Advisory Committee on
Fishery Management

ICES CM 1998/Assess:7

REPORT OF THE

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

ICES Headquarters
6–15 October 1997

PART 3 OF 3

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

11 PLAICE IN DIVISION VIID

11.1 Catch Trends

Landings data reported to ICES are shown in Table 11.1.1 together with the total landings estimated by the Working Group. The unallocated landings are mainly due to discrepancies between the officially reported figures and those available to Working Group members. No correction was made for SOP discrepancies which are very low since 1992. The trend in landings is shown in Figure 11.1.1. Landings peaked at 10,400 t in 1988 and have declined by nearly half since then to 5,400 t in 1996 which is just below the 6,000 t predicted in last year's assessment. France contributes mainly to the official landings in 1996 with 48.8% followed by Belgium (20.6%) and UK (15.9%). Plaice is caught all year with sole by Belgian and UK offshore beam trawlers and French inshore trawlers. It's also a seasonal target in winter for some French offshore otter trawlers. There is no separate TAC for VIId plaice which at present is managed together with area VIIe (TAC_{96} = 7,530 t).

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

This year the natural mortality was assumed constant over ages and years at 0.10 as for the North Sea (Table 11.2.1), previously it was taken to be 0.12. The maturity ogive used is similar to that for VIIe plaice, it is shown in Table 11.2.1. Age compositions for 1980–96 were available for the UK and for 1981–96 for Belgium. However, levels of sampling prior to 1985 were poor and those data are considered to be less reliable. Age compositions were provided by France since 1989.

Quarterly catch weights were available from UK since 1980 and from Belgium since 1986. French catch weights have been collected since 1989.

The age-composition data and the mean weight at age in the catch are shown in Tables 11.2.2 and 11.2.3. In 1996 international landings covered by sampling schemes represented 96% of the total landings. Stock weights at 1 January were calculated from a smoothed curve of catch weights (Table 11.2.4). Data before 1996 were not revised. The data do not include discards which are not sampled for this stock although they are probably quite substantial.

11.3 Catch, Effort and Research Vessel Data

Commercial effort and CPUE data were available from five commercial fleets covering inshore and offshore trawlers. All fleets show a steep decline in CPUE from 1988/89 to 1996. Effort has increased in all fleets since 1983 to 1989 and remained thereafter at a high level. Trends in effort and CPUE are shown in Table 11.3.2 and Figure 11.3.1 (see also overview in Section 2.3).

Effort and age composition were available for the same three commercial fleets than last year. For the FRENCH INSHORE TRAWL age composition were derived from total French age composition. Survey data were obtained since 1988 from two trawl surveys covering most of VIId. These were the English beam trawl survey in August (Table 11.3.3) and French otter trawl ground fish survey in October. Recruit survey estimates for 0 and 1-gp fish were also available from smaller scale surveys in VIId, the English and French YFS (Table 11.3.4).

All these data (including age 1) were used to tune the VPA. The range of ages and years used in each fleet is shown in the input file for tuning (Table 11.3.1).

11.4 Catch at Age Analysis

As for last year the analysis was carried out with XSA.. A number of trial runs were made to select the most appropriate model for the data and a multi stage process was used to select the final tuning options:

1. A separable VPA was made to check the input data (Table 11.4.1a). High residuals in the recent years occur for the recruits (age 1/2) and ages above 10. Age 10 was therefore used as a plus group.

2. Choice of age to be treated as recruits. An exploratory run was made with all ages below 8 (default) treated as recruits (all other options accepted also by defaults). Examination of the regression statistics showed that for all fleets no slopes were significantly different from 1.0. for the younger ages (only significantly different for age 4 in FR OFF TR and for age 7 in UK IN TR and FR IN TR). The two options <2 and <3 concerning the

age to be treated as recruits were explored and the results were very similar. Catchabilities were therefore set to be dependent on year class strength for ages<3 as last year.

3. Choice of age for which catchability can be assumed to be constant. From the previous trial run where catchability depend on year class strength for ages <3 and not dependant of age until 8 (default), the patterns of q with age were examined for each fleet. In most fleets, q showed a slight decline with age from a peak at age 4 and catchability become constant at age 7. Age 7 was therefore taken as an acceptable value (as in 96 Working Group).

4. Trends in catchability were examined for residual trends by fleet. Trends were examined from exploratory runs using XSA where each fleet was weighted separately to 1. We noticed big residuals and a change in the trend for age 1 in the UK INSHORE TRAWL METIER before 1990 so this age was therefore removed. The English BTS index was revised at age 6 and the French GFS which show big residuals at age 6 was removed. As the data were relatively poor before 1989 (as shown in the separable VPA) this period was down weighted using a tricubic weight over 15 years (10 years in 96 Working Group).

5. F at the oldest age group was taken as the mean of ages 6–8 in the final run (as in 96 Working Group).

6. Retrospective analysis was carried out using final XSA options and shrinking to SEs of 0.3, 0.5 and 0.7 were examined (Figure 11.4.2). There was a tendency to a small underestimate of F in the previous year (underestimate by 20% in 96 Working Group) and we noticed that there is no important effect of the shrinkage. The shrinkage of 0.5 was accepted (as in 96 Working Group).

7. Catchability residuals of the fleets from final XSA are presented in Figure 11.4.1.

The tuning fleets, input parameters and output from the final run are shown in Tables 11.4.1. Fishing mortality and stock numbers are in Tables 11.4.2 and 11.4.3 respectively. The weights of tuning categories are presented in Figure 11.4.3.

11.5 Recruit Estimates

Research vessel survey indices of 0, 1 and 2 year olds were available and are shown in Table 11.3.4. Until 1996 these survey data (except 0 group) were already used in XSA together with those of the three commercial fleets. The Figure 11.5.1 presents the survey indices compared with the VPA numbers (year class 1981 to 1993).

RCT3 was used to predict recruitment at age 1, and the input file using 0 and 1 group indices is presented in Table 11.5.1. Results are shown in Table 11.5.2 and can be compared to those of XSA:

Year Class	RCT3 Weighted average at age 1 (*10-3)	Var Ratio	XSA (age 1*10-3)
1994	27539	0.76	**23340**
1995	26436	0.35	**17126**
1996	**24073**	1.41	-
1997	20209	1.12	

The estimation of the 1994 and 1995 year class is not very far with the two methods and the XSA estimation was accepted. The RCT3 value of 24.1 million at age 1 was used for the 1996 year class and because the 1997 year class is not well estimated by RCT3 the GM_{80-94} of 22.7 millions was used.

For age 2 in 1997 the XSA value of $14432*10^3$ was accepted ($23038*10^3$ given by RCT3 using VPA age 2).

11.6 Historical Stock Trends

Trends in fishing mortality, SSB and recruitment are shown in Table 11.6.1 and Figure 11.1.1. Fishing mortality shows big variations in recent years, increasing steeply in 1991 and fluctuates at a high level. This recent trend in F is connected with the evolution of the effort made by the various fleets (see overview Section 2.3). SSB increased rapidly in 1987 following recruitment of the strong 1985 year class. Since 1990 it has declined steeply until 1992 and after a plateau it is now decreasing further to 7,000 t. Apart from two slightly above average year classes (1991 and 1994), recruitment has been close to the GM level of 22.7 million of 1 yr olds since 1989.

11.7 Short-Term Forecast

The input data for the catch forecasts are given in Table 11.7.1. Stock numbers in 1997 were taken from the VPA output adjusted for recruitment at age 1 and the GM of 22.7 million was used for age 1 in 1998 and 99. The exploitation pattern was the mean of the period 1994–96, scaled to the 1996 $F_{(2-6)}$ value of 0.68. Catch and stock weights at age were the mean for the period 1994–96 and proportions of M and F before spawning were set to zero. The results of the *status quo* catch prediction are given in Table 11.7.3 and Figure 11.7.5. The predicted catch in 1997 is estimated to be 5,600 t with a SSB of 6,200 t. This compares with a figure of 5,700 t forecast for the catch and 8,600 t for the SSB made last year. Continuing with the same level of F implies a stability in catch with 5,700 t in 1998 and a predicted SSB to 5,900 t in 1998 and 5,700 t in 1999. A detailed prediction output by age is shown in Table 11.7.4.

The results of sensitivity analysis of the status quo catch prediction are shown in Figures 11.7.6 and 11.7.7. The input data are included in Table 11.7.2.

Figure 11.7.6 shows that the yield in 1998 and the SSB in 1999 are very dependant of the fishing mortality in 1998 and 1997. In the same Figure is shown the proportion of total variance of the estimated yields and spawning biomass contributed by the input parameters. For yield in 1998 and SSB 1999, most of the variance is contributed by N1, HF98 and sH2.

Figure 11.7.7 shows probability profiles for yields in 1998 and spawning biomass in 1999.

11.8 Medium-Term Predictions

A medium-term prediction (10 years) was carried out assuming that recruitment is fitted with a Beverton model. One run of 500 simulations was carried out for the status quo (F=1.0*F96). Results in Figure 11.8.1 show the 5, 10, 20, 50 and 95 percentiles for yield, recruitment and SSB. These figures indicate a slight decrease in all these parameters for the medium-term period. Hence with a 95% probability, the yield and also the corresponding SSB will be between 4,000 t and 8,000 t.

11.9 Long-Term Considerations

The current level of F is well above F_{med} (Figure 11.9.1). The stock has been fished down from an historically high level following the strong recruitment in 1985 and at average levels of recruitment, SSB is likely to decrease to around 6,000 t which is just above the estimation of B_{lim} (see Section 11.12).

11.10 Comments on the Assessment

The methodology used this year was very similar to last year and XSA was used again. Separate fleet age composition for the French fleets has not been resolved yet. The French 0 gp survey (fbts0) was removed from input file of RCT3 because it shows negative correlation with VPA numbers. For this stock discards are not included in XSA and this could introduce some differences between RCT3 and XSA estimates on younger ages.

If we compare with last year's assessment some changes appear as an increasing in F for 1995 with the consequence of a decrease in the SSB, the 1993 and 1994 year classes are also smaller than estimated previously. The assessment indicates a rapid decline in the stock with SSB appearing to decline from 8,300 t in 1995 to 5,700 t in 1999 instead in last year's assessment the SSB appeared to be stable. The current trend in SSB matches the decline in CPUE show in Figure 11.3.1.

The current F is well above F_{med}. In this situation, the SSB will be expected to decrease at average levels of recruitment. However, the calculation of F_{med} is not very precise because of the small number of data points available and thus conclusions about the long term stability of this stock should be treated with caution.

11.11 Biological Reference Points

A stock-recruitment scatter plot is shown in Figure 11.9.1. The current F (0.68) is well above the value of F_{med} (0.50). The yield per recruit input values are given in Table 11.11.1 and the output summary in Table 11.11.2. The YPR and SSB/R curves are shown in Figure 11.7.5. Assuming recruitment of 22.7 millions, the equilibrium yield at *status quo* F will average 5,700 t with a corresponding SSB of 5,700 t, slightly under current levels of biomass.

The relevant biological reference points are shown below:

$F_{0.1}$	F_{max}	F_{med}	F_{96}	F_{high}
0.13	0.23	0.50	0.68	0.83

11.12 Definition of Safe Biological Limits using PA and Limit Reference Points

Due to the short period data are available for this stock and because recruitment has been very stable at levels of SSB ranging from 6,000 to 14,000 t it is not clear at what level B_{lim} should be set. The most appropriate approach is to consider that B_{lim} is the lowest SSB encountered (5,600 tonnes).

Figure 11.12.1 shows F levels which on medium-term are associated with probabilities of 20, 10 and 5% of SSB < B_{lim} in 2006. The value of F_{pa} and B_{pa} are as follows:

B_{lim}=B_{loss}	$F_{pa,5}$	$F_{pa,10}$	$F_{pa,20}$	F_{loss}	SSB $_{pa,5}$	SSB $_{pa,10}$	SSB $_{pa,20}$
5600 t	0.58	0.60	0.61	0.57	7100 t	6800 t	6400 t

Even though F_{pa} is poorly estimated because inadequate data model F_{96} appears to be close to F_{pa}.

Figure 11.12.2 shows the distribution of F_{loss}, the value of 0.57 is considered to be the best estimation of F_{crash}. The fact that the estimate of F_{pa} is the same as F_{loss} indicates that these reference points are not well estimated.

Table 11.1.1 Plaice in Division VIId. Nominal landings (tonnes) as officially reported to ICES, 1976–1996.

Year	Belgium	Denmark	France	UK (E+W)	Others	Total reported	Un-allocated	Total as used by WG
1976	147	1[1]	1,439	376	-	1,963	-	1,963
1977	149	81[2]	1,714	302	-	2,246	-	2,246
1978	161	156[2]	1,810	349	-	2,476	-	2,476
1979	217	28[2]	2,094	278	-	2,617	-	2,617
1980	435	112[2]	2,905	304	-	3,756	-1,106	2,650
1981	815	-	3,431	489	-	4,735	34	4,769
1982	738	-	3,504	541	22	4,805	60	4,865
1983	1,013	-	3,119	548	-	4,680	363	5,043
1984	947	-	2,844	640	-	4,431	730	5,161
1985	1,148	-	3,943	866	-	5,957	65	6,022
1986	1,158	-	3,288	828	488[2]	5,762	1,072	6,834
1987	1,807	-	4,768	1,292	-	7,867	499	8,366
1988	2,165	-	5,688[2]	1,250	-	9,103	1,317	10,420
1989	2,019	+	3,265[13]	1,383	-	6,666	2,092	8,758
1990	2,149	-	4,170[13]	1,479	-	7,798	1,249	9,047
1991	2,265	-	3,606[13]	1,566	-	7,437	376	7,813
1992	1,560	1	3,099[3]	1,553	19	6,232	105	6,337
1993	0,877	+[2]	2,792[3]	1,075	27	4,771	560	5,331
1994	1,418	+	2,740[13]	993	23	5,174	648	6,121
1995	1,157	-	2,598[3]	796	18	4,569	561	5,130
1996	1,112	-	2,631[3]	856	+	4,599	794	5,393

[1]Estimated by the Working Group from combined Division VIId+e.
[2]Includes Division VIIe.
[3]Provisional.

Table 11.2.1 Plaice in Division VIId. Natural mortality and proportion mature.

Age	Nat Mor	Mat.
1	.100	.000
2	.100	.150
3	.100	.530
4	.100	.960
5	.100	1.000
6	.100	1.000
7	.100	1.000
8	.100	1.000
9	.100	1.000
10+	.100	1.000

Table 11.2.2 Plaice in Division VIId. Catch numbers at age.

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

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE							
1,	53,	16,	265,	92,	350,	142,	679,
2,	2644,	2446,	1393,	3030,	1871,	5714,	4884,
3,	1451,	6795,	6909,	3199,	7310,	6195,	7034,
4,	540,	2398,	3302,	5908,	2814,	4883,	3663,
5,	490,	290,	762,	931,	1874,	413,	1458,
6,	75,	159,	206,	226,	533,	612,	562,
7,	45,	51,	96,	92,	236,	164,	254,
8,	44,	42,	62,	122,	101,	99,	69,
9,	4,	56,	21,	4,	34,	139,	19,
+gp,	103,	200,	88,	101,	100,	50,	34,
0 TOTALNUM,	5449,	12453,	13104,	13705,	15223,	18411,	18656,
TONSLAND,	2650,	4769,	4865,	5043,	5161,	6022,	6834,
SOPCOF %,	100,	94,	92,	90,	86,	92,	100,

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	25,	16,	826,	1632,	1542,	1665,	740,	1242,	2592,	1119,
2,	8499,	5011,	3638,	2627,	5860,	6193,	7606,	3633,	4340,	4847,
3,	7508,	18813,	7227,	8746,	5445,	4450,	3817,	6968,	2933,	3606,
4,	3472,	4900,	9453,	5983,	4524,	1725,	1259,	3111,	2928,	1547,
5,	1257,	1118,	2672,	3603,	2437,	1187,	542,	850,	922,	1436,
6,	430,	541,	588,	801,	1681,	1044,	468,	419,	228,	488,
7,	442,	439,	288,	243,	286,	698,	334,	312,	277,	179,
8,	154,	127,	179,	203,	120,	200,	287,	267,	225,	176,
9,	105,	105,	81,	178,	113,	116,	102,	275,	122,	165,
+gp,	77,	174,	197,	231,	125,	118,	152,	312,	258,	347,
0 TOTALNUM,	21969,	31244,	25149,	24247,	22133,	17396,	15307,	17389,	14825,	13910,
TONSLAND,	8366,	10420,	8758,	9047,	7813,	6337,	5331,	6121,	5130,	5393,
SOPCOF %,	98,	92,	93,	98,	96,	98,	99,	99,	98,	102,

Table 11.2.3 Plaice in Division VIId. Catch weights at age.

Table 2 Catch weights at age (kg)

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE							
1,	.3090,	.2390,	.2450,	.2660,	.2330,	.2540,	.2260,
2,	.3120,	.2990,	.2710,	.2960,	.2950,	.2780,	.3060,
3,	.4990,	.3730,	.3530,	.3490,	.3360,	.3010,	.3310,
4,	.6270,	.4640,	.4310,	.4200,	.4020,	.4270,	.4060,
5,	.7870,	.7120,	.6400,	.5420,	.5080,	.5020,	.5460,
6,	1.1390,	.8700,	.7950,	.8220,	.6890,	.5700,	.4860,
7,	1.1790,	.8630,	1.1530,	.9530,	.7030,	.5570,	.6290,
8,	1.2930,	.8970,	1.0670,	1.1440,	.9450,	1.0810,	.8710,
9,	1.4750,	.9920,	1.5040,	.9430,	1.0280,	.8490,	1.4460,
+gp,	1.5572,	1.1736,	1.3552,	1.5907,	1.4269,	1.4209,	1.5789,
0 SOPCOFAC,	.9995,	.9353,	.9208,	.9003,	.8632,	.9239,	1.0001,

Table 2 Catch weights at age (kg)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	.2510,	.2920,	.2010,	.2010,	.2250,	.1820,	.2200,	.2430,	.2180,	.2210,
2,	.2820,	.2680,	.2680,	.2560,	.2770,	.2770,	.2720,	.2700,	.2710,	.3000,
3,	.3600,	.3210,	.3210,	.3260,	.3110,	.3520,	.3360,	.2880,	.3130,	.2900,
4,	.4770,	.4320,	.3700,	.3780,	.3900,	.4290,	.4320,	.3560,	.3900,	.3960,
5,	.5770,	.5600,	.4730,	.4830,	.4540,	.5090,	.5070,	.4660,	.4850,	.4750,
6,	.7830,	.6570,	.6480,	.6100,	.5560,	.5850,	.5910,	.5760,	.6880,	.6430,
7,	.7350,	.7700,	.8370,	.7810,	.7450,	.7010,	.7410,	.6860,	.6120,	.7640,
8,	1.1420,	.9080,	.9070,	.9630,	1.0870,	.8370,	.8200,	.9280,	.8060,	.9340,
9,	1.2680,	1.2180,	1.2040,	1.1590,	.9240,	.8500,	.9340,	.9690,	1.1500,	1.0570,
+gp,	1.5148,	1.3280,	1.5195,	1.3099,	1.6015,	1.1947,	1.1555,	1.2866,	1.2977,	1.3124,
0 SOPCOFAC,	.9757,	.9224,	.9313,	.9795,	.9625,	.9846,	.9940,	.9930,	.9807,	1.0201,

Table 11.2.4 Plaice in Division VIId. Stock weights at age.

Table 3 Stock weights at age (kg)

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE							
1,	.1710,	.1100,	.1050,	.0970,	.0820,	.0840,	.1010,
2,	.3320,	.2160,	.2080,	.1920,	.1640,	.1710,	.2050,
3,	.4820,	.3170,	.3080,	.2860,	.2480,	.2590,	.3110,
4,	.6220,	.4140,	.4060,	.3790,	.3330,	.3480,	.4200,
5,	.7510,	.5060,	.5020,	.4700,	.4200,	.4400,	.5320,
6,	.8700,	.5940,	.5960,	.5600,	.5070,	.5330,	.6460,
7,	.9770,	.6770,	.6870,	.6480,	.5960,	.6280,	.7630,
8,	1.0740,	.7560,	.7760,	.7350,	.6860,	.7250,	.8820,
9,	1.1610,	.8300,	.8620,	.8210,	.7770,	.8240,	1.0040,
+gp,	1.3392,	1.0419,	1.1184,	1.1688,	1.0858,	1.2060,	1.3126,

Table 3 Stock weights at age (kg)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
1,	.1220,	.0840,	.0790,	.0850,	.0650,	.0880,	.1080,	.1650,	.0580,	.1780,
2,	.2420,	.1680,	.1620,	.1720,	.1410,	.1770,	.2140,	.2150,	.1720,	.2380,
3,	.3610,	.2540,	.2500,	.2620,	.2270,	.2680,	.3150,	.2740,	.2840,	.3070,
4,	.4790,	.3400,	.3420,	.3550,	.3240,	.3610,	.4140,	.3440,	.3960,	.3850,
5,	.5960,	.4270,	.4390,	.4510,	.4320,	.4560,	.5090,	.4220,	.5060,	.4730,
6,	.7120,	.5140,	.5410,	.5490,	.5500,	.5520,	.6010,	.5110,	.6150,	.5690,
7,	.8260,	.6030,	.6480,	.6510,	.6790,	.6510,	.6900,	.6090,	.7230,	.6750,
8,	.9390,	.6920,	.7590,	.7550,	.8190,	.7510,	.7760,	.7160,	.8300,	.7900,
9,	1.0510,	.7830,	.8740,	.8620,	.9690,	.8530,	.8580,	.8340,	.9350,	.9150,
+gp,	1.3055,	.9519,	1.2112,	1.1247,	1.4036,	1.1158,	1.0384,	1.1472,	1.1891,	1.2233,

Table 11.3.1 Plaice in VIId. Tuning input file.

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Plaice in the Eastern English Channel (Fishing Area VIId) (run name: XSAATT01)
107
FLT02: BELGIAN BEAM TRAWL( HP corr, 5/9/93),all gears age comp (Catch: Unknown) (Effort: Unknown)
1981 1996
1 1 0.00 1.00
2 10
   24.4    285.9   1126.5    593.3     67.3     21.6      8.3      7.1     13.3     14.1
   29.8    147.8   1065.4    688.2    187.2     55.1     21.1      6.5      4.6      4.0
   26.4    476.7    654.3   1384.5    165.0     52.2     23.0     31.6      1.3      1.4
   35.4     92.0   1570.4    712.1    467.5    134.3     61.0     28.2      5.4      6.8
   33.4    557.2   1125.3   1115.1     93.9    197.2     52.9     31.9      5.3      6.1
   30.8    700.6   1141.8    667.8    269.9    145.9     60.3     11.3      5.6      6.4
   49.3   1944.8   1639.7    889.0    343.1     92.7    154.5     41.1     28.0     14.1
   48.9    773.0   4264.6   1301.8    237.1    109.9    113.2     35.8     25.4     24.0
   43.8     73.6   1733.7   2950.5    973.4    212.8    113.1     61.1     21.7      0.1
   38.5    372.1   2687.5   1942.8   1007.0    184.8     43.9     50.5     13.1     14.0
   32.8    595.4   1689.2   1149.4   1089.5    698.4     86.9     36.0     58.9      1.7
   30.9    889.8   1031.7    403.8    277.6    282.1    159.7     58.2     60.7      6.7
   28.2    488.8    684.2    274.3    197.6    121.6     74.7     62.8     10.6     19.3
   32.8    424.6   1259.2   1426.5    268.0    132.6    109.5     75.5     90.0     37.6
   31.7     39.8    591.9    925.2    396.5     82.0    140.1     82.6     26.1      0.7
   32.6    259.3    689.3    541.5    503.7    137.6     46.4     49.9     38.4     44.4
FLT03: English BTS (Catch: Unknown) (Effort: Unknown)
1988 1996
1 1 0.50 0.75
1 6
   1   26.5   31.3   43.8    7.0    4.6    1.5
   1    2.3   12.1   16.6   19.9    3.3    1.5
   1    5.2    4.9    5.8    6.7    7.5    1.8
   1   11.7    9.1    7.0    5.3    5.4    3.2
   1   16.5   12.5    4.2    4.2    5.6    4.9
   1    3.2   13.4    5.0    1.7    1.9    1.6
   1    8.3    7.5    9.2    5.6    2.0    0.8
   1   11.3    4.1    3.0    3.7    1.5    0.6
   1   13.2   11.9    1.3    0.7    1.3    0.9
FLT04: French GFS (Catch: Unknown) (Effort: Unknown)
1988 1996
1 1 0.75 1.00
1 5
   1    8.0   17.6    9.9    1.7    0.6
   1    3.5    7.4    2.7    1.1    0.1
   1    3.3    0.9    2.3    1.4    1.3
   1    1.6    0.6    0.4    0.2    0.2
   1   37.7    3.2    0.5    0.2    0.1
   1   10.0    5.4    2.0    0.4    0.2
   1    6.3    2.4    0.9    0.3    0.2
   1    3.9    3.7    1.5    0.9    0.2
   1    5.7    3.3    0.4    0.2    0.2
FLT05: English YFS (Catch: Unknown) (Effort: Unknown)
1985 1996
1 1 0.50 0.75
1 1
   1    1.7
   1    2.1
   1    2.4
   1    1.6
   1    1.5
   1    0.8
   1    0.6
   1    1.5
   1    0.9
   1    0.8
   1    3.3
   1    1.4
FLT06: French YFS (Catch: Unknown) (Effort: Unknown)
1987 1996
1 1 0.50 0.75
1 1
   1    0.9
   1    0.8
   1    0.2
   1    0.4
   1    0.4
   1    1.4
   1    0.4
   1    1.1
   1    1.0
   1    0.3
FLT07: UK INSHORE TRAWL METIER <40 trawl lands, all trawl age comp (Catch: Thousands) (Effort: Unknown)
1985 1996
1 1 0.00 1.00
2 10
    2708   638.6   433.4   228.4    19.4     0.0     0.0     0.0    19.6     0.0
    1919   257.2   324.5   143.7    55.7     7.0     5.1     3.1     0.0     0.0
    2679   485.6   458.1   163.2    51.2    26.7     5.4     6.7     4.6     0.0
    2479   379.6   849.8   140.7    57.4    29.8    14.0     2.7     4.0     5.2
    2491    45.5   212.9   447.0    93.2    39.6    18.3     5.2     1.2     6.0
     968    28.7    77.2    44.1    47.7    15.1     6.3     4.6     3.0     2.6
    2049   197.2   188.6   136.8    62.9    53.3     8.8     3.5     1.7     1.1
    2291   243.6   184.4   114.8    63.6    45.2    36.1    12.0     2.4     1.9
    2285   263.2   154.4    56.7    34.5    25.6    18.3    21.3     7.2     3.2
    1891   141.1   192.6    79.9    30.3    16.8    13.6     7.1    14.4     2.8
    1617   124.7    71.0    54.8    23.6     8.5     5.0     5.5     3.9     6.8
    1553   256.5    59.6    15.8    17.9     9.3     2.4     2.9     2.3     2.4
FLT08: FRENCH INSHORE TRAWL F1.4 CRTS (Catch: Thousands) (Effort: Unknown)
1989 1996
1 1 0.00 1.00
1 10
  1044.1   117.3   482.7   663.5   666.5   189.1    29.8    13.9    13.8     7.8     6.5
   909.1    99.5   114.5   307.7   211.5   119.5    25.2     7.0     5.4     7.6     2.4
   967.0   109.3   348.5   219.8   207.7    75.4    48.2    10.7     4.5     3.3     3.6
   505.2   109.6   270.4   162.3    44.0    36.2    33.4    21.8     4.5     2.7     2.0
   544.6    43.4   382.3   155.7    45.7    11.4    13.9    10.7     7.4     3.1     1.1
   643.0    82.3   185.3   347.9    93.7    31.4    14.7     9.8    11.4     8.4     6.5
   621.9   136.2   197.0    93.7    73.7    12.8     3.3     3.1     4.3     3.4     4.4
   676.3    37.6   119.5    93.9    29.4    27.8     9.9     4.1     3.8     4.0     3.8
```

Table 11.3.2

Plaice in Division VIId. Catch per unit effort

Year	United Kingdom Beam trawl (kg/hr)	United Kingdom Inshore trawl (kg/day)	Belgium Beam trawl (kg/hr)	France Offshore trawl (kg/(hr*kw*10-4))	France Inshore trawl (kg/(hr*kw*10-4))
1980			24.4		
1981			31.2		
1982			24.5		
1983	21.6		36.2	187.9	
1984	18.5		25.9	301.5	
1985	19.9	158.9	31.8	224.9	527.2
1986	27.7	149.7	34.9	221.1	701.4
1987	15.5	181.5	33.7	318.0	843.0
1988	8.9	213.0	40.7	316.8	1258.5
1989	17.6	129.3	42.8	190.5	739.5
1990	17.4	111.1	48.8	224.0	362.0
1991	18.3	115.8	45.5	173.4	382.9
1992	14.2	117.0	34.9	148.9	485.0
1993	11.9	97.9	24.2	117.2	417.1
1994	11.1	109.7	32.4	131.7	421.5
1995	9.3	98.7	25.7	109.4	287.2
1995	10.0	87.2	26.2	103.4	199.8

Plaice in Division VIId. Effort data

Year	United Kingdom Beam trawl(1) ('000 hr)	United Kingdom Inshore trawl ('000 days)	Belgium Beam trawl(1) ('000 hr)	France Offshore trawl(1) hr*kw*10-4	France Inshore trawl(1) hr*kw*10-4
1980			29.8		
1981			24.4		
1982			29.8		
1983	2.9		26.4	1816.8	
1984	2.3		35.4	2801.7	
1985	7.9	2.7	33.4	6768.4	228.8
1986	7.3	1.9	30.8	8069.0	411.2
1987	24.3	2.7	49.3	6035.8	573.2
1988	19.7	2.5	48.9	6064.3	942.2
1989	24.6	2.5	43.8	5939.3	1044.1
1990	32.8	0.9	38.5	7485.7	909.1
1991	29.5	2.0	32.8	9537.7	967.0
1992	35.0	2.3	30.9	9260.6	505.2
1993	29.2	2.3	28.2	8981.0	544.6
1994	26.8	1.9	32.8	9375.6	643.0
1995	28.1	1.3	31.7	9299.4	621.9
1996	37.1	1.5	32.6	12478.8	676.3

1. Corrected for HP

e:\acfm\wgnssk98\t-11-3-2.xls

Table 11.3.3.- Plaice in Division VIId. English beam trawl survey numbers per hr raised to 8m beam trawl equivalent (mean no/rectangle, average across rectangles).

Age	1	2	3	4	5	6	7	8	9	10+	1+	3+
1988	26.47	31.33	43.75	6.96	4.64	1.51	0.77	0.70	0.60	1.21	117.94	60.14
1989	2.31	12.13	16.63	19.94	3.30	1.48	1.32	0.54	0.30	1.65	59.60	45.16
1990	5.16	4.86	5.76	6.70	7.53	1.76	0.65	0.97	0.75	0.37	34.51	24.49
1991	11.75	9.06	6.98	5.30	5.43	3.20	1.22	0.99	0.06	1.24	45.23	24.42
1992	16.53	12.54	4.19	4.17	5.57	4.88	3.44	0.66	0.49	0.72	53.18	24.12
1993	3.22	13.40	4.96	1.75	1.89	1.57	2.05	2.78	0.39	0.57	32.57	15.95
1994	8.33	7.46	9.17	5.56	1.95	0.77	0.90	1.83	1.24	0.81	38.03	22.23
1995	11.32	4.06	3.00	3.67	1.49	0.58	0.59	1.32	0.82	0.78	27.63	12.25
1996	13.2	11.9	1.3	0.7	1.3	0.9	0.4	0.3	0.4	2.8	33.3	8.1
1997	33.1	13.5	4.2	0.6	0.3	0.3	0.2	0.2	0.2	1.9	54.6	8.0

Table 11.3.4.- Plaice in division VIId. Survey indices of recruitment

	English YFS		English BTS			French YFS		French CGFS		
Year class	0 gp	1 gp	1 gp	2 gp	3 gp	0 gp	1 gp	0 gp	1 gp	2 gp
1980		0.36				1.12	0.04	-		
1981	3.4	0.45				5.31	0.25	-		
1982	2.5	1.14				1.49	0.04	-		
1983	14.5	0.73				2.42	-	-		
1984	6.3	1.71				-	-	-		
1985	10.9	2.08			43.75	-	-	-		
1986	20.1	2.38		31.33	16.63	-	0.94	-	-	26.46
1987	22.3	1.61	26.47	12.13	5.76	4.44	0.82	-	10.33	8.79
1988	13.0	1.47	2.31	4.86	6.98	1.11	0.22	0.19	4.08	1.27
1989	3.7	0.76	5.16	9.06	4.19	2.38	0.4	0.16	3.95	0.91
1990	6.5	0.64	11.75	12.54	4.96	1.04	0.39	0.16	1.95	6.05
1991	2.7	1.45	16.53	13.4	9.17	3.02	1.36	0.15	33.61	6.79
1992	4.3	0.85	3.22	7.46	3.00	2.19	0.45	0.98	11.68	3.45
1993	7.6	0.83	8.33	4.06	1.3	0.88	1.12	2.41	9.02	4.32
1994	17.2	3.27	11.32	11.9	4.2	3.95	0.95	7.39	5.07	4.59
1995	12.0	1.42	13.2	13.5		6.72	0.33	0.77	6.84	
1996	2.5	0.42	33.1			2.95		21.13		
1997	2.4									

Table 11.4.1a Plaice in Division VIId. Separable VPA.

Title : 107D PLAICE 1997 WG,1-15+,80-96,SEXES COMB [rev: 11/9/97-AT]
At 15/09/1997 15:05
Separable analysis
from 1980 to 1996 on ages 1 to 14
with Terminal F of .500 on age 3 and Terminal S of .700
Initial sum of squared residuals was 509.909 and
final sum of squared residuals is 285.674 after 105 iterations

Matrix of Residuals

Years, Ages	1980/81,	1981/82,	1982/83,	1983/84,	1984/85,	1985/86,
1/ 2,	-1.927,	-2.992,	-1.153,	-1.210,	-1.838,	-2.394,
2/ 3,	-.458,	-1.037,	-1.026,	-.576,	-1.785,	-.522,
3/ 4,	-.538,	.172,	-.597,	-.108,	-.782,	-.346,
4/ 5,	.418,	.442,	.353,	.778,	.589,	.168,
5/ 6,	1.035,	-.223,	.444,	.339,	-.038,	-1.218,
6/ 7,	.445,	.105,	.203,	-.090,	.208,	.132,
7/ 8,	.281,	-.436,	-.683,	.019,	.067,	.277,
8/ 9,	.051,	.534,	2.379,	1.469,	-1.039,	1.145,
9/10,	-2.339,	.693,	.291,	-1.598,	-.134,	1.345,
10/11,	1.565,	.797,	.019,	-.274,	1.734,	4.720,
11/12,	-1.346,	-.042,	.115,	.102,	4.322,	2.410,
12/13,	.455,	1.628,	.266,	.413,	4.162,	-.687,
13/14,	-.329,	.137,	-.466,	-1.145,	-.911,	-4.981,
TOT ,	.003,	.002,	.001,	.001,	.000,	.000,
WTS ,	.001,	.001,	.001,	.001,	.001,	.001,

Years,	1986/87,	1987/88,	1988/89,	1989/90,	1990/91,	1991/92,	1992/93,	1993/94,	1994/95,	1995/96,	TOT,	WTS,
1/ 2,	-.797,	-3.782,	-3.881,	.279,	-.112,	-.227,	-.498,	.051,	-.094,	.788,	.001,	.171,
2/ 3,	-.145,	-.771,	-.359,	-1.039,	-1.190,	-.149,	-.025,	.234,	-.154,	.105,	.002,	.447,
3/ 4,	.458,	-.104,	.131,	-.561,	-.420,	.122,	.163,	-.197,	-.083,	.000,	.002,	.713,
4/ 5,	.661,	.457,	-.076,	.110,	-.286,	.189,	-.089,	-.149,	.122,	-.076,	.002,	.780,
5/ 6,	.938,	.317,	.132,	.552,	-.206,	-.105,	-.148,	-.134,	.387,	-.002,	.000,	.465,
6/ 7,	.115,	-.375,	.304,	.432,	.272,	.126,	.244,	.185,	-.334,	-.224,	-.001,	1.000,
7/ 8,	.530,	1.054,	.735,	.070,	.125,	-.223,	.161,	.164,	-.255,	.149,	-.002,	.579,
8/ 9,	-.310,	.270,	.367,	-.196,	.085,	-.466,	.027,	.062,	.283,	.086,	-.003,	.305,
9/10,	-.549,	-.146,	.309,	-.288,	.670,	.376,	.160,	-.294,	.291,	-.534,	-.002,	.277,
10/11,	2.081,	-.141,	1.172,	-.259,	.840,	.172,	-.778,	-.335,	.914,	.012,	-.001,	.183,
11/12,	-5.529,	-1.299,	-.329,	-.203,	.775,	-.152,	-.333,	.169,	.389,	-.073,	.000,	.123,
12/13,	-3.063,	2.960,	-1.295,	.875,	.192,	-.112,	-.145,	-.452,	-.236,	.941,	.001,	.150,
13/14,	-3.280,	.173,	-1.201,	.558,	2.239,	-.231,	-.447,	.637,	.024,	.029,	.002,	.150,
TOT ,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	-10.984,	
WTS ,	.001,	.001,	.001,	.001,	.001,	1.000,	1.000,	1.000,	1.000,	1.000,		

Fishing Mortalities (F)

,	1980,	1981,	1982,	1983,	1984,	1985,	1986,			
F-values,	.2579,	.4238,	.4633,	.4130,	.6667,	.4365,	.3291,			
,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
F-values,	.4613,	.5413,	.6856,	.8173,	.7309,	.6285,	.4394,	.5918,	.4786,	.5000,

Selection-at-age (S)

,	1,	2,	3,	4,						
S-values,	.1250,	.6713,	1.0000,	.9086,						
,	5,	6,	7,	8,	9,	10,	11,	12,	13,	14,
S-values,	.6560,	.4965,	.4209,	.4104,	.4351,	.4701,	.4999,	.5053,	.4585,	.7000,

1
Run title : 107D PLAICE 1997 WG,1-15+,80-96,SEXES COMB [rev: 11/9/97-AT]

At 15/09/1997 15:05
Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEAR, AGE	1980,	1981,	1982,	1983,	1984,	1985,	1986,
1,	-.0302,	-.0518,	-.0475,	-.0471,	-.0694,	-.0499,	-.0300,
2,	-.0137,	-.1720,	-.1847,	-.1316,	-.3387,	.0041,	-.0198,
3,	-.0002,	.2660,	.0116,	.0141,	-.1136,	.1207,	.3220,
4,	.0857,	.4020,	.3638,	.5013,	.1426,	.4127,	.3873,
5,	.3506,	-.0186,	.2579,	.2072,	.2609,	-.0815,	.3301,
6,	.1560,	.0772,	.0407,	.0863,	.1725,	.2497,	.2645,
7,	.1444,	.1117,	.0624,	-.0034,	.2260,	.0746,	.1879,
8,	.0815,	.1864,	.4257,	.3743,	-.0125,	.1954,	.0157,
9,	-.0899,	.1654,	.0791,	-.1154,	-.0318,	.4289,	-.0394,
10,	.2140,	.2379,	.0086,	.0184,	.2787,	.0004,	.0121,
11,	-.0512,	-.0798,	.0326,	.0055,	.1969,	-.1389,	-.1645,
12,	.0625,	.3537,	-.0946,	.0081,	-.0276,	-.2206,	-.1663,
13,	-.0214,	-.0064,	-.0837,	-.1113,	-.1047,	-.2001,	-.1509,
14,	-.0001,	.0443,	-.0592,	-.0251,	.1408,	.2161,	.1930,

Fishing mortality residuals

YEAR, AGE	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
1,	-.0569,	-.0671,	-.0366,	-.0142,	-.0229,	-.0234,	-.0024,	-.0024,	.0445,	.0000,
2,	-.1385,	-.1757,	-.2998,	-.3501,	-.0272,	-.0361,	.0492,	-.0439,	.0234,	-.0723,
3,	.0246,	.0822,	-.2777,	-.1833,	-.0159,	.0720,	-.0431,	-.0411,	.0079,	-.0139,
4,	.2948,	.1241,	.0505,	-.1095,	.0611,	-.1029,	-.0067,	.0529,	-.0067,	.0121,
5,	.1793,	.1218,	.2902,	-.0025,	.0418,	-.0322,	-.0500,	.0670,	.0004,	.0227,
6,	.0482,	.0891,	.1096,	.0584,	.1010,	.0896,	.0123,	-.0267,	-.0455,	.0009,
7,	.4456,	.2297,	.0103,	-.0359,	-.0355,	.0594,	.0119,	-.0324,	.0576,	-.0029,
8,	.1171,	.1219,	.0293,	-.0113,	-.0754,	.0252,	.0152,	-.0247,	.0227,	.0329,
9,	.1260,	.0869,	.0517,	.1681,	-.0431,	.0469,	.0175,	.0080,	-.0739,	.0087,
10,	.0571,	.3454,	.0202,	.3322,	-.0686,	-.1346,	.0055,	.1655,	-.0554,	.0156,
11,	-.2023,	.1677,	-.0473,	.2184,	-.0141,	-.1214,	.0256,	.1630,	-.0781,	-.0756,
12,	.2709,	-.1713,	.9093,	.0153,	-.0861,	.0419,	-.0479,	-.0154,	.0413,	-.0839,
13,	-.1007,	-.2192,	.0951,	1.1754,	-.0528,	-.0585,	.0784,	.0649,	.0478,	-.1285,
14,	-.0532,	-.2371,	-.3379,	-.1532,	-.0770,	.0175,	.0776,	-.1132,	.1056,	.0933,

Table 11.4.1 Plaice in Division VIId. Tuning diagnostics.

Lowestoft VPA Version 3.1

7-Oct-97 15:40:33

Extended Survivors Analysis

Plaice in VIId (run: XSAATT01/X01)

CPUE data from file /users/fish/ifad/ifapwork/wgnssk/ple_eche/FLEET.X01

Catch data for 17 years. 1980 to 1996. Ages 1 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
FLT02: BELGIAN BEAM ,	1981,	1996,	2,	9,	.000,	1.000
FLT03: English BTS (,	1988,	1996,	1,	6,	.500,	.750
FLT04: French GFS (C,	1988,	1996,	1,	5,	.750,	1.000
FLT05: English YFS (,	1985,	1996,	1,	1,	.500,	.750
FLT06: French YFS (C,	1987,	1996,	1,	1,	.500,	.750
FLT07: UK INSHORE TR,	1985,	1996,	2,	9,	.000,	1.000
FLT08: FRENCH INSHOR,	1989,	1996,	1,	9,	.000,	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 15 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 >= 7

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 3 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 had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00170

Final year F values

Age ,	1,	2,	3,	4,	5,	6,	7,	8,	9
Iteration 29,	.0712,	.3191,	.8509,	.9018,	.7811,	.5590,	.4674,	.4917,	.4885
Iteration 30,	.0712,	.3191,	.8509,	.9017,	.7809,	.5588,	.4671,	.4914,	.4881

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Regression weights

,	.482,	.610,	.725,	.820,	.893,	.944,	.976,	.993,	.999,	1.000

Fishing mortalities

Age,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1,	.001,	.001,	.054,	.096,	.078,	.065,	.064,	.095,	.124,	.071
2,	.179,	.203,	.173,	.218,	.513,	.448,	.413,	.448,	.485,	.319
3,	.510,	.653,	.445,	.696,	.819,	.828,	.486,	.731,	.703,	.851
4,	.775,	.653,	.717,	.718,	.856,	.587,	.516,	.829,	.693,	.902
5,	.547,	.538,	.810,	.582,	.640,	.498,	.325,	.700,	.549,	.781
6,	.288,	.425,	.535,	.533,	.523,	.553,	.330,	.397,	.358,	.559
7,	.760,	.473,	.374,	.390,	.326,	.379,	.302,	.340,	.440,	.467
8,	.417,	.448,	.318,	.436,	.302,	.353,	.235,	.374,	.390,	.491
9,	.565,	.494,	.509,	.531,	.409,	.473,	.273,	.329,	.260,	.488

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Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1987	3.17E+04	5.45E+04	1.98E+04	6.77E+03	3.14E+03	1.80E+03	8.73E+02	4.75E+02	2.56E+02
1988	2.66E+04	2.87E+04	4.12E+04	1.07E+04	2.82E+03	1.64E+03	1.22E+03	3.70E+02	2.83E+02
1989	1.64E+04	2.41E+04	2.12E+04	1.94E+04	5.06E+03	1.49E+03	9.71E+02	6.90E+02	2.14E+02
1990	1.87E+04	1.41E+04	1.83E+04	1.23E+04	8.58E+03	2.04E+03	7.90E+02	6.04E+02	4.54E+02
1991	2.16E+04	1.53E+04	1.02E+04	8.27E+03	5.42E+03	4.34E+03	1.08E+03	4.84E+02	3.54E+02
1992	2.78E+04	1.80E+04	8.31E+03	4.09E+03	3.18E+03	2.59E+03	2.33E+03	7.07E+02	3.24E+02
1993	1.25E+04	2.36E+04	1.04E+04	3.28E+03	2.06E+03	1.75E+03	1.35E+03	1.44E+03	4.49E+02
1994	1.44E+04	1.06E+04	1.41E+04	5.81E+03	1.77E+03	1.34E+03	1.14E+03	9.00E+02	1.03E+03
1995	2.33E+04	1.19E+04	6.11E+03	6.16E+03	2.29E+03	7.97E+02	8.18E+02	7.33E+02	5.61E+02
1996	1.71E+04	1.87E+04	6.62E+03	2.74E+03	2.79E+03	1.20E+03	5.04E+02	4.77E+02	4.49E+02

Estimated population abundance at 1st Jan 1997

,	.00E+00	1.44E+04	1.23E+04	2.56E+03	1.01E+03	1.15E+03	6.20E+02	2.86E+02	2.64E+02

Taper weighted geometric mean of the VPA populations:

,	2.07E+04	1.85E+04	1.22E+04	6.38E+03	3.19E+03	1.67E+03	9.91E+02	6.24E+02	3.75E+02

Standard error of the weighted Log(VPA populations) :

,	.3719	.4211	.5507	.5922	.4849	.4683	.4360	.4612	.6527

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Log catchability residuals.

Fleet : FLT02: BELGIAN BEAM

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	99.99	-.43	.36	-1.60	.37	.48
3	99.99	-.49	-.18	-.19	-.27	-.15
4	99.99	.01	.33	-.03	-.04	-.30
5	99.99	.10	-.32	.06	-1.21	-.40
6	99.99	-.42	-.09	.19	.35	.07
7	99.99	-.26	-.72	.57	.06	-.05
8	99.99	.66	.95	-.50	.92	-1.00
9	99.99	.60	.58	-.26	-1.61	-.01

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	.38	.01	-2.35	.18	.95	1.27	.42	.91	-1.80	-.27
3	-.62	-.33	-.54	.28	.61	.39	-.31	-.04	.06	.17
4	-.39	-.52	-.16	.01	.10	-.29	-.40	.66	.15	.48
5	-.53	-.79	.27	-.20	.53	-.31	-.20	.27	.37	.49
6	-1.09	-.75	.16	-.16	.57	.25	-.21	.02	.08	.25
7	.48	-.29	.01	-.59	-.09	-.17	-.32	.09	.75	.11
8	-.39	-.25	-.29	-.16	-.18	.00	-.60	-.03	.31	.25
9	-.08	-.31	-.07	-1.19	.67	.88	-1.19	-.01	-.64	.05

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
Mean Log q	-5.4788	-5.1280	-5.2765	-5.5881	-5.7117	-5.7117	-5.7117
S.E(Log q)	.3770	.3882	.4708	.4216	.3882	.4047	.7617

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	1.12	-.118	7.01	.11	15	1.25	-7.32

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	1.55	-1.634	3.30	.55	15	.53	-5.48
4	1.15	-.540	4.59	.65	15	.47	-5.13
5	.96	.117	5.39	.54	15	.48	-5.28
6	.84	.590	5.89	.65	15	.37	-5.59
7	1.40	-.906	5.24	.42	15	.55	-5.71
8	1.35	-.882	5.61	.46	15	.53	-5.83
9	1.26	-.502	5.92	.34	15	.96	-5.92

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Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

Fleet : FLT03: English BTS (

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	99.99	.21	-.52	-.23	.03	-.05	-.08	.27	-.05	.32
2	99.99	.29	-.27	-.40	.13	.17	-.06	.32	-.23	.04
3	99.99	.73	.30	-.46	.39	.10	-.17	.29	-.01	-.84
4	99.99	-.01	.48	-.15	.10	.40	-.33	.49	-.07	-.79
5	99.99	.54	-.20	-.05	.11	.59	-.16	.27	-.36	-.56
6	99.99	.01	.17	.04	-.14	.82	-.05	-.44	-.23	-.10
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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
Mean Log q	-7.1076	-6.8561	-6.5641	-6.6799
S.E(Log q)	.4661	.4360	.3973	.3651

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.50	1.326	8.72	.54	9	.28	-7.60
2	.76	.787	7.81	.64	9	.27	-7.18

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	.70	1.544	7.79	.81	9	.30	-7.11
4	.74	1.471	7.35	.84	9	.30	-6.86
5	1.00	.006	6.57	.63	9	.43	-6.56
6	.78	1.047	6.85	.79	9	.28	-6.68

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Fleet : FLT04: French GFS (C

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	99.99	.04	-.76	-.93	-2.30	2.66	1.27	.40	-.83	.03
2	99.99	.49	.10	-.66	-.83	.02	.06	.37	.54	-.07
3	99.99	.82	.00	.20	-.85	-.41	.45	-.44	.88	-.39
4	99.99	.70	-.28	.42	-1.01	-.53	.31	-.27	.65	.14
5	99.99	1.04	-1.10	.74	-.62	-.90	.08	.55	.16	.17
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

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
Mean Log q	-8.4936	-8.7901	-8.9426
S.E(Log q)	.6082	.5731	.7050

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	1.66	-.305	6.64	.03	9	1.58	-7.91
2	.63	.639	8.79	.33	9	.51	-8.22

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	.83	.465	8.64	.57	9	.54	-8.49
4	1.04	-.098	8.79	.53	9	.64	-8.79
5	1.43	-.552	9.31	.22	9	1.06	-8.94

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Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

Fleet : FLT05: English YFS (

Age	1981	1982	1983	1984	1985	1986
1	99.99	99.99	99.99	99.99	-.05	-.46
2	No data for this fleet at this age					
3	No data for this fleet at this age					
4	No data for this fleet at this age					
5	No data for this fleet at this age					
6	No data for this fleet at this age					
7	No data for this fleet at this age					
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	.37	-.02	.42	-.55	-1.10	-.10	.00	-.29	1.22	.30
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	1.39	-.605	9.43	.26	12	.68	-9.57

1

Fleet : FLT06: French YFS (C

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	-.12	-.05	-.82	-.28	-.44	.46	.10	.91	.36	-.48
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	.93	.103	10.29	.24	10	.57	-10.32

1

Fleet : FLT07: UK INSHORE TR

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	99.99	99.99	99.99	99.99	2.04	.46
3	99.99	99.99	99.99	99.99	.41	.49
4	99.99	99.99	99.99	99.99	.37	.42
5	99.99	99.99	99.99	99.99	-.85	.21
6	99.99	99.99	99.99	99.99	99.99	-1.01
7	99.99	99.99	99.99	99.99	99.99	-.38
8	99.99	99.99	99.99	99.99	99.99	-.16
9	99.99	99.99	99.99	99.99	1.57	99.99

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	.41	.70	-4.02	-2.32	.59	.59	.46	.31	.31	1.42
3	.13	.16	-.66	-.47	.31	.39	-.17	.05	.03	-.12
4	.30	-.28	.30	-.61	.23	.53	.01	.11	-.22	-.53
5	-.10	.19	.21	-.14	-.13	.24	-.01	.36	-.06	-.38
6	-.24	.11	.53	.20	-.05	.21	-.07	-.01	-.03	-.21
7	-.60	-.03	.42	.51	-.25	.31	.14	.22	-.25	-.45
8	.07	-.49	-.53	.48	-.38	.39	.19	-.18	-.07	-.19
9	.38	.19	-.73	.38	-.74	-.39	.29	.37	-.20	-.36

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
Mean Log q	-11.5024	-11.5151	-11.6026	-11.6828	-11.9792	-11.9792	-11.9792
S.E(Log q)	.3365	.3883	.2741	.3041	.3643	.3458	.5331

Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

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,	2.28,	-.901,	14.91,	.07,	12,	1.71,	-12.05,

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,	1.15,	-.599,	11.83,	.68,	12,	.41,	-11.50,
4,	.95,	.215,	11.38,	.73,	12,	.39,	-11.52,
5,	1.10,	-.438,	11.96,	.73,	12,	.32,	-11.60,
6,	.93,	.324,	11.37,	.74,	11,	.30,	-11.68,
7,	.69,	1.543,	10.44,	.79,	11,	.23,	-11.98,
8,	.76,	1.084,	10.69,	.75,	11,	.25,	-12.04,
9,	.71,	.961,	10.29,	.62,	11,	.38,	-12.04,

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Fleet : FLT08: FRENCH INSHOR

Age	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1	99.99,	99.99,	.06,	-.07,	-.19,	.07,	.07,	.31,	.28,	-.54
2	99.99,	99.99,	-.09,	-1.14,	.25,	.54,	.59,	.31,	.33,	-.94
3	99.99,	99.99,	.00,	-.38,	-.14,	.42,	-.07,	.37,	-.08,	-.18
4	99.99,	99.99,	.38,	-.17,	.21,	-.11,	.04,	.16,	-.16,	-.27
5	99.99,	99.99,	.87,	-.08,	-.12,	.27,	-.61,	.56,	-.63,	-.03
6	99.99,	99.99,	.35,	.01,	-.17,	.65,	-.02,	.17,	-.79,	-.09
7	99.99,	99.99,	.16,	-.18,	-.16,	.46,	.19,	.12,	-.62,	.07
8	99.99,	99.99,	.46,	-.15,	-.23,	.06,	-.28,	.52,	-.21,	.06
9	99.99,	99.99,	1.15,	.52,	-.18,	.39,	.03,	.06,	-.24,	.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
Mean Log q,	-10.1532,	-10.3256,	-10.6827,	-10.9126,	-11.1257,	-11.1257,	-11.1257,
S.E(Log q),	.2749,	.2183,	.5165,	.4281,	.3338,	.3122,	.4774,

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.81,	.413,	11.48,	.47,	8,	.31,	-11.87,
2,	1.24,	-.253,	10.79,	.17,	8,	.73,	-10.58,

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,	1.02,	-.072,	10.17,	.72,	8,	.31,	-10.15,
4,	.84,	1.567,	10.07,	.95,	8,	.17,	-10.33,
5,	.86,	.417,	10.31,	.61,	8,	.47,	-10.68,
6,	.72,	1.239,	9.94,	.79,	8,	.30,	-10.91,
7,	.71,	1.527,	9.92,	.84,	8,	.22,	-11.13,
8,	1.02,	-.051,	11.19,	.57,	8,	.35,	-11.11,
9,	2.20,	-1.643,	16.73,	.26,	8,	.83,	-10.92,

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Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 1995

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT02: BELGIAN BEAM ,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: English BTS (,	19891.,	.300,	.000,	.00,	1,	.338,	.052
FLT04: French GFS (C,	14828.,	1.681,	.000,	.00,	1,	.011,	.069
FLT05: English YFS (,	19420.,	.722,	.000,	.00,	1,	.058,	.053
FLT06: French YFS (C,	8933.,	.643,	.000,	.00,	1,	.074,	.113
FLT07: UK INSHORE TR,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT08: FRENCH INSHOR,	8394.,	.385,	.000,	.00,	1,	.205,	.119
P shrinkage mean ,	18479.,	.42,,,,				.184,	.056
F shrinkage mean ,	11938.,	.50,,,,				.130,	.085

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
14432.,	.18,	.15,	7,	.848,	.071

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Age 2 Catchability dependent on age and year class strength

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT02: BELGIAN BEAM ,	9365.,	1.316,	.000,	.00,	1,	.012,	.400
FLT03: English BTS (,	12250.,	.213,	.046,	.22,	2,	.447,	.319
FLT04: French GFS (C,	10748.,	.518,	.211,	.41,	2,	.079,	.357
FLT05: English YFS (,	41759.,	.845,	.000,	.00,	1,	.026,	.105
FLT06: French YFS (C,	17536.,	.635,	.000,	.00,	1,	.047,	.233
FLT07: UK INSHORE TR,	50935.,	1.879,	.000,	.00,	1,	.006,	.087
FLT08: FRENCH INSHOR,	13011.,	.339,	.471,	1.39,	2,	.168,	.303
P shrinkage mean ,	12231.,	.55,,,,				.097,	.320
F shrinkage mean ,	7827.,	.50,,,,				.118,	.463

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
12268.,	.15,	.11,	12,	.735,	.319

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

Year class = 1993

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT02: BELGIAN BEAM ,	2804.,	.386,	.386,	1.00,	2,	.103,	.799
FLT03: English BTS (,	2103.,	.207,	.304,	1.47,	3,	.251,	.967
FLT04: French GFS (C,	2704.,	.418,	.327,	.78,	3,	.072,	.819
FLT05: English YFS (,	1915.,	.754,	.000,	.00,	1,	.015,	1.027
FLT06: French YFS (C,	6349.,	.645,	.000,	.00,	1,	.021,	.432
FLT07: UK INSHORE TR,	2297.,	.349,	.064,	.18,	2,	.126,	.914
FLT08: FRENCH INSHOR,	2543.,	.222,	.168,	.76,	3,	.266,	.854
F shrinkage mean ,	3276.,	.50,,,,				.145,	.716

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
2557.,	.13,	.09,	16,	.743,	.851

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Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

Age 4 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
FLT02: BELGIAN BEAM ,	1426.,	.296,	.150,	.51,	3,	.137,	.709
FLT03: English BTS (,	809.,	.213,	.263,	1.24,	4,	.191,	1.036
FLT04: French GFS (C,	1477.,	.379,	.188,	.50,	4,	.074,	.691
FLT05: English YFS (,	1000.,	.749,	.000,	.00,	1,	.008,	.905
FLT06: French YFS (C,	1112.,	.627,	.000,	.00,	1,	.011,	.843
FLT07: UK INSHORE TR,	746.,	.282,	.198,	.70,	3,	.147,	1.090
FLT08: FRENCH INSHOR,	858.,	.196,	.082,	.42,	4,	.287,	.999
F shrinkage mean ,	1454.,	.50,,,,				.145,	.699

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1006.,	.12,	.09,	21,	.728,	.902

Age 5 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
FLT02: BELGIAN BEAM ,	1524.,	.281,	.123,	.44,	4,	.137,	.640
FLT03: English BTS (,	888.,	.225,	.144,	.64,	5,	.193,	.932
FLT04: French GFS (C,	1476.,	.386,	.205,	.53,	5,	.067,	.655
FLT05: English YFS (,	1046.,	.745,	.000,	.00,	1,	.004,	.836
FLT06: French YFS (C,	1826.,	.689,	.000,	.00,	1,	.005,	.559
FLT07: UK INSHORE TR,	854.,	.225,	.086,	.38,	4,	.254,	.955
FLT08: FRENCH INSHOR,	1170.,	.206,	.107,	.52,	5,	.202,	.773
F shrinkage mean ,	1887.,	.50,,,,				.138,	.544

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1155.,	.12,	.07,	26,	.636,	.781

1

Age 6 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 .
FLT02: BELGIAN BEAM ,	831.,	.266,	.125,	.47,	5,	.155,	.444
FLT03: English BTS (,	568.,	.221,	.103,	.47,	6,	.213,	.597
FLT04: French GFS (C,	646.,	.384,	.166,	.43,	5,	.038,	.541
FLT05: English YFS (,	205.,	.846,	.000,	.00,	1,	.002,	1.181
FLT06: French YFS (C,	400.,	.655,	.000,	.00,	1,	.003,	.771
FLT07: UK INSHORE TR,	545.,	.198,	.052,	.26,	5,	.293,	.616
FLT08: FRENCH INSHOR,	554.,	.219,	.115,	.52,	6,	.188,	.609
F shrinkage mean ,	855.,	.50,,,,				.109,	.433

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
620.,	.11,	.05,	30,	.473,	.559

Age 7 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
FLT02: BELGIAN BEAM ,	311.,	.239,	.080,	.34,	6,	.196,	.436
FLT03: English BTS (,	260.,	.231,	.100,	.43,	6,	.137,	.503
FLT04: French GFS (C,	352.,	.395,	.227,	.57,	5,	.023,	.395
FLT05: English YFS (,	166.,	.829,	.000,	.00,	1,	.001,	.707
FLT06: French YFS (C,	215.,	.682,	.000,	.00,	1,	.002,	.583
FLT07: UK INSHORE TR,	264.,	.188,	.138,	.73,	6,	.297,	.497
FLT08: FRENCH INSHOR,	269.,	.209,	.164,	.78,	7,	.247,	.491
F shrinkage mean ,	395.,	.50,,,,				.098,	.358

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
286.,	.11,	.06,	33,	.533,	.467

Table 11.4.1 cont. Plaice in Division VIId. Tuning diagnostics.

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT02: BELGIAN BEAM ,	351.,	.217,	.139,	.64,	7,	.204,	.390
FLT03: English BTS (,	210.,	.217,	.135,	.62,	6,	.093,	.587
FLT04: French GFS (C,	189.,	.398,	.181,	.45,	5,	.019,	.635
FLT05: English YFS (,	401.,	.850,	.000,	.00,	1,	.001,	.349
FLT06: French YFS (C,	116.,	.819,	.000,	.00,	1,	.001,	.894
FLT07: UK INSHORE TR,	241.,	.175,	.078,	.44,	7,	.300,	.528
FLT08: FRENCH INSHOR,	225.,	.185,	.120,	.65,	8,	.289,	.557
F shrinkage mean ,	426.,	.50,,,,				.094,	.332

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
264.,	.10,	.06,	36,	.610,	.491

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT02: BELGIAN BEAM ,	271.,	.220,	.082,	.37,	8,	.195,	.456
FLT03: English BTS (,	278.,	.235,	.137,	.58,	6,	.076,	.447
FLT04: French GFS (C,	126.,	.423,	.235,	.55,	5,	.013,	.807
FLT05: English YFS (,	244.,	.928,	.000,	.00,	1,	.001,	.496
FLT06: French YFS (C,	237.,	.786,	.000,	.00,	1,	.001,	.509
FLT07: UK INSHORE TR,	242.,	.177,	.085,	.48,	8,	.304,	.500
FLT08: FRENCH INSHOR,	249.,	.188,	.069,	.37,	8,	.298,	.489
F shrinkage mean ,	237.,	.50,,,,				.112,	.508

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
250.,	.11,	.04,	38,	.356,	.488

1
1
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Table 11.4.2 Plaice in Division VIId. F at age.

Run title : Plaice in VIId (run: XSAATT01/X01)
At 7-Oct-97 15:43:19

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE							
1,	.0022,	.0013,	.0110,	.0048,	.0147,	.0050,	.0118,
2,	.1677,	.1180,	.1337,	.1511,	.1150,	.3114,	.2111,
3,	.2784,	.7311,	.4957,	.4511,	.5709,	.5908,	.6872,
4,	.3334,	.8827,	.8641,	.9324,	.8078,	.8402,	.7473,
5,	.6167,	.2677,	.6887,	.5582,	.7766,	.2252,	.5701,
6,	.4140,	.3650,	.2758,	.3928,	.6406,	.5513,	.4776,
7,	.3982,	.4867,	.3481,	.1705,	.8104,	.3641,	.4115,
8,	.2533,	.7024,	1.8478,	.8788,	.2556,	.8649,	.2285,
9,	.3562,	.5200,	.8276,	.4799,	.5685,	.5850,	.3448,
+gp,	.3562,	.5200,	.8276,	.4799,	.5685,	.5850,	.3448,
FBAR 2- 6,	.3620,	.4729,	.4916,	.4971,	.5822,	.5038,	.5387,
FBAR 3- 6,	.4106,	.5616,	.5811,	.5836,	.6990,	.5519,	.6206,

Table 8 Fishing mortality (F) at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	FBAR 94-96
AGE											
1,	.0008,	.0006,	.0543,	.0964,	.0782,	.0649,	.0645,	.0948,	.1241,	.0712,	.0967,
2,	.1790,	.2031,	.1729,	.2184,	.5134,	.4478,	.4135,	.4483,	.4849,	.3191,	.4174,
3,	.5097,	.6530,	.4446,	.6960,	.8188,	.8280,	.4858,	.7308,	.7027,	.8509,	.7614,
4,	.7745,	.6529,	.7167,	.7179,	.8555,	.5868,	.5158,	.8286,	.6931,	.9017,	.8078,
5,	.5472,	.5382,	.8099,	.5821,	.6401,	.4979,	.3246,	.7004,	.5492,	.7809,	.6768,
6,	.2883,	.4254,	.5351,	.5333,	.5230,	.5525,	.3302,	.3970,	.3578,	.5588,	.4378,
7,	.7597,	.4733,	.3739,	.3904,	.3257,	.3788,	.3022,	.3400,	.4401,	.4671,	.4157,
8,	.4172,	.4482,	.3185,	.4357,	.3020,	.3532,	.2348,	.3735,	.3897,	.4914,	.4182,
9,	.5651,	.4944,	.5085,	.5313,	.4094,	.4726,	.2729,	.3289,	.2597,	.4881,	.3589,
+gp,	.5651,	.4944,	.5085,	.5313,	.4094,	.4726,	.2729,	.3289,	.2597,	.4881,	
FBAR 2- 6,	.4597,	.4945,	.5358,	.5495,	.6702,	.5826,	.4140,	.6210,	.5575,	.6823,	
FBAR 3- 6,	.5299,	.5674,	.6266,	.6323,	.7094,	.6163,	.4141,	.6642,	.5757,	.7731,	

Table 11.4.3.- Plaice in Division VIId. N at age.

Run title : Plaice in VIId (run: XSAATT01/X01)
At 7-Oct-97 15:43:19

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

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE							
1,	25595,	12949,	25377,	20101,	25178,	29967,	60964,
2,	18002,	23109,	11701,	22710,	18100,	22449,	26980,
3,	6277,	13774,	18583,	9263,	17666,	14598,	14878,
4,	2002,	4300,	6000,	10243,	5338,	9032,	7316,
5,	1119,	1298,	1609,	2288,	3648,	2154,	3527,
6,	233,	547,	899,	731,	1185,	1518,	1556,
7,	144,	139,	343,	617,	447,	565,	792,
8,	207,	87,	77,	219,	471,	180,	355,
9,	14,	145,	39,	11,	82,	330,	68,
+gp,	360,	516,	163,	277,	241,	118,	122,
TOTAL,	53953,	56864,	64792,	66460,	72357,	80910,	116558,

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	GMST80-94	AMST80-94
AGE													
1,	31703,	26640,	16427,	18672,	21554,	27844,	12460,	14429,	23340,	17126,	0,	22689,	24657,
2,	54516,	28662,	24090,	14078,	15342,	18036,	23611,	10570,	11875,	18654,	14432,	20408,	22130,
3,	19767,	41244,	21168,	18337,	10239,	8308,	10429,	14129,	6109,	6616,	12268,	14355,	15911,
4,	6771,	10744,	19423,	12279,	8272,	4085,	3284,	5805,	6156,	2737,	2557,	6627,	7660,
5,	3135,	2824,	5061,	8583,	5419,	3182,	2056,	1774,	2294,	2785,	1006,	2735,	3178,
6,	1805,	1641,	1492,	2037,	4339,	2585,	1750,	1344,	797,	1198,	1155,	1307,	1577,
7,	873,	1224,	971,	790,	1081,	2327,	1346,	1138,	818,	504,	620,	674,	853,
8,	475,	370,	690,	604,	484,	707,	1442,	900,	733,	477,	286,	367,	485,
9,	256,	283,	214,	454,	354,	324,	449,	1031,	561,	449,	264,	153,	270,
+gp,	187,	467,	517,	586,	390,	328,	667,	1167,	1183,	940,	772,		
TOTAL,	119487,	114098,	90051,	76420,	67475,	67726,	57494,	52289,	53865,	51487,	33360,		

Table 11.5.1 Plaice in Division VIId. RCT3 input file.

7D PLAICE - VPA AGE 1 / indices all * per 100

6	17	2					
'YEARCLASS'	'VPA'	'eyfs0'	'eyfs1'	'fyfs0'	'fyfs1'	'ebt1'	'fbt1'
1981	25377	340	45	531	25	-11	-11
1982	20101	250	114	149	4	-11	-11
1983	25178	1450	73	242	-11	-11	-11
1984	29967	630	171	-11	-11	-11	-11
1985	60964	1090	208	-11	-11	-11	-11
1986	31703	2010	238	-11	94	-11	-11
1987	26640	2230	161	444	82	2647	1033
1988	16427	1300	147	111	22	231	408
1989	18672	370	76	238	40	516	395
1990	21554	650	64	104	39	1175	195
1991	27844	270	145	302	136	1653	3361
1992	12460	430	85	219	45	322	1168
1993	14429	760	83	88	112	833	902
1994	-11	1720	327	395	95	1132	507
1995	-11	1200	142	672	33	1320	684
1996	-11	250	42	295	-11	3310	-11
1997	-11	240	-11	-11	-11	-11	-11

Table 11.5.2 Plaice in Division VIId. RCT3 output.

