of this probability it is then possible to find a value of F which produces a probability that $G_{loss}<G_F$ which is acceptably low. This will correspond to sustainable fishing.

16.2.4 Results for North Sea demersal stocks

The methods described above have been applied to the six main North Sea demersal stocks. The input data are the stock-recruit summary data from the VPA and the input to sensitivity analysis used in the catch forecast. The latter gives estimates of the CVs for the "per recruit" parameters needed in the analysis.

North Sea cod (Figure 16.4): Spawning stock has declined for many years and there is evidence of lower recruitment at low SSB. The estimated G_{loss} distribution (vertical shading) lies somewhat above the replacement line distribution for the present exploitation level (horizontal shading). This gives a probability that the present exploitation regime will lead to stock sizes below the lowest observed SSB of about 10%. This is substantially lower than the probability estimated in Cook (1996) of 63% and is due to (a) a slightly higher value for G_{loss} based on the current assessment, (b) lower selectivities on the youngest fish and (c) lower CVs estimated for the "per recruit" input values. The estimate of the probability $G_F > G_{loss}$ is very sensitive to (b) and must therefore be interpreted carefully (see Section 16.2.5).

Equilibrium yields and SSB show steady declines as F increases and this is consistent with the historical data. The trajectory of equilibrium SSB suggests that the stock has been exploited at levels close to those which would cause collapse. The steepness of the slope of the equilibrium SSB and yield curves suggest that small increases in F could lead to large reductions in SSB and yield. Given uncertainties in assessments this implies a precautionary approach would require target fishing mortalities significantly lower than recent levels.

Haddock (Figure 16.5): Like cod, haddock has been reduced to very low SSB levels in recent years. Unlike cod, however, these low levels are below the expected equilibrium state and are likely to have been due to lower than expected recruitment. Nevertheless the present exploitation level has a 13% probability of being above G_{loss}. Since the lowest SSBs observed are close to the origin, G_{loss} is likely to be a good estimate of G_{crash} which implies a reduction in fishing mortality rate would be highly desirable to ensure sustainability. The equilibrium SSB and yield curves are rather flat over the range of fishing mortalities observed. Only moderate increases in equilibrium SSB could be expected from quite large reductions in F.

Whiting (Figure 16.6): Whiting SSB has not reached the very low levels observed for cod and haddock. Thus the estimate of G_{loss} is likely to be much lower than G_{crash}. The probability that G_F exceeds G_{loss} is 16% which implies a moderate chance that the stock will decline below the lowest observed levels. It is noteworthy that recruitment in the last decade has been lower than previous years and is the reason why recently observed values of SSB and yield lie below the predicted equilibrium values.

Saithe (Figure 16.7): The fishery for saithe developed more recently than the other gadoids and this is reflected in the relationship between the observed SSB and yield and the predicted equilibrium states. An apparently almost virgin stock in the 1970s lead to very high yields, well above the equilibrium state. However, fishing mortality in the 1980s appears to have been well beyond sustainable levels and the stock declined rapidly. More recently F has reduced and SSB is increasing in line with the expected equilibrium. The present level of F gives a replacement line with a low probability of exceeding G_{loss} (3%), However, like cod, saithe SSB is very sensitive to small changes in F and it would be desirable to keep the exploitation level away from G_{loss}.

Sole (Figure 16.8): Recruitment in sole is characterised by periods of relatively stable recruitment with occasional very large year classes. This leads to periodic large departures of SSB and yield above the expected equilibrium state. Since the 1960s SSB has declined and yield increased in line with the expected equilibria. In recent years the fishing mortality rate has remained close to 0.45 and the stock has cycled around the expected equilibrium state. Although sole SSB has reached low levels, the present exploitation rate has a low probability of exceeding G_{loss} (1%) and therefore has a low probability of falling below the lowest observed SSB.

Plaice (Figure 16.9): The results for plaice are rather similar to sole with recruitment having a similar pattern. The observed yield and SSB values track the predicted equilibrium trends but in general lie above the equilibrium states. This is partly due to the occasional large year classes. The equilibrium plots suggest that the recent fairly rapid decline in the SSB was due mainly to the stock returning to equilibrium after the large 1985 year class was fished out. The present exploitation rate gives a replacement line with a 9% probability of exceeding G_{loss}. However, G_{loss} is likely to be well below G_{crash} and there is therefore only a moderate probability of declining below the lowest observed SSB at present F levels.

16.2.5 Sensitivity of replacement lines

As noted in the results for cod above, a number of relatively small changes in the assessment appear to have a large effect on the estimate of the probability that $G_F > G_{loss}$. This is a cause for concern if the analytical method is not robust. It appears that the main cause of the change in the cod analysis is due to the data used to calculate G_F. In order to investigate the problem a sensitivity analysis was performed on G_F using the same methodology as is used in the catch forecast sensitivity analysis (Cook, 1993). The results show that the various stocks display different sensitivities related to their biology and this has implications for management.

Cod (Figure 16.10): Replacement lines (i.e. R/SSB) are most sensitive to the overall exploitation rate and the selectivities at ages 2–4, the juvenile stage. There is also some sensitivity to natural mortality. This means that relatively small changes in the exploitation rate and exploitation pattern can have a large effect on the replacement line. Theoretically is means managers have potentially a large amount of control of the fishery. It also means however, that small changes in exploitation regime could quickly move the stock outside safe biological limits.

Haddock (Figure 16.11): Most sensitivity is due to natural mortality, both its overall magnitude and age effects on the youngest fish. There is high sensitivity to overall fishing mortality rate but this is small compared with natural mortality. It shows that changing fishing mortality rate will have a comparatively smaller influence on the replacement line giving managers less control of the fishery unless very large changes are made to the exploitation rate. It does mean, however, that the stock is less vulnerable to fishing mortality rate.

Whiting (Figure 16.12): Results for whiting are very similar for haddock showing a high dependence on natural mortality.

Saithe (Figure 16.13): Sensitivities for saithe are similar to cod with fishing mortality dominating the replacement lines.

Sole and plaice (Figures 16.14 and 16.15): The flatfish show similar characteristics. Both are sensitive to fishing mortality rate but with a comparatively low sensitivity to the exploitation pattern. Unlike the roundfish they display moderate sensitivity to weight at age (i.e. growth) and the proportion mature at ages three and four.

It is clear from the sensitivity analysis that the replacement lines for a stock are closely related to their biology. Fish with a high cumulative mortality before the age of maturity (i.e. cod and saithe) are very vulnerable to the exploitation pattern and level of fishing mortality. Small changes in exploitation rate are expected to have a large effect on the stock. For these stocks, it would be desirable to ensure that the probability that $G_F > G_{crash}$ is kept very low.

For fish with a later age of full recruitment to the fishery and a low age of maturity (e.g. whiting) large changes in exploitation rate are required to alter the replacement line. These fish are less vulnerable to high exploitation rates. For such stocks a higher probability level for $G_F > G_{crash}$ might be acceptable, particularly since most of the uncertainty in the replacement line is due to exogenous factors such as natural mortality. Haddock are somewhat intermediate between cod and whiting in this respect.

The flatfish have low natural mortality and an intermediate age of maturity. Their sensitivity is mostly due to exploitation rate and intrinsic factors such as maturity and growth. However, the magnitude of the sensitivities is much lower than the roundfish.

Figure 16.1 F levels corresponding to probabilities of 80, 90 and 965 % of SSB being above MBAL in medium term.