```
Analysis by RCT3 ver3.1 of data from file : rct3_961.csv
7D PLAICE - VPA AGE 1 / indices all * per 100,,,,,,,
Data for     6 surveys over    17 years :  1981 - 1997
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   4 points used for regression
Forecast/Hindcast variance correction used.
```

Yearclass = 1994

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
eyfs0	1.96	-2.86	1.46	.083	13	7.45	11.74	1.793	.015
eyfs1	1.52	2.82	.63	.326	13	5.79	11.65	.876	.062
fyfs0	.82	5.53	.43	.337	10	5.98	10.47	.562	.151
fyfs1	1.38	4.52	1.28	.065	10	4.56	10.83	1.584	.019
ebt1	.43	6.96	.25	.645	7	7.03	10.01	.320	.466
fbt1	1.50	-.06	1.50	.047	7	6.23	9.29	1.937	.013
					VPA Mean =		10.04	.418	.274

Yearclass = 1995

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
eyfs0	1.99	-3.08	1.49	.082	13	7.09	11.04	1.775	.016
eyfs1	1.51	2.85	.62	.341	13	4.96	10.37	.728	.095
fyfs0	.85	5.41	.45	.327	10	6.51	10.94	.680	.109
fyfs1	1.38	4.47	1.25	.070	10	3.53	9.34	1.529	.021
ebt1	.44	6.94	.25	.644	7	7.19	10.08	.329	.462
fbt1	1.52	-.19	1.53	.046	7	6.53	9.73	1.961	.013
					VPA Mean =		10.03	.420	.284

Yearclass = 1996

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
eyfs0	2.03	-3.35	1.52	.080	13	5.53	7.87	1.981	.015
eyfs1	1.51	2.88	.60	.357	13	3.76	8.55	.857	.083
fyfs0	.88	5.26	.47	.316	10	5.69	10.26	.602	.168
fyfs1									
ebt1	.44	6.90	.25	.641	7	8.11	10.49	.393	.393
fbt1									
					VPA Mean =		10.02	.422	.341

Yearclass = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
eyfs0	2.08	-3.70	1.57	.077	13	5.48	7.73	2.107	.039
eyfs1									
fyfs0									
fyfs1									
ebt1									
fbt1									
					VPA Mean =		10.00	.424	.961

Year Class	Weighted Average Prediction at Age 1	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1994	27539	10.22	.22	.19	.76		
1995	26436	10.18	.22	.13	.35		
1996	24073	10.09	.25	.29	1.41		
1997	20209	9.91	.42	.44	1.12		

Table 11.6.1 Plaice in Division VIId. Historical stock data.

Run title : Plaice in VIId (run: XSAATT01/X01)

At 7-Oct-97 15:43:19

Table 16 Summary (without SOP correction)

YEAR	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2- 6,	FBAR 3- 6,
1980,	25595,	16529,	5600,	2650,	.4732,	.3620,	.4106,
1981,	12949,	14362,	6572,	4769,	.7257,	.4729,	.5616,
1982,	25377,	15113,	7593,	4865,	.6408,	.4916,	.5811,
1983,	20101,	15220,	8164,	5043,	.6177,	.4971,	.5836,
1984,	25178,	14240,	7522,	5161,	.6861,	.5822,	.6990,
1985,	29967,	15936,	8253,	6022,	.7297,	.5038,	.5519,
1986,	60964,	23416,	10260,	6834,	.6661,	.5387,	.6206,
1987,	31703,	32273,	13707,	8366,	.6103,	.4597,	.5299,
1988,	26640,	24891,	13491,	10420,	.7724,	.4945,	.5674,
1989,	16427,	22129,	14761,	8758,	.5933,	.5358,	.6266,
1990,	18672,	20183,	14105,	9047,	.6414,	.5495,	.6323,
1991,	21554,	15317,	10877,	7813,	.7183,	.6702,	.7094,
1992,	27844,	14910,	8640,	6337,	.7334,	.5826,	.6163,
1993,	12460,	16267,	9028,	5331,	.5905,	.4140,	.4141,
1994,	14429,	15494,	9282,	6121,	.6595,	.6210,	.6642,
1995,	23340,	12350,	8347,	5130,	.6146,	.5575,	.5757,
1996,	17126,	14850,	7031,	5393,	.7670,	.6823,	.7731,
1997,	24073(*)						
Arith. Mean ,	24137,	17852,	9602,	6356,	.6612,	.5303,	.5951,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

(*) rct3 estimate

Table 11.7.1 Plaice in Division VIId. Inputs for prediction.

The SAS System 11:39 Monday, October 13, 1997

Plaice in the Eastern English Channel (Fishing Area VIId)

Prediction with management option table: Input data

Year: 1997

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	24073.000	0.1000	0.0000	0.0000	0.0000	0.134	0.1064	0.227
2	14432.000	0.1000	0.1500	0.0000	0.0000	0.208	0.4592	0.280
3	12268.000	0.1000	0.5300	0.0000	0.0000	0.288	0.8376	0.297
4	2557.000	0.1000	0.9600	0.0000	0.0000	0.375	0.8886	0.381
5	1006.000	0.1000	1.0000	0.0000	0.0000	0.467	0.7445	0.475
6	1155.000	0.1000	1.0000	0.0000	0.0000	0.565	0.4816	0.636
7	620.000	0.1000	1.0000	0.0000	0.0000	0.669	0.4573	0.687
8	286.000	0.1000	1.0000	0.0000	0.0000	0.779	0.4600	0.889
9	264.000	0.1000	1.0000	0.0000	0.0000	0.895	0.3948	1.059
10+	772.000	0.1000	1.0000	0.0000	0.0000	1.187	0.3948	1.299
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
1	22689.000	0.1000	0.0000	0.0000	0.0000	0.134	0.1064	0.227
2	.	0.1000	0.1500	0.0000	0.0000	0.208	0.4592	0.280
3	.	0.1000	0.5300	0.0000	0.0000	0.288	0.8376	0.297
4	.	0.1000	0.9600	0.0000	0.0000	0.375	0.8886	0.381
5	.	0.1000	1.0000	0.0000	0.0000	0.467	0.7445	0.475
6	.	0.1000	1.0000	0.0000	0.0000	0.565	0.4816	0.636
7	.	0.1000	1.0000	0.0000	0.0000	0.669	0.4573	0.687
8	.	0.1000	1.0000	0.0000	0.0000	0.779	0.4600	0.889
9	.	0.1000	1.0000	0.0000	0.0000	0.895	0.3948	1.059
10+	.	0.1000	1.0000	0.0000	0.0000	1.187	0.3948	1.299
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1999

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	22689.000	0.1000	0.0000	0.0000	0.0000	0.134	0.1064	0.227
2	.	0.1000	0.1500	0.0000	0.0000	0.208	0.4592	0.280
3	.	0.1000	0.5300	0.0000	0.0000	0.288	0.8376	0.297
4	.	0.1000	0.9600	0.0000	0.0000	0.375	0.8886	0.381
5	.	0.1000	1.0000	0.0000	0.0000	0.467	0.7445	0.475
6	.	0.1000	1.0000	0.0000	0.0000	0.565	0.4816	0.636
7	.	0.1000	1.0000	0.0000	0.0000	0.669	0.4573	0.687
8	.	0.1000	1.0000	0.0000	0.0000	0.779	0.4600	0.889
9	.	0.1000	1.0000	0.0000	0.0000	0.895	0.3948	1.059
10+	.	0.1000	1.0000	0.0000	0.0000	1.187	0.3948	1.299
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANATT03
Date and time: 13OCT97:11:41

Table 11.7.2 Plaice in Division VIId. Input data for catch forecast and linear sensitivity analysis.

Populations in 1997			Stock weights			Nat.Mortality			Prop.mature		
Labl	Value	CV	Labl	Value	CV	Labl	Value	CV	Labl	Value	CV
N1	24072	.29	WS1	.13	.49	M1	.10	.10	MT1	.00	.10
N2	14432	.20	WS2	.21	.16	M2	.10	.10	MT2	.15	.10
N3	12268	.20	WS3	.29	.06	M3	.10	.10	MT3	.53	.10
N4	2556	.20	WS4	.38	.07	M4	.10	.10	MT4	.96	.10
N5	1004	.20	WS5	.47	.09	M5	.10	.10	MT5	1.00	.10
N6	1154	.20	WS6	.57	.09	M6	.10	.10	MT6	1.00	.00
N7	618	.20	WS7	.67	.09	M7	.10	.10	MT7	1.00	.00
N8	285	.20	WS8	.78	.07	M8	.10	.10	MT8	1.00	.00
N9	263	.20	WS9	.89	.06	M9	.10	.10	MT9	1.00	.00
N10	770	.20	WS10	1.19	.03	M10	.10	.10	MT10	1.00	.00

HC selectivity			HC.catch wt		
Labl	Value	CV	Labl	Value	CV
sH1	.11	.37	WH1	.23	.06
sH2	.46	.30	WH2	.28	.06
sH3	.84	.04	WH3	.30	.05
sH4	.89	.04	WH4	.38	.06
sH5	.74	.08	WH5	.47	.02
sH6	.48	.15	WH6	.64	.09
sH7	.46	.18	WH7	.69	.11
sH8	.46	.09	WH8	.89	.08
sH9	.40	.23	WH9	1.06	.09
sH10	.40	.23	WH10	1.30	.01

Year effect M			HC relative eff		
Labl	Value	CV	Labl	Value	CV
K97	1.00	.10	HF97	1.00	.10
K98	1.00	.10	HF98	1.00	.10
K99	1.00	.10	HF99	1.00	.10

Recruitment		
Labl	Value	CV
R98	22688	.41
R99	22688	.41

Proportion F before spawning= .00
Proportion M before spawning= .00

Stock numbers in 1997 are VPA survivors.
These are overwritten at Age 1

Table 11.7.3 Plaice in Division VIId. Prediction with management options table.

The SAS System 11:39 Monday, October 13, 1997
Plaice in the Eastern English Channel (Fishing Area VIId)

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
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	0.6823	13633	6158	5626	0.0000	0.0000	13586	5895	0	19592	10411
.	.	.	.	.	0.1000	0.0682	.	5895	734	18807	9780
.	.	.	.	.	0.2000	0.1365	.	5895	1425	18071	9194
.	.	.	.	.	0.3000	0.2047	.	5895	2075	17380	8647
.	.	.	.	.	0.4000	0.2729	.	5895	2687	16733	8137
.	.	.	.	.	0.5000	0.3412	.	5895	3264	16124	7662
.	.	.	.	.	0.6000	0.4094	.	5895	3807	15553	7219
.	.	.	.	.	0.7000	0.4776	.	5895	4320	15017	6806
.	.	.	.	.	0.8000	0.5458	.	5895	4805	14512	6420
.	.	.	.	.	0.9000	0.6141	.	5895	5262	14037	6059
.	.	.	.	.	1.0000	0.6823	.	5895	5695	13590	5723
.	.	.	.	.	1.1000	0.7505	.	5895	6104	13168	5408
.	.	.	.	.	1.2000	0.8188	.	5895	6491	12771	5113
.	.	.	.	.	1.3000	0.8870	.	5895	6857	12396	4838
.	.	.	.	.	1.4000	0.9552	.	5895	7205	12043	4580
.	.	.	.	.	1.5000	1.0235	.	5895	7534	11709	4339
.	.	.	.	.	1.6000	1.0917	.	5895	7847	11393	4113
.	.	.	.	.	1.7000	1.1599	.	5895	8144	11094	3901
.	.	.	.	.	1.8000	1.2281	.	5895	8426	10812	3702
.	.	.	.	.	1.9000	1.2964	.	5895	8694	10544	3515
.	.	.	.	.	2.0000	1.3646	.	5895	8949	10291	3340
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANATT03
Date and time : 13OCT97:11:41
Computation of ref. F: Simple mean, age 2 - 6
Basis for 1997 : F factors

Table 11.7.4

The SAS System 19:20 Tuesday, October 14, 1997

Plaice in the Eastern English Channel (Fishing Area VIId)

Single option prediction: Detailed tables

Year: 1997	F-factor: 1.0000		Reference F: 0.6823			1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.1064	2314	526	24073	3218	0	0	0	0
2	0.4592	5076	1423	14432	3007	2165	451	2165	451
3	0.8376	6668	1980	12268	3537	6502	1875	6502	1875
4	0.8886	1443	549	2557	959	2455	921	2455	921
5	0.7445	506	240	1006	470	1006	470	1006	470
6	0.4816	422	268	1155	653	1155	653	1155	653
7	0.4573	217	149	620	415	620	415	620	415
8	0.4600	101	90	286	223	286	223	286	223
9	0.3948	82	87	264	236	264	236	264	236
10+	0.3948	240	312	772	784	772	784	772	784
Total		17070	5626	57433	13501	15225	6026	15225	6026
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1998	F-factor: 1.0000		Reference F: 0.6823			1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.1064	2181	496	22689	3033	0	0	0	0
2	0.4592	6888	1931	19584	4080	2938	612	2938	612
3	0.8376	4484	1332	8250	2379	4373	1261	4373	1261
4	0.8886	2711	1032	4804	1801	4612	1729	4612	1729
5	0.7445	478	227	951	444	951	444	951	444
6	0.4816	158	100	432	244	432	244	432	244
7	0.4573	226	156	646	432	646	432	646	432
8	0.4600	125	111	355	277	355	277	355	277
9	0.3948	51	54	163	146	163	146	163	146
10+	0.3948	197	256	632	642	632	642	632	642
Total		17500	5695	58506	13478	15101	5787	15101	5787
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999	F-factor: 1.0000		Reference F: 0.6823			1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.1064	2181	496	22689	3033	0	0	0	0
2	0.4592	6492	1820	18458	3845	2769	577	2769	577
3	0.8376	6085	1807	11195	3228	5933	1711	5933	1711
4	0.8886	1823	694	3231	1211	3101	1163	3101	1163
5	0.7445	899	427	1787	835	1787	835	1787	835
6	0.4816	149	95	409	231	409	231	409	231
7	0.4573	85	58	242	162	242	162	242	162
8	0.4600	130	116	370	288	370	288	370	288
9	0.3948	63	67	203	181	203	181	203	181
10+	0.3948	151	196	485	492	485	492	485	492
Total		18059	5776	59068	13507	15299	5640	15299	5640
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRATT01
Date and time : 14OCT97:19:43
Computation of ref. F: Simple mean, age 2 - 6
Prediction basis : F factors

Table 11.11.1

Plaice in the Eastern English Channel (Fishing Area VIId)

11:39 Monday, October 13, 1997

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	1.000	0.1000	0.0000	0.0000	0.0000	0.134	0.1064	0.227
2	.	0.1000	0.1500	0.0000	0.0000	0.208	0.4592	0.280
3	.	0.1000	0.5300	0.0000	0.0000	0.288	0.8376	0.297
4	.	0.1000	0.9600	0.0000	0.0000	0.375	0.8886	0.381
5	.	0.1000	1.0000	0.0000	0.0000	0.467	0.7445	0.475
6	.	0.1000	1.0000	0.0000	0.0000	0.565	0.4816	0.636
7	.	0.1000	1.0000	0.0000	0.0000	0.669	0.4573	0.687
8	.	0.1000	1.0000	0.0000	0.0000	0.779	0.4600	0.889
9	.	0.1000	1.0000	0.0000	0.0000	0.895	0.3948	1.059
10+	.	0.1000	1.0000	0.0000	0.0000	1.187	0.3948	1.299
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDATT03
Date and time: 13OCT97:12:03

Table 11.11.2

Plaice in the Eastern English Channel (Fishing Area VIId)

11:39 Monday, October 13, 1997

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	7716.828	8.325	7300.866	8.325	7300.866
0.2000	0.1365	0.496	270.284	5.556	2765.838	3.437	2367.835	3.437	2367.835
0.4000	0.2729	0.657	284.138	3.962	1432.273	1.901	1050.225	1.901	1050.225
0.6000	0.4094	0.730	271.038	3.241	934.084	1.232	566.285	1.232	566.285
0.8000	0.5458	0.770	259.194	2.845	707.005	0.884	351.994	0.884	351.994
1.0000	0.6823	0.796	251.183	2.597	586.409	0.679	242.929	0.679	242.929
1.2000	0.8188	0.814	246.048	2.425	513.867	0.548	180.830	0.548	180.830
1.4000	0.9552	0.827	242.752	2.298	465.639	0.457	142.095	0.457	142.095
1.6000	1.0917	0.838	240.591	2.198	430.984	0.391	116.105	0.391	116.105
1.8000	1.2281	0.846	239.133	2.117	404.576	0.341	97.631	0.341	97.631
2.0000	1.3646	0.853	238.116	2.049	383.549	0.302	83.895	0.302	83.895
-	-	Numbers	Grams	Numbers	Grams	Numbers	Grams	Numbers	Grams

Notes: Run name : YLDATT03
Date and time : 13OCT97:12:03
Computation of ref. F: Simple mean, age 2 - 6
F-0.1 factor : 0.1882
F-max factor : 0.3332
F-0.1 reference F : 0.1284
F-max reference F : 0.2273
Recruitment : Single recruit

Figure 11.1.1 Stock summary, Plaice ,English Channel

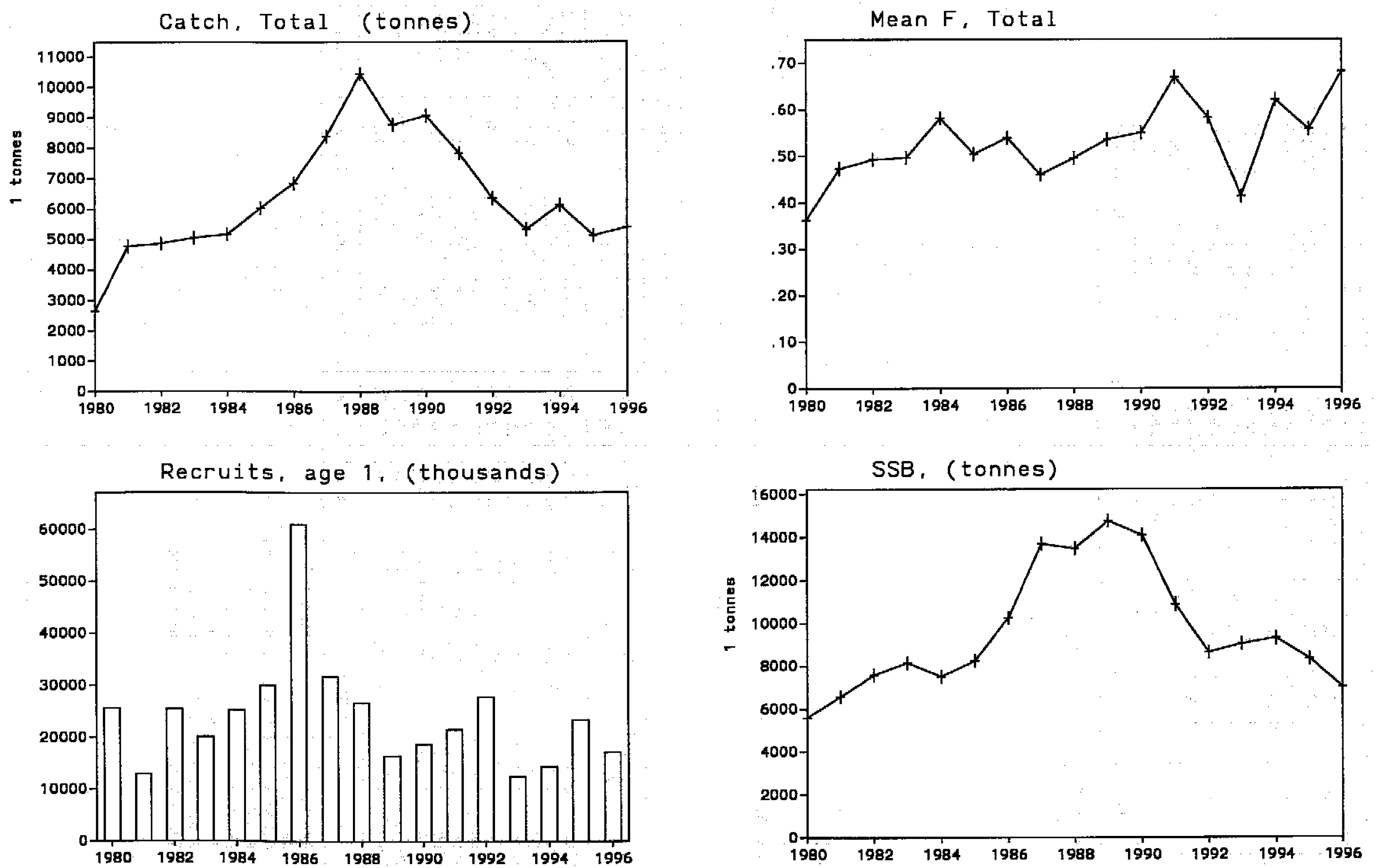
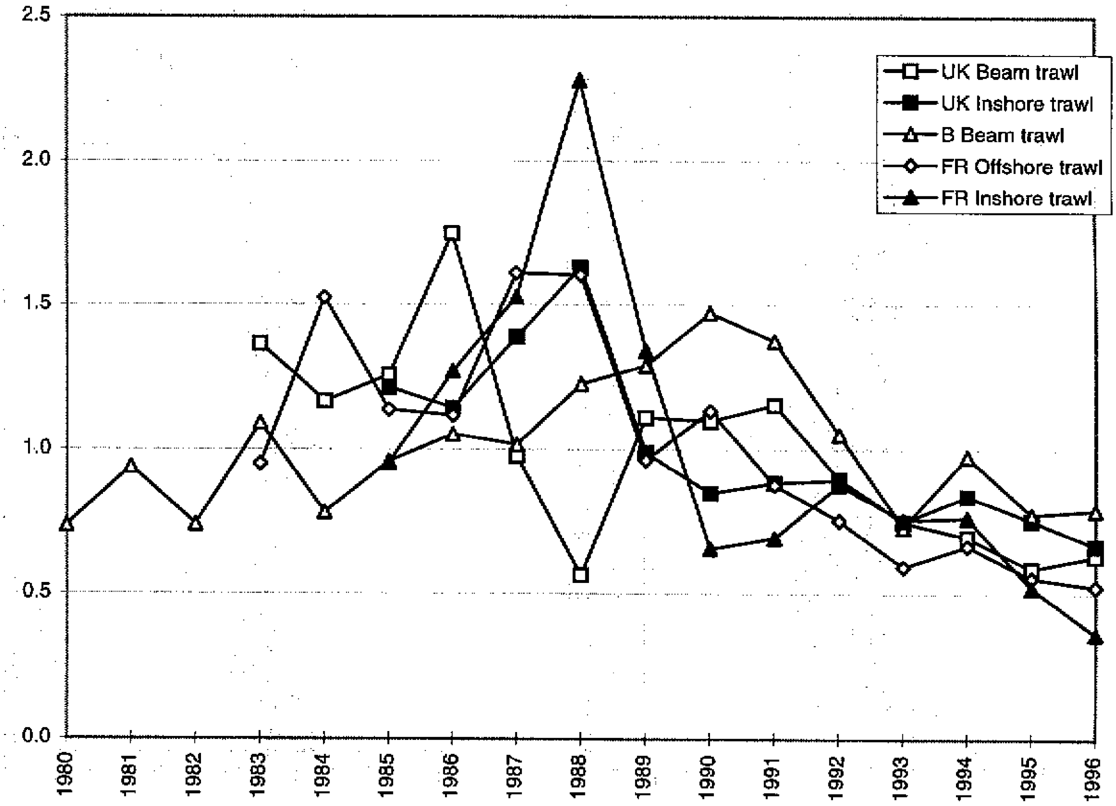


Figure 11.3.1

Plaice in Division VIId. Standardised CPUE.



Plaice in Division VIId. Standardised effort.

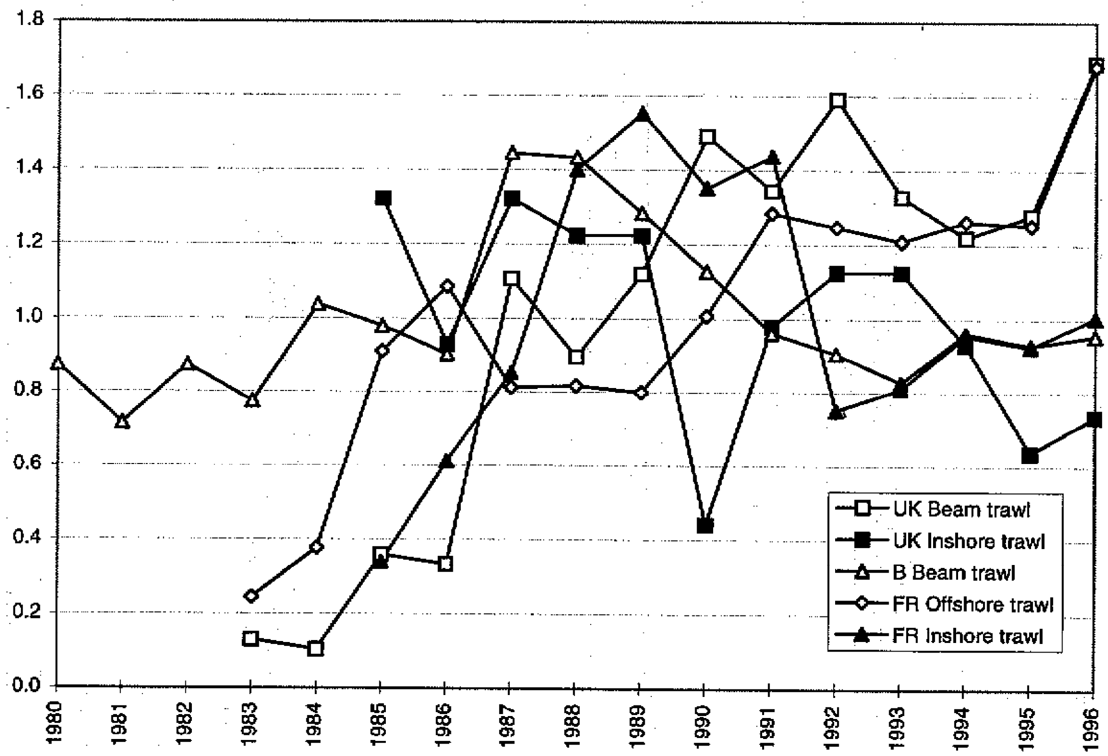


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Figure 11.4.1 Plaice in Division VIId. Log q residual per fleet and age (XSA, final Run).

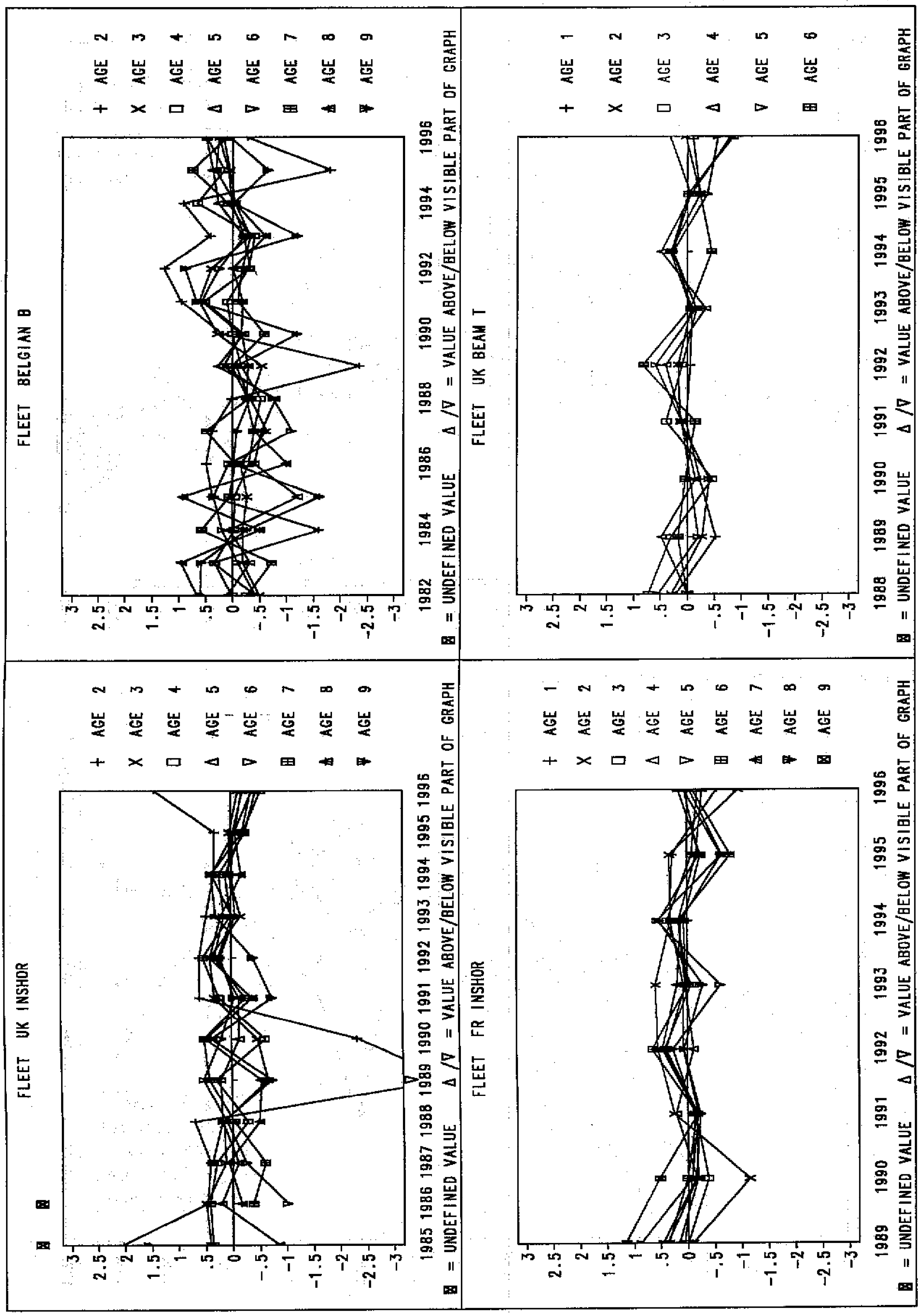


Figure 11.4.1 Plaice in Division VIId. Log q residual per fleet and age (XSA, final Run). (cont)

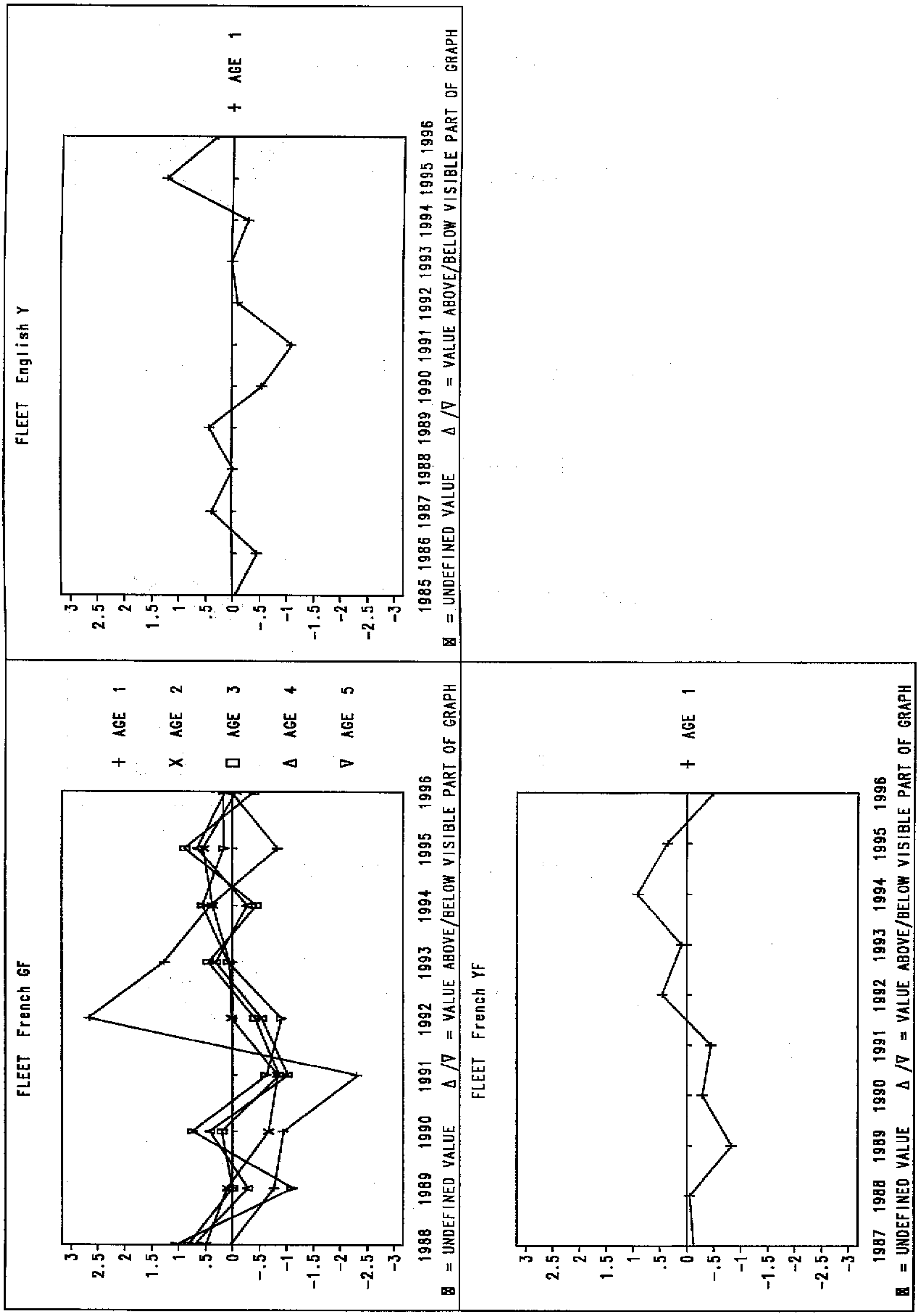
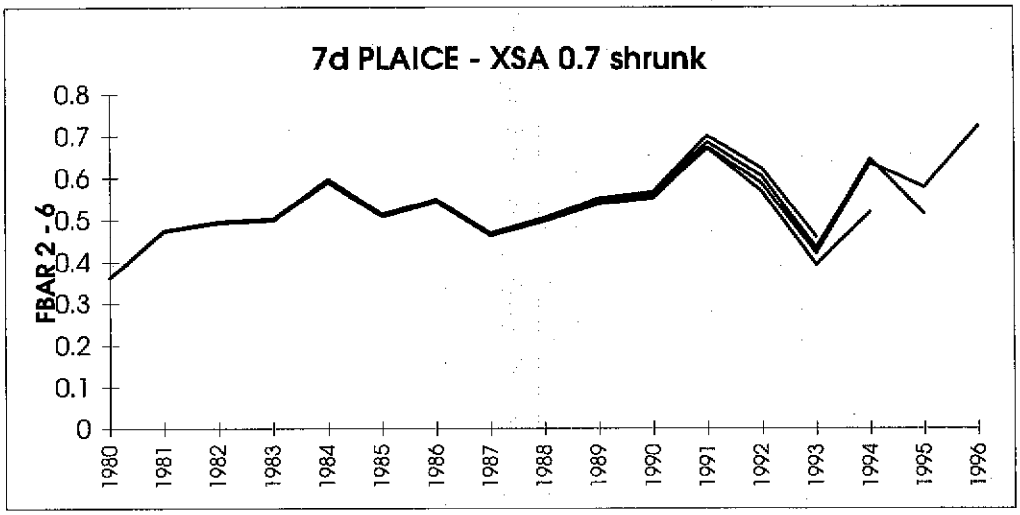
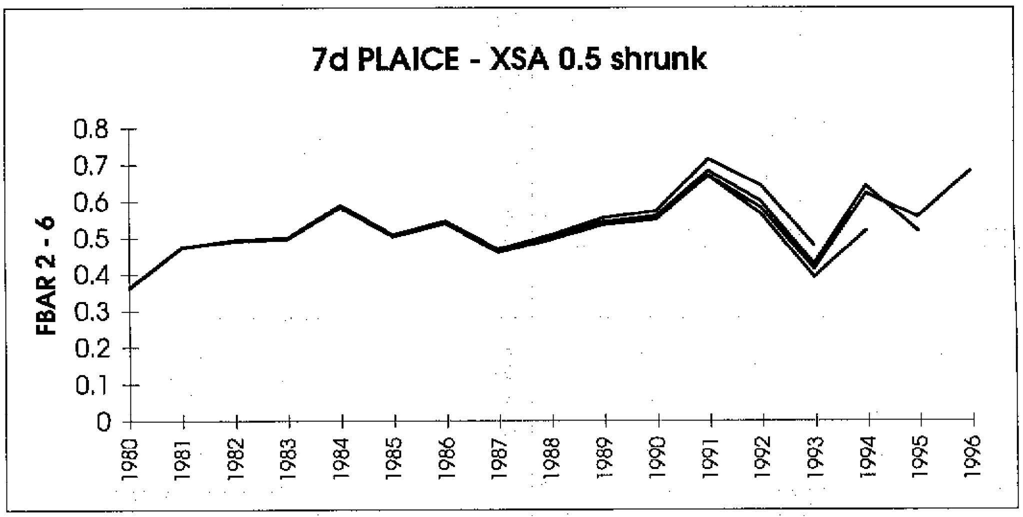


Figure 11.4.2 Plaice in Division VIId. Retrospective analysis with final Run.





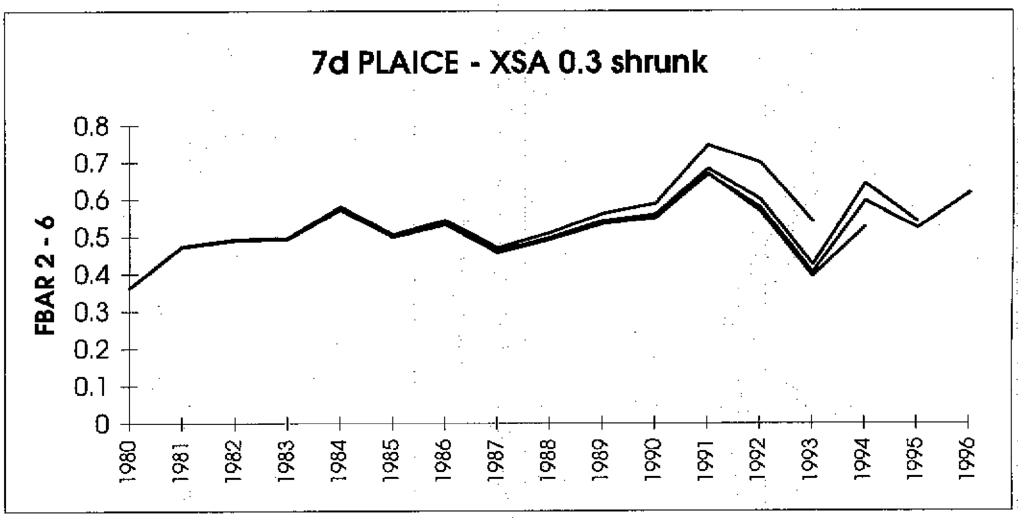


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Figure 11.4.3 Plaice in Division VIId. Weights of tuning categories in final assessment.

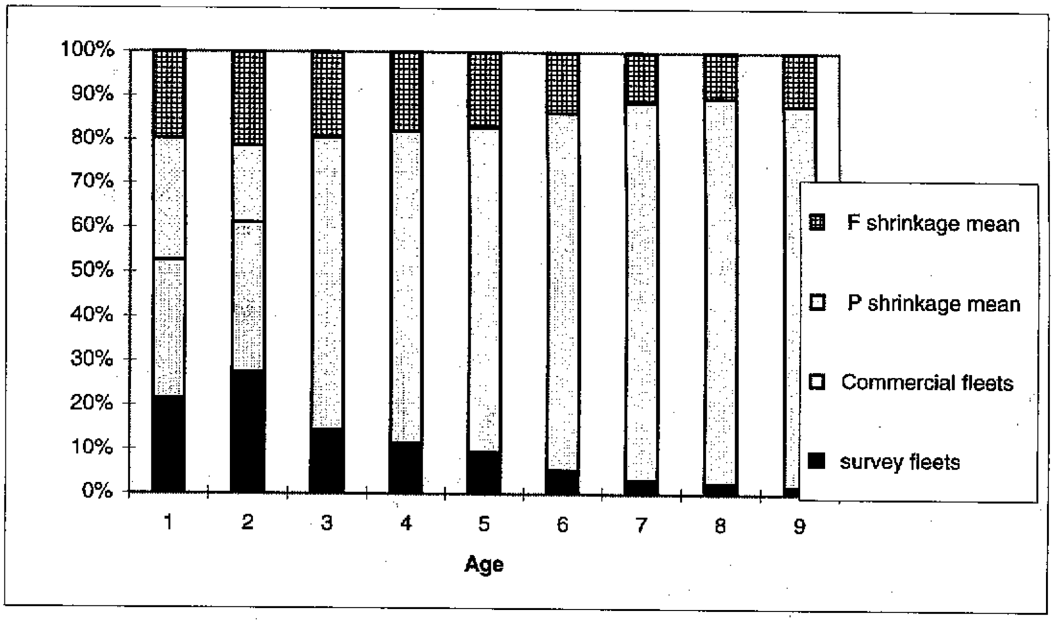

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Figure 11.5.1 Plaice in Division VIId. Survey index versus VPA-N

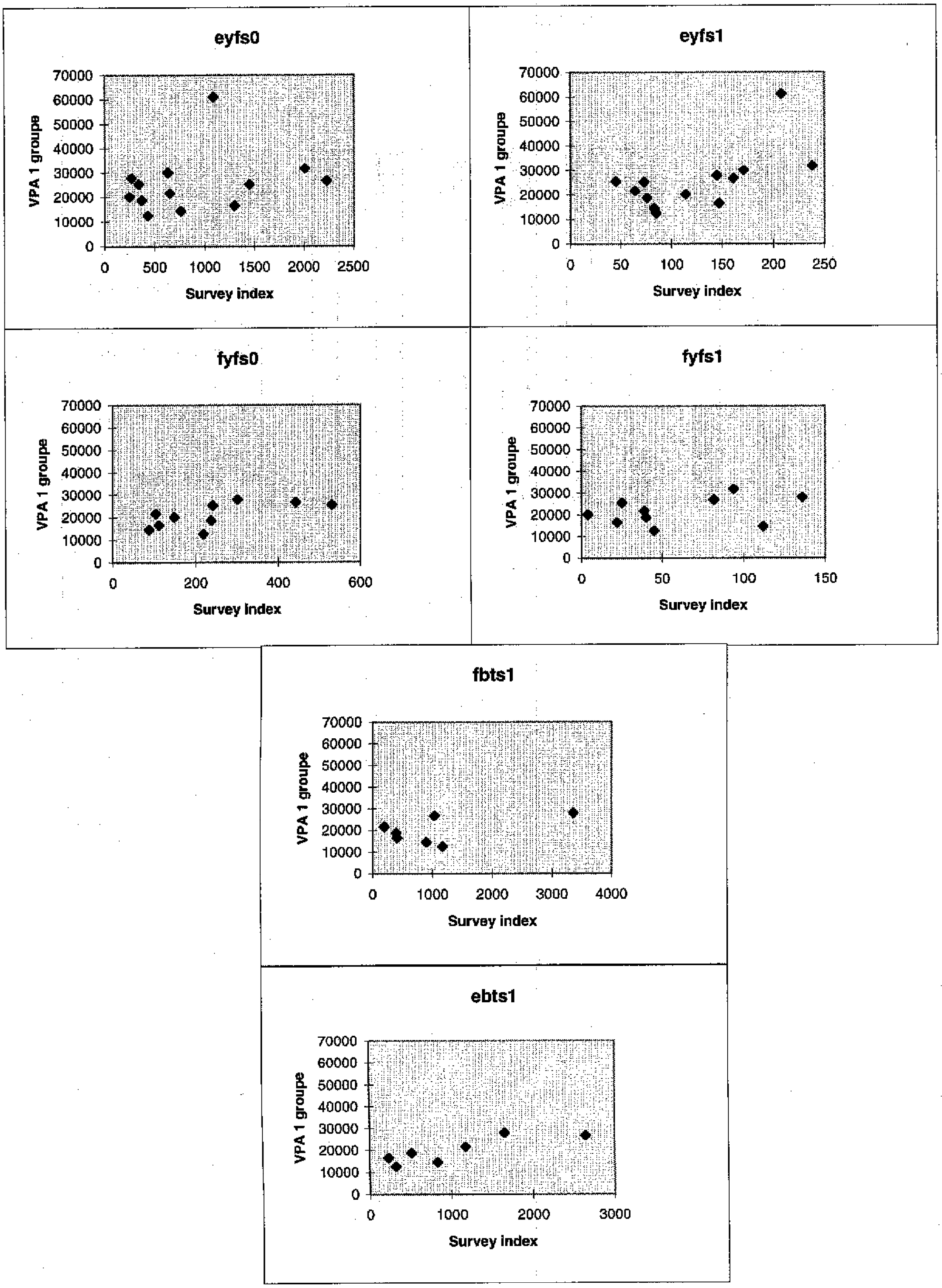
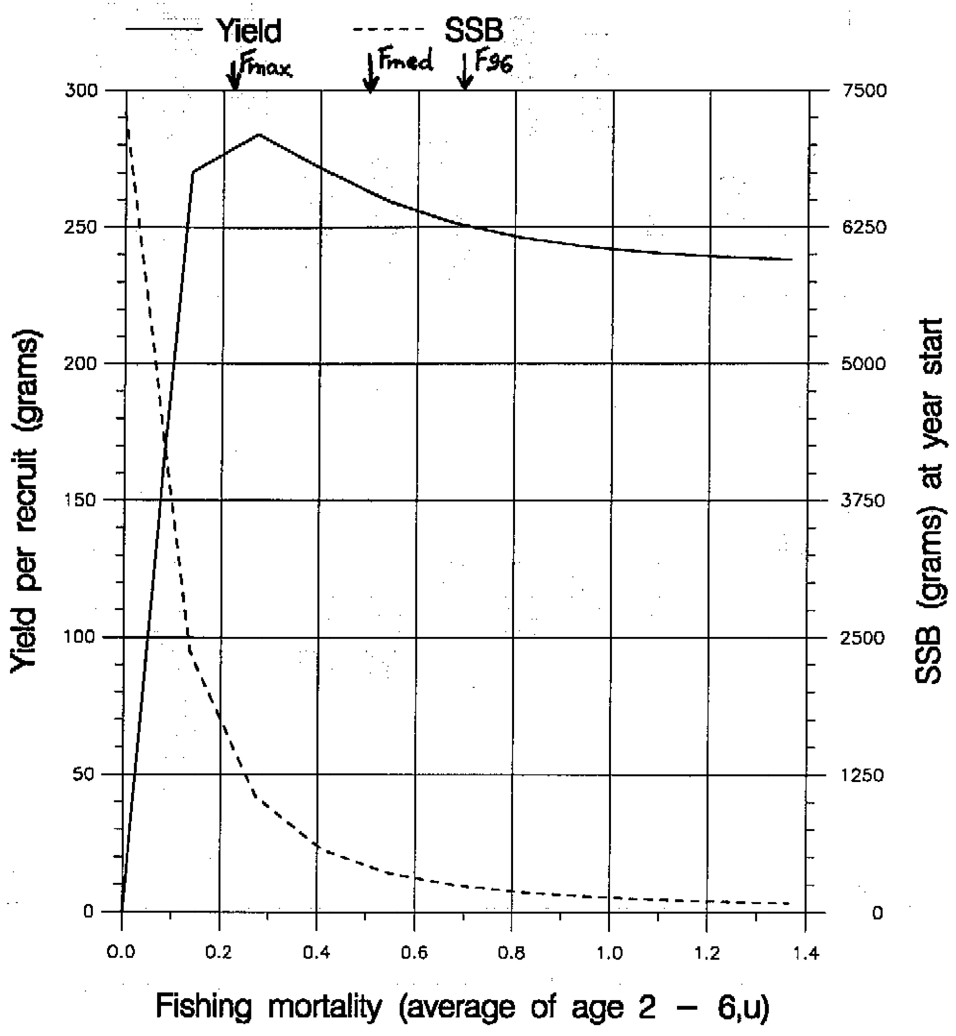


Figure 11.7.5

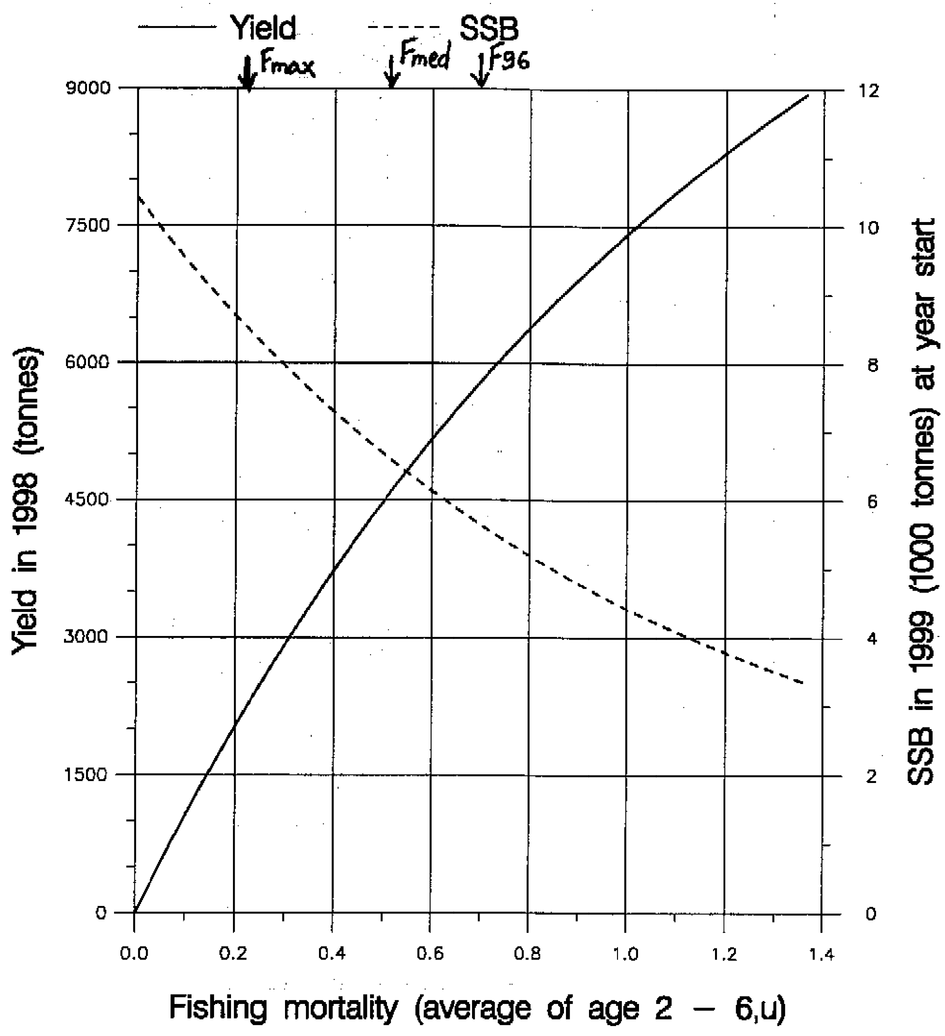
Fish Stock Summary
Plaice in the Eastern English Channel (Fishing Area VIId)
13 – 10 – 1997

Long term yield and spawning stock biomass



(run: YLDATT03) C

Short term yield and spawning stock biomass



(run: MANATT03) D

Figure 11.7.6 Plaice,English Channel East. Sensitivity analysis of short term forecast.

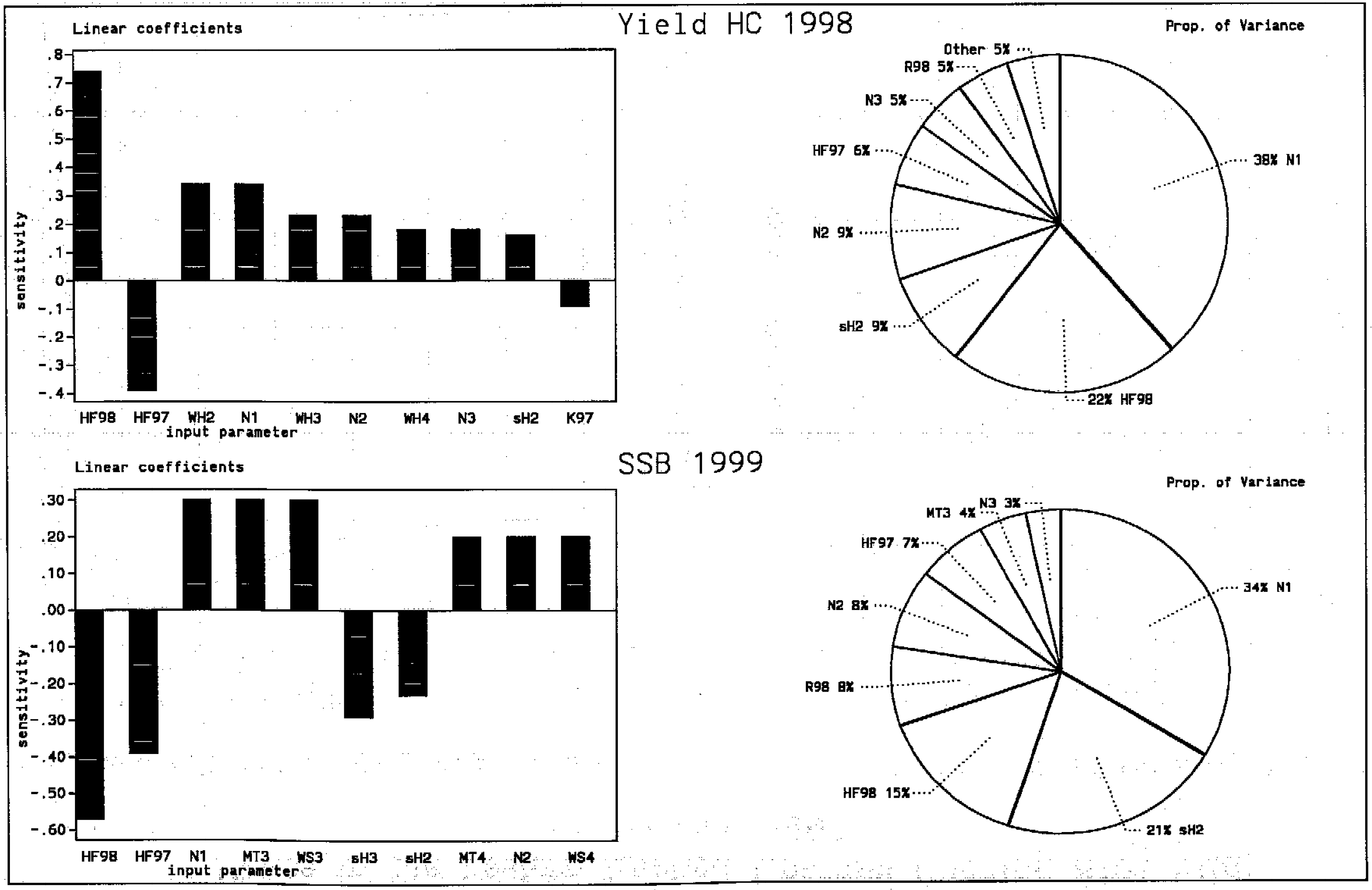


Figure 11.7.7 Plaice,English Channel East. Probability profiles for short term forecast.

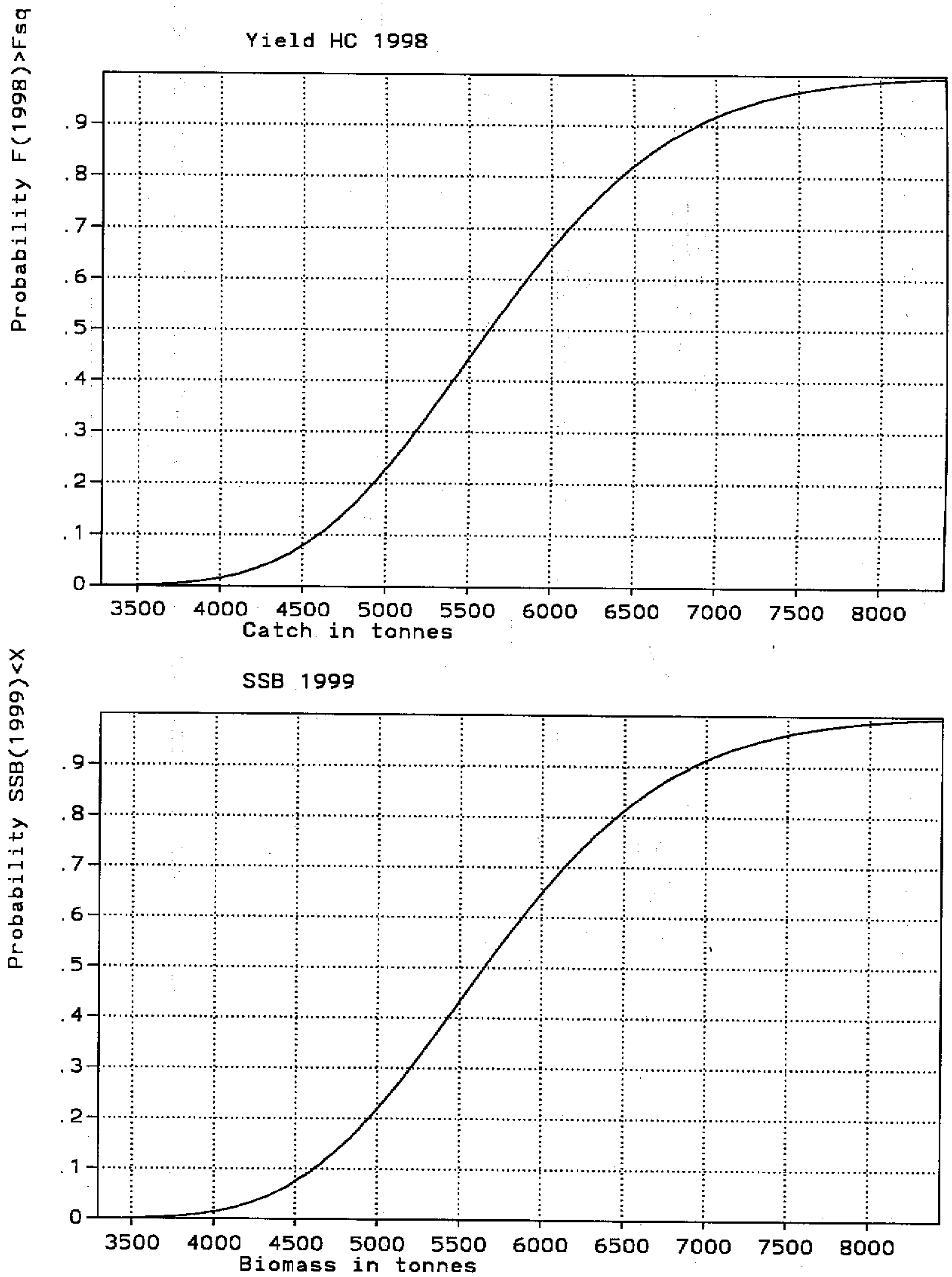


Figure 11.8.1 Plaice in VIID. Medium term projections showing 5, 10, 20, 50 and 95 percentiles from Beverton-Holt recruitment model.

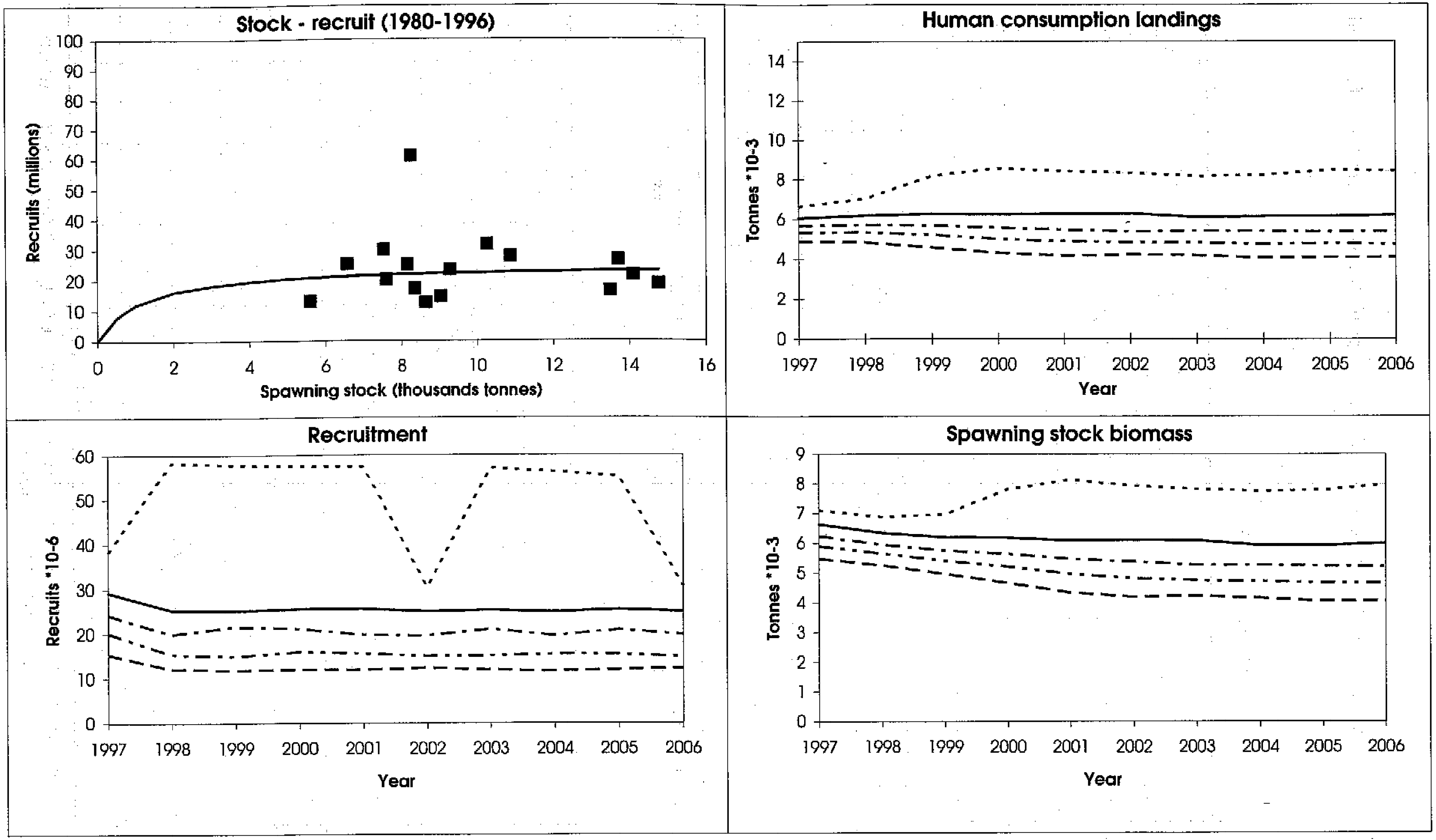


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Figure 11.9.1

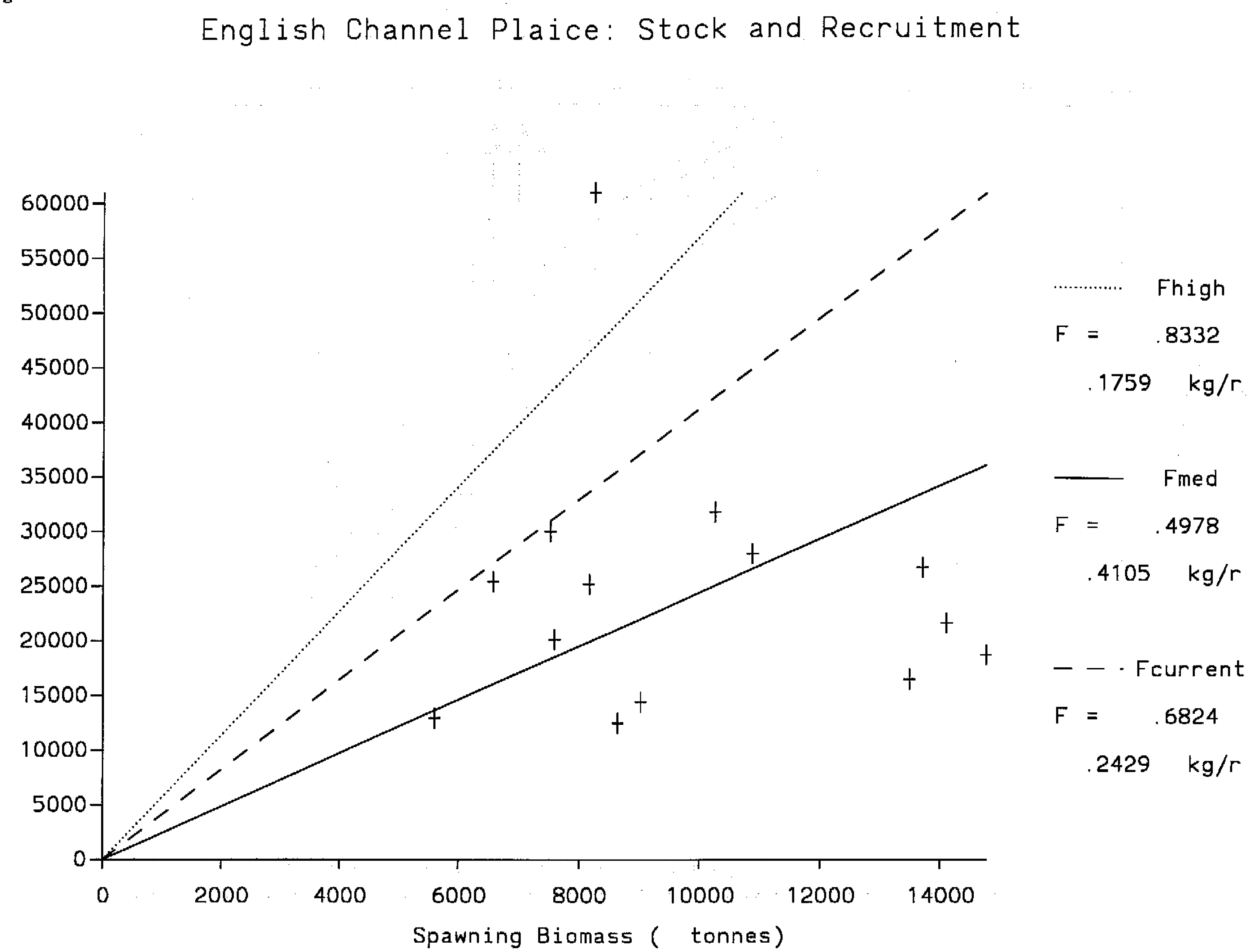
English Channel Plaice: Stock and Recruitment
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0
2000
4000
6000
8000
10000
12000
14000
Spawning Biomass (tonnes)
Fhigh
F = .8332
.1759 kg/r
Fmed
F = .4978
.4105 kg/r
Fcurrent
F = .6824
.2429 kg/r

Figure 11.12.1 Plaice in Division VIId. Medium term projection showing 5, 10, 20 and 50 percent probabilities that SSB in 2006 will fall below given levels at different levels of F.

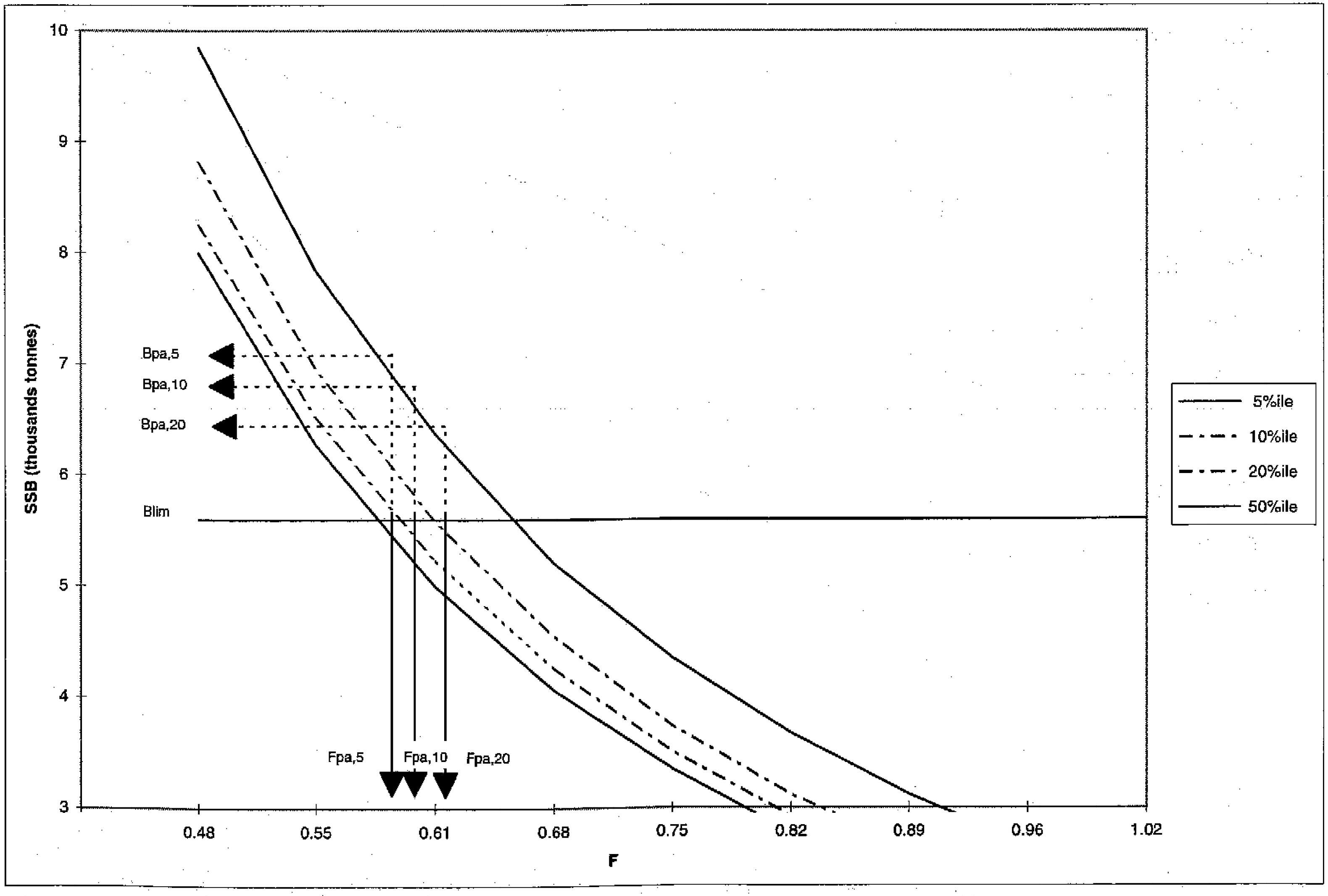

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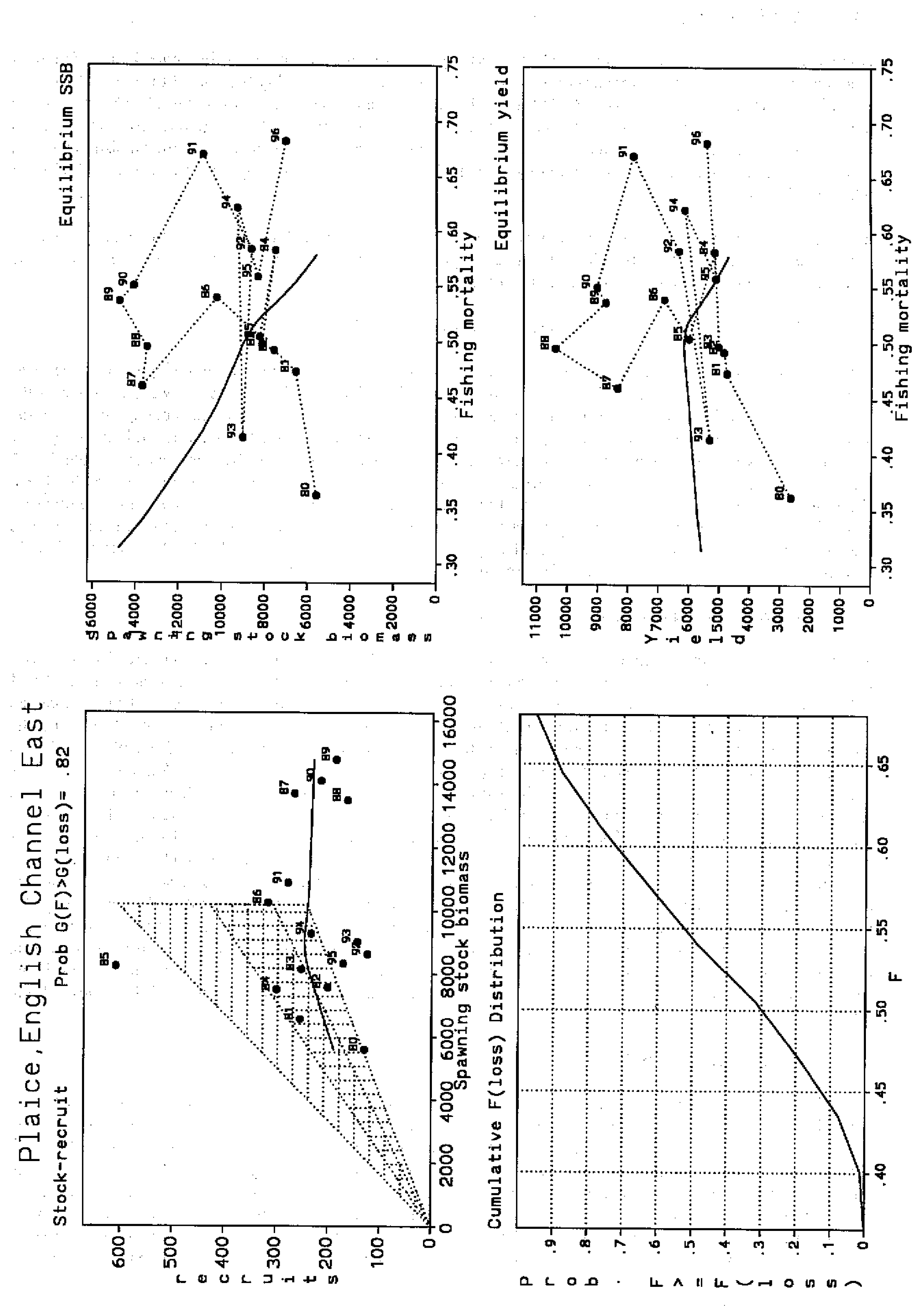
Figure 11.12.2



12 NORWAY POUT IN SUB-AREA IV AND DIVISION IIIA

12.1 Catch Trends

Annual landings (1957–1996) as provided by Working Group members are shown in Table 12.1.1. The total landings in 1995 of 241,000 t were larger than previous year's landings probably because of the strong 1994 year class. The landings has decreased to 166,000 t in 1996 which is near the long-term average of 186,000 t for the period 1985–1996 with relatively low catches compared to the period 1968–1984 with a long-term average catch of 387,000 t. The decline in the catches from 1995 to 1996 is mainly due to relatively low Danish catches in 1996. Plots of total yield is shown in Figure 12.6.1. In 1997 the TAC for Norway pout was set to 220,000 t of which EU has 180,000 t available.

The landings by month and country are shown in Table 12.1.2. The seasonal distribution of the landings in 1996 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. Mean weight at age in the catch was estimated as a weighted average of Danish and Norwegian data, Table 12.2.2. The mean weights at age in the catches are very variable between years and seasons, and also between countries, for the same age groups in the same year. 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 but the model is now based on fixed estimates from the 1996 assessment. Table 12.2.2 includes data from 1983 to 1997 and data from the period 1974–1982 are assumed to be the same as for 1983. Data for mean weight at age in the stock, maturity ogive and natural mortality were the same as used in previous years, Table 12.2.3. The natural mortality is set to 0.4 for all age groups in all seasons which results in an annual natural mortality of 1.6 for all age groups (see background description for this in ICES CM 1987/Assess:17, p. 4–5) which also is at the same level of the MSVPA estimate of M for Norway pout.

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. Previous years' reports (latest in ICES CM 1997/Assess:6) give a background description of the commercial fishery tuning series used. In 1997 Norwegian effort data have been revised as described in Sections 13.1.3.1 (and 1.3.2) for sandeel. More details and the coefficients of the different previous regression models used can be found in two reports of the Working Group on the Assessment of Norway Pout and Sandeel (ICES CM 1994/Assess:7; ICES CM 1995/Assess:5). Tables 12.3.1 and 12.3.2 give CPUE data for the Danish and Norwegian commercial fishery fleets divided by vessel category in the period 1983–1996, respectively. Note that catches in 1990 are estimated catches from the assessment performed in 1996. The combined and standardized Danish and Norwegian fishing effort data for commercial vessels targeting Norway pout are shown in Table 12.3.3. Tuning should ideally have been performed on divided national commercial fleets. However, long term catch data series back to 1974 divided by commercial fleet for each country have not been compiled and were not available for the Working Group this year in order to split the combined Danish and Norwegian commercial fishery into two assessment tuning fleets. The fleet specific long-term catch data will be compiled and made available for the Working Group to be used in next years assessment. Research vessel data: Survey indices series of abundance of Norway pout were available from the IBTS, the EGFS (English Ground Fish Survey) and the SGFS (Scottish Ground Fish Survey), Table 12.3.4.

12.4 Catch-at-Age Analysis

The SXSA (Seasonal Extended Survivors Analysis) was used to estimate quarterly stock numbers and fishing mortalities for Norway pout in the North Sea and Skagerrak. For details concerning the SXSA see Appendix 1 in ICES CM 1994/Assess:7. In the SXSA the catchability was assumed to be constant within the period 1983–1997. Tuning was performed over the period 1983 to 1997 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. 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. For this years

SXSA the catch at age numbers for 1990 was set as fixed values based on the estimates from the 1996 assessment which are also expected to be used in the coming years assessment. 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. In Figure 12.4.4 the SSQ Residuals are shown. Weighting factors for computing survivors of the different tuning fleets are shown in Figure 12.4.3. Retrospective analyses has been done for recruitment and SSB as in previous years. The results of the these analyses are shown in Figure 12.4.1. In Table 12.4.2 the relative bias in performing annual VPA compared to seasonal VPA is shown. Compiled results of the SXSA are shown in Table 12.6.1 and in Figures 12.6.1 and 12.6.2.

The log residual stock numbers are as expected least variable for 1 and 2 year old fish as these age groups is the most abundant (Figure 12.4.2). There is no apparent trend in the residuals with time.

Figure 12.4.4 indicates large yearly variations with large SSQ residuals for commercial fishery in 1992 (3rd quarter), 1993 (4th quarter), 1995 (3rd quarter), and 1996 (4th quarter). The sum of squared residuals for the surveys show relatively smaller yearly variations in SSQ compared to the commercial fishery. However, the English Ground Fish Survey gives slightly higher residuals with peaks in 1987, '92, and '96.

The weights in the tuning process in the base run (constant catchability) were even distributed over the different CPUE series with a general tendency towards most weight given to the CPUE data from the commercial fishery (CF), Figure 12.4.3. In the 2nd and 4th quarter only, the commercial fishery is used in the tuning while survey weighting also is performed for 1st and 3rd quarter. However, for several age groups and seasons approximately the same weight were given to the IBTS (formerly IYFS) and SGFS surveys as the weight given to the commercial fishery. Higher weight is given to SGFS age 3 season 3 compared to EGFS and the commercial fishery.

The retrospective analyses for recruitment and SSB performed as in previous years (Figure 12.4.1) revealed a general tendency to overestimate SSB and recruitment values in the last year. In most cases the estimates converged rapidly, but the initial high estimates of the large 1991 and 1994 year classes have in general been gradually revised downwards in the successive years. Investigations during the 1995 assessment showed that when the cosine time taper was applied the tendency to overestimate SSB and recruitment was somewhat reduced.

12.5 Recruitment Estimates

A complementary recruitment analysis (RCT3 program) was in previous years performed where the 0- and 1-group indices of the EGFS and SGFS surveys were used to estimate the stock numbers in the 3rd quarter of the assessment year 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. This has not been performed in the present assessment in 1997. As the surveys used in the RCT3 analysis are the Scottish and English groundfish surveys both performed in August, and as the VPA performed in 1997 includes the also 1st and 2nd quarter of 1997 these surveys has been included in the VPA based on the assumption that the surveys in August are representative for the stock situation first of July.

SXSA estimated values of the 0- and 1-group in the 3rd quarter in 1996 were 174 and 12 billions respectively. These values are above the averages (1983–1994) and at the same level as the estimates of 0- and 1-group in 1991. The stock numbers estimated for the 1994 year class in the 1997 assessment do not deviate much from the estimated numbers in the 1996 assessment, as the estimates of stock number per age group for the 1994 year class in the 1997 assessment are only slightly below the 1996 assessment estimates where the RCT3 method was used and SGFS and EGFS indices were not included in the SXSA.

The catch levels of 1-group fish in 1995 and 2-group fish in 1996, and survey indices in the period 1994–1996, suggest that the 1994 year class is strong. The catches of 1-group fish in 1996 and 2-group fish in 1997, and survey indices in the period 1995–1997, indicate an average 1995 year class. All survey indices indicated strong 1991 and 1994 year classes and also indicate a relatively strong 1996 year class.

12.6 Historical Stock Trends

The landings (yield) of Norway pout for the period 1974–1996 are presented in Table 12.6.1. In addition, the estimated average fishing mortality for the 1- and 2-group, the trends in the Spawning Stock Biomass (SSB), and the recruitment trends for the period 1974–1996/1997 are shown in Table 12.6.1. These results are also presented in Figure 12.6.1. Historical trends in fishing mortality for 1- and 2-group are shown in Figure 12.6.2.

Average fishing mortality for ages 1–2 was at a level of around 1.0 in the early 1980s up to 1986 but then declined to the a level of approximately 0.7 until 1994 and then again declined to a level around 0.4 in 1995 and 1996 (Figure 12.6.1). Total effort was high in the period 1982–86. The fishery in 1995 and 1996 concentrated on the very strong 1994 year class as the fishery is targeting both the 1-group and the 2-group. The 1991 year class was strong, while the 1992 and 1993 year classes were of intermediate strength. The 1996 year class also seems to be relatively strong at the same level as the 1991 year class. Spawning stock biomass decreased in the mid 1980s after have reached peaks above 300,000 t in 1983–84, but has since slowly increased again with a smaller drop in 1994 and 1995. The spawning stock biomass was estimated to more than 350,000 t in 1996 and to around 250,000 t in the 1997 assessment. (Figure 12.6.1 and Table 12.6.1). The spawning stock biomass has in 1997 decreased to the level of 1993 from a peak in 1996 due to the historical strongest 1994 year class (since 1981) which is now disappearing. Thus, from Figure 12.6.1 it seems that the fishery responded to the lower CPUE by reducing effort in 1987, and this reduction of F and in addition good recruitment in 1991, 1994 and probably 1996 has given an increase in SSB in the years 1989–1996. The level of the SSB should also be related to the recent smaller decline in fishing mortality and effort in 1995–96.

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

Comprehensive analyses related to predictions have been performed for the sandeel in the North Sea and Skagerrak. However, it has not been possible within the time available to make similar detailed analyses for Norway pout this year. Similar analyses for Norway pout should be performed dependent of the choice of type of assessment for sandeel in the future based on the results from these analyses (see Section 12.9 with comments on the assessment). However, it should be taken into account that the relative bias (F/M-relationship) in performing annual VPA compared to seasonal VPA show much higher variance for Norway pout than for sandeel (Table 12.4.2).

SSB/R and Y/R -plots were generated for Norway pout in order to produce long-term considerations for the stock using a quarterly based model for the period 1974–1995 and to calculate F_{low} and F_{med}. However, no F_{max} could be estimated based on the Y/R-plot.

12.8 Biological Reference Points

MBAL (=B_{lim}) has been defined based on the stock recruitment plot shown in Figure 12.8.2. MBAL is estimated to 150,000 t. MBAL is suggested as a limit reference point for SSB based on historical low levels for the stock and low recruitment in the late 1980s (Figure 12.8.1). A stock below this level may based on Figure 12.8.2 indicate reduced recruitment even though it has not been possible to establish a realistic stock-recruitment relationship for the Norway pout stock in the North Sea and Skagerrak. In the historical times series of SSBs the stock has been below this limit 1986–1990. A major concern is to ensure that the stock remains on a high enough level to be food source for a variety of predator species besides ensuring yield to the fisheries. (See also under comments to the assessment).

F_{med} and F_{high} was in the last assessment (ICES CM 1997/Assess:6, part III) estimated to be 1.24 and 1.88, respectively (Figure 12.8.1). In this year's assessment F_{med} and F_{hig}h was estimated to 0.57 and 2.06 using mean weights and fishing mortalities from 1993–1996.

12.9 Comments on the Assessment

It should be noted that the natural mortality for Norway pout is very much higher than the fishery mortality. The natural mortality is set to 0.4 for all age groups in all seasons which results in an annual natural mortality of 1.6 for all age groups (see background description for this in ICES CM 1987/Assess:17, p. 4–5) which also is within the same level of the MSVPA estimate of M for Norway pout. Thus, the M-value is far beyond the annual fishery mortality for age group 1 and 2 which experience the highest fishing pressure. The dynamics of the Norway pout stock in the North Sea and Skagerrak is mainly dependent of the changes caused by predation mortality and not fishery.

Detailed analyses of differences between seasonal and annual assessments have been made for sandeel in the North Sea and Skagerrak in a working paper to the present Working Group (Kell *et al.* 1997 and O'Brien *et al.*

1997). The results of this approach for sandeel showed that both methods produce similar estimates of reference points and it could not find any relationship between SSB and recruitment. However, the seasonal assessment is more variable. This might reflect convergence problems in the VPA, or else the greater variability of the seasonal data. It has not been possible within the time available to make a similar detailed bootstrap analysis for Norway pout this year. Similar analyses for Norway pout should be performed dependent of the choice of type of assessment for sandeel in the future based on the results from these analyses. However, a table of the relative bias in performing annual VPA compared to seasonal VPA show much higher bias for Norway pout than for sandeel. (See Table 12.4.2). This indicate that seasonal VPA is most adequate to use for Norway pout. The reasons for performing seasonal VPA is that there are seasonal differences in the fishery and in the fishing pattern (and most likely also in the natural mortality). If the ratio between F and M varies between seasons then seasonal and annual VPAs will produce different results.

The fisheries mortalities and the catches vary very much for both age groups between years and seasons (Table 12.4.2). On that basis there is a good argument for calculating an average fisheries mortality for the 1- and 2-group. However, as the fisheries mortalities vary very much between years and seasons for both age groups measurement of a weighted average of the two Fs would give a more precise picture. Variance in the fisheries mortalities between age groups, years, and season can be a result of a) changes in distribution of fishing effort which could have lead to reduction in effort targeted at a certain age group; b) when the proportion of a certain age group is very low in the catches one year this proportion is estimated with a higher CV; c) age reading problems can further increase the uncertainty. (Figures 12.6.1 and 12.6.2).

Table 12.1.1 Norway pout annual landings ('000 t) in the North Sea and Division IIIa, by country, for 1957–1996. (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	305.1
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	475.4
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	167.5
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	+	-	0.1	299.8
1993	97.3	7.8	2.4	76.7	-	-	+	184.2
1994	97.9	6.6	3.6	74.2	-	-	+	182.3
1995	138.4	50.3	8.9	43.1	0.1	-	0.2	241.0
1996	74.3	36.2	7.6	47.8	0.2	0.1	+	166.2

Table 12.1.2 Norway Pout, North Sea and Skagerrak. National landings (t) by month, 1993-1996. (Data provided by Working Group members).

Month	Denmark	Norway	Total	Denmark	Norway	Total
		1993			**1994**	
Jan	5,678	2,578	8,256	8,600	3,425	12,025
Feb	10,871	7,460	18,331	9,579	4,146	13,725
Mar	6,654	2,558	9,212	4,603	3,478	8,101
Apr	0	4,128	4,128	681	5,126	5,807
May	79	12,585	12,664	0	4,209	4,209
Jun	1,419	10,171	11,590	0	5,340	5,340
Jul	9,646	10,713	20,359	312	9,653	9,965
Aug	10,686	7,866	18,552	4,763	13,524	18,287
Sep	12,609	7,358	19,967	13,697	8,629	22,326
Oct	20,741	4,168	24,909	17,750	8,435	26,185
Nov	10,650	3,995	14,645	21,538	4,706	26,244
Dec	8,296	3,092	11,388	16,335	3,501	19,836
Total	97,329	76,672	174,001	97,858	74,192	172,050

Month	Denmark	Norway	Total	Denmark	Norway	Total
		1995 [1]			**1996**	
Jan	6,501	1,195	7,696	3,246	458	3,704
Feb	6,501	8,966	15,467	3,307	3,304	6,611
Mar	8,345	5,360	13,705	3,390	6,842	10,232
Apr	3,448	2,646	6,074	1,675	1,802	3,477
May	6,695	5,326	12,021	1,118	1,351	2,469
Jun	7,191	2,667	9,858	153	1,128	1,281
Jul	19,833	1,671	21,504	1,134	6,739	7,873
Aug	11,620	471	12,091	7,192	9,053	16,245
Sep	32,529	3,648	36,177	17,861	11,674	29,535
Oct	39,772	6,837	46,609	14,475	3,028	17,503
Nov	31,378	2,578	33,956	14,813	1,361	16,174
Dec	14,675	1,716	16,391	5,893	1,077	6,970
Total	188,488	43,117	231,605	74,257	47,817	122,074

[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 were estimated within the SXSA program used in the 1996 assessment.

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	20	993	0	0	734	3,486	0	0	879	954
1	1,840	1,780	971	1,181	1,501	636	1,519	1,048	3,556	1,522	3,457	2,784
2	584	572	185	116	1,336	404	215	187	1,086	293	389	267
3	20	19	6	4	93	19	22	18	118	20	1	2
4+	10	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	700	1,692
1	1,942	813	1,147	1,050	1,975	372	1,029	1,148	3,992	1,905	2,545	3,348
2	699	473	912	445	591	285	421	134	240	256	47	59
3	15	58	19	2	56	29	71	0	6	32	3	3
4+	0	0	0	0	0	0	0	0	0	0	0	0
Age Year	1996											
0	0	0	724	2,517								
1	535	560	1,043	650								
2	772	201	1,002	333								
3	14	38	37	2								
4+	0	0	0	0								

Table 12.2.2 Norway pout in North Sea + Division IIIa. Mean weights (grams) at age, by quarter, 1983–1997, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as 1983.

Year	Qtr	0	1	2	3	4
		Age-Group				
1983	1	.00	7.00	22.00	40.00	56.00
1983	2	.00	15.00	34.00	50.00	56.00
1983	3	4.00	25.00	43.00	60.00	.00
1983	4	6.00	23.00	42.00	58.00	.00
1984	1	.00	6.55	24.04	39.54	.00
1984	2	.00	8.97	22.66	37.00	.00
1984	3	6.54	17.83	34.28	34.10	.00
1984	4	6.54	20.22	35.07	46.23	.00
1985	1	.00	7.86	22.70	45.26	41.80
1985	2	.00	12.56	28.81	43.38	.00
1985	3	8.37	23.10	36.52	58.99	.00
1985	4	6.23	26.97	40.90	.00	.00
1986	1	.00	6.69	29.74	44.08	82.51
1986	2	.00	14.49	42.92	55.39	.00
1986	3	.00	28.81	43.39	47.60	.00
1986	4	7.20	26.90	44.00	.00	.00
1987	1	.00	8.13	28.26	52.93	63.09
1987	2	.00	12.59	31.51	.00	.00
1987	3	5.80	20.16	34.53	.00	.00
1987	4	7.40	23.36	37.32	46.60	.00
1988	1	.00	9.23	27.31	38.38	69.48
1988	2	.00	11.61	33.26	.00	.00
1988	3	9.42	26.54	39.82	.00	.00
1988	4	7.91	30.60	43.31	.00	.00
1989	1	.00	7.98	26.74	39.95	.00
1989	2	.00	13.49	28.70	44.39	.00
1989	3	7.48	26.58	35.44	.00	.00
1989	4	6.69	26.76	34.70	46.50	.00
1990	1	.00	6.51	25.47	37.72	68.00
1990	2	.00	13.75	25.30	40.35	0.00
1990	3	6.40	20.29	32.92	39.40	0.00
1990	4	6.67	28.70	38.90	52.94	0.00
1991	1	.00	7.85	20.54	35.43	44.30
1991	2	.00	12.95	28.75	49.87	.00
1991	3	6.06	30.95	44.28	67.25	.00
1991	4	6.64	30.65	43.10	59.37	.00

Table 12.2.2 (cont'd) Norway pout in North Sea + Division IIIa. Mean weights (grams) at age, by quarter, 1983–1997, from Danish and Norwegian catches combined. Data for 1974 to 1982 are assumed to be the same as 1983.

1992	1	.00	8.78	25.73	41.80	43.90
1992	2	8.00	11.71	31.25	49.49	.00
1992	3	6.70	26.52	42.42	50.00	.00
1992	4	8.14	27.49	44.14	50.30	.00
1993	1	.00	9.32	24.94	46.50	.00
1993	2	.00	14.76	30.58	48.73	.00
1993	3	4.40	25.03	35.19	55.40	.00
1993	4	8.14	26.24	36.44	70.80	.00
1994	1	.00	8.56	25.91	42.09	.00
1994	2	.00	15.22	29.27	46.88	.00
1994	3	5.40	29.26	38.91	53.95	.00
1994	4	8.81	31.23	49.59	.00	.00
1995	1	.00	7.70	24.69	50.78	.00
1995	2	.00	10.99	22.95	37.69	.00
1995	3	5.01	25.37	33.40	45.56	.00
1995	4	7.19	24.60	39.57	57.00	.00
1996	1	.00	8.86	21.62	37.58	.00
1996	2	.00	11.50	25.77	37.94	.00
1996	3	3.85	28.47	42.89	50.44	.00
1996	4	7.03	27.85	40.30	56.00	.00
1997	1	.00	6.77	21.54	42.40	.00
1997	2	.00	11.07	26.39	31.44	.00

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

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Table 12.3.1 Norway pout. Danish CPUE data (tonnes/day fishing) by vessel category for 1983–1996.

Vessel GRT	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
51-100	11.37	12.53	11.60	10.83	11.73	20.26	14.64	9.68	12.56	-	-	-	29.53	-
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	20.67
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	32.55
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	25.00
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	30.25
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	85.38

Table 12.3.2 Days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1982–1997.

		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	Effort	475	1045	1129	501
	Ave GRT	227.5	206.6	217.8	219.8
1994	Effort	436	450	1302	686
	Ave Grt	226.5	223.5	212.0	211.4
1995	Effort	545	237	155	297
	Ave Grt	223.6	233.8	221.7	218.1
1996	Effort	456	136	547	132
	Ave Grt	213.6	219.9	208.3	207.2
1997	Effort	143	180		
	Ave Grt	222.0	243.8		

Table 12.3.3 Combined Danish and Norwegian fishing effort (standardised) for Norway pout.

		Q1	Q2	Q3	Q4	Total
1987	Norway	441	547	197	355	1539
	Denmark	1169	7	1333	1946	4455
	Total	1610	554	1530	2301	5994
1988	Norway	316	143	75	617	1151
	Denmark	910	3	464	1957	3334
	Total	1226	146	539	2574	4485
1989	Norway	146	483	1093	1701	3423
	Denmark	565	76	1323	2009	3973
	Total	711	559	2416	3710	7396
1990	Norway	408	2001	1165	1188	4762
	Denmark	574	616	446	1167	2803
	Total	982	2617	1611	2355	7565
1991	Norway	824	833	1027	869	3553
	Denmark	979	18	517	1524	3038
	Total	1803	851	1544	2393	6591
1992	Norway	901	357	1087	1191	3536
	Denmark	1682	101	1213	1264	4260
	Total	2583	458	2300	2455	7796
1993	Norway	525	1115	1229	547	3416
	Denmark	1210	35	1527	1650	4422
	Total	1735	1150	2756	2197	7838
1994	Norway	502	514	1447	761	3224
	Denmark	1106	27	452	1283	2868
	Total	1608	541	1899	2044	6092
1995	Norway	581	256	165	315	1317
	Denmark	685	78	571	1561	2895
	Total	1266	334	736	1876	4212
1996	Norway	562	173	657	158	1550
	Denmark	1049	118	763	1801	3731
	Total	1611	291	1420	1959	5281
1997	Norway	143	180			
	Denmark	496	92			
	Total	639	272			

Table 12.3.4 Research vessel indices of abundance for Norway Pout.

Year Class	IYFS[1] February			EGFS[2,3] August				SGFS[4] 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	-	-	-	-	-	-	-	-	-
1975	4,599	334	-	-	-	-	-	-	-	-	-
1976	4,813	1,215	-	-	-	-	-	-	-	-	-
1977	1,913	240	-	-	-	-	-	-	-	-	12
1978	2,690	611	-	-	-	-	-	-	-	346	9
1979	4,081	557	-	-	-	-	77	-	1,928	127	22
1980	1,375	403	9	-	-	39	0.4	-	185	44	1
1981	3,315	663	58	-	2,609	114	14	-	991	91	9
1982	2,331	802	71	6,594	1,558	359	0	8	490	69	5
1983	3,925	1,423	23	6,067	3,605	307	80	13	615	173	9
1984	2,109	384	65	457	1,201	150	0.9	2	636	54	1
1985	2,043	469	13	362	717	122	21	5	389	23	4
1986	3,023	760	178	285	552	134	20	38	338	209	14
1987	127	260	46	8	102	621	23	7	38	21	2
1988	2,079	773	129	165	1,274	158	6	14	382	51	6
1989	1,320	677	33	1,530	917	399	157	2	206	42	24
1990	2,497	902	259	2,692	683	1,069	0	58	732	221	20
1991	5,121	2,644	67	1,509	6,193	1,715	7	10	1,715	329	6
1992	2,681	375	77	2,885	3,278	112	14	12	580	106	21
1993	1,868	785	234	5,699	1,305	387	2	2	387	234	8
1994	5,941	2,635	670	7,764	6,174	303	32	136	2,438	321	31
1995	912	1,474	-	7,546	1,262	364	-	36	412	130	-
1996	9,752	-	-	3,274	5,579	-	-	127	2154	-	-
1997	-	-	-	1,103	-	-	-	1	-	-	-

[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]1982-91 EGFS numbers adjusted from Granton trawl to GOV trawl by multiplying by 3.5.
[4]Scottish groundfish surveys, arithmetic mean catch no./h.

Table 12.4.1 Survivors analysis (SXSA) of Norway Pout in the North Sea and Skagerrak.

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The following parameters were used:

Year range:                                     1983 - 1997
Seasons per year:                               4
The last season in the last year is:            2
Youngest age:                                   0
Oldest age:                                     3 (Plus age-group:  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:                            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:                         0
  (0: No; 1: No SOP corr; 2: SOP corr; 3: Sep. F)

6: Weighting of rhats:                           0
  (0: Manual)

7: Weighting of shats:                           2
  (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:                                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
```