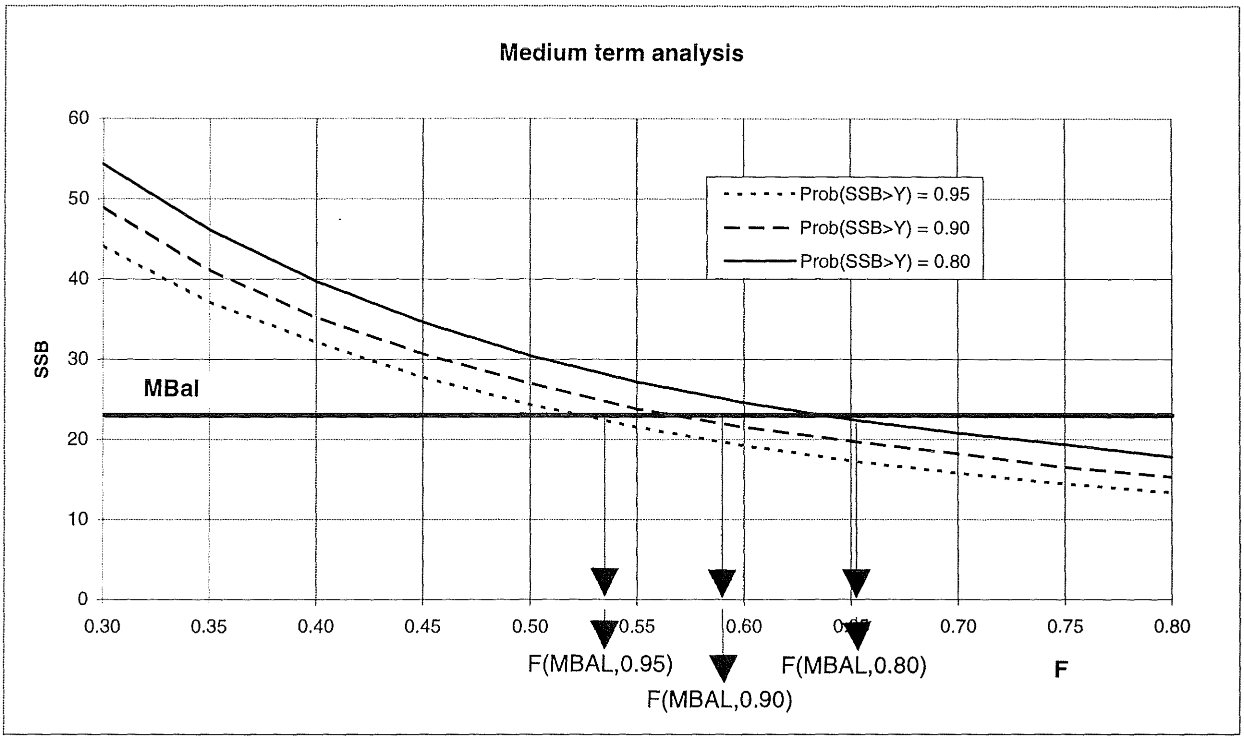


Figure 16.2

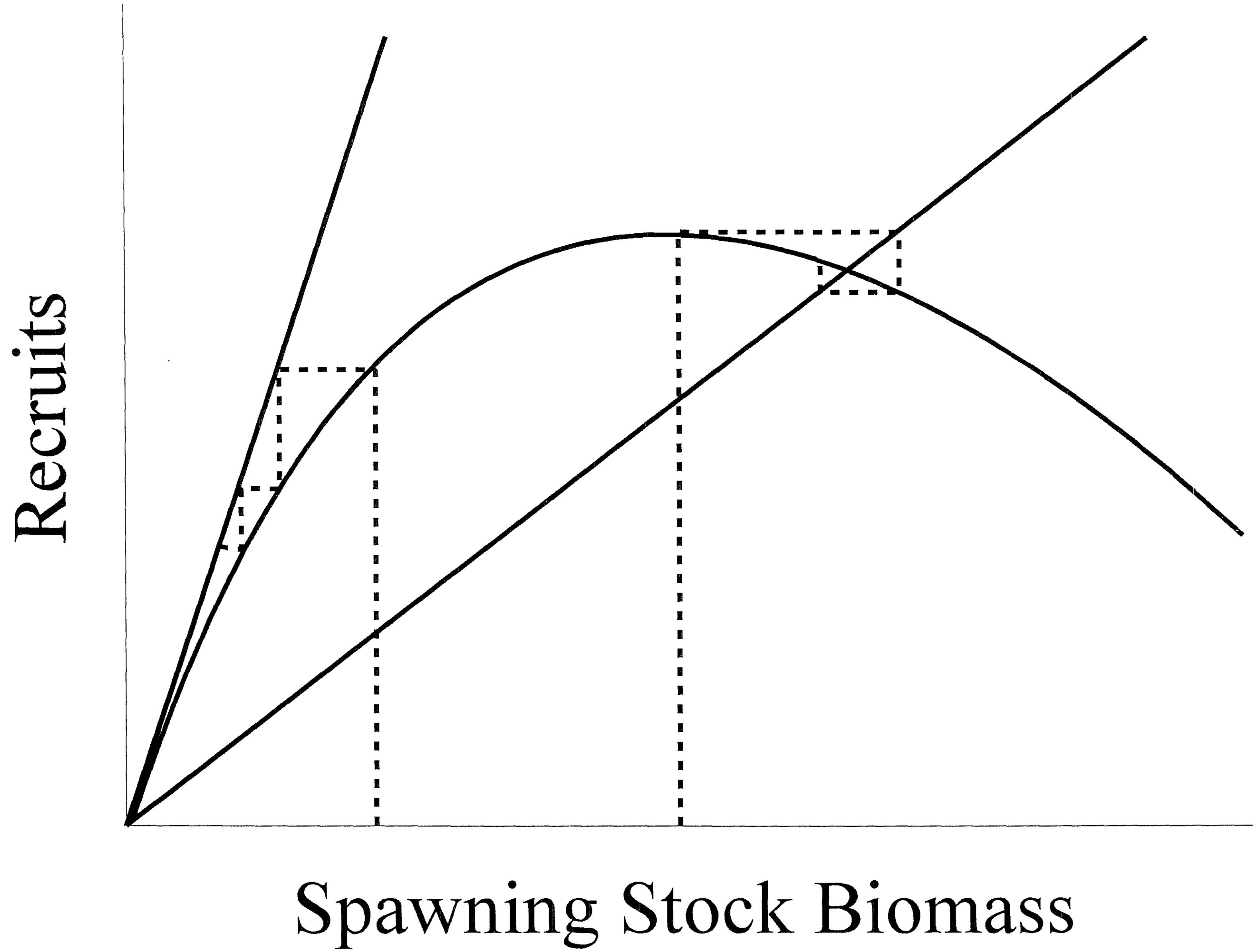


Figure 16.3

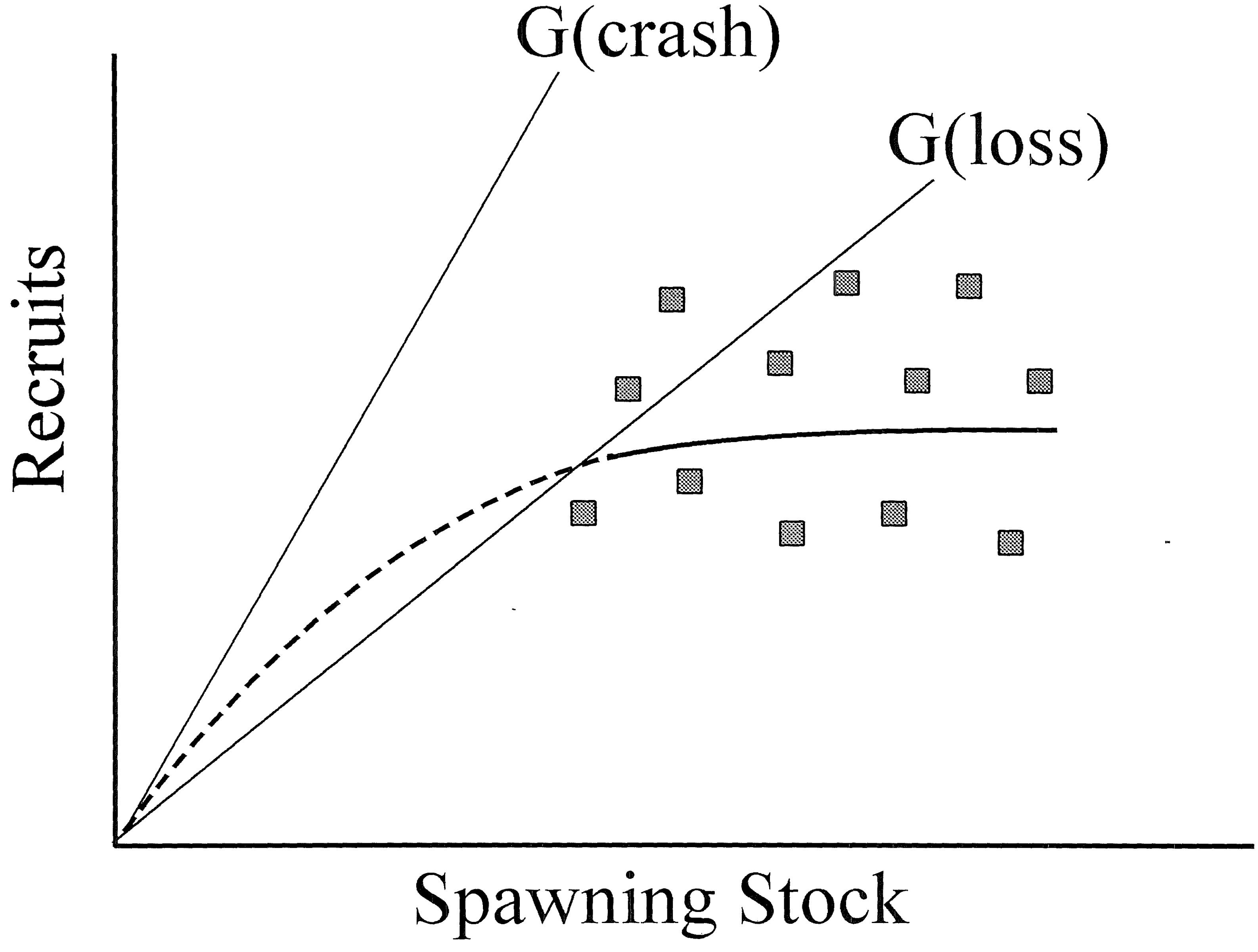


Figure 16.4. Cod, IIIa+IV+VIId

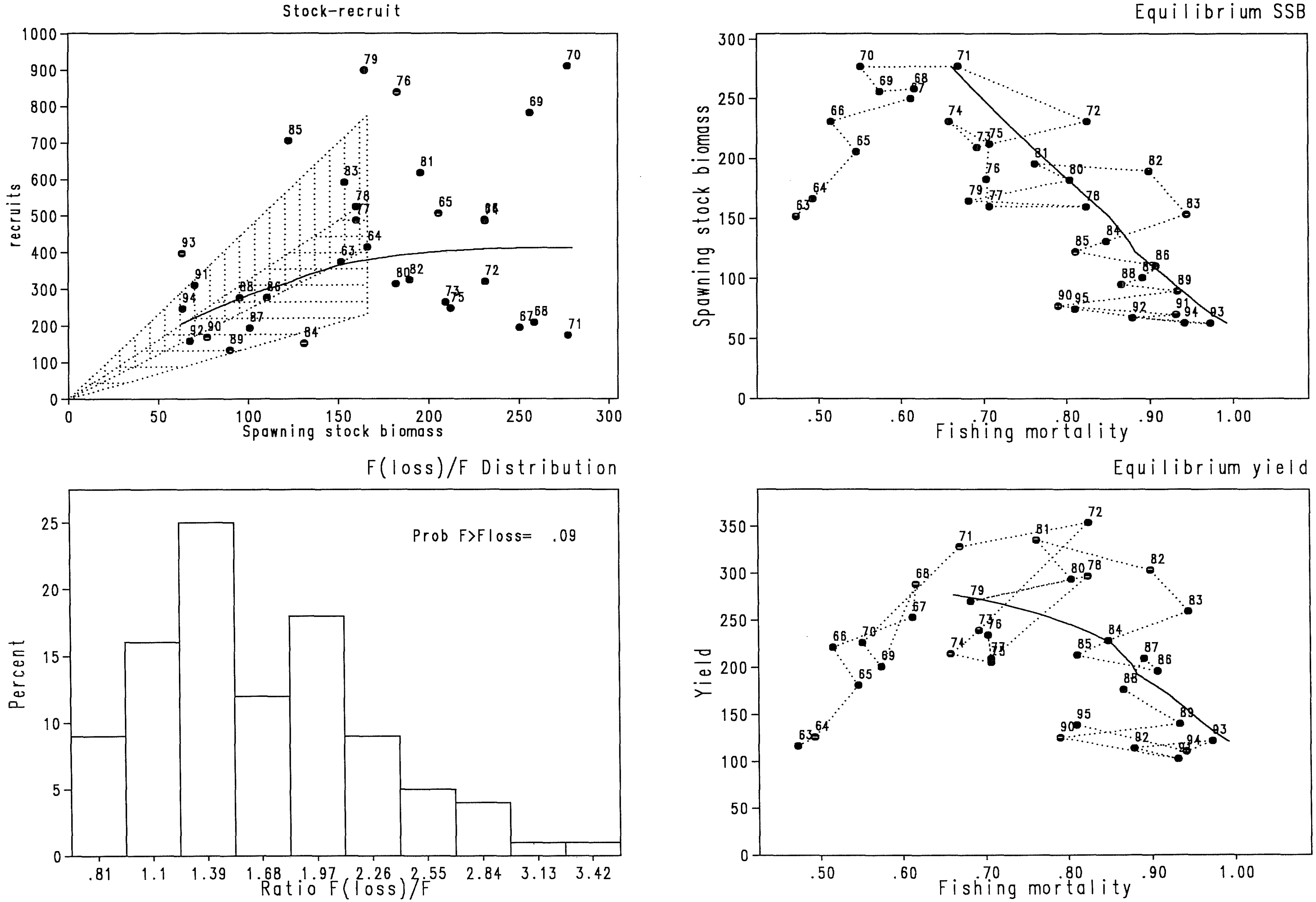


Figure 16.5. Haddock, IV+IIIa

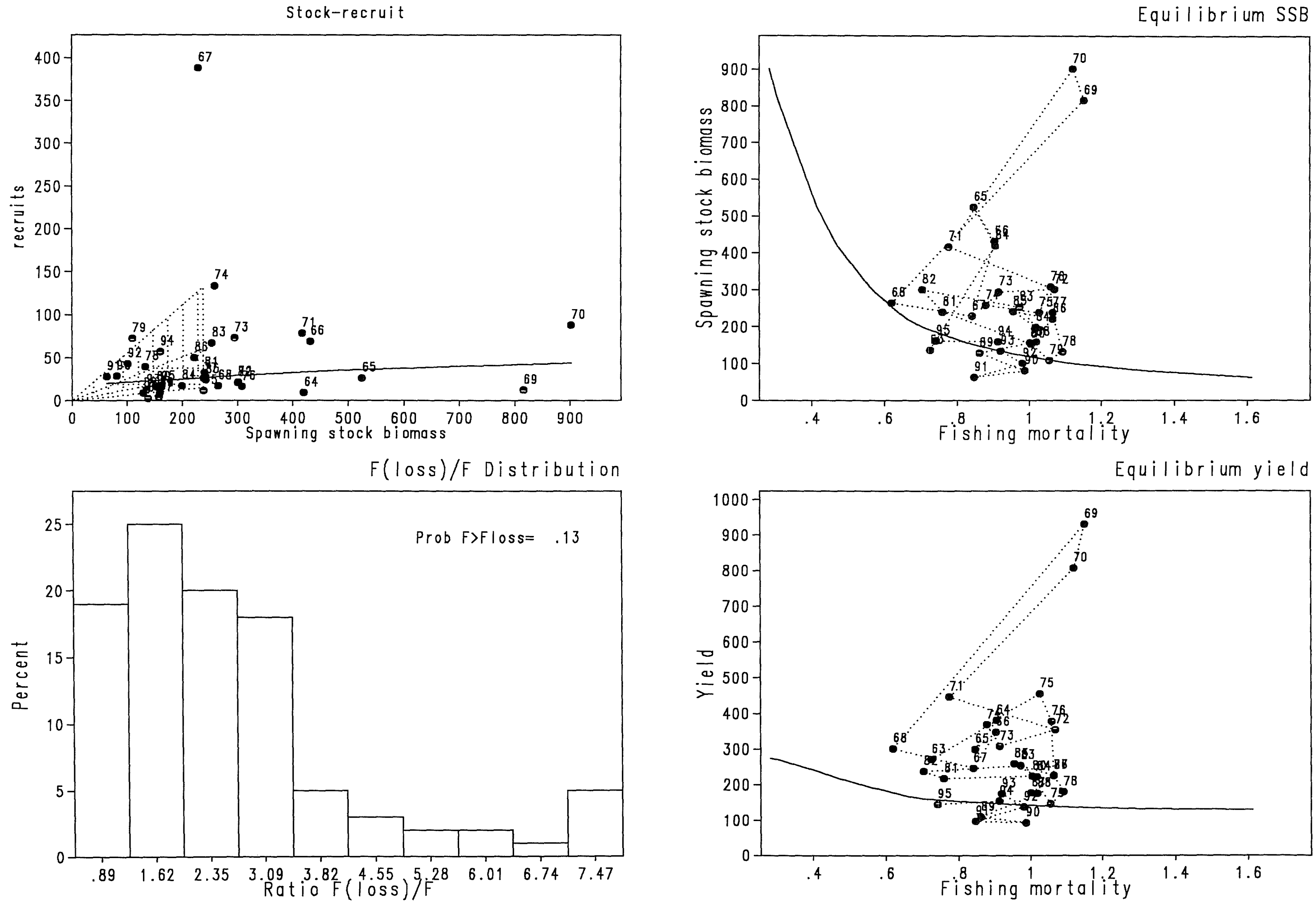


Figure 16.6. Whiting, IV+VIId

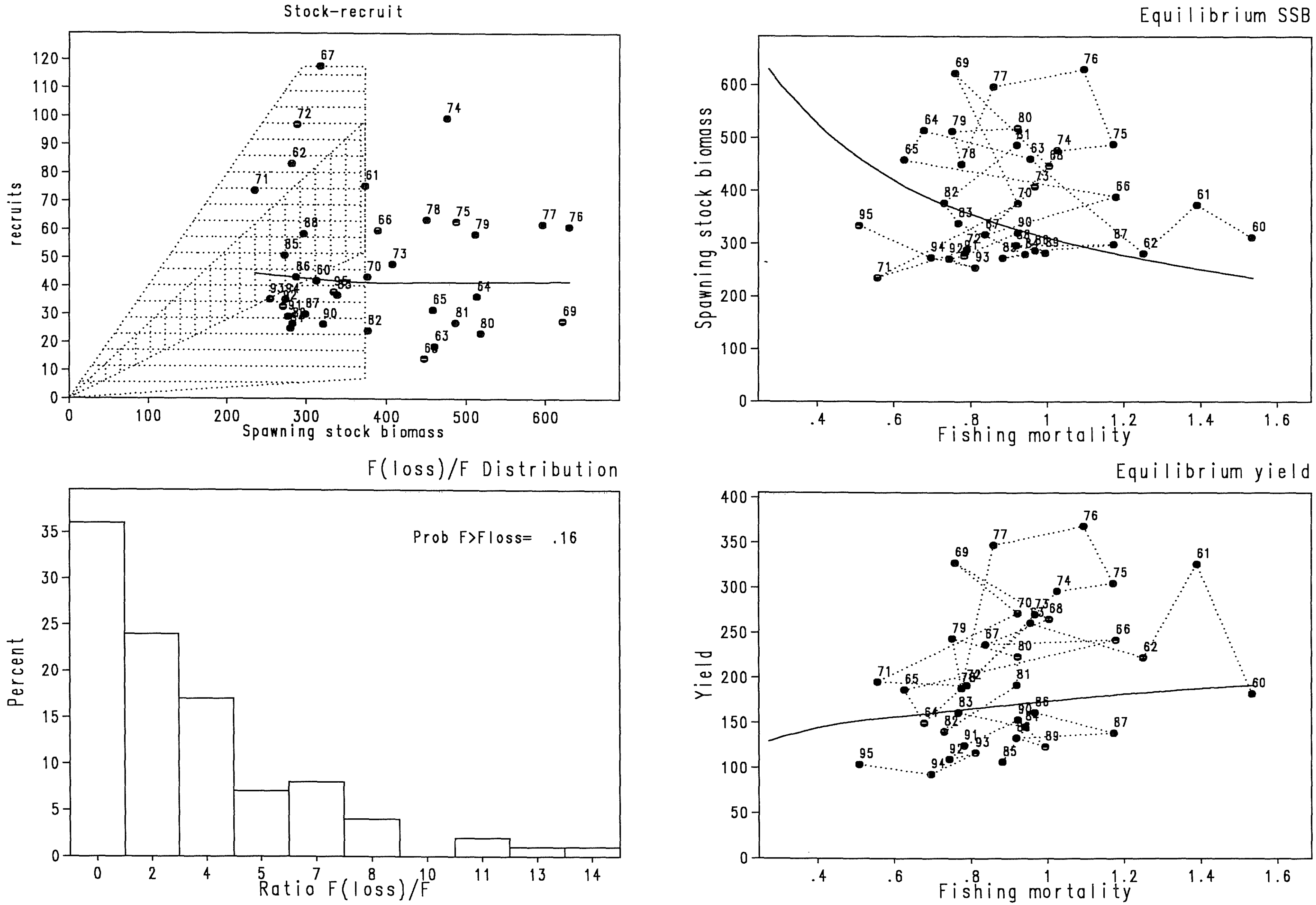


Figure 16.7. Saithe, IV + IIIa

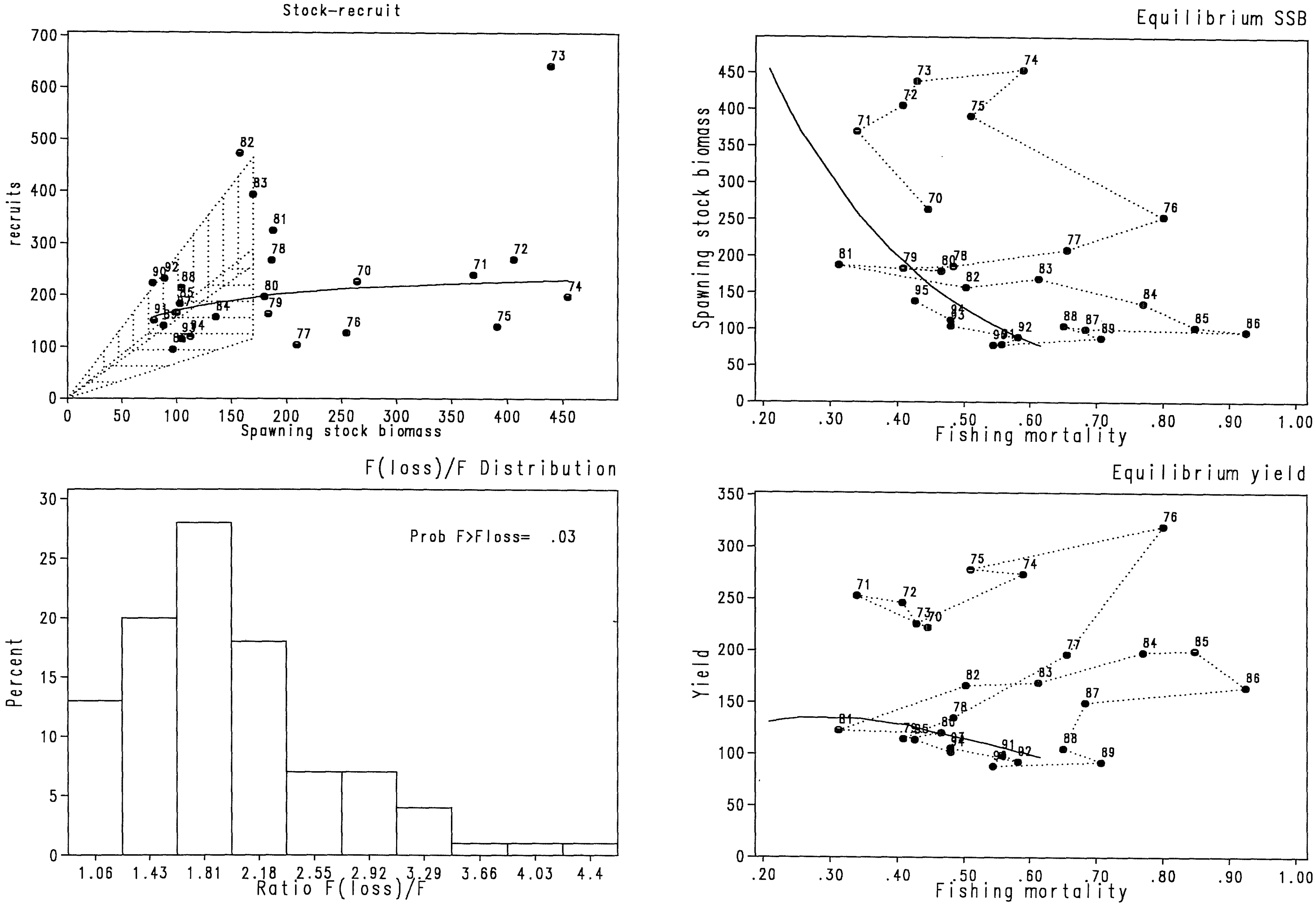


Figure 16.8. Sole, North Sea

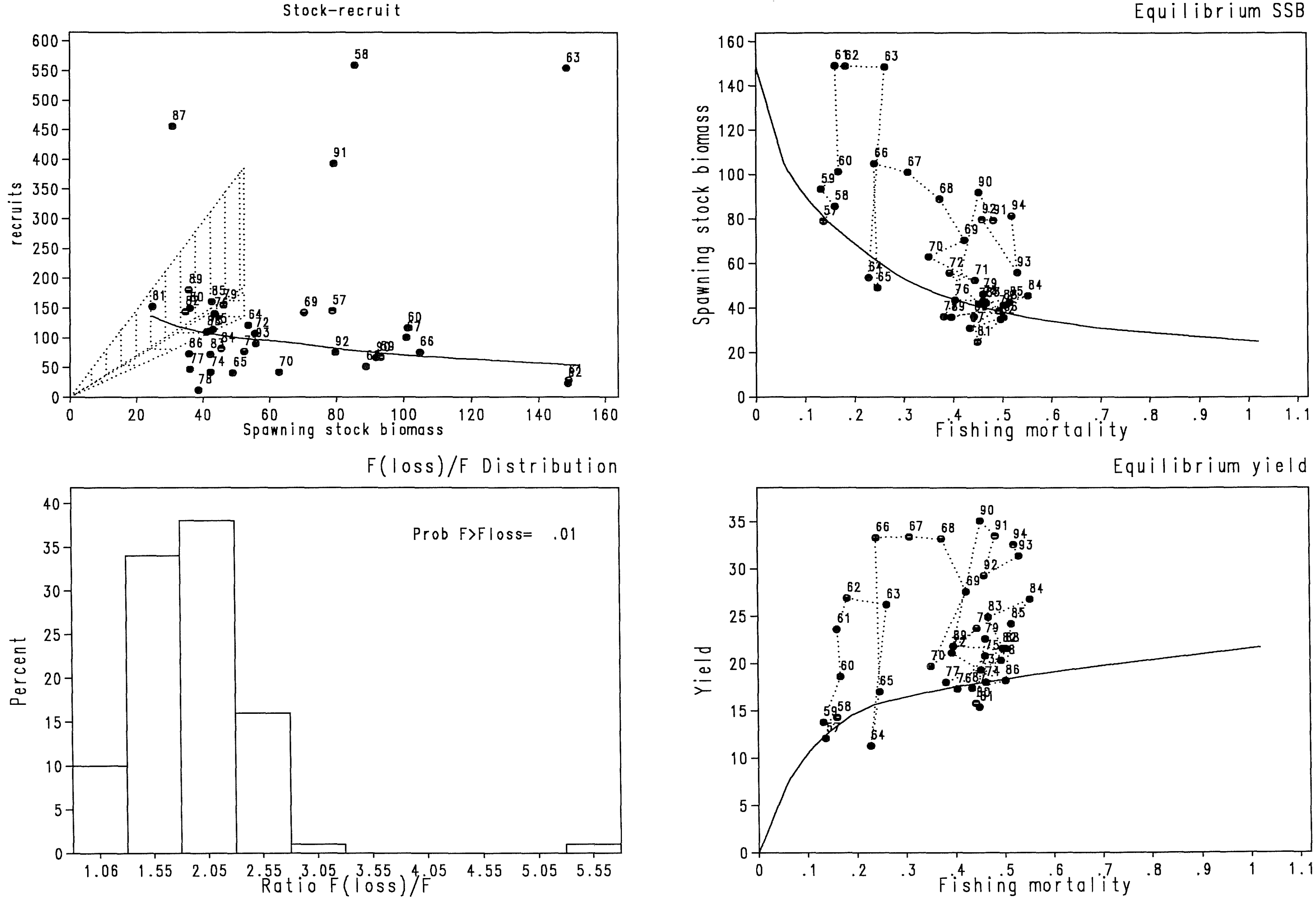


Figure 16.9. Plaice, North Sea

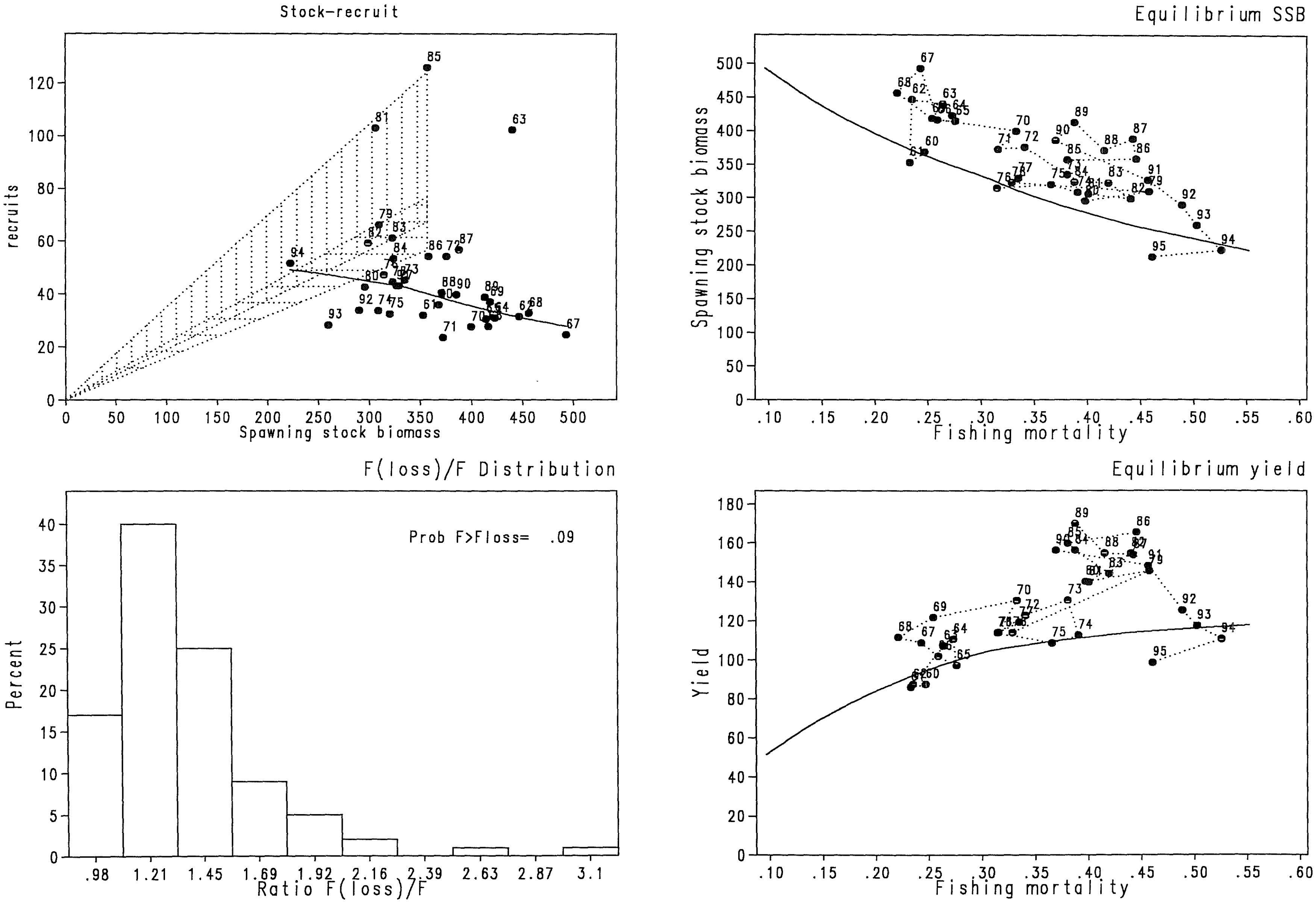


Figure 16.10. Cod, IIIa+IV+VIId. Sensitivity analysis of replacement line slope.

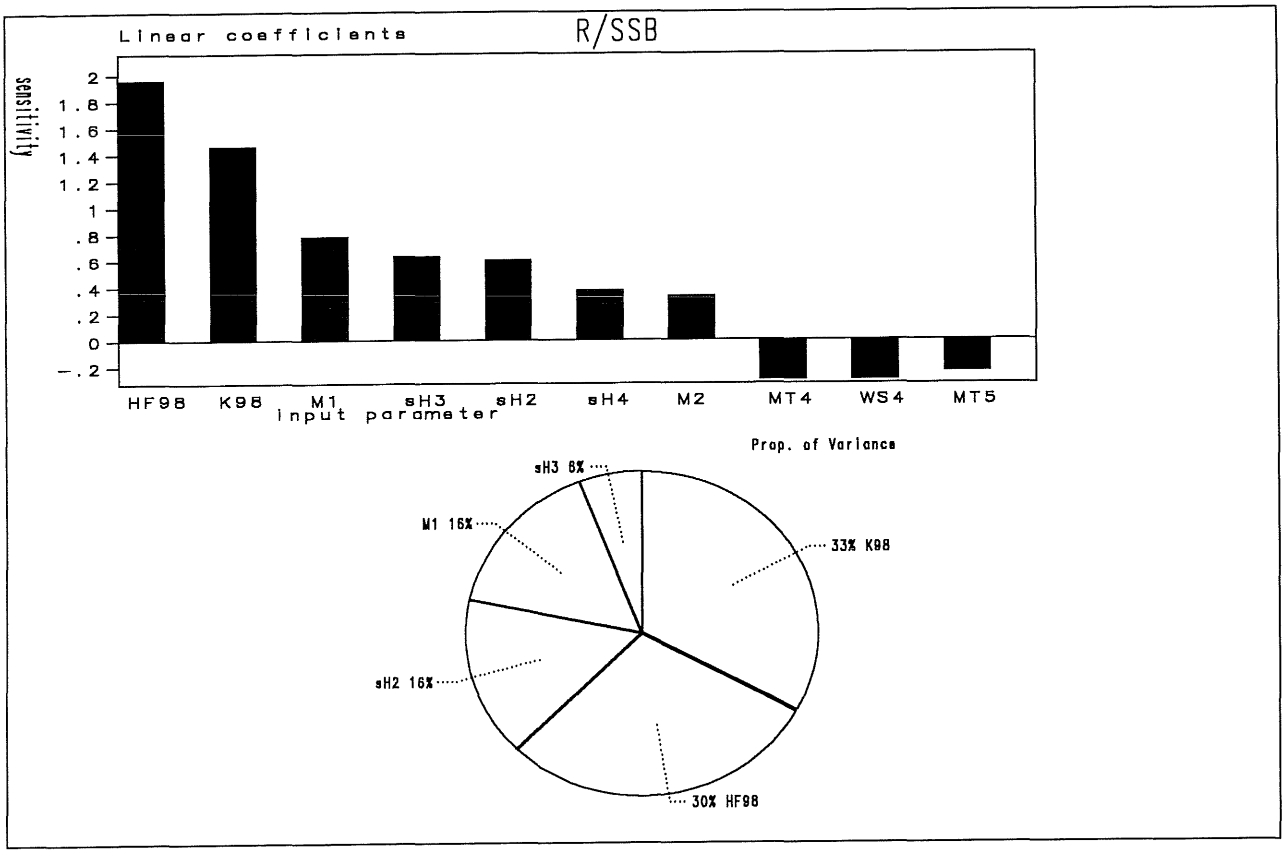


Figure 16.11. Haddock,North Sea + IIIa. Sensitivity analysis of replacement line slope.

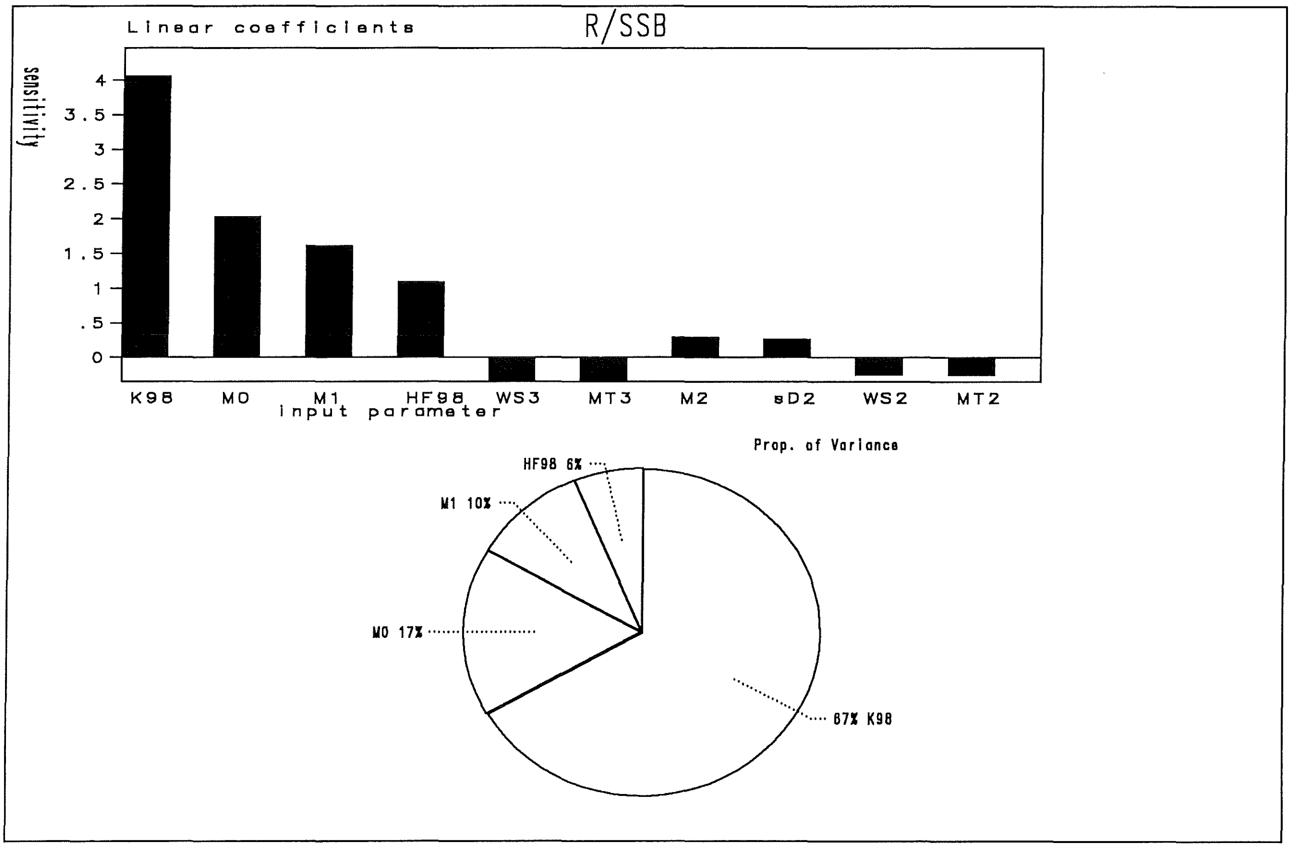


Figure 16.12. Whiting,North Sea and VIId. Sensitivity analysis of replacement line slope.