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	*	*	154586.	103257.	*	*	82721.	55449.	*	*	58023.	38889.
1	109751.	70124.	45510.	25738.	67028.	42671.	26759.	13606.	35342.	21836.	13936.	08195.
2	13752.	8156.	4456.	1698.	13735.	8081.	4464.	1614.	6262.	3081.	1947.	656.
3	118.	67.	37.	11.	828.	437.	73.	42.	481.	165.	100.	51.
4+	6.	3.	0.	0.	1.	1.	1.	0.	29.	19.	13.	8.
SSN	24851.				21267.				10306.			
SSB	384433.				382268.				183346.			
TSN	123627.	78349.	204590.	130704.	81592.	51191.	114018.	70712.	42113.	25101.	74018.	47799.
TSB	1075867.	1332640.	1949936.	1283467.	804545.	936753.	1196201.	715900.	405998.	441608.	670190.	452333.

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	116029.	77776.	*	*	33701.	22584.	*	*	91540.	60754.
1	25513.	16777.	11033.	6425.	47574.	29689.	19021.	11418.	14953.	9820.	6504.	4210.
2	3045.	1165.	710.	275.	2841.	1575.	1007.	535.	5893.	3377.	2203.	1272.
3	297.	140.	91.	56.	153.	92.	62.	41.	168.	96.	64.	43.
4+	40.	24.	16.	11.	45.	29.	20.	13.	32.	22.	15.	10.
SSN	5933.				7796.				7589.			
SSB	98952.				104428.				148652.			
TSN	28894.	18107.	127880.	84544.	50612.	31387.	53810.	34592.	21046.	13315.	100326.	66290.
TSB	259682.	299632.	775956.	629259.	404141.	505177.	657337.	422998.	242854.	268144.	627380.	517301.

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	103160.	69021.	*	*	99950.	66982.	*	*	170032.	113375.
1	38149.	24151.	15633.	9111.	42292.	26843.	16536.	10289.	44087.	28323.	18465.	11134.
2	2305.	1506.	900.	385.	4682.	2660.	1315.	730.	5930.	2882.	1601.	897.
3	521.	344.	226.	148.	182.	106.	55.	32.	394.	188.	111.	56.
4+	36.	24.	16.	11.	96.	56.	37.	25.	35.	19.	12.	8.
SSN	6676.				9189.				10768.			
SSB	100247.				145245.				179065.			
TSN	41011.	26025.	119936.	78675.	47252.	29665.	117894.	78059.	50446.	31412.	190221.	125469.
TSB	340588.	432008.	855749.	648419.	411685.	501505.	873059.	671073.	456810.	533278.	1217240.	977227.

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	78682.	52022.	*	*	62979.	42137.	*	*	237669.	158785.
1	73144.	46118.	29667.	17056.	34091.	21262.	13586.	8168.	27283.	16672.	10871.	6444.
2	6605.	3538.	2132.	1110.	9154.	5564.	3343.	1494.	4615.	2610.	1516.	672.
3	448.	204.	120.	80.	526.	340.	181.	106.	637.	381.	232.	97.
4+	28.	17.	11.	7.	57.	38.	25.	17.	81.	54.	36.	24.
SSN	14396.				13146.				8061.			
SSB	216030.				249470.				150633.			
TSN	80225.	49877.	110613.	70277.	43827.	27204.	80114.	51922.	32617.	19717.	250323.	166022.
TSB	676834.	823199.	1155307.	755705.	464241.	527255.	746145.	509544.	322519.	360899.	1301534.	1134782.

Year	1995				1996				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	69472.	45995.	*	*	174116.	116120.	*	*
1	102966.	65752.	42515.	26415.	29446.	19301.	12479.	7511.	75777.	49946.
2	3380.	2069.	1177.	751.	14965.	9399.	6136.	3293.	4502.	2705.
3	341.	224.	124.	81.	455.	293.	166.	81.	1935.	1242.
4+	81.	55.	37.	25.	68.	46.	31.	20.	68.	46.
SSN	14099.				18433.				14082.	
SSB	164618.				371854.				233276.	
TSN	106768.	68100.	113325.	73266.	44934.	29039.	192927.	127025.	82281.	53939.
TSB	813306.	1070881.	1398822.	919737.	557365.	626315.	1282223.	1012482.	710670.	905822

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.	28287.	39713.	26156.	45242.	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				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	700.	1692.	*	*	724.	2517.	*	*
1	3992.	1905.	2545.	3348.	535.	560.	1043.	650.	1036.	444.
2	240.	256.	47.	59.	772.	201.	1002.	333.	382.	140.
3	6.	32.	3.	3.	14.	38.	37.	0.	67.	105.
4+	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SOP	36942.	28019.	69763.	97048.	21956.	13062.	77291.	49253.	18074.	11911.

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	0.050	*	*	0.000	0.021
1	0.048	0.032	0.167	0.223	0.051	0.066	0.269	0.363	0.081	0.049	0.129	0.554
2	0.121	0.200	0.532	0.309	0.128	0.190	0.577	0.736	0.300	0.059	0.636	0.378
3	0.164	0.188	0.746	1.326	0.232	1.125	0.142	0.000	0.619	0.102	0.263	0.000
4+	0.000	1.807	*	*	0.000	0.000	0.000	0.000	0.031	0.000	0.000	0.000
F (1- 2)	0.084	0.116	0.349	0.266	0.090	0.128	0.423	0.549	0.190	0.054	0.383	0.466

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.000	0.090	*	*	0.000	0.012	*	*	0.010	0.065
1	0.019	0.019	0.139	0.399	0.071	0.045	0.109	0.255	0.020	0.012	0.035	0.199
2	0.528	0.094	0.517	0.186	0.186	0.047	0.227	0.694	0.154	0.027	0.147	0.468
3	0.341	0.025	0.083	0.000	0.100	0.000	0.006	0.157	0.155	0.000	0.000	0.000
4+	0.095	0.000	0.000	0.000	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.274	0.057	0.328	0.293	0.128	0.046	0.168	0.475	0.087	0.019	0.091	0.333

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.002	0.089	*	*	0.000	0.018	*	*	0.005	0.038
1	0.057	0.035	0.138	0.259	0.054	0.084	0.074	0.149	0.042	0.028	0.105	0.120
2	0.026	0.113	0.429	0.337	0.162	0.296	0.185	0.211	0.312	0.184	0.176	0.285
3	0.014	0.021	0.025	0.112	0.142	0.242	0.140	0.162	0.329	0.130	0.276	0.473
4+	0.000	0.000	0.000	0.000	0.135	0.000	0.000	0.000	0.229	0.000	0.000	0.000
F (1- 2)	0.041	0.074	0.283	0.298	0.108	0.190	0.129	0.180	0.177	0.106	0.140	0.203

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.014	0.022	*	*	0.002	0.034	*	*	0.003	0.033
1	0.061	0.041	0.151	0.218	0.071	0.047	0.107	0.168	0.091	0.027	0.121	0.240
2	0.219	0.105	0.246	0.336	0.097	0.108	0.390	0.432	0.167	0.141	0.397	0.272
3	0.372	0.126	0.010	0.031	0.034	0.228	0.135	0.023	0.112	0.096	0.447	0.000
4+	0.136	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)	0.140	0.073	0.199	0.277	0.084	0.078	0.249	0.300	0.129	0.084	0.259	0.256

Year	1995				1996				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	0.012	0.046	*	*	0.005	0.027	*	*
1	0.048	0.036	0.075	0.165	0.022	0.036	0.106	0.110	0.017	0.011
2	0.090	0.161	0.049	0.100	0.064	0.026	0.218	0.130	0.108	0.065
3	0.020	0.187	0.030	0.046	0.038	0.169	0.304	0.004	0.043	0.108
4+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F (1- 2)	0.069	0.099	0.062	0.133	0.043	0.031	0.162	0.120	0.062	0.038

Table 12.4.1 (cont'd)

Log inverse catchabilities, fleet no: 1
Commercial fishery

Season	1	2	3	4
AGE				
0	*	*	15.574	11.562
1	10.586	10.315	9.981	9.498
2	9.372	8.897	9.017	9.186
3	9.372	8.897	9.017	9.186

Log inverse catchabilities, fleet no: 2
IYFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	2.789	*	*	*
2	1.696	*	*	*
3	1.696	*	*	*

Log inverse catchabilities, fleet no: 3
EGFS

Season	1	2	3	4
AGE				
0	*	*	4.078	*
1	*	*	2.344	*
2	*	*	1.557	*
3	*	*	*	*

Log inverse catchabilities, fleet no: 4
SGFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	3.384	*
2	*	*	2.642	*
3	*	*	2.642	*

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	*	*	1.220	-0.278	*	*	-4.130	0.083	*	*	-1.147	-0.498
1	-0.384	-0.592	-0.509	-0.396	-0.182	0.294	0.085	0.001	0.211	0.809	0.177	0.692
2	-0.665	-0.177	-0.315	-0.381	-0.473	-0.067	-0.116	0.397	0.313	-0.424	0.809	-0.002
3	-0.356	-0.240	0.023	1.076	0.119	1.712	-1.515	*	1.037	0.128	-0.075	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	0.421	*	*	0.088	-0.607	*	*	1.221	0.897
1	-1.580	-0.528	0.294	-0.194	0.544	0.891	0.405	0.384	-0.443	0.779	0.329	0.019
2	0.531	-0.345	0.646	-1.288	0.297	-0.474	0.167	1.067	0.378	0.297	0.809	0.566
3	0.093	-1.656	-1.187	*	-0.318	*	*	-0.404	0.362	*	*	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	-1.653	0.893	*	*	-0.388	0.030	*	*	0.716	0.222
1	1.134	0.669	-0.214	0.038	0.572	-0.024	-0.050	-0.223	-0.085	-0.435	-0.025	-0.414
2	-0.863	0.503	0.081	-0.150	0.748	-0.252	0.059	-0.159	0.715	0.444	-1.234	0.147
3	-1.304	-1.171	*	-1.242	1.121	0.086	0.341	0.074	0.767	0.115	-2.339	0.614

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	*	*	0.271	-0.781	*	*	-0.829	0.186	*	*	1.160	0.461
1	-0.141	0.563	0.064	0.110	0.387	0.138	-0.262	-0.074	0.730	0.225	0.414	0.494
2	-0.023	0.274	-0.176	0.235	-0.523	-0.381	0.134	0.570	0.154	0.443	0.593	0.308
3	0.520	0.683	-3.405	-1.931	-1.629	0.361	-0.909	-2.487	-0.237	0.059	0.750	*

Year	1995				1996				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	1.940	-0.843	*	*	1.531	-0.185	*	*
1	0.314	0.003	-0.372	-0.151	-0.931	-1.335	-0.336	-0.287	-0.147	-1.455
2	-0.277	0.622	-1.639	-0.876	-0.754	-0.822	0.181	-0.435	0.443	0.360
3	-1.772	0.769	-1.965	-1.651	-1.290	1.444	0.569	-3.799	-0.263	1.057

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	-0.849	*	*	*	0.167	*	*	*	0.199	*	*	*
2	-1.089	*	*	*	-0.895	*	*	*	0.535	*	*	*
3	-0.610	*	*	*	-0.669	*	*	*	0.224	*	*	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	0.466	*	*	*	0.258	*	*	*	-1.777	*	*	*
2	0.034	*	*	*	0.169	*	*	*	-0.091	*	*	*
3	-0.525	*	*	*	1.080	*	*	*	-0.602	*	*	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	0.098	*	*	*	-0.461	*	*	*	0.130	*	*	*
2	-0.281	*	*	*	0.159	*	*	*	-0.149	*	*	*
3	0.821	*	*	*	0.575	*	*	*	0.911	*	*	*

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	0.350	*	*	*	0.471	*	*	*	0.341	*	*	*
2	-0.007	*	*	*	0.690	*	*	*	-0.548	*	*	*
3	-0.564	*	*	*	1.197	*	*	*	-0.313	*	*	*

Year	1995				1996				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	*	*	*	*	*	*	*	*
1	0.151	*	*	*	-0.483	*	*	*	0.939	*
2	0.469	*	*	*	0.181	*	*	*	0.821	*
3	0.411	*	*	*	1.242	*	*	*	0.848	*

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	*	*	1.035	*	*	*	-0.927	*	*	*	-0.806	*
1	*	*	-0.764	*	*	*	0.648	*	*	*	0.143	*
2	*	*	-1.699	*	*	*	-0.537	*	*	*	0.157	*
3	*	*	*	*	*	*	0.158	*	*	*	*	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	-1.738	*	*	*	-1.837	*	*	*	-2.043	*
1	*	*	-0.135	*	*	*	-0.954	*	*	*	-1.602	*
2	*	*	0.406	*	*	*	-0.262	*	*	*	-0.985	*
3	*	*	1.655	*	*	*	2.081	*	*	*	0.629	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.062	*	*	*	0.657	*	*	*	-0.451	*
1	*	*	0.091	*	*	*	-0.322	*	*	*	-0.713	*
2	*	*	1.557	*	*	*	-0.288	*	*	*	0.438	*
3	*	*	-0.663	*	*	*	0.934	*	*	*	-1.045	*

Year	1992				1993				1994			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	0.971	*	*	*	1.869	*	*	*	0.851	*
1	*	*	1.037	*	*	*	1.163	*	*	*	0.471	*
2	*	*	1.166	*	*	*	1.246	*	*	*	-0.698	*
3	*	*	2.020	*	*	*	*	*	*	*	-1.565	*

Year	1995				1996				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	2.057	*	*	*	0.300	*	*	*
1	*	*	0.642	*	*	*	0.293	*	*	*
2	*	*	0.661	*	*	*	-1.163	*	*	*
3	*	*	-0.417	*	*	*	-2.537	*	*	*

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	*	*	-0.881	*	*	*	-0.080	*	*	*	0.547	*
2	*	*	-0.840	*	*	*	-1.102	*	*	*	0.668	*
3	*	*	-0.483	*	*	*	0.683	*	*	*	-0.048	*

Year	1986				1987				1988			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	0.293	*	*	*	-0.404	*	*	*	-1.549	*
2	*	*	0.469	*	*	*	-0.846	*	*	*	0.544	*
3	*	*	0.554	*	*	*	-1.289	*	*	*	0.055	*

Year	1989				1990				1991			
Season	1	2	3	4	1	2	3	4	1	2	3	4
AGE												
0	*	*	*	*	*	*	*	*	*	*	*	*
1	*	*	-0.074	*	*	*	-0.775	*	*	*	0.396	*
2	*	*	-0.745	*	*	*	-0.334	*	*	*	-0.729	*
3	*	*	0.065	*	*	*	-0.424	*	*	*	0.039	*

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	*	*	0.793	*	*	*	0.471	*	*	*	0.296	*
2	*	*	0.674	*	*	*	0.679	*	*	*	0.340	*
3	*	*	1.227	*	*	*	0.694	*	*	*	-0.634	*

Year	1995				1996				1997	
Season	1	2	3	4	1	2	3	4	1	2
AGE										
0	*	*	*	*	*	*	*	*	*	*
1	*	*	0.752	*	*	*	0.214	*	*	*
2	*	*	1.242	*	*	*	-0.021	*	*	*
3	*	*	1.073	*	*	*	-0.066	*	*	*

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

Season	1	2	3	4
AGE				
0	*	*	0.581	1.713
1	1.418	1.306	3.178	2.933
2	1.761	2.177	1.365	1.570
3	1.011	0.983	0.589	0.487

Weighting factors for computing survivors:
Fleet no: 2
IYFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	1.471	*	*	*
2	1.780	*	*	*
3	1.222	*	*	*

Weighting factors for computing survivors:
Fleet no: 3
EGFS

Season	1	2	3	4
AGE				
0	*	*	0.722	*
1	*	*	1.210	*
2	*	*	0.994	*
3	*	*	*	*

Weighting factors for computing survivors:
Fleet no: 4
SGFS

Season	1	2	3	4
AGE				
0	*	*	*	*
1	*	*	1.417	*
2	*	*	1.283	*
3	*	*	1.377	*

Table 12.4.2 Relative error in performing seasonal and annual VPA.

Relative bias		1988	1989	1990	1991	1992	1993	1994	1995	1996
Age	0	-48%	-51%	-50%	-48%	-41%	-49%	-49%	-46%	-47%
	1	-38%	-29%	-15%	-21%	-25%	-17%	-21%	-22%	-26%
	2	-25%	-37%	-3%	6%	-10%	-31%	-16%	3%	-20%
	3	69%	-31%	0%	-7%	54%	-2%	-8%	0%	-11%
	4			69%	71%	69%	65%			

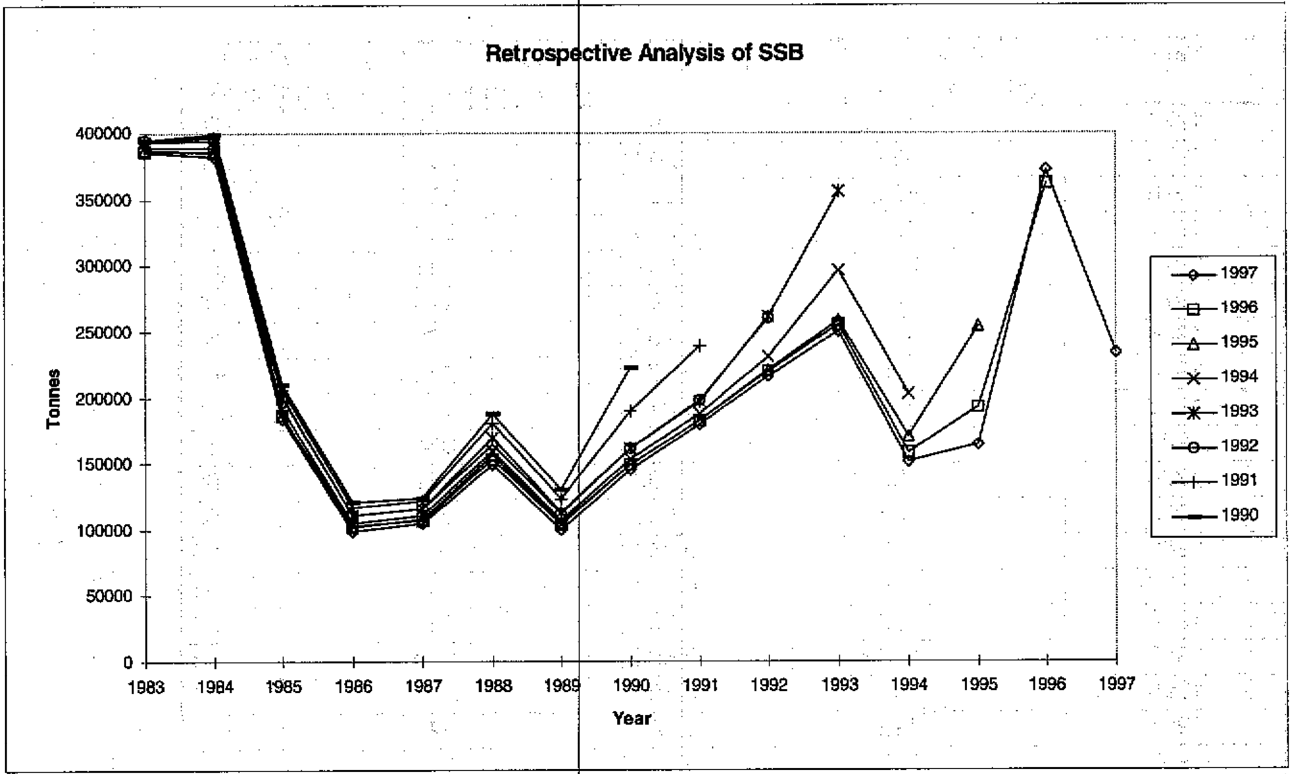
Table 12.6.1 Trends in Yield, Average fishing mortality for 1- and 2-group, SSB (beginning of year) and Recruitment (beginning of Q3) for Norway Pout in North Sea and Skagerrak[1].

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	0.815	384	155
1984	393.0	1.190	382	83
1985	205.1	1.093	183	58
1986	178.4	0.952	99	116
1987	149.3	0.817	104	34
1988	109.5	0.530	149	92
1989	172.5	0.696	100	103
1990	151.6	0.607	145	100
1991	192.9	0.626	179	170
1992	299.8	0.689	216	79
1993	184.2	0.711	249	63
1994	182.3	0.728	151	238
1995	241.0	0.363	165	69
1996	166.2	0.356	372	174
1997			233	

[1] The estimates before 1983 are based on previous assessment runs which do not include data from Skagerrak.

Figure 12.4.1 Retrospective analyses of SSB and Recruitment.

SXSA - Norway pout in the North Sea and Skagerrak



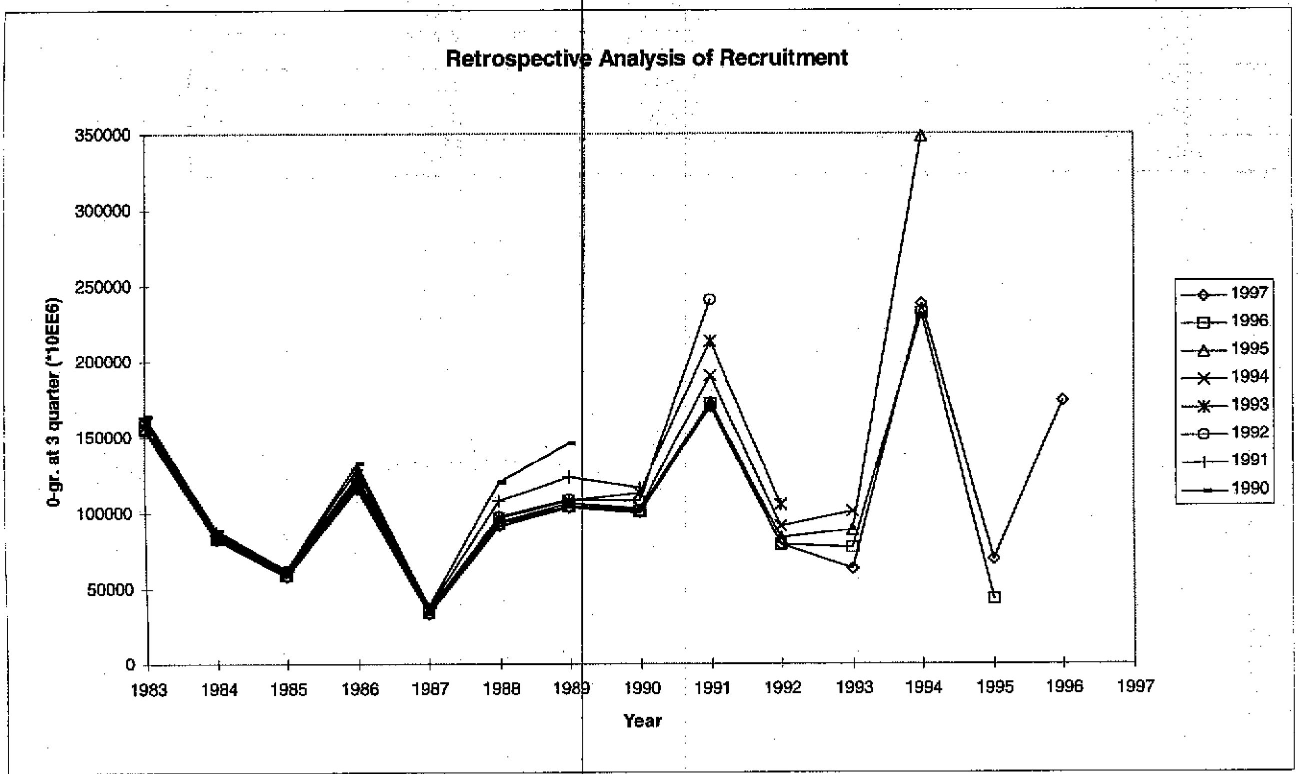


Figure 12.4.2 Log residual stock numbers per age group divided by fleet and season.

SXSA - Norway pout in the North Sea and Skagerrak

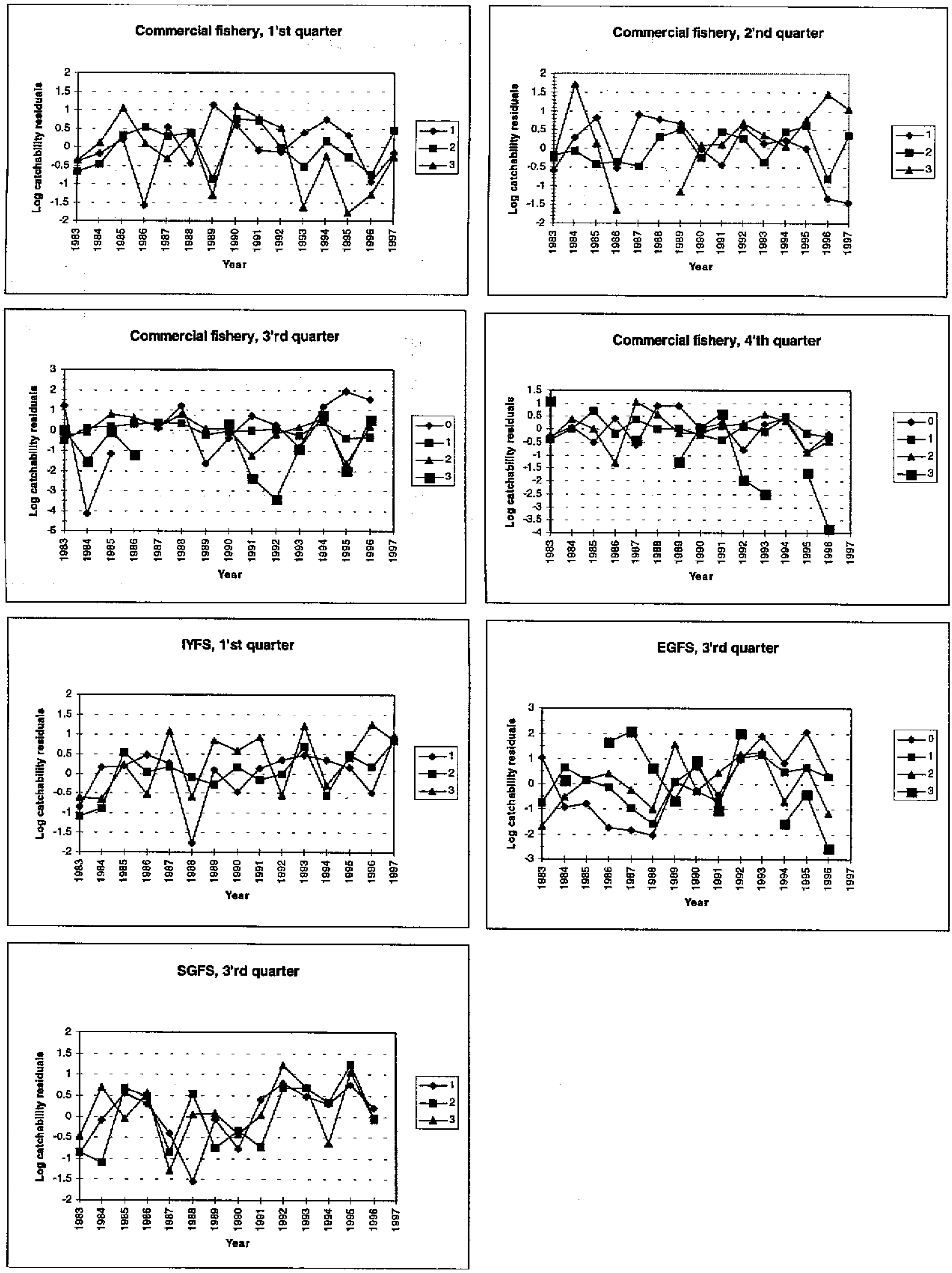


Figure 12.4.3 Weighting factors for computing survivors.

SXSA - Commercial fishery (CF), IYFS, EGFS and SGFS

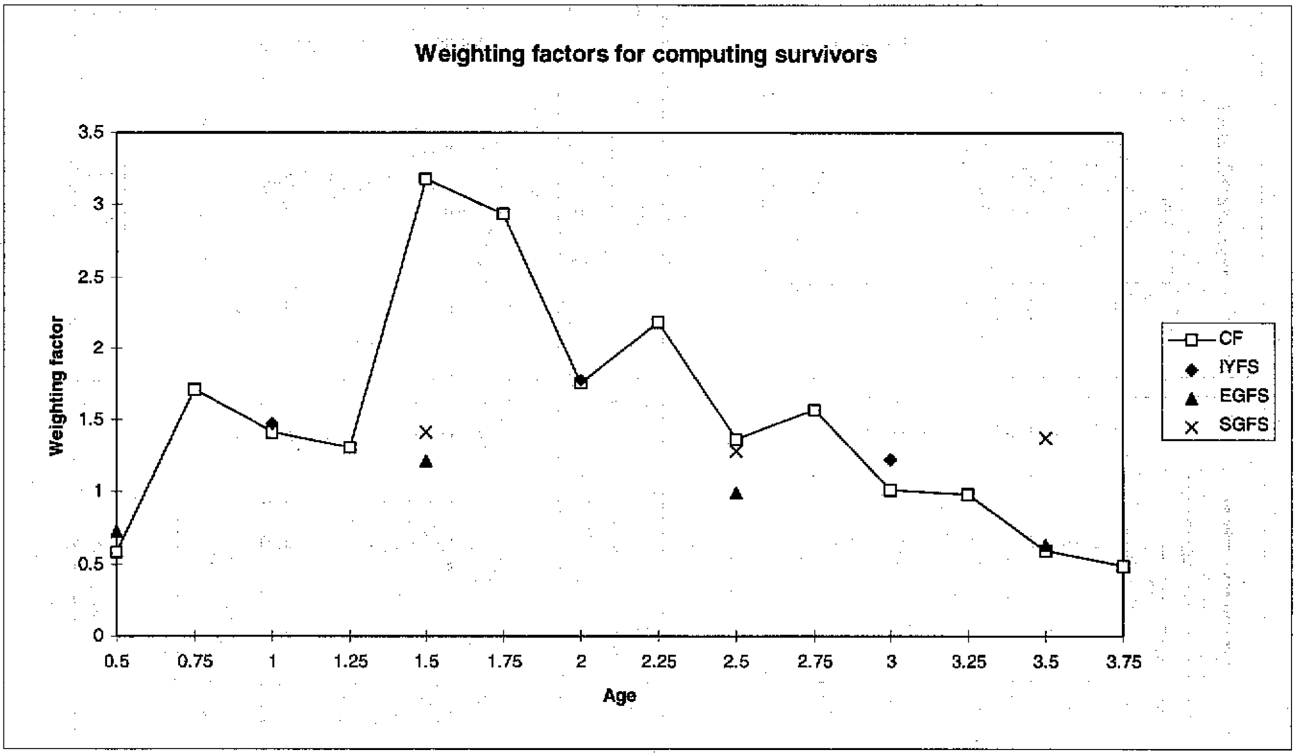
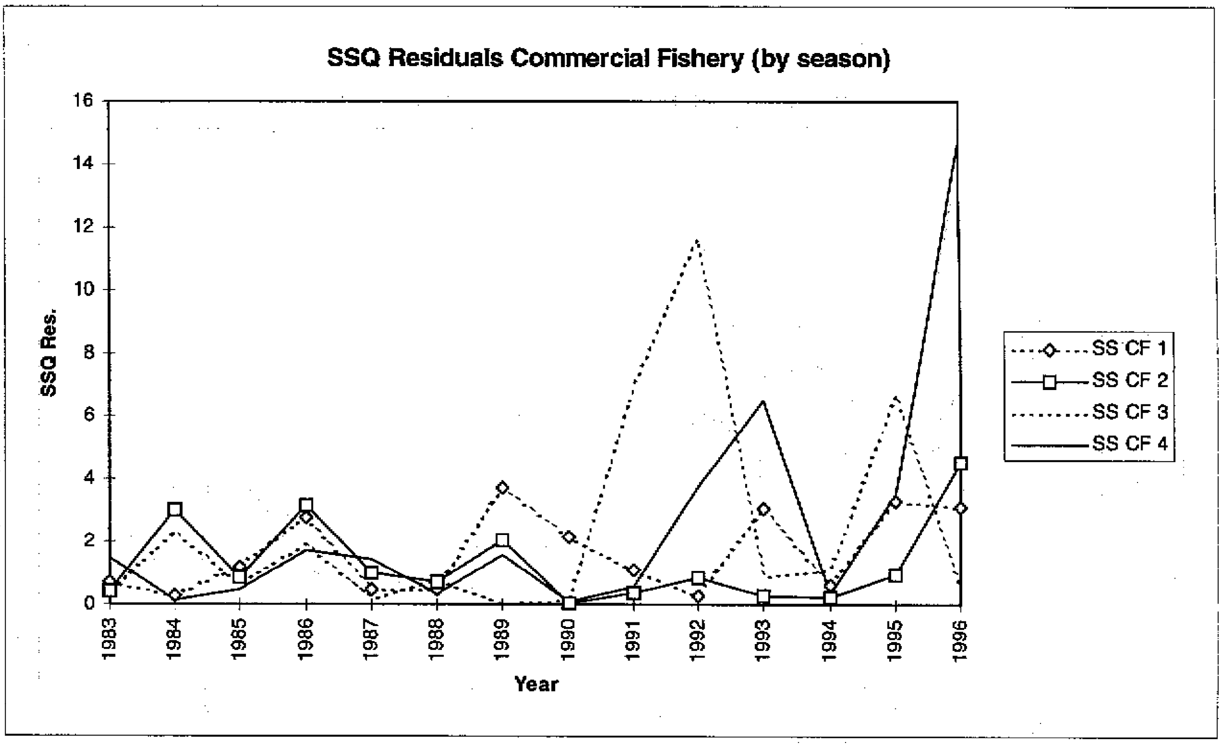


Figure 12.4.4 SSQ Residuals for commercial fishery (by season) and for the survey series.

SXSA - Commercial fishery (CF), IYFS, EGFS and SGFS



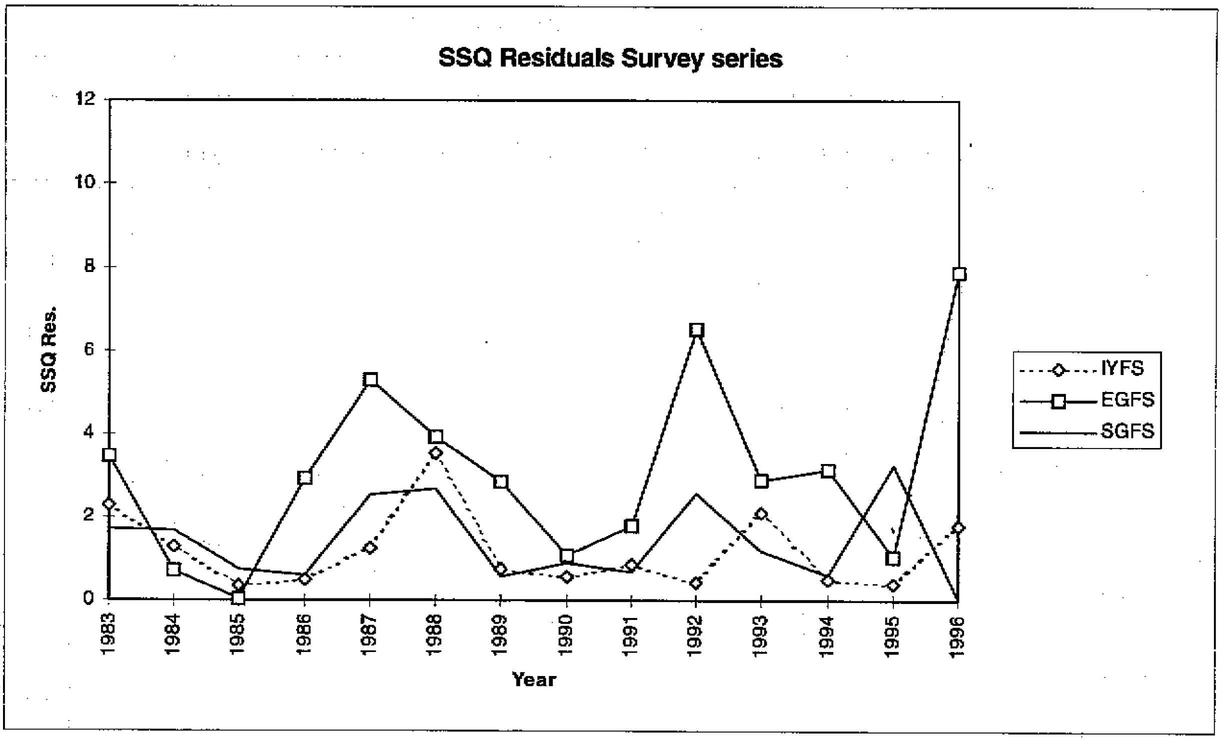
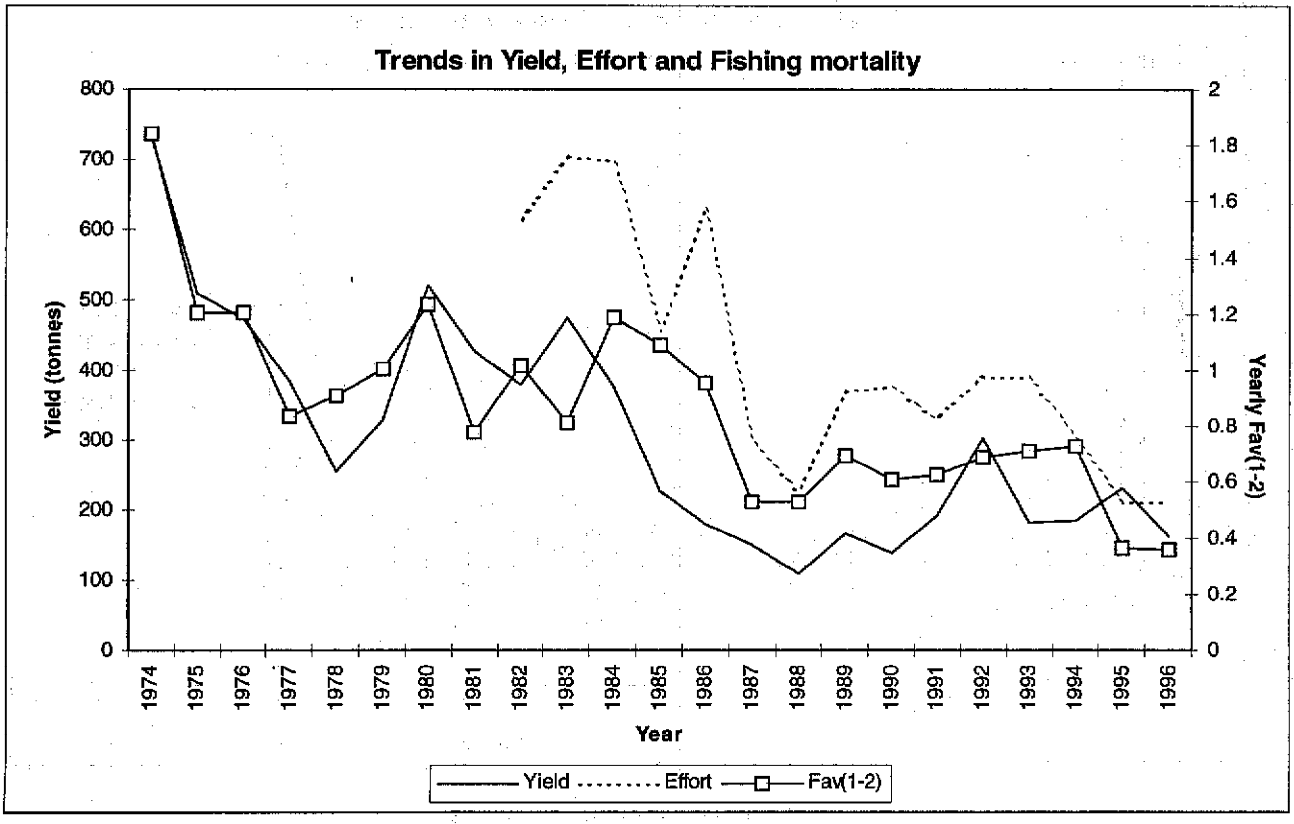
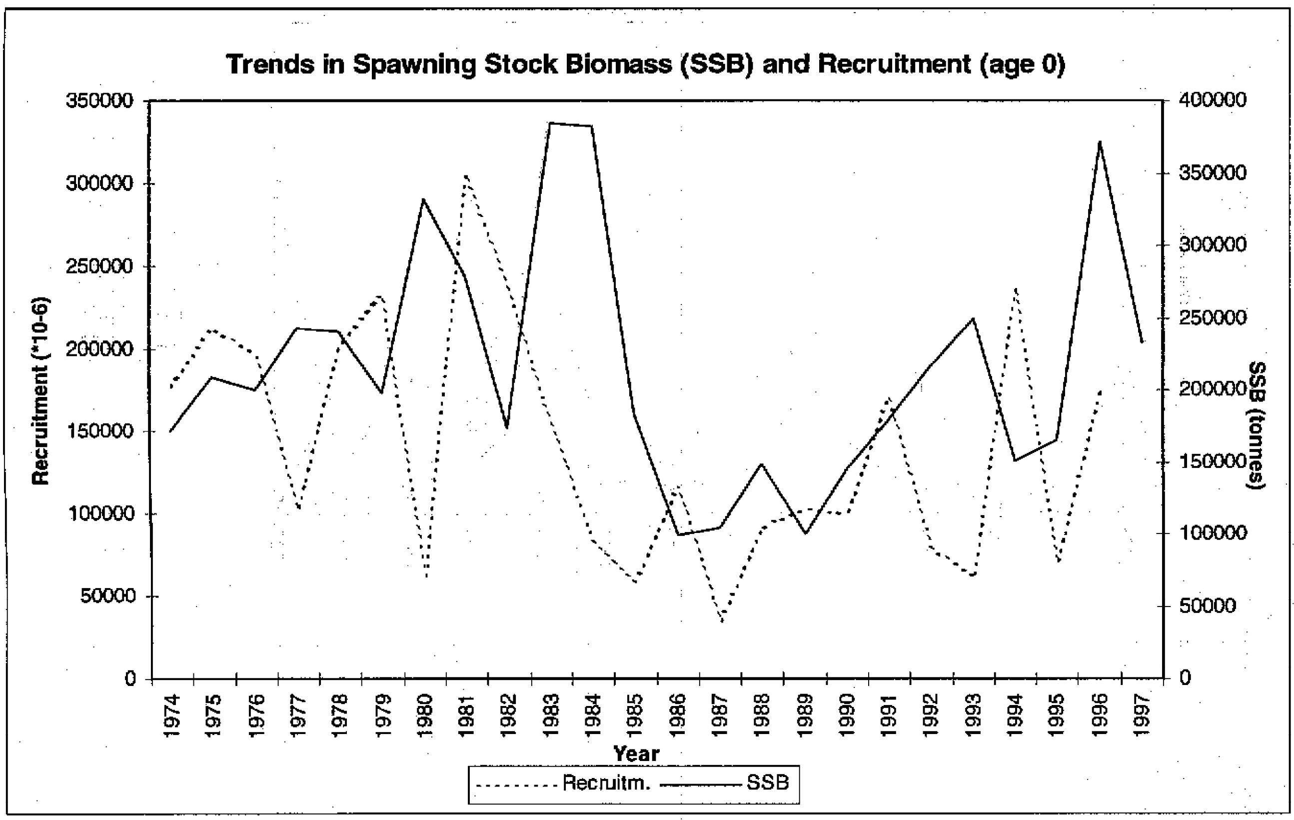


Figure 12.6.1 Historical trends in Yield, Effort, Average fishing mortality for 1- and 2-group, SSB and Recruitment.

SXSA - Norway pout in the North Sea and Skagerrak[1]





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

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

SXSA - Norway pout in the North Sea and Skagerrak

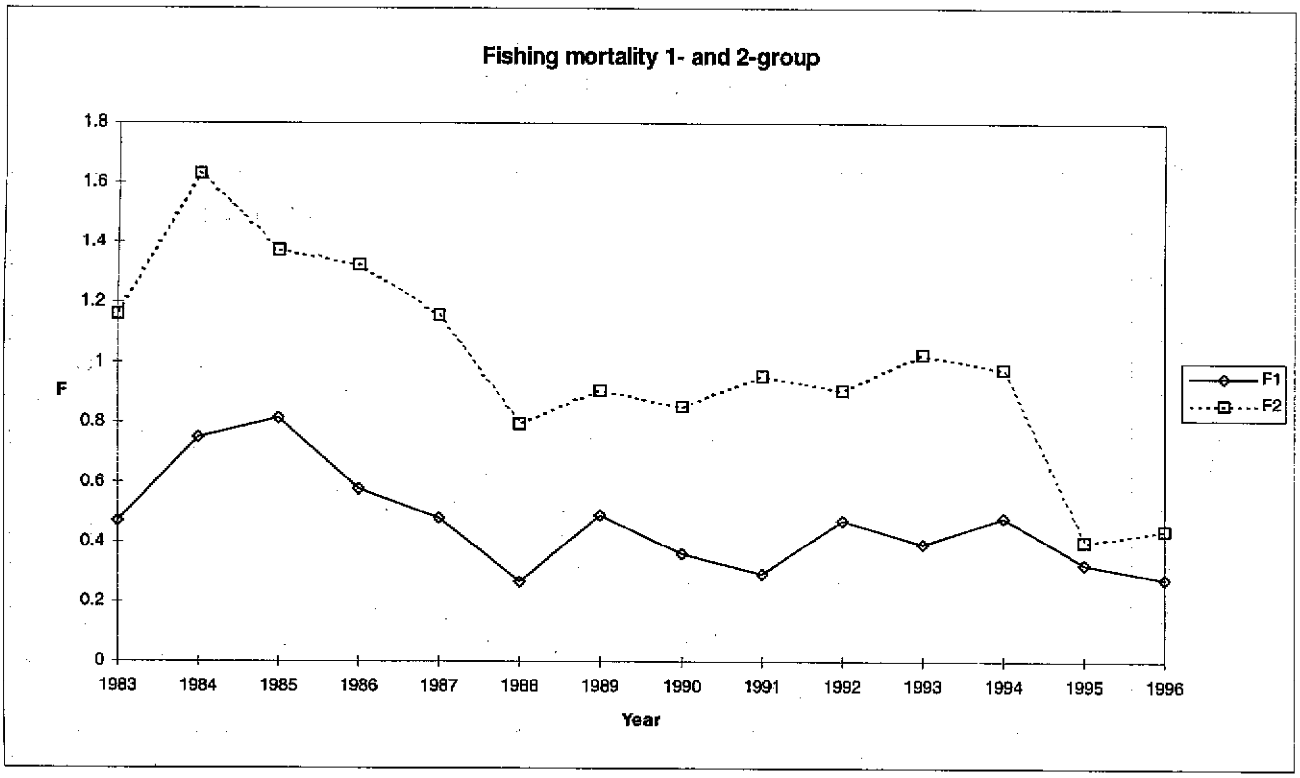
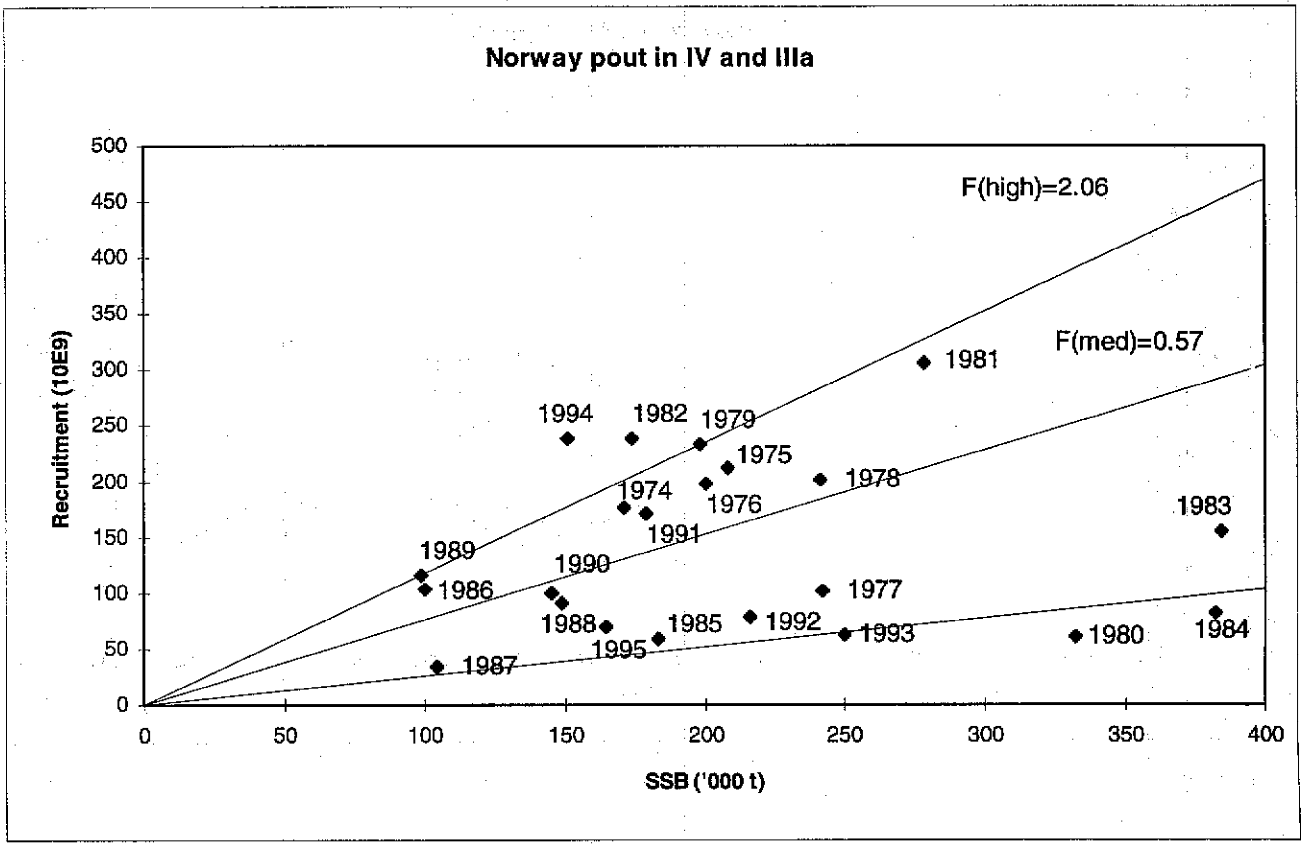


Figure 12.8.1 Recruitment/SSB plot used to calculate F_{med} and F_{high}.

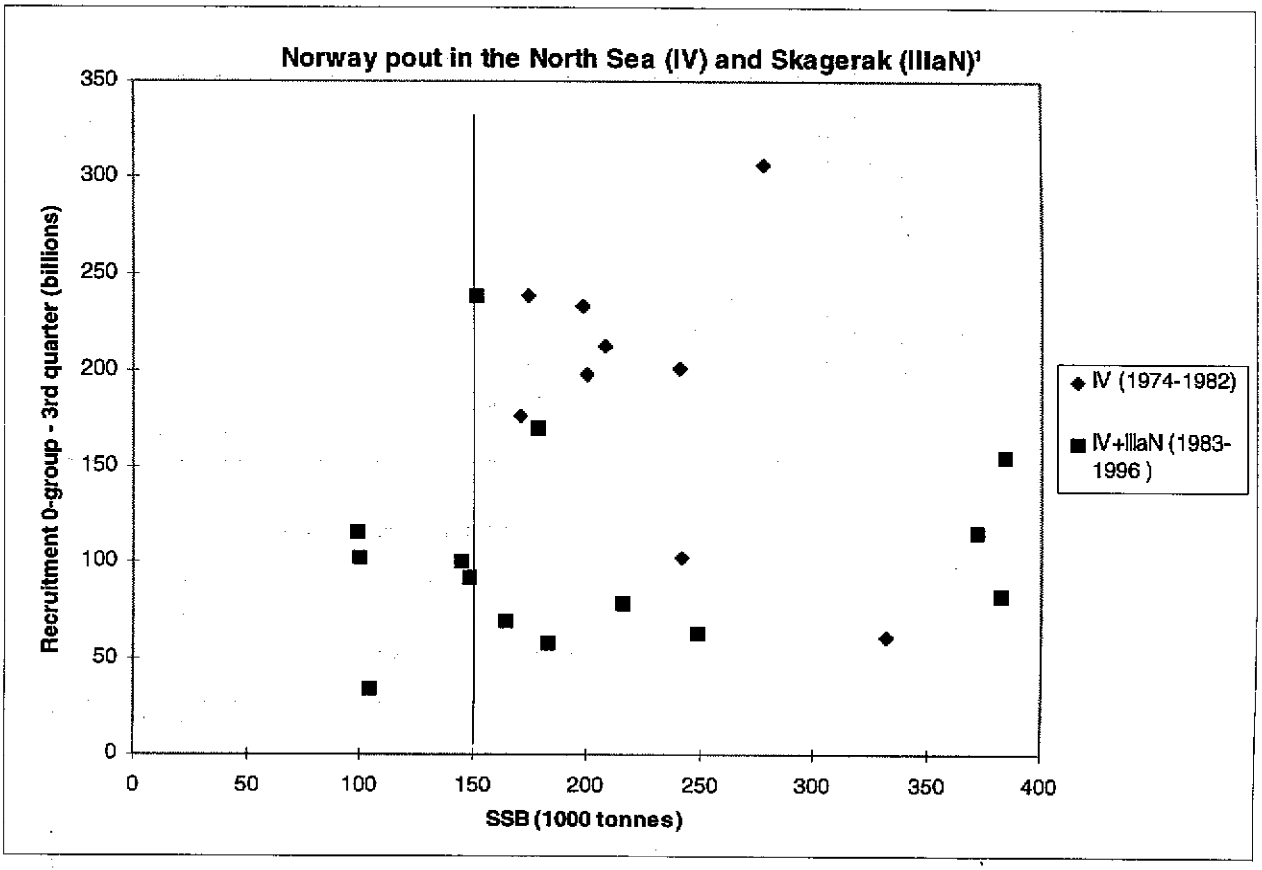
SXSA - Norway pout in the North Sea and Skagerrak



(SSB and recruitment numbers from 1974 to 1995)

Figure 12.8.2 Recruitment versus SSB.

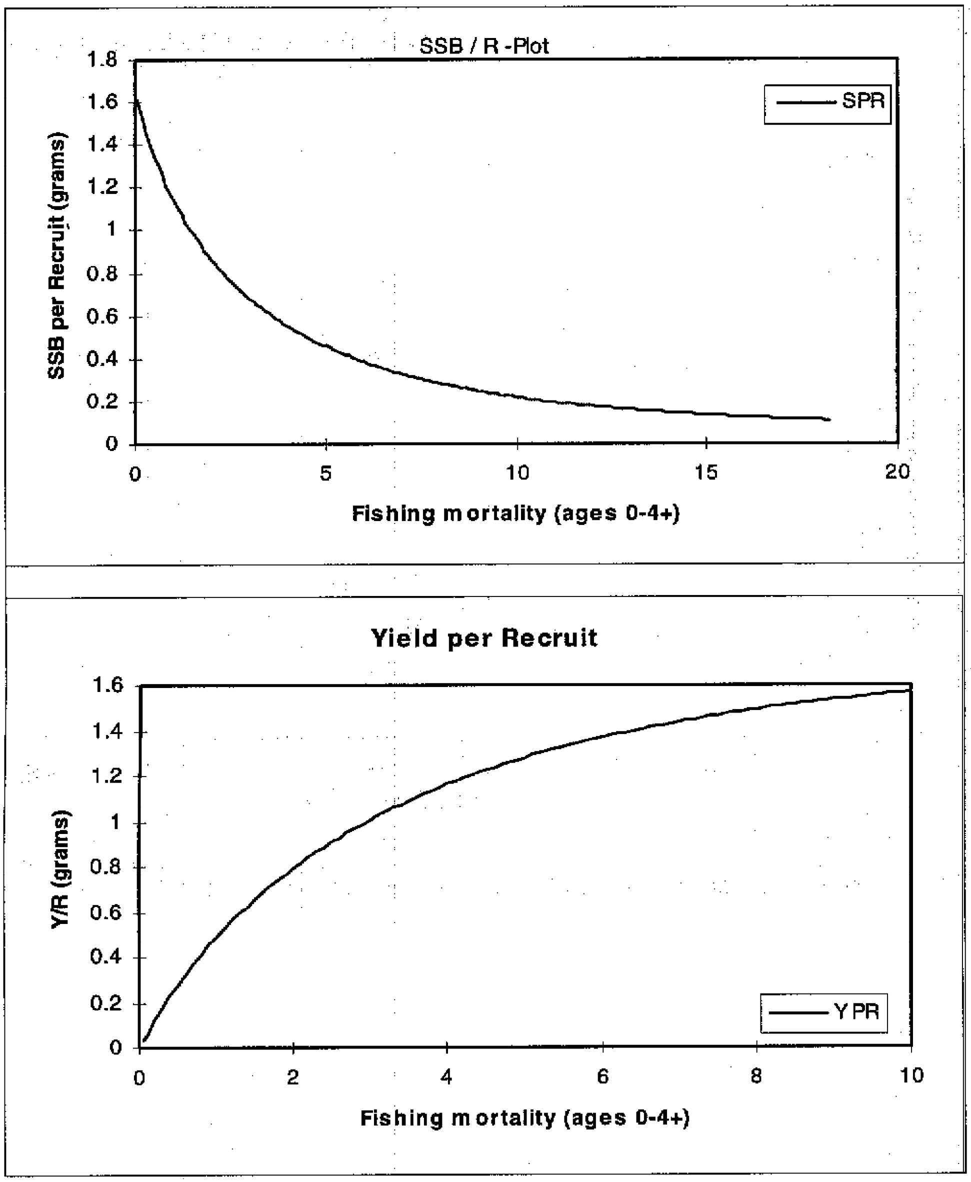
SXSA - Norway pout in the North Sea and Skagerrak



[1] Results and data previous to 1983 do not include Skagerrak (IIIaN)

Figure 12.8.3 SSB / R - plot and Y / R - plot.

SXSA - Norway pout in the North Sea and Skagerrak



(SSB, Yield and Recruitment numbers from 1974 to 1995)

13 SANDEEL

13.1 Sandeel in Sub-area IV and Division IIIa

13.1.1 Catch trends

The overall landings of sandeel decreased from 917,000 t in 1995 to 775,000 t in 1996, of which 78% was landed by the Danish fishery, Table 13.1.1.1. Figure 13.1.1.1 shows the areas for which catches are tabulated in Tables 13.1.1.3 and 13.1.1.4.

The distribution of the fishery by area was similar in 1995 and 1996. Landings decreased in both areas in 1996 by about 15%. In the northern North Sea catches made in the new fishery on the Viking Bank decreased from 147,000 tonnes in 1995 to 31,000 tonnes in 1996. In spite of the general decrease in 1996 the fishery on the traditionally important grounds along the Norwegian deep (area 3) more than doubled In the southern North Sea 1996 landings decreased in all areas compared to 1995. Figure 13.1.1.2, based on fishermen's logbooks, shows the distribution of catches by quarter and ICES statistical rectangle for 1996 and the first half of 1997.

In the first half year of 1997 the combined Danish and Norwegian landings of 838,000 tonnes are - apart from 1989 - the highest on record since 1976, Table 13.1.3.6 and 13.1.3.4.

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

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

Values of natural mortality and maturity at age assumed in the assessment were the same as used at previous meetings and are given together with weight at age in the stock in Table 13.1.2.1. Natural mortality is an average over years of multispecies Ms. 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.

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. Catch in numbers and weight at age are given in Tables 13.1.2.2 and 13.1.2.3.

Catch numbers and weight at age for the southern North Sea were based on Danish age composition data, Tables 13.1.2.4 and 13.1.2.5. Weights at age are average values prior to 1987 in the southern North Sea and 1989 for the northern North Sea. For both areas catch at age 0 in 1996 and at age 1 in 1997 indicates a strong 1996 year class.

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. Total international standardised effort was estimated as described in last year's report. Input data for these calculations are given in the Tables 13.1.3.1–13.1.3.6 and total international effort is given in Tables 13.1.3.4 and 13.1.3.6.

The estimation procedure of the Norwegian fleet effort was changed for 1993 and onwards. The number of fishing days is now estimated as the number of trips of the fleet, which is known, multiplied by an estimate of the average number of days per trip. The latter is obtained from a sample of the fleet. This change in estimation procedure resulted in substantial changes of the Norwegian fleet effort for 1994 and 1995, which increased by about 40 and 70 percent respectively, Table 13.1.3.6.

13.1.3.2 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 year's assessment, half-yearly fixed weighting factors were applied to the catchabilities in order to down weight 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. The Lowestoft version of the seasonal SXA described in Section 1.4.5. used the inverse variance of the expected survivors to estimate the weighting factors, the weights and the population estimates were in accordance with the those estimated by the Skagen version.

In last year's report missing catch at age data for 1990 were estimated assuming a constant catchability over the period 1983–1996 under the constraint that the estimated SOP in 1990 should equal the observed landings. These catch estimates have been used in this year's assessment.

In the SXSA catchability was assumed to remain constant over the time period considered (1983–1997). The options used (Table 13.1.4.1) were the same as in last year's report apart from that the plus group was changed from age 5 to 4. The reason for that was that the estimated F at age 5+ for the second half of 1996 and the first half of 1997 were unrealistically high. As this may be due to sampling errors or problems with the age determination the plus group was reduced to 4+. 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 =0.77) 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 1996 is estimated to be the highest on record. 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 1996.

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 0.57.

Recruitment has been fluctuating with a pattern of alternating strong and weak year classes. The 1996 year class is estimated to be the largest in the time series. There is no doubt that the year class is strong as the catches in the northern North Sea of the 0-group in the second half of 1996 and 1-group in the first half of 1997 are the highest on record and because the catches of the same year class in the southern North Sea also are very high. However, the estimate should be treated with caution due to the generally high log stock number residuals of the SXSA in the northern North Sea 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 a little above the long-term average.

13.1.6 Stock projections

Stock projections were made using the Lowestoft seasonal XSA, contained in FishLab, to provide estimates of uncertainty using the bootstrap and Monte Carlo simulation. A working paper (Kell *et al.*, 1997: A Bootstrapped Seasonal Extended Survivors Analysis for North Sea Sandeels) was presented to the Group.

The assessments based on input data from last year's Working Group report are compared to the Skagen version of SXSA and the results are given in Figure 13.1.6.1. The assessments using the Lowestoft and Skagen seasonal XSAs are in good agreement. For all years except for 1985 and 1996 estimated recruits, spawning stock biomass and average F were not significant different at a 10 percent level. The Lowestoft version estimates Fbar in 1985 and recruits in 1996 to be higher and lower respectively relative to the Skagen version. Differences are also apparent between the values generated under the Skagen-version of SXSA and the Lowestoft-version of SXSA for the initial years in the times series and are due to differences in the estimation of terminal N's for cohorts without tuning data.

Empirical probability distributions of quantities of interest, numbers at age, fishing mortality and various reference points, were obtained by bootstrapping the catch at age data. Future stock size was estimated by projecting forward the terminal population estimates obtained. The advantage of this approach compared to the deterministic XSA is that CV of estimated N and F is not underestimated (Anon. 1996) and because the correlation between F and N is included. Recruitment was modelled as a time series including autoregression. Uncertainty in growth, selectivity and natural mortality was included by the use of a non-parameteric Monte Carlo simulation where observed weights, partial Fs and natural mortality were randomly resampled from the observed historical values. This procedure was thought to better reflect the uncertainty in the sandeel stock.

The projection investigated the probability of SSB remaining above the 95th percentile of the minimum SSB over a ten year period for different levels of F by applying multipliers of .5, .75, 1, 1.25 and 1.50.

The projections are presented in Figure 13.1.6.2, SSB increases sharply due to the presence of a strong year class in 1996 after which the population declines. In the case of *Status Quo* F the projected SSB remains above the 95th percentile of the minimum SSB with a probability of 0.95 until 2004. With multipliers of 1.25 and 1.50 it remains above this level until 2001 and 1999 respectively, while multipliers of 0.5 and 0.75 ensure that SSB has a less than 5% chance of falling below it.

13.1.7 Comments on the assessment

Basic problems in the assessment are still - as mentioned in last year's report - the lack of information on the abundance of sandeel outside the fishing grounds within the North Sea, resulting in the catch at age data not necessarily reflecting the true age composition. This is likely to be of particular importance in sandeel stocks as adult fish sub stocks are stationary. This may result in VPA underestimating biomass and overestimating fishing mortality for the entire stock. Although the adult stock may be composed of local sub stocks recruitment is probably a global phenomenon related to the entire North Sea.

Another problem is that the dynamics of the sandeel stock is that natural mortality is about twice fishing mortality and is highly variable. Estimates of population size and reference points are very different if annual rather than average Ms from the Multispecies Working Group are used.

Quality control diagrams are shown in Table 13.1.7.1.