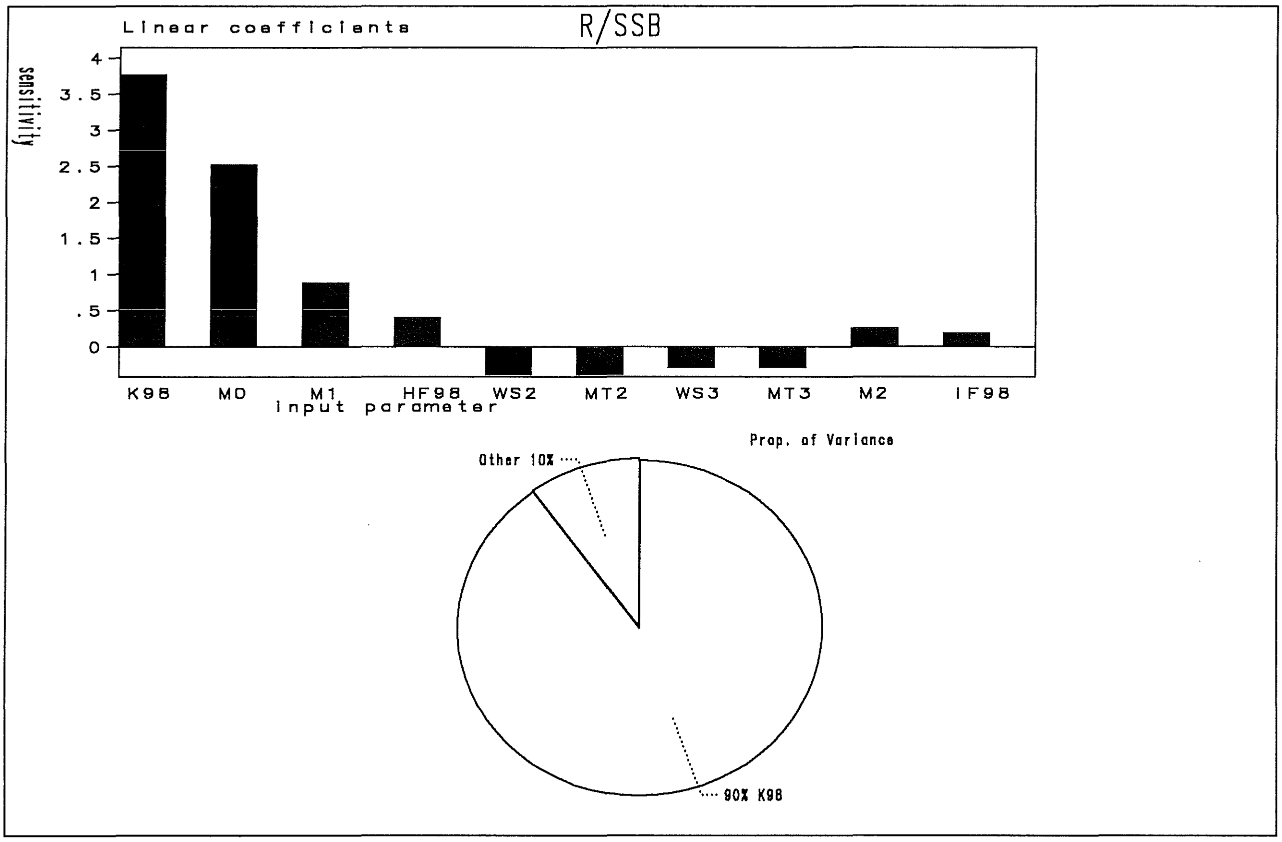


Figure 16.13. Saithe,North Sea +IIIa. Sensitivity analysis of replacement line slope.

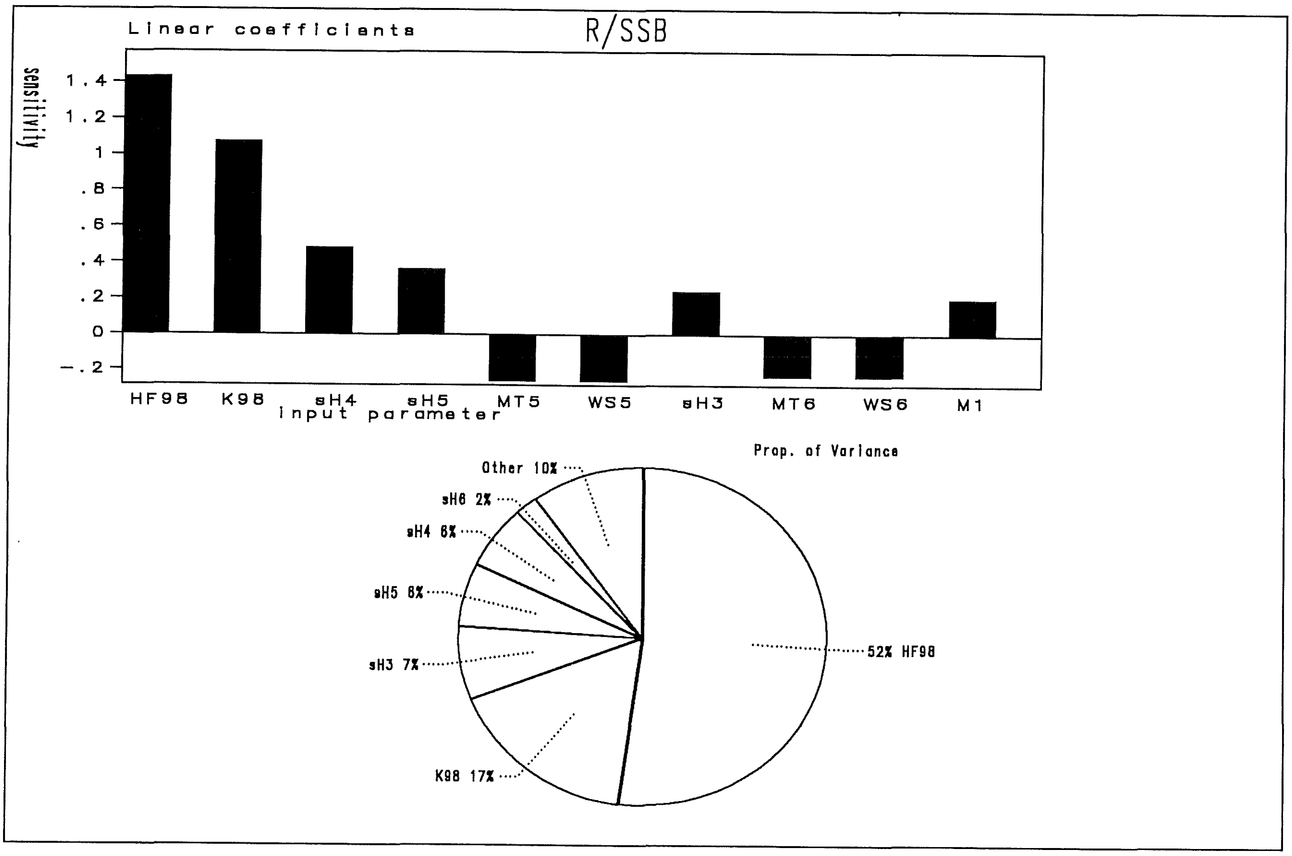


Figure 16.14. Sole,North Sea. Sensitivity analysis of replacement line slope.

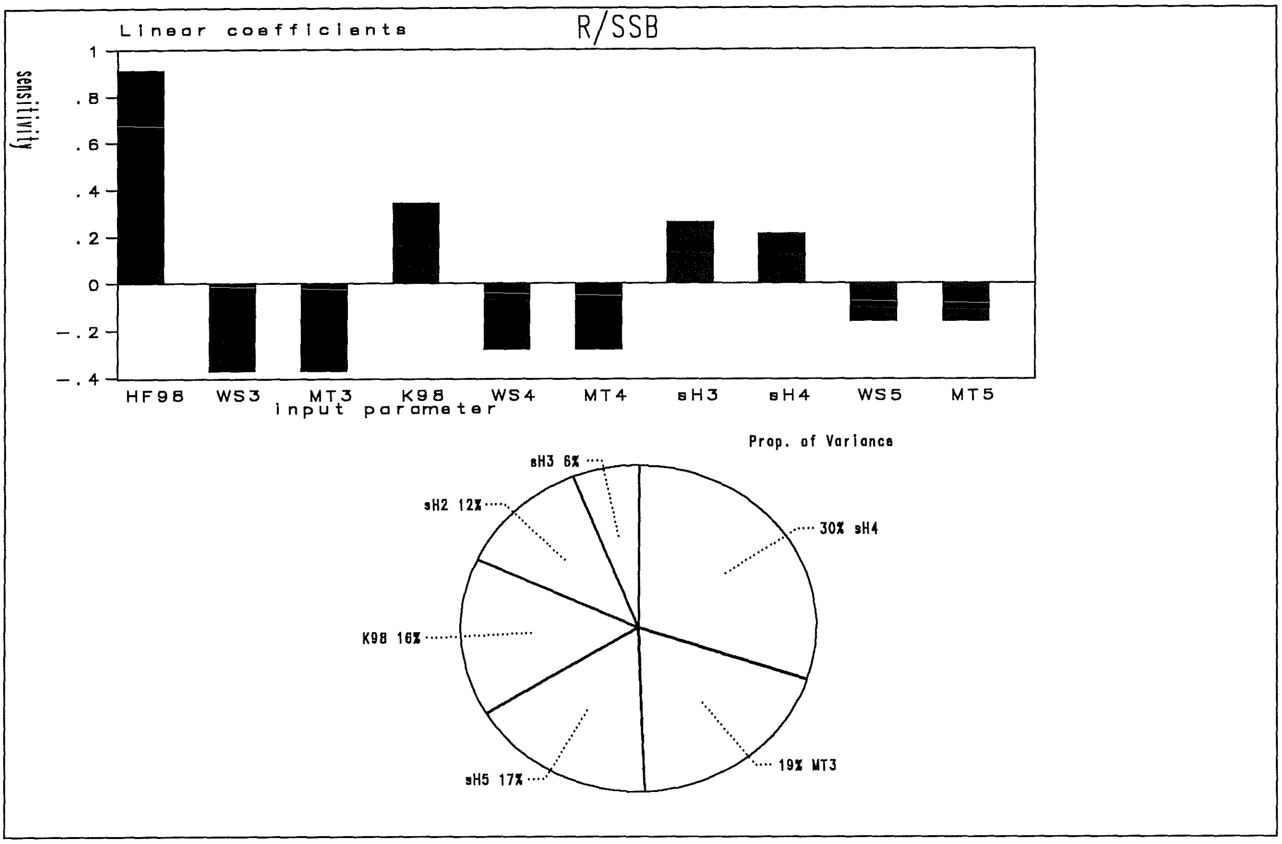
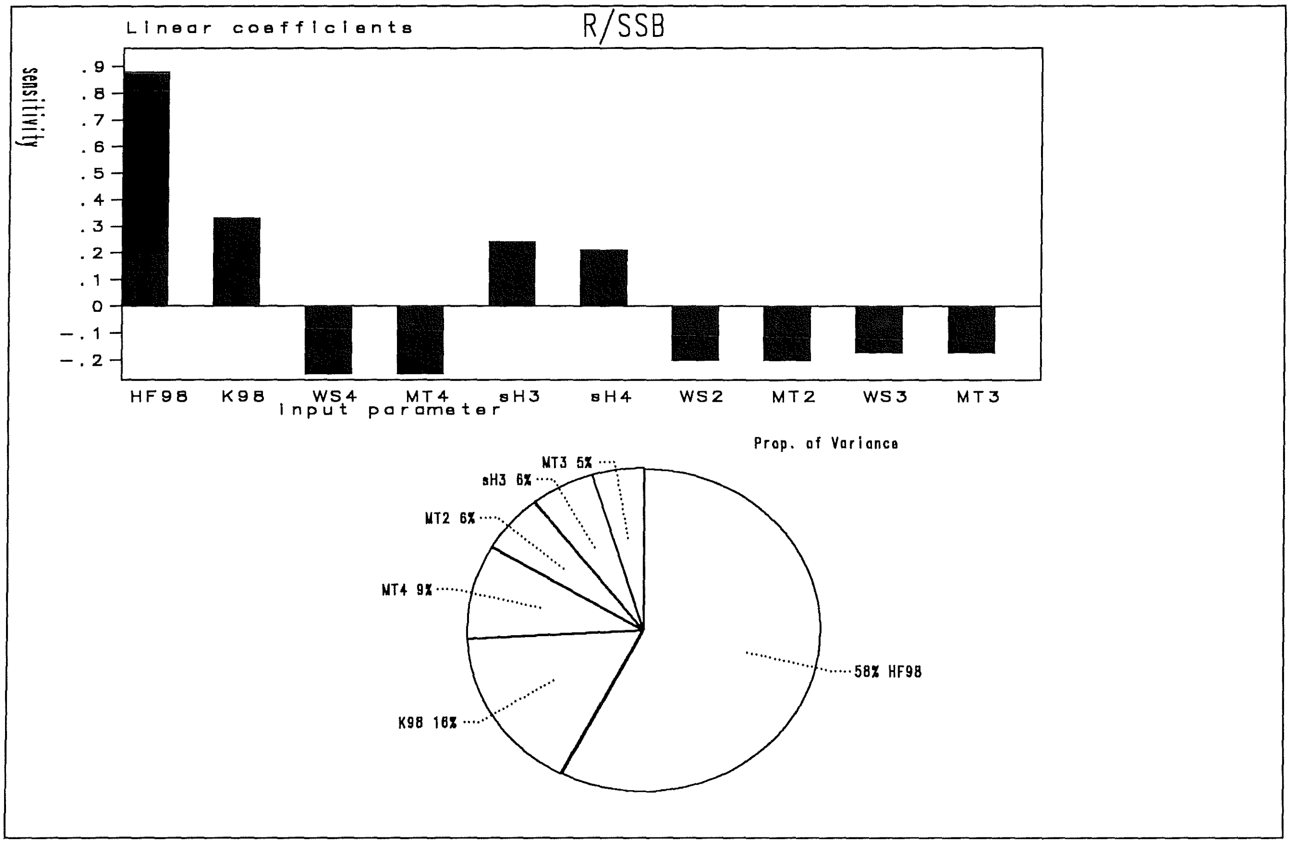


Figure 16.15. Plaice,North Sea. Sensitivity analysis of replacement line slope.



17 DATA FOR THE MULTISPECIES ASSESSMENT GROUP

Quarterly catch at age and mean weight at age data for the North Sea stocks of roundfish are being provided directly to the multispecies data base co-ordinator. The quarterly data for Norway pout and sandeel are included in this report. The data have been compiled as totals for the North Sea for 1993 and 1994. Data for 1993 were not provided from last years meeting as the data were requested on a 'Sub-division' basis and it was not possible for the Working Group to deliver the data with this resolution. It was furthermore not clear what was actually meant by Sub-division and it was noted by the Working Group that the majority of data were not sampled on sampling strata as fine as rectangles or even roundfish areas. The Working Group recommended last year that a request for better spatial resolution should be based on an *ad hoc* workshop to specify the exact data needs, exchange protocols and work organisation. This workshop has not been held and the Working Group assumes that the request this year, which does not specifically state the spatial resolution needed, concerns totals for the North Sea.

18 EVALUATION OF EFFECTS OF SANDEEL FISHERIES ON LOCAL AGGREGATIONS

Introduction

In general the industrial fishery removes only a relatively small proportion of the total annual production of sandeel in the North Sea. Gislason (1994) estimated that in the order of 20% of the annual production of the North Sea sandeel stock was removed by fishing, while for cod, sole, saithe and plaice more than 70% of the annual production was harvested by man. Even though 80% of the total production of North Sea sandeel would thus be left to natural predators and other sources of natural mortality, this does not exclude that the sandeel fishery could be envisaged to leave considerably less of the total production of sandeel to be consumed by natural predators in certain areas, and that this could lead to negative consequences at the population level for these predators.

A working document (Wright, work. Doc. 8) presented to the Working Group discussed how to evaluate the effects of sandeel fisheries on local aggregations of sandeels close to important wildlife assemblages such as seabird colonies. An evaluation involves considerations of the effects of fisheries on population size and structure; identification of potential interactions between the fisheries and wildlife; and identification of areas where such interactions may take place.

As indicated by the spatial distribution of the fishery (Figure 13.1.1.2) the distribution of sandeels in the North Sea is patchy. Adult sandeels are found in areas of coarse sand often in association with high current velocities. The size and distribution of the grounds inhabited by post-settled sandeels reflects the patchiness of their preferred sediment.

Around Shetland the size of identified sandeel grounds range from 0.6–10 km^2 , whilst in the southern North Sea some grounds may be 10's km^2 (Macer, 1966). Tagging experiments indicate that there is little movement of post-settled sandeel (Kunzlik *et al.*, 1986), although movement of several kilometres may be expected due to passive transport by tidal streams. Therefore, assuming a limited movement of post-settled sandeels a sandeel aggregation could be regarded as a collection of adjacent grounds, some of which may be very small, within a defined area no larger than an ICES statistical rectangle. Such a spatial limitation would also be relevant for comparison with seabird colonies since most seabirds tend to feed within 40 km of their colonies.

The assessment of sandeel in the North Sea is done on a much larger scale. The sandeel stock in the North Sea has traditionally been assessed by dividing the population into a northern, a southern and a Shetland population. This division has primarily been based on differences in growth rates between areas and on the geographic isolation of the sandeel grounds near Shetland from other grounds in the North Sea. The sampling system has been designed to meet the needs of the assessment, and insufficient information is therefore available on a spatial scale that would be relevant for evaluating of the impact of the fishery on local sandeel aggregations close to important wildlife assemblages such as seabird colonies.

Before considering the possible effects that sandeel fisheries may have on local aggregations of sandeels it is important to realise that sandeel populations frequently undergo very large inter-annual changes in size, even in the absence of fisheries (Kawasaki, 1980; Sherman *et al.*, 1981; Wright, 1996). Consequently, it is essential that changes in the abundance of local aggregations are considered in relation to both fishery and naturally induced variability. Given the above definition of local aggregations and the caveat concerning natural variability there are a number of questions that need to be answered. These questions and possible approaches for tackling them are given below, together with information on relevant research that has been completed or is in progress.

The questions are:

- Where is it likely that interactions between sandeel fisheries and wildlife take place?

- How can the local abundance of sandeels be determined?

- Is the sandeel population in these areas genetically distinct from sandeels in other areas?

- How large is the interchange of adult sandeel between these areas and adjacent areas?

- What determines recruitment to the local sandeel population?
- What is the impact of fisheries on the local sandeel population?
- What is the impact of sandeel predators on the local sandeel population?

Identification of areas where interaction between sandeel fisheries and important wildlife assemblages is likely

A knowledge of the extent to which the distributions of top predators, sandeels and fisheries overlap is an important first step to evaluating whether there may be competition. Consideration must also be given to the life-history stage exploited by each predator since the distribution of sandeels prior to settlement is often far more extensive than that of settled sandeels. Identification of sensitive areas requires information on the foraging distribution of predators and their prey requirements.

The distribution of the sandeel fishery in the North Sea by quarter in 1995 and the first half of 1996 is shown in Figure 13.1.1.2 and similar maps for earlier years can be found in last years report from this Working Group and in the reports from the now disbanded Working Group on Industrial Fisheries. These maps show that the major sandeel fisheries take place along the Norwegian Deep, along the Danish coast, in the south-eastern part of the Dogger Bank and in the Firth of Forth. They also show that sandeel is caught in lower quantities in several other areas. Because sandeel is not caught by the gear used by the regular bottom trawl surveys, it is impossible to say to whether the distribution of the fishery reflects the distribution of the stock. Data on the occurrence of sandeel in whiting stomachs collected during the ICES International Stomach Sampling programmes (Jensen *et al.*, 1994) and the occasional discovery of new fishing areas, such as the development of a fishery in ICES stat. sq. 43E9 and 43F0 in 1994 (ICES 1995) would suggest that sandeel at least in the northern North Sea is likely to have a wider distribution than reflected by the present fishery.

The wildlife predators which may be of relevance in this context include seals, small cetaceans and seabirds. Most information is available on the feeding areas of seabirds in particular during the breeding season. During this time feeding is restricted to the vicinity of the colony and chick growth and survival is dependent on the amount of food brought back.

In the North Sea areas important to seabirds are identified in Skov *et al.* (1995), Figure 18.1, which shows the location and extent of these areas as well as the location of breeding colonies of international importance. Six areas were found to be particularly important of which the Orkney-Shetland area and the Moray Firth-Aberdeen Bank-Tees area (including the Firth of Forth) are described as areas where sandeels are of importance to birds. Note that the map includes the winter distribution of seabirds, whereas sandeel fisheries mainly takes place in summer. The ICES Seabird/Fish Interaction Study Group estimated that around 75% of the sandeels that are consumed by seabirds in the North Sea are consumed in the north western North Sea, i.e. ICES areas IVa west and IVb west (ICES, 1994). Jensen *et al.* (1994) attempted to provide a spatial comparison between the distribution of 3 species of auk and fisheries data and found in general little spatial overlap between the distribution of the seabirds and the industrial fishery for sandeel. Correlation between bird distribution and sandeel abundance as reflected by the proportion of sandeel in whiting stomachs showed significant positive correlation in seven out of twelve cases in the third quarter of the year, but not for any other quarter. The interaction occurred mainly off the north-east Scottish coast and around Shetland. The Moray Firth area, and the coast off eastern Scotland to the south of Aberdeen appear to be the areas where guillemot, puffin, and razorbill are most likely to forage on sandeel in the third quarter.

A more accurate spatial comparison of guillemot and sandeel distribution in Scottish waters is currently in progress that utilises a recently compiled data base on post-settled sandeel distribution (Wright & Begg, in prep.). Studies of predator foraging distribution and sandeel distribution at a much finer resolution have been conducted around the Shetland Isles, the Farne Islands and the Moray Firth. Results from parallel studies of seabird and sandeel distribution in the Firth of Forth (Wanless, Wright & Bailey, unpubl. data) and in south Shetland (Monaghan *et al.*, 1996) have found that diving species, such as shags and guillemots, may concentrate their foraging effort on sandeel aggregations that are too small for a fishery to exploit. An EC funded study examining the foraging distributions of seals and seabirds in the region of the Wee and Marr Bankie sandeel fishery will begin in 1997 (ELIFONTS EC DG XIV).

The Working Group did not feel competent to evaluate the use of bioenergetic models to predict feeding requirements and foraging ranges of seabirds. Such information is clearly needed in order to define the area of importance to the seabirds, and hence the extension of the local area that need to be considered in studies of the impact of fisheries.

Information required to evaluate the effect of sandeel fisheries on local aggregations

In order to evaluate the effect of sandeel fisheries on local aggregations of sandeels data are needed on the size of the local aggregation, its isolation from adjacent aggregations, and information on sandeel growth, mortality and recruitment at the locality. Information is needed on inter-annual variability in sandeel abundance by age class, fishing effort, natural mortality and settlement by 0-group sandeels at a few specific aggregations subject to exploitation. No such data currently exists at a suitable spatial scale.

a) Estimates of local abundance

Once important aggregations have been identified their size will have to be determined. Due to the sediment preference of sandeel it will be important to study the sediment characteristics in the area in order to map the distribution of sediments suitable for sandeels, e.g. by acoustic bottom type mapping. It will be important to estimate the population size of the local sandeel aggregation by fisheries independent methods such as acoustical surveying with high frequency echosounders (200 kHz). Depending on the time of day and the season part of the sandeel population will, however, remain buried in the sand, and bottom trawl fishing and acoustic surveying will therefore have to be supplemented by dredge sampling in order to estimate the fraction of the local population that is inaccessible to being recorded by the echosounder. Models of sandeel abundance in relation to sediment characteristics should be developed in order to reduce the variance of the population estimates.

b) Information on the extent of genetic isolation of local populations

It is important to note that we do not know the extent of reproductive isolation between sandeel aggregations and hence cannot say whether they are self sustaining. The stock structure of sandeel in the North Sea is uncertain and there is insufficient knowledge to determine whether there are genetically distinct substocks in the area. An EC funded project (Population structuring of the lesser sandeel XIV/1810/C1/94/071), co-ordinated by the Marine Laboratory, Aberdeen is currently investigating sub-structuring in relation to sandeel distribution and genetic differentiation. Initial analysis of allozyme variation has shown considerable heterozygosity within the eastern North Atlantic and North Sea, suggesting there is sub-structuring within this region. However, allozymes are unlikely to provide a genetic marker that can be used to define reproductively isolated stocks. Work is in progress on the development of more sensitive molecular markers (micro- and mini-satellites, cDNA, mtDNA) for the analysis of sandeel population structure. Nevertheless, it is important to note that the large size of sandeel populations makes the discovery of suitable genetic markers all the more difficult. Further work will clearly be needed.

c) Information on movement of adult sandeel between local areas

From previous tagging experiments it appears that there is little movement of post-settled sandeels (Kunzlik *et al.* 1986, ICES 1979), although movement of several kilometres may be expected due to passive transport by tidal streams. It is , however, often the case that vessels fishing for sandeels will queue to fish in the same trawl track over several days, and this implies that some active movement of fish into the fishing area is likely to occur. Further studies on the movement of sandeel between adjacent grounds will be necessary in order to evaluate the importance of migrations on observed changes in local abundance. Studies of otolith microstructure and relative year class strength in different areas of the North Sea would help us to evaluate the importance of larger scale movements of adult sandeel.

d) Information on recruitment of 0-groups to the local area

In order to obtain a wider understanding of the role of settlement/recruitment of 0-group sandeel we need to know whether local aggregations are likely to be sustained by recruitment of locally spawned progeny. This requires an understanding of population structure. A study of the recent changes in sandeel abundance around Shetland provides a good example for this need (Wright, 1996). The decline and recovery in sandeel abundance around Shetland was found to be the result of changes in the numbers of fish that recruited to the region. However, research suggested that these changes were largely brought about by fluctuations in the numbers of young sandeels immigrating into Shetland waters from unexploited areas outside the designated Shetland stock area. This observation highlights the uncertainty surrounding current stock divisions used in fishery assessment (i.e. ICES area VIa (west coast), Shetland, Northern North Sea and Southern North Sea).

The Shetland study also found that rates of recruitment among regions within Shetland waters differed with respect to total 0-group abundance (Wright, 1996). Indeed, sandeel densities at certain fished grounds appeared to be maintained despite the overall stock decline. This maintenance of high densities at certain grounds, by preferences in settlement and movement away from less preferred areas, could have had consequences to both fishermen and seabirds. Fishing at certain grounds could have remained economically viable and seabirds could have foraged successfully on these grounds even when overall stock density was low. However, this could also mean that sandeel availability to seabirds foraging in marginal habitats is subject to greater variability than would be expected from changes in total abundance. Work is needed to examine the spatial dynamics of sandeel stocks and to identify preferred habitat in relation to settling of 0-group sandeel in other areas of the North Sea.

Berntsen *et al.* (1994) used a 3-D hydrographic model to predict the drift of sandeel larvae. In the model the larvae were released in the major fishing areas and their drift was simulated assuming that the larvae would behave like passive tracers. In the northern sandeel area the results suggested that strong year classes were unlikely if retention due to unfavourable hydrographic conditions was poor, but in the southern area no clear coupling between year class strength and larval drift was found. One problem in this study was that the transport of the larvae proved to be sensitive to the vertical distribution of the larvae, to the location of the presumed spawning grounds, to hatching time and to the length of the drifting period. Additional information on these topics is necessary before hydrographic models can be used to identify the origin of the sandeel larvae recruiting to a specific area in the North Sea.

e) Information on the fishery in the area and its impact on the local sandeel population

It is clear that more information is needed on the fishery within areas important to wildlife assemblages. There is a need to map the distribution of catch and effort on a scale matching the scale of individual sandeel grounds in order to quantify the impact. If there is no or little migration between individual grounds it will be necessary to collect biological samples from each individual fishing ground in order to estimate the age and size composition of the catch taken at that ground. These samples can probably only be obtained by observers onboard the vessels.

It will also be necessary to collect information on the relationship between local abundance of sandeel and fishing effort in order to predict how local fishing effort will respond to changes in sandeel abundance in the present fishery. The vessels would normally stop fishing when the catch rate drops below 20 t per day (Kirkegaard and Gislason, in prep.), but we know nothing about the relationship between population abundance and catch rate, and cannot therefore predict the size of the remaining population.

f) Information on the impact of sandeel predators on the sandeel population

The importance of the fishery cannot be evaluated without an estimate of the importance of other sources of mortality. It will be necessary to identify the most important sandeel predators (seabirds, marine mammals, predatory fish) in the area in order to estimate their total intake of different size and age groups of sandeel. Bailey *et al.* (1991) reported that seabirds would switch from sandeels to other prey in proportion to the abundance of sandeels, and that there was no evidence of a non-linear functional response. However, the estimates upon which this conclusion was based were subject to considerable uncertainty and annual data on the consumption of sandeels and other prey would be needed to verify the result.

It will also be necessary to study how the availability of sandeel to the predators will depend on hydrographical and other factors. Wright and Bailey (1993) found that changes in the emergence of sandeels from the sand could be an important factor influencing their availability to seabirds during the chick rearing period.

Conclusions

The effect of fisheries on local aggregations of sandeels

Due to the current gaps in knowledge it is not yet possible to determine the impact of fishing on local sandeel aggregations. It will soon be possible to identify areas that are important locations for wildlife foraging on sandeels, but additional studies are needed before the effect of the fisheries on the local aggregations can be determined. In the case of seabirds the breeding season is the most critical period . The critical areas to consider would thus be located within the foraging ranges of the colonies. For other predators the critical areas are much more difficult to delimit.

The effect of seasonal and localised catch regulations

Without an understanding of the extent to which sandeel aggregations are reproductively isolated we cannot predict the consequences of seasonal and localised catch regulations on the local spawning stock for the subsequent recruitment to the area.

General seasonal restrictions could be used to avoid the capture of 0-group sandeels, which are of major importance to the chicks of small surface feeding seabirds such as kittiwakes and Arctic terns. However, 0-group are rarely taken by the major North Sea fishing fleets during the months of June and July when these seabirds feed their chicks. Because the effect of a ban of fishing on 0-groups thus will be indirect, acting through the effect on recruitment of an increase in overall SSB, a quantitative prediction on its effect on chick survival is impossible.