13.1.8 Response to comments by ACFM

The working paper (Kell *et al.*, 1997) mentioned above also addressed comments made concerning last year's assessment by ACFM.

The comments addressed are: 1. Differences between seasonal and annual assessments. 2. The effect of combining tuning fleets by area. 3. The necessity of re-estimating the missing 1990 catch at age data each year.

1. Comparison of annual and seasonal assessments

The reasons for performing a seasonal XSA for sandeel is that there are seasonal differences in fishing and natural mortality. If the ratio between F and M varies between seasons then seasonal and annual VPAs will produce different results. The relative error in performing a seasonal and an annual VPA is shown in the below Table. The difference between the two methods is small.

Relative error of estimated F at age in performing a seasonal and annual VPA

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	-3%	-1%	-4%	6%	8%	2%	5%	-1%	-5%
2	11%	5%	5%	9%	10%	8%	3%	5%	-2%
3	3%	12%	1%	10%	10%	8%	7%	9%	2%
4	-10%	-	2%	9%	10%	8%	10%	10%	6%

There is a further consideration when using estimates from seasonal and annual VPA in the calculation of reference points. Results show that that there is little difference between the spawner per recruit curves but a big difference in between the yield per recruit curves. In the yield per recruit case it is not the method of estimation but the use of annual or seasonal projections that is important. Seasonal vectors could be derived from seasonal catches without performing a seasonal XSA. However, in the case of sandeel reference points such as F_{Max} or F_{MSY} obtained from the yield per recruit that attempt to optimise yield are not relevant as the major concern is stock conserve sandeel as a food source for predator species.

A comparison of the effect of performing a seasonal as opposed to an annual assessment was also investigated using the bootstrapped XSA. The effect can best be compared by looking at statistics of interest and a variety of reference points are plotted in Figure 13.1.8.1. It can be seen that the expected values are similar, however, the variances of the annual estimates of variance are less than the seasonal ones.

Summarising, the analyses indicate that seasonal and annual assessments give similar results.

2. Combination of tuning fleets by area.

If the northern and southern tuning fleets are combined the assessment becomes unstable in the earlier period. Reference points based on average F vectors taken from the later period can still be estimated, but i.e. F_{med} seems to be unreliable, Figure 13.1.8.2. The spatial dynamics of the North Sea sandeel stock is important and this might offer some explanation of this behaviour. The analyses indicate that the northern and southern fleets should not be combined.

3. The estimation of missing catch at age data

The Skagen SXSA estimates the missing 1990 catch at age data as part of the assessment. An alternative approach is to iterate XSA itself. Estimates of the missing data are obtained after each iteration using the derived selection pattern and the observed weights at age and landings until convergence. This was the procedure adopted with the FishLab version of XSA. The results , Figure 13.1.8.3 indicate that there is no benefit in re-estimating the missing data after 1995.

13.1.9 Biological reference points

Biological reference points are plotted in Figure 13.1.9.1 and tabulated in Table 13.1.9.1.

Stock recruitment modelling showed no clear indications of a reduction in recruitment at the lower levels of SSB in the time series. However, a major concern is to ensure that the stock remains high enough to provide food for a variety of predator species.

A precautionary limit reference point for SSB is proposed based on the minimum level of SSB observed. Its empirical probability distribution is plotted in Figure 13.1.9.1. Values prior to 1976 were omitted due to difference between the Skagen and Lowestoft versions of XSA in the early period. It can be seen that the expected value (the median) is below the deterministic estimate. The 95th percentile of this statistic is proposed as the precautionary approach reference point.

A definition of B_{lim} based on the North Sea assessment 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 sub stocks the use of a B_{lim} for the entire North Sea is inappropriate. An alternative would be to consider the biological processes and the interactions of the fisheries and sub stocks with other species and propose safe biological limits on this basis.

Reference points based on F to optimise yield are not relevant to this stock. Candidates for precautionary F reference points are F_{crash} and F_{loss}. F_{crash} is an estimate of the fishing mortality where the equilibrium spawning stock is zero and depends on the slope at the origin of an appropriate stock recruitment relationship. However, such models are seldom fitted using data at or near the origin. A proxy for F_{crash}, has been defined as the replacement line (G_{loss} which corresponds to the lowest observed spawning stock (Cook, 1996)) from which F_{loss} can be calculated. G_{loss} is not a central measure of the S-R distribution but an extreme statistic and the estimate of the uncertainty associated with G_{loss} will be very sensitive to the procedure used to estimate it. A working paper (O'Brien *et al.*) investigated how three bootstrap procedures (S-R pairs, residuals around a fitted model and the assessment) and the use of either linear or quadratic local regressions influence the estimation of this statistic, Table 13.1.9.2. The estimates of G_{loss} obtained from the bootstrapped S-R data are biased relative to those obtained from a bootstrap of the assessment. The assumed natural mortality also has a big influence on the estimates, as seen when Multispecies Working Group Ms that vary by year. It is concluded that G_{loss} is inappropriate for this stock.

13.2 Sandeel at Shetland

13.2.1 Catch trends

The sandeel population adjacent to Shetland has been exploited since the early 1970s. The grounds fished are close inshore and the vessels involved are generally small and local. Seasonal closures were introduced in 1989 following a decline in SSB and recruitment and poor breeding success of sandeel-dependent seabird populations, and the fishery was closed completely over 1991–1994. A restricted fishery has operated since 1995. Trends in landings are given in Table 13.2.1.1.

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

Natural mortality values used are the same as those used in the main North Sea assessment. However, the assessment of this stock has been done on an annual basis rather than a semi-annual basis as previously, so the half-year values have been combined to give annual Ms. These are given in Table 13.2.2.1. The maturities used are also in this table; these values originate from biological sampling at Shetland. Annual age composition data are given in Table 13.2.2.2. Long-term mean weights at age from the first half-year catches are used as stock weights. These are given in Table 13.2.2.3.

13.2.3 Catch, effort and research vessel data

Total effort figures are available for this fishery and are used in tuning. These are given in Table 13.2.2.1. Research vessel surveys for sandeel have been conducted at Shetland in August of each year since 1984, although there were no surveys in 1987 or 1995. Indices from this survey are given in Table 13.2.3.2. During the 1997 survey, very large numbers of 0-gp fish were caught on grounds throughout Shetland, and this is reflected in the 0-gp index from that survey which is the highest in the series.

13.2.4 Catch at age analysis

Recent assessments of this stock have used a semi-annual separable VPA (Cook and Reeves, 1993) but it did not prove possible to use this method at the 1996 Working Group meeting. This failure was attributed to the sparsity of recent data with many zero catches in the recent semi-annual catch matrix due to seasonal and annual closures, as well as gaps in the survey data series. In preliminary investigations made prior to the current Working Group meeting, the SSV again failed to converge. To overcome this problem this assessment has used similar methodology but in a different implementation.

To implement a separable model in a more flexible way and thus investigate whether it would be possible to overcome the problems with the sparsity of recent data the approach used was to implement the model in a spreadsheet. This allowed periods with zero catches to be excluded from the minimisation and thus reduce the number of parameters to be estimated. Furthermore, the model was implemented on an annual, rather than semi-annual basis, following exploratory runs with a semi-annual version which were again unsuccessful. Implementation in an annual form also further reduced the number of parameters. In other respects, the methodology used is the same as that used by Cook and Reeves (1993), and is thus an implementation of the CAGEAN approach of Deriso *et al.* (1985).

Whilst lacking the robustness of more conventional assessment software, the flexibility allowed by the spreadsheet-based implementation does have advantages given the nature of the data problems of this assessment. In addition, even though age composition data for the 1997 catches were not available in time for inclusion in this assessment, the existence of effort and survey data for 1997 means that it has been possible to estimate F and populations for 1997.

In fitting the separable model, the catch data were downweighted relative to the survey data which is appropriate given the zero catches in some recent years. Catches at age 0 were downweighted relative to the older ages, but in the survey data, older ages were downweighted. This is appropriate as the survey takes place in August when the availability of older age classes in the water column is low (Reeves, 1994). Selectivity at the oldest true age (6) was assumed equal to that at age 3, and in the survey data, catchability was assumed constant at age 3 upwards. These options were chosen based on knowledge of the stock and its fishery rather than any clear diagnostic criteria. Diagnostics from the model fit are given in Table 13.2.4.1. The model was fitted over the period 1984–1997, the year range for which survey data are available. Estimates of F and stock number have been obtained for the full year range of the data by using the fitted population estimates for 1984 to initialise a cohort analysis. The resultant estimates of F and of stock numbers are given in Tables 13.4.2.3 and 13.2.4.4.

In fitting the model with different relative weights to e.g. the ages in the catch data or the catch data relative to the survey data, it was apparent that the results were highly sensitive to the values used. With different values the stock estimates tended to show similar trends but the overall level was rather variable. Clearly the stock estimates resulting from this assessment can only be regarded as an indication of the overall trends in the stock and not of absolute levels.

13.2.5 Historical stock trends

The stock trends indicated by the current assessment are given in Table 13.2.5.1 and Figure 13.2.5.1. Landings reached a peak at around 50,000 t in 1982 then declined steadily. A period of high recruitment during the early eighties was followed by a declining trend in recruitment. This led to a decline in SSB and a decline in effort in response to reduced catch rates, leading to the decrease in landings. After a period of very low recruitment in the late-eighties, the strong 1991 year class led to an increase in the SSB. The estimate of the 1997 year class, which is based on only one survey index and is thus subject to particularly high uncertainty, indicates that it is very strong. Since the fishery was re-opened in 1995, fishing mortality has been at a very low level.

13.2.6 Short- and medium-term forecasts

At the current extremely low level of exploitation, the future trajectory of this stock will be determined largely by recruitment and by the high and variable natural mortality, with fishing mortality having a negligible effect. This makes stock projections inappropriate in this case.

13.2.7 Comments on the assessment

This assessment represents a substantial change in methodology since the last assessment of this stock, with a change from a semi-annual to an annual assessment, and a change in the way the separable model is implemented. Because of the very low catches in recent years, the model is, in essence, just using the catch data to scale the survey indices to nominal population level. The assessment is thus very sensitive to the input options used and as a result the results can only be taken as an indication of trends in the stock. This effect probably results from the extremely low level of fishing mortality compared to natural mortality as much as from the change in implementation.

When the fishery was re-opened at the start of 1995, precautionary management measures were put in place with the intention that they be retained for the next three years. This has been the case. The management will again be reviewed in advance of the 1998 season, again with the intention of fixing management measures for the next three year period. In view of this and the very low level of exploitation of this stock, there does not appear to be a need for annual assessments of this stock. Instead, the frequency of assessments need only reflect the three-year management cycle. Unless instructed otherwise, the Working Group will no longer perform annual assessments for this stock.

13.2.8 Safe biological limits

Reference points defined as a level of fishing mortality are appropriate in the case of stocks where fishing has a marked effect on the abundance and fishing mortality can thus be estimated with a reasonable degree of precision. Neither of these criteria are met in this case. It is also inappropriate to define reference points on the basis of the stock-recruit scatter plot, as in some years a substantial proportion of recruits to the Shetland population originate from spawning areas away from Shetland (Wright and Bailey, 1993; Wright, 1996). This means that spawning stock and recruitment as measured by this assessment are not closely linked. Many of these considerations are discussed further in Section 15.

Given the above restrictions and the unquantified uncertainty associated with this assessment it would not be appropriate to define safe biological limits for this stock in terms of analytically defined reference points. Instead a more precautionary approach is required. This should address the importance of the Shetland sandeel population as a food supply for the archipelago's local aggregations of predators, which include seals, cetaceans and other fish species, as well as large concentrations of seabirds. Recent management of the stock, involving a pre-emptive TAC of 3,000 t, together with seasonal closure and restricted access, has sought to maintain exploitation at a low level and thereby minimise the possibility of the fishery having an adverse impact on the availability of sandeels to local predator populations. As a result, recent exploitation of the stock has been at a very low level. and recent management of this stock can therefore be regarded as having been precautionary. Continued management using the existing or similar measures should maintain the stock within safe biological limits.

Table 13.1.1.1 Landings ('000 t) of sandeel from the North Sea, 1952-1996. (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
1996	601.6	-	5.0	-	159.8	-	8.2	774.6

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

Table 13.1.1.2 Sandeel North Sea. Monthly landings (t) by country, 1988–1997. (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

[1]Excluding the Faroes.

continued

Table 13.1.1.2 (continued)

1996	Mar	1,202		829	-	2,031
	Apr	30,651		7,720	-	38,371
	May	137,629		45,637	2,742	186,008
	Jun	184,507		50,912	3,740	239,159
	Jul	131,018	n/a	17,610	68	148,696
	Aug	67,913		11,829	-	79,742
	Sep	34,257		11,955	-	46,212
	Oct	13,222		12,480	-	25,702
	Nov	-		927	-	927
	Total	600,399		159,899	6,550	766,848
1997	Mar	15,343		22,480		37,823
	Apr	88,690		50,916		139,606
	May	208,648		70,923	n/a	279,571
	Jun	276,974		104,769		381,743
1st half	Total	589,655		249,088		838,743

[1]Excluding the Faroes.

Table 13.1.1.3 Monthly landings of sandeels (t) from each area in Figure 13.1, 1993–1997 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	5,438	247	0	534	
May	78,847	13,217	4,595	13,739	54,993	611	18,817	2,509	455	3,064	
Jun	112,059	81	20,441	12,692	32,264	489	25,078	7,097	1,711	35,186	
Jul	108,624	1,976	59	1,282	9,565	1	22,477	2,885	802	6,034	
Aug	1,313	461	3,679	7,153	8,849	125	34,315	0	0	5,441	
Sep	875	43	767	1,256	12,586	3,307	19,781	0	0	2,262	
Oct	0	2,671	0	726	10,252	0	8,156	0	0	0	
Nov	0	48	0	0	879	0	0	0	0	0	
Total	310,510	18,560	31,102	40,792	152,951	4,533	134,062	12,738	2,968	52,521	
1997											
Mar	17	7,392	2,273	1,402	25,519	0	1,220	0	0	0	
Apr	23,736	34,591	5,608	11,404	41,295	517	21,686	588	0	160	
May	117,700	6,295	575	24,309	75,291	480	36,443	3,074	1,768	13,636	
Jun	132,631	2,736	0	37,674	140,657	0	36,937	1,121	51	29,935	
Total	274,084	51,014	8,456	74,789	282,762	997	96,286	4,783	1,819	43,731	

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	419.0
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	310.5	18.6	31.2	40.8	153.0	4.5	134.1	12.7	3.0	52.5	0	341.2	419.5
1997[2]	332.5	51.2	8.5	86.1	294.0	1.0	107.7	15.8	3.1	75.5	0	465.3	510.1

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

[2]Only January–June included.

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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	
	1996 Jan-Jun	1996 Jul-Dec	1997 Jan-Jun		Jan-Jun	Jul-Dec
0	0.00	2.90	2.41	0.0		0.8
1	6.75	10.33	5.86	0.0	1.0	0.2
2	9.99	16.13	9.78	1.0	0.4	0.2
3	14.52	20.52	11.62	1.0	0.4	0.2
4	21.70	30.71	15.27	1.0	0.4	0.2
5	20.38	33.87	24.89	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		1997
	1	2	1	2	1	2	1	2	1	2	1
0	137	6,797	-	26,960	398	456	-	4,046		31,822	853
1	9,871	48	15,768	1,004	28,490	829	36,140	3,374	11,507	1,706	65,715
2	4,056	3	2,635	112	7,225	1,211	3,360	338	5,377	1,772	2,877
3	486	-	1,023	34	5,954	396	1,091	26	760	136	4,987
4	195	-	207	8	1,579	12	116	2	238	24	198
5+	110	-	439	14	577	12	29	-	62	31	928

[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	-	2.94
1	7.80	10.85
2	14.98	14.92
3	25.93	15.59
4	36.29	20.72
5+	42.04	25.81
1997	**Half-year**	
Age	1	
0	2.41	
1	5.03	
2	8.30	
3	11.78	
4	15.15	
5+	24.89	

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		1997
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1
0			-	12,115	2	134	-	838	-	-	-	-	-	2,089	
1			20,058	11,411	60,337	3,903	3,581	1,037	24,697	4,093	39,683	3,166	10,152	2,031	47,744
2			9,224	344	10,021	382	14,659	953	2,594	322	6,607	2,789	15,949	4,082	3,494
3			1,320	111	1,002	157	3,707	266	2,654	198	1,555	307	6,377	536	2,542
4			454	-	427	25	451	60	447	116	988	93	596	312	696
5			-	-	69	2	375	17	268	21	217	41	477	550	
6					103	5	186	10	61	-	21	20	91	148	
7+					22	2			31	-		3	29	13	

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 1993–1996 and 1997 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	-	2.3
1	5.6	9.9
2	8.3	16.7
3	13.2	21.8
4	15.9	31.5
5	17.9	33.3
6	18.0	36.8
7		43.8

1997	Half-year
Age	1
0	-
1	7.0
2	11.0
3	11.3
4	15.3

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
1997	24.9	34.9	51.4	56.1	76.8	58.6	90.2
				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
1996	15.3	30.6	41.9	37.8	47.4	44.9	47.3

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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
1997	24.9	34.9	51.4	56.1	76.8	58.6	90.2
				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
1996	22.9	23.3	56.3	69.4	81.0	87.5	123.6

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

$CPUE = \beta . GRT^{\alpha}$

	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	0.43	4.3	0.96	42.3
1997	0.47	5.13	0.95	62.5				

Southern North Sea

	Jan-Jun				Jul-Dec			
Year	**SLOPE**	**$e^{INTERCEPT}$**	**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	0.68	1.97	0.93	73.8
1997	0.51	5.20	0.92	76.8				

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	292.5	5.5
	2	73.8	138.7	1.9
1997	1	76.8	410.2	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	1,999	692	223.9	218.6
1997	3,088		224.0	

[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	1,579	70.7	44.8	133.8	40.8	42.2	189.0	4.5
1994	2,701	130.1	48.0	299.6	70.3	63.6	413.4	6.5
1995	3,442	208.6	60.6	143.2	57.8	59.5	348.5	5.9
1996	2,034	100,9	49.6	107.1	38.9	44.1	202.8	4.6
1997	3258	246.2	75.6	206.7	62.5	69.1	441.0	6.3
				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	972	30.7	31.6	59.4	37.4	35.4	87.0	2.5
1994	785	35.7	45.5	90.8	56.1	53.1	76.4	1.4
1995	1018	53.3	52.3	77.6	55.5	54.2	72.6	1.3
1996	752	42.9	57.0	93.3	42.3	47.0	140.7	3.0

Table 13.1.4.1

```
SURVIVORS ANALYSIS OF:
Sandeel in the North Sea


The following parameters were used:

Year range: 1983 - 1997
Seasons per year:    2
The last season in the last year is season : 1
Youngest age:  0; Oldest age:  3; (Plus age:  4)
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:              0
  (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

Weighting factor
(Inv.catchabilities at oldest age):     0.0
Min. value for the survivor number:     1.0
```

Table 13.1.4.1 cont.

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	*	871465.	*	229451.	*	1214142.	*	632511.	*	268882.	*	752047.
1	99684.	31870.	380039.	94798.	103099.	31573.	537312.	156687.	279368.	84222.	120312.	36858.
2	88978.	29970.	25602.	13965.	67996.	10707.	24035.	7979.	117040.	50924.	60935.	11375.
3	3520.	1522.	21712.	3563.	11242.	4677.	5628.	2296.	5840.	2680.	35484.	8039.
4+	306.	6.	768.	292.	2556.	1214.	2567.	1696.	3042.	1836.	3479.	739.
SSN	92805.		48082.		81794.		32230.		125921.		99898.	
SSB	1213251.		722230.		1132591.		478043.		1651313.		1529256.	
TSN	192489.	934833.	428121.	342070.	184893.	1262312.	569542.	801169.	405289.	408543.	220210.	809058.
TSB	1714662.	1815079.	2280390.	1583578.	1564576.	2069076.	2724006.	2964595.	2964342.	2136108.	2058628.	1840294.

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	353595.	*	657460.	*	837691.	*	328414.	*	639258.	*	859534.
1	329071.	59735.	156614.	34792.	286529.	67856.	359151.	89541.	142920.	40842.	268604.	66554.
2	29016.	13928.	43788.	10151.	25390.	7550.	44447.	18269.	69735.	32586.	31591.	13137.
3	8794.	2340.	11006.	1939.	7654.	3306.	5845.	2700.	14609.	5920.	25715.	10190.
4+	5120.	689.	2338.	440.	1568.	495.	3002.	1503.	3276.	1657.	5870.	2277.
SSN	42930.		57133.		34612.		53294.		87620.		63177.	
SSB	656849.		818626.		496781.		737774.		1188903.		889440.	
TSN	372001.	430288.	213747.	704781.	321141.	916898.	412445.	440426.	230539.	720263.	331781.	951691.
TSB	2104761.	1368607.	1485802.	1470481.	1725992.	1831616.	2203109.	1802856.	1832042.	1967354.	2570900.	7267148.

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	305534.	*	2078115.	*
1	385907.	95978.	134573.	36370.	911026.
2	50037.	25380.	72663.	31247.	26396.
3	9368.	4113.	17950.	6189.	20286.
4+	9553.	5500.	7483.	4333.	7703.
SSN	68953.		98096.		54384.
SSB	1148434.		1148920.		611493.
TSN	454865.	436506.	232669.	2156255.	965411.
TSB	3899951.	3060628.	2057290.	7166324.	5950106.

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.
SOP	50681.	37464.	91792.	20871.	101385.	12683.	174378.	128325.	303699.	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.
SOP	437540.	57222.	177160.	73221.	371383.	55404.	111761.	38189.	178029.	86477.	400659.	82173.

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	4046.	*	31822.	*
1	36140.	3374.	11507.	1706.	65715.
2	3360.	338.	5377.	1772.	2877.
3	1091.	26.	760.	136.	4987.
4+	116.	2.	238.	24.	198.
SOP	347368.	71351.	198646.	141123.	416172.

Table 13.1.4.1 cont.

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.
SOP	377835.	61745.	553661.	80581.	472371.	112257.	335960.	47108.	296207.	105008.	447548.	39901.

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.
SOP	309472.	22224.	438031.	30046.	345866.	123092.	613364.	47305.	255526.	33853.	221427.	47119.

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	0.	*	2089.	*
1	39683.	3166.	10152.	2031.	47744.
2	6607.	2789.	15949.	4082.	3494.
3	1555.	307.	6377.	536.	2542.
4+	988.	93.	596.	312.	696.
SOP	421977.	66204.	282881.	114594.	412015.

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	*	0.013	*	0.000	*	0.000	*	0.016	*	0.002	*	0.026
1	0.095	0.011	0.055	0.015	0.044	0.004	0.076	0.052	0.159	0.080	0.138	0.039
2	0.021	0.012	0.085	0.010	0.090	0.030	0.170	0.069	0.134	0.005	0.764	0.034
3	0.037	0.017	0.013	0.015	0.130	0.028	0.052	0.000	0.085	0.000	0.064	0.019
4+	0.054	0.000	0.009	0.000	0.206	0.007	0.000	0.000	0.045	0.000	0.013	0.027
F (1- 2)	0.058	0.011	0.070	0.012	0.067	0.017	0.123	0.060	0.147	0.042	0.451	0.036

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	*	0.024	*	0.030	*	0.063	*	0.001
1	0.337	0.078	0.178	0.057	0.267	0.016	0.050	0.001	0.191	0.028	0.191	0.014
2	0.106	0.022	0.170	0.033	0.149	0.004	0.134	0.000	0.053	0.004	0.335	0.108
3	0.641	0.000	0.165	0.067	0.171	0.003	0.117	0.000	0.103	0.007	0.344	0.044
4+	0.000	0.000	0.159	0.060	0.228	0.007	0.089	0.000	0.086	0.005	0.403	0.006
F (1- 2)	0.222	0.050	0.174	0.045	0.208	0.010	0.092	0.000	0.122	0.016	0.263	0.061

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	0.019	*	0.022	*
1	0.169	0.040	0.150	0.055	0.124
2	0.091	0.016	0.107	0.069	0.152
3	0.167	0.007	0.066	0.026	0.375
4+	0.016	0.000	0.041	0.006	0.033
F (1- 2)	0.130	0.028	0.129	0.062	0.138

Table 13.1.4.1 cont.

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	0.037	0.008	0.296	0.117	0.128	0.069	0.139	0.039	0.026	0.043	0.033	0.000
2	0.616	0.109	0.117	0.007	1.070	0.401	0.479	0.043	0.280	0.155	0.297	0.023
3	0.383	0.455	1.124	0.197	0.324	0.713	0.420	0.123	0.280	0.084	0.873	0.334
4+	1.592	0.481	0.525	0.180	0.127	0.160	0.014	0.006	0.059	0.027	0.967	0.100
F (1- 2)	0.326	0.059	0.207	0.062	0.599	0.235	0.309	0.041	0.153	0.099	0.165	0.012

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	*	0.021	*	0.001	*	0.002	*	0.000
1	0.264	0.031	0.269	0.058	0.128	0.205	0.303	0.049	0.043	0.029	0.166	0.071
2	0.217	0.013	0.751	0.049	0.588	0.052	0.331	0.023	0.295	0.033	0.120	0.029
3	0.181	0.017	0.931	0.151	0.249	0.038	0.242	0.066	0.375	0.051	0.153	0.022
4+	1.240	0.215	0.898	0.137	0.461	0.000	0.195	0.019	0.188	0.041	0.114	0.058
F (1- 2)	0.241	0.022	0.510	0.054	0.358	0.128	0.317	0.036	0.169	0.031	0.143	0.050

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	0.000	*	0.001	*
1	0.185	0.038	0.133	0.065	0.090
2	0.180	0.130	0.318	0.160	0.185
3	0.238	0.086	0.552	0.101	0.191
4+	0.134	0.019	0.103	0.083	0.117
F (1- 2)	0.183	0.084	0.225	0.112	0.138

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

Season	1	2
AGE		
0	*	4.910
1	3.540	4.197
2	3.572	4.648
3	3.572	4.648

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

Season	1	2
AGE		
0	*	6.968
1	4.080	3.363
2	3.034	3.340
3	3.034	3.340

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	*	1.104	*	*	*	-1.949	*	-0.192	*	-1.685	*	0.463
1	0.491	0.159	0.059	0.503	-0.053	-0.423	-0.513	0.247	0.036	1.083	-0.480	0.167
2	-0.968	0.761	0.521	0.513	0.689	2.046	0.317	0.979	-0.109	-1.318	1.262	0.474
3	-0.432	1.076	-1.365	0.926	1.065	2.003	-0.860	*	-0.564	*	-1.215	-0.100

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	-0.150	*	0.643	*	0.489	*	1.929	*	1.227	*	-2.592
1	0.139	0.864	0.146	0.631	0.378	-0.659	-0.660	-2.702	0.378	-0.300	0.014	-0.388
2	-0.982	0.046	0.134	0.529	-0.171	-1.518	0.368	-3.446	-0.868	-1.826	0.605	2.089
3	0.814	*	0.100	1.254	-0.033	-1.952	0.235	*	-0.202	-1.303	0.633	1.193

Table 13.1.4.1 cont.

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	0.705	*	0.015	*
1	-0.014	0.721	0.119	0.192	-0.391
2	-0.595	0.232	-0.189	0.881	-0.150
3	0.009	-0.537	-0.676	-0.112	0.750

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	*	2.225	*	*	*	1.531	*	-1.822	*	-0.251	*	*
1	-1.338	-2.006	0.655	0.425	-0.281	-0.511	0.136	-0.404	-0.988	-0.574	-1.472	*
2	0.420	0.538	-1.322	-2.369	0.799	1.232	0.324	-0.345	0.327	0.690	-0.320	-0.419
3	-0.053	1.966	0.942	0.926	-0.395	1.808	0.192	0.711	0.327	0.074	0.758	2.244

Year	1989		1990		1991		1992		1993		1994	
Season	1	2	1	2	1	2	1	2	1	2	1	2
AGE												
0	*	-4.736	*	1.046	*	2.248	*	-0.981	*	0.836	*	*
1	0.487	0.598	0.515	1.024	0.301	0.903	0.710	-0.179	-0.727	-0.080	1.090	0.818
2	-0.756	-0.287	0.496	0.845	0.780	-0.499	-0.246	-0.949	0.147	0.029	-0.279	-0.101
3	-0.936	-0.063	0.712	1.959	-0.078	-0.812	-0.560	0.094	0.384	0.468	-0.034	-0.368

Year	1995		1996		1997
Season	1	2	1	2	1
AGE					
0	*	*	*	-0.193	*
1	0.554	-0.009	0.355	-0.010	0.003
2	-0.522	1.202	0.182	0.865	-0.320
3	-0.240	0.791	0.734	0.409	-0.289

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

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

Table 13.1.5.1 North Sea sandeel. Average fishing mortality, recruitment and SSB, 1976-96.

Year	Mean F (age 1-2)	Recruits age 1 in year (billions)	SSB ('000 t)
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	0.45	100	1213
1984	0.35	380	722
1985	0.92	103	1133
1986	0.53	537	478
1987	0.44	279	1651
1988	0.66	120	1529
1989	0.54	329	657
1990	0.78	157	819
1991	0.70	287	497
1992	0.45	359	738
1993	0.34	143	1189
1994	0.52	269	889
1995	0.43	386	1148
1996	0.53	135	1149
Average	0.57	243	890

Table 13.1.7.1 Assesment Quality Control Diagrams for Sandeel in the North Sea

Assessment Quality Control Diagram 1

Average F(1-2,u)									
Date of assessment	Year								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1990									
1991									
1992									
1993									
1994 b	0.66	0.52	0.83	0.36	0.54	0.46			
1995 b	0.64	0.54	0.78	0.70	0.43	0.32	0.35		
1996 b	0.64	0.54	0.82	0.71	0.46	0.37	0.49	0.38	
1997	0.66	0.54	0.78	0.70	0.45	0.34	0.52	0.43	0.53

Assessment Quality Control Diagram 2

Recruitment (age 1) Unit: **billions**									
Date of assessment	Year class								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
1990									
1991									
1992									
1993									
1994 a[1]	321	128	287	385	111				
b	332	138	273	287	134				
1995 b	329	146	292	362	160	502			
1996 b	323	155	288	332	148	279	439	133	
1997	329	157	287	359	143	269	386	135	911

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

Table 13.1.7.1 cont.

Assessment Quality Control Diagram 3

Spawning stock biomass ('000 t)											
Date of assessment	Year										
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1990 a	655	1913									
1991											
1992											
1993 a	711	804	498	647	2020						
1994 a	687	789	524	755	1299						
b	677	844	452	657	859						
1995 b	685	829	490	755	1209	962					
1996 b	688	812	477	732	1077	834	1158				
1997	657	819	497	738	1189	889	1148	1149			

Table 13.1.9.1 North Sea Sandeel biological reference points.

	Deterministic	Median	5th %ile
SSB in 1997	507612	459655	266928
Fbar in 1996	0.54	0.57	0.40
SPR in 1996	40.49	39.37	31.93
Virgin SPR	6.82	6.82	6.82
Flow	0.46	0.27	0.07
Fmed	0.88	0.96	0.68
Fhigh	2.08	2.24	1.52
F 30% SPR	0.81	0.81	0.61
F Max	13.86	15.79	7.13
F Opt1	0.77	0.77	0.68
F Crash	1.58	1.47	1.01
FLoss	1.51	1.89	1.20
SSB 50% R	250000	250000	250000
SSB 90% R 90% Surv	593390	590974	454195
SSB 20% Virgin	673796	601117	518006

Slope at the origin for F Crash was estimated by a line drawn through the origin and the point corresponding to median recruitment and an SSB of 500,000 t

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Table 13.1.9.2 Estimates of G_{loss}

Bootstrap method	LOWESS degree	Assessment Type								
		Lowestoft			Lowestoft with multi-species Ms			Skagen		
		Det.	Median	5th %ile	Det.	Median	5th %ile	Det.	Median	5th %ile
Pairs	linear	1.0	0.9	0.6	4.6	4.0	3.0	1.2	1.1	0.7
Residuals		1.0	1.0	0.7	4.6	4.5	3.5	1.2	1.3	0.9
Assessment		1.0	1.2	0.9	-	-	-	-	-	-
Pairs	quadratic	0.9	0.8	0.5	4.4	4.0	2.5	1.0	1.0	0.6
Residuals		0.9	0.9	0.6	4.4	4.4	3.1	1.0	1.0	0.5
Assessment		0.9	1.2	0.6	-	-	-	-	-	-

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Table 13.2.1.1 Sandeel at Shetland
Landings, 1974-1996
Figures are Working Group estimates in ('000) t

Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Landings	7.4	12.9	20.2	21.5	28.1	13.4	25.4	46.7	52	37

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Landings	32.6	17.2	14	7.2	4.7	3.5	2.3	0	0	0

Year	1994	1995	1996	1997*
Landings	0	1	1	1

* provisional

Table 13.2.2.1 Sandeel at Shetland
Natural Mortality and proportion mature

Age	M (annual)	p(mature)
0	0.8	0
1	1.2	0
2	0.6	1
3	0.6	1
4	0.6	1
5	0.6	1
6	0.6	1
7+	0.6	1

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Table 13.2.2.2 Sandeel at Shetland
Catch numbers at age (annual), millions.

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	929	4309	4268	5970	5453	1403	6432	13243	16851	5605
1	1318	242	1928	3508	4894	2665	739	2962	6182	3428
2	148	708	399	768	1216	365	487	1216	1064	772
3	34	122	124	43	114	44	344	389	385	243
4	36	13	27	56	29	20	118	142	107	111
5	7	15	11	5	28	10	70	55	81	33
6	1	6	6	6	4	1	34	25	26	18
7+	1	3	7	3	1	0	17	5	7	5

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	6773	2192	2226	419	530	33	14	0	0	0
1	2324	1328	616	984	33	8	162	0	0	0
2	1218	470	377	69	154	7	22	0	0	0
3	437	249	351	45	108	199	14	0	0	0
4	144	75	152	46	49	96	60	0	0	0
5	47	28	61	23	28	34	29	0	0	0
6	15	9	15	5	15	14	5	0	0	0
7+	10	3	6	1	4	4	6	0	0	0

Age	1994	1995	1996
0	0	43	31
1	0	185	169
2	0	23	52
3	0	11	4
4	0	6	2
5	0	2	3
6	0	0.1	0.1
7+	0	0.1	0.1

Table 13.2.2.3 Sandeel at Shetland
Stock weights at age

Age	Wt. (g)
0	0.746
1	3.095
2	5.409
3	8.585
4	11.143
5	13.705
6	15.605
7+	21.254

Table 13.2.3.1 Sandeel at Shetland
Total Fishing effort, days absent.

Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Effort	460	847	1188	1351	1397	592	1006	1806	1937	1410

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Effort	1391	660	561	278	272	168	102	0	0	0

Year	1994	1995	1996	1997*
Effort	0	149	133	146

* provisional

Table 13.2.3.2 Sandeel at Shetland
Survey indices, Mean No. fish per 30 minute tow

				Age				
Year	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
1997	3129222	94210	6687	9534	1225	1443	1236	381

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Table 13.2.4.1 Sandeel at Shetland
Diagnostics from separable model fit

	SSQ	df	Wt	Weighted SSQ
Catch	43.73469	54	0.33	14.43245
Population	36.9138	66	1	36.9138
year effect	2.503597	9	1	2.503597
			Total SSQ	53.84984

Small number 0.00001

alpha 1
ref age 3

	Weightings for catch data		Weightings for survey indices	
Age	Wt	SSQ at age	Wt	SSQ at age
0	0.1	9.503057	1	7.2712
1	1	7.79528	1	5.443791
2	1	1.438524	1	2.710851
3	1	8.768693	0.5	4.437068
4	1	6.42966	0.5	4.149536
5	1	4.204678	0.5	5.735558
6	1	5.594793	0.2	7.165794
7+	0	0		

Age effects, s(a)		RV Q(a)
0	6.75E-05	0.009453
1	0.00023	0.004113
2	8.67E-05	0.00191
3	5.05E-05	0.00116
4	6.62E-05	0.00116
5	6.23E-05	0.00116
6	5.05E-05	0.00116

Population residuals

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
-0.485	-1.082	0.779		0.162	1.885	0.004	-0.301	-0.191	0.394	-1.182		0.027	0.002
-0.771	0.143	0.142		-1.482	0.122	0.682	-0.162	0.959	-0.552	0.879		-0.207	0.259
-0.014	0.454	-0.343		-0.259	-0.071	0.650	-0.703	-0.899	0.474	0.574		0.173	-0.067
0.033	0.671	0.615		0.346	0.200	1.334	0.939	-1.306	0.780	1.001		-0.943	1.008
0.182	0.765	0.091		0.537	0.735	0.014	1.384	-0.758	-0.678	1.816		-0.206	-0.744
0.133	0.097	0.080		0.255	0.299	0.086	-2.912	-0.947	-0.283	-0.260		-1.182	0.594
0.474	0.383	0.278		-0.121	-1.007	-0.602	-3.321	-3.922	0.213	-2.391		1.155	-0.697

Log catch residuals

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
-0.773	-0.780	-0.864	-2.150	-1.480	1.578	2.139					0.642	1.662
0.419	-0.179	0.283	-1.033	0.427	2.129	-0.209					-0.597	-1.151
0.148	-0.019	-0.151	0.400	-0.231	0.288	-0.189					0.468	-0.917
-0.198	-0.152	-0.775	0.065	-0.915	-2.003	-1.531					-0.506	0.807
0.094	0.456	0.082	0.143	-0.089	-1.514	-1.129					1.502	0.597
0.179	0.303	0.080	0.531	0.243	-0.767	-0.970					-0.781	1.263
0.278	0.262	0.204	0.996	0.418	-0.253	0.351					1.663	1.134
0.514	1.102	0.727	2.033	1.340	1.266	0.840					2.094	1.723

Year effect residuals

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0.170	0.177	-0.103	-0.033	-0.345	-0.457	-0.980	0.000	0.000	0.000	0.000	0.675	0.829	0.009

Table 13.2.4.3 Sandeel at Shetland
Fishing mortalities
Values 1984 - 1997 are fitted separable fishing mortalities, values prior to 1984 are VPA estimates

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	0.031	0.057	0.080	0.091	0.094	0.040	0.068	0.122	0.131	0.095
1	0.106	0.195	0.274	0.311	0.322	0.136	0.232	0.416	0.446	0.325
2	0.040	0.073	0.103	0.117	0.121	0.051	0.087	0.157	0.168	0.122
3	0.023	0.043	0.060	0.068	0.071	0.030	0.051	0.091	0.098	0.071
4	0.030	0.056	0.079	0.089	0.092	0.039	0.067	0.120	0.128	0.093
5	0.029	0.053	0.074	0.084	0.087	0.037	0.063	0.113	0.121	0.088
6	0.023	0.043	0.060	0.068	0.071	0.030	0.051	0.091	0.098	0.071
7	0.023	0.043	0.060	0.068	0.071	0.030	0.051	0.091	0.098	0.071
Mean F(1-3)	0.056	0.104	0.146	0.166	0.171	0.073	0.123	0.221	0.237	0.173

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.079	0.037	0.042	0.019	0.026	0.018	0.018	0	0	0
1	0.270	0.127	0.143	0.066	0.088	0.061	0.063	0	0	0
2	0.102	0.048	0.054	0.025	0.033	0.023	0.024	0	0	0
3	0.059	0.028	0.031	0.015	0.019	0.013	0.014	0	0	0
4	0.078	0.037	0.041	0.019	0.025	0.018	0.018	0	0	0
5	0.073	0.034	0.039	0.018	0.024	0.017	0.017	0	0	0
6	0.059	0.028	0.031	0.015	0.019	0.013	0.014	0	0	0
7	0.059	0.028	0.031	0.015	0.019	0.013	0.014	0	0	0
Mean F(1-3)	0.144	0.068	0.076	0.035	0.047	0.033	0.033	0.000	0.000	0.000

Age	1994	1995	1996	1997
0	0	0.005	0.004	0.010
1	0	0.017	0.013	0.033
2	0	0.007	0.005	0.013
3	0	0.004	0.003	0.007
4	0	0.005	0.004	0.010
5	0	0.005	0.004	0.009
6	0	0.004	0.003	0.007
7	0	0.004	0.003	0.007
Mean F(1-3)	0.000	0.009	0.007	0.018

Table 13.2.4.4 Sandeel at Shetland
Estimated Populations, millions.

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	82853	59789	70822	76503	54918	74294	117155	170612	179060	108616
1	9830	36606	23977	28962	30373	14433	17749	23279	32894	38978
2	1519	2237	10893	6163	6798	6462	7259	8328	10800	15974
3	857	724	703	5682	2814	2830	3276	3637	4145	5520
4	539	445	307	294	3087	1460	1520	1543	1756	2072
5	356	269	235	149	120	1673	786	747	742	882
6	58	190	137	121	78	45	910	380	369	347
7	31	48	125	135	131	107	81	517	449	407

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	59377	39752	33092	3688	6836	13074	9495	144218	25508	45320
1	24969	15746	10376	9329	1017	1937	3699	2860	43438	7683
2	19322	13062	8188	5554	4952	545	1038	2030	1569	23839
3	8263	10312	6947	4429	2990	2682	295	570	1114	861
4	2803	4372	5431	3741	2370	1612	1445	162	313	611
5	1057	1486	2308	2928	2004	1279	870	793	89	172
6	456	564	790	1248	1576	1085	692	477	435	49
7	386	436	533	704	1056	1417	1355	1108	870	717

Age	1994	1995	1996	1997
0	34040	23244	60710	330236
1	13650	10075	6908	17686
2	4217	7442	5501	3744
3	13083	2305	4072	2997
4	473	7144	1260	2214
5	336	258	3907	685
6	94	183	141	2128
7	420	282	255	217

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Table 13.2.5.1 Sandeel at Shetland
Stock Summary

Year	Landings 000t	Fbar(1-3)	Recruits Millions	SSB 000t
1974	7.4	0.056	82853	28.027
1975	12.9	0.104	59789	30.950
1976	20.2	0.146	70822	76.384
1977	21.5	0.166	76503	92.192
1978	28.1	0.171	54918	100.966
1979	13.4	0.073	74294	101.412
1980	25.4	0.123	117155	111.038
1981	46.7	0.221	170612	120.619
1982	52	0.237	179060	139.038
1983	37	0.173	108616	183.047
1984	32.6	0.144	59377	236.481
1985	17.2	0.068	39752	246.319
1986	14	0.076	33092	219.751
1987	7.2	0.035	3688	184.320
1988	4.7	0.047	6836	153.365
1989	3.5	0.033	13074	108.514
1990	2.3	0.033	9495	75.782
1991	0	0.000	144218	59.555
1992	0	0.000	25508	48.047
1993	0	0.000	45320	161.496
1994	0	0.000	34040	155.389
1995	1	0.009	23244	152.052
1996	1	0.007	60710	139.919
1997	1	0.018	330236	117.862

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

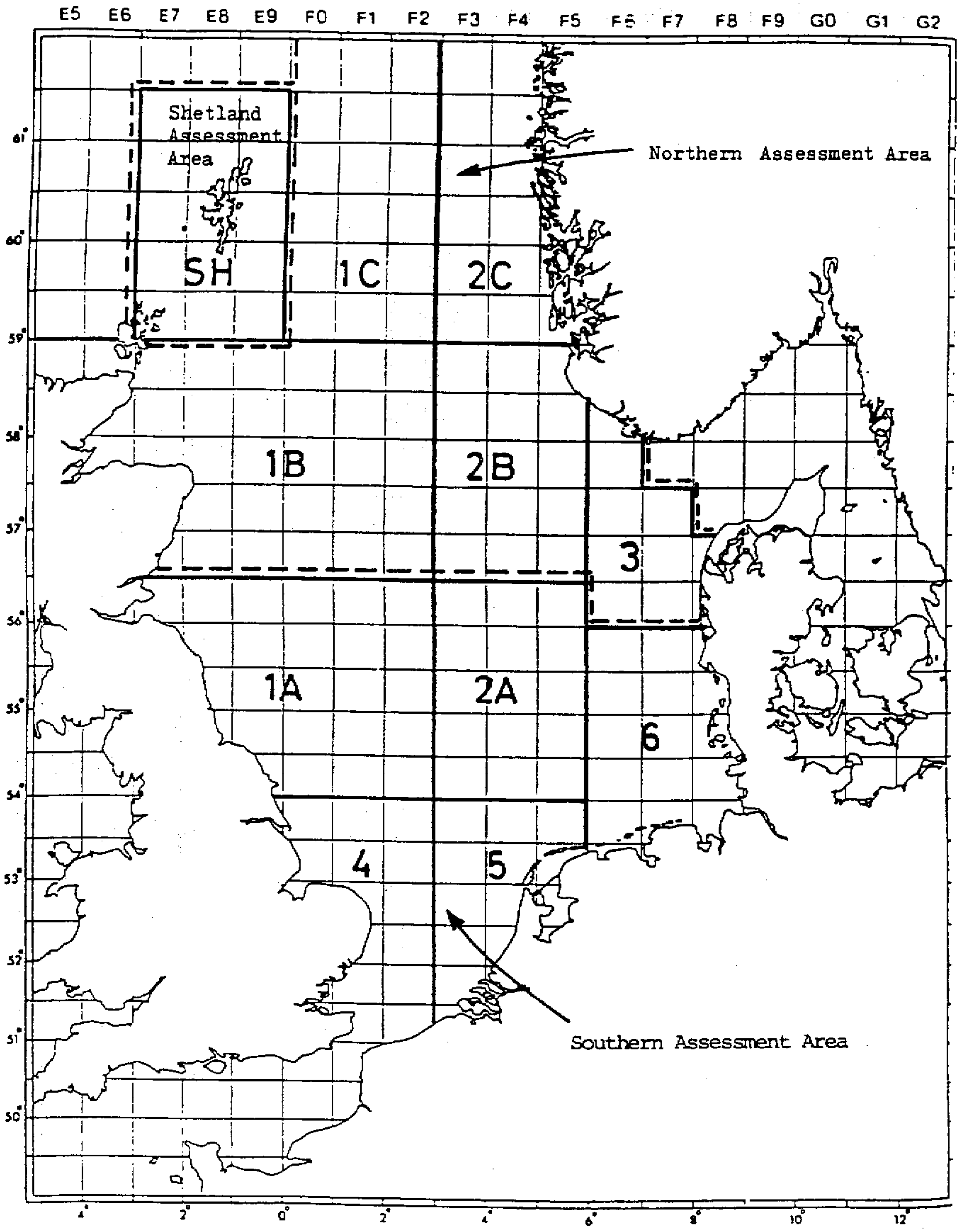


Figure 13.1.1.2 Sandeel landings in 1996 and 1997 (1st half) by ICES statistical rectangle and quarter. Data from Denmark, Norway and UK.

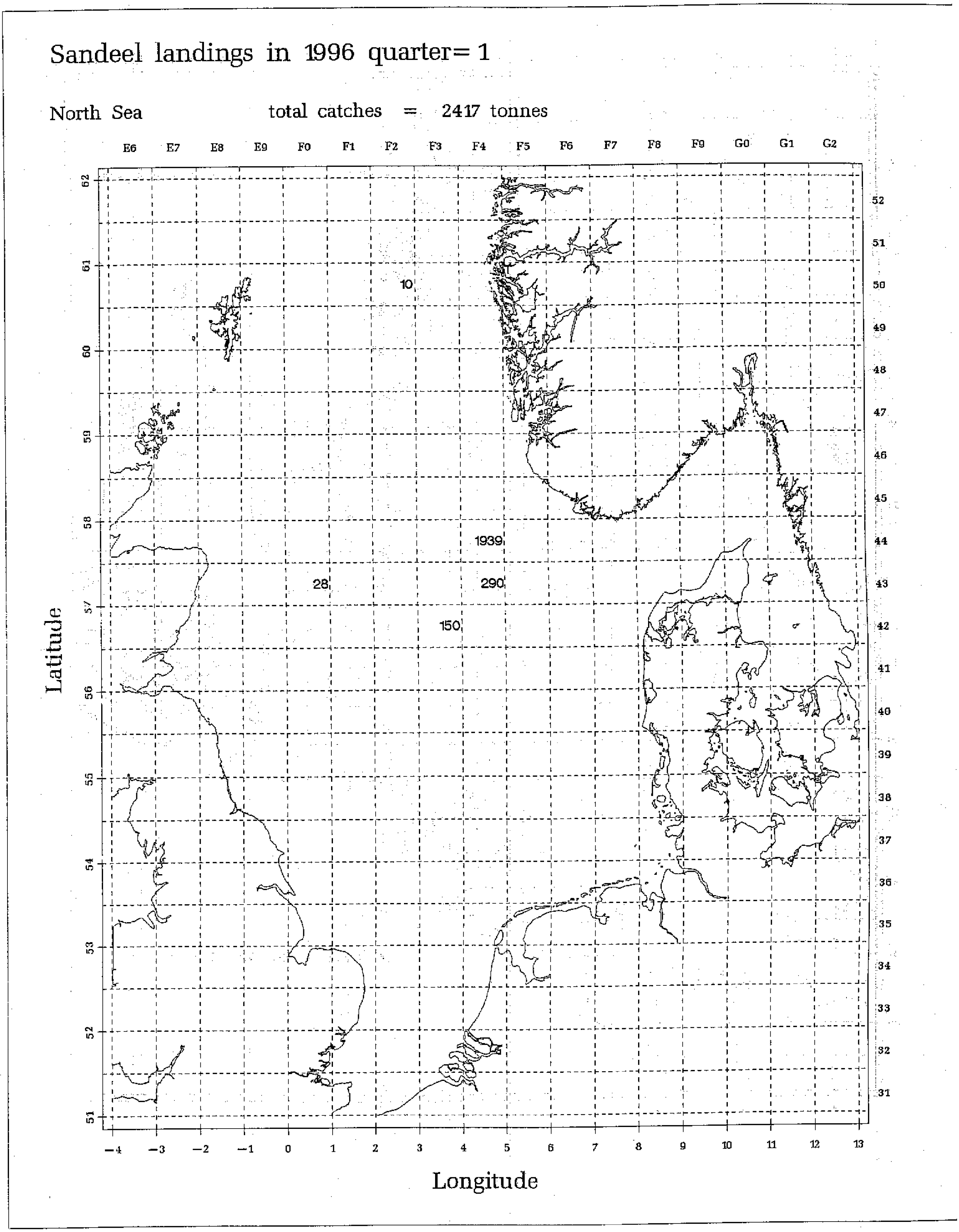


Figure 13.1.1.2 cont.

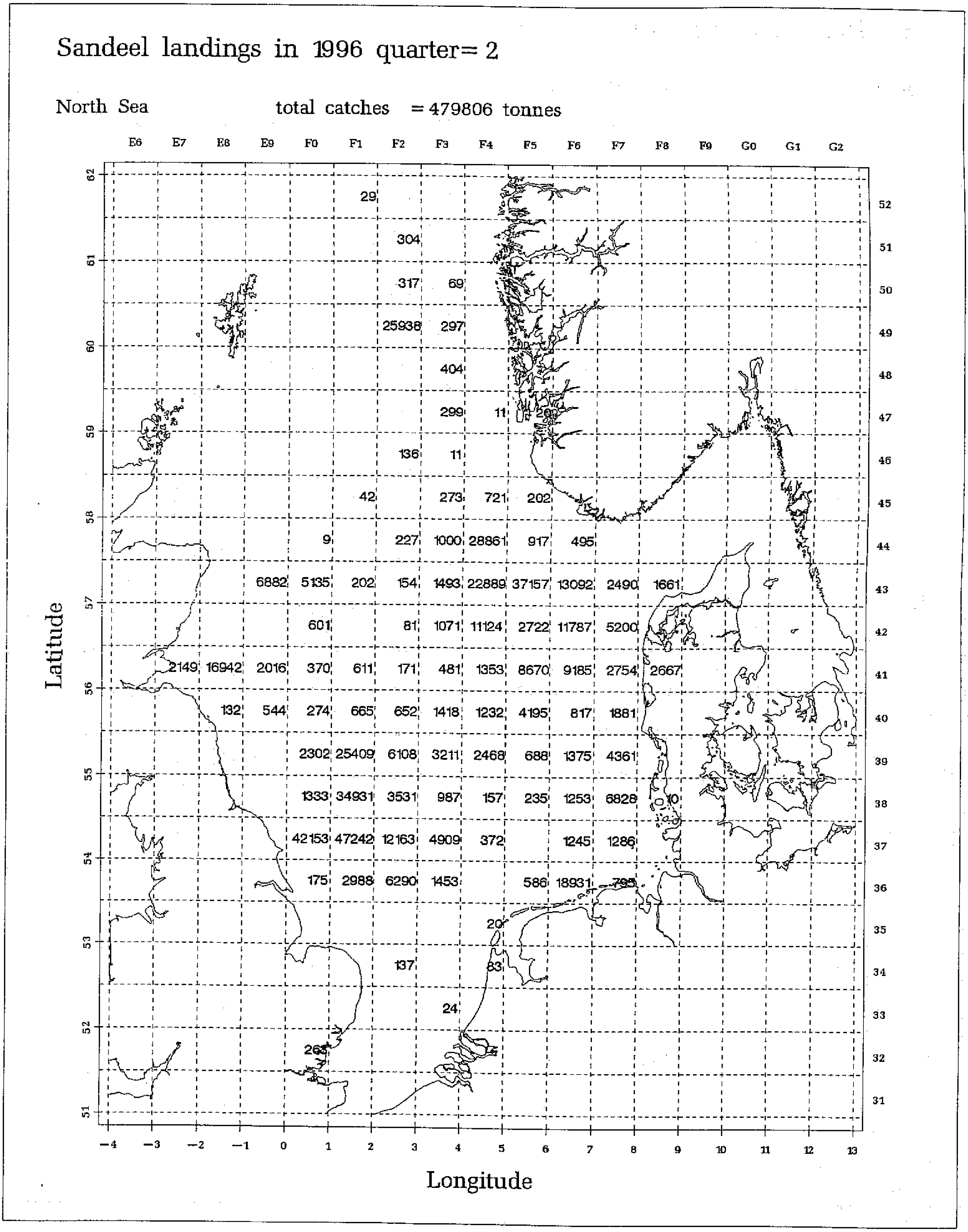


Figure 13.1.1.2 cont.

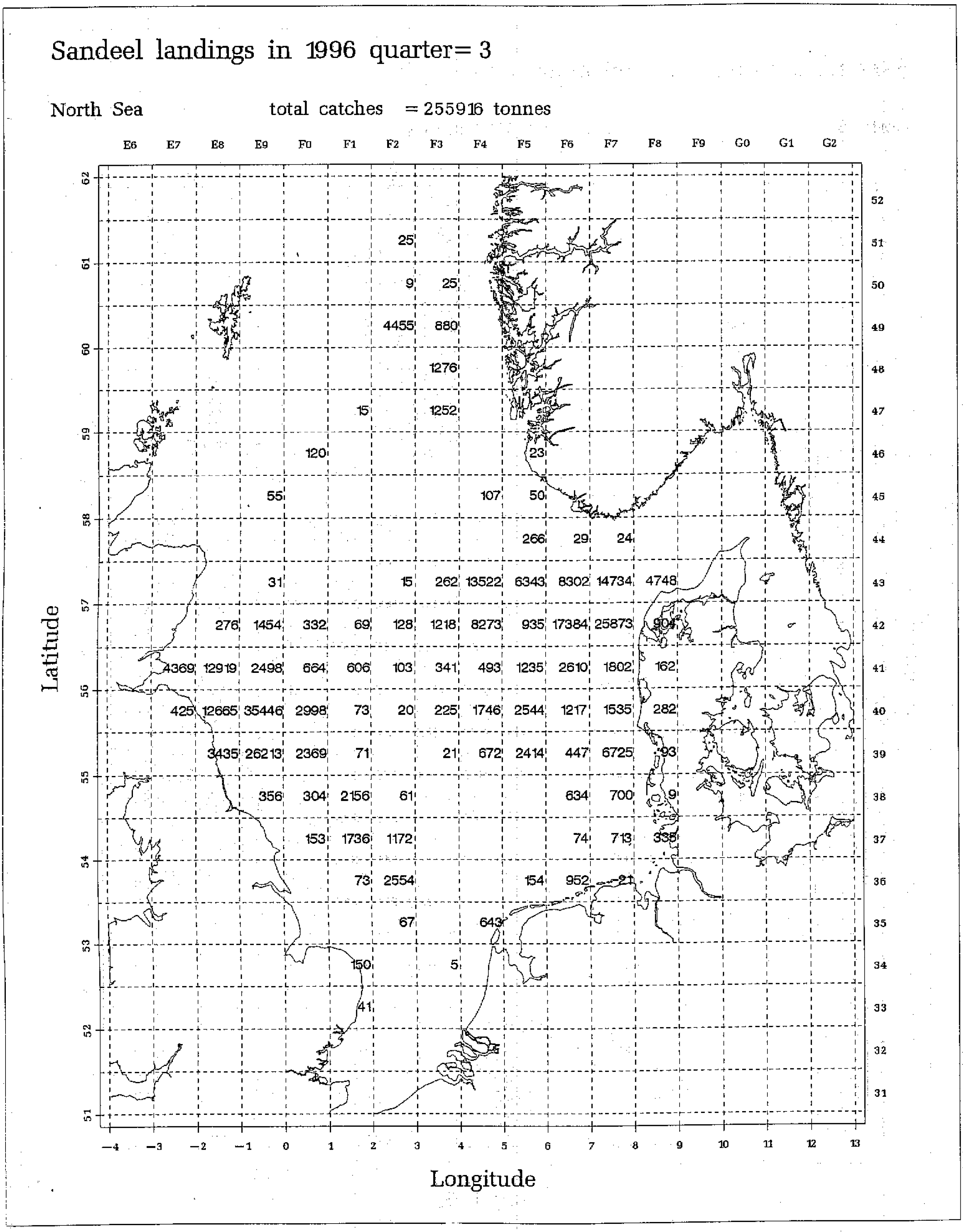


Figure 13.1.1.2 cont.

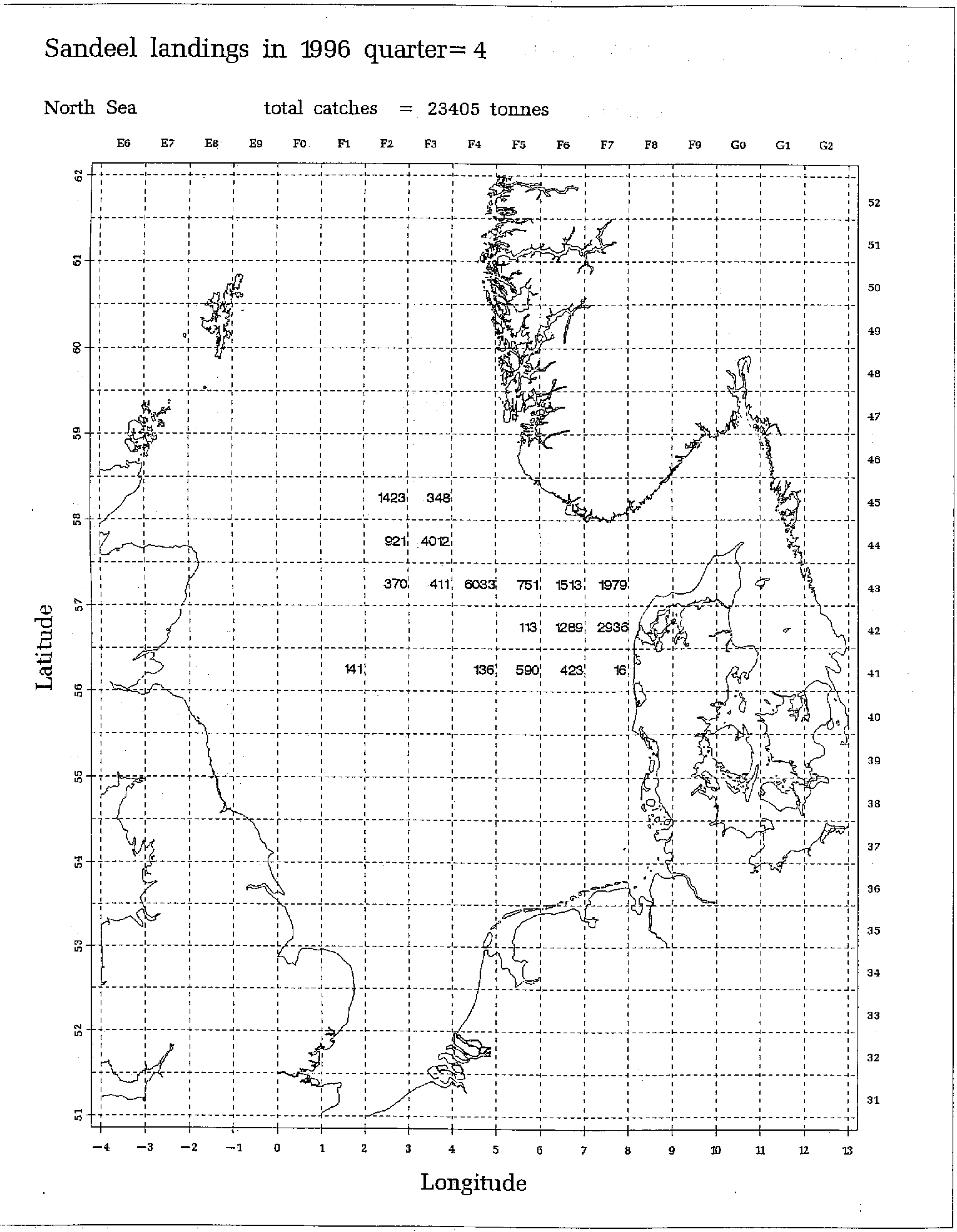


Figure 13.1.1.2 cont.

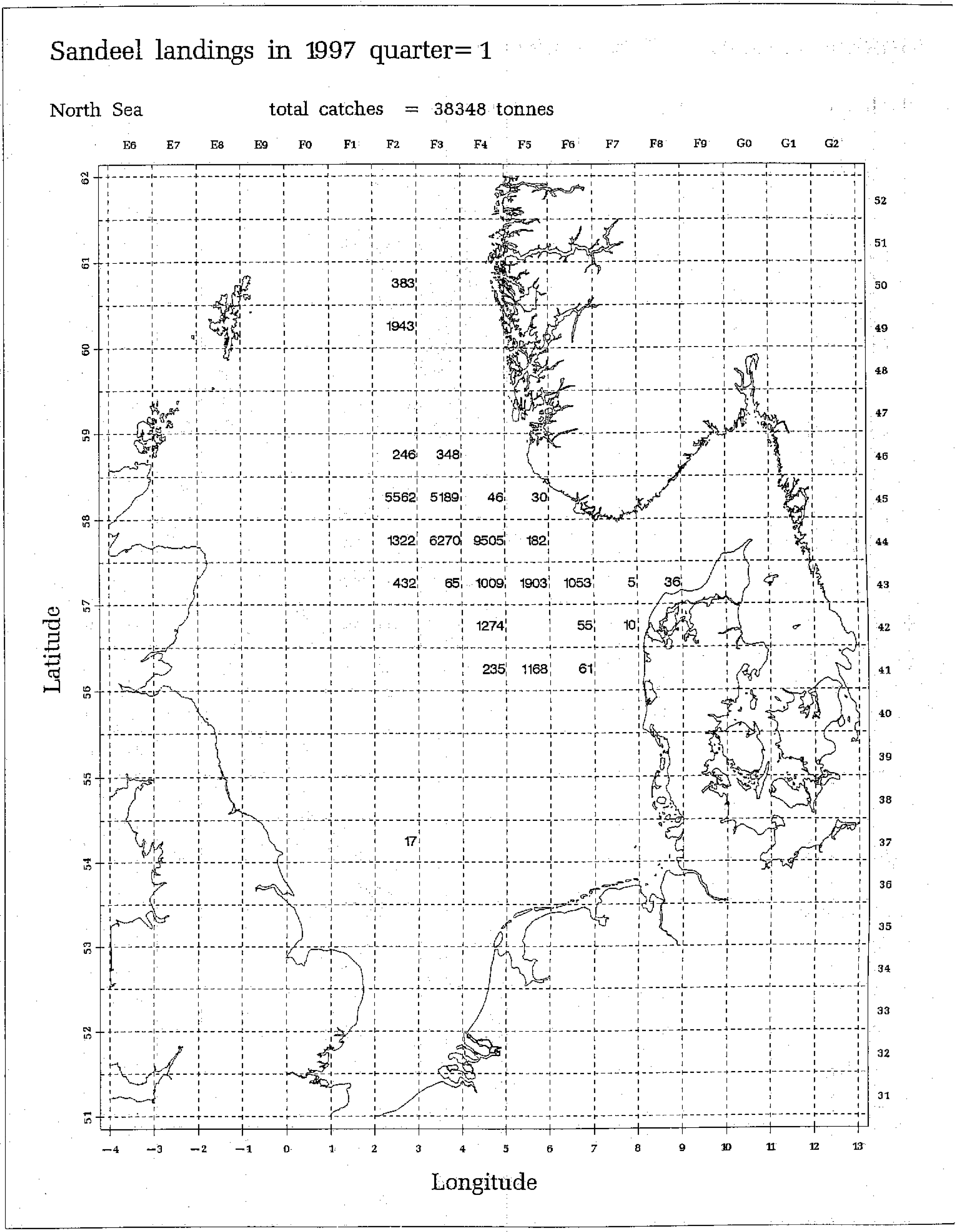


Figure 13.1.1.2 cont.

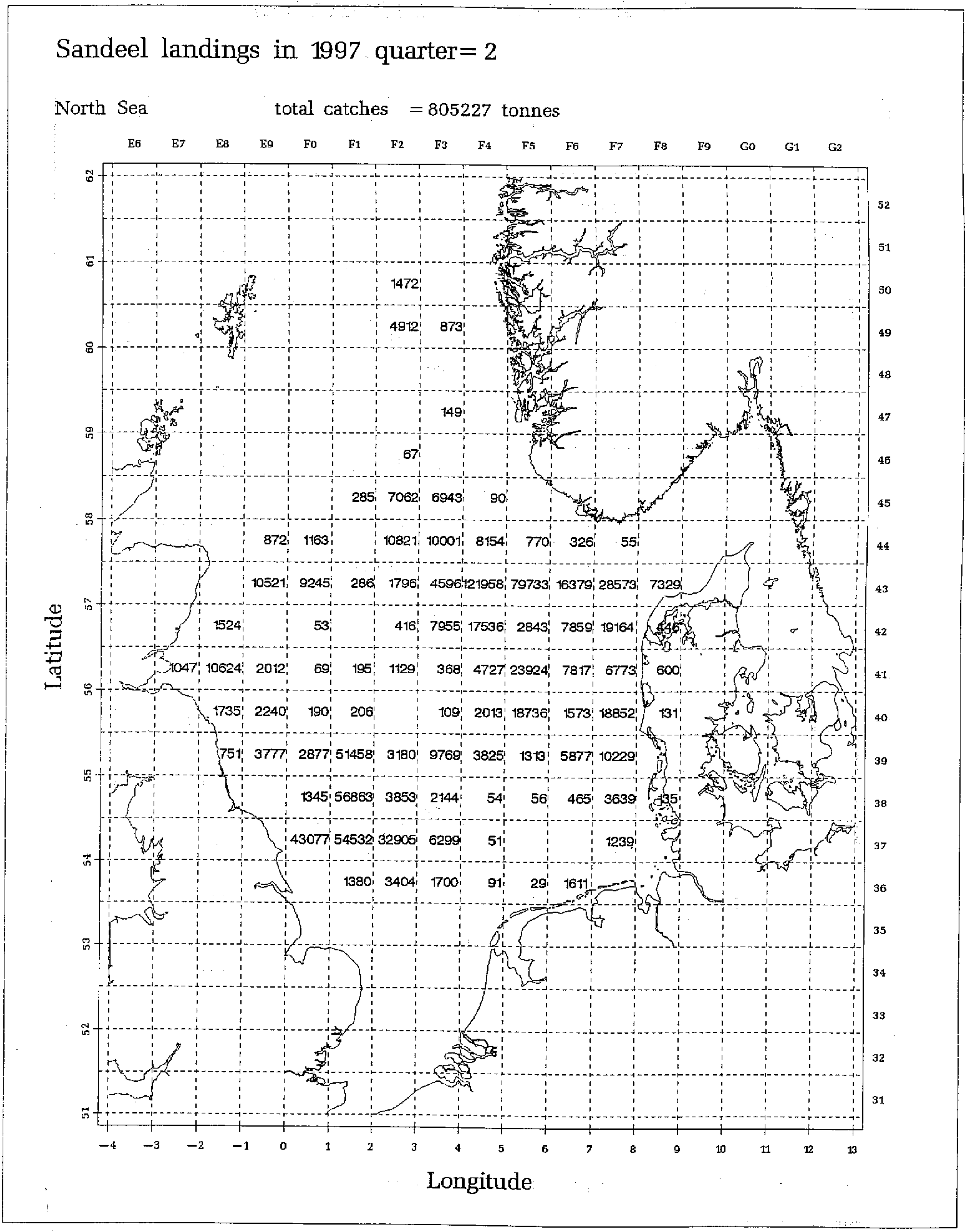
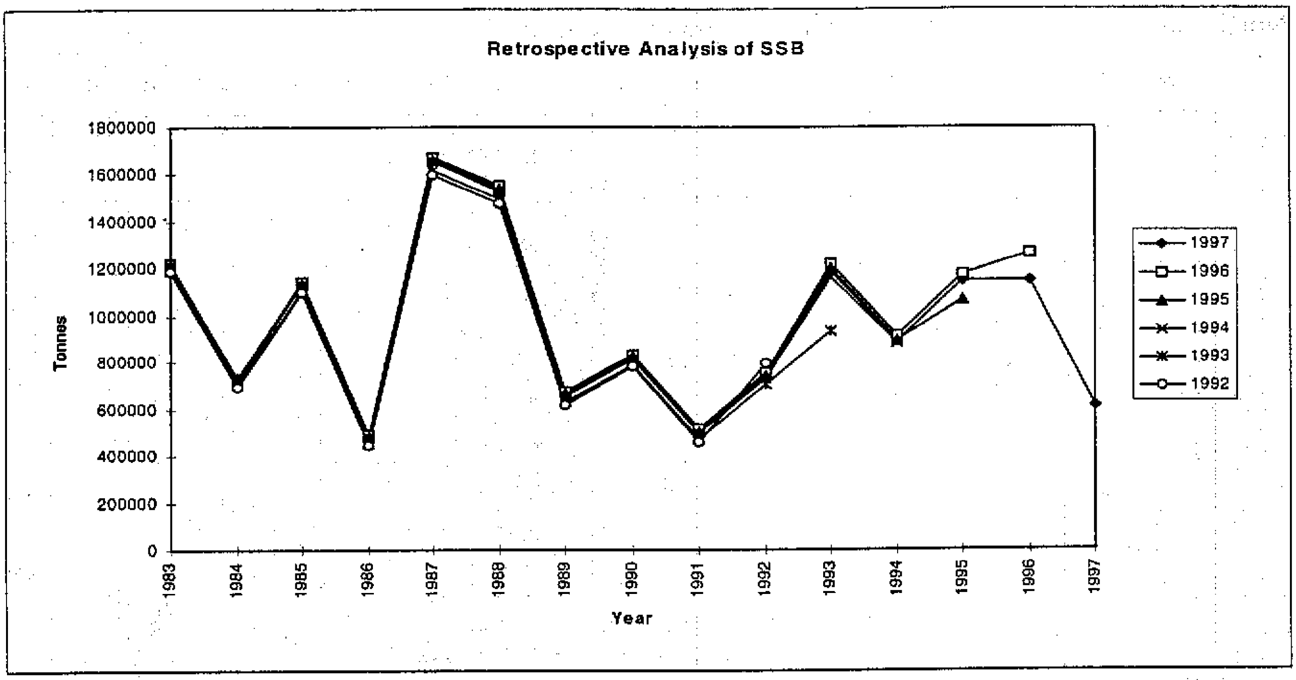
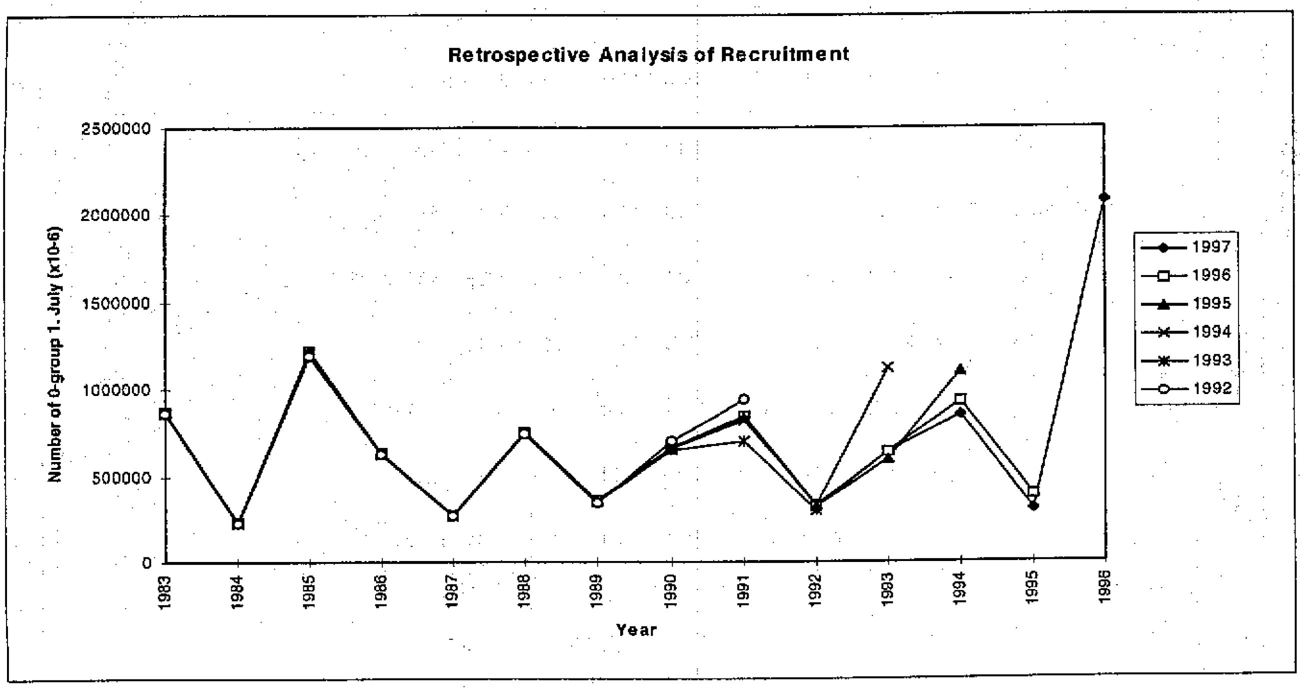


Figure 13.1.4.1 Retrospective analysis of SSB and Recruitment[1]

SXSA - Sandeel in the North Sea





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

Figure 13.1.4.2 Log residual stocknumbers by fleet and season.

SXSA - Sandeel in the North Sea

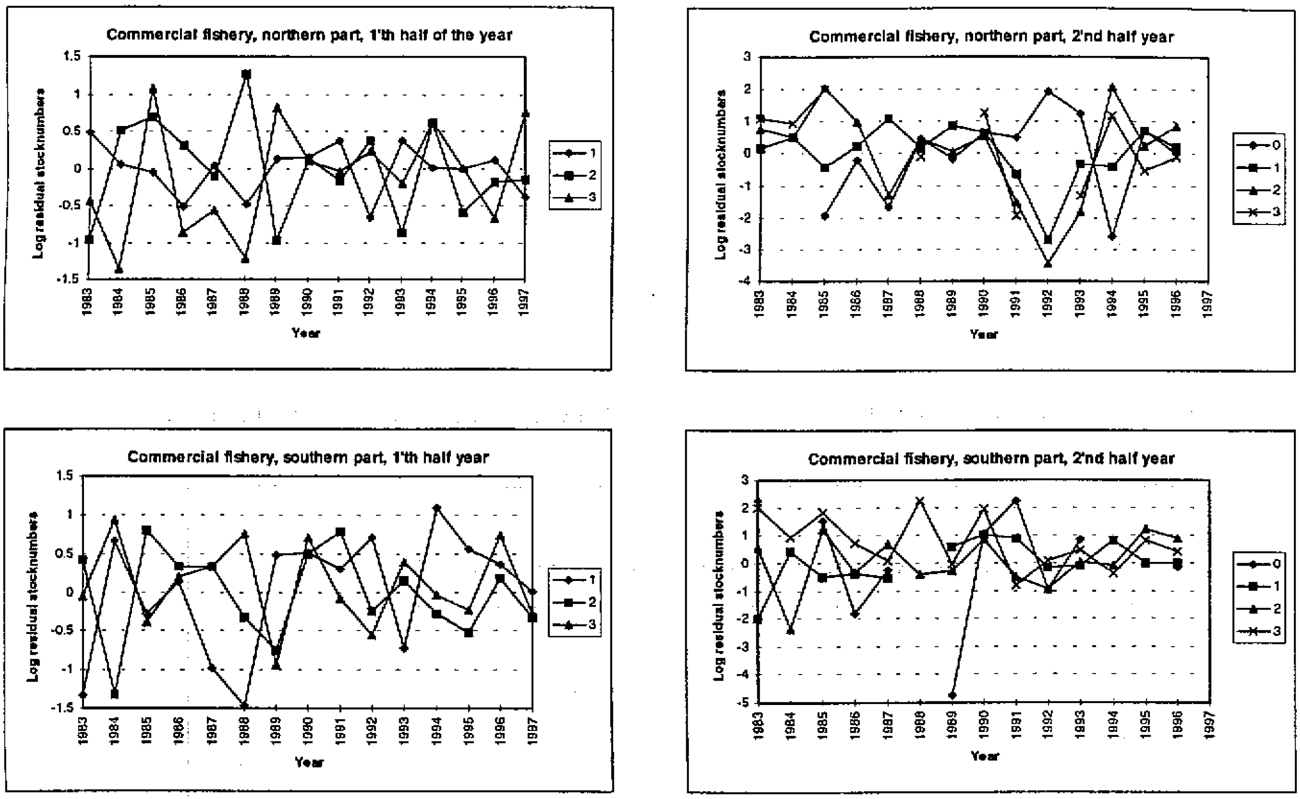


Figure 13.1.4.3 North Sea sandeel . Average fishing mortality for ages 1 and 2 versus fishing effort

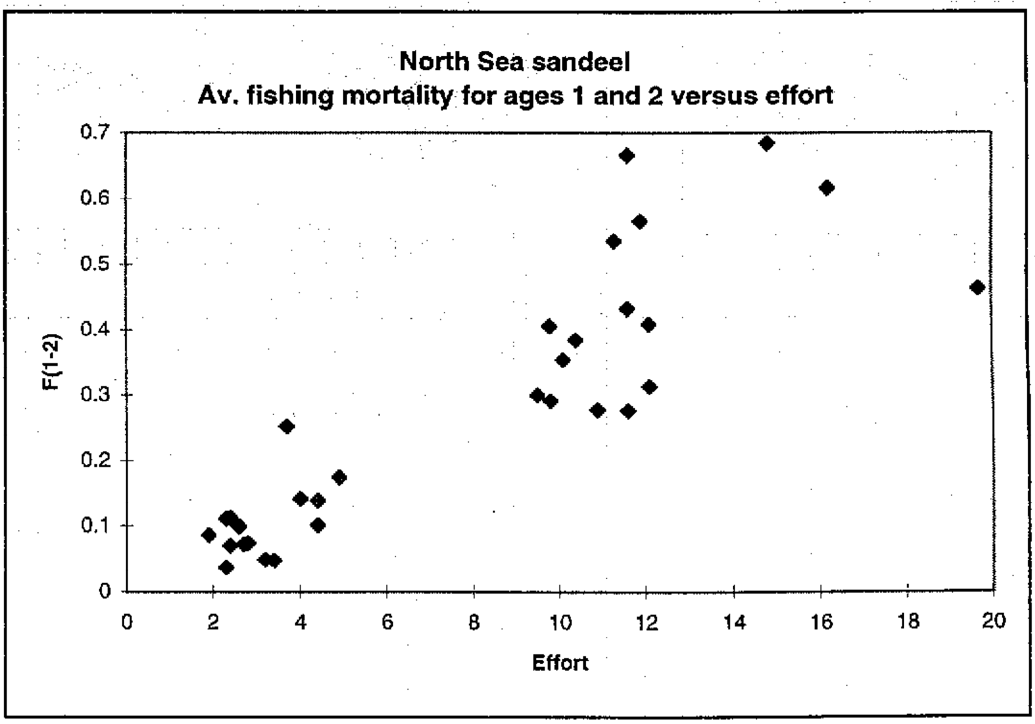


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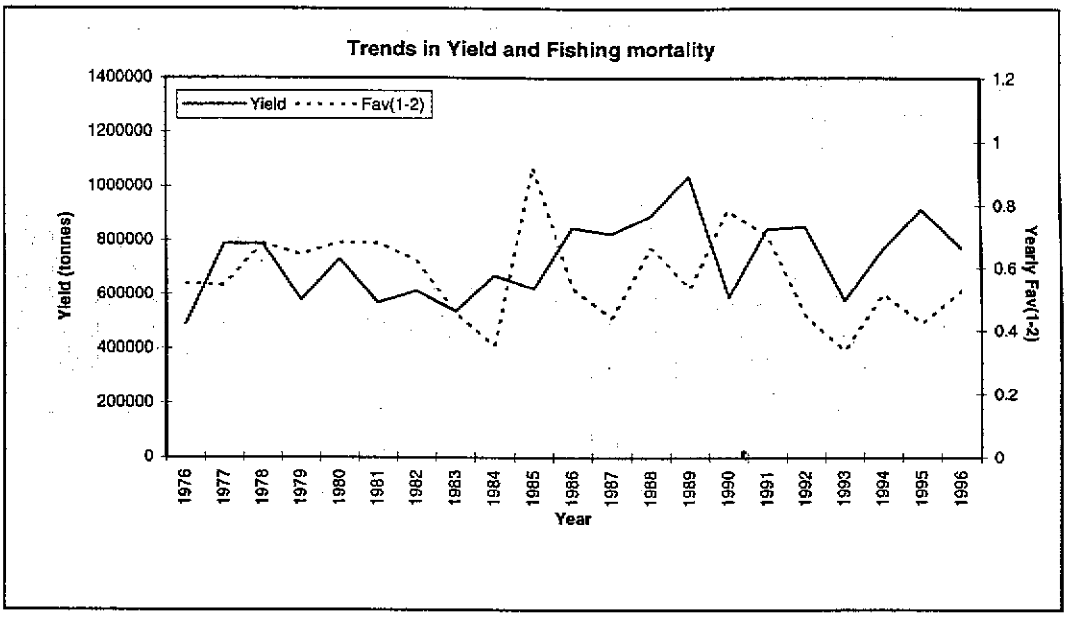
Figure 13.1.5.1 Trends in yield, fishing mortality (Fav1-2), SSB and Recruitment.



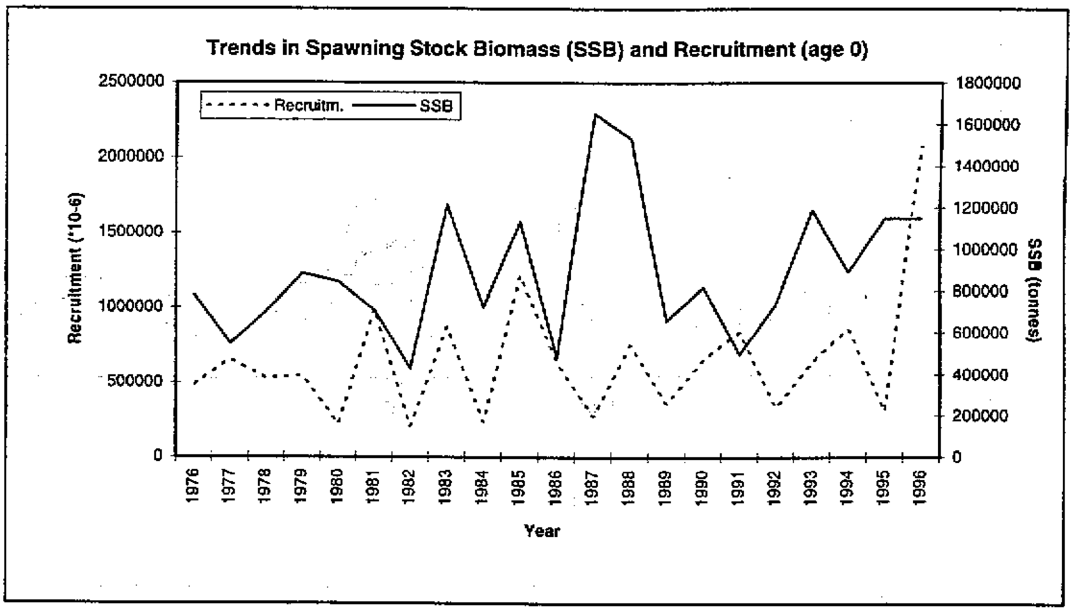


Figure 13.1.6.1 A comparison between the Lowestoft and Skagen versions of SXSA.

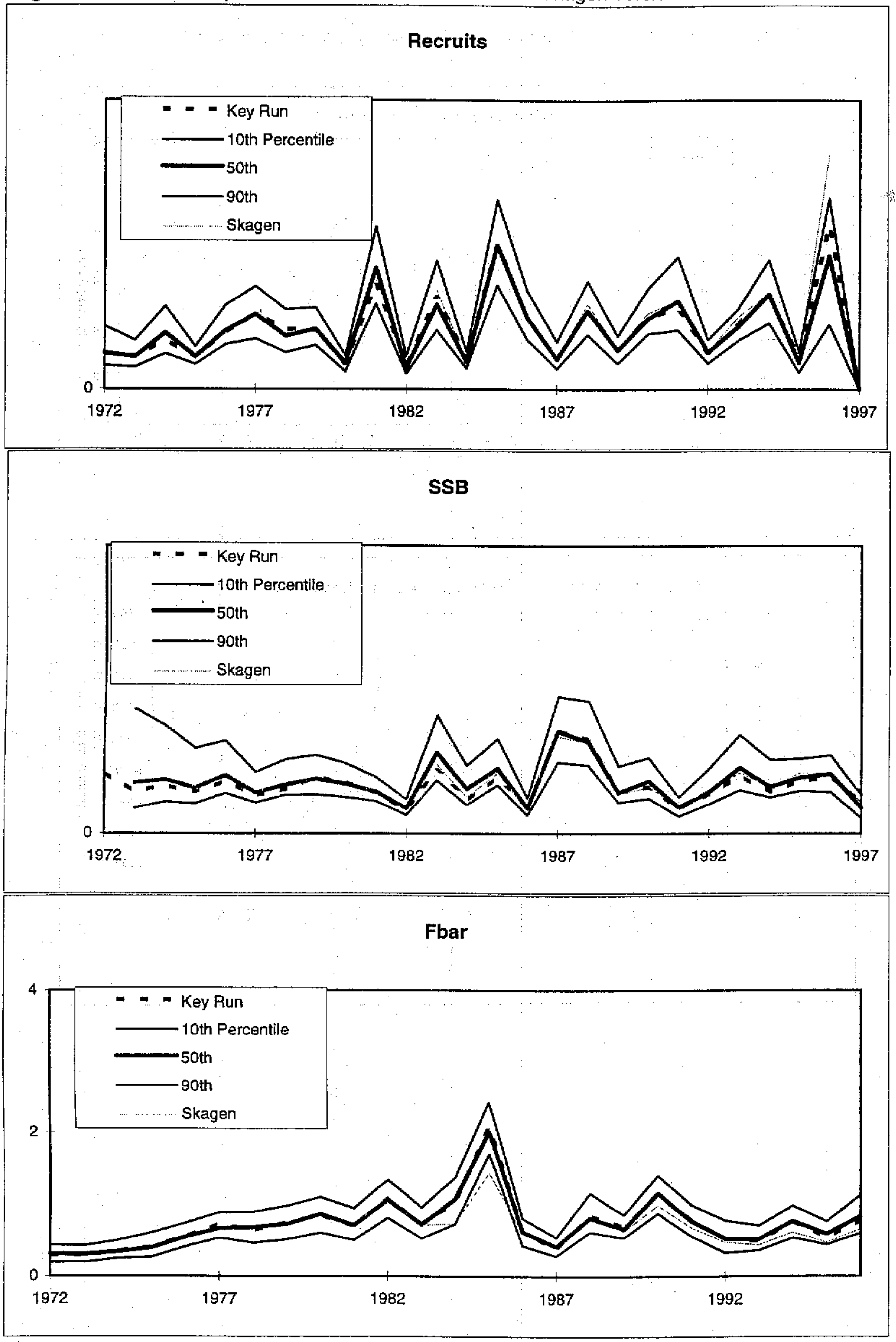


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Figure 13.1.6.2

Figure 13.1.6.2 Projected SSB, the 5th, 50th and 95th percentiles of SSB are shown.

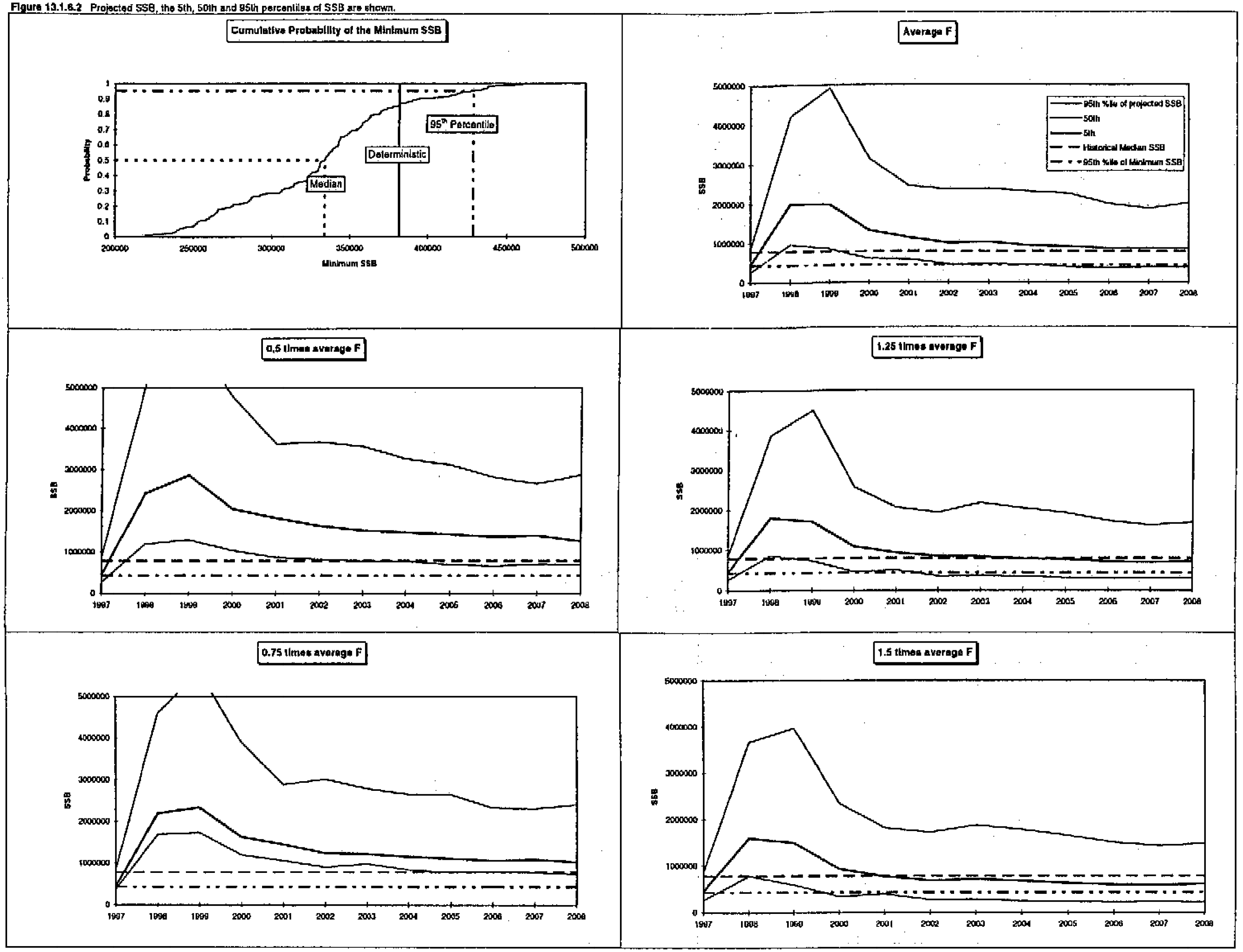

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Figure 13.1.8.1 A comparison between performing a seasonal and an annual XSA

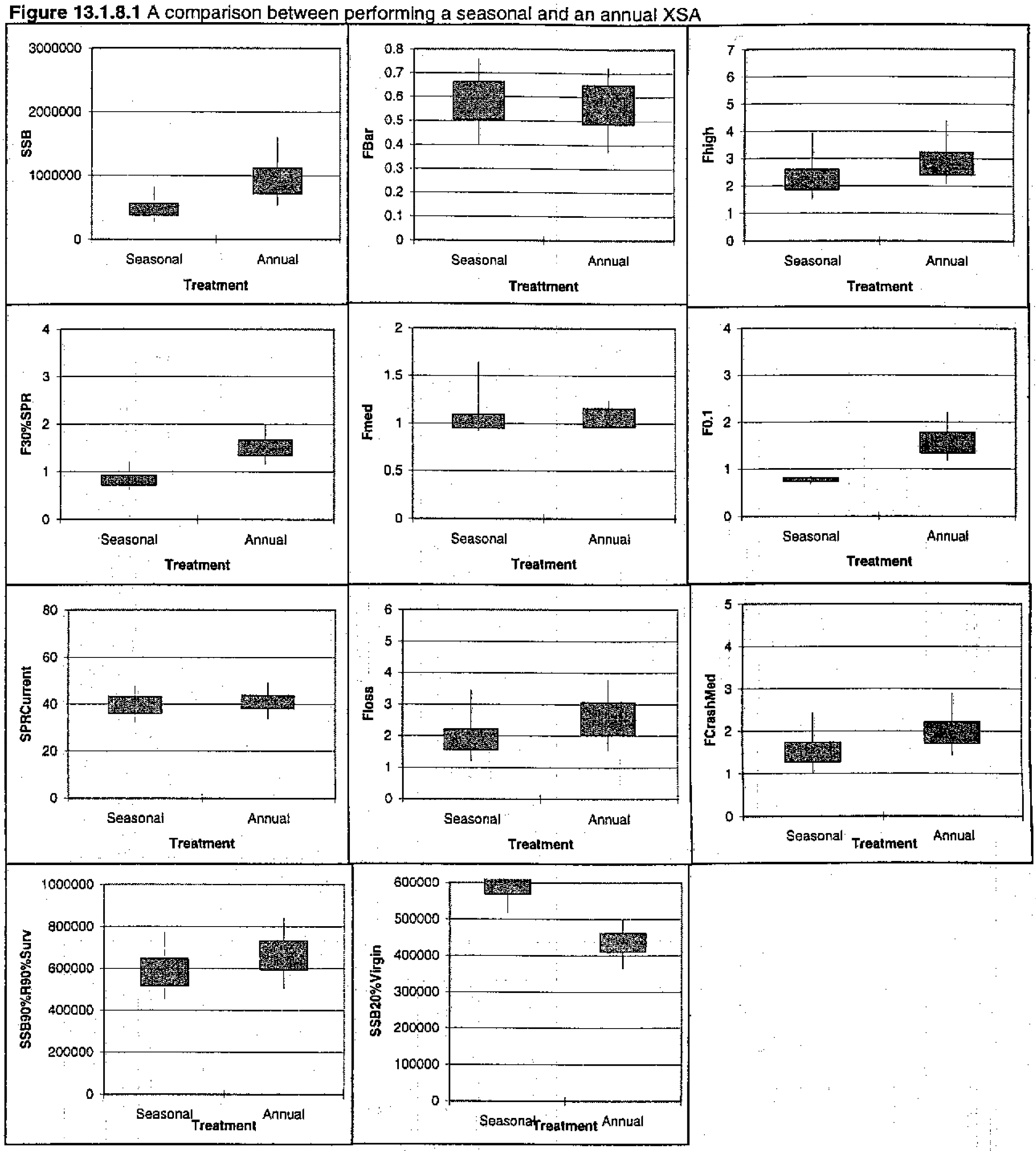

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Figure 13.1.8.2 A comparison between tuning XSA with a single North Sea fleet and northern and southern fleets.

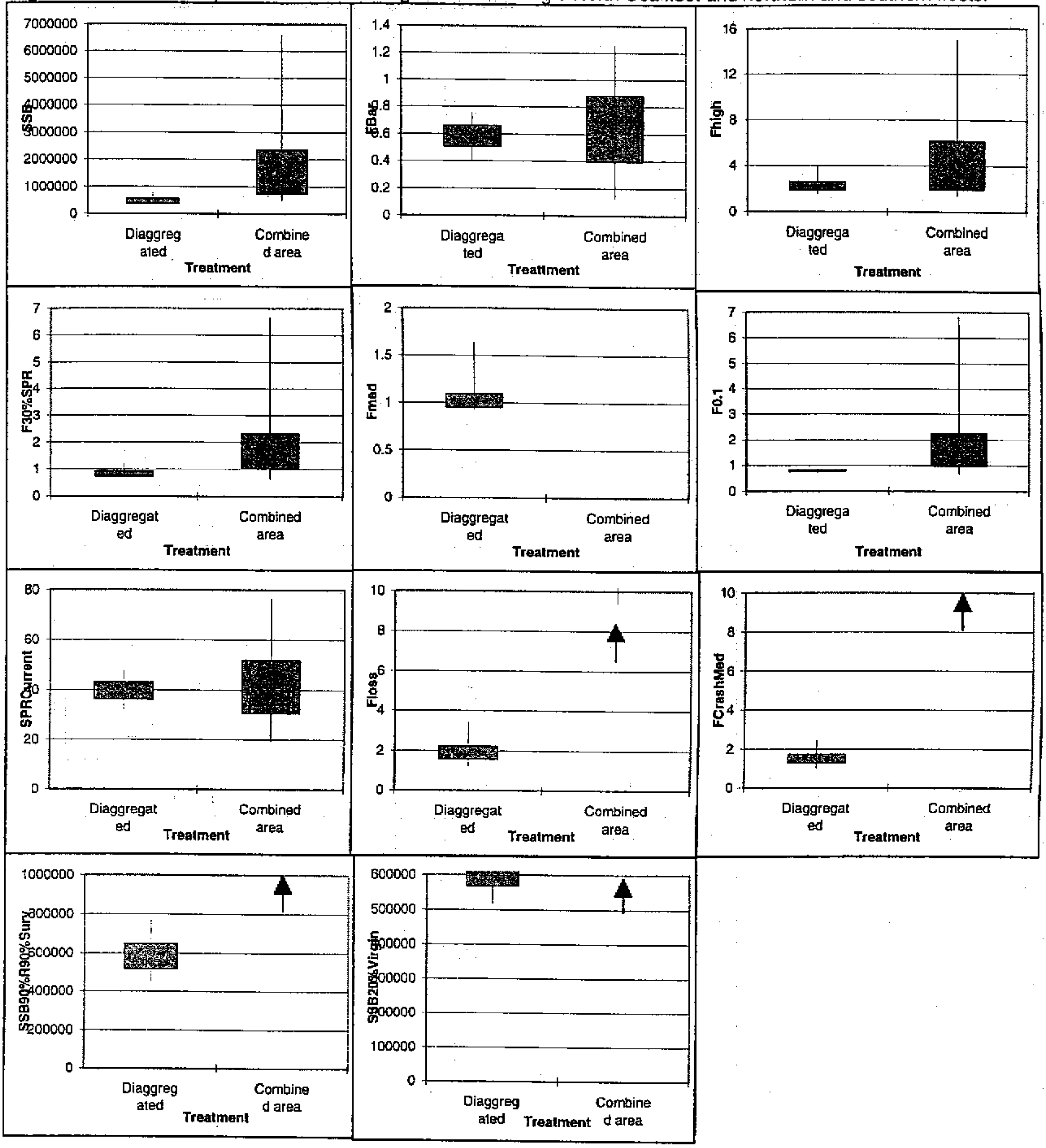

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Table 13.1.8.3 A comparison between using estimates for the missing 1990 data made from 1991and 1995 data sets

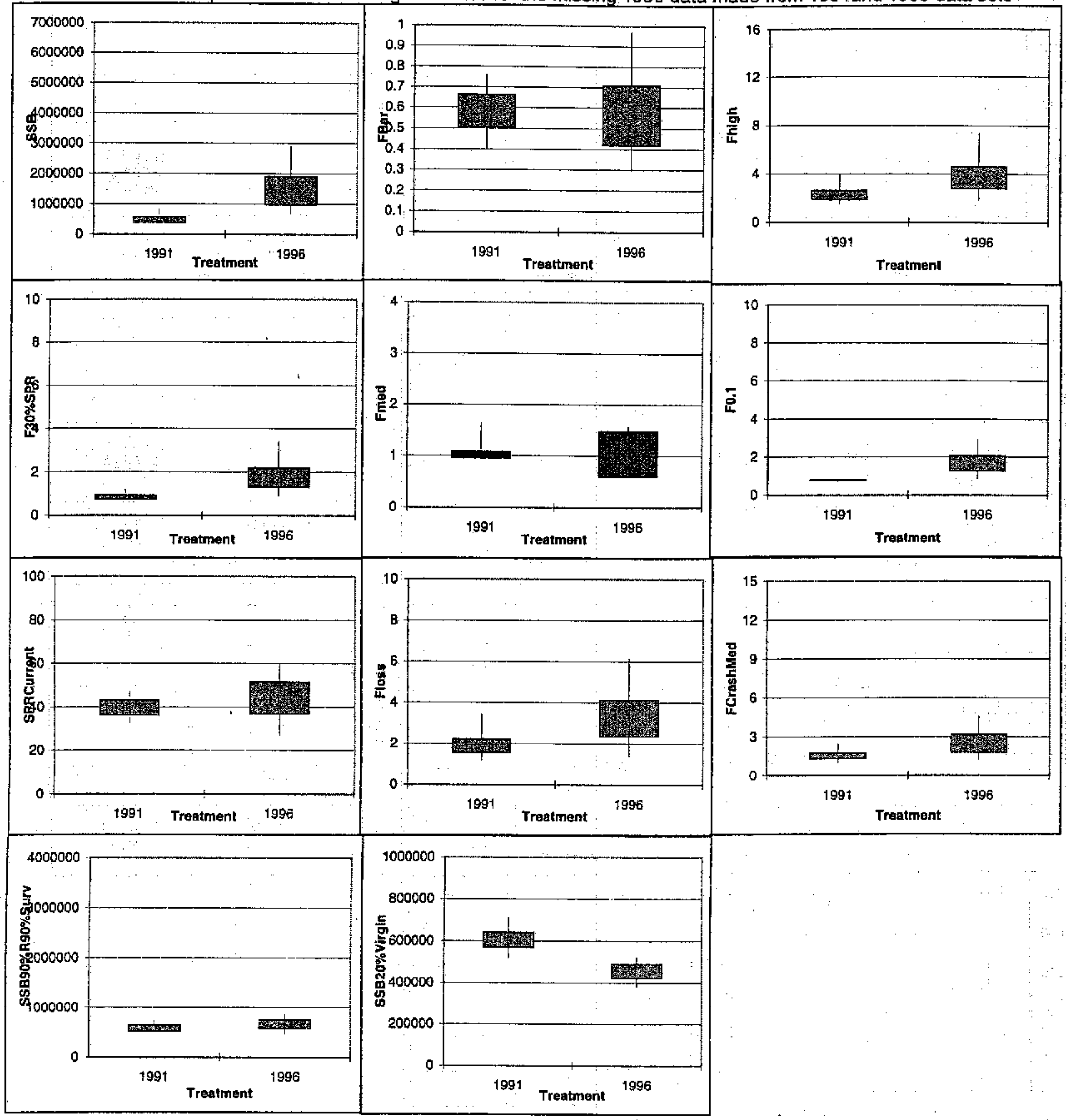

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Figure 13.1.9.1 North Sea Sandeel biological reference points.

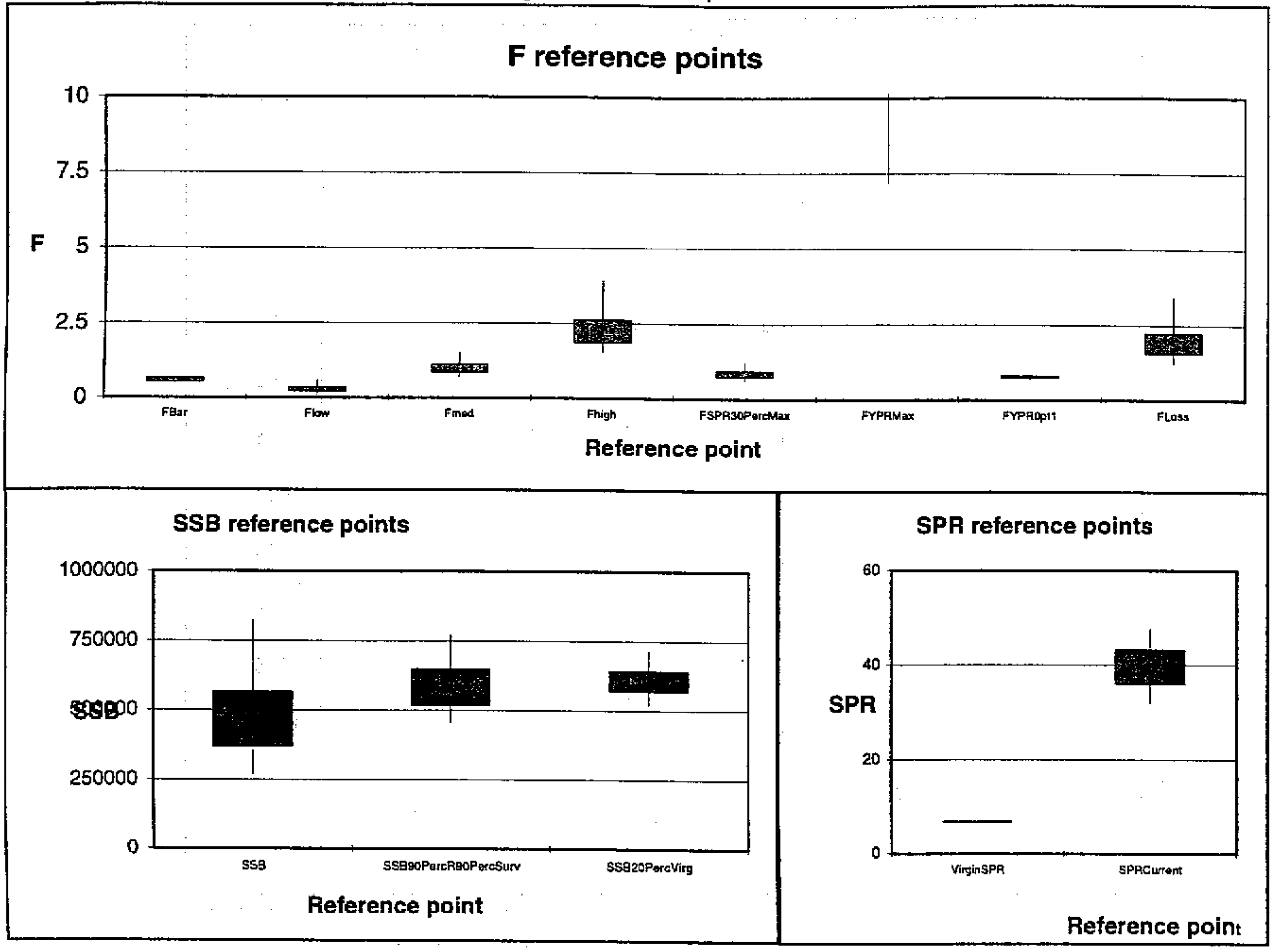

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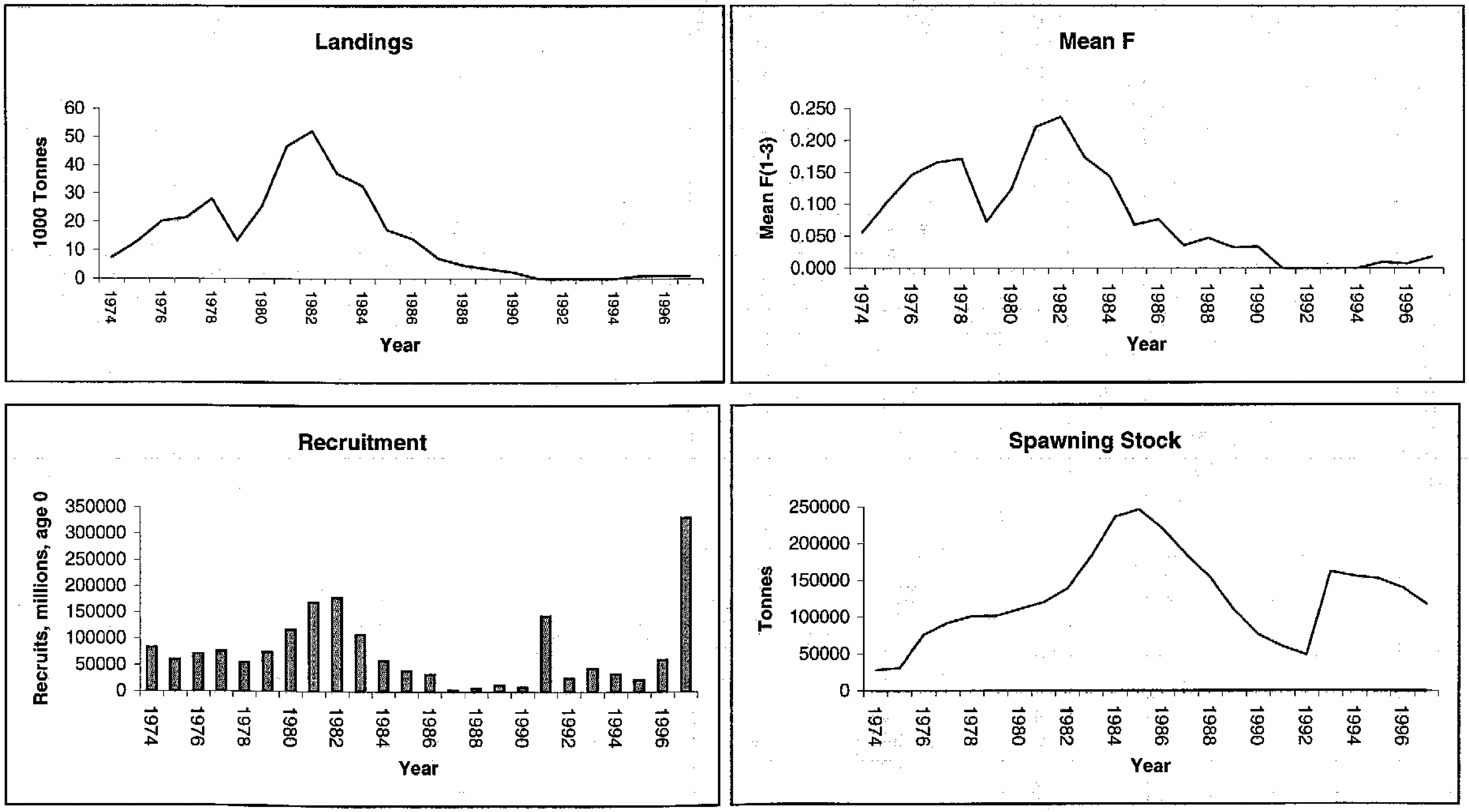
Figure 13.2.5.1 Sandeel at Shetland
Long-term trends in Landings, fishing mortality, recruitment and SSB



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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 bycatches in the Norway pout fishery. The sandeel fishery has a small bycatch 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 bycatch 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 6,322 t, which is below the series average of 12,375 t. No data are available on bycatches in this fishery. In addition, no age composition date are available so there are insufficient data available to assess this stock.

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 14.3.1.1, and trends in landings are given in Figure 14.3.1.1. In 1996 landings increased from the 1995 figure of 7,111 t to 13,257 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 Assessment

The assessment given in the previous Working Group Report (ICES CM 1997/Assess:6) used provisional data for 1996. Data for the 1997 catches were not available before or during the 1997 Working Group meeting, and changes to the 1996 data were slight so the assessment of this stock has not been updated. As with the fishery at Shetland, management of this fishery is on a three-yearly basis, with management measures to limit effort being agreed and then kept in place for a three year period. This limits the utility of annual assessments. Unless requested otherwise, the Working Group will no longer perform annual assessments of this stock.

Table 14.1.1 Norway Pout. Annual landings (t) in Division VIa (Data officially reported to ICES)

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Denmark	37714	5849	28180	3316	4348	5147	7338	14147	24431	6175
Faroes	-	376	11	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-	-	1	-
Netherlands	-	-	-	-	-	10	-	-	7	7
Norway	-	-	-	-	-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-	-	-
UK (E+W)	-	-	-	-	-	1	-	1	-	-
UK (Scotland)	553	517	5	-	-	-	-	+	-	140
Total	38267	6742	28196	3316	4348	5158	7338	14148	24439	6322

Table 14.3.1.1 Sandeel, Division VIa
Landings (tonnes), 1981-1996, as officially reported to ICES,

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Denmark	-	-	-	-	-	-	-	-	-	-
UK, Scotland	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	1996
Denmark	-	-	80	-	-	-
UK, Scotland	8532	4935	6156	10627	7111	13,257
Total	8532	4935	6236	10627	7111	13257

Figure 14.2.1 Norway Pout in Division VIa
Catch trends

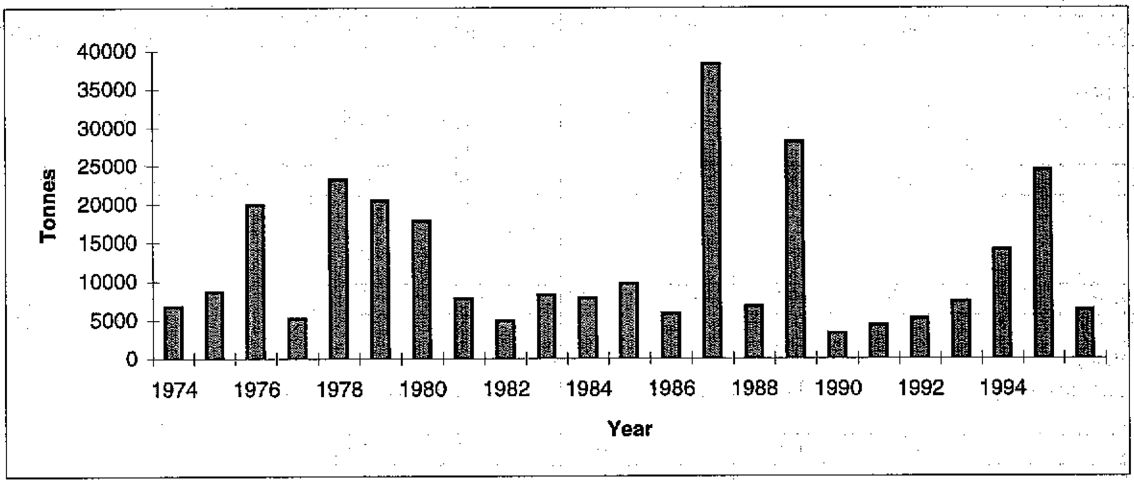
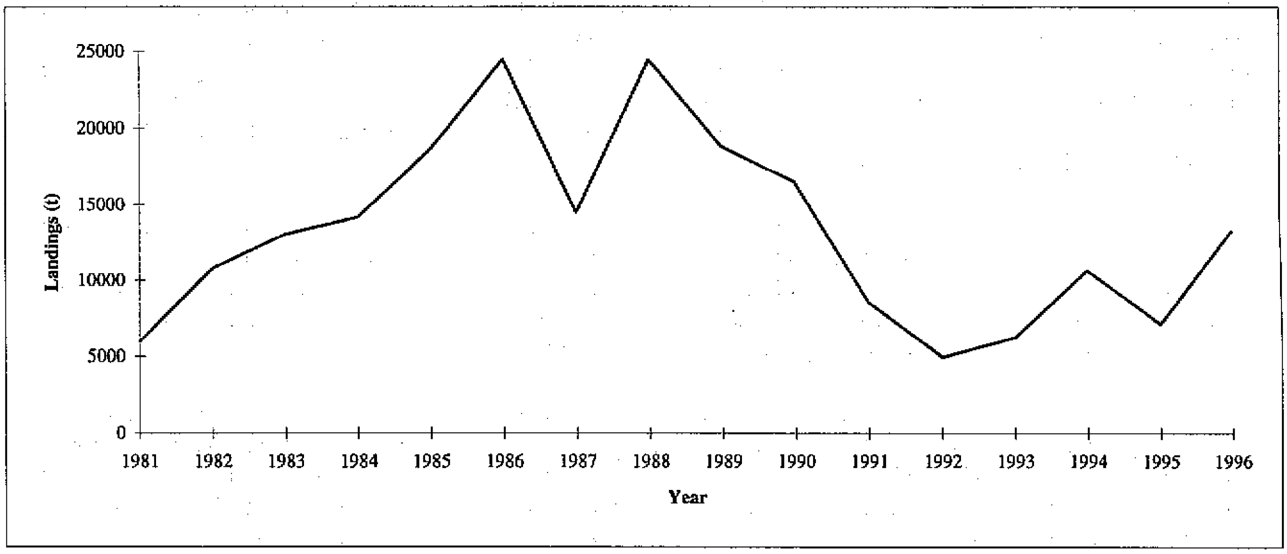


Figure 14.3.1.1 Sandeel in Division VIa.
Trends in landings



15 NEED FOR MANAGEMENT MEASURES TO SAFEGUARD THE STOCKS OF SANDEEL AND NORWAY POUT

Analyses based on seasonal XSA were conducted on data from sandeel in the North Sea. At this time, comparisons between seasonal and annual XSA models, as well as most of the stock recruitment modelling, have only been done for sandeel. For both the Norway pout and sandeel stocks in the North Sea, the current assessments (Sections 12 and 13 respectively) show SSB in 1996 and 1997 to be above average, and fishing mortality to be below average in 1995 and 1996 (Tables 12.6.1 and 13.1.5.1). A consideration in both assessments is that high levels of total mortality have existed throughout the time series, and that natural mortality is much larger relative to fishing mortality.

For the sandeel, stock recruitment modelling showed no clear indications of a reduction in recruitment at the lower levels of SSB in the time series. However, a major concern is to ensure that the total stock biomass remains high enough to provide food for a variety of predator species, who prey on different sizes of sandeel at different times. Nonetheless, previous work based on multispecies VPA suggests that even with increased fish predator populations, it may not be necessary to reduce the fishery for sandeel (SEC (92) 2406).

The relatively high values of natural mortality in this stock mean that the maximum of the yield per recruit curve is at a very high F, implying that fish should be caught before they are predated. Therefore, reference points based on optimising catch, such as F_{MSY} or $F_{0.1}$, are clearly not appropriate. Using alternative assessment methods, based on multispecies and/or hazard regression models (Cox, 1972), it may be possible to formulate reference points and management based on considerations of total mortality, rather than on fishing mortality.

A practical alternative is a precautionary limit reference point for SSB, based on the minimum level of SSB observed. This appears sensible since neither recruitment nor the overall abundance of sandeel in the North Sea appears to have been reduced at historical levels of SSB. It is possible to estimate the empirical distribution function of the lowest observed SSB (SSB min) and then decide on a particularly low probability level, such that the probability of falling below SSB min should be lower than this level over a specific time frame. The probability level will, of course, be determined by assumptions made about the uncertainty of the biological parameters as well as of the catch at age data. Projections based on multipliers of the average of the 1994–1996 catches or effort could be performed and assessed against statistics obtained from SSB min. Details of this approach are contained in the sandeel assessment report, Sections 13.1.6 and 13.1.9.

A definition of this biomass limit (SSB min), based on the North Sea assessment, assumes that the sandeel stock can be treated as a unit stock. If sandeel in the North Sea actually consists of a number of smaller, interrelated sub-stocks, then the use of a limit for the entire North Sea is inappropriate. An alternative would be to consider the biological processes, size structure of the sandeel population, and the interactions of the fisheries and sub stocks with other species, and to propose safe biological limits from an ecological rather than a purely stock assessment view point (ICES CM 1997/Assess:6, p. 595–599).

The evaluation of management measures will need to be undertaken within a simulation framework that allows the full uncertainty in biology, fleet dynamics, assessment, and implementation to be investigated. Experiments that include process, observation, and model error, as recommended by the Comprehensive Fisheries Evaluation Working Group (ICES CM 1997/Assess:15) may then be used to explore fully any alternative management measures.

In conclusion, the application of a stochastic simulation model to sandeel data, based on defining a minimum SSB level, appears to be a reasonable assessment-based tool for use in sandeel management. Further work on the spatial structure of sandeel stocks is proceeding.

For Norway pout, a similar approach may be appropriate, pending evaluation of the higher seasonal F to M ratios found for this species. As well, key issues for Norway pout are more likely related to by-catch, rather than stock structure.

16 EVALUATION OF THE EFFECT OF SANDEEL FISHERIES ON LOCAL AGGREGATIONS OF SANDEEL

The Working Group has been requested to 'define the information required to evaluate, and, if possible, carry out an evaluation of 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'.

The Working Group was given the same request in 1996 and a review of information and a definition of data needs was given in Section 18 of the report (ICES CM 1997/Assess:6). The present request is therefore understood as a request for updating this review if possible. The Working Group has not been able to identify new primary information relating to this issue. Reference is therefore made to Section 18 of last year's report. The Working Group of Ecosystem Effects of Fisheries has been given the same request and will have its first opportunity to address it at its meeting in 1997.

17 BIOLOGICAL REFERENCE POINTS

The Working Group is requested to 'provide a definition of safe biological limits using target reference points based, where appropriate, on biomass, fishing mortality, maturity, growth, age structure, exploitation pattern, geographic distribution and other relevant parameters; based on the above parameters, propose limit reference points to be avoided with a high probability.'

According to usual definitions of reference points as emerging from international conventions etc. target reference points 'are intended to meet management objectives' while limit reference points 'set boundaries which are intended to constrain harvesting within safe biological limits within which the stock can produce maximum sustainable yield' (quotes from UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks).

Target reference points relate to management objectives which have not been defined for the stocks considered by the present Working Group and can not be defined solely on a biological-technical basis. It is therefore not considered appropriate that the Working Group attempts to define management objectives beyond biological sustainability.

Recent discussions on the precautionary approach to fisheries management (e.g. ICES CM 1997/Assess:7; ICES CM 1997/Assess:15) have led to the following concepts of reference points:

- Target reference points: referring to management objectives,
- PA (precautionary approach) reference points: reference points confining the fishery to a region with a low probability of limit reference points to be exceeded,
- Limit reference points: reference points beyond which the stock is considered outside safe biological limits.

PA reference points are not independent reference points as they are associated with limit reference points through probability considerations. ICES CM 1997/Assess:7 suggested 'low probability' to be a probability of 0.05 or smaller. PA reference points should thus be derived directly from limit reference points if the distributions of fishing mortality and/or biomasses are known. PA reference points may in practice become target points if it were the case that management objectives were limited to sustainable yield maximisation with a sustainability criterion based on limit reference points.

The Study Group on the Precautionary Approach to Fisheries Management (ICES CM 1997/Assess:7) focused its discussion of limit reference points on fishing mortalities but added that corresponding and compatible biomass reference points would be used as well to be consistent with a precautionary approach. The discussion on fishing mortality based limit points has focused on F_{crash} (which may be impossible to estimate due to its sensitivity to the shape of the stock-recruitment relationship near the origin) or, as a conservative proxy to F_{crash}, F_{loss}, F_{med}, which is supposed to be an estimate of sustainable fishing mortality, has been discussed as a candidate for F_{lim} as well, but mainly as a value which is expected to be below F_{crash}, and therefore could serve as a precautionary proxy in a situation with poor data.

Biomass based limit points should ideally be derived from or in the same process as these F_{lim} estimates if they are to be 'corresponding and compatible'. However, the proposals for B_{lim} reference points which have been brought forward are in some cases independent of proposals for F_{lim} reference points. There is a need for further developments of concepts and methodology before a consistent framework of F and B limit reference points has been developed.

Biomass based limit reference points have played an important role in the management of several of the demersal stocks in the North Sea and Skagerrak. The MBAL concept has been a cornerstone in the considerations on Safe Biological Limits to the extent that the concepts of MBAL and SBL have been used as if they were equivalent. In its 1996 report (ICES CM 1997/Assess:6) this Working Group discussed and presented MBAL concepts and values in relation to the stocks dealt with by the Working Group. The values presented in last year's Working Group report are based on the ACFM (1991) criteria with the necessary extension needed to handle recent historic low SSB found in some stocks. The criteria were:

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.

These criteria will result in MBAL being equal to B_{loss} except in two cases: 1) when there is an indication of lower recruitment on the left hand side of the plot of historic stock and recruitment and 2) when recent SSB values are the lowest in the historical record in which case the lowest SSB from which the stock has recovered is used.

The MBAL estimates of last year's Working Group report are summarised in Table 17.1.

Within the framework of limit, target and precautionary approach reference points the concept of MBAL has lost its former status of a limit-type reference point which in some cases were determined such that there was some aspect of precautionarity built into it. The MBAL concept is now used in a much narrower sense as criteria a) above. This means that MBAL is undefined for stocks without apparent reductions in recruitment at low spawning stock biomasses.

Recent analysis of these stocks (Cook xxx, ICES CM 1997/Assess:6, Section 16.2) has provided a better understanding of the fishing mortality levels which may be considered as limit reference points. The basic approach is to compare present exploitation rates with F_{loss}, which is used as a limit reference point in lack of F_{crash}. Distributions of F_{loss} and $F_{present}$ are evaluated and the overlap between these are used as estimators for the probability that present F levels are at or above F_{loss}. A precautionary reference point in the sense discussed above would in this context be a fishing mortality which has a probability of 0.05 or less of being at or above F_{loss}. This approach has been explored by the Northern Shelf Working Group.

Given the history of biomass based limit reference points for the stocks considered by the Working Group, the Working Group has opted to base its discussion of reference points on biomass based limit reference points and derive precautionary reference points from these. The approach used is based on precautionary reference points being derived from biomass limit points on basis of terminal probability distributions of SSB from medium-term forecasts. In its 1996 report the Working Group presented plots of the lower fractiles of the medium-term SSB distribution as a function of fishing mortality. This approach has been expanded to incorporate the new concepts of F_{pa} as derived from limit reference points: given a biomass based limit reference point B_{lim}, an F level can be estimated which will be associated with a probability of α% of SSB being below B_{lim} in the medium term (Figure 17.1). This level ($F_{pa,\alpha}$) is then used as a precautionary reference point which is consistent with the limit reference point. $F_{pa,\alpha}$ will in the medium term be associated with a median SSB. This SSB level, $B_{pa,\alpha}$, will be a biomass based precautionary reference point which is consistent with $F_{pa,\alpha}$ and B_{lim}.

This approach should in principle be based on probability distributions of both the SSB in a medium-term projection and B_{lim}. Probability distributions of B_{lim} have not been estimated on a routine basis, but a model has been developed for sandeel in which case the estimation of $F_{p,5}$ can be based on overlaps between the distributions of medium-term SSB and B_{lim}.

The recruitment models to be used for this purpose in medium-term projections should be chosen to reflect the precautionarity: if the historic data seem to contain little or no information on the stock-recruitment relationship near the origin a recruitment model should be chosen which best reflects the possibility that B_{loss} may be the inflection point below which reduced recruitment is expected. The choice of recruitment model is thus not based on a judgement of the biological realism of the model but rather as a limit model implying a rapid reduction of recruitment with reduced SSB.

The Study Group on the Precautionary Approach to Fisheries Management recommended precautionary reference points to be associated with a probability of not more than 0.05 of limit reference points to be exceeded in which case $F_{pa,5}$ and $B_{pa,5}$ should be the recommended precautionary reference points. Reference points have however as a standard been presented on basis of α=5, 10 and 20%.

The set of reference points B_{lim}, $F_{pa,5}$ and $B_{pa,5}$ for the stocks assessed by this Working Group are summarised in Table 17.1.

The reference points estimated for the present stocks should be evaluated keeping in mind that:

- The reference points are very sensitive to the recruitment model chosen. For technical reasons it has not in all cases been possible to use a recruitment model reflecting the possibility that B_{loss} or MBAL (in the present sense) is the inflection point below which recruitment is reduced. The right hand tail of the stock-recruitment relationship will also have influence on the lower tail of the medium-term SSB distributions, and there is generally very little basis for estimating the shape of that part of the recruitment curve.

- Some implementations of the medium-term projections do not include all sources of variability. The model used for most stocks in the present report only includes the variance on initial parameter estimates and subsequent recruitment variation. However, several other factors will be subject to variability: growth, natural mortality, maturity, fishing mortality level and pattern (or rather: management should be integrated into the model rather than assuming a constant F-level) etc.

- The procedures used to estimate the variances may provide underestimates (Kell *et al.*, working document to this Working Group)

These points will all tend to result in underestimates of the variability in SSB in the medium term and thus in overestimates of F_{pa}. For several stocks the precautionary approach reference points indicated should therefore be considered overestimates of F_{pa} and underestimates of B_{pa}. It is therefore crucial that there is further development in methods and tools allowing appropriate recruitment models to be used and more complete estimates of variability to be included.

Another problem arises for stocks which have been exploited on a more or less constant level over the available time series and for which only a short time series is available. For these stocks the dynamic range in the data is too limited to establish any understanding of the dynamics of the stock on the longer term or when exploitation is changed. As an example: consider a stock which has always been exploited on a low level and which has a fairly stable recruitment pattern. B_{loss} will in this case be close to the mean SSB and a medium-term prediction at current exploitation will almost certainly give a high probability of SSB falling below B_{loss}. A precautionary reference point derived in the way described above will be considerably higher than current F even if F is on a low level. The reverse situation will be true if a short time series with high exploitation level is available.

Table 17.1 Biological reference points based on ACFM 1991 criteria (ICES CM 1997/Assess:6) and precautionary approach criteria (present report). Biomass estimates in '000 t.

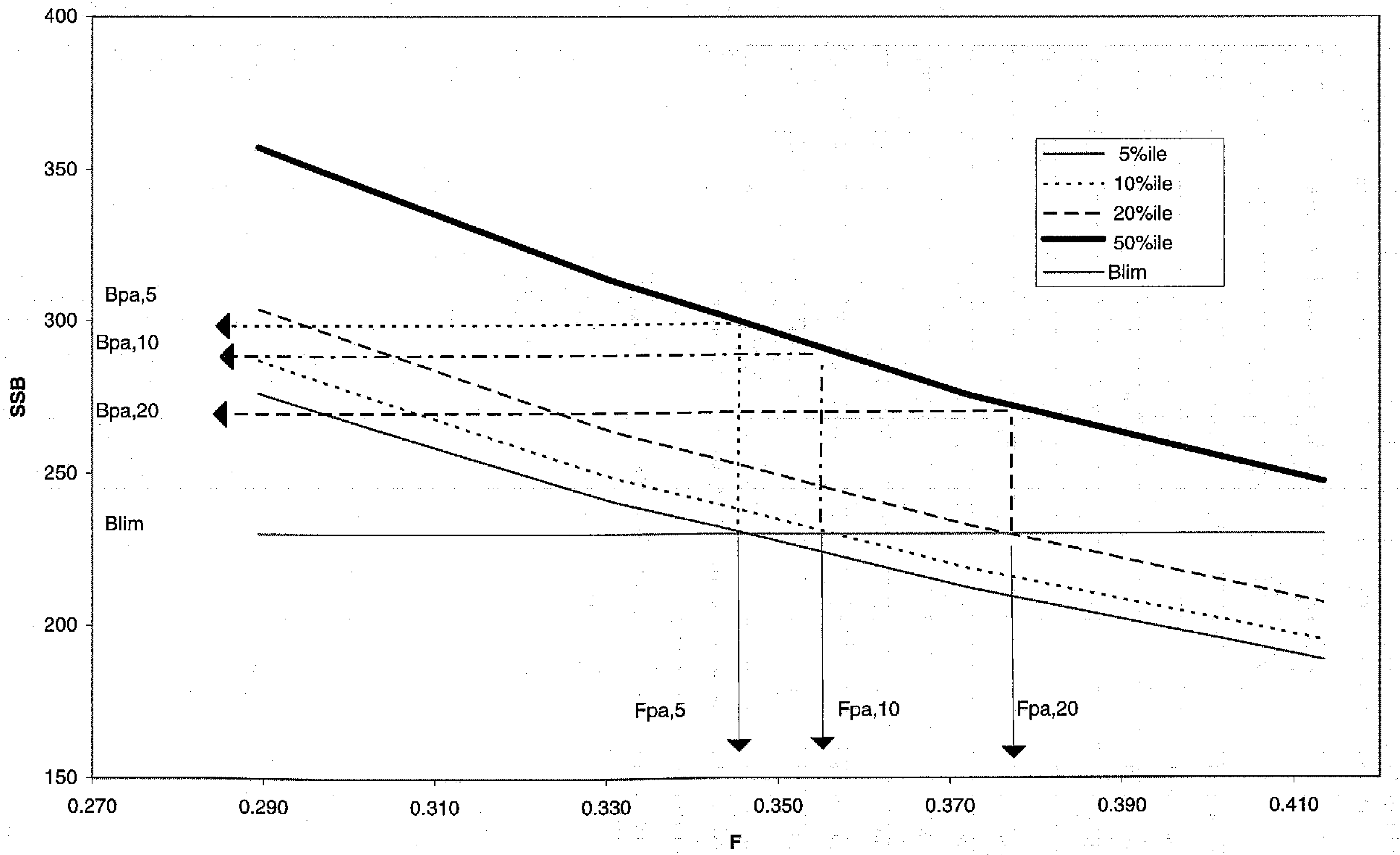
Stock	MBAL as per ACFM 1991criteria, From 1996 WG report		Biological reference points based on PA criteria [1] Present WG report			
	MBAL	Criterion [2]	Blim	Basis	$F_{pa,5}$	$B_{pa,5}$
Cod in IV, VIId and Skagerrak	150	a)	150	MBAL	.73	221
Haddock in IV and IIIa	65	b)	63	Bloss	.92	154
Whiting in IV and VIId	250	b)	238	Bloss	.93	420
Saithe in IV and IIIa	150	a)	125	MBAL	.49	175
Sole in IV	25	b)	25	Bloss	.43	41
Sole in VIId	7	b)	7.8	Bloss	.44	10.4
Plaice in IV	300	b)	220	Bloss	.37	283
Plaice in VIId	6	b)	5,6	Bloss	.58	7.1
Plaice in IIIa	25	b)	24	Bloss	.95	34
Norway pout in IV and IIIa	120	a)	150	MBAL	na	na
Sandeel in IV	430	b)	330	Median of boostrapped minimumSSB for the period 1976-1997	na	na

1 See details in respective stock sections. MBAL is here used in the present sense of the concept, see text.

2 The criteria a) and b) are described in the text.

na : not available as appropriate medium term projection not available

Figure 17.1 Reference points: derivation of precautionary reference points from B_{lim}, see text.



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18 DISCARD

18.1 Introduction

The Working Group has been asked to provide information on quantities of discard by gear type and area for the stocks and fisheries considered this Group.

Discards appear in most fisheries. Fish are discarded because they are either of no economic interest or illegal to land. Discards due to economic interests usually consisted of non commercial or low value commercial fish or fish sizes. Discards due to legal restrictions usually consist of undersized or overquota fish, but at times fish are discarded due to an economic optimisation of the vessel quota. Discarding due to quotas and minimum-landing-size is originally for protection purposes, but discarding may contribute to an increased mortality for the fish discarded. The significance of the discard mortality is under investigation.

Discards have been recorded since the 1920s, but most of the existing data are not quantitative. Several national and international sampling schemes has been conducted or are being conducted the recent years. Oncoming sampling schemes are planned to include several countries around the North Sea.

Recently, discards was treated in the Study group on Ecosystem Effects of Fishing Activities. The Study Group presented a table quantifying the discard of haddock and whiting in the North Sea (ICES 1995 Coop. Res. Rep. No 200).

This Working Group was provided with data from five sampling schemes. The data is either preliminary or given in relative amounts character for several of the sampling schemes, and therefore not directly comparable. Each sampling scheme is therefore presented separately below.

The sampling schemes are the German sampling scheme by BFAFi, Hamburg, the Dutch sampling scheme by RIVO, IJmuiden, the Danish discard sampling scheme by DIFRES, the English sampling scheme by CEFAS and the University of East Anglia, and the Scottish sampling scheme by FRS Marine Lab, Aberdeen. The Danish, English, and Scottish sampling schemes are collaborating in the EC Project: 95/094, On-board sampling of fish landed and discarded by commercial vessels (EC Project: 95/094).

Of these sampling schemes only the Scottish is currently used to estimate discard for stock assessments. The sampling schemes, exempt for the Dutch, are ongoing, with the intention to provide more discard information for fish stock assessments.

18.2 The German Discard Sampling Scheme (1994-ongoing)

Information on discards in the German fishery are available for the three main fleets in the North Sea (EU-Study). However, as the years of investigation (1995–1997) are not covered in all seasons, conclusions on the amount of discards per year can be drawn only for parts of it (Tables 18.2.1–18.2.6).

The **fishery on saithe in Division IVa** is conducted as a one-boat fishery with roller gear attached to the groundrope. In the 2 years of investigation the fleet consisted of 24 and 15 trawlers respectively. Freezer trawlers only had a marginal share.

The proportion of discards by weight of the 16 trips investigated varied between 0,4 and 18.2%. On an average 6.1% of the catch has been thrown over board in this fishery. In 1996 the average catch per hour of marketable fish in this fleet was 478.6 kg, the respective discards amounted to 31.0 kg. The estimates for 1996 total to 780,000 saithe, 120,000 cod, 355,000 whiting, and 700,000 haddock as discards. Soles are absent and plaice catches are marginal.

The **mixed gadoid fishery in Division IVb and c** throughout uses meshes of 100 mm mesh opening. It is aimed for cod and is carried out with one or two boats. Partly the trawl gears are equipped with rollers. The number of vessels in the relevant segments G16 and G17 went down from 52 in 1995 to 40 in 1996.

The fishery was carried out in all quarters of 1995 and 1996, with some emphasis in the summer months. This is a recent development, as traditionally it has been observed mainly in the months October to March. The shift to the quarters 2 and 3 has to be seen in connection with the general decrease of the cod stock, leading to small catches in the German Bight in winter. Due to irregular landings in German ports, in each year only 2 trips had observers on board. Therefore, it seems difficult to extrapolate from the available data to the total German cod fishery. The investigated landings constitute to more than 95% of cod, which means that this is a rather „clean" fishery. The share of the catch that had to be discarded also was remarkably low: between 2.8 and 9.2%. These favourable conditions, however, at least partially find their explanation in the sequence of low year classes of cod.

The **fishery on flatfish in Division IVb and c** is carried out mainly by small beamtrawlers. They are classified in the segments C11 (shrimpers), C12 (beamtrawlers <20m) and G13 (Euro-cutters). Whereas the segments C12 and G13 have been rather constant in number, does the number under C11 show a strong decrease. The area of operation is in the eastern central North Sea, mainly the German Bight. When catching for plaice, the fishery mostly is concentrated along the Danish coast.

The beamtrawl fishery has a clear seasonality with a peak in the second or third quarter. The catches during the first quarter are mainly landed by Dutch fishermen under German flag.

The data of 10 fishing trips were collected: 7 of them are originated from 1995, covering three quarters of the year. In 1996 two quarters were covered only. By adoption of the sampling results from 1995, the sole and plaice discards for quarter 2-96 has been also estimated.

The German beamtrawl fishery aims either at sole or plaice. The share of fish discards per trip vary in the fishery on sole (80 mm mesh opening) between 60 and 82%, and on plaice (100 mm mesh opening) between 47 and 63%. On an average, the data show for all fishing trips a figure of 66.1% discards, for 1995 alone it is 68.2%. Expressed in catch per hour, the German beam-trawl fishery in 1995 caught 68.7 kg/h marketable fish and 148.0 kg/h were discarded.

Sole discards in quarters 2 to 4/1995 were estimated to 2.6 million and in the same period in 1996 to 0.7 million fish. Plaice is discarded in much greater quantities: The estimated discards during the 3 quarters sum up to 60 and 24 million respectively, for the German fleet alone.

Cod discards in the beamtrawl fishery are estimated for 1995 to 1.6 million young cod with a weight of 380 tonnes.

18.3 The Dutch Discard Sampling Scheme (1976–1990)

Discard data have been collected by the Netherlands on board of commercial twin beam trawlers in the periods 1976–1983 (43 vessels) and 1989–1990 (6 vessels). The aim of the sampling scheme programme was to get information on the level of discards of plaice and sole, which are the target species of this fleet.

Beam trawlers in the Netherlands usually make fishing trips of one week (Monday to Friday). Haul duration may vary between trips, depending of the amount of (by)catch in each haul and fishing ground but are generally 2 hours. In most trips two observers stayed on board for the whole week to sample discards and landings. The sampling procedure between the two periods differed, because of changes in logistic procedures in handling of the catch have been introduced between these periods. In the first period the catch in both cod-ends were emptied on deck and commercial legal sized fish were sorted out by the crew. Thereafter, the remaining catch was estimated and a sample of 40 kg (one basket) was taken by the observers and sorted out for all species. The length distribution of all fish species was recorded and raised to the total catch of the haul. At the end of the trips the measurement in the individual hauls were combined and raised to the total number of fishing hours made by the vessel. In general about 80% of the hauls were sampled. Weighted samples of species landings were measured 2–4 times a day and combined and raised to the total landings at the end of the trip. In the second period the codends were emptied in reservoirs and the catch was transported to a sorting table by conveyor belts and sorted by the crew. The remaining catch was discarded immediately after sorting. It was thus not possible to estimate the remaining catch after being sorted. Therefore the total catch was estimated before it was sorted and the discarded catch was obtained by deducting the amount of landings from it each haul. Discard samples were taken at the end of the sorting table and processed in the same way as in the first period. Sampling procedure of landings were the same as in the first period.

Trips on board of otter- and pair trawlers were made between 1976–1985 (35 vessels) and 1989–1990 (10 vessels). The target species in these fishery was cod. Whiting was the most important bycatch. Some of these vessels may target for herring or horse mackerel in some periods of the year, but this is considered a different fishery and has not been covered by the sampling programme.

The duration of the trips on pair trawlers vary between one day and one week. Most pair trawlers are operating in coastal waters during the night and land their catch in the following morning. Otter trawlers usually go further away from landing ports and make longer trips. Sampling procedures of landings and discards in both periods were the same as described in the first period for beam trawlers since no innovations had been introduced in this fishery.

The results of the discard trips have been published in a EC contract report. The information given in Table 18.3.1 has been taken from that report. Since the pattern of discards is very variable between seasons and areas, it has not been possible to make quantitative annual estimates of the total amount of discards from the limited number of samples. The amount of discards also vary between years, pending on the strength of year classes present on the fishing grounds. Survival of sole and plaice discards have been estimated by a number of experiments and is estimated to be low (<10%).

18.4 The Danish Discard Sampling Scheme (1995-ongoing)

Discard in Danish fisheries has been sampled in various programmes since the late 1980s. Since mid-1995 a regular sampling scheme covering all major fleets in the North Sea and Skagerrak has been in operation. The sampling effort is presently around 500 fishing days per year distributed on fleets according to their total landings and the expected amount of discards.

The data will be used to develop a model for annual estimation of the total amount of discards per species and size discarded per fleet. However, the data presently available are not sufficient to establish such a model and discards are therefore only given as relative amounts.

Preliminary results from the first 1½ years sampling scheme are presented in Table 18.4.1. The Danish fishery in the North Sea and Skagerrak is very diverse in terms of vessel and gear types used, and the accumulated coverage is therefore still low in some fleets. These data should therefore be treated as very preliminary pending a model based on a full set of 3 years data.

18.5 The English Discard Sampling Scheme (1994-ongoing)

A discard sampling programme for roundfish has been operating since 1994 from ports on the north east coast of England. The main fleets targeted are otter trawlers, pair trawlers and Danish fly seiners where the permitted mesh size is 100 mm and vessels fishing for *Nephrops* with 70 mm mesh nets. From 1994 to the first quarter of 1997, sampling was stratified by gear with up to 12 hauls per quarter from each of the main gear types. Since then, as part of an EU funded programme (EU Project:95/094) vessels are sampled at random based on strata defined by their percentage contribution to a cumulative total. The total is based on (vessel capacity units*total hours fished)/average trip length. Vessels landing a higher share of the total catch will be more regularly selected. Preliminary reports of the sampling schemes are given in ECPROJECT: 95/094. Discard rates for cod, haddock and whiting are shown in Tables 18.5.1–3.

18.6 The Scottish Discard Sampling Scheme (1974-ongoing)

18.6.1 Introduction

The Scottish discard sampling scheme commenced in 1975 in response to an ICES resolution (ICES 1975 Coop. Res. Rep. No. 44) which stressed the importance of the collection of discard data as an aid to improving the assessment of fish stocks. Sampling of the North Sea fisheries started in 1975, and in 1976, the scheme was extended to cover ICES area VIa (West of Scotland).

18.6.2 Coverage

At present discards are sampled for four main commercial species (cod, haddock, whiting and saithe) from five major gears (seine, light trawl, *Nephrops* trawl, pair trawl and beam trawl). Originally the gears sampled were heavy trawl, seine net and light trawl. Trawlers were defined as vessels trawling for demersal species, excluding beam trawl and trawl gears designed specifically for industrial and shellfish fisheries. The division between light and heavy trawl was originally made from Fishery Office classifications, but since 1989, a vessel length of 90 feet (27.4 metres) has been used to divide the two categories. Sampling of *Nephrops* trawlers started in 1982. In 1987, sampling of heavy trawlers stopped, as effort by these vessels had declined considerably, and sampling of pair trawlers commenced.

The areas sampled are the same as those used for routine market sampling. The sampling scheme aims to sample each major area once per quarter for each gear. A "major area" is defined as one with more than 10,000 hours of fishing effort by that gear in that quarter, so the major areas can differ with time and between gears.

At present the Scottish discard sampling scheme involves around 60–70 sampling trips a year, with the majority of these being in the North Sea. The area coverage within the North Sea reflects the areas where most Scottish catches are taken, i.e. principally in the areas closer to the Scottish coast such as Buchan and Shetland. *Nephrops* trawlers fish in more restricted areas in both the North Sea and Division VIa, and this is reflected in the sampling coverage. More samples tend to be taken in the second and third quarters of the year as less fishing time is lost to bad weather over this period.

18.6.3 Uses of Scottish discard data

The estimates of Scottish discards of North Sea haddock and whiting are routinely used in the assessment of these stocks. In both cases, the Scottish landings account for a large proportion of the total international landings so the Scottish discard estimates can be taken as being representative of overall discarding practices. No other time series of discards are available for these stocks. For North Sea cod, the Scottish landings account for a smaller proportion of the total landings, so the Scottish discard data have not been routinely used in assessments.

The original discard sampling scheme is described in Jermyn and Hall (1978), and data from the first five years are summarised in Jermyn and Robb (1981). The processing of Scottish demersal landings and discard data is described in Armstrong and Hall (1987). Current discard sampling procedures are given in Jermyn (1985). Reeves (1990) fitted linear models to a subset of the data for North Sea haddock. Data on discards of non-commercial species collected as part of the sampling scheme have recently been summarised by Jensen, Emslie and Coull (1994). Scottish discard and selectivity data are used by Furness (1992) to predict the effects of changes in selectivity and fishing effort on the availability of discards to seabirds. Data from the Scottish discard sampling scheme have recently been analysed as part of a PhD study (Stratoudakis, 1997).This study included the estimation of total quantities of discards by Scottish vessels of both target and non-target species, and these are presented in Table 18.6.1. The estimates for haddock and whiting given in this table may differ from the estimates used in the assessments due to the different raising procedures used.

Table 18.2.1 Discard of saithe in selected German fisheries.

Saithe in IV		Discard sample data - Germany								Fleet (Whole)			
		Landing		Discard		Discard as % of landings		Hauls/Nets		Landings		Estimated discard	
1995	Fleet	Weight (t)	No	Weight (t)	No	Weight (t)	No	No/meters	Soak time	Weight (t)	No	Weight (t)	No
Q3	Saithe4a	79.1	16406	0	0	0	0		59.7	2890		0	0
Q4	Saithe4a	76.9	92321	5.92	11639	7.2	11.2		214.1	4180		321.8	632653
Whole Year													
	Saithe4a												
1996													
Q1	Saithe4a	254.8	182460	2.77	6568	1.1	3.5		569.8	3171		34.5	81739
Q2	Saithe4a	216.2	145414	6.29	10687	2.8	6.9		493.8	2407		70	118981
Q3	Saithe4a	198.2	113851	3.14	5249	1.6	4.4		481.1	2595		41.1	68724
Q4*)	Saithe4a	76.9	92321	5.92	11639	7.2	11.2			3363		258.9	508998
Whole Year													
	Saithe4a											404.5	778442
1997													
Q1	Saithe4a	40.7	27434	0.01	6	0.005	0.02		161.3	1956		0.1	288

*) Sampling results from Qu4-95

Table 18.2.2 Discard of cod in selected German fisheries.

Cod in IV		Discard sample data - Germany								Fleet (Whole)			
		Landing		Discards		Discards as % of landings		Hauls/Nets		Landings		Estimated discards	
1995	Fleet	Weight (t)	No	Weight (t)	No	Weight (t)	No	No/meters	Soak time (hours)	Weight (t)	No	Weight (t)	No
Q2	Beam4bc	1.3	1036	1.3	6136	50.0	85.6		194.8			228.9	1080550
Q3	Saithe4a	17.4	5109	0.1	255	0.6	4.8		59.7	847.6		4.0	9317
	Cod4bc	42.6	38140	0.8	2312	1.8	5.7		131.3	2417.8		47.8	131220
	Beam4bc	0.2	172	0.6	2080	75	92.4		236.8			105.7	366288
Q4	Saithe4a	4.6	5654	0.7	1777	13.2	23.9		214.1	239.2		37.5	96591
	Beam4bc	0.4	552	0.3	915	41.4	62.4		79.1			52.8	161131
Whole Year													
	Saithe4a												
	Cod4bc												
	Beam4bc											387.4	1607970
1996													
Q1	Saithe4a	7.8	4854	0.62	1473	7.4	23.3		569.8	285.4		7.8	18332
Q2	Saithe4a	6	2589	0.66	1221	9.9	32.1		493.8	268.2		6.9	12752
	Cod4bc									2479.0			
Q3	Saithe4a	11.5	4007	0.35	713	3.0	15.1		481.1	415.5		4.6	9341
	Beam4bc	0.02	10	0.01	828	41.1	98.8		213.0			1.1	93448
Q4	Saithe4a*)	4.6	5654	0.7	1777	13.2	23.9			665.4		30.2	77712
	Cod4bc	40	23874	1.6	3874	3.9	14		293.1	682.0		27.3	66052
	Beam4bc	0.36	311	0.66	1846	64.8	85.6		58.0			124.1	347048
Whole Year													
	Saithe4a											49.5	118137
	Cod4bc												
	Beam4bc												
1997													
Q1	Saithe4a	6.6	3947	0.08	279	1.2	6.6		161.3	165.1		3.5	12739
	Cod4bc									533			
	Beam4bc												

*) Sampling results from Qu4-95

Table 18.2.3 Discard of whiting in selected German fisheries.

Whiting in IV		Discard sample data - Germany								Fleet (Whole)			
		Landings		Discards		Discards as % of landings		Hauls/Nets		Landings		Estimated discards	
1995	Fleet	Weight (t)	No	Weight (t)	No	Weight (t)	No	No/meters	Soak time	Weight (t)	No	Weight (t)	No
Q1	Saithe4a									10.3			
	Cod4bc									16.8			
Q2	Saithe4a									9.4			
	Cod4bc									19.4			
	Beam4bc	0	0	0.23	2004	100.0	100.0		194.8			36.4	316932
Q3	Saithe4a	0	0	0.008	35	100.0	100.0		59.7	8.5		0.4	1279
	Cod4bc	0.24	354	0.11	421	31.7	54.3		131.2	19.7		6.2	23894
	Beam4bc	0	0	0.23	1880	100.0	100.0		236.8			29.4	240000
Q4	Saithe4a	0.4	698	1.73	5554	81.2	88.8		214.1	8.2		93.5	298456
	Cod4bc									32.7			
	Beam4bc	0	0	0.07	587	100.0	100.0		79.1			20.4	170817
Whole Year													
	Saithe4a												
	Cod4bc												
	Beam4bc												
1996													
Q1	Saithe4a	0.4	425	2.34	6207	85.4	93.6		569.8	6.4		28.7	76136
	Cod4bc									31.5			
Q2	Saithe4a	0.1	21	0.81	1809	89	98.9		493.8	13.7		8.8	19584
	Cod4bc									26.0			
Q3	Saithe4a	0.3	297	0.77	1677	72	85		481.1	6.4		8.1	17582
	Cod4bc									48.6			
	Beam4bc	0	0	0.01	59	100.0	100.0		213			1.1	6659
Q4	Saithe4a*)	0.4	698	1.73	5554	81.2	88.8			19.1		66.9	241834
	Cod4bc	0.04	46	0.05	345	80.3	88.2		293.1	34.0		0.9	5882
	Beam4bc	0	0	0.03	158	100.0	100.0		58			5.6	29704
Whole Year													
	Saithe4a											112.5	355136
	Cod4bc												
	Beam4bc												
1997													
Q1	Saithe4a	0.1	65	0.18	834	64.3	92.8		161.3	6.4		8.6	41039

*) Sampling results from Qu4-95

Table 18.2.4 Discard of haddock in selected German fisheries.

Haddock in IV		Discard sample data - Germany								Fleet (Whole)			
		Landings		Discards		Discards as % of landings		Hauls/Nets		Landings		Estimated discards	
1995	Fleet	Weight (t)	No	Weight (t)	No	Weight (t)	No	No/meters	Soak time	Weight (t)	No	Weight (t)	No
Q1	Cod4bc									16.5			
Q2	Saithe4a									217.3			
	Cod4bc									126.7			
	Beam4bc	0	0	0	0	-	-		194.8			0.0	0
Q3	Saithe4a	1.8	2899	0.15	526	7.7	15.4		59.7	250		5.5	19214
	Cod4bc	0.03	35	0.04	78	52.9	69		131.2	142.6		2.2	4427
	Beam4bc	0	0	0	0	-	-		236.8			0.0	0
Q4	Saithe4a	1.2	1666	0.75	3849	38.5	69.8		214.1	65.6		40.8	209209
	Cod4bc									60.4			
	Beam4bc	0	0	0	0	-	-		79.1			0.0	0
Whole Year													
	Saithe4a												
	Cod4bc												
	Beam4bc												
1996													
Q1	Saithe4a	5.2	4469	4.04	12378	43.7	73.5		569.8	161.6		50.3	154038
Q2	Saithe4a	3.8	2780	6.34	16641	62.5	85.7		493.8	336.7		70.6	185268
	Cod4bc									141.4			
Q3	Saithe4a	4	3645	5.8	15541	59.2	81		481.1	180.2		74.2	198884
	Cod4bc									347.5			
	Beam4bc	0	0	0	0	-	-		213			0.0	0
Q4	Saithe4a*)	1.2	1666	0.75	3849	38.5	69.8		-	330.1		32.8	168318
	Cod4bc	0.02	29	0	0	0	0		293.1	249.0		0.0	0
	Beam4bc	0	0	0	0	-	-		58			0.0	0
Whole Year													
	Saithe4a											227.9	706509
	Cod4bc												
	Beam4bc												
1997													
Q1	Saithe4a	5.6	6228	0.3	1251	5.1	16.7		161.3	97.3		14.4	60118
	Cod4bc												
	Beam4bc												

*) Sampling results from Qu4-95

Table 18.2.5 Discard of plaice in selected German fisheries.