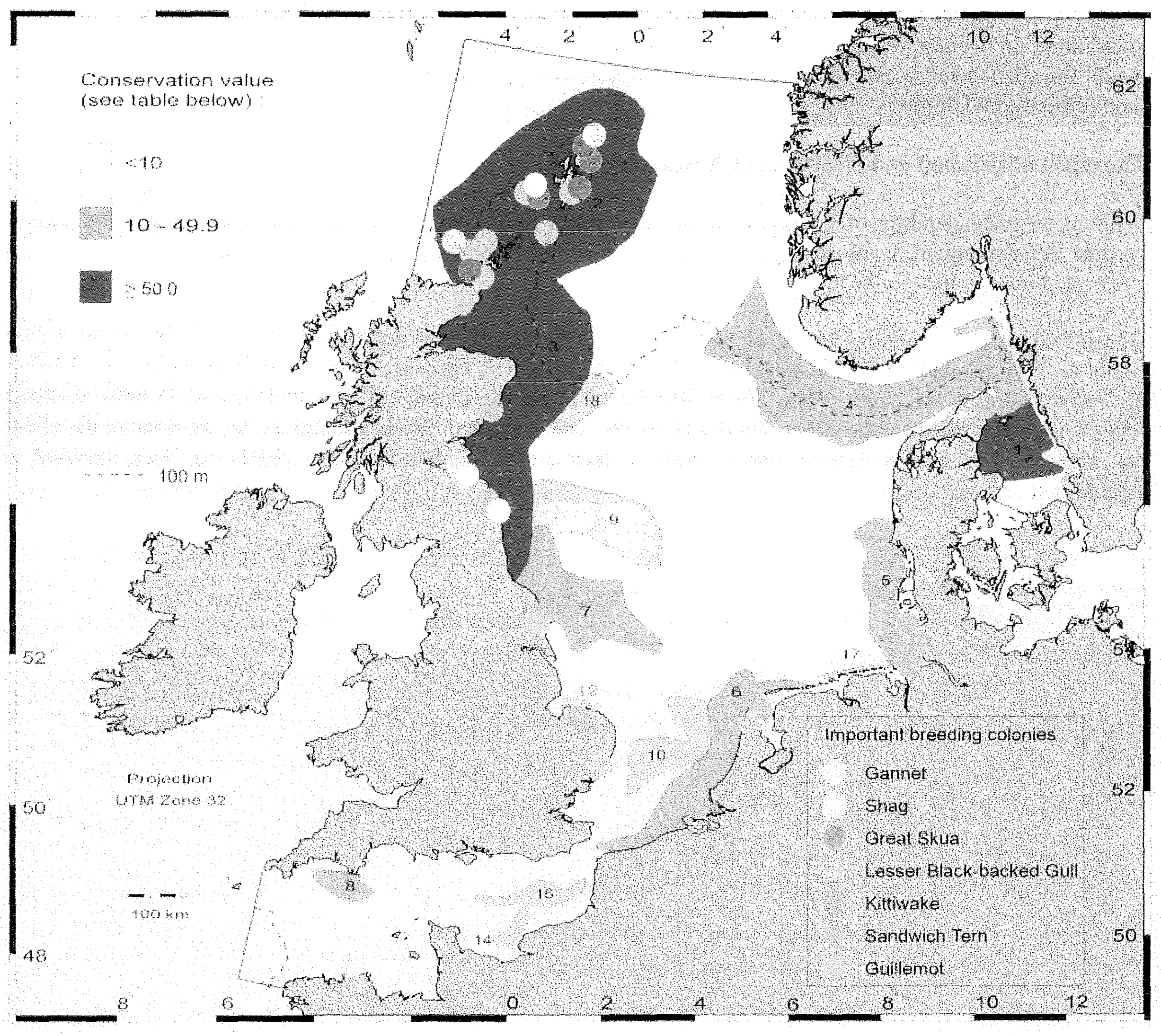


Figure 18.1 Location and extent of the 20 selected areas and breeding colonies of seabirds in the North Sea, the Channel and the Kattegat (Skov *et al.* 1995).

19 ASSESSMENT SUMMARIES

In order to provide an overview of the assessments contained in this report assessment overviews in tabular form are provided. These should in a systematic way present the data and the assessments and give an overview of biological reference points available for the various stocks.

Assessment summary table, Stock: Cod IIIa+IV+VIId

		Availability and source	Comments
Data	Catch-at-age	available Y/N : Yes Data coverage of total catch % : 81% land Y/N: Y discards Y/N: N ind-bycatch Y/N/NA: N year range : 1963-1995 age range : 1-15 plus-group : 11	Non- and misreporting is corrected for in WG-estimate
	Weight in catch	Available Y/N: Y source : Weighted mean of national data.	
	Weight in stock	Source : weight in catch. Annual data / average based on years : Annual.	
	catch-effort data	Surveys fleets : no and year range 6, 1976-1995 Commercial fleets : no and year range 11, 1976-1995	
	Maturity	source : surveys /other : IYFS data. type : observation / assumed/ knife edge: observation.	
	Nat. mort	Source : msvpa / assumed: MSVPA 1986 for cod in IV if from msvpa, years used:	Multispecies WG, 1986 / Assess : 19
Catch-at-age analysis	Type	XSA - ICA - separable - other : XSA	Comments on tuning : 4 fleets are not included in tuning.
	Fleets	Surveys : no, year range : 4, 1976-1995 Commercial : no, year range : 9, 1976-1995	
	Setup	Time taper : 10 years, no taper. Shrinkage : P-age range : 6-10 Other : age 1 treated as recruits.	
	Retrospective	Available Y/N Yes.	
Recruitment	indices available	List : source/age: 6 survey indices at age 0 and 1.	
	type	RCT3 / XSA / Other : RCT3 for R1 in 1996 and 1997.	
	results	Arith. Mean: 400 Geom. Mean: 344	years and ages replaced: None
Short term forecast	Assumption	status quo/quota/other : Status quo. Input used for F (expl. pattern) and weight-at-age : average pattern of last 5 years raised to '95. Reference age range : 2-8	
	Sensitivity	Prediction sensitive to : F96, F97, 93YC, 94YC	

Medium term forecast	type	software : WGMTERM recruitment model : Shepherd, with moving average.	
Stock status, prediction and reference points Units : ''000 t Million	Stock status Stable on very low level	Short term prediction Status quo / quota /other : -	Reference points Agreed reference points : MBAL Source :

Assessment			Recruitment :																		
1995			Yrclass, age : 1				1996		1997		1998	SSB '000 t		F							
Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
139	0.8	75	399	248	183	302	103	168	124	158	124	150		0.86	1.23	0.15	0.25				

General comments on the assessment:
A combined assessment was made for the first time for Sub-area IV, Division IIIa, and Division VIId. It is therefore not comparable with previous assessments, which have been made for each area separately. Landings from Sub-area IV have contributed 86% of the total from the combined areas on average over the past 5 years. The present assessment is therfore similar to that carried out last year for Sub-area IV.

Assessment summary table, Stock: Haddock in IV and IIIa

		Availability and source	Comments
Data	Catch-at-age	Supplied age data covered 93% of 95 IV HC landings Industrial bycatch and discard data also used year range : 1963 - 1995 age range : 0-10+	First assessment to combine North Sea/Division IIIa haddock Catches in latter area v small proportion of the total.
	Weight in catch	As catch-at-age	
	Weight in stock	Weights at age in total catch (HC+D+Ind) used	
	catch-effort data	Five survey series, two commercial series available. Details in Table 4.7	IBTS Q2 and Q4 indices used for first time (short time series)
	Maturity	Based on observed values from IBTS surveys	
	Nat. mort	Based on average from MSVPA estimates	
Catch-at-age analysis	Type	XSA	Comments on tuning : Possibly a year effect in Scottish Groundfish survey in 1995 Previous XSA used 20 year tricubic with ages 0 and 1 treated as recruits. These changes make little difference
	Fleets	Five survey series, two commercial series used in Catch-at-age analysis.	
	Setup	Time taper : 10 year flat Shrinkage : P-age range : 0 Other : Q-plateau at age 7	
	Retrospective	Available	
Recruitment	indices available	Additional indices from four 1996 surveys including English and Scottish August 0-group surveys	
	type	RCT3	
	results	Ages 0 and 1 in 1996 use RCT3 indices	
Short term forecast	Assumption	Status quo in 1996 Mean Fs/weights at age over 1993-1995	North Sea/Division IIIa area split prediction complicated by lack of IIIa data by category. Only North Sea weights at age used.
	Sensitivity	Prediction sensitive to : 1994 year class	
Medium term forecast	type	software : wgmterm recruitment model : random-bootstrapped	

Stock status, prediction and reference points Units : ‘‘000 t Billion	Stock status Likely to remain above MBAL in the medium term							Short term prediction Status quo					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB ‘000 t		F							
	Land.	F	SSB	‘93	‘94	‘95	‘96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
Landings given are IV HC only	75	0.74	162	12.5	60	16.4	21.7	233	114	243	128	210	63		0.58	0.97	0.20	0.40				

General comments on the assessment:
Tendency for short-term catch predictions to be over-optimistic, particularly due to over-estimation of strong year classes. Current prediction driven by one strong year class (1994). F95 (0.74) rather low.

Assessment summary table, Stock: Whiting in IV and VIId

		Availability and source	Comments
Data	Catch-at-age	Catch at age data covering ??% of the landings?? Human consumption landings, discards and industrial by-catch data are available for whiting in IV. There are no discards data for whiting in VIId. There is no industrial fishery for whiting in VIId. year range : 1960 - 1995 age range : 0 - 12 available plus-group : at age 10	Scottish discard data used to estimate discards for other commercial fleets. Misreporting not considered a problem for this stock.
	Weight in catch	Available separately for human consumption, discards and industrial by-catch components. source : length compositions raised to weights using L-W relationships	
	Weight in stock	Source : weight in catch Annual data	
	catch-effort data	Surveys fleets : 8; ages from 0-7 Commercial fleets : 4; minimum of 11 years to more than 20 years	Dutch groundfish survey now discontinued.
	Maturity	source : surveys type : observation (North Sea IBTS QI; 1981-1985)	
	Nat. mort	Source : msvpa (rounded average by age) if from msvpa, years used for average : ??	
Catch-at-age analysis	Type	XSA	Comments on tuning : Dutch and German groundfish surveys excluded. Some ages excluded from French Channel tuning fleet. Converged in *ca* 25 iterations. Retrospective analysis excluded three short time-series survey fleets that were used in the final XSA; a restricted year range was also necessary to include all commercial fleets in the retrospective runs. No clear interpretation of the results because of this, although recruitment estimates appear noisy.
	Fleets	Surveys : 6; max 1986 to date; min 1991 to date Commercial : 4; 1986 to date	
	Setup	Time taper : 10 years untapered Shrinkage : P-age range : Not Applied Other : F shrinkage SE=0.5; age independent Lnq>age 6	
	Retrospective	Available Y/N; Yes	
Recruitment	indices available	List : source/age	Few apparent relationships between survey indices and XSA estimates of recruits. In earlier years, RCT3 estimates were always revised down by subsequent catch at age analysis. For the sake of year to year consistency, they are not now used, although it may be the commercial data that are given a false signal.
	type	Estimated by XSA, but not using recruit calibration	
	results	year and ages replaced : none	

Short term forecast	Assumption	status quo Input used for F (expl. pattern) and weight-at-age : average pattern of last 5 years raised to '95 Reference age range : 2-6 human consumption landings plus discards component	Industrial by-catch mortalities treated as invariant in prediction.
	Sensitivity	Prediction sensitive to : HF97, K96, M0, K97	
Medium term forecast	type	software : WGMTERM recruitment model : bootstrap of observed recruitments	May overestimate current levels of recruitment due to the apparent downwardsshift in the overall level observed in recent years.

Stock status, prediction and reference points Units : ''000 t billion	Stock status							Short term prediction Status quo					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age : 0				1996		1997		1998	SSB '000 t		F							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	47 hc 27 ind	0.51	334	35	35	38	gm 34	367	58 28	375	64 28	374	? 250 ?		.88	> 1	.23	> 1				

General comments on the assessment: XSA and EngGFS derived spawning stock indices seem to track each other (until 1995), as do spawning stock indices derived from the Sco GFS and QI IBTS. However, the two sets indicate different spawning stock trajectories during the late 1980s and early 1990s.

Assessment summary table, Stock: Saithe in the North Sea

		Availability and source	Comments
Data	Catch-at-age	available Yes Data coverage of total catch % : 93.5% land Y discards N ind-bycatch N year range : 1970 - 1995 age range : 1 - 10 plus-group : 10	
	Weight in catch	Available Y source : Observations	
	Weight in stock	Source : weight in catch Annual data	
	catch-effort data	Surveys fleets : 2 surveys 1977 - 1995 Commercial fleets : 2 fleets 1978 - 1995	
	Maturity	source : surveys type : observation	
	Nat. mort	Source : assumed if from msvpa, years used for average :	
Catch-at-age analysis	Type	XSA - ICA - separable - other : XSA	Comments on tuning :
	Fleets	Surveys : 2 surveys age 2 and 3 Commercial : 2 fleets age 3 to 10	
	Setup	Time taper : 10 year no taper Shrinkage : 0.5 P-age range : 1-3 Other :	
	Retrospective	Available Yes	
Recruitment	indices available	List : 3 indices at age 0, 2 and 3	
	type	RCT3	
	results	year and ages replaced : 1995 age 1, and 1996 age 1 and 2	
Short term forecast	Assumption	status quo Input used for F (expl. pattern) and weight-at-age : average pattern of last 5 years raised to '95 Reference age range : 3-6	
	Sensitivity	Prediction sensitive to : HF96, HF95, WS6, MT6, N4	
Medium term forecast	type	software : WGMtermA recruitment model : Beverton and Holt	

Stock status, prediction and reference points Units : ''000 t Million	Stock status Close to safe biological limits							Short term prediction Status quo					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	114	.43	139	115	221	220	179	143	110	163	113	164	150		.46	.73	.12	.22			.47	

General comments on the assessment:
The lack of recruitment indices for recent and incoming year classes makes catch predictions uncertain.