		Discard sample data - Germany								Fleet (Whole)			
Plaice in IV		Landings		Discards		Discards as % of landings		Hauls/Nets		Landings		Estimated discards	
1995	Fleet	Weight (t)	No	Weight (t)	No	Weight (t)	No	No/meters	Soak time	Weight	No	Weight (t)	No
Q1	Beam4bc									959.1			
Q2	Beam4bc	9.1	28411	17.03	148734	65.17	84.0		194.8	1671.8		2692.9	23522124
Q3	Saithe4a	0	0	0	0	-	-		59.7			0	0
	Cod4bc	0.3	747	0.05	178	14.6	19.2		131.2			2.6	10103
	Beam4bc	6.4	13565	16.89	142725	72.52	91.3		236.8	2436.1		2156.2	18219866
Q4	Saithe4a	0.002	4	0.001	1	4.8	20		214.1			0.001	54
	Cod4bc												
	Beam4bc	1.2	3350	6.64	64461	84.69	95.1		79.1	1281.9		1931.4	18758151
Whole Year													
	Saithe4a												
	Cod4bc												
	Beam4bc												
1996													
Q1	Saithe4a	0.006	8	0.002	5	26.6	38.5		569.8			0.03	62
	Beam4bc									1331.6			
Q2	Saithe4a	0.017	22	0.001	3	8.2	12		493.8			0.02	33
	Cod4bc												
**)	Beam4bc	9.1	28411	17.03	148734	65.2	84.0		-	1182.6		626.8	6227841
Q3	Saithe4a	0.006	10	0	0	0	0		481.1			0	0
	Beam4bc	11.2	35172	12.51	87893	52.8	71.4		213.0	1252.8		1412.0	9920032
Q4 *)	Saithe4a	0.002	4	0.001	1	4.8	20		-			0.01	44
	Cod4bc	0.4	1196	0.33	1803	42.5	60.1		293.1			5.6	30741
	Beam4bc	1.6	4793	5.27	40103	76.71	89.3		58.0	738.6		990.8	7539364
Whole Year													
	Saithe4a												
	Cod4bc												
	Beam4bc												
1997													
Q1	Saithe4a	0	0	0	0	-	-		161.3			0	0
	Beam4bc									864.3			
*) Sampling results from Qu4-95				**) Sampling results from Qu2-95									

Table 18.2.6 Discard of sole in selected German fisheries.

Sole in IV		Discard sample data - Germany								Fleet (Whole)			
		Landings		Discards		Discards as % of landings		Hauls/Nets		Landings		Estimated discards	
1995	Fleet	Weight (t)	No	Weight (t)	No	Weight (t)	No	No/meters	Soak time	Weight (t)	No	Weight (t)	No
Q1	Beam4bc									143.6			
Q2	Beam4bc	4.7	17105	1.06	10550	18.40	38.1		194.8	743.3		167.9	1668471
Q3	Saithe4a	0	0	0	0	-	-					0	0
	Cod4bc	0	0	0	0	-	-					0	0
	Beam4bc	3.4	14223	0.4	4595	10.53	24.4		236.8	446.8		51.5	586585
Q4	Saithe4a	0	0	0	0	-	-					0	0
	Cod4bc												
	Beam4bc	0.8	2706	0.15	1384	15.79	33.8		79.1	232.8		42.1	392268
Whole Year													
	Saithe4a	0	0	0	0	-	-					0	0
	Cod4bc												
	Beam4bc												
1996													
Q1	Fleet												
	Saithe4a	0	0	0	0	-	-					0	0
	Beam4bc									151.3			
Q2	Saithe4a	0	0	0	0	-	-					0	0
**)	Beam4bc	4.7	17105	1.06	10550	18.40	38.1		-	196.8		44.5	441753
Q3	Saithe4a	0	0	0	0	-	-					0	0
	Beam4bc	0.1	162	0.001	22	0.99	12.0		213.0	188.8		1.5	69227
Q4	Saithe4a	0	0	0	0	-	-					0	0
*)	Cod4bc	0	0	0	0	-	-					0	0
	Beam4bc	0.7	2632	0.11	915	13.58	25.8		58.0	131.6		20.6	172020
Whole Year													
	Saithe4a	0	0	0	0	-	-					0	0
	Cod4bc												
	Beam4bc												
1997													
Q1	Saithe4a	0	0	0	0	-	-		161.3			0	0
	Beam4bc									112.0			

*) Sampling results from Qu4-95 **) Sampling results from Qu2-95

Table 18.3.1 Discard of selected species in the Dutch pair trawl and otter trawl fisheries.

The Dutch pair trawl and otter trawl fisheries, Percentages discards and numbers per 100 fishing hours.

Discards		No of samples	Area	Cod		Whiting		Haddock		Bib		Plaice		Dab	
				%	No	%	No	%	No	%	No	%	No	%	No
Average	1976-1990	45	North Sea	20	6179	53	27944	29	303	88	949	84	3647	84	20499
	1989-1990	10	North Sea	44	7827	80	44671	29	1101	na	459	na	4878	na	85780

Average percentages are weighted over total catch numbers

Table 18.3.2 Discard of selected species in the Dutch beam trawl fishery.

The Dutch beam trawl fishery, Percentages discards and numbers per 100 fishing hours.

Discards		No of samples	Area	Plaice		Sole		Dab		Flounder		Whiting		Cod	
				%	No	%	No	%	No	%	No	%	No	%	No
Average	1976-1990	49	North Sea	49	29064	16	239	98	100953	81	1411	85	8508	66	2762
	1978	8	North Sea	41	16910	9	912	98	75310	100	197	93	12926	41	1591
	1979	9	North Sea	55	27101	5	908	99	103525	100	64	71	3508	49	1735
	1980	9	North Sea	58	50052	5	246	96	80832	80	1547	70	5860	71	8217
	1981	8	North Sea	59	42494	21	2125	96	92940	84	6152	81	6454	87	5520
	1982	5	North Sea	20	7503	29	5214	98	54234	0	0	86	15663	49	630
	1989-1990	6	North Sea	46	32972	22	8263	99	202118	54	640	96	12469	61	32
			Plaicebox	83	83433	8	935	99	160347	100	201	88	3852	80	10215
			Nonplaicebox	36	17489	18	2658	97	75979	81	1647	85	8953	51	1308

Average percentages are weighted over total catch numbers

Table 18.4.1 Discard in percent of catch for selected Danish fishing fleets.

	Danish vessel groups															
	TRAWLERS								DANISH SEINERS	GILL-NETTERS					PURSE SEINE	
	DEMERSAL North	DEMERSAL South	INDUSTRIAL	Herring	NEPHROPS day trip	NEPHROPS freize	PANDALUS day trip	PANDALUS freize		Cod	Plaice	Turbot	Hake	Common sole	Herring	Mackerel
Number of hauls 1995+1996	7	64	75	15	20	23	32	33	50	110	15	25	16	3	14	27
%discard	25.5	8.0	0.0	0.0	73.1	40.8	34.1	30.6	18.7	4.8	8.2	20.1	0.0	38.2	0.5	3.8
Sprat																
Monk	<0.1					0.4		<0.1	<0.1			0.2				
Nephrops					17.7	1.6	<0.1	1.8								
Whiting					10.2	<0.1	0.3	9.0						2.1		
Dab	0.4	0.2			21.2			<0.1	2.6	<0.1	2.7			34.4		
Haddock		<0.1			3.0	1.4	1.2	12.2	4.3	<0.1						
Hake					0.8	0.8	0.4			<0.1						
Mackerel		<0.1				<0.1						1.3			0.3	3.5
Turbot		<0.1									0.2	4.6				
Plaice	<0.1	2.6			1.4				<0.1		0.8	0.4		0.6		
Saithe	24.7	<0.1			2.1		<0.1		<0.1	0.1		<0.1				
Herring							2.0	<0.1							0.2	
Cod	0.2	4.9			4.0	2.7	0.4	3.0	1.1	2.2	2.5	5.5				
Common sole												<0.1				

Table 18.5.1 Discard rates by weight and number for cod in selected English fisheries.

Cod		Q1			Q2			Q3			Q4		
Geartype		% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls
Fly seine	1994	No data	No data	0	98	93	15	96	88	12	No data	No data	0
Nephrops	1994	30	9	10	43	8	3	18	8	7	69	41	11
Nephrops	1995	76	25	11	No data	No data	0	No data	No data	0	45	12	16
Nephrops	1996	40	8	12	34	8	12	No data	No data	0	80	41	17
Nephrops	1997	92	38	5	No data	No data	0						
Otter	1994	30	11	27	38	13	28	66	35	34	38	23	18
Otter	1995	12	2	12	12	6	33	47	22	17	33	14	15
Otter	1996	17	4	29	19	4	23	4	1	17	47	21	22
Otter	1997	39	19	22	22	8	64						
Pair	1994	10	2	8	45	21	12	57	32	6	18	4	6
Pair	1995	No data	No data	0	18	5	11	23	8	8	No data	No data	0
Pair	1996	No data	No data	0	18	5	11	23	8	8	No data	No data	0
Pair	1997	10	1	5	11	3	6						

Table 18.5.2 Discard rates by weight and number for haddock in selected English fisheries.

Haddock		Q1			Q2			Q3			Q4		
Geartype		% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls
Fly seine	1994	No data	No data	0	93	88	15	99	98	12	No data	No data	0
Nephrops	1994	93	81	10	21	13	3	100	100	7	97	82	11
Nephrops	1995	82	46	11	No data	No data	0	No data	No data	0	81	67	16
Nephrops	1996	78	72	12	89	79	12	No data	No data	0	65	49	17
Nephrops	1997	79	78	5	No data	No data	0						
Otter	1994	69	59	27	41	26	28	66	50	34	28	18	18
Otter	1995	No data	No data	12	38	19	33	93	84	17	85	72	15
Otter	1996	70	48	29	58	46	23	67	57	17	30	19	22
Otter	1997	74	74	22	39	36	64						
Pair	1994	100	100	8	61	50	12	74	60	6	0	0	6
Pair	1995	No data	No data	0	84	77	8	73	53	13	53	31	16
Pair	1996	No data	No data	0	39	26	11	32	21	8	No data	No data	0
Pair	1997	0	0	5	50	48	6						

Table 18.5.3 Discard rates by weight and number for whiting in selected English fisheries.

Whiting		Q1			Q2			Q3			Q4		
Geartype		% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls	% by No.	% by WT	No. Hauls
Fly seine	1994	No data	No data	0	95	90	15	98	97	12	No data	No data	0
Nephrops	1994	94	84	10	100	98	3	97	94	7	99	98	11
Nephrops	1995	96	90	11	No data	No data	0	No data	No data	0	94	88	16
Nephrops	1996	85	75	12	98	93	12	No data	No data	0	93	86	17
Nephrops	1997	78	77	5	No data	No data	0						
Otter	1994	47	29	27	64	52	28	91	83	34	53	37	18
Otter	1995	66	58	12	26	18	33	48	35	17	48	34	15
Otter	1996	33	23	29	62	52	23	100	100	17	24	17	22
Otter	1997	19	18	22	53	39	64						
Pair	1994	76	59	8	39	32	12	59	46	6	92	87	6
Pair	1995	No data	No data	0	80	66	8	92	87	13	71	55	16
Pair	1996	No data	No data	0	42	30	11	60	47	8	No data	No data	0
Pair	1997	36	24	5	100	100	6						

Table 18.6.1 Annual estimates of discards (total biomass in tonnes) for species caught by Scottish demersal vessels in the North Sea.

Species	1988	1989	1990	1991	1992	1993
Anglerfish	64	182	172	431	125	362
Cod	2230	11846	8338	3727	2586	5946
Common dab	8947	3528	2712	1351	1919	4360
Cuckoo ray	436	132	194	218	269	360
Grey gurnard	2030	1617	3018	2058	3380	4632
Haddock	42289	29742	24569	33027	43709	60714
Hake	7	4	208	41	40	16
Herring	1159	478	168	3393	95	1465
Horse mackerel	81	530	664	304	130	657
Lemon sole	2690	3388	1095	3064	1415	1005
Lesser argentine	37	50	75	212	58	419
Lesser spotted dogfish	462	178	114	295	261	734
Long rough dab	1122	425	511	1305	1187	1135
Mackerel	14	193	231	711	55	257
Megrim	130	47	79	22	43	70
Norway pout	90	110	74	9489	1778	863
Plaice	2344	1915	946	520	580	1696
Poor cod	34	29	27	70	56	54
Red gurnard	25	18	13	423	95	376
Saithe	137	863	332	1698	1533	9510
Spotted ray	21	0	0	10	0	6
Starry ray	4850	637	1821	1951	2657	2854
Whiting	26672	27576	25520	32251	24332	32165
Witch	668	577	192	486	246	262
Other	643	929	830	779	1021	1066

The tabulated estimates are obtained using the weighted ratio estimator under the fill-in from A study of fish discarded by Scottish demersal fishing vessels, Yorgos Stratoudakis, Ph.d-thesis 1997

19 DATA FOR THE MULTISPECIES ASSESSMENT WORKING 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 coordinator. The quarterly data for Norway pout and sandeel are included in this report.

20 EVALUATION OF ICA IN RELATION TO ASSESSMENTS OF ROUNDFISH AND FLATFISH

20.1 General Observations

Integrated Catch-at-age Analysis (ICA: see Patterson and Melvin 1996 for details of version 1.2) is a stock-assessment computer package that implements the population dynamics model of Deriso *et al.* (1985). Version 1.3 has recently been integrated with the IFAP system at ICES. The principal distinguishing feature of ICA is that catches-at-age are assumed to be measured with independent lognormally-distributed errors. Neither tuning nor shrinkage are required. For the most recent years in the dataset, a separable model is fitted using non-linear least-squares regression, and this is coupled with a more conventional VPA on the earlier years initiated by the populations in the first year to which the separable model is applied. This dual approach both saves on computational load and avoids the problem of negative year-classes which can arise from the assumption of non-correlated errors. A separate suite of programs (ICAVIEW3, ICP3 and VPROS), which are not yet fully installed on IFAP, allow for the plotting of model diagnostics and medium-term projected stock dynamics. The projection program estimates uncertainty in future stock numbers by a multivariate Monte Carlo method. Parameter estimates (held in matrix **X**) obtained from the ICA separable model have correlated errors which are expressed in a variance-covariance matrix **C**. The Monte Carlo simulation then proceeds by generating pseudo-data vectors $\mathbf{X}^* = \mathbf{X} + \mathbf{e}$, where $\mathbf{e} \sim \mathbf{N}(\mathbf{0},\mathbf{C})$, and using them to drive an assumed population process (dependent on the imposed stock-recruitment model) over the required future time period. The distributions of future stock parameters (stock sizes, recruitments, and so on) produced by many iterations of this procedure can be viewed as estimates of the expected probability distributions for those quantities. The ICA projection program ICP3 thus makes use of variance and covariance in all parameters and for all projection years, and will therefore generally give wider confidence bands about the projected stock quantities than WGMTERM which relies on recruitment variation only for much of the projection period.

The aim of this study was to produce a straightforward comparison of the results from the XSA and ICA packages when applied to the stocks within the remit of this Working Group. In a previous Northern Shelf Demersal Working Group (ICES CM 1997/Assess:1) a comprehensive series of ICA runs were performed with differing parameters for each stock, the intention being to determine which combination of parameters would lead to the smallest coefficient of variation for a reference value of *F*. The analysis was therefore purely data-driven and took no account of stock or fleet characteristics. Furthermore, the investigation of as wide a range of parameter-setting combinations as possible is not feasible for North Sea stocks, which in general have many more tuning indices than their Northern Shelf counterparts.

The study undertaken for this Working Group took a more pragmatic approach. Input parameters for the ICA program were determined in consultation with the relevant stock assessors, thus giving rise to models that were actually pertinent to the stocks in question. This permitted more direct comparison with the corresponding XSA models which undergo a similar process of parameter determination. For all stocks the first ICA run (referred to here as the *comparison run*) used exactly the same data as the equivalent XSA final runs, save for a change in the start point of some time-series (ICA requires that data series begin no earlier than 1960).

Certain default parameters were defined as follows. The number of years over which the separable constraint is assumed to apply cannot be less than 3 in the ICA package; the default for the Separable VPA within the Lowestoft VPA package is 6, and this was generally considered appropriate for ICA also. Using fewer years may lead to model underfitting, while using more years increases computational load substantially with no guarantee of any resultant benefit. Default weighting for all ages and years was assumed unless there were strong prior reasons to do otherwise. Catchability models for indices were usually taken to be linear: a power model is generally only used when there is some clear evidence of curvature in the relationship, or some statistical reason to expect curvature. Graphical diagnostic plots of residuals from each age in each fleet were examined for evidence of curvature. If there was such evidence, the model was re-estimated with a power relationship imposed on the relevant indices and the diagnostic plots were re-examined. In this study, age-correlation coefficients of 1.0 were assumed for all fleets (in the absence of outstanding reasons to do otherwise) as this gave equal weighting to indices regardless of the age ranges they covered (K. R. Patterson, pers. comm.) This is a departure from earlier versions of ICA, in which the choice of age correlation (in other words, the degree to which errors in an index at a given age are correlated with those in other ages in the same index) was driven largely by the prior perception of whether the principal errors lay with the measurement of total stock size or with the age-length key used to generate age-structured data. The selection pattern for the model was assumed to be constant.

With regard to the package of medium-term projection programs, future values of *F* were assumed to be equal to the value of *F* from the final year of the separable model, and 5-year means were used for calculation of population parameters. Errors were taken to be autocorrelated. The so-called Ockham stock-recruitment model was assumed. This uses the mean recruitment over the observed SSB range, coupled with a straight line to the origin from the mean recruitment at the lowest observed spawning-stock size, and is both parsimonious and adherent to the required precautionary approach. Discard projections were not used in this analysis. The current implementation of the projection programs permits the use of only 5 tuning fleets, 10 ages and 20 years of historical data, and a second run (referred to hereafter as the *projection run*) was therefore performed for each stock using a suitably trimmed database. The choice of fleets to be removed, if this was necessary, was based on the mean sum-of-squared errors statistic presented in the standard ICA output from the main run: the fleets with the lowest MSQs were deemed to be contributing least to the model fit and their removal would thus have least effect on the analysis. This is rather a fine point, as in any case the projections are only lightly influenced by fleet data, and indeed for the cod, haddock and whiting stocks a simpler scheme of removing survey fleets was implemented. In the graphical projection output, each median estimate (solid line) is given along with its 25 and 75 (dashed) and 9 and 95 (dotted) percentile lines. It should be noted that the "risk to SSB" plots have a *y*-axis label *P*(SSB<MBAL), whether MBAL was used as the reference or not. Residual plots for the stock-recruitment relationship are also given: the *x*-axis range in these plots is often smaller than the recruitment range, and points which would thus lie beyond the limits of the plot are represented in a bunch at the axis extremity.

The study was limited to the North Sea groundfish and flatfish fisheries, as the seasonal aspect of the industrial sandeel and Norway pout fisheries cannot yet be addressed by ICA. Furthermore, retrospective analyses cannot be attempted on the IFAP implementation of ICA, although this presents no difficulty to the stand-alone version.

20.2 Stock-Specific Issues and Results

ICA 1.3 is nominally integrated with the IFAP system, but problems arose during the analyses which suggested that the interface between the two programs is not yet fully functional. All the flatfish stocks, along with North Sea saithe, ran correctly on the ICA/IFAP system, but with the remaining roundfish stocks (cod, haddock and whiting in Sub-Area IV and Division IIIa) the data interface developed difficulties and consistently failed. It is to be hoped that such impediments will be removed in the near future, but for the time being the option was taken of running a Windows version of ICA on a stand-alone PC for the three troublesome stocks. PC-based runs of ICA can take a long time, up to an hour in some cases, so full diagnostic tests were not carried out on these stocks. All of the PC-based runs used a restricted time-series starting in 1977, due to memory considerations.

20.2.1 Cod in Areas IIIa (Skagerrak), IV and VIId

There were 8 tuning fleets used in the analysis of North Sea cod: Scottish trawlers, seiners and light trawlers, English trawlers and seiners, Scottish and English groundfish surveys, and the first-quarter International Bottom Trawl Survey. The age range was 1 to 11+ years. The reference age for the separable constraint was defined as 2, a selection of $S = 1.0$ was fixed on the last age, and default age and year weightings were used. Linear catchability models were used for all fleets. Figure 20.2.1 gives the comparison of XSA and ICA results for mean reference *F*, SSB and recruits. These estimates are extremely close except for the final-year mean *F*: the clear XSA upturn is not emulated by ICA.

The projection run used only the five commercial fleets, as it was decided that for this stock the survey fleets would have little influence on future stock dynamics. Figure 20.1.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model) and spawning stock size. Figure 20.1.3 gives the SSB projection in relation to the best current estimate of MBAL (150,000 tonnes). The stock is predicted to increase substantially over the next six years or so before stabilising at a level roughly twice the current estimate. The WGMTERM analysis discussed in Section 3.8 followed a similar pattern, although with a moderate decline towards the end of the projection period. Finally, Figure 20.1.4 gives residual plots for the assumed stock-recruitment relationship.

20.2.2 Haddock in Sub-Area IV and Division IIIa

A total of 7 fleets were used in the analysis of North Sea haddock, namely: Scottish seiners and trawlers, English and Scottish groundfish surveys, and three components of the International Bottom Trawl Survey (first-quarter, Scottish second-quarter and English fourth-quarter). The age range was 0 to 10 years. The reference age for the separable constraint was defined as 4, a selection of $S = 1.0$ was fixed on the last age, and default age and year weightings were used. Linear catchability models were used for all fleets. Figure 20.2.1 gives the comparison of XSA and ICA results for mean reference F, SSB and recruits. ICA estimates of F are higher than the XSA counterparts for all but one of the years of the separable model, while the ICA 1994 recruiting year-class is significantly lower. Both of these elements contribute to a lower ICA estimate of 1996 SSB.

Only the two Scottish commercial fleets were retained for the projection run. Figure 20.2.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model) and spawning stock size. Figure 20.2.3 gives the SSB projection in relation to the best current estimate of B_{loss} (63,000 tonnes). Even when the relatively high final-year estimate of mean F is taken into account, the risk that SSB will fall below B_{loss} does not appear to be significantly different from zero: the same conclusion was reached following the WGMTERM analysis discussed in Section 4.8. For completeness, Figure 20.2.4 gives residual plots for the assumed stock-recruitment relationship.

20.2.3 Whiting in Sub-Area IV and Division IIIa

There were 11 fleets used in the analysis of North Sea whiting: Scottish seiners and light trawlers, three French trawler fleets, Scottish, English and French groundfish surveys, and three components of the International Bottom Trawl Survey (first-quarter, Scottish second-quarter and English fourth-quarter). The age range was 0 to 8 years. The reference age for the separable constraint was defined as 4, a selection of $S = 1.0$ was fixed on the last age, and default age and year weightings were used. Linear catchability models were used for all fleets. Figure 20.3.1 gives the comparison of XSA and ICA results for mean reference F, SSB and recruits. Final-year F is lower for ICA than for XSA, and the corresponding SSB is higher. Recent-year recruitment estimates diverge significantly.

The four Sub-Area IV commercial fleets were retained for the projection run. Figure 20.3.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model) and spawning stock size. Figure 20.3.3 gives the SSB projection in relation to the best current estimate of B_{loss} (238,000 tonnes), while Figure 20.3.4 gives residual plots for the assumed stock-recruit model. The low ICA estimates of recruitment in 1996 and 1997 depress the stock level initially and it falls below B_{loss}, but then the similarly low *status quo* estimate of mean F leads to a stock recovery towards the end of the decade. This mirrors the upward trend suggested by the WGMTERM projection presented in Section 5.1.8.

20.2.4 Saithe in Sub-Area IV and Division IIIa

There were 4 tuning fleets used in the analysis of North Sea saithe; North Sea and French trawlers, and English and Scottish groundfish surveys. The age range was 1 to 9 years, with the last age being a plus group. The reference age for the separable constraint was defined as 4, selection S on the last age was fixed to 1.0, and default age and year weightings were used. Post-run graphical diagnostics revealed no particular reason to deviate from the default parameter inputs. Figure 20.4.1 gives the comparison of XSA and ICA results for mean reference F, SSB and recruits. Mean F is higher for ICA than XSA for most years, resulting in lower SSB. Recruitment estimates are very similar, save for the most recent years when significant divergence occurs.

The first year in the time-series was changed to 1977 for the projection run. Figure 20.4.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model), and spawning stock size. Figure 20.4.3 shows the SSB projection in relation to the best current estimate of MBAL (125,000 tonnes), along with a plot showing the probability that SSB will fall below MBAL over the projection period. This demonstrates that, given current levels of fishing mortality and the high ICA estimates thereof, there is a moderate risk to SSB which fluctuates about MBAL over the next ten years. The same conclusion was reached in the medium-term projection in Section 6.8, which if anything predicted lower SSB levels for the projection period. Finally, Figure 20.4.4 shows the residuals about the assumed stock-recruitment relationship.

20.2.5 Sole in Sub-Area IV

Five tuning fleets were used in the analysis of North Sea sole, namely UK beam trawl CPUE, Netherlands commercial beam trawl, SNS-Tridens survey, German Solea survey, and Netherlands BTS-ISIS survey. The first year of the data time-series was changed to 1960, and the age range was 1 to 15 years with the last age being a plus group. The reference age for the separable constraint was defined as 3, selection S on the last age was fixed to 0.8, and the first age was down-weighted to 10% of normal. The last age of the Netherlands commercial beam trawl was a plus group. Post-run graphical diagnostics revealed no strong evidence of any power catchability relationships, and thus no reason to deviate from the default parameter inputs. Figure 20.5.1 gives the comparison of XSA and ICA results for mean reference F, SSB and recruits: these are remarkably similar, with the exception of the most recent years' estimates of F for which ICA seems somewhat erratic.

For the projection run, the first year in the time-series was changed to 1977, the oldest age was reduced to 10 (plus group), and the German Solea fleet was removed as its lack of data for 1995 and 1996 prevented the ICP3 program from functioning correctly. Figure 20.5.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model), and spawning stock size. Figure 20.5.3 shows the SSB projection in relation to a previous estimate of "MBAL" (35,000 tonnes), along with a plot showing the probability that SSB will fall below this MBAL over the projection period (note that this "MBAL" was defined by ACFM in 1991 and does not correspond to the current criteria for calculating MBAL). There would appear to be at least a 95% likelihood of this occurring within a single year, and it is more than 50% likely that SSB will not recover to a level above MBAL during the entire projection period. The WGMTERM analysis discussed in Section 7.8 also suggests a sharp decrease in SSB in the first year, but the behaviour of the projection is different thereafter: MBAL is exceeded fairly rapidly (due to the large 1996 year class which is not present in the ICA analysis), followed by a steady decline back below it. For completeness, the residuals about the assumed stock-recruitment relationship are presented in Figure 20.5.4.

20.2.6 Sole in Division VIId

There were 6 tuning fleets used in the analysis of English Channel sole; Belgian beam trawl, UK >40 ft beam trawl, UK beam trawl survey, English young fish survey, French young fish survey, and French inshore otter trawl. The age range was 1 to 11 years, with the last age being a plus group. The reference age for the separable constraint was defined as 4, selection *S* on the last age was fixed to 0.8, and a weighting of 0.1 was used for the youngest age. Post-run graphical diagnostics revealed no particular reason to deviate from the default parameter inputs. Figure 20.6.1 gives the comparison of XSA and ICA results for mean reference *F*, SSB and recruits, and shows that the estimates diverge markedly in recent years. ICA recruitment appears to be much higher than its XSA counterpart, and the combination of this with the lower mean reference *F* in the last years results in an ICA SSB estimate which is higher than the XSA estimate and rising.

Figure 20.6.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model), and spawning stock size. Figure 20.6.3 shows the SSB projection in relation to the best current estimate of MBAL (8,000 tonnes), along with a plot showing the probability that SSB will fall below MBAL over the projection period. Given the relatively high final-year value of SSB estimated by ICA, there is very little risk of SSB falling below the MBAL level over the next ten years. The WGMTERM projection presented in Section 8.8 is founded on the basis of a much lower final-year SSB (and higher *F*), and thus predicts much lower SSB of the projection period. Residuals for the assumed stock-recruitment model are shown in Figure 20.6.4.

20.2.7 Plaice in Sub-Area IV

Four tuning fleets were used in the analysis of North Sea plaice, being UK beam trawl CPUE, Netherlands commercial beam trawl, SNS-Tridens survey, and Netherlands BTS-ISIS survey. The first year of the data time-series was changed to 1960, and the age range was 1 to 15 years with the last age being a plus group. The reference age for the separable constraint was defined as 4, selection *S* on the last age was fixed to 1.0, and default year and age weightings were used. The last age of the UK beam trawl CPUE was a plus group.

Post-run graphical diagnostics indicated a strong trend in time residuals at age for the Netherlands commercial beam trawl fleet. The model was therefore re-estimated using a power catchability relationship for that fleet, but the improvement in fit was minor and the overall sum-of-squares pattern was significantly distorted. It was thus decided that there was no good reason to change the default parameter inputs, and a linear catchability model was re-instated. Figure 20.7.1 gives the comparison of XSA and ICA results for mean reference *F*, SSB and recruits. ICA returns consistently higher *F* values, and consequently lower SSB values. Recruitment for both models is similar, save for the rather higher ICA estimate of the 1994 year class. Rerunning the model with final-year selection reduced to 0.8 had no significant effect on these high F estimates. The time trend in the Netherlands commercial beam trawl fleet may be one cause of these differences, as it is likely that ICA and XSA behave differently when faced with such trends.

For the projection run, the first year in the time-series was changed to 1977, and the oldest age was reduced to 10 (plus group). Figure 20.7.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ockham model), and spawning stock size. Figure 20.7.3 shows the SSB projection in relation to the best current estimate of MBAL (300,000 tonnes), along with a plot showing the probability that SSB will remain below MBAL over the projection period. This probability is high for the entire projection period, and while it falls appreciably there is still a reasonable likelihood that SSB will not exceed MBAL over the next ten years (given the high ICA estimate for final-year *F*). The steady rise is in contrast with the medium-term projection in Section 9.8, which postulates a rise towards MBAL followed by a decline over the latter half of the projection period. Figure 20.7.4 gives residual plots for the assumed stock-recruitment model.

There was a degree of caution over the validity of this WGMTERM projection with regard to the imposed stock-recruitment relationship and its possible lack of adherence to the precautionary approach. The ICA projection suite was thus further utilised to investigate the effect of using a number of different stock-recruitment relationships. Standard projection outputs are given, augmented by diagnostic plots for the stock-recruitment models, for the Ockham model (Figures 20.7.2–20.7.4), the Shepherd model (Figures 20.7.5–20.7.6), the Beverton-Holt model (Figures 20.7.8–20.7.10), the Ricker model (Figure 20.7.11–20.7.13) and the historic mean model (Figures 20.7.14–20.7.16). Note, firstly, that the Shepherd residual plot (Figure 20.7.7) could not be printed due to an unspecifiable ICA run-time error; and secondly, that the Ricker curve does not appear to be fitted correctly by this version of the ICA projection package and the projection based thereon must be viewed with suspicion. It can be seen that, while projections are similar in all cases, the Ockham and historic mean models result in slightly more pronounced patterns of stock recovery.

20.2.8 Plaice in Division IIIa

There were four tuning fleets used in the analysis of plaice in the Kattegat and Skagerrak; the Argos first-quarter IBTS, Danish gill-netters, Danish trawlers and Danish seiners. The age range was 2 to 11 years, with the last age being a plus group. The reference age for the separable constraint was defined as 6 and selection *S* on the last age was fixed to 1.0. Age groups older than 7 years were derived from few, noisy landings data and were therefore downweighted (weighting = 0.1). Post-run graphical diagnostics revealed no particular reason to deviate from the default parameter inputs, although the majority of marginal year and age totals for the separable model log residuals were quite large and negative. Figure 20.8.1 gives the comparison of XSA and ICA results for mean reference *F*, SSB and recruits. SSB plots are very similar, while the ICA mean *F* can be thought of as a smoothed counterpart to the XSA mean *F*. ICA recruitment is essentially identical to that for XSA until the 1995 year-class, which ICA would appear to have been over-estimated (although the presence of increased recruitment *is* suggested by XSA results). This propensity for ICA to deliver erratic recent-years recruitment estimates is discussed in the Conclusions Section below.

The first year in the time-series was changed to 1977 for the projection run. Figure 20.8.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ricker model), and spawning stock size. Figure 20.8.3 shows the SSB projection in relation to the best current estimate of MBAL (25,000 tonnes), along with a plot showing the probability that SSB will fall below MBAL over the projection period. The rapid increase and subsequent decline in SSB and landings is probably an artefact induced by the over-estimated 1995 year class. This year class also has the effect of making the ICA projections substantially different from those discussed in Section 10.8. Figure 20.8.4 shows residual plots for the stock-recruitment relationship.

20.2.9 Plaice in Division VIId

There were a total of seven tuning fleets used in the analysis of plaice in the English Channel, namely Belgian beam trawlers, English beam trawl survey, French groundfish survey, English and French young fish surveys, and UK and French inshore trawlers. The age range was 1 to 10 years, with the last age being a plus group. The reference age for the separable constraint was defined as 2 and selection *S* on the last age was fixed to 1.0. The first age in the analysis was downweighted by a factor of 10, to allow for potentially noisy data on that age. Post-run graphical diagnostics suggested that the Belgian beam trawl fleet had both a distinct SSQ pattern and a noticeable trend in log catch residuals. The comparison run was performed with a power catchability model imposed on this fleet, which greatly improved its diagnostics and thus improved the model. Figure 20.9.1 gives the comparison of XSA and ICA results for mean reference *F*, SSB and recruits. ICA returns significantly higher mean *F* in the last two years than XSA and somewhat higher recruitment in recent years, while SSB estimates are almost identical.

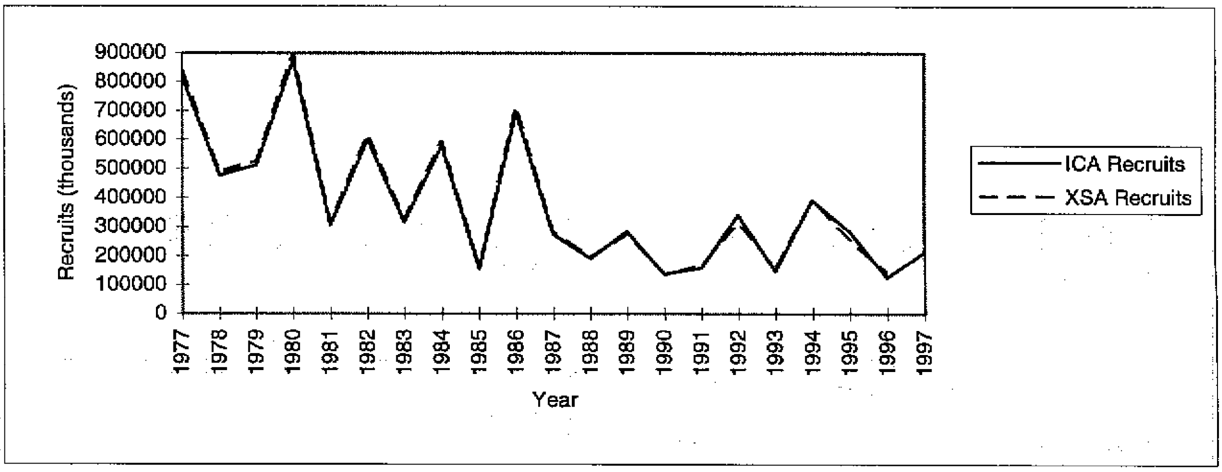
The number of fleets in the tuning dataset had to be reduced from 7 to 5 to allow the projection software to operate. The choice of fleets to remove was made with reference to weighted MSQs: the UK and French inshore trawl fleets had the lowest results in this regard and were discarded forthwith. Figure 20.9.2 shows projected landings, fishing mortality (fixed), recruitment (based on the Ricker model), and spawning stock size. Figure 20.9.3 shows the SSB projection in relation to the best current estimate of MBAL (5,600 tonnes), along with a plot showing the probability that SSB will fall below MBAL over the projection period. This suggests that plaice SSB is more likely than not to fall below MBAL at some point in the next ten years if current fishing mortality levels are maintained. The same conclusion is reached in Section 11.8. Figure 20.9.4 gives plots of the residuals about the imposed stock-recruitment relationship.

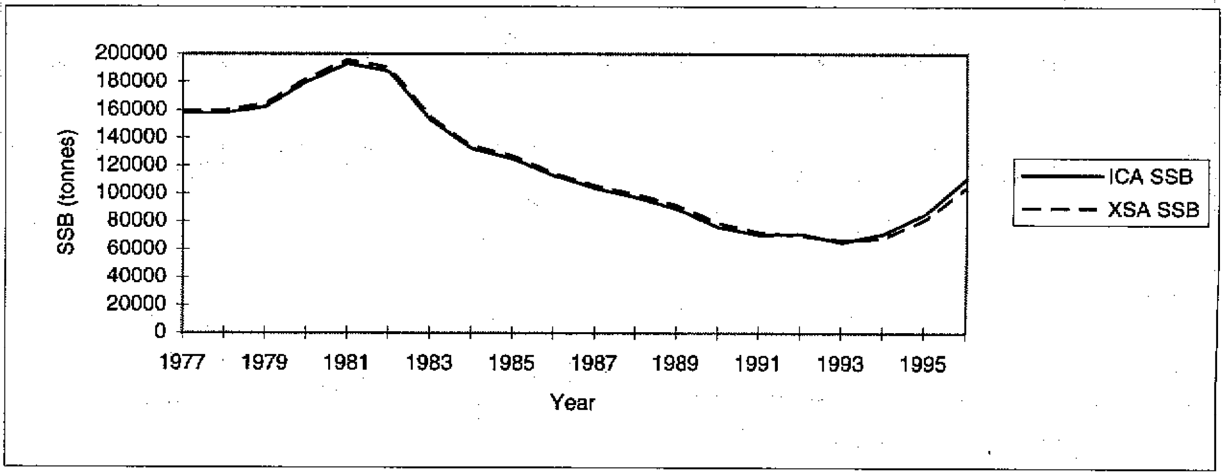
20.3 Conclusions

While ICA and XSA are certainly different in the details of their approaches, the broad methodological viewpoint is similar for both models and explanations must be sought for the variations that have been seen in this section. For example, for several stocks (namely sole in the North Sea and English Channel, plaice in the North Sea, Kattegat and Skagerrak, and saithe in the North Sea) ICA estimates of recruitment in the last years of analysis seem erratic, although this is also a general problem with XSA and ADAPT estimates. One instance of this is the 1994 year class of plaice in the Kattegat and Skagerrak (one-year-old recruits in 1996), which is estimated by ICA to be an order of magnitude higher than the previous expectation and is clearly erroneous. Several approaches were taken to the solution of this problem. The catch matrix element in question was downweighted, different age-correlation parameters were attempted, the downweighting on the older ages was removed, the youngest age and the most recent year were downweighted; but without conspicuous success. The recruiting year-class is larger than would be expected in both catch and tuning datasets, while the older year-classes are all smaller than expected, so it is reasonable to conclude that the non-linear least-squares model is overfitting to the youngest age. Recent recruitments are notoriously difficult to estimate accurately in any system, and it seems that ICA may be no exception to this rule. The problems noted above regarding roundfish assessment are less worrying, and are most likely to be due to temporary data-transfer problems within IFAP.

The principal advantages of ICA may be enumerated as: 1) it has a firmer statistical footing than XSA and estimates of parameter variance arise naturally as a result of the model-fitting process; and 2) the underlying model is more transparent than that of XSA (being in essence a least-squares minimisation) and therefore model behaviour is more apparent. Further work needs to be done on establishing the relative merits of XSA and ICA, but initial exploratory runs such as have been conducted here are essential in highlighting issues to be examined more closely. The main conclusion of this Section must be that detailed exploration of the ICA method, including a more detailed analysis of the numerous ICA diagnostics than has been possible here, by assessors familiar with the properties and behaviour of each stock should be carried out before a full comparison can be made.

Figure 20.1.1 Comparative plots for Cod in Sub-Area IV and Division IIIa.





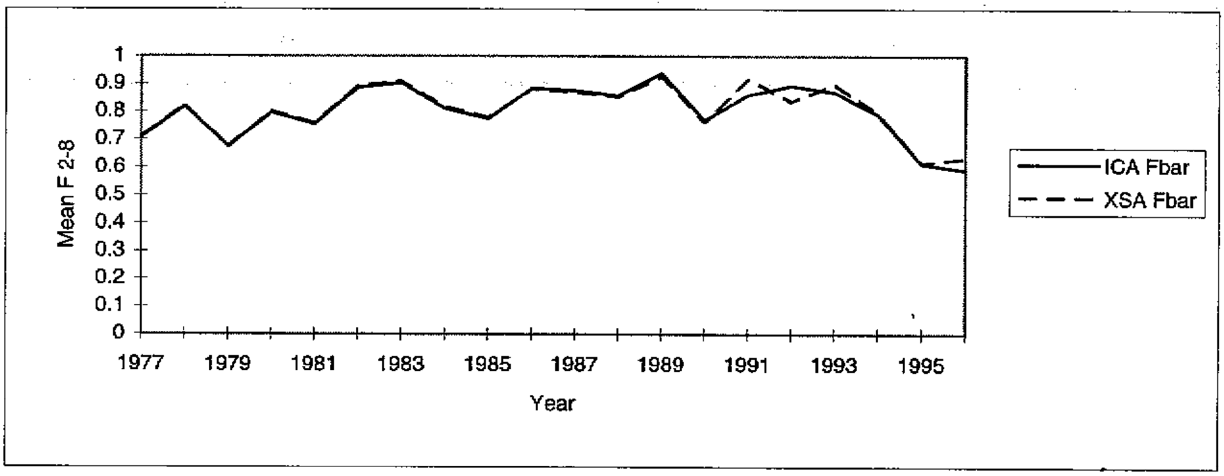


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Figure 20.1.2. Cod in Sub-Area IV and Division IIIa: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

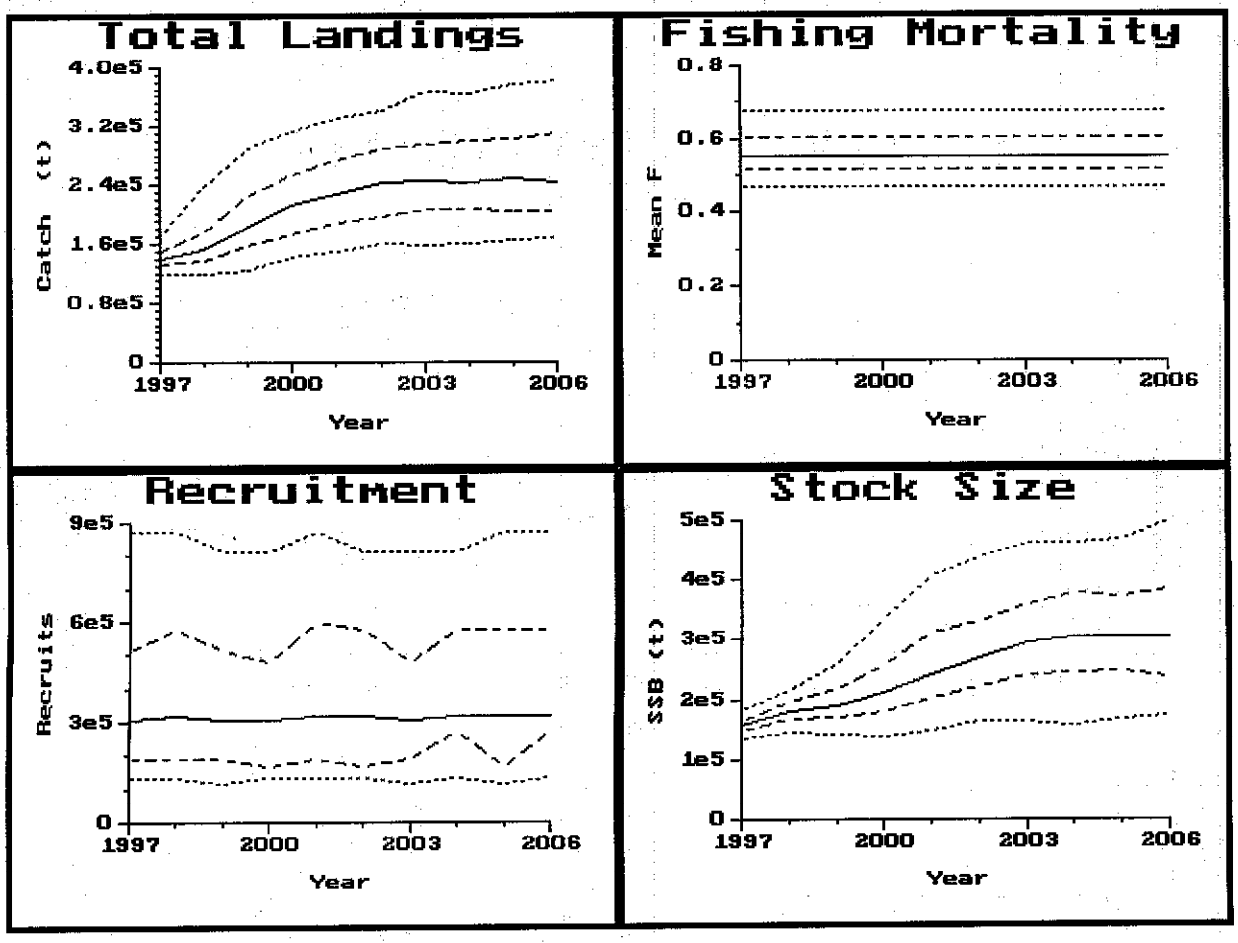


Figure 20.1.3. Cod in Sub-Area IV and Division IIIa. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham recruitment model.

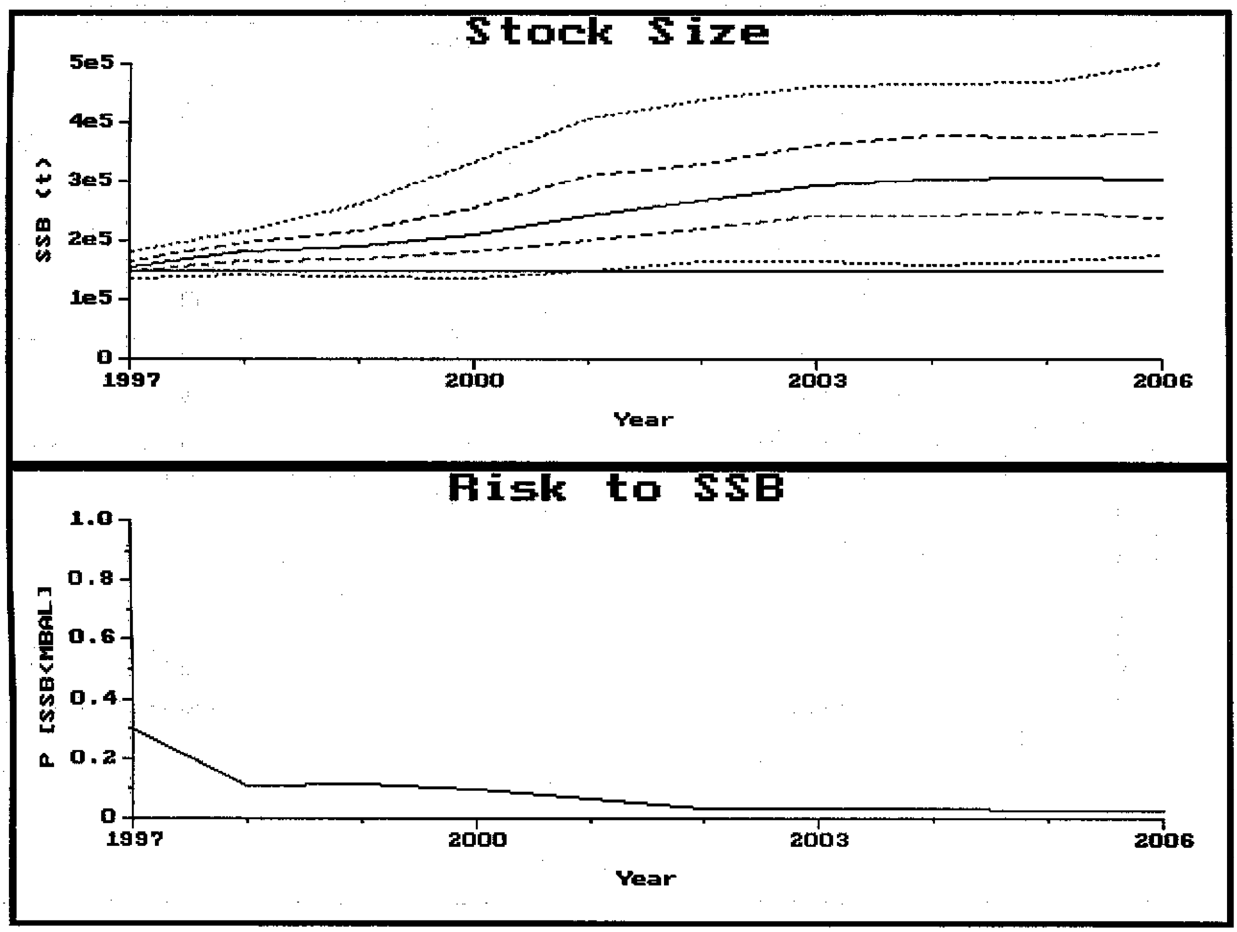


Figure 20.1.4. Cod in Sub-Area IV and Division IIIa. Diagnostic plots for the Ockham stock-recruitment curve.

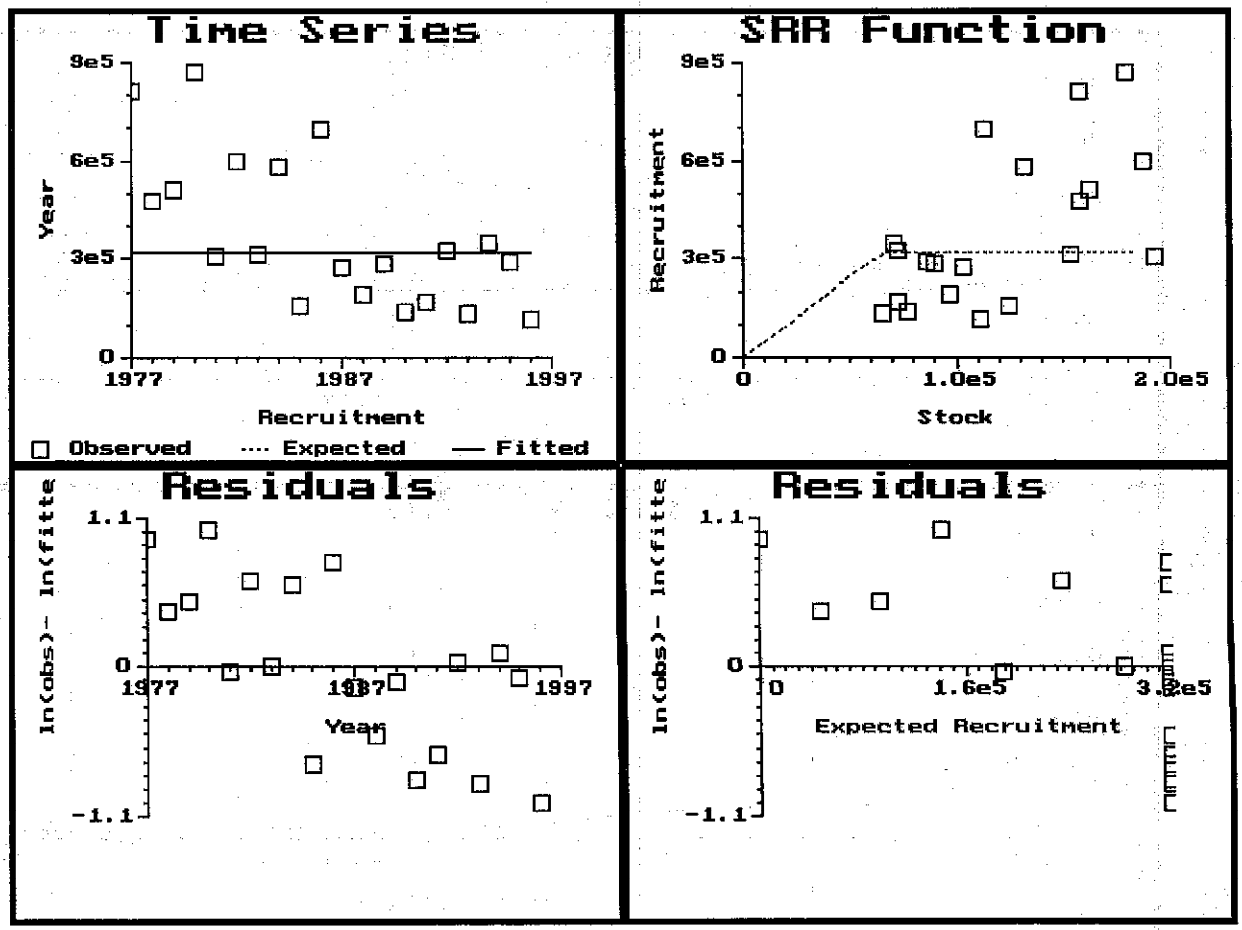
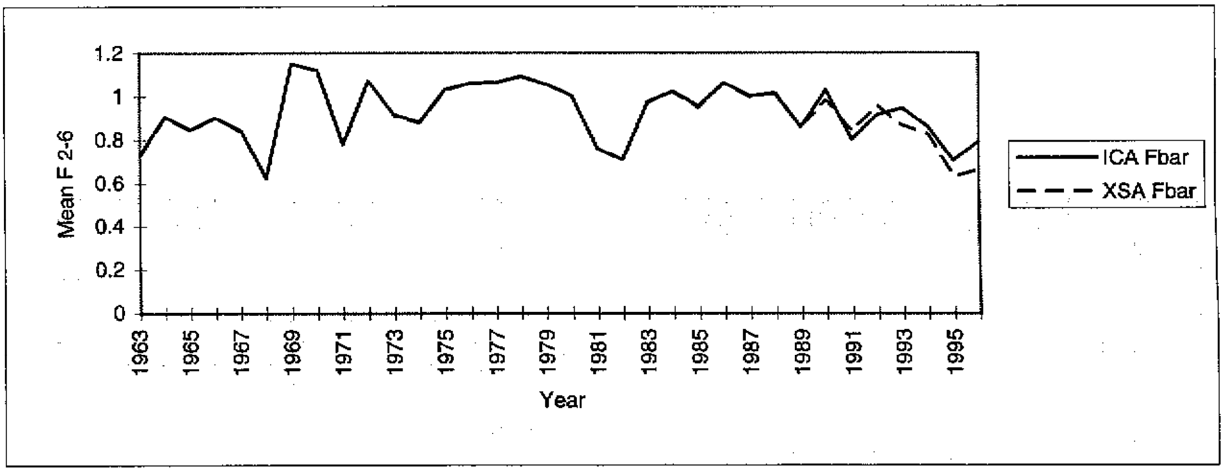
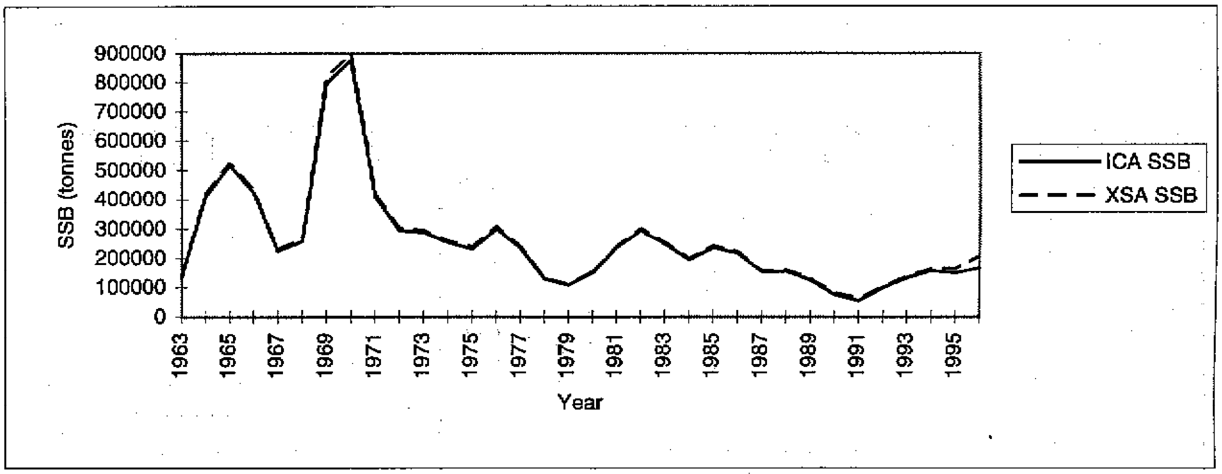


Figure 20.2.1 Comparative plots for Haddock in Sub-Area IV and Division IIIa.





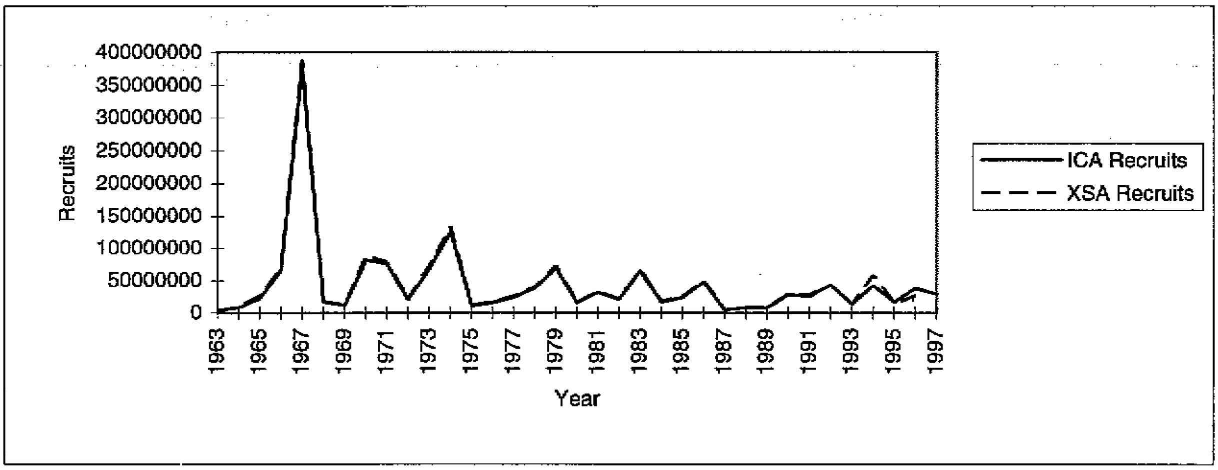


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Figure 20.2.2. Haddock in Sub-Area IV and Division IIIa: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

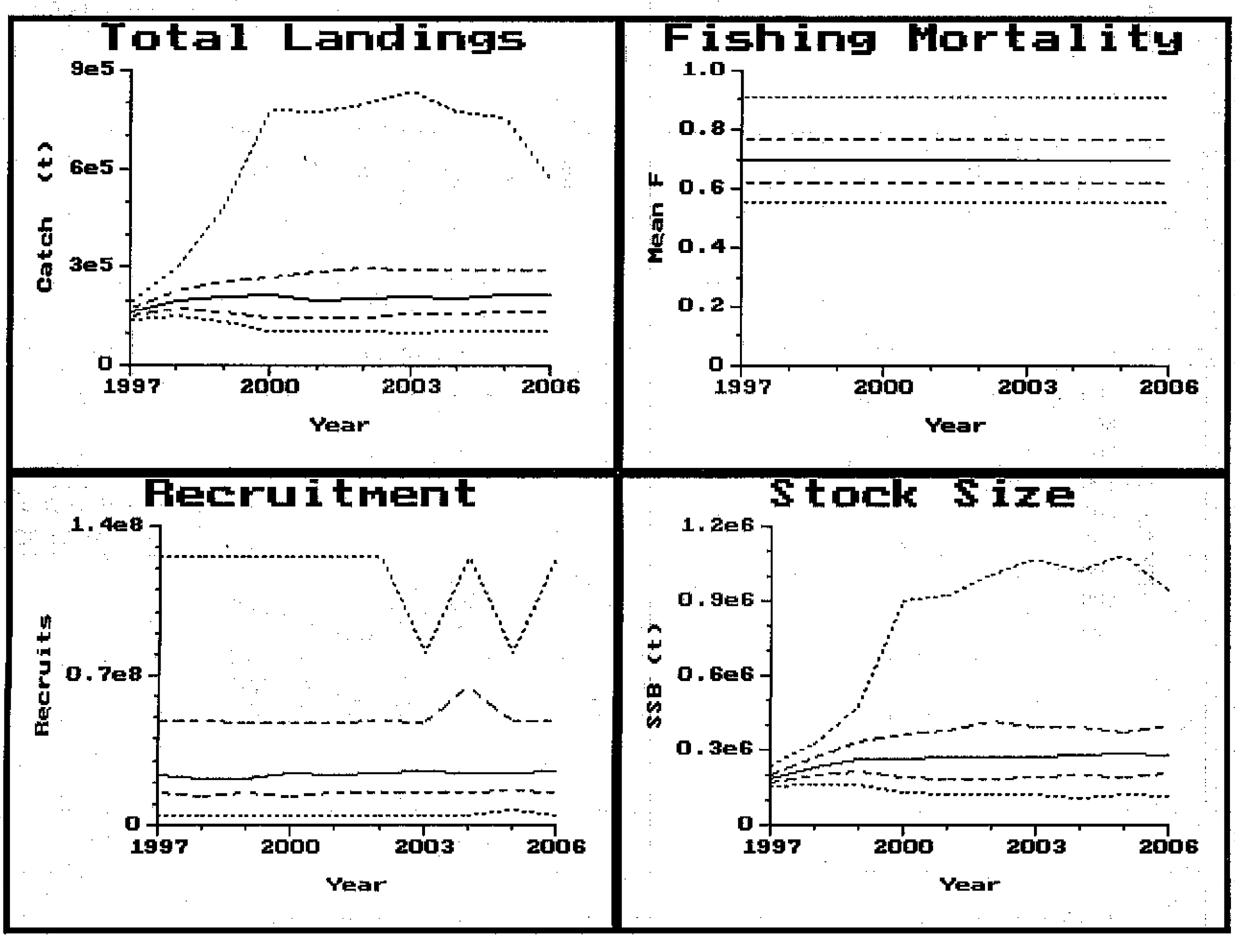


Figure 20.2.3. Haddock in Sub-Area IV and Division IIIa. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and B_{loss} (horizontal line). Lower plot: estimated probability that SSB will fall below B_{loss} for each of the projected years, based on the Ockham recruitment model.

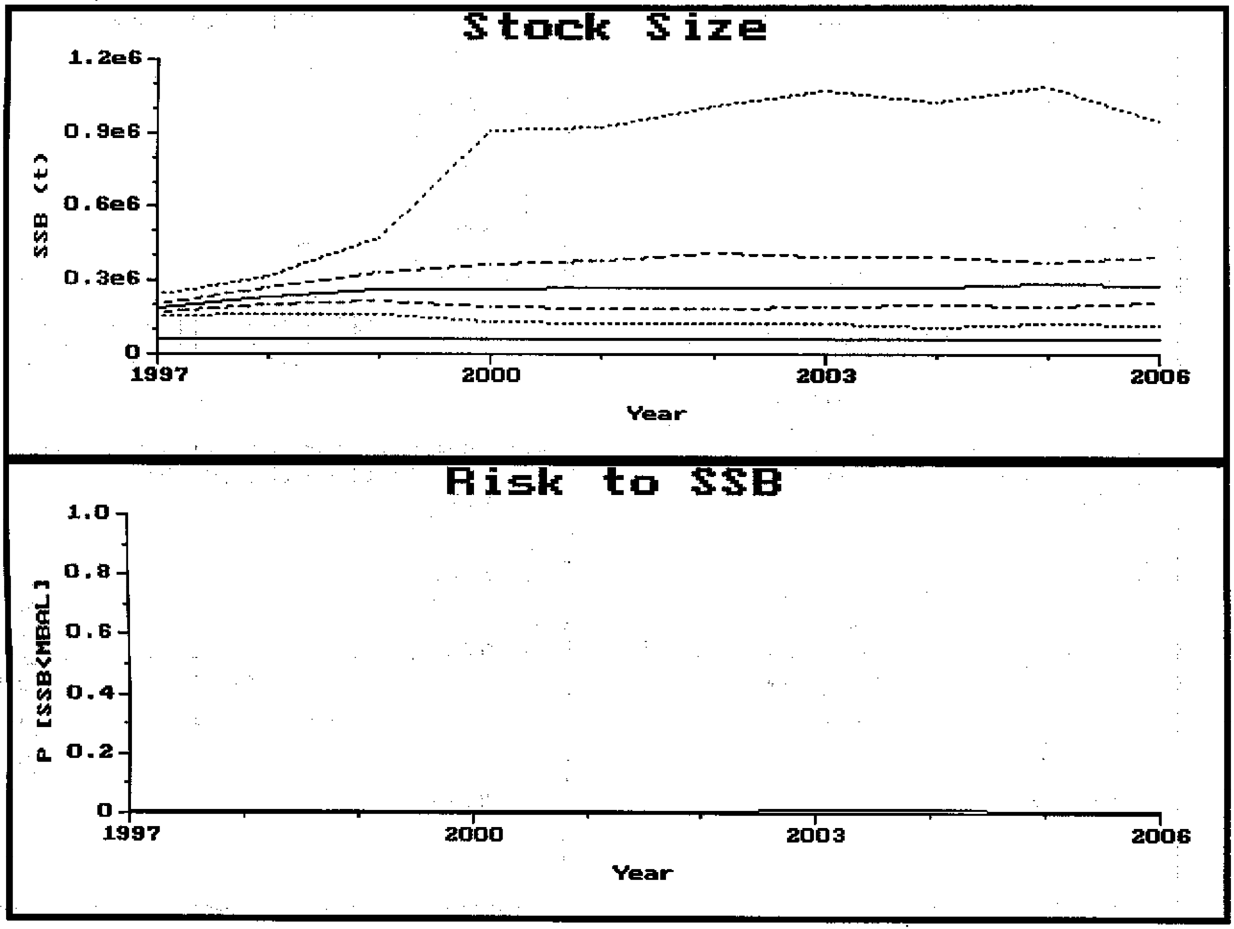


Figure 20.2.4. Haddock in Sub-Area IV and Division IIIa. Diagnostic plots for the Ockham stock-recruitment curve.

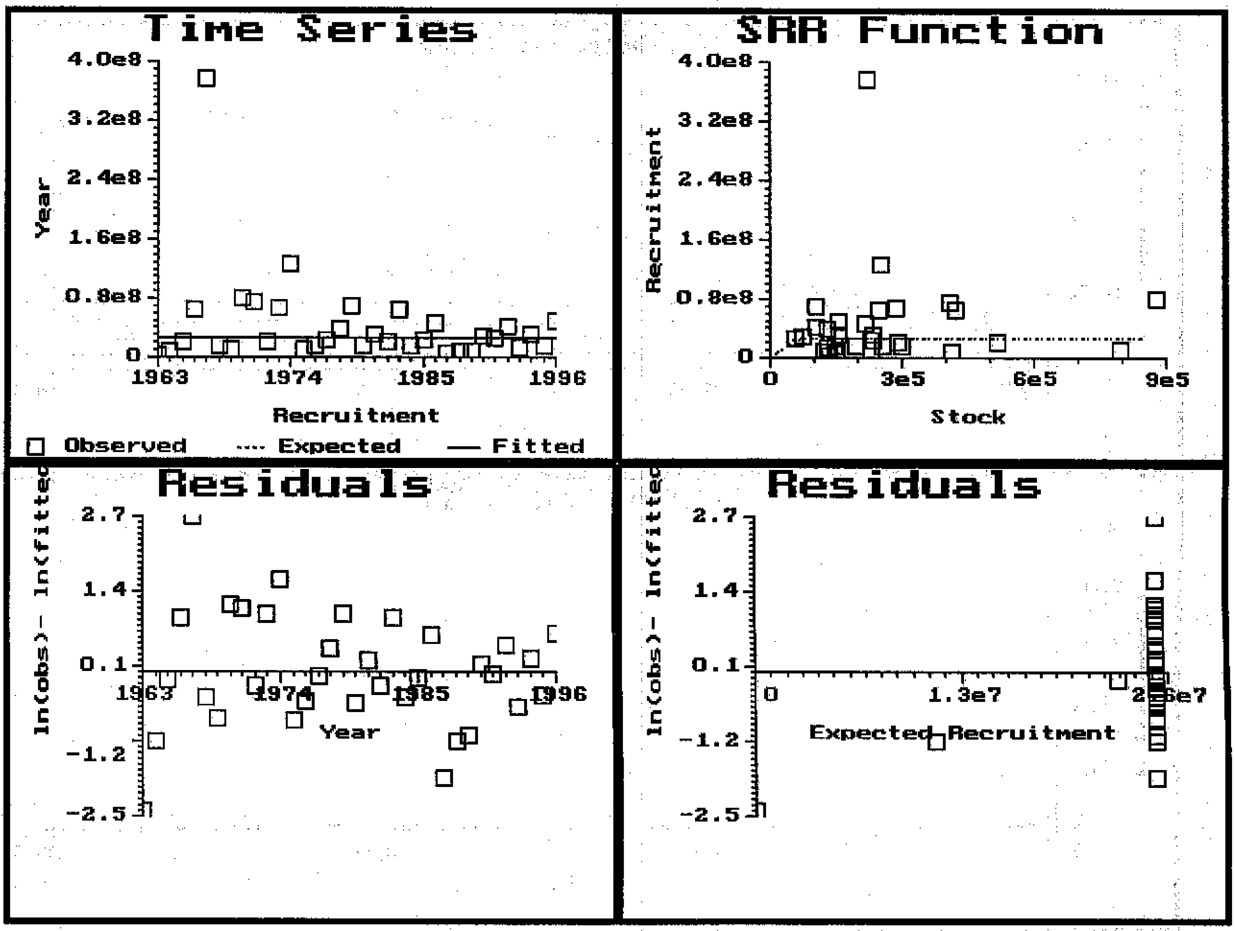
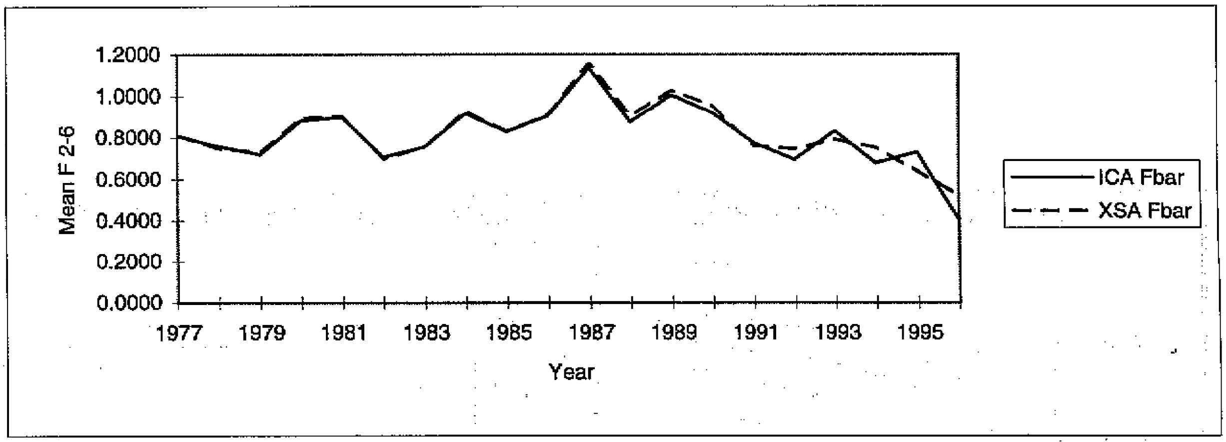
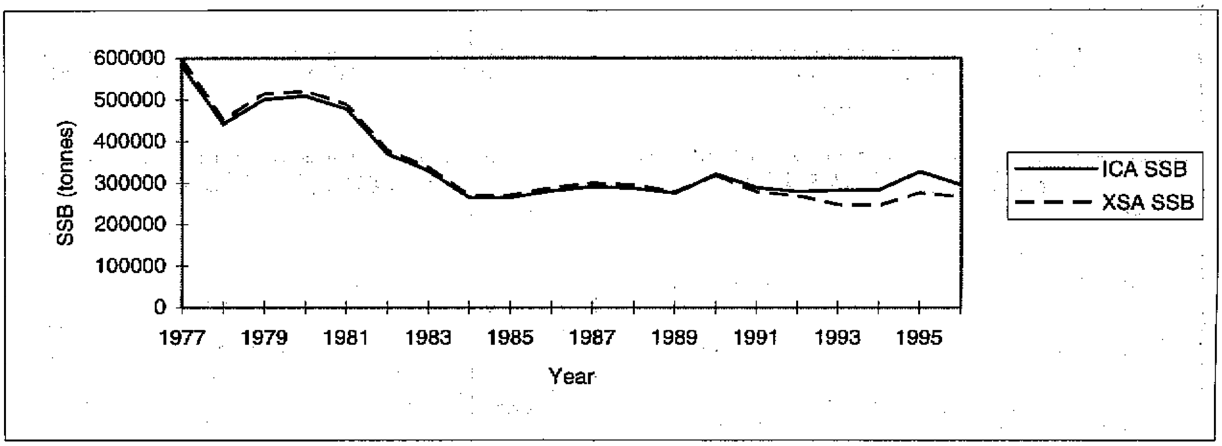


Figure 20.3.1 Comparative plots for Whiting in Sub-Area IV and Division IIIa.





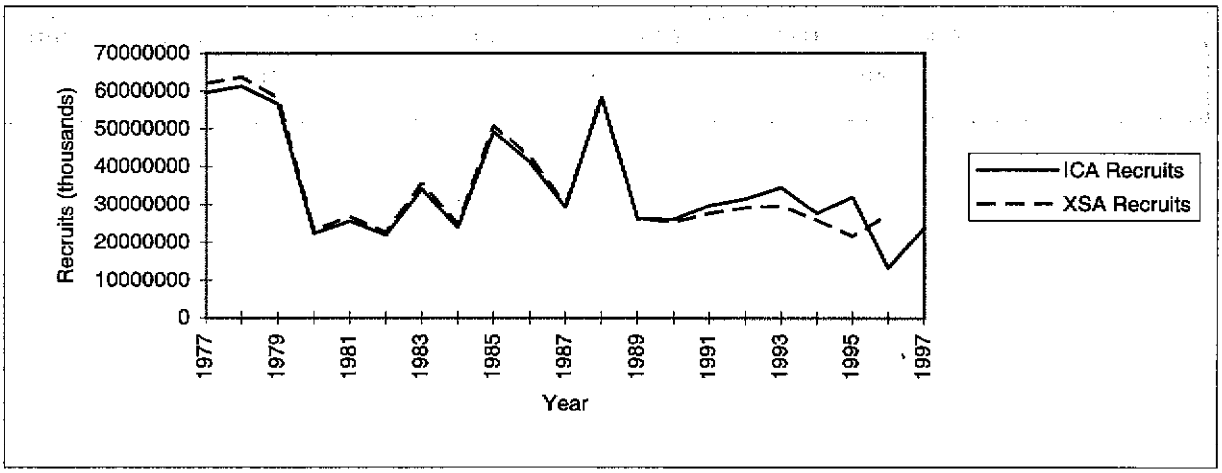


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Figure 20.3.2. Whiting in Sub-Area IV and Division IIIa: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

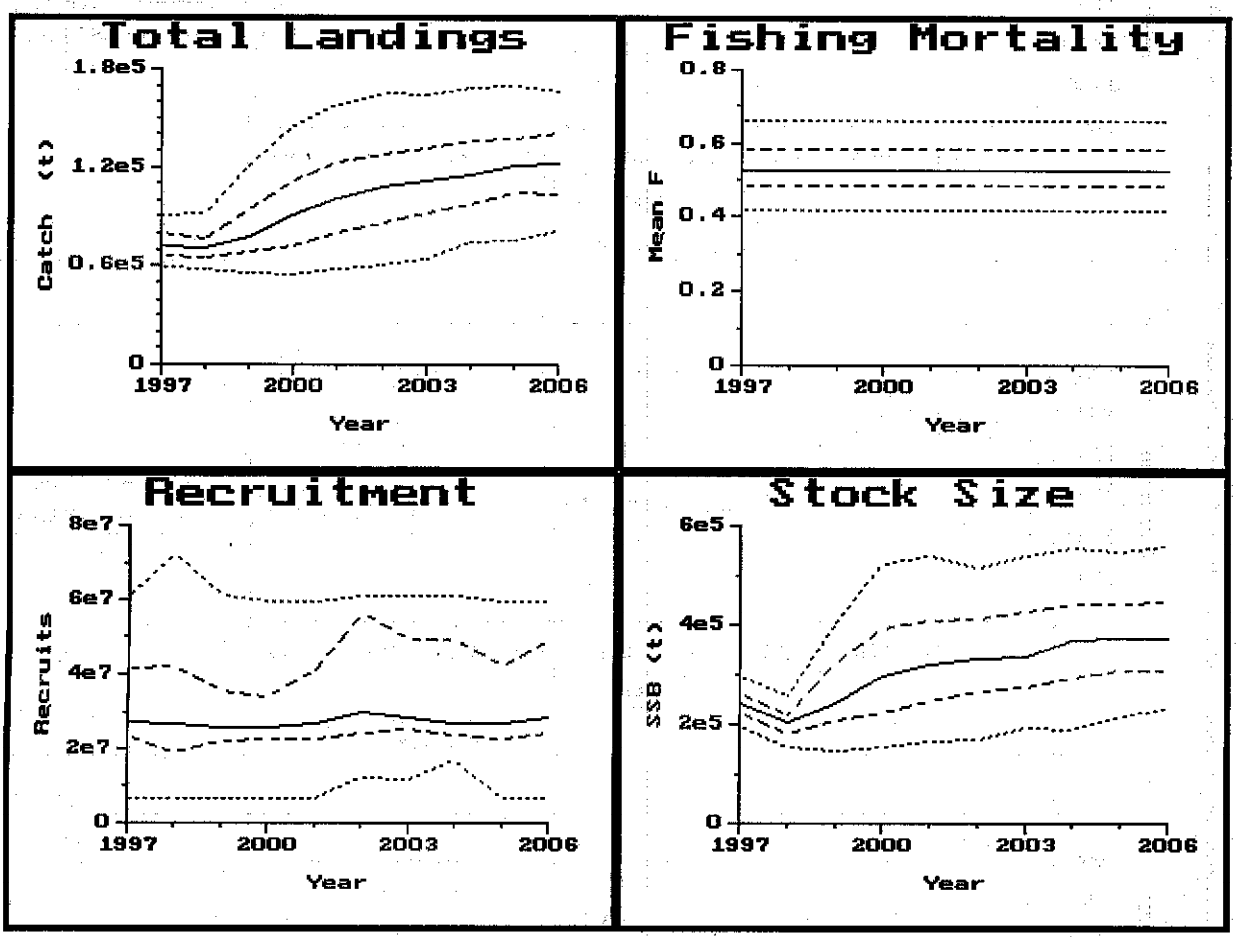


Figure 20.3.3. Whiting in Sub-Area IV and Division IIIa. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and B_{loss} (horizontal line). Lower plot: estimated probability that SSB will fall below B_{loss} for each of the projected years, based on the Ockham recruitment model.

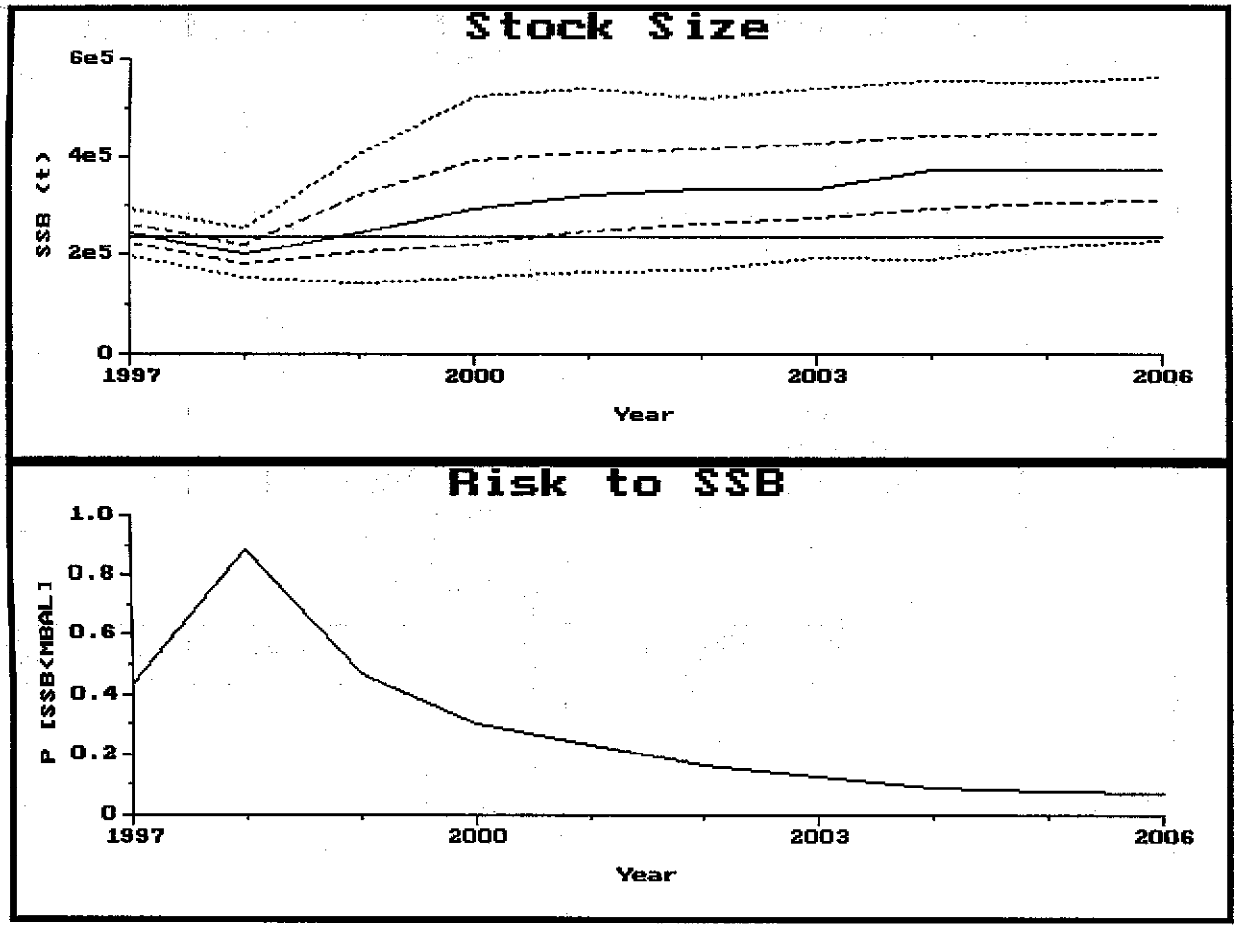


Figure 20.3.4. Whiting in Sub-Area IV and Division IIIa. Diagnostic plots for the Ockham stock-recruitment curve.

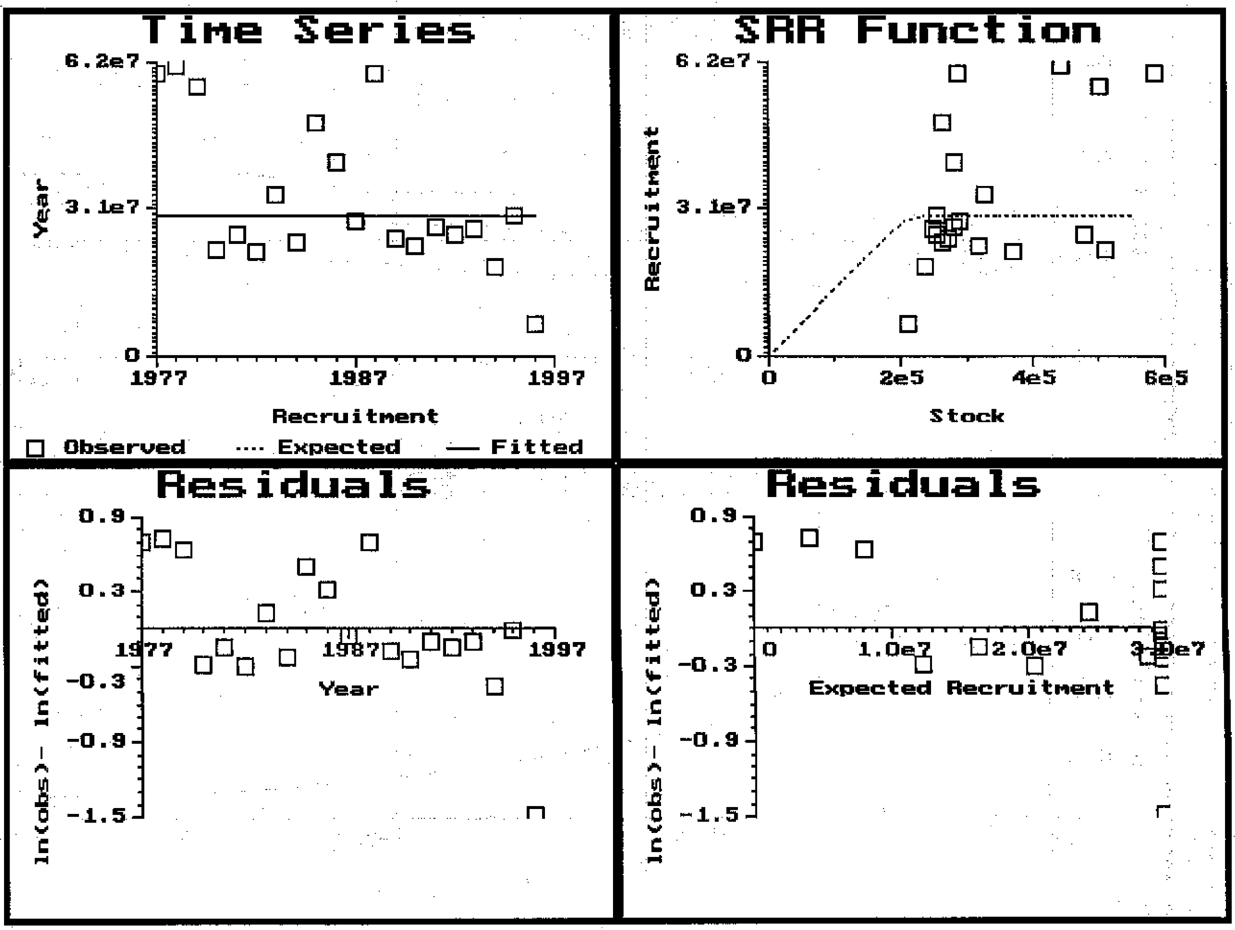
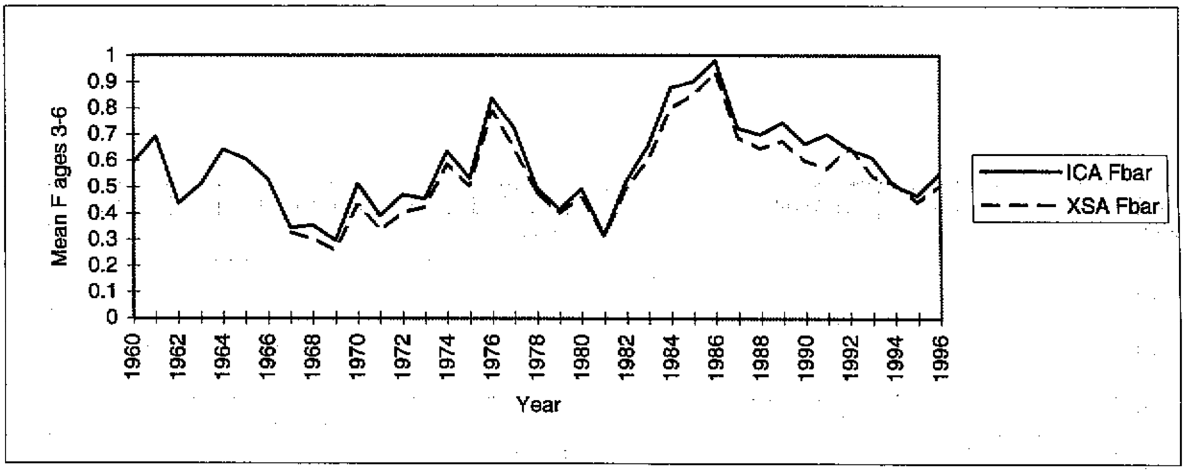
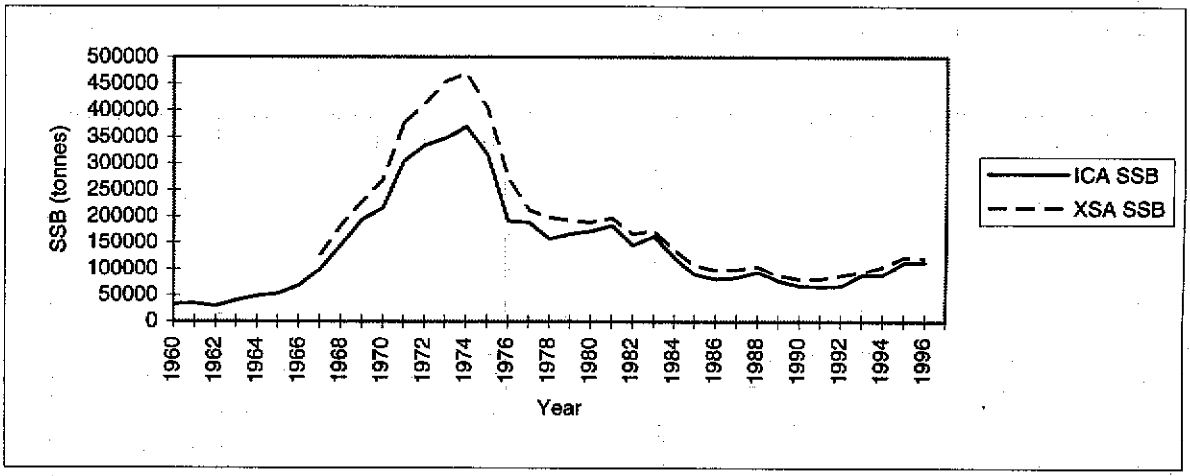


Figure 20.4.1 Comparative plots for Saithe in Sub-Area IV and Division IIIa





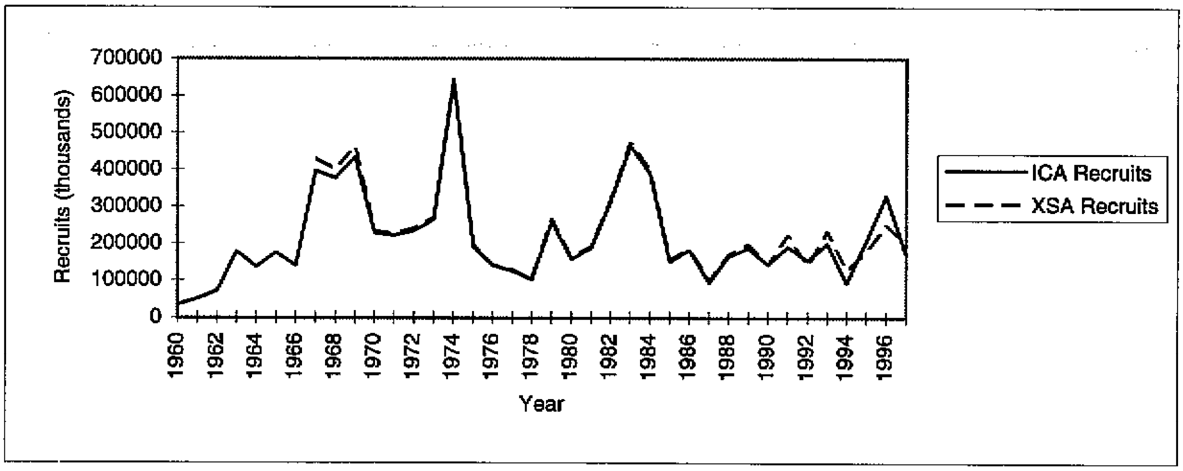


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Figure 20.4.2. Saithe in Sub-Area IV and Division IIIa: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

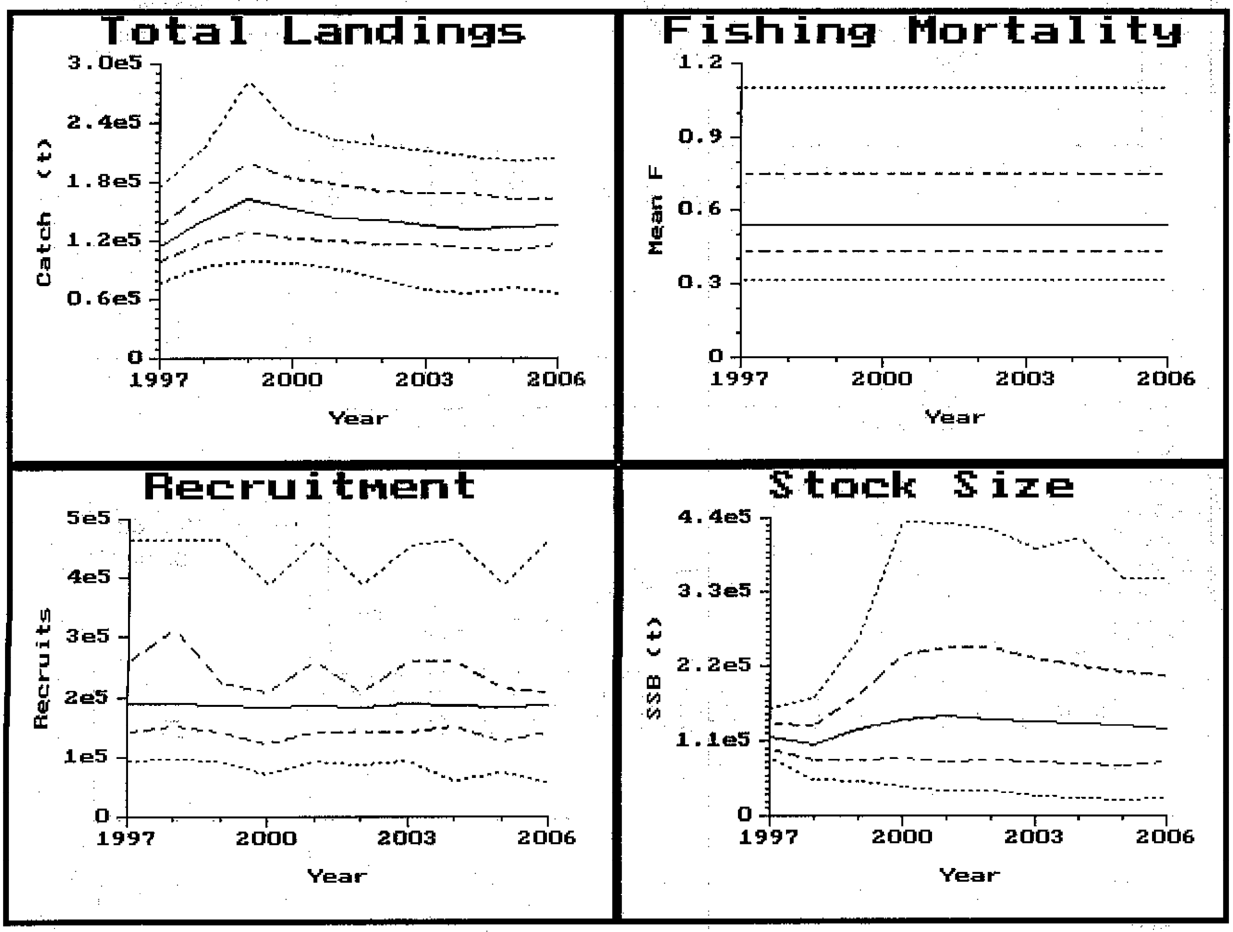


Figure 20.4.3. Saithe in Sub-Area IV and Division IIIa. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham recruitment model.

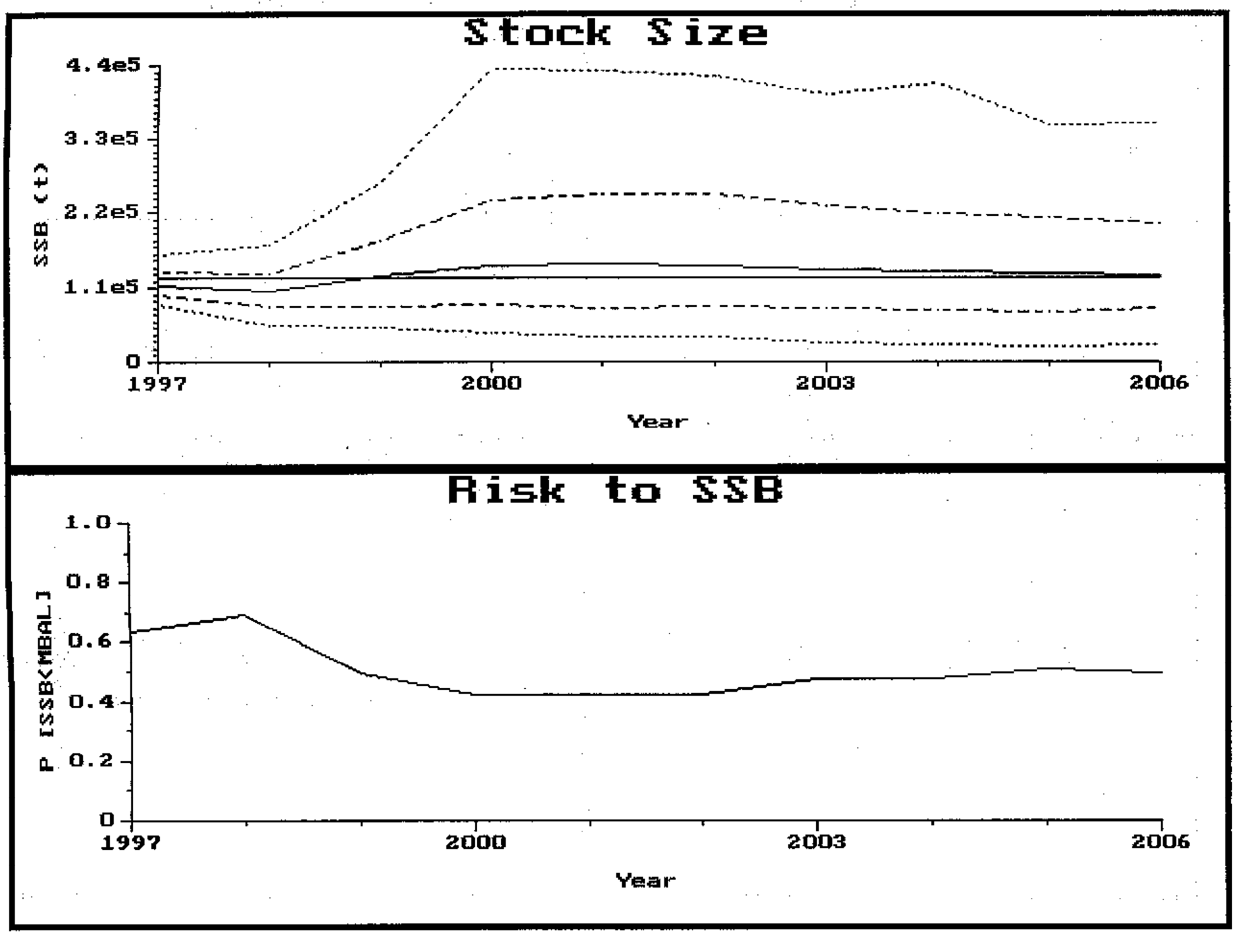


Figure 20.4.4. Saithe in Sub-Area IV and Division IIIa. Diagnostic plots for the Ockham stock-recruitment curve.

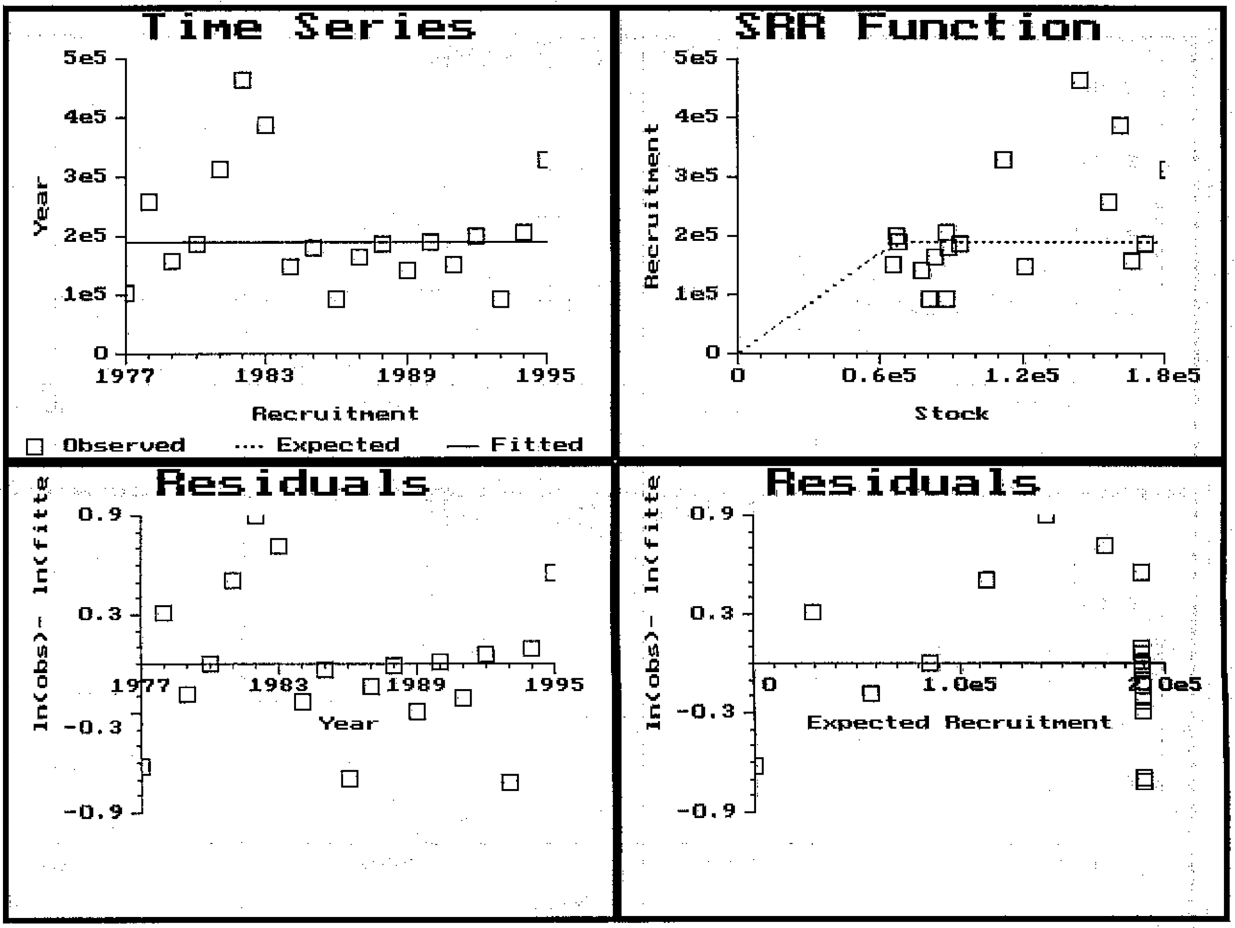
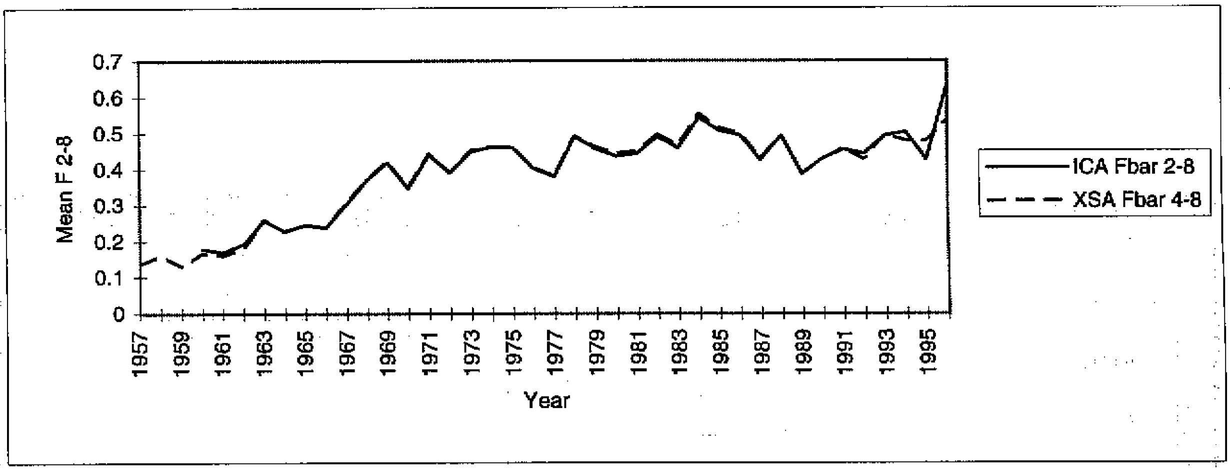
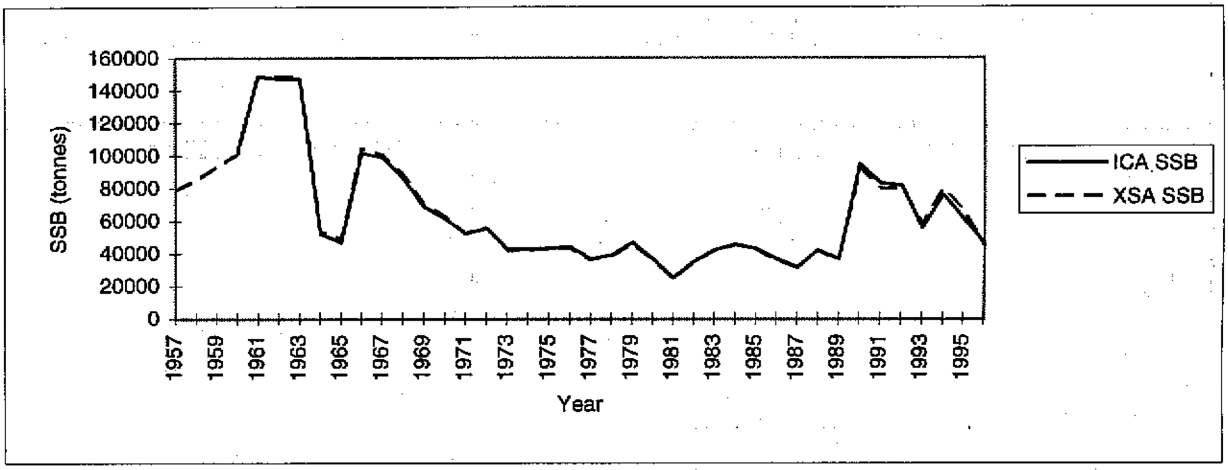


Figure 20.5.1 Comparative plots for Sole in Sub-Area IV.





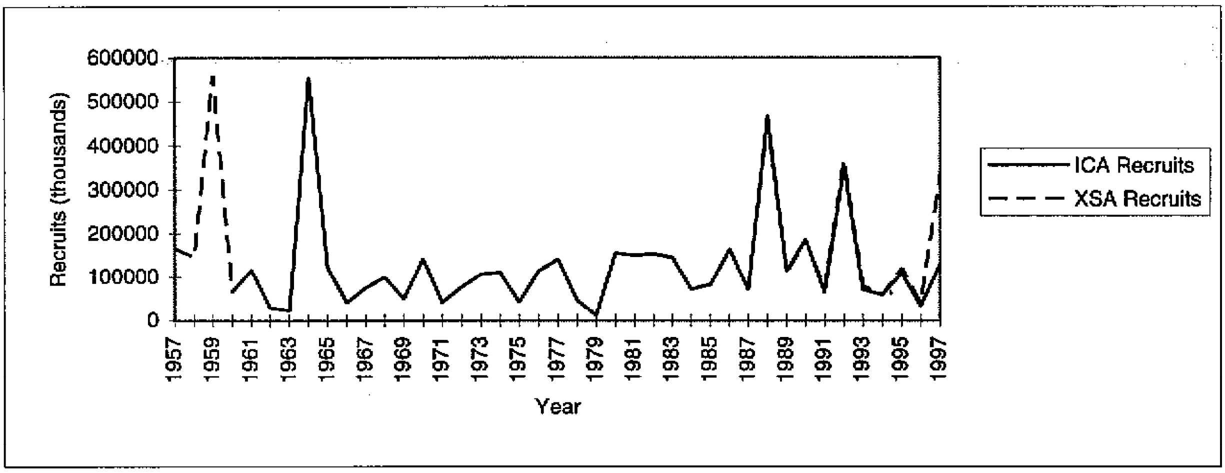


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Figure 20.5.2. Sole in Sub-Area IV: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

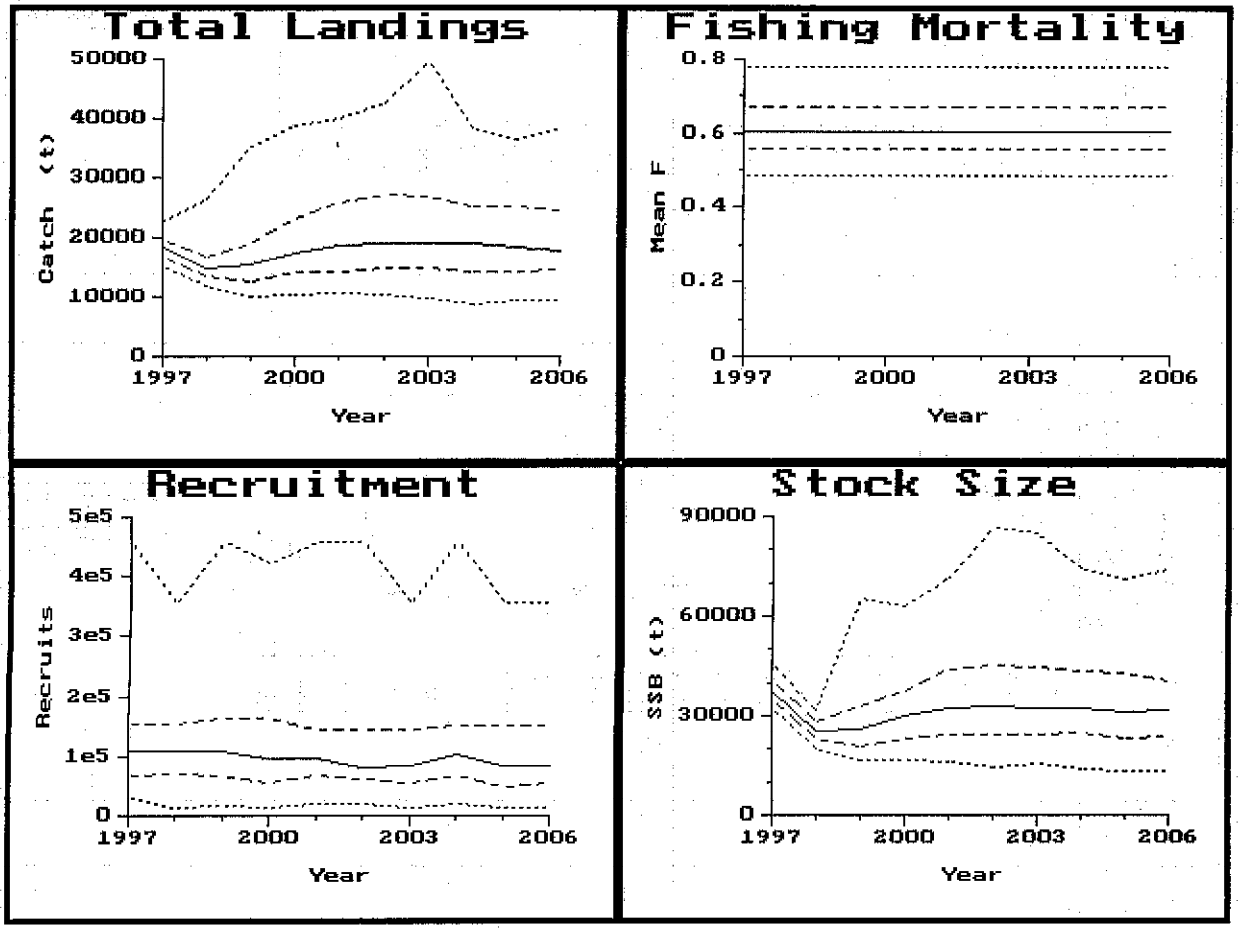


Figure 20.5.3. Sole in Sub-Area IV. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham recruitment model.

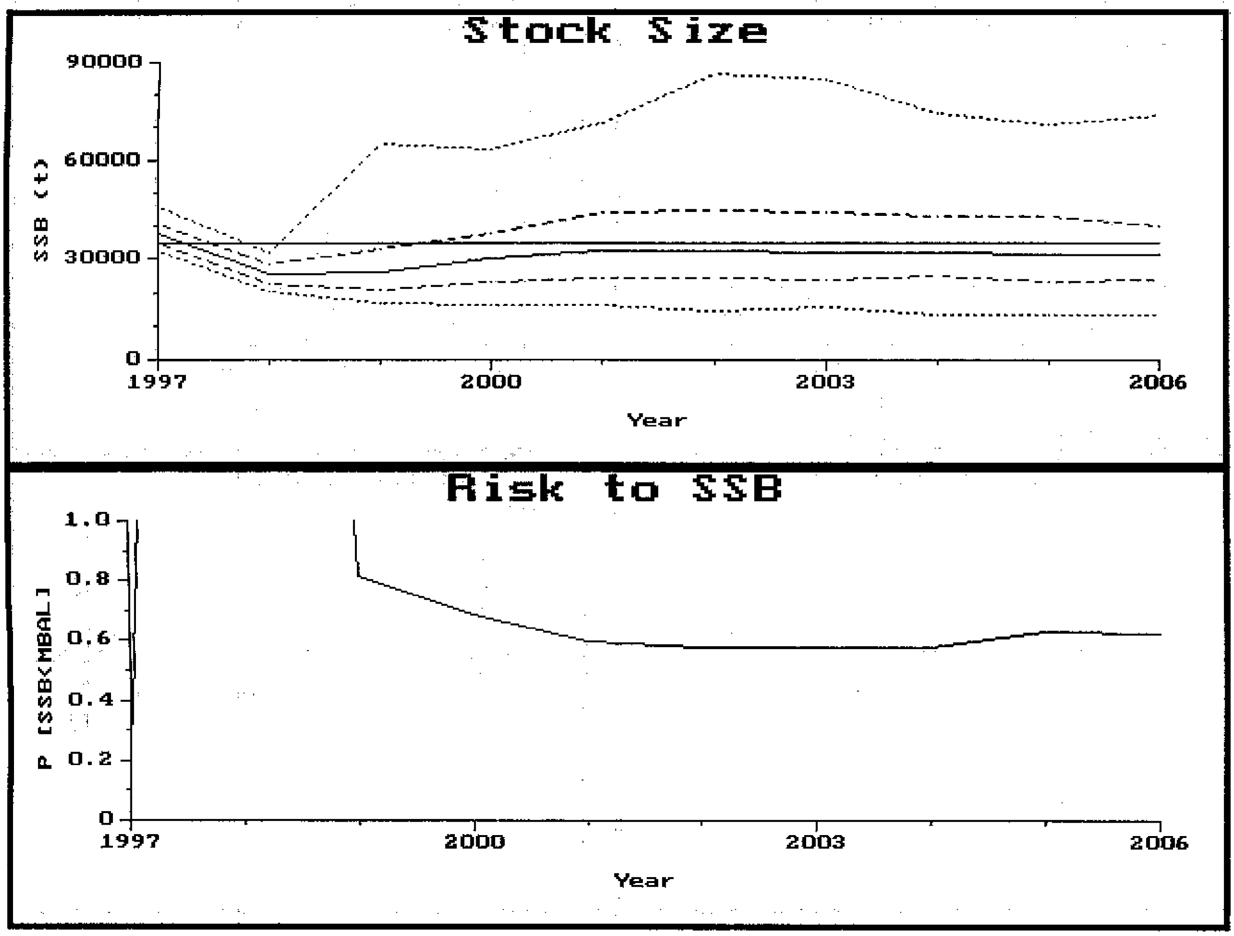


Figure 20.5.4. Sole in Sub-Area IV. Diagnostic plots for the Ockham stock-recruitment curve.

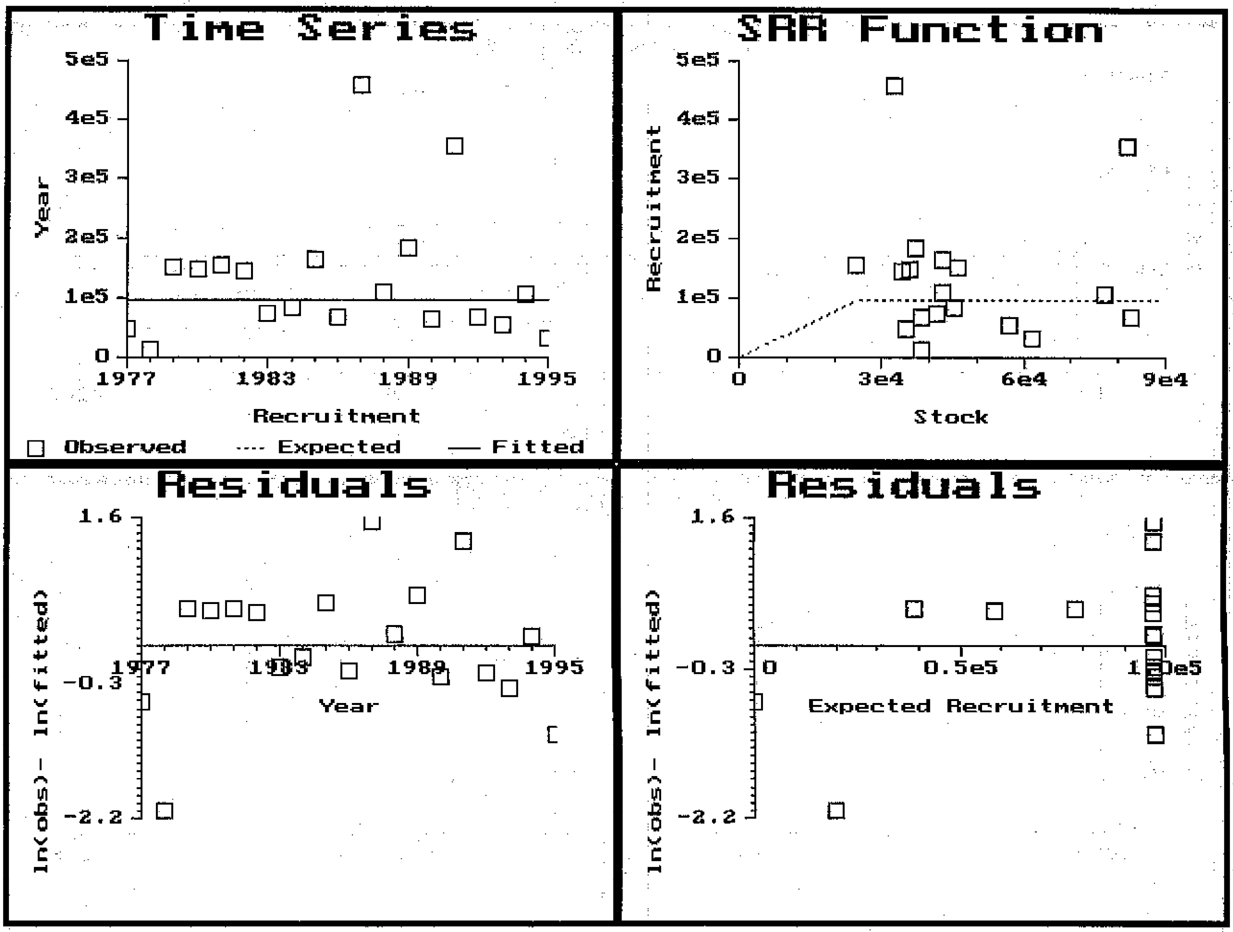
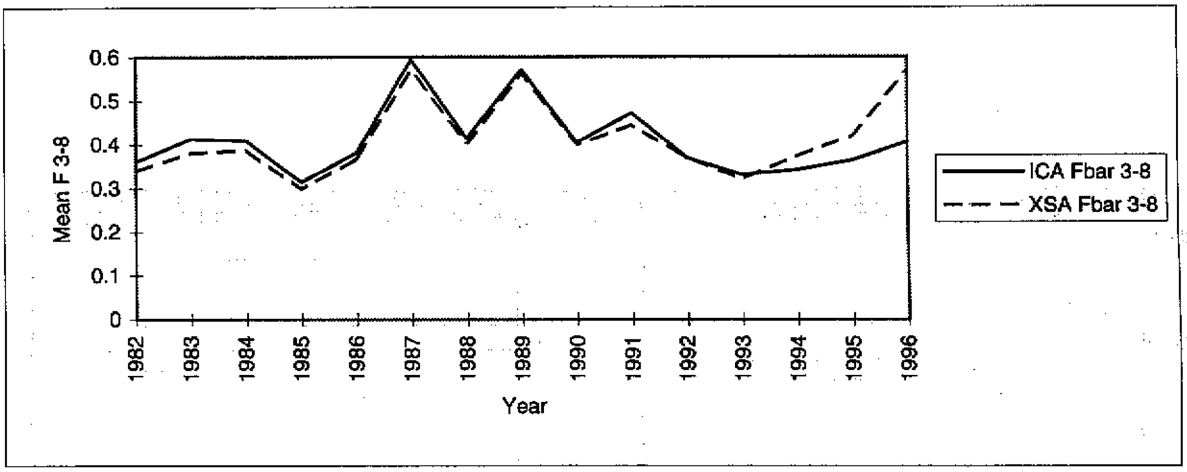
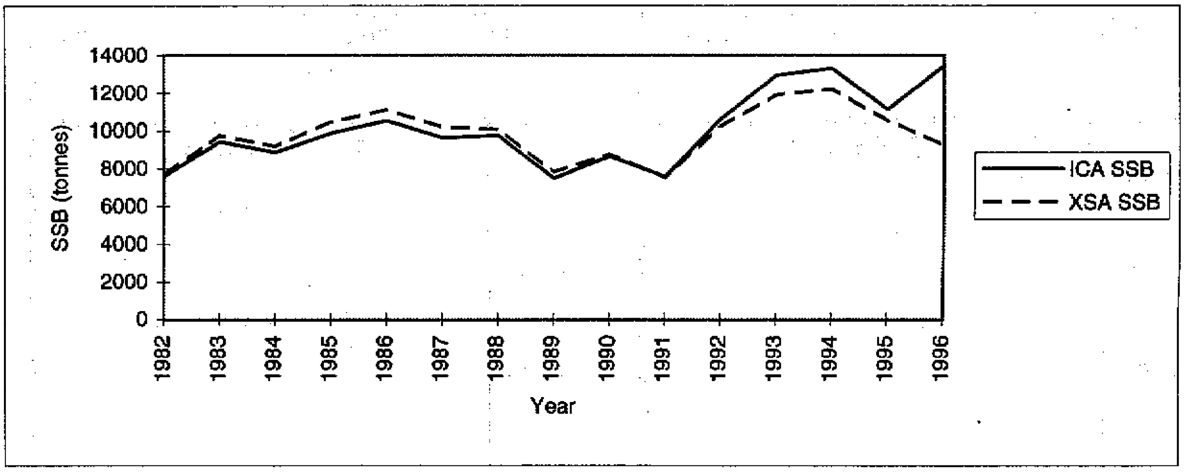


Figure 20.6.1 Comparative plots for Sole in Division VIId





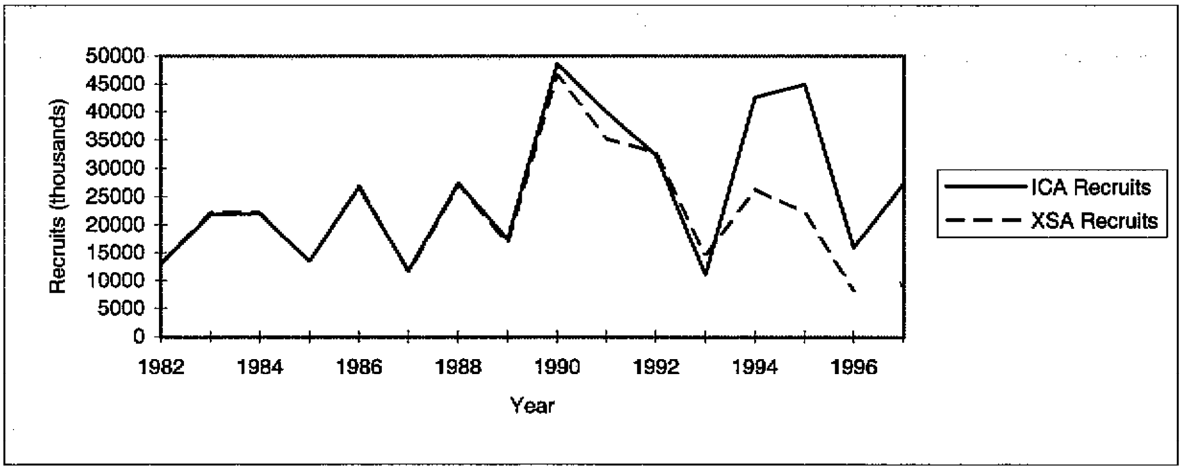


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Figure 20.6.2. Sole in Division VIId: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

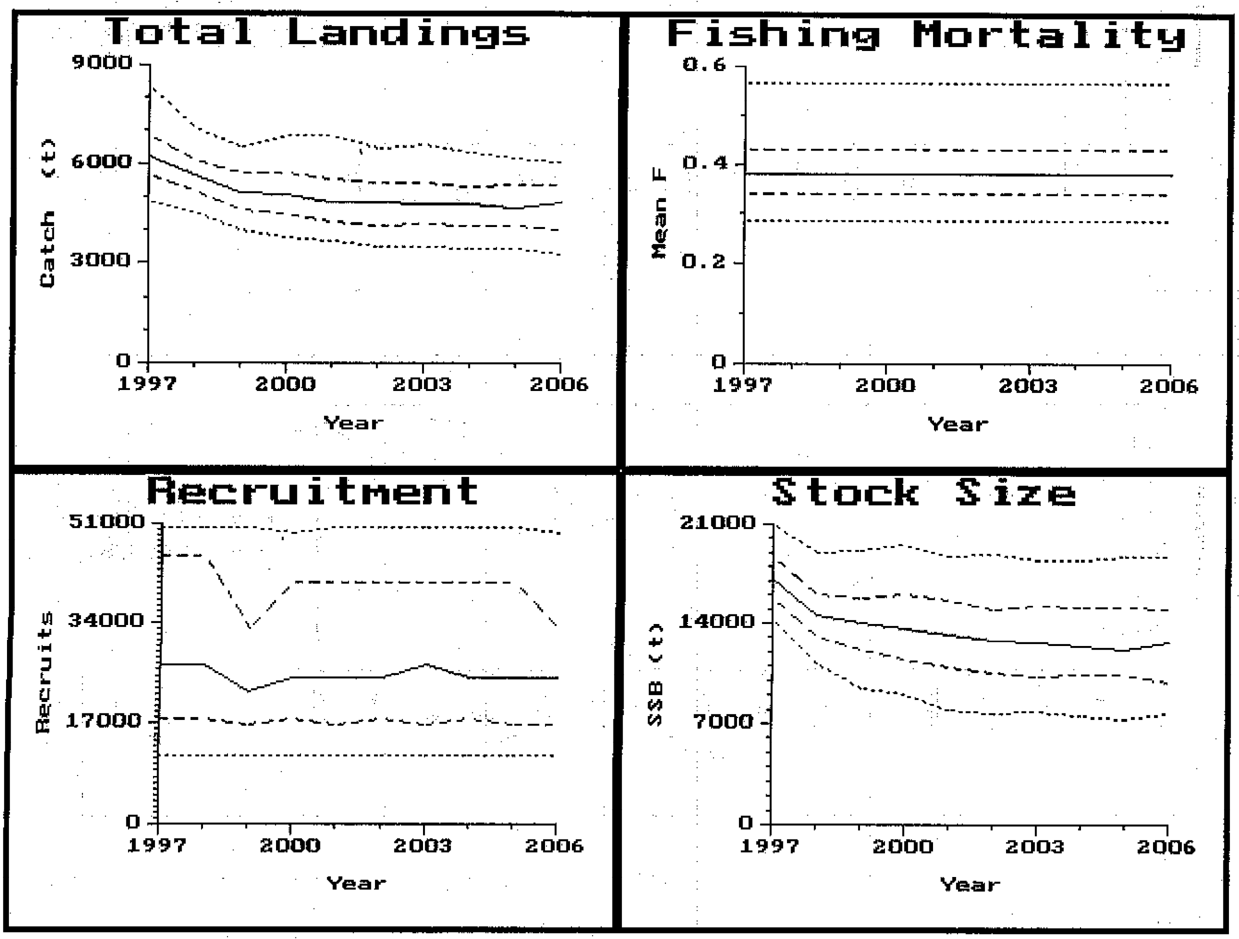


Figure 20.6.3. Sole in Division VIId. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham recruitment model.

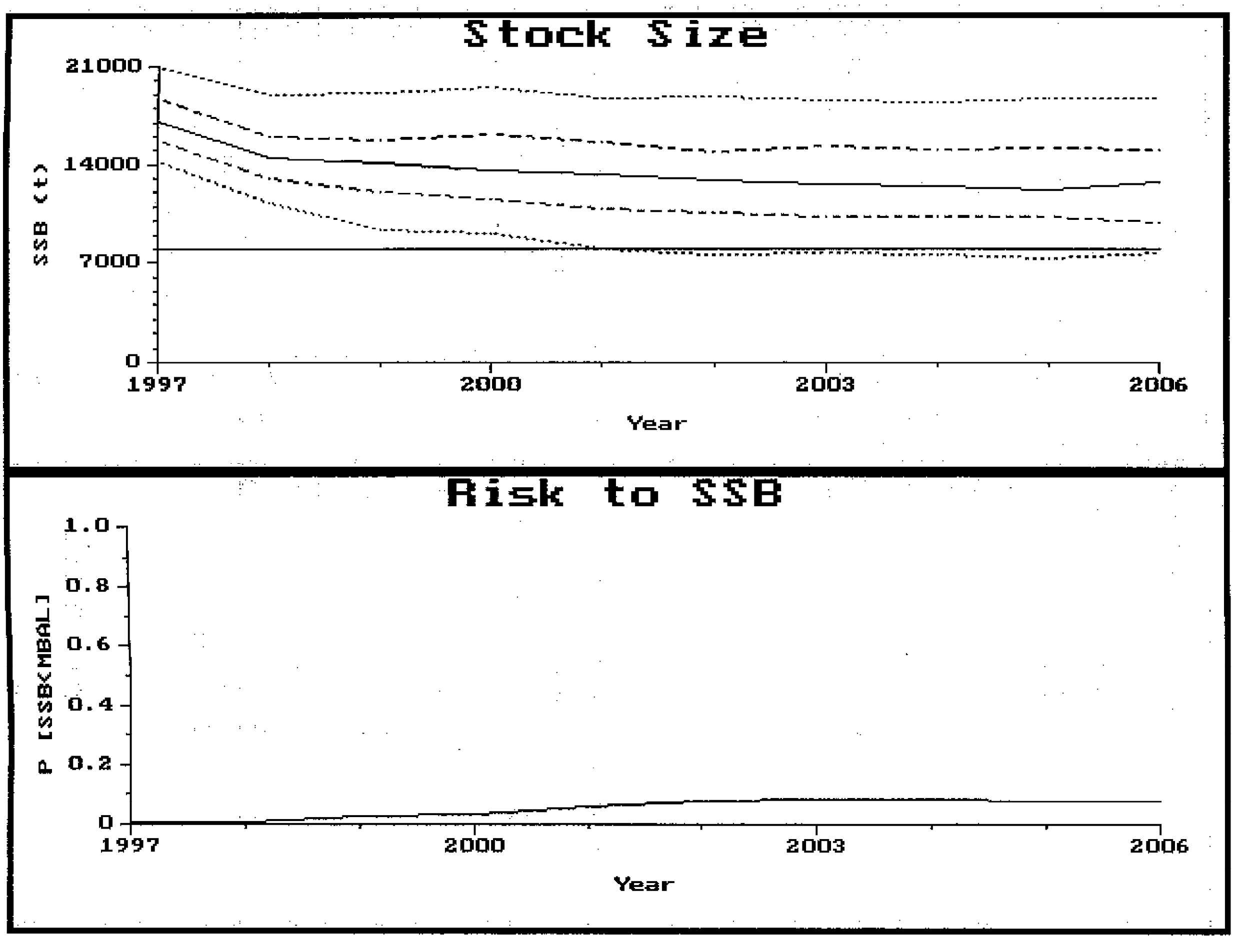


Figure 20.6.4. Sole in Division VIId. Diagnostic plots for the Ockham stock-recruitment curve.

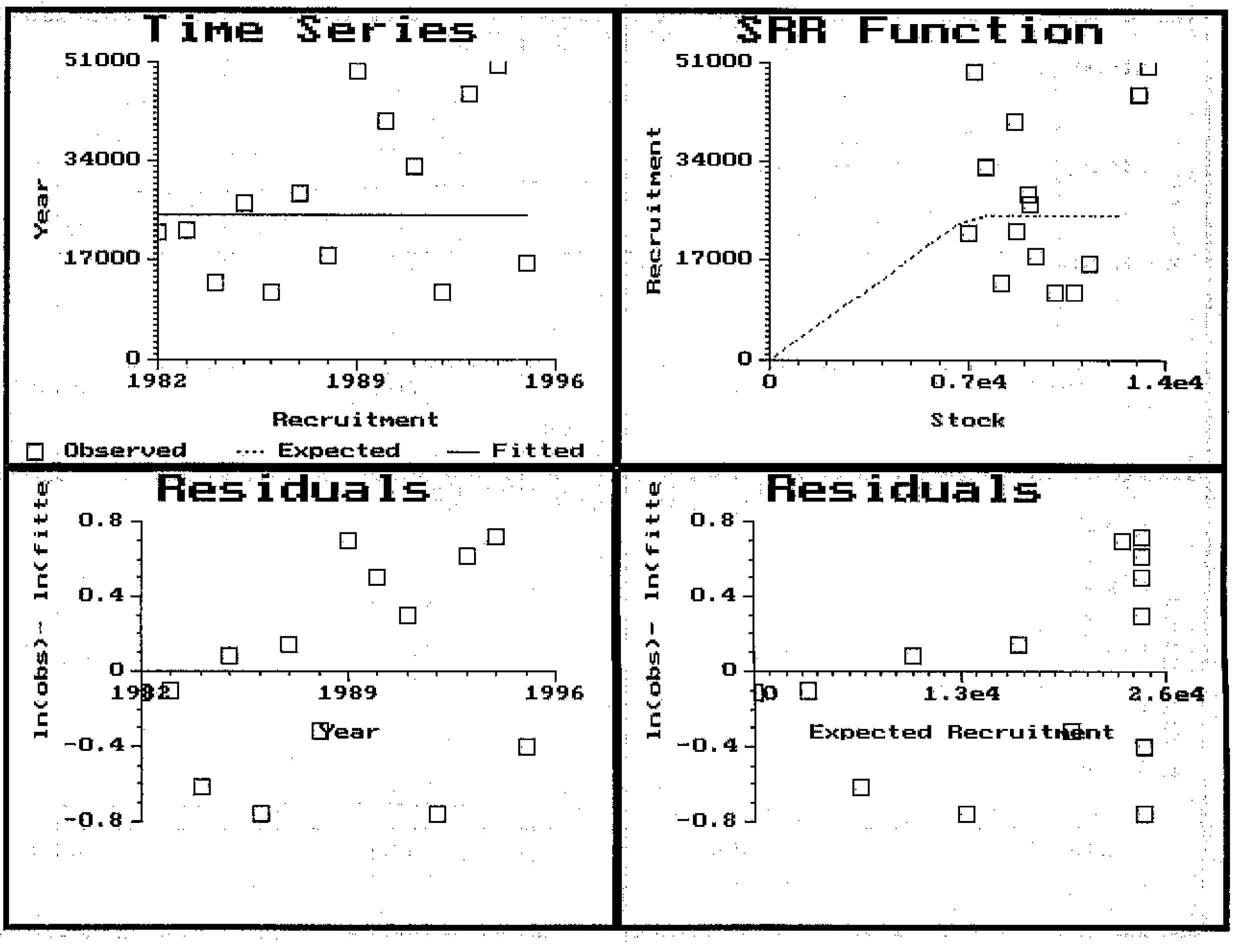
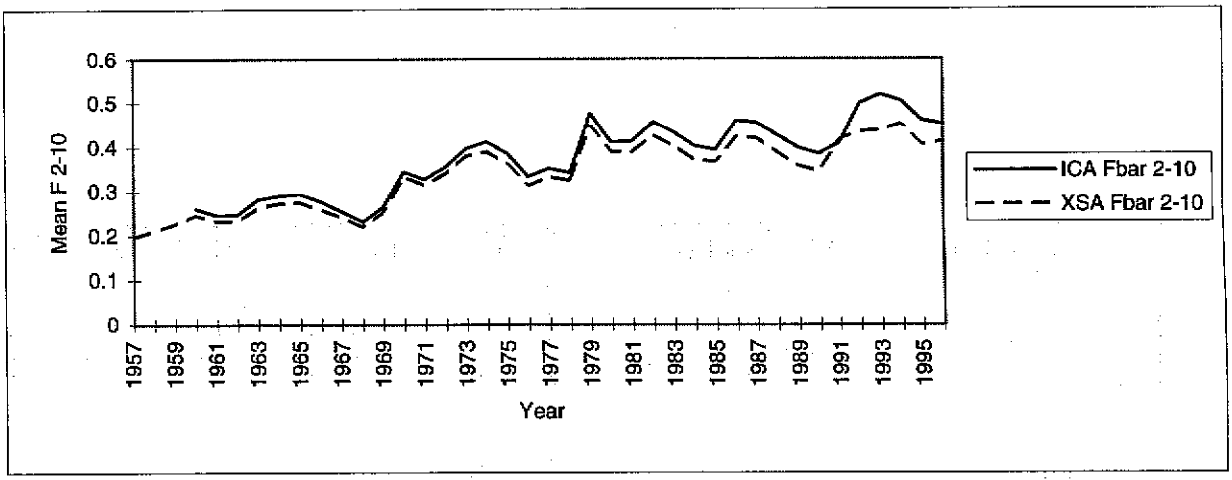
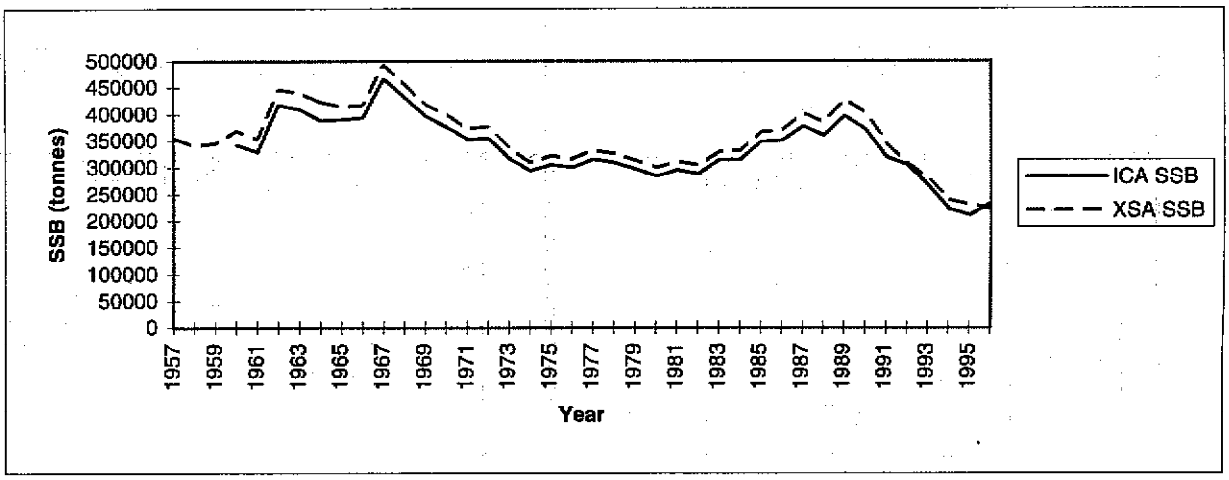


Figure 20.7.1 Comparative plots for Plaice in Sub-Area IV.





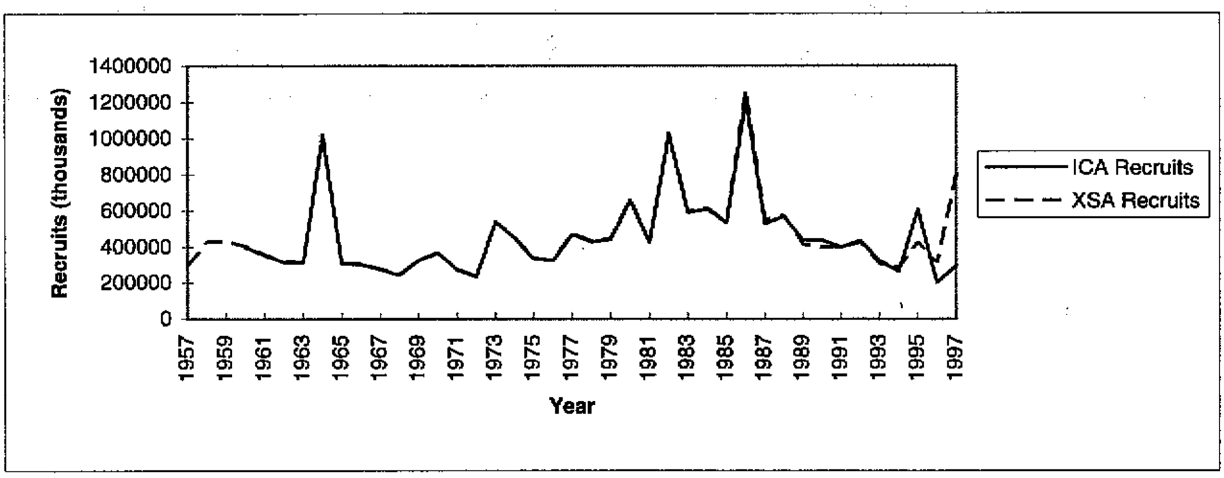


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Figure 20.7.2. Plaice in Sub-Area IV: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

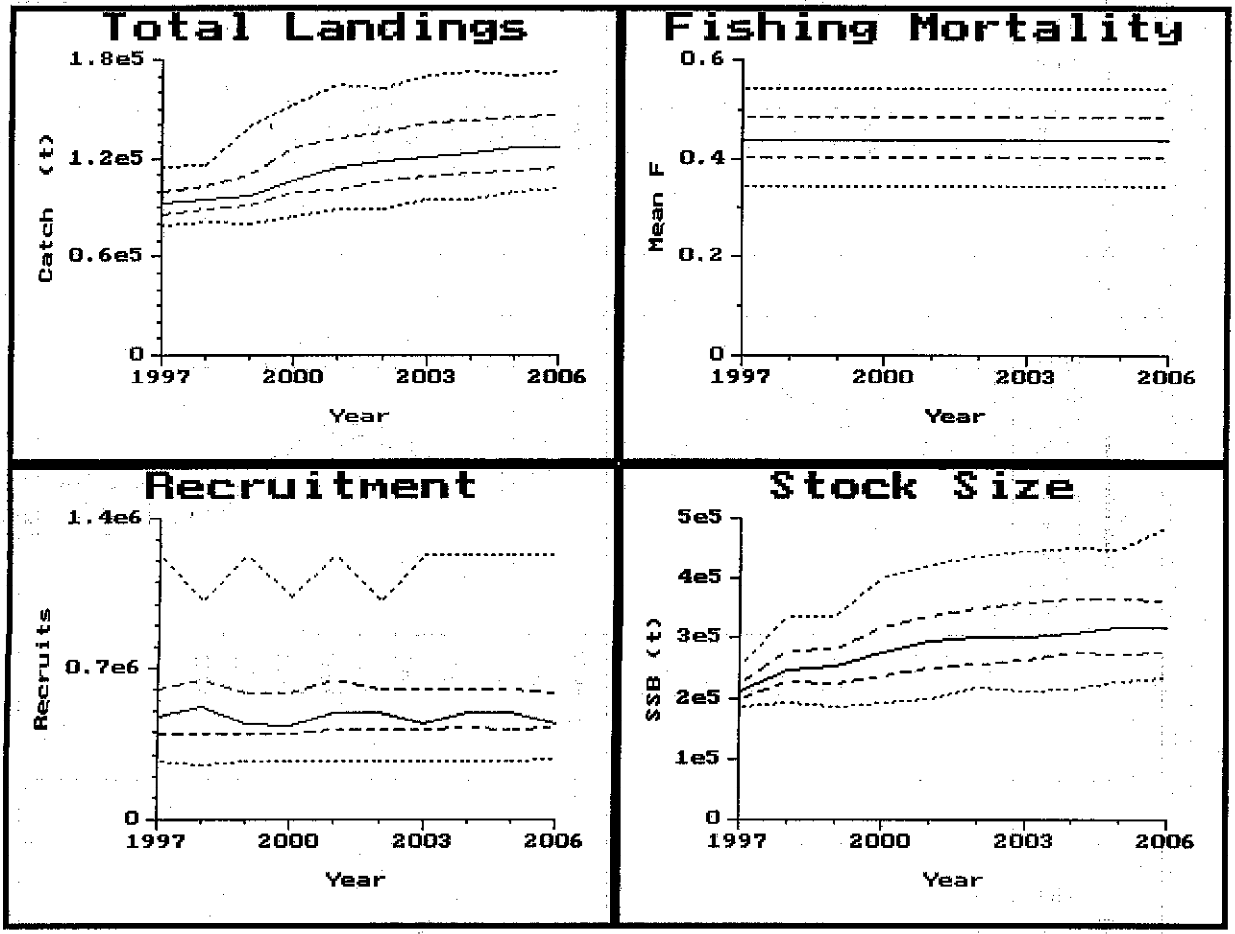


Figure 20.7.3. Plaice in Sub-Area IV. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham model.

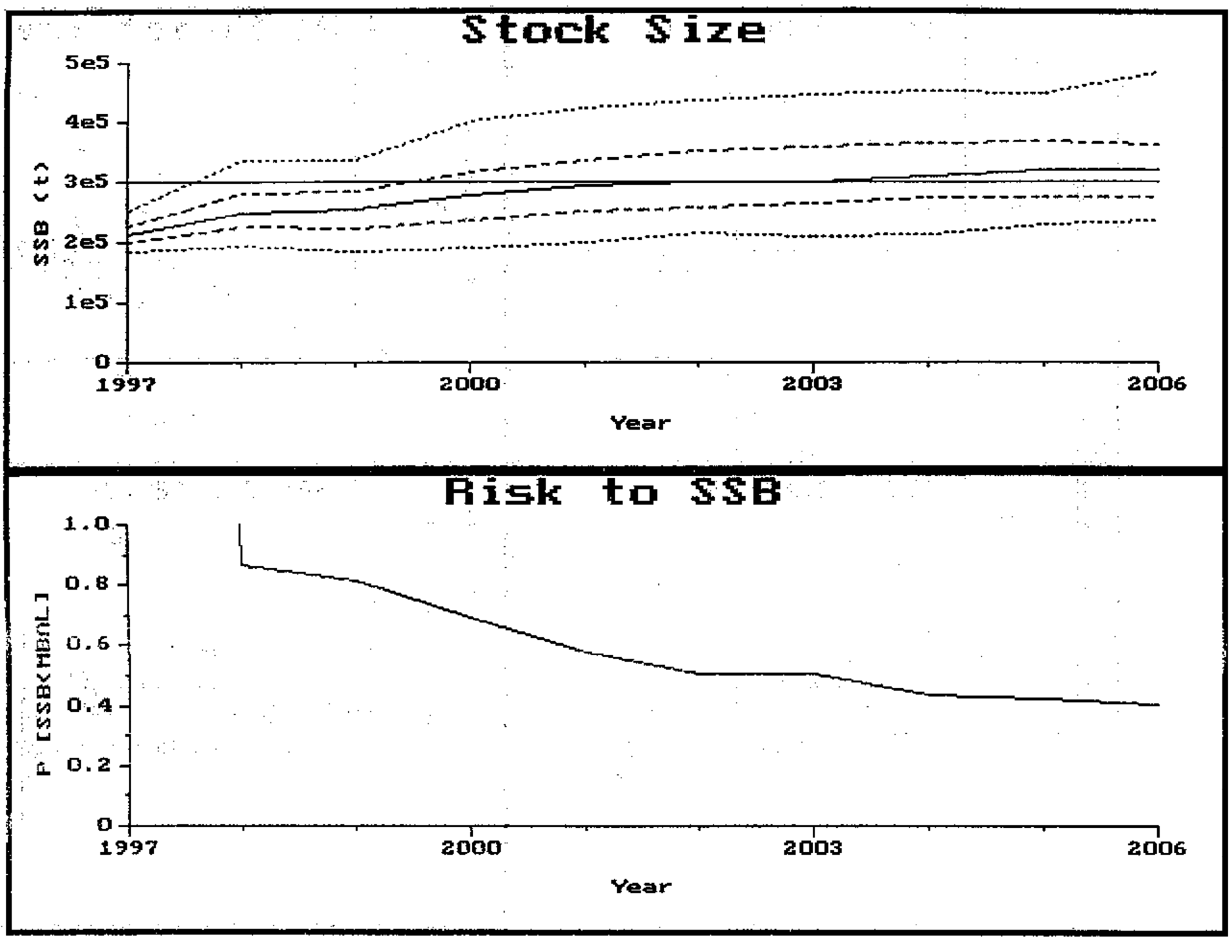


Figure 20.7.4. Plaice in Sub-Area IV. Diagnostic plots for the Ricker stock-recruitment curve.

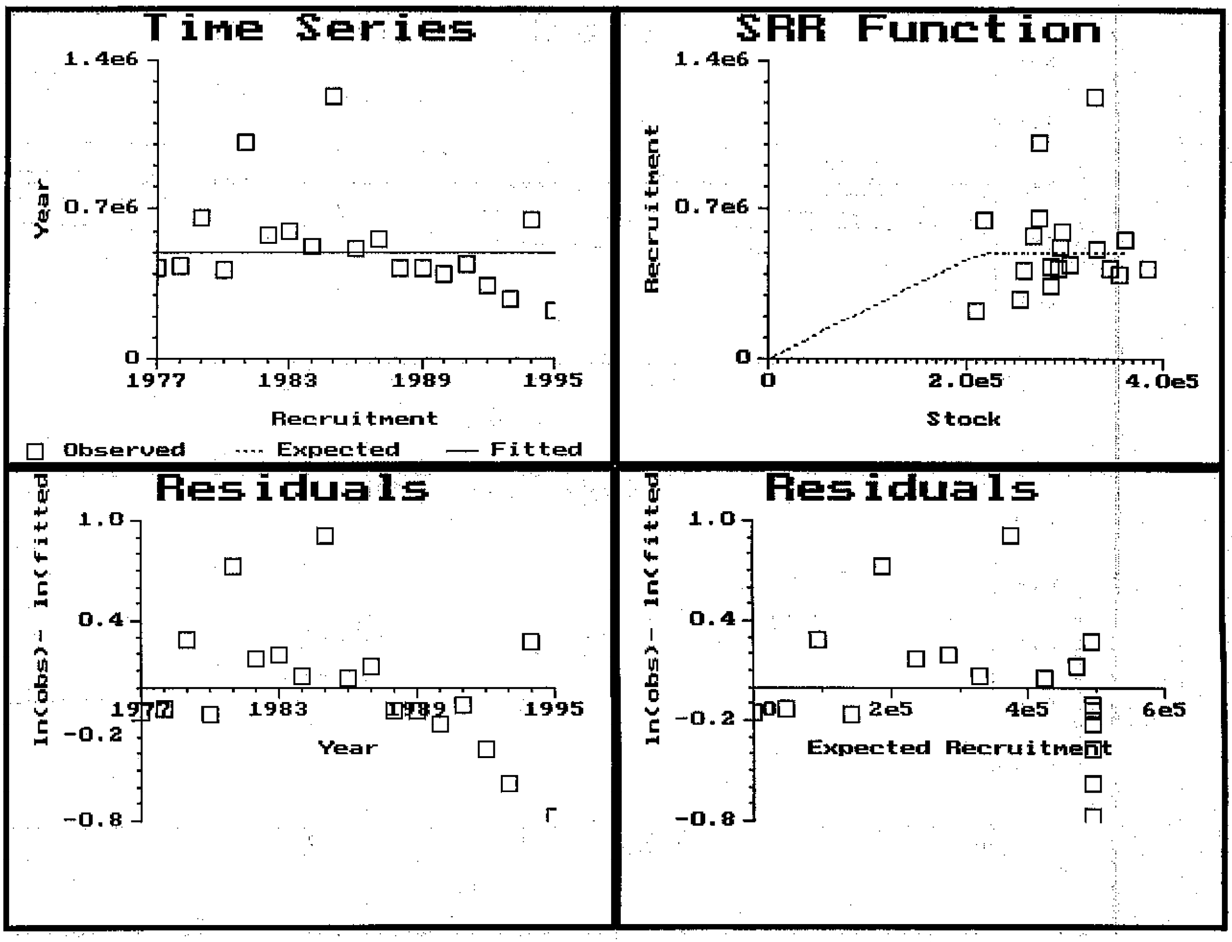


Figure 20.7.5. Plaice in Sub-Area IV: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on a Shepherd model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

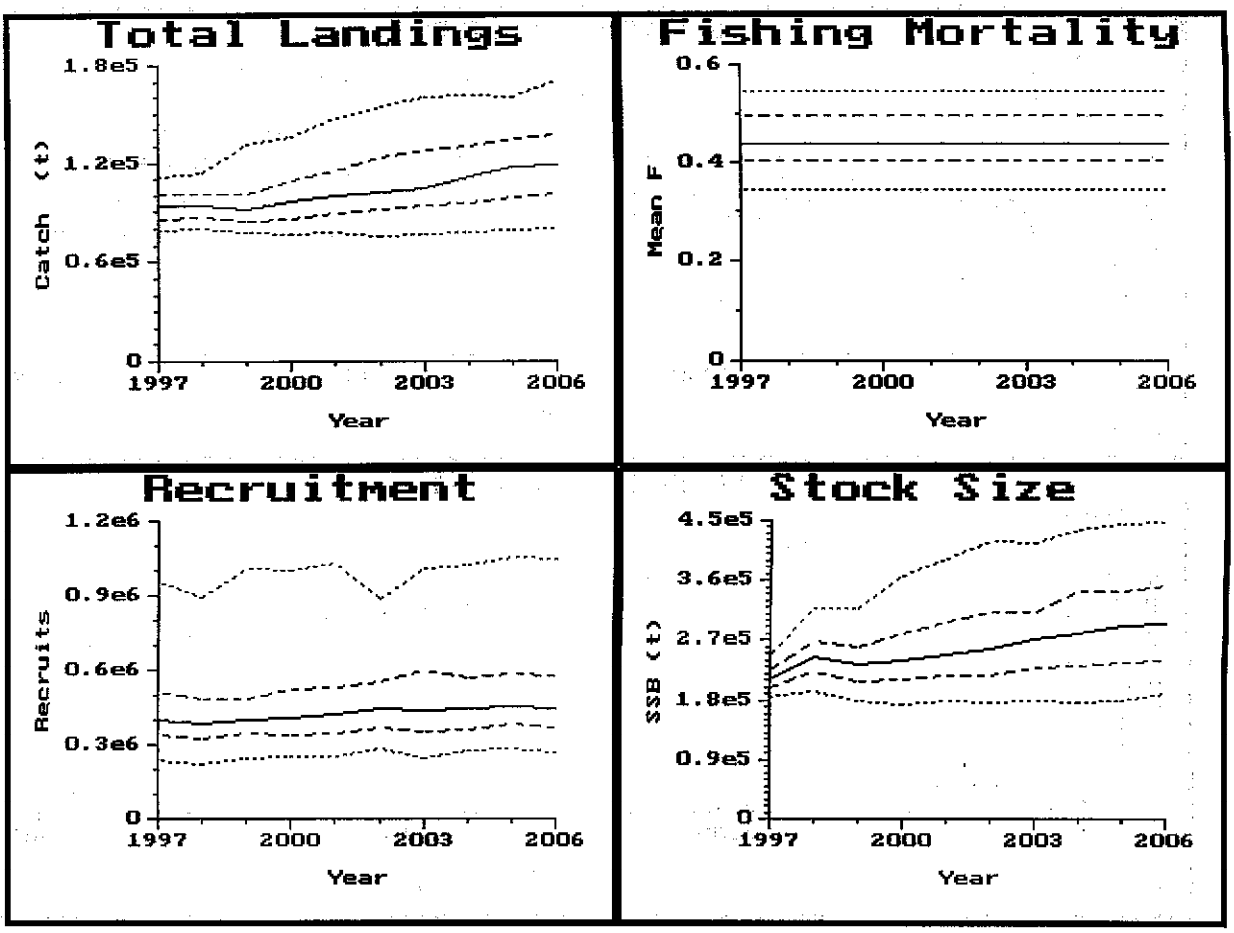


Figure 20.7.6. Plaice in Sub-Area IV. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Shepherd model.