Assessment summary table, Stock: North Sea sole

		Availability and source	Comments
Data	Catch-at-age	available Data coverage of total catch : 91% land : Y discards : N ind-bycatch : N year range :1957-1995 age range : 1-15 plus-group : 15	unreported landings reduced
	Weight in catch	Available annual measured weights source : 5 commercial fleets	no smoothing applied
	Weight in stock	Source : weight in catch Annual data : 2nd quarter measured weights	no smoothing applied
	catch-effort data	Surveys fleets : Commercial fleets : 5 fleets / 1957-1995	most of them not usable
	Maturity	source : type : knife edge at age 3	
	Nat. mort	Source : assumed at 0.1 ; except 1963 : 0.9	uncertain in forecast
Catch-at-age analysis	Type	XSA	Comments on tuning :
	Fleets	Surveys : 3 surveys / 70-95 / 80-94 / 85-95 Commercial : 1 fleet / 79-95	
	Setup	Time taper : 10 year window with No taper Shrinkage : 0.5 - 5 years and 5 ages Other : dependent on stocksize < 3 and q-plateau : 7	
	Retrospective	Available : no trends	
Recruitment	indices available	Surveys ages 0, 1, 2 and 3	GM : 100.000 - AM : 139.000
	type	RCT3	
	results	yearclassess '93 '94 and '95 replaced in recruits and survivors	
Short term forecast	Assumption	status : TAC constraint Input used for F (expl. pattern) and weight-at-age : average of last 3 years for weight in catch and stock average pattern of last 3 years raised to '95 for F Reference age range : 2-8	Age 1,2 and 3 of stock in 1996 replaced by RCT3 GM recruitment in 1997 and later
	Sensitivity	Prediction sensitive to : F96, F97 and M	
Medium term forecast	type	software : Aberdeen recruitment model : Random bootstrap	

Stock status, prediction and reference points Units : ''000 t Million/billion	Stock status : is expected to decrease below Mbal in short term							Short term prediction : TAC for 1996; Status quo in 1997					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	30.3	0.51	68.5	48	99	49	100	48	23	40	18	31	35		0.30	0.95	0.08	0.22			0.36	

General comments on the assessment:

Assessment summary table, Stock: Sole in Division VIId

		Availability and source	Comments
Data	Catch-at-age	Quarterly data all countries Data coverage of total catch : >95 % land Y discards NA ind-bycatch NA year range : 82-95 age range used : 1-11 plus-group used : 11+	Data poor before 1980; UK & Belgium 1981-1984; All countries post 1984 Sampling or ageing problem with age 2 in 1994 and 3 in 1995
	Weight in catch	Available Y source : sampling of the landings (F, UK, B)	
	Weight in stock	Source : calculate for first january from smoothed weight in catch, annual data	
	catch-effort data	Surveys fleets : 3, year range : 85-95 Commercial fleets : 3, year range : 82-95	
	Maturity	source : as N Sea sole type : knife edged at age 3	
	Nat. mort	Source : as N Sea sole	
Catch-at-age analysis	Type	XSA	Comments on tuning :
	Fleets	Surveys :3, year range : 85-95 Commercial : 3, year range : 82-95	
	Setup	Time taper : power 0 over 10 years. Catchability dependent on stock size for ages < 3. Catchability independant of age for ages >= 7. Shrinkage : 0.3 of the final 4 years or 4 oldest age. Other :	Strong shrinkage (0.3) compared with 1995 WG because of catch at age problems
	Retrospective	Available Y	
Recruitment	indices available	English yfs, ages 0 and 1. English bts, age 1 and 2. French yfs, ages 0 and 1.	
	type	XSA/RCT3	
	results	year and ages replaced : 1995, age 1 : RCT3 1996, 1997 and 1998, age 1 : GM 81-91 yr classes	

Short term forecast	Assumption	status quo Input used for : F (expl. pattern):average pattern of last 5 years scaled to F 3-8 in 95 weight-at-age : mean 93-95. Reference age range : 3-8	Previous years mean of 3 years only; average of 5 years to smooth high F from data problems
	Sensitivity	Prediction sensitive to : N2, N1, HF97	
Medium term forecast	type	software : WGTERMA (Aberdeen). recruitment model : random bootstrapped.	

Stock status, prediction and reference points Units : tonnes	Stock status							Short term prediction : status quo					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age : 1				1996		1997		1998	SSB tonnes		F 3-8							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	Land	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	4502	0.485	9481	27387	41852	21800	21800	9543	5024	10976	5227	?	7000*	?	0..39	0.77	0.11	0.23	?	?	0.44	?

General comments on the assessment:
Problems with age compositions at age 2/3 in 1994/95 causing over-estimate of F which was not matched by effort in main fleets.

* MBAL taken as minimum historical level but only short time series makes this level uncertain.

Assessment summary table, Stock: Plaice North Sea

		Availability and source	Comments
Data	Catch-at-age	available Y Data coverage of total catch % : 90% land Y discards N ind-bycatch N year range : 1957-95 age range : 1-15 plus-group : 15	Discarding is substantial (about 50% in numbers). No data available to include in assessment. Discard pattern is likely to have changed over time due to changes in growth and discarding practice.
	Weight in catch	Available Y source : annual mean from market samples	gutted weights raised to whole weight (x1.11). Growth rate has varied over time. Growth of recent cohorts has recovered from the decrease in the late 1980s.
	Weight in stock	Source : weight in catch / surveys /other: market samples Annual data: 1st quarter weights	gutted weights raised to whole weight (x1.11)
	catch-effort data	Surveys fleets : BTS-ISIS, BTS-Belgica Commercial fleets : Netherlands beam trawl, Belgium beam trawl, UK beamtrawl, UK otter trawl, UK seine	
	Maturity	source : surveys /other type : assumed mean of male and female	Data available from market sampling data indicate that since 1957 the maturation proportion for 3, 4 and 5-yr old females has increased. Indication for further increase since 1990. Sex ratio changes with age and is a function of the exploitation level.
	Nat. mort	Source : msvpa / assumed if from msvpa, years used for average :	estimated from mortality of cohorts during 2nd world war
Catch-at-age analysis	Type	XSA - ICA - separable - other : XSA	Change in catchability of Netherlands commercial beam trawl in 1989 coinciding with establishment of a protected area ('plaice box').
	Fleets	Surveys : 2: BTS-ISIS: 1985-96; SNS-Tridens: 1970-96 Commercial : 2: Neth Beam Trawl: 1979-1995; UK seine: 1980-96.	
	Setup	Time taper : tri-cubic over 20 years Shrinkage : P-age range : 1-3 Other :	
	Retrospective	Available Y	
Recruitment	indices available	DFS-international: 0-, 1-group; SNS-Tridens: 0-, 1-, 2- and 3-group; BTS-ISIS: 1-, 2-, 3-group	
	type	RCT3	
	results	year and ages replaced : 1996: age 1 and age 2	

Short term forecast	Assumption	status quo/quota/other: TAC constraint in 1996 (0.8xF95) Input used for F (expl. pattern) and weight-at-age : average pattern of last 3 years raised to '95 Reference age range : 2-10	
	Sensitivity	Prediction sensitive to : ycls 1994, 1995 and F97 (yield) and ycls 96, 95, 94 (SSB)	
Medium term forecast	type	software : ABERDEEN recruitment model : Beverton & Holt with autocorrelation	

Stock status, prediction and reference points Units : ''000 t Million	Stock status							Short term prediction Status quo / quota /other : TAC					Reference points Agreed reference points : MBAL Source : ACFM 1995										
	Assessment			Recruitment :																			
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F								
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	98	0.46	212	283	516	430	654	209	81	215	83	267	300	-	0.28	0.49	0.09	0.24	0.24	-	-	-

General comments on the assessment:

- The assessment is considered to be reliable.
- The problem of the recent discrepancies between recruitment estimates from survey data and VPA has been resolved. The discrepancies coincided with a to decrease in pre-recruit growth of year classes born between 1985 and 1990. Growth of year classes born since 1990 has improved.
- Information from the fishery indicates that the TAC in 1996 will constrain fishing mortality. The 'plaice box' is expected to enhance future recruitment now it is closed during the whole year for trawlers >300 hp.
- Time series of VPA estimates of recruitment may be biased due to changes in discarding. The VPA estimates of SSB are not corrected for changes in sex ratio and changes in the proportion mature females. There is information suggesting that the proportion mature females of age groups 3, 4 and 5 has increased in recent years.
- Results of the medium term projections are dependent of the expected increase in recruitment following the establishment of the plaice box. Simulations suggest that recruitment may increase by 12%–22%.

Assessment summary table, Stock: Plaice in Division VIId

		Availability and source	Comments
Data	Catch-at-age	available Y Data coverage of total landings : 96 % land Y discards NA ind-bycatch NA year range : 80-95 age range used : 1-10 plus-group used : 10+	
	Weight in catch	Available Y source : sampling of the landings (F, UK, B)	
	Weight in stock	Source : calculate for first january from weight in catch, annual data	
	catch-effort data	Surveys fleets : 4, year range : 85-95 Commercial fleets : 3, year range : 81-95	
	Maturity	source : idem than VIIe plaice. type : ?	
	Nat. mort	Source : msvpa / assumed ? if from msvpa, years used for average :	
Catch-at-age analysis	Type	XSA	Comments on tuning : For the FRENCH INSHORE TRAWL age composition were deraised from total French age composition
	Fleets	Surveys : 4, year range : 85-95 Commercial : 3, year range : 81-95	
	Setup	Time taper : power 3 over 10 years. Catchability dependent on stock size for ages < 3. Catchability independant ofage for ages >= 7. Shrinkage : 0.5 of the final 5 years or 3 oldest age. P-age range : Other :	
	Retrospective	Available Y	
Recruitment	indices available	English yfs, ages 0 and 1. English bts, age 1. French yfs, ages 0 and 1. French gfs, ages 0 and 1.	
	type	XSA/RCT3	
	results	year and ages replaced : 1996, age 1 : RCT3 1997 and 1998, age 1 : GM 80-95	

Short term forecast	Assumption	status quo Input used for : F (expl. pattern):average pattern of last 3 years raised to 95 weight-at-age : AM 93-95. Reference age range : 2-6	
	Sensitivity	Prediction sensitive to : HF96, HF97	
Medium term forecast	type	software : WGTERMA (Aberdeen). recruitment model : random bootstrapped.	

Stock status, prediction and reference points Units : ''000 t Million	Stock status							Short term prediction : status quo					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB tonnes		F 2-6							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	5.1	0.46	8.9	21.2	29.4	25.1	25.1	8.6	5.7	9.2	6.0	9.7	5.8	?	0.49	0.76	0.14	0.26	?	?	0.61	?

General comments on the assessment:
The consistency of this assessment seems good but because the data series is short we have to be careful.

Assessment summary table, Stock: Plaice in IIIa

		Availability and source	Comments
Data	Catch-at-age	available from Denmark accounting for >90% of the catch. land Y discards N ind-bycatch no importanse year range : 1978-1995 age range :2-11 plus-group : 11	
	Weight in catch	Available Y source : Danish market samplings	
	Weight in stock	Source : weight in catch Annual data	
	catch-effort data	Surveys fleets : IBTS available but not used Commercial fleets : 3 fleets (1987-1995) Log-book recodings in market categories splitted by age information by market categories from market samples.	IBTS data not age-disagregated Same marget-category-age keys used to split both total catches and fleet cpue's into agegroups
	Maturity	source : Historically used ogive type : knife edge	
	Nat. mort	Source : assumed if from msvpa, years used for average :	
Catch-at-age analysis	Type	XSA	Comments on tuning : SE on catcabilities estimated at 0.3-0.4 (=> CV's at 35-50%) for age groups 4-7 . Larger for younger and older.
	Fleets	Surveys : not used Commercial : 3, 1987-1995	
	Setup	Time taper : 3-Q-20 years Shrinkage : P-age range : 2 Other :	Little trends in log-residuals
	Retrospective	Available Y	No systematics in retrospective runs
Recruitment	indices available	List : none	
	type	GM of historical recruitments used in the forcast	
	results	year and ages replaced :	

Short term forecast	Assumption	status quo Input used for F (expl. pattern) and weight-at-age : average pattern of last 3 years raised to '95 Reference age range : 4-8	
	Sensitivity	Prediction sensitive to : yield 1997 to F(96) and F(97) SSB 1998 to N(95) Mat,Wgt (93)	
Medium term forecast	type	software : Aberdeen recruitment model :Random bootstraping	

Stock status, prediction and reference points Units : ''000 t Million/billion	Stock status							Short term prediction Status quo / quota /other : Status quo					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	SSB	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	11	.78	36	35	50	50	50	31	11	32	10	34	ca. 23		.74	5	.08	.16				

General comments on the assessment:

Assessment summary table, Stock: Norway Pout in the North Sea and Skagerrak

		Availability and source	Comments
Data	Catch-at-age	Available: Y Data coverage of total catch : 96% land: Y discards: none year range : 1974-1996 age range : 0-4+ plus-group : 4	
	Weight in catch	Available: Y source : Danish and Norwegian samples	
	Weight in stock	Source : Average based	
	catch-effort data	Surveys fleets : 3 Commercial fleets : 1 Year range: 1982-1996	
	Maturity	source : type : Proportions 0 0.1 1 1 1	
	Nat. mort	0.4 Source :	Output from MSVPA (1992) calculated quarterly M's ranging from 0.14 to 1.2. Overall mean M was 0.3965
Catch-at-age analysis	Type	XSA - ICA - separable - other : Seasonal XSA	Comments on tuning :
	Fleets	Surveys : IYFS, EGFS, SGFS Commercial fleets: 1 (combined), year range: 1976-1996	
	Setup	Time taper : None Shrinkage : None Other :	Catches in 1990 estimated by assuming constant catchability and adjusting effort until the SOP is in accordance with the reported catch
	Retrospective	Available Y	No indication of bias in estimates of terminal populations
Recruitment	indices available	List : Commercial fishery (q3 & q4), EGFS (q3), SGFS (q3)	SGFS (q3) not used
	type		
	results	year and ages replaced :	
Short term forecast	Assumption	status quo/quota/other Input used for F (expl. pattern) and weight-at-age : Reference age range :	
	Sensitivity	Prediction sensitive to :	
Medium term forecast	type	software : recruitment model :	

Stock status, prediction and reference points	Stock status							Short term prediction					Reference points										
Units : ''000 t Million/billion	Fluctuating with cycles between 3 and 5 years							Status quo / quota /other :					Agreed reference points : Source : F_{med}, F_{high} ICES CM 1996/Assess:6										
	Assessment			Recruitment :																			
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F								
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	Land	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	241	.374	164	45	217	42							120		.99	3.9						

General comments on the assessment:

Assessment summary table, Stock: Sandeel in the North Sea

		Availability and source	Comments
Data	Catch-at-age	Available: Y Data coverage of total catch % : 99 land: Y discards: none year range :1976-1989, 1991-1996 age range : 0-5+ plus-group : 5	Northen and southern North Sea separate
	Weight in catch	Available: Y source : Danish and Norwegian samples	
	Weight in stock	Source : weight in catch Annual data: 1981-96 / average based on years : 1972-80	
	catch-effort data	Surveys fleets : 0 Commercial fleets : 2 Year range: 1976-96, 1982-96	
	Maturity	source : untraceable ??????? type : knife edge	
	Nat. mort	Source : msvpa smoothed (C.M. 1987/Assess:17) if from msvpa, years used for average : 1978-1982	
Catch-at-age analysis	Type	XSA - ICA - separable - other : SXSA	Comments on tuning : The SXSA for sandeel produces large population residuals,
	Fleets	Surveys : not available Commercial fleets: 2, year range: 1976-1996	
	Setup	Time taper : None Shrinkage : None Other : Downweighting of term. ages and Jul-Dec	Catches in 1990 estimated by assuming constant catchability and adjusting effort until the SOP is in accordance with the reported catch
	Retrospective	Available Y	No indication of bias in estimates of terminal populations
Recruitment	indices available	List : none	No recruitment surveys available
	type		
	results	year and ages replaced :	
Short term forecast	Assumption	status quo/quota/other Input used for F (expl. pattern) and weight-at-age : average pattern of last x years raised to '95 / other Reference age range :	
	Sensitivity	Prediction sensitive to : M,W,F,N,S/R rel.	
Medium term forecast	type	software : recruitment model : constrained bootstrap	

Stock status, prediction and reference points	Stock status							Short term prediction					Reference points									
Units : ''000 t Million/billion	Fluctuating without any trend							Status quo / quota /other :					Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	Land	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}
	918	.38	1158	663	978	303							427									

General comments on the assessment:
The interannul changes in the spatial distribution of effort and the stationary behaviour of settled sandeels makes the usual fisheries models less suited and this is probably the reason for the large residuals in the SXSA.

Assessment summary table, Stock: Sandeel at Shetland

		Availability and source	Comments
Data	Catch-at-age	Catch-at-age data available for 1974-1995, but zero catches in 1991-1994 due to closure. ages 0-7+	
	Weight in catch	As catch at age	
	Weight in stock	Long-term average weight in catch used	
	catch-effort data	Commercial effort data for whole fleet plus survey data from August surveys 1984-1996 (not 1987 or 1995)	
	Maturity	Knife-edge at age 2, based on observed data	
	Nat. mort	North Sea MSVPA values used.	
Catch-at-age analysis	Type	Semi-annual Separable VPA SSV - no convergence.	Comments on tuning : No analytical assessment possible, probably due to sparseness of catch-at-age matrix and missing years in survey.
	Fleets		
	Setup		
	Retrospective		
Recruitment	indices available		
	type		
	results		
Short term forecast	Assumption		None possible
	Sensitivity	Prediction sensitive to :	-
Medium term forecast	type	software : recruitment model :	-

Stock status, prediction and reference points Units : ''000 t Million/billion	Stock status Thought to be within safe biological limits.							Short term prediction Status quo / quota /other :					Reference points Agreed reference points : Source :									
	Assessment			Recruitment :																		
	1995			Yrclass, age :				1996		1997		1998	SSB '000 t		F							
	Land.	F	SSB	'93	'94	'95	'96	SSB	Land	SSB	Land	Land	MBAL	B_{msy}	F_{med}	F_{high}	$F_{0.1}$	F_{max}	F_{MSY}	F_{crash}	$F_{90\%}$	F_{comfie}

General comments on the assessment:

Assessment summary table, Stock: Sandeel in Divison VIa

		Availability and source	Comments
Data	Catch-at-age	Catch at age data for 1984-1996, 0-7+, Coverage of most landings.	
	Weight in catch	As catch at age; long-term mean used	
	Weight in stock	Long-term mean catch weights used	
	catch-effort data	Effort data for all landings into Scotland (usually 90%+) raised to total landings. No survey data	
	Maturity	Values from Shetland (observed) used. Knife-edge, age 2	
	Nat. mort	Values from North Sea stock (MSVPA) used	
Catch-at-age analysis	Type	Semi-annual Separable VPA	Comments on tuning : Reduced time series used to overcome catchability trend
	Fleets	Total catch and effort from 1989 onwards	
	Setup	Effort weighted equal with catch data; 0-gp catches downweighted	
	Retrospective	Available N	
Recruitment	indices available	None	
	type	RCT3 / XSA / Other	
	results	year and ages replaced :	
Short term forecast	Assumption	status quo/quota/other Input used for F (expl. pattern) and weight-at-age : average pattern of last x years raised to '95 / other Reference age range :	
None	Sensitivity	Prediction sensitive to : -	
Medium term forecast	type	software : recruitment model :	

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<table>
<tr><td rowspan="5">Stock status, prediction and reference points

Units :
''000 t
Million</td><td colspan="7">Stock status
To recent year classes strong
High SSB.</td><td colspan="5" rowspan="2">Short term prediction
Status quo / quota /other : None</td><td colspan="10" rowspan="2">Reference points
Agreed reference points :
Source :
None</td></tr>
<tr><td colspan="3">Assessment</td><td colspan="4">Recruitment :</td></tr>
<tr><td colspan="3">1995</td><td colspan="4">Yrclass, age : 0</td><td colspan="2">1996</td><td colspan="2">1997</td><td>1998</td><td colspan="2">SSB '000 t</td><td colspan="8">F</td></tr>
<tr><td>Land.</td><td>F</td><td>SSB</td><td>'93</td><td>'94</td><td>'95</td><td>'96</td><td>SSB</td><td>Land</td><td>SSB</td><td>Land</td><td>Land</td><td>MBAL</td><td>B_{msy}</td><td>F_{med}</td><td>F_{high}</td><td>$F_{0.1}$</td><td>F_{max}</td><td>F_{MSY}</td><td>F_{crash}</td><td>$F_{90\%}$</td><td>F_{comfie}</td></tr>
<tr><td>7.1</td><td>0.2</td><td>37</td><td>21</td><td>10
1</td><td>7</td><td>-</td><td>67</td><td>13.3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="23">General comments on the assessment:
Subject to large changes in level from year to year. Gives indication of broad trends only.</td></tr>
</table>

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20 WORKING PAPERS AND REFERENCES

Working papers

WP 1: van Beek, F. Note to the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak with regard to the effects of low water temperatures in severe winters on the mortality of North Sea sole.

WP 2: Cook, Robin. North Sea roundfish. Paper presented at: The precautionary approach to North Sea Fisheries Management. Oslo, 9–10 September 1996.

WP 3: Dornheim, H and U. Damm. First results of a research fishery on industrial species by 'RV Walther Herwig III' (27/4–6/5 96) and in the German fishery zone.

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WP 5: Reeves, S. Some considerations in preparing data for combined North Sea/Skagerrak/Eastern Channel assessments.

WP 6: Rijnsdorp, A.D. and F.A. van Beek. Recent developments in North Sea plaice and the effect of a protected area ("plaice box").

WP 7: Weber, W. A new year class index for cod from a survey in the German Bight.

WP 8: Wright, P.J. Evaluating the effect of sandeel fisheries on local aggregations of sandeels in areas close to important wildlife assemblages such as seabird colonies, and the effects of seasonal and localised catch regulations.

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ANNEX 1

The effects of low water temperatures in severe winters on the mortality of North Sea sole

Frans van Beek

The common or Dover sole (*Solea solea* L.) is a warm water species and occurs in the North Sea in its most northern area of distribution. The stock in the North Sea is the largest known of this species. In cold winters sole shows an abnormal distribution pattern. In order to avoid the extreme water temperatures, soles migrate to the deeper and relative warmer areas in the southern North Sea. A directed fishery in that period is conducted to the concentrated populations in these areas and is characterised by high CPUE's. In the past, it has been demonstrated that sole in the North Sea is vulnerable to extreme low water temperatures in cold winters. Large amounts of dead soles or soles with skin lesions were reported in the catches of fishermen in extreme winters, such as those of 1929, 1947 and 1963 (Woodhead 1964b, Lumby & Atkinson 1929), mostly in March. To a lesser extend dead soles and soles with skin lesions were observed in the catches in the cold winters of 1969 (de Veen 1969, Rauck 1969), 1979 (Anon 1979), 1987 (van Beek 1987) and also in 1996.

The mortality is caused by a failure of the osmo-regulation mechanism in the fish at cold water temperatures, which controls the plasma sodium and potassium level in the blood (Woodhead 1964b). The dead and affected soles show open wounds on the skin. The skin shows loss of scales, partly mortifies and loosens from the body. The failure of the osmo-regulation mechanism causes a deterioration of the physical condition of the fish, which than become more vulnerable to infections and the fish eventually dies. Most catches of dead soles and infected soles in poor condition take place at the end of the cold period when the water temperature is rising again. Juveniles (1-2 year olds) appear to be more vulnerable than older soles. In the winter of 1963 first reports of dead soles occurred when the sea water temperature had dropped below 3.5 ^{o}C during a period of 35 days (de Veen 1969). Qualitative analyses of the after-effects of extreme winters, showed that a considerable increase in natural mortality can take place (Woodhead, 1964a,b). Based on a comparison of CPUE data the ICES North Sea Flatfish Working Group estimated the natural mortality in the winter of 1963 to 60%, M=0.9 (Anon. 1979).

In the winter of 1995-1996 the Dutch and UK fisheries incidentally reported soles in the catch showing the characteristics described above. R.V. "Tridens" also reported catches of dead soles in the German Bight in February 1996. A survey was carried out by RV "Isis" in the period 25-29 March 1996 in order to estimate the prevalence of affected sole. Due to permit restrictions the vessel could only operate in Dutch waters. The survey was carried out using two standard BTS 8-m beam trawls with cod-ends of 40 mm. mesh size.

In total 28 hauls were done between 51^{o}30' and 54^{o}30' latitude. Soles were present in all hauls. Most numbers were caught near Puzzle Hole at a depth of 51 m and near Tea Kettle Hole. The depth in the other hauls varied between 20 and 30 m. The water temperature on the bottom was already rising in the shallow parts of the North Sea and soles were already migrating out of the deeper parts. In the deeper parts the temperature was still between 2.3 and 2.9 ^{o}C and in the shallow parts it varied between 4.5 and 5.5 ^{o}C.

Affected soles with skin lesions were observed in 17 out of 28 hauls (table 1). Most affected soles (60%) showed minor wounds. The other 40% had more severe wounds. Dead soles were not caught. The prevalence of affected soles in the individual hauls varied between 0 and 27%. The prevalence in the whole survey was 11.5%. There was only little difference between the infection rate of soles below the minimum landing size of 24 cm (12%) and marketable soles (10%). No dead soles were caught.

The length distribution of the catch shows that also smaller fish managed to escape from the cold water in this winter (figure 1). These smaller fish are extra vulnerable, especially when the water temperature decreases suddenly, because they may not migrate fast enough to avoid the sudden temperature decrease.
It is difficult in interpret de survey data to quantify the extra natural mortality caused by the effects of the cold winter. It is probable that the seriously affected soles do no recover and eventually die because of the injuries. It

could be expected that, if these fish would recover, they would show scars on the skin. However, soles with scars in the skin, which could be related to the cold winters, have never been observed. Since the survey was restricted to part of the Dutch waters, the situation observed in the sampled area may not be representative for the whole sole population in the North Sea. Incidental information from the Dutch fishery in the summer of 1996 indicates that catch rates of sole have decreased considerable along the Danish Coast and in the German Bight compared to previous years, while in southern part of IVc catch rates have remained high.

In the assessments of the sole in the North Sea, natural mortality is assumed to be 10% for all age groups, corresponding with M=0.1, except in 1963, where M was estimated to be 0.9. In the catch forecast for 1980 (Anon. 1979) options provided by the Working Group were based on M values for 1979 ranging between 0.1 and 0.5. In later Working Groups a value of M=0.1 has continued to be used. If the prevalence of affected sole observed in the 1996 survey is representative for the natural mortality rate of the whole stock, the extra natural mortality would correspond with a M ranging between 0.2 and 0.25.

It should also be noted that extra mortality in cold winters may affect expected recruitment to the fishery. In the VPA, year class strength is calculated from the cohort of landings of that year class in different years and at different ages. In fact year class strength should be considered as an index of "exploitable year class" or "apparent year class" because it excludes the part of the year class which has not been seen (killed by discarding and extra natural mortality not accounted for in an event). This means that "apparent" poor year classes may have not been poor in an early life stage. Therefore, in a prediction, caution has to be taken with estimates of recruitment based on indices obtained before the event.

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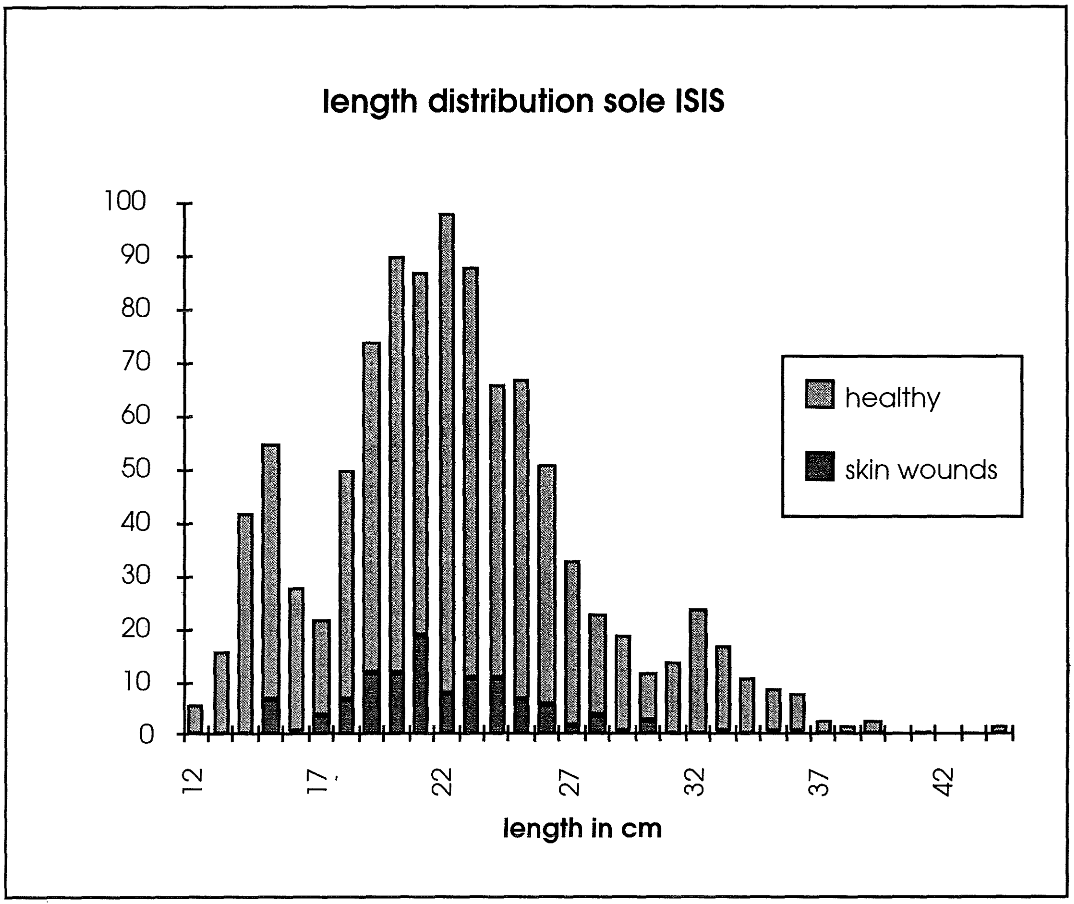
Table 1 Trawllist ISIS

Haul	rectangle	latitude N	longitude E	Depth in meter	bottom temp	number of sole captured per f.h.	prevalence of sole with scars on skin a) light	b) mediate	c) severe	a+b+c	% total
1	34f4	52.36	4.23	19	3.9	15					0
2	34f4	52.35	4.10	22	4.3	19		3	1	4	21
3	34f3	52.34	3.52	26	4.8	4					0
4	34f3	52.34	3.39	30	5.1	5					0
5	34f3	52.41	3.16	33	5.6	39					0
6	34f3	52.54	3.16	32	5.5	34	5	1		6	18
7	37f4	54.19	4.15	51	2.9	54	1	1	1	3	6
8	37f4	54.21	4.17	51	2.9	33	3	1		4	12
9	37f4	54.24	4.17	51	2.8	44	4	1		5	11
10	37f4	54.30	4.17	51	2.6	30	1	1		2	7
11	38f4	54.40	4.14	51	2.3	20	1	1		2	10
12	37f4	54.27	4.21	51	2.8	29					0
13	37f4	54.23	4.22	51	2.8	46	4			4	9
14	37f4	54.19	4.24	51	2.4	80	2			2	3
15	37f4	54.12	4.23	49	2.9	86	4	5	1	10	12
16	36f4	53.30	4.24	27	3.9	25					0
17	35f4	53.24	4.15	28	4.2	5					0
18	35f4	53.24	4.04	27	4.6	7					0
19	35f3	53.26	3.45	31	4.5	4					0
20	35f3	53.23	3.18	30	3.9	4					0
21	35f3	53.16	3.24	31	4.5	48	11	2		13	27
22	35f3	53.12	3.25	32	4.5	67	7			7	10
23	35f3	53.09	3.25	32	4.6	110	15	7	4	26	24
24	35f3	53.09	3.20	31	4.8	38	7			7	18
25	32f2	51.33	2.41	28	5.2	75	6	4	7	17	23
26	32f2	51.30	2.52	24	5.2	21	2	1		3	14
27	32f2	51.37	2.58	33	4.7	64	1	1	2	4	6
28	33f4	52.18	4.07	23	_	17					0
					4.01	1023	74	29	16	119	12

e:\acfm\wgnssk97\annex.xls

Figure 1


length distribution sole ISIS
100
90
80
70
60
50
40
30
20
10
0
12
17
22
27
32
37
42
length in cm
healthy
skin wounds