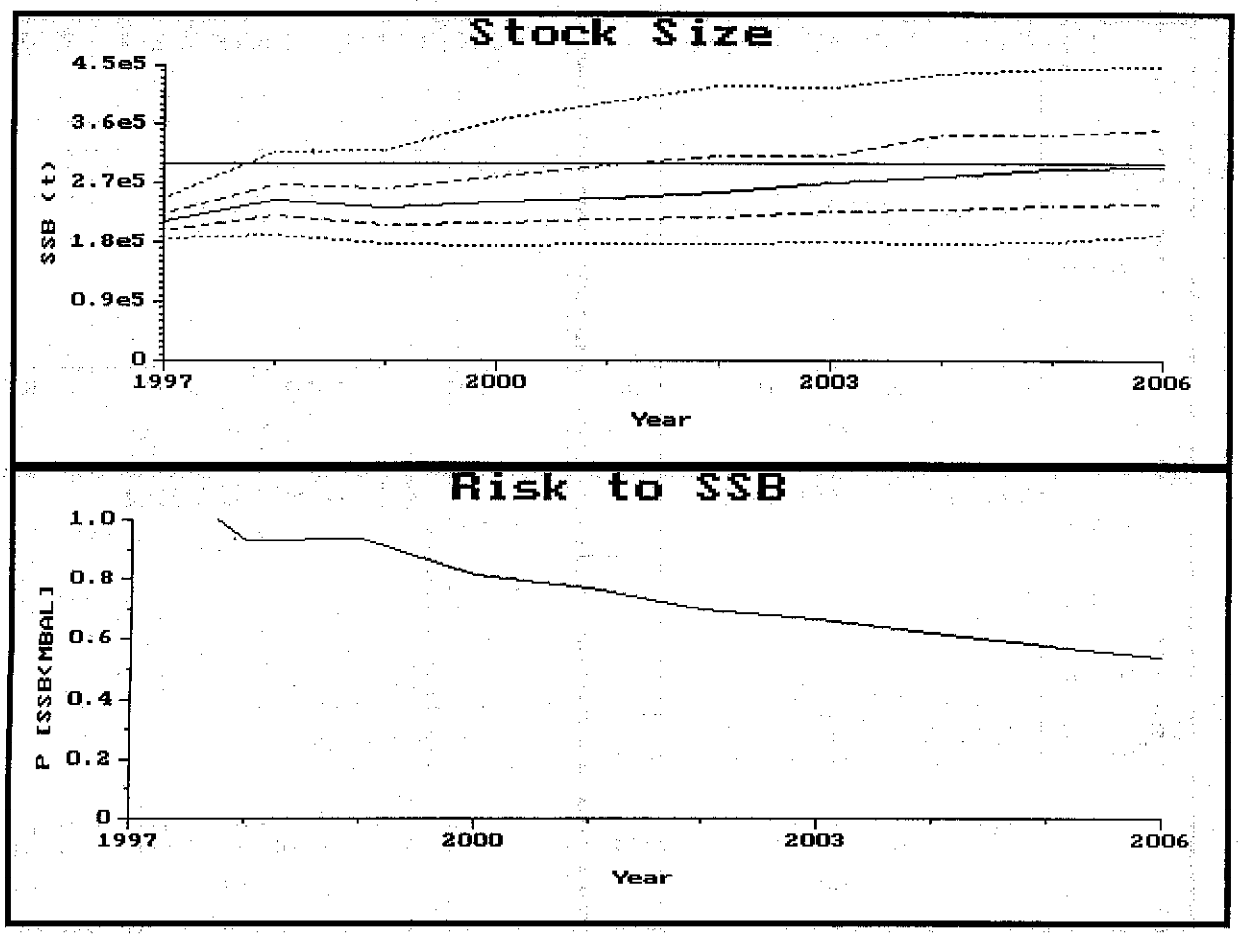


Figure 20.7.8. Plaice in Sub-Area IV: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on a Beverton-Holt model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

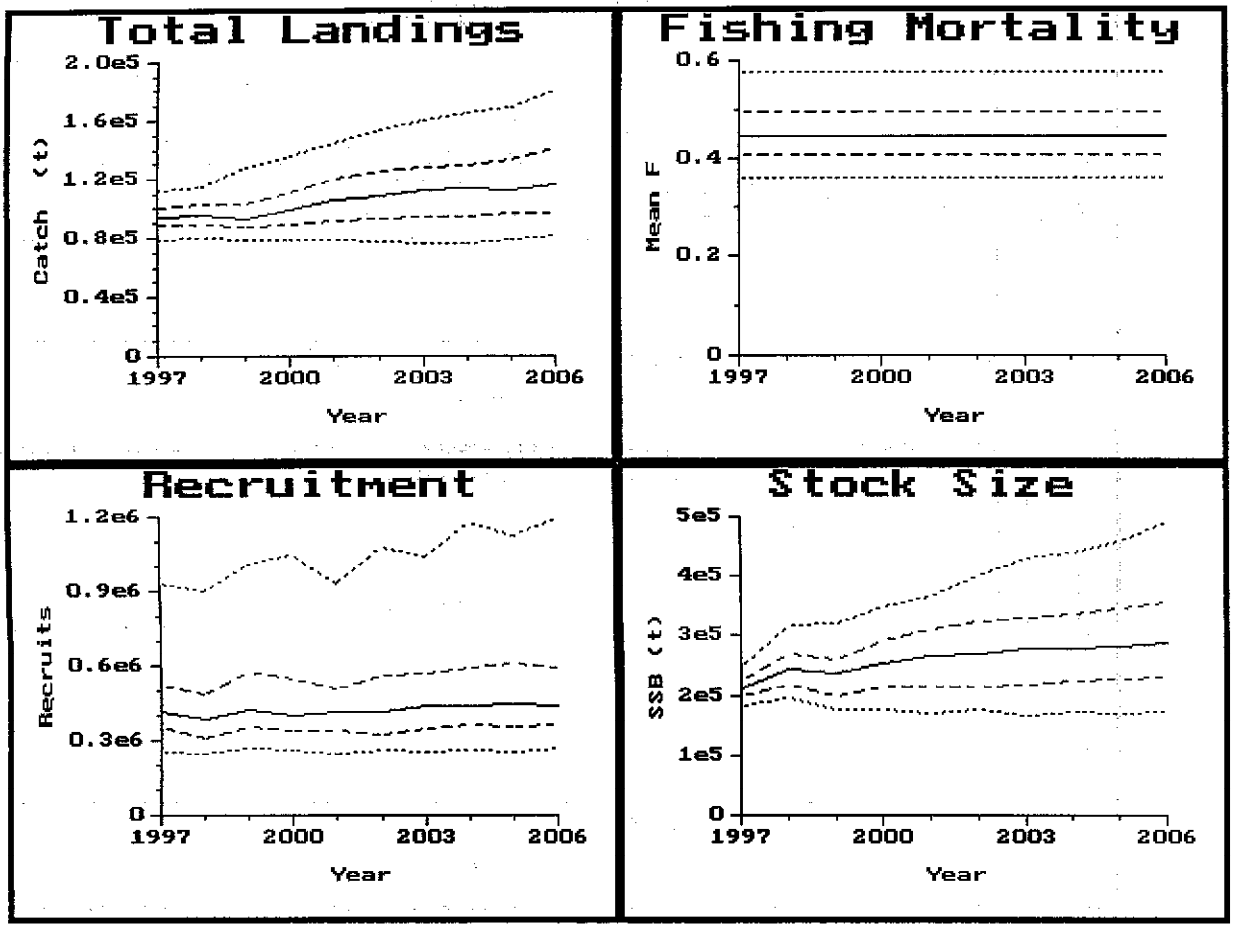


Figure 20.7.9. Plaice in Sub-Area IV. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Beverton-Holt model.

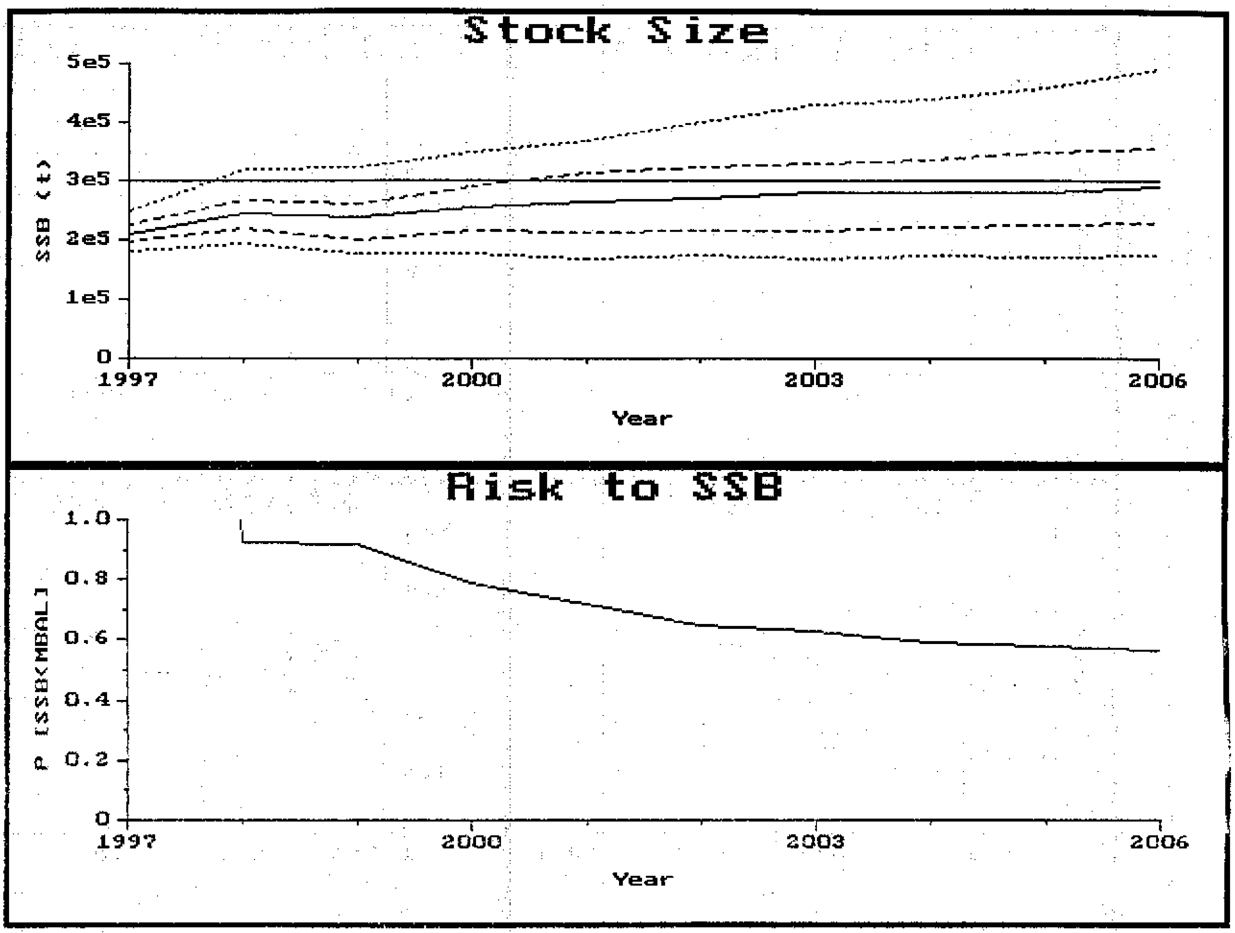


Figure 20.7.10. Plaice in Sub-Area IV. Diagnostic plots for the Beverton-Holt stock-recruitment curve.

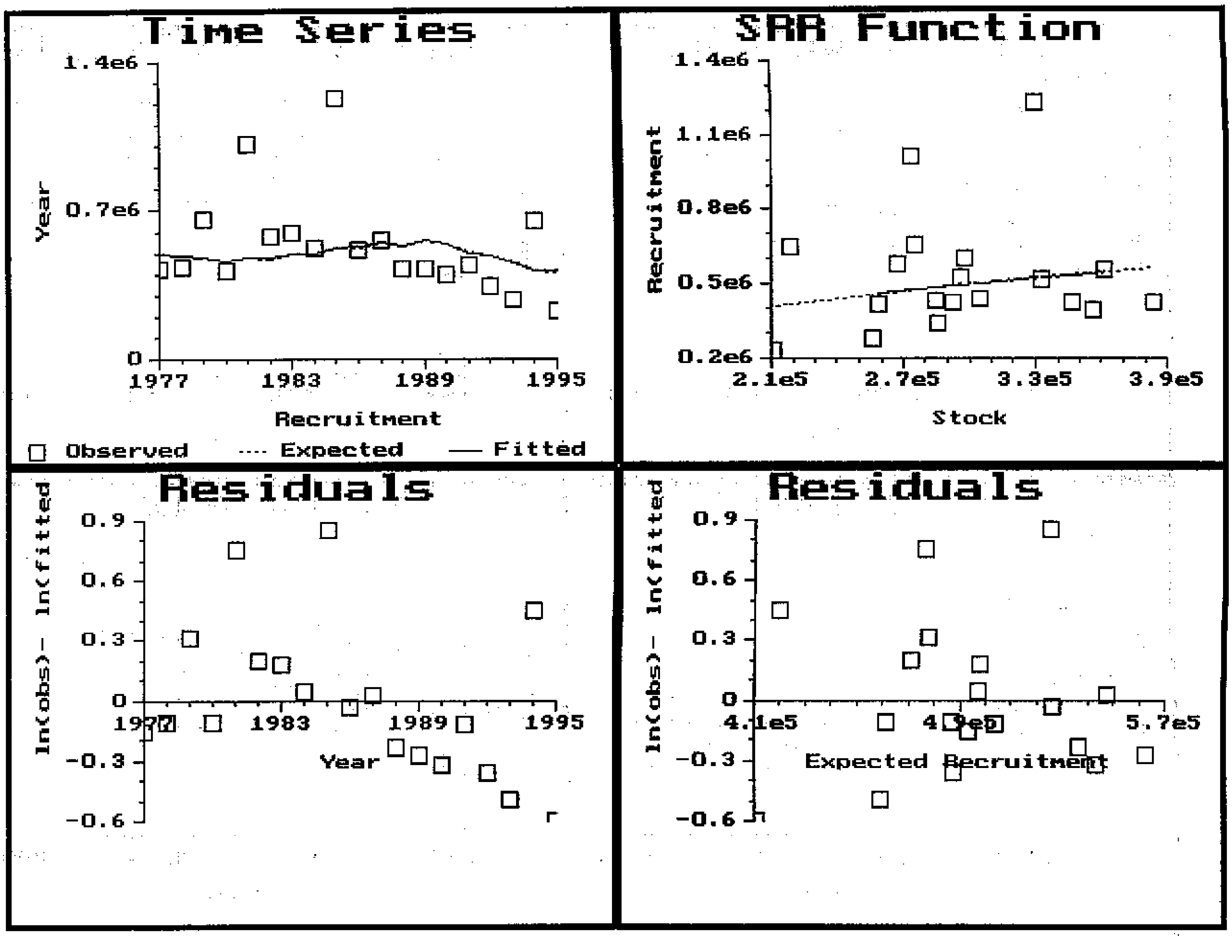


Figure 20.7.11. Plaice in Sub-Area IV: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on a Ricker model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

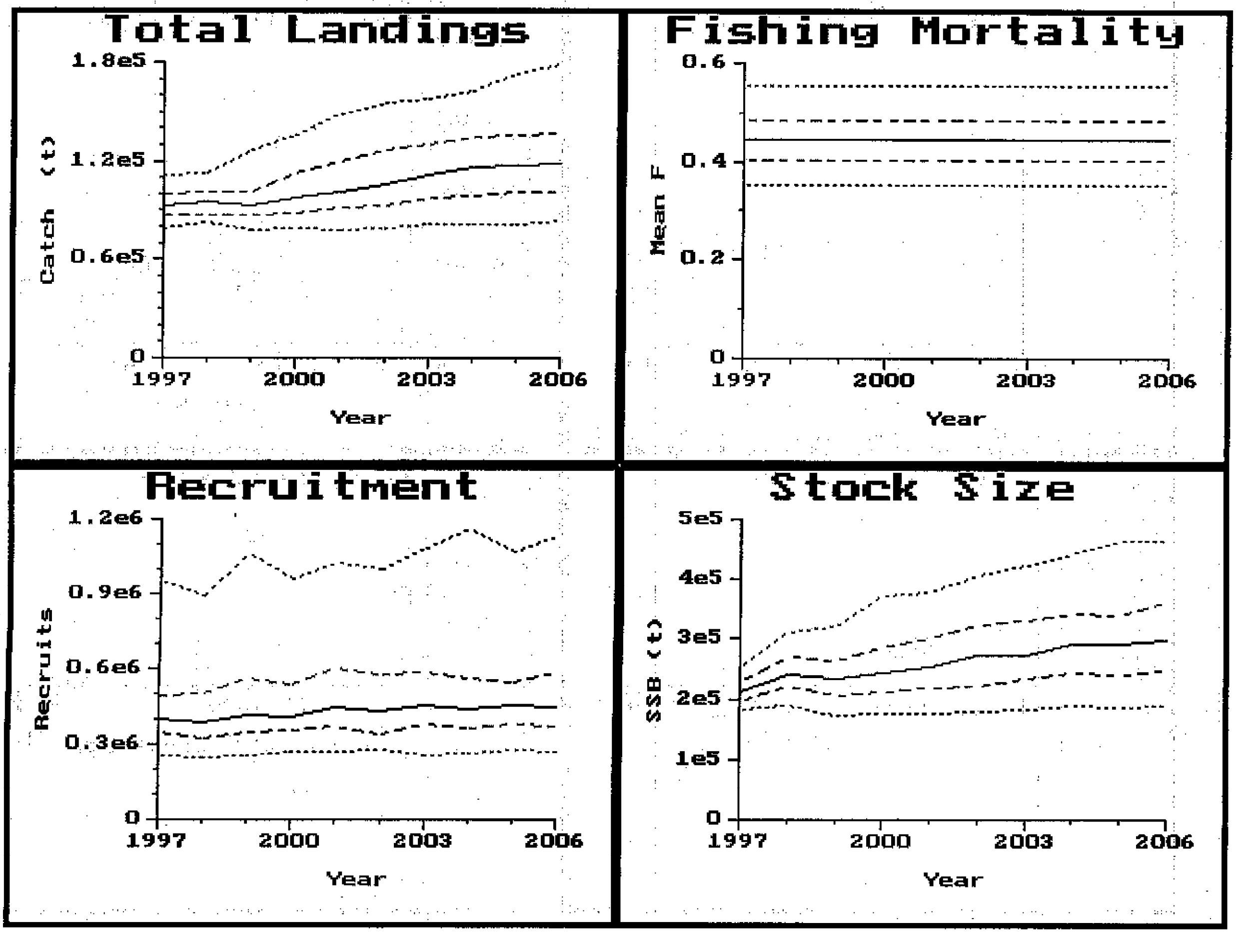


Figure 20.7.12. Plaice in Sub-Area IV. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ricker model.

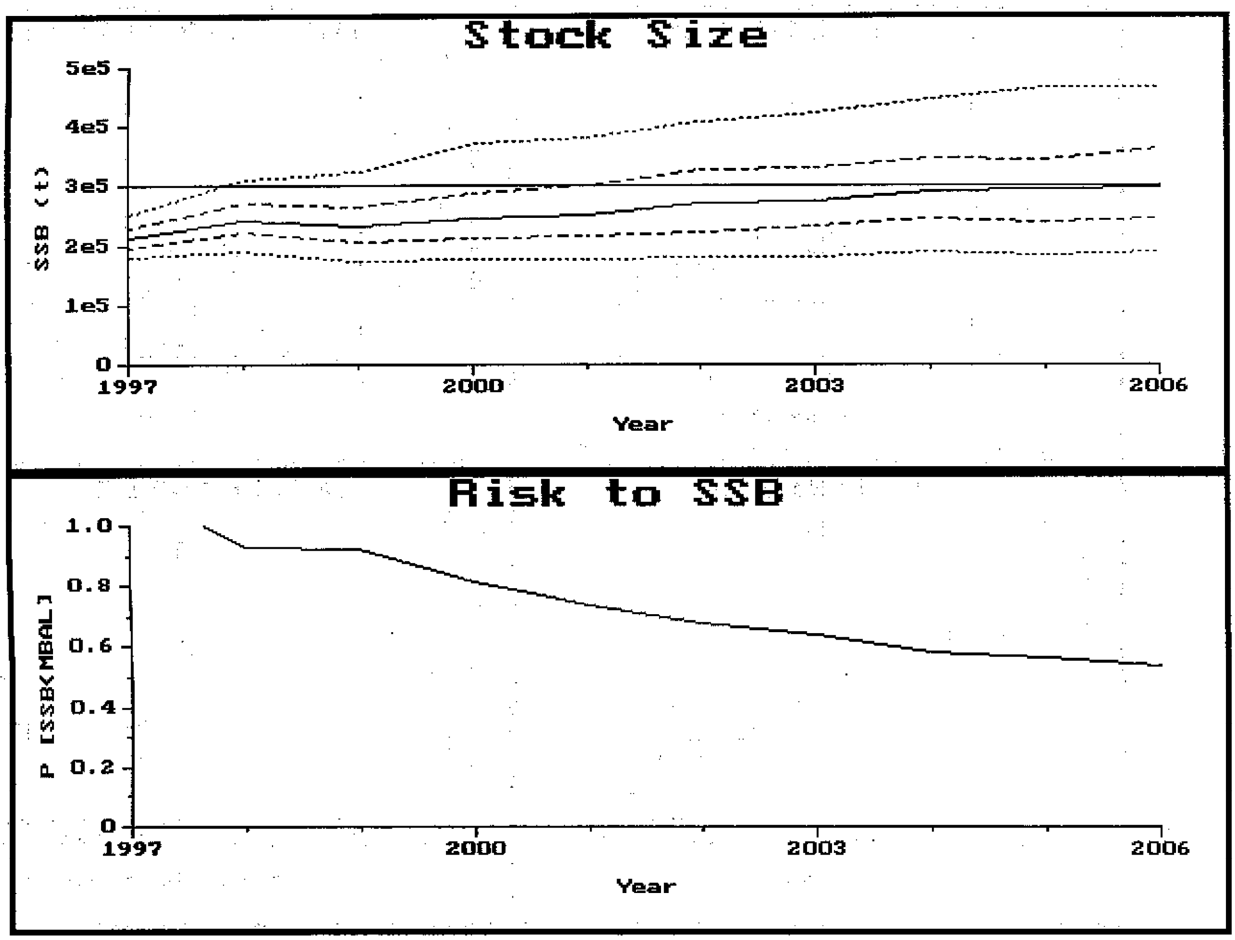


Figure 20.7.13. Plaice in Sub-Area IV. Diagnostic plots for the Ricker stock-recruitment curve.

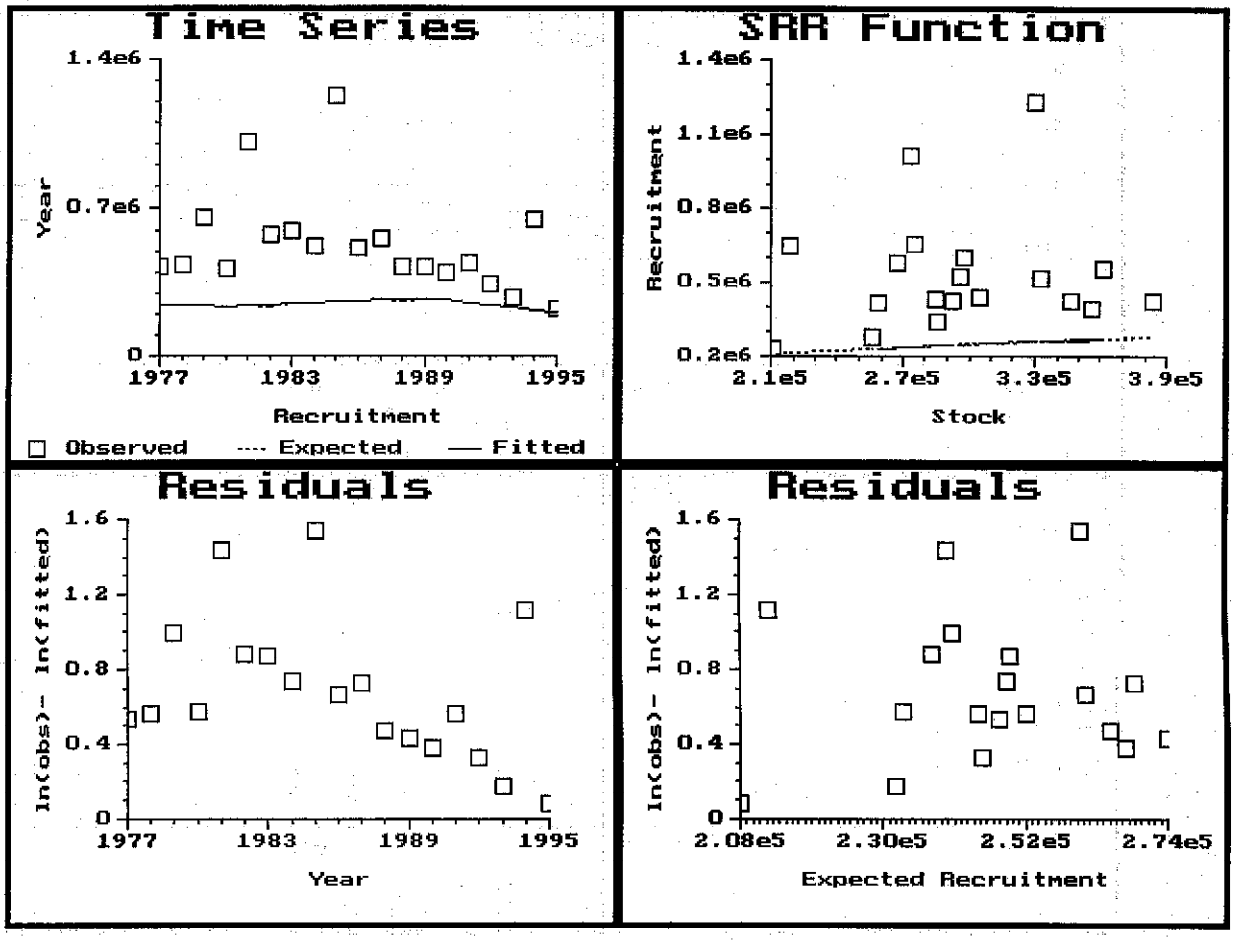


Figure 20.7.14. Plaice in Sub-Area IV: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on a historic mean model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

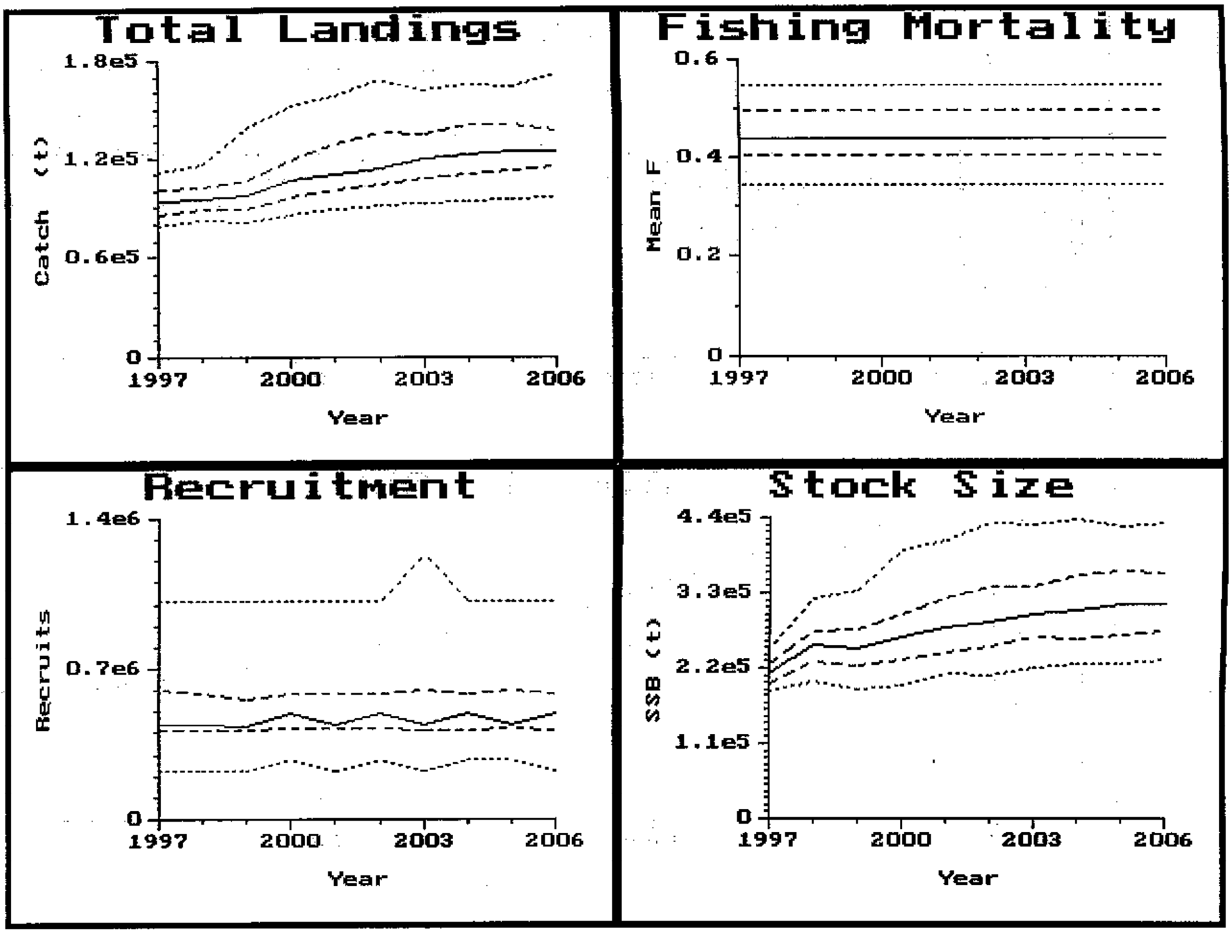


Figure 20.7.15. Plaice in Sub-Area IV. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the historic mean model.

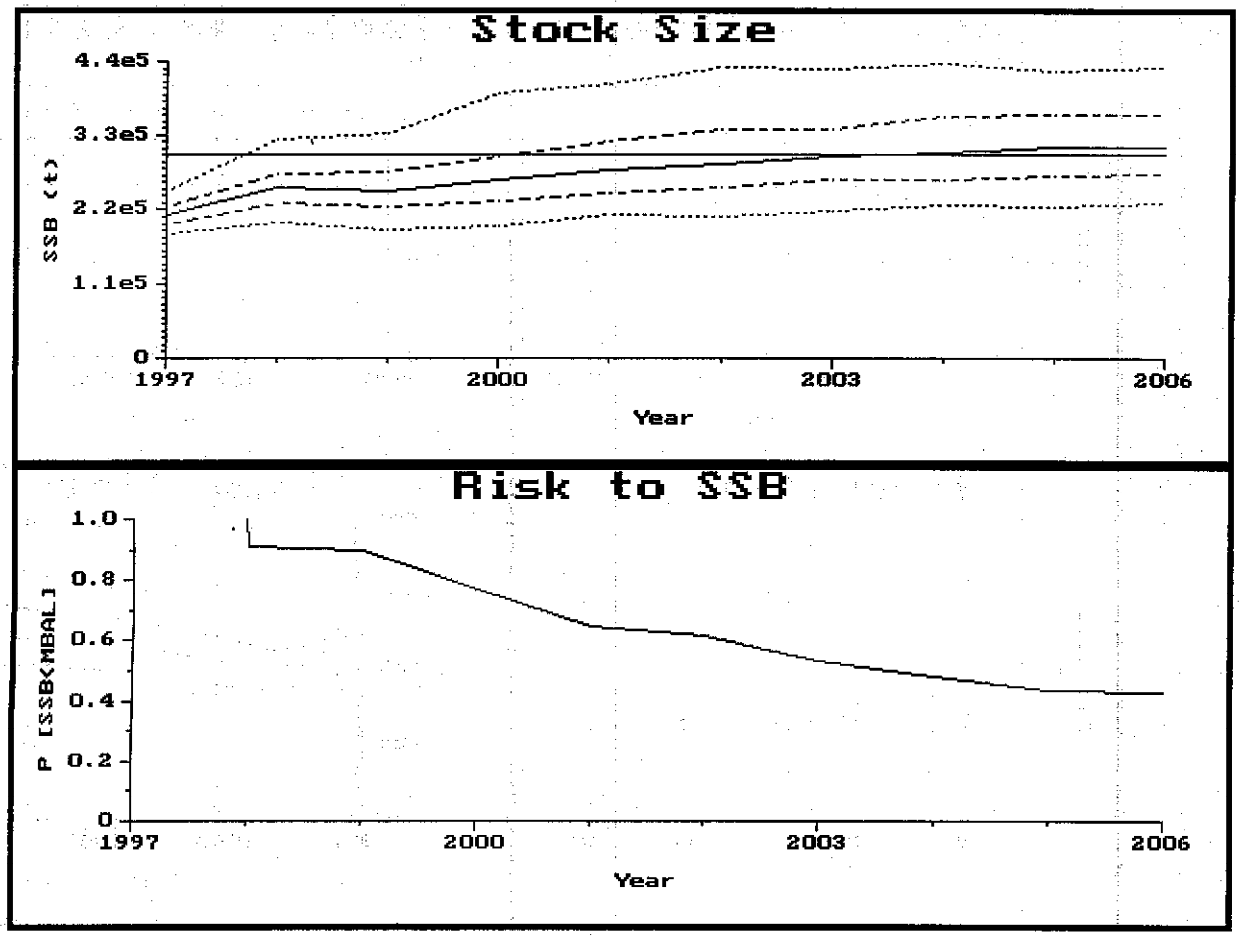


Figure 20.7.16. Plaice in Sub-Area IV. Diagnostic plots for the historic mean stock-recruitment line.

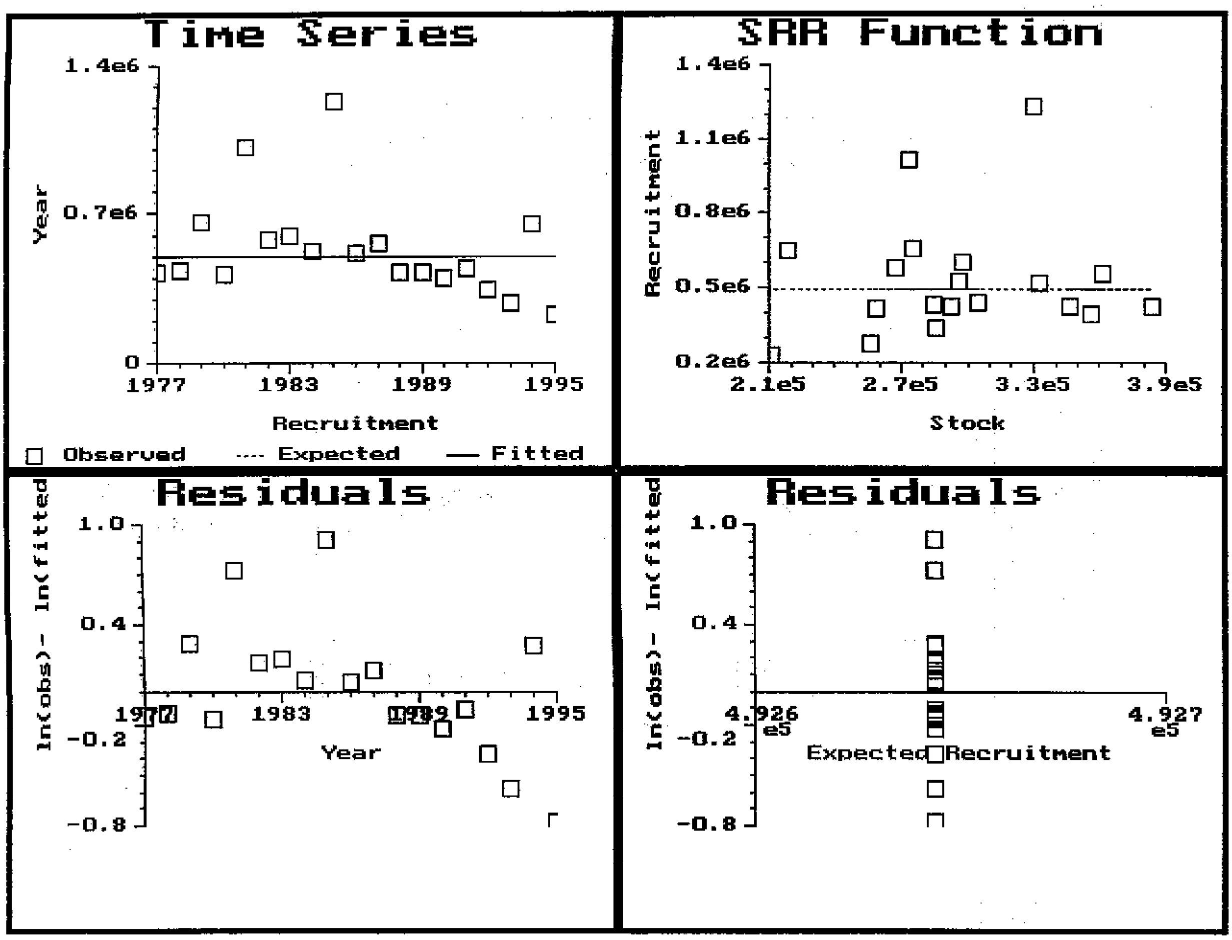
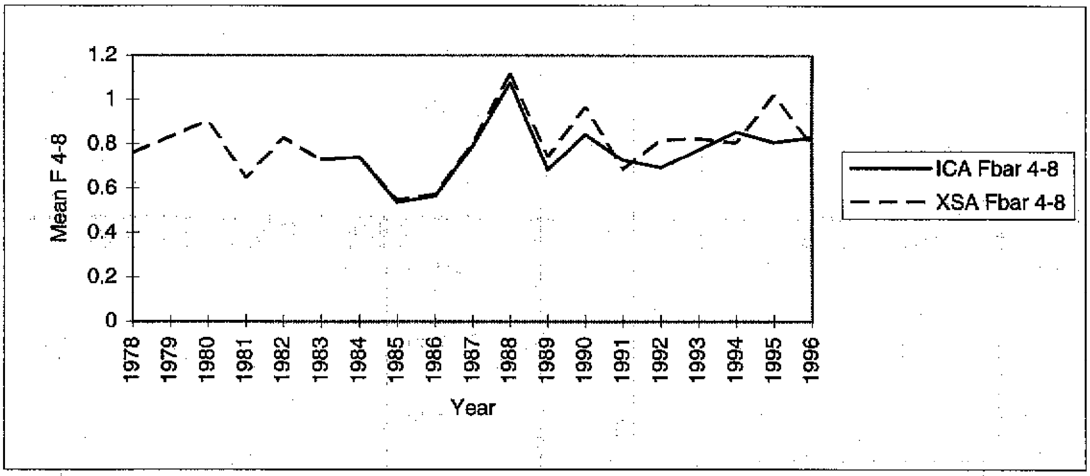
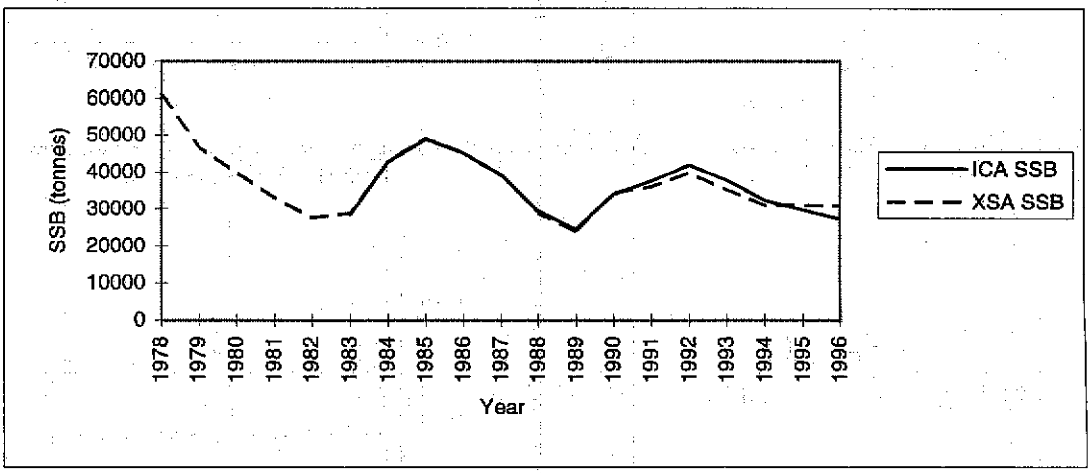


Figure 20.8.1 Comparative plots for Plaice in Division IIIa.





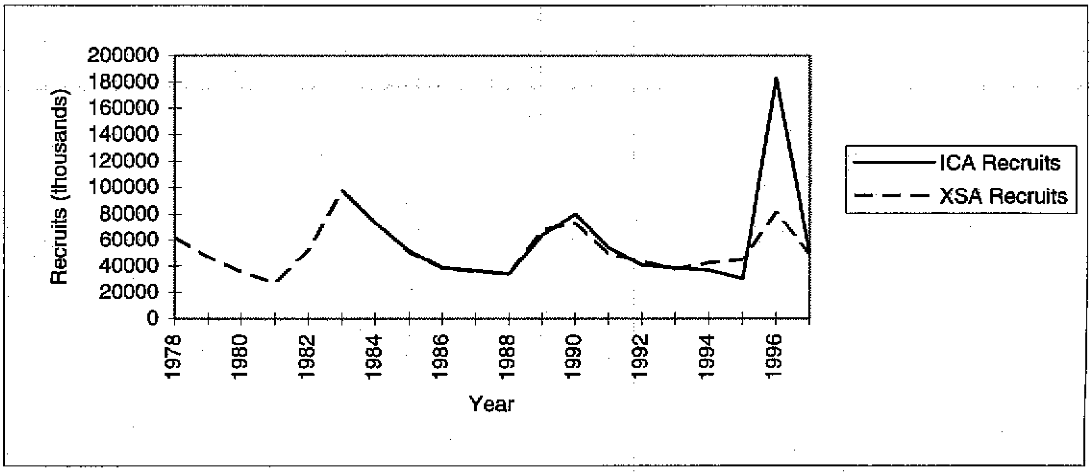


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Figure 20.8.2. Plaice in Division IIIa: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

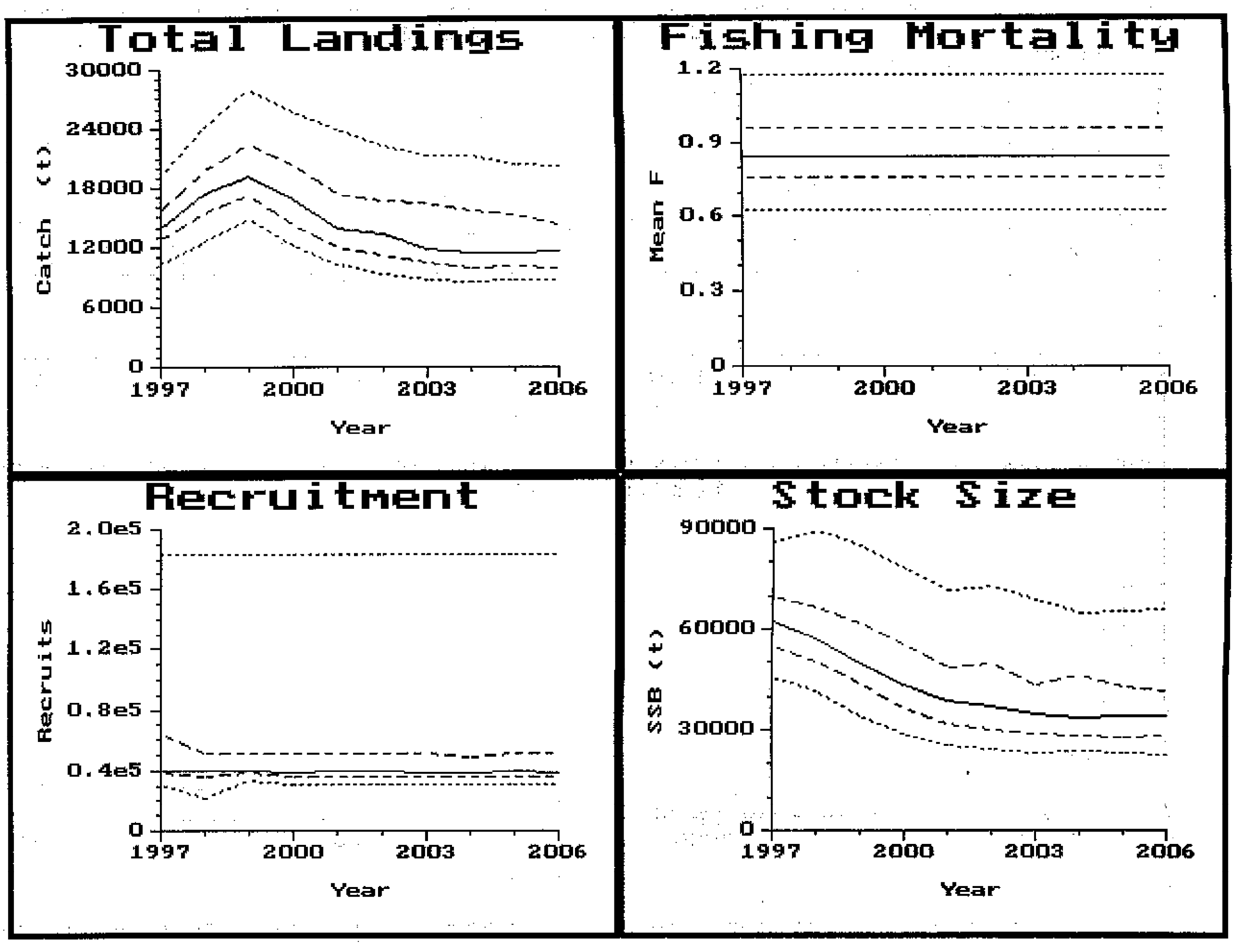

Figure 20.8.3. Plaice in Division IIIa. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham model.

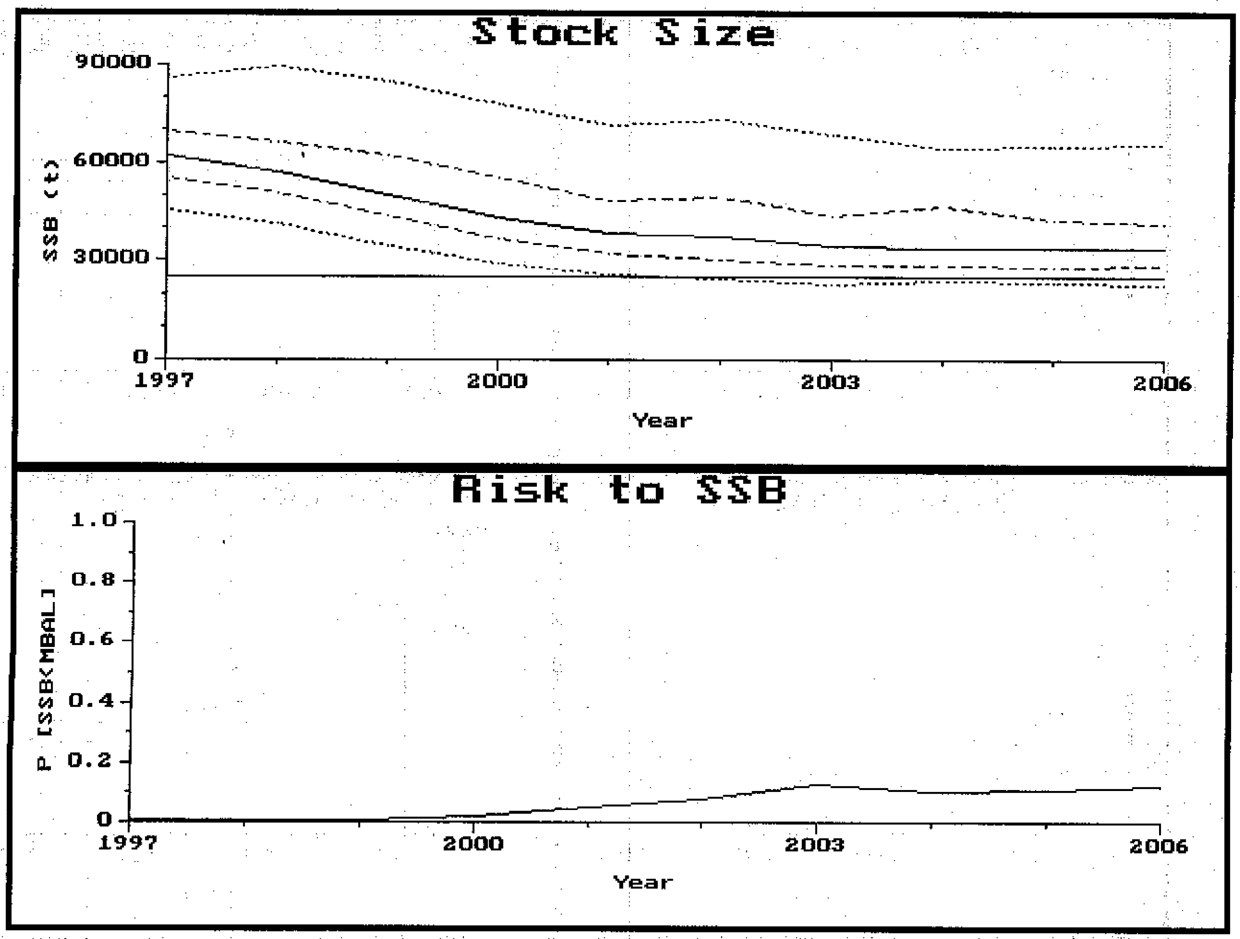

Figure 20.8.4 Plaice in Division IIIa. Diagnostic plots for the Ockham stock-recruitment curve.

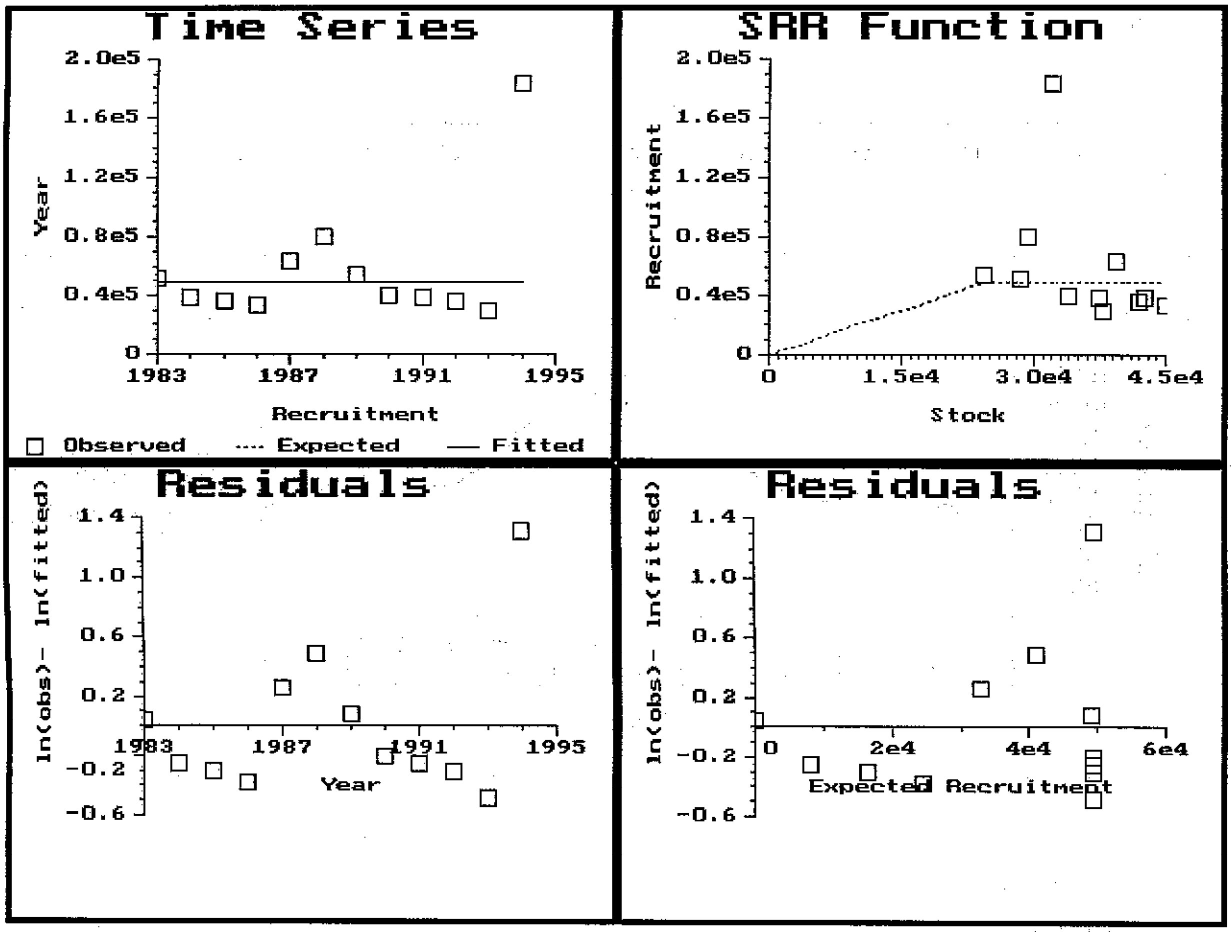

Figure 20.9.1 Comparative plots for Plaice in Division VIId.

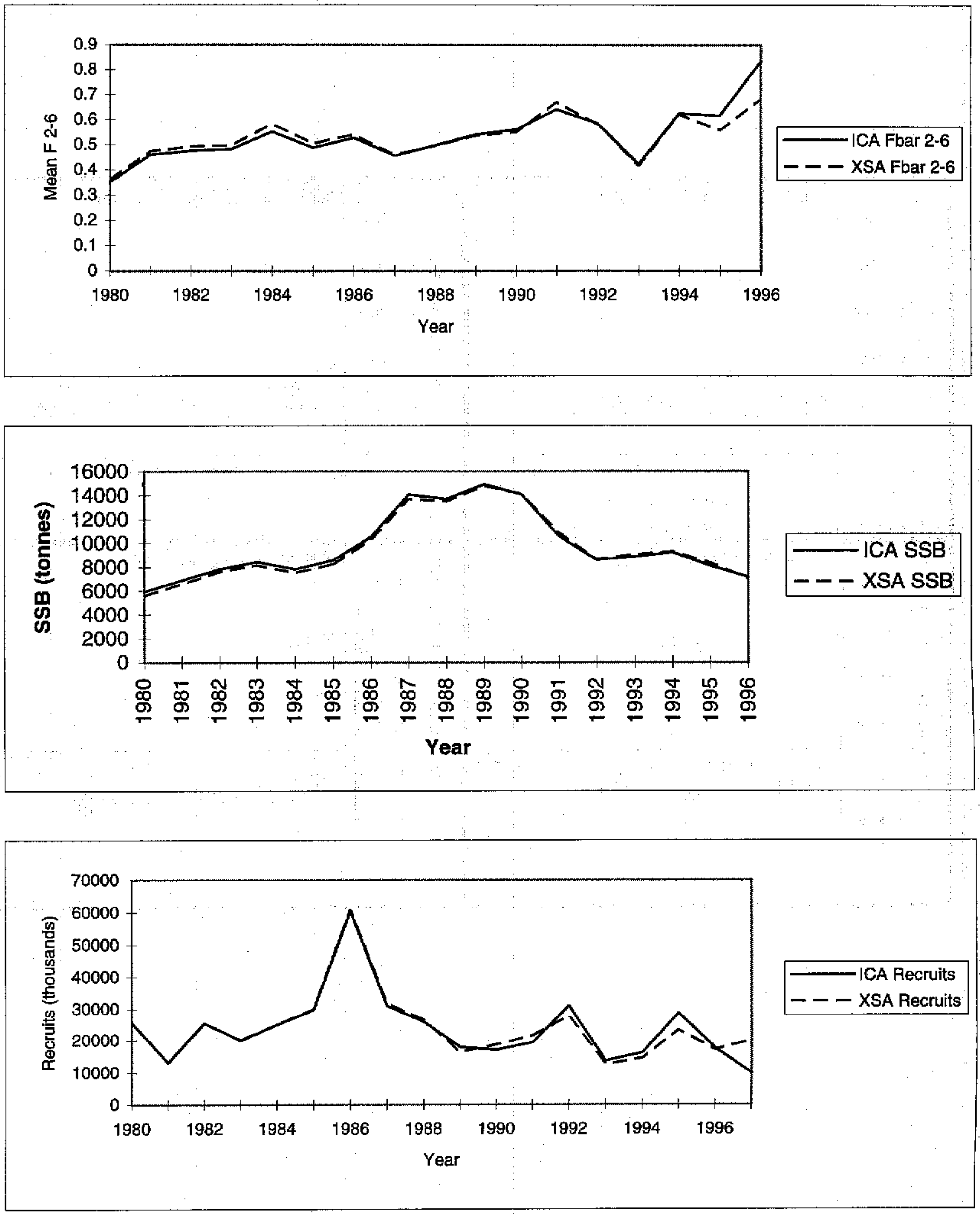

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Figure 20.9.2. Plaice in Division VIId: projected landings, fishing mortality (fixed by 1996 estimate), recruitment (based on an Ockham model with autocorrelated errors), and spawning stock size. Solid line gives median (50%) estimate; dashed lines, 25% and 75% percentiles; dotted lines, 5% and 95% percentiles.

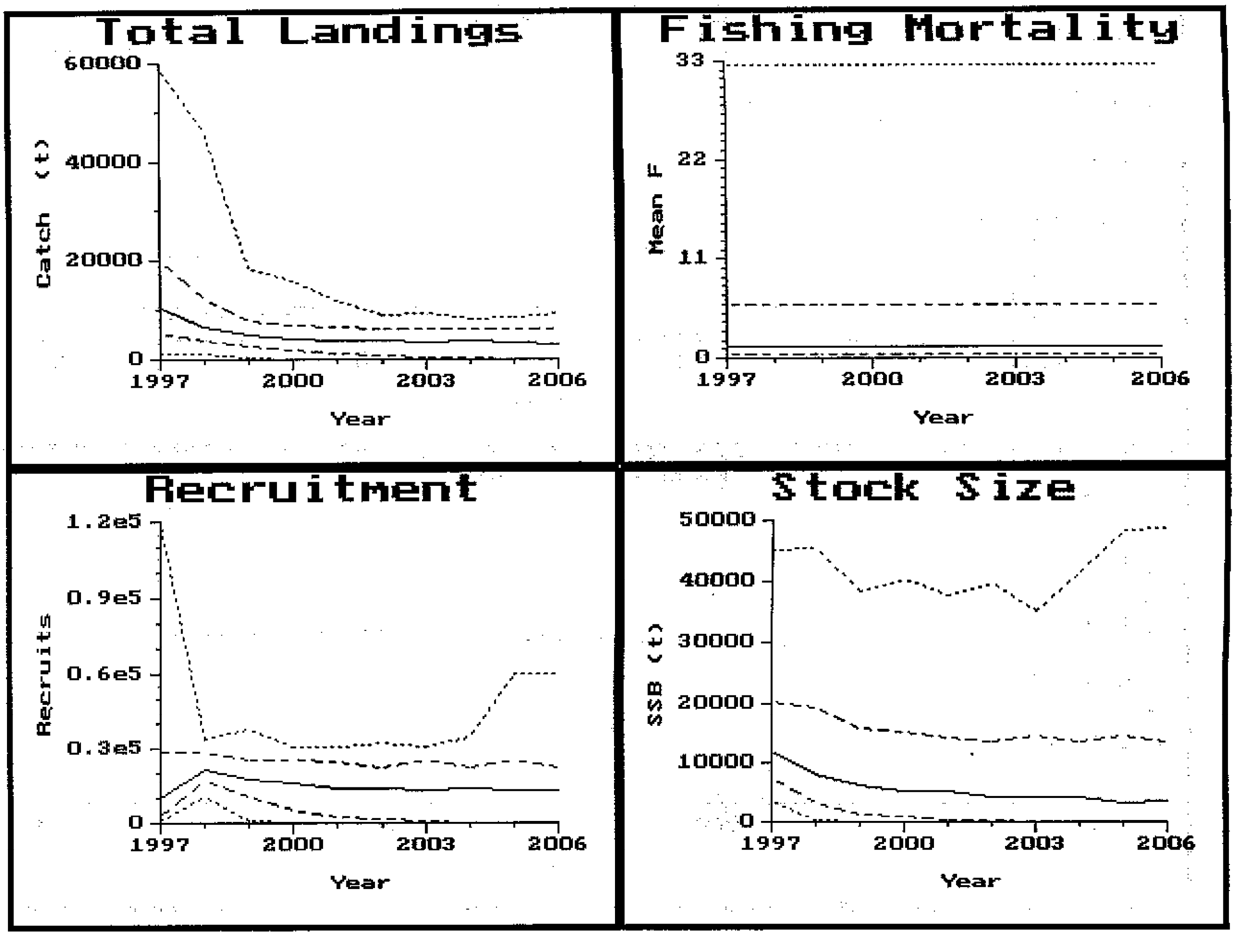


Figure 20.9.3. Plaice in Division VIId. Upper plot: projected spawning stock size (solid curve with quartiles and 5%-95% percentiles) and MBAL (horizontal line). Lower plot: estimated probability that SSB will fall below MBAL for each of the projected years, based on the Ockham model.

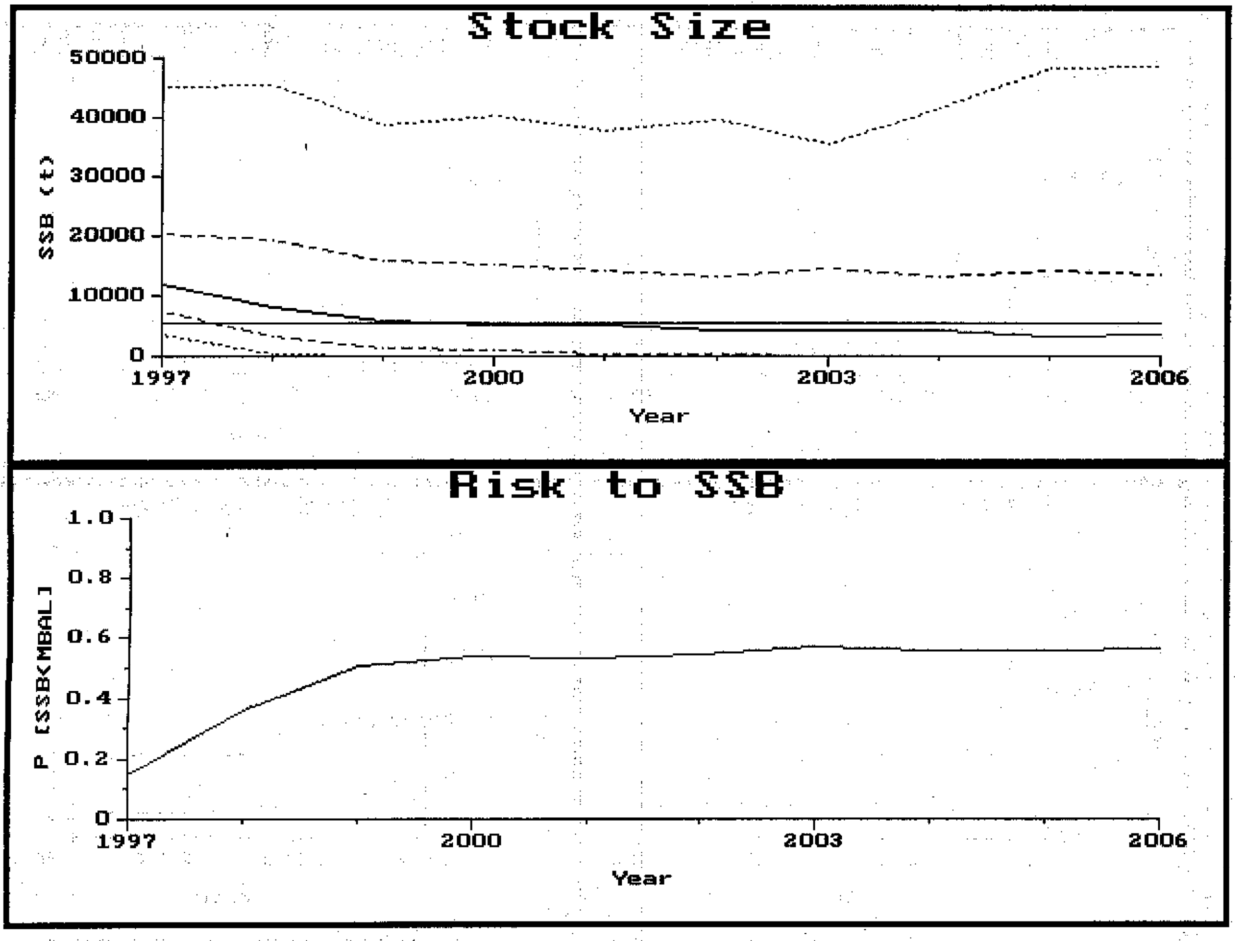
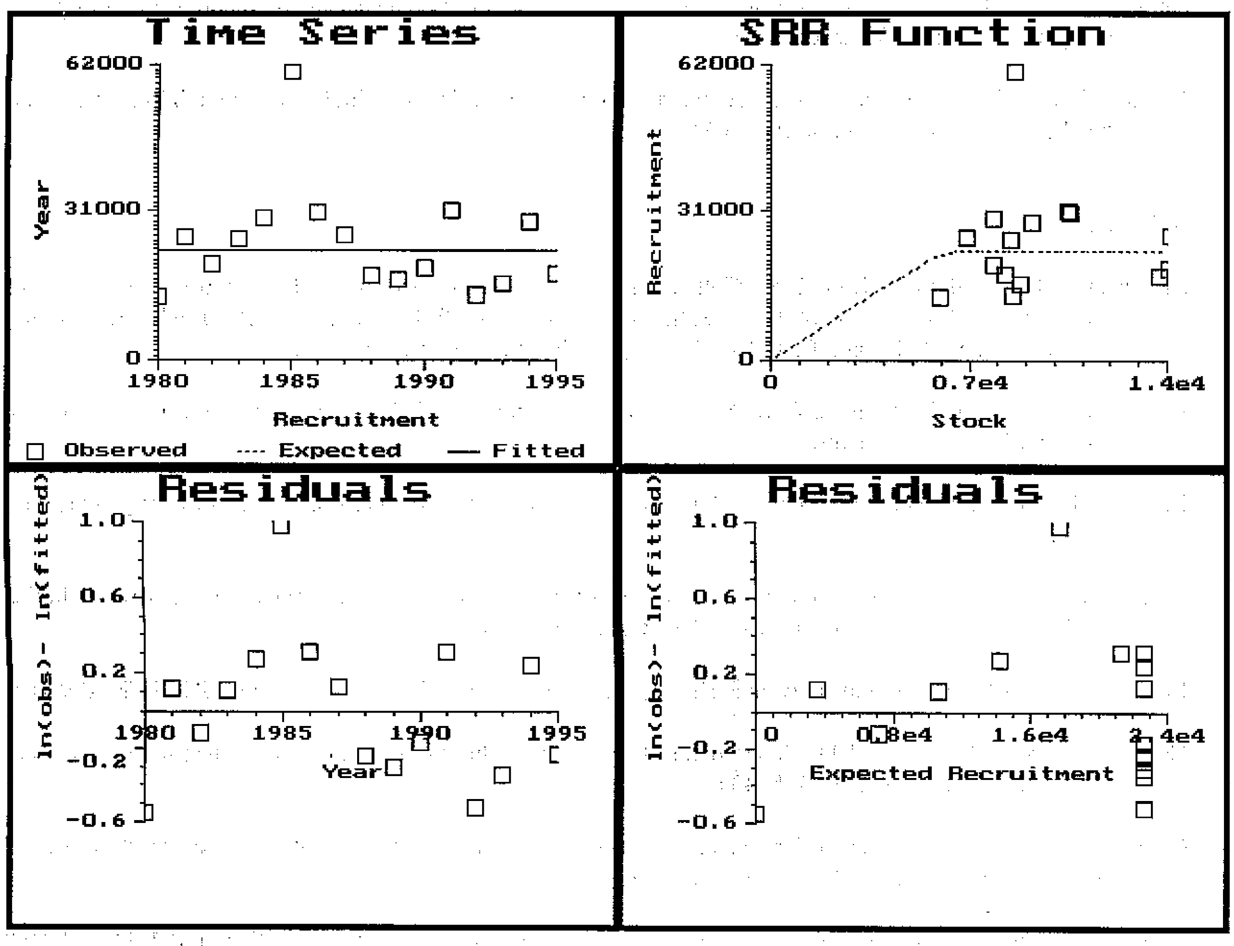


Figure 20.9.4 Plaice in Division VIId. Diagnostic plots for the Ockham stock-recruitment curve.



21 WORKING DOCUMENTS AND REFERENCES

Working Documents

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ANNEX 1

Working paper to 1997 Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

Modifications to the French Gadoids database for North Sea and English Channel

by

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Introduction

Some modifications to the French gadoids database for North Sea and English Channel gadoids were undertaken during 1997 to improve five main issues; length/weight relationships, age-length keys, identification of fleets, computation of the length compositions and raising of samples to the total landings. Table 1 summarises the differences between the old database and the new database. The data have been revised back to 1985.

Length-weight relationships

The previous method used for each species the same length-weight relationships for the four quarters and all areas, North Sea and Eastern Channel included. Saithe and haddock are mainly caught in the northern part of the North Sea (IVa and IVb) but this is not the case for whiting and cod which are caught everywhere. One can consider for saithe and haddock that individuals caught in the southern North Sea and Eastern Channel originate in the North and hence the length-weight relationship applied can be the same for all areas. Nevertheless it appeared useful to have one relationship per quarter. Growth of cod and whiting is not the same in the northern and southern parts of the North Sea but is very similar in the southern part of the North Sea and Eastern Channel. It was therefore decided to use different length-weight relationships in IVa–IVb and IVc–VIId. A total of eight relationships have been used for cod and whiting. The relationships used in IVa and IVb for the four species are those Scottish data. In IVc and VIId the relationships used are derived from English and French for cod and whiting respectively.

Age-length keys

Quarterly age-length keys are used for the four species. For saithe and haddock the keys are the same in all the area and come from Scotland. The whiting and cod keys in area IVa- IVb come from Scotland as well. The revised age-length keys only concern the whiting and the cod in IVc-VIId. In previous keys some anomalies have been detected which have been corrected by using available data from the Netherlands, England and France.

Identification of fleets

French data have been completely revised by fleet. French landings are available by species, area, type of boat, fishing gear, quarter and commercial category. In class « type of boat » we identify the inshore and offshore artisan boats, the freezers and the trawlers fishing for fresh human consumption species. Among the fishing gears we can identify bottom trawl, midwater trawl, beam trawl, dredging, fix net and other.

Previously the database distinguished on one hand the towed gear together by type of boat and on the other hand the fixed gears by type of boat. A total of seven fleets were identified. For instance the artisan fleet named « FIX » included fixed nets, fixed lines, pots and the artisan fleet « TRC » included all kind of trawlers. This fleet included boats which operated both in inshore and offshore waters.

In the new database a distinction between different types of boats, different kinds of gears and between inshore and offshore has been made. However a fleet was retained only when landings were significant, otherwise the data were allocated to « OTH », which means « OTHer ». A total of 40 fleets were allowed but 20 fleets kept. In the freezer fleet a distinction has been made between the boats which come from Brittany and those from the North of France. This was done in order to see if catch and effort are more representative for the new fleets.

Table 2 shows the correspondence between the name of fleets obtained with the previous method and the new one. The fleets indicated in Table 2 represent operational fleets stored in the database for the years between 1985 and 1996 and are not polluted by data which do not correspond to specific criteria for each fleet.

Computations of length composition

Most of the gadoids caught by French fleets are landed in Boulogne-sur-mer (70% to 80% between 1985 and 1996). The number of commercial categories is relatively important and a method to calculate length composition without sampling was finalised many years ago. The number of local categories landed in Boulogne-sur-mer are recorded. Calculation of the length composition is based on the minimum and maximum numbers of fish included in a box and the weight of the box. These three numbers can be considered as a standard. There are as many standards as existing local categories. The number of local categories recorded has been checked and it appears that there were more categories recorded in the database than were actually landed. Some adjustments were carried out before creating the new database.

In the previous method the length composition was calculated by species, quarter and local category for only two fleets, larger vessels fishing for fresh fish and smaller artisan boats including fixed nets and trawlers, inshore and offshore zones. Moreover there were no indications about the origin of the boxes and data of each type of boat from areas IVa, IVb, IVc, VIId were amalgamated.

In the new method for each fleet, the length composition is obtained by species, quarter, local category and area. This was facilitated by cross-examining two databases which had common parameters. It was possible to identify exactly where the data came from. The result is that each fleet now has its own length composition.

Raising of length composition to the total landed

In the previous method length composition by local categories were summed before raising to the total landed weight. In the new method the length composition of each category is raised to the total landed for that local category (Boulogne-sur-mer) or European Union category (other ports) and then summed.

Table 1 Differences between the two databases

	old database	new database
length-weight relationship	1 length/weight relationship by species whatever area	8 length/weight relationships by species : IVa-IVb : 4 quarterly Scottish relationships by species IVc-VIId : saithe and haddock : same relationships than in IVa-IVb : cod : 4 quarterly English relationships : whiting : 4 quarterly Scottish relationships by species
age-length keys		Review of whiting and cod age-length keys between 1985 and 1995
fleets	see old database fleets below	see new database fleets below
computations of length composition	- origin of the boxes unknown, area IVa, IVb, IVc, VIId join - number of standards in Boulogne landings database > true number of standards	- origin of the boxes known, areas IVa, IVb, IVc, VIId identified - standardisation of the standards - deletion of unreliable data in Boulogne landings database used to calculate length composition of each fleet
raising of sample to the total landed	- all local categories of each fleet cumulated before raising to the total landed	- Boulogne-sur-mer : local categories no cumulated before raising to the total. - Other ports : - local categories cumulated in European Union categories - raising of each EU category to the total landing of EU category - cumulating of the EU categories.

fleets – old database

	Freezer	Trawlers fishing for fresh HC species			All artisans
type	10	20 or 30			
		< 1000 cv	1000 ≤ < 1500 cv	≥ 1500 cv	
all type of Ftrawlers	TRF TRV	TRS	TRM	TRB	TRC
other than trawlers			-	-	FIX

- Boulogne landings database: no boat number but a code :
TRS = 500 TRM = 1250 TRB = 2000 TRC = FIX = 0

fleets – new database

	Freezer	Trawlers fishing for fresh HC species					Small vessels fishing for HC species (Artisans)		Other
		Fishing ports in Eastern Channel			Fishing ports in Brittany				
type	10	20 or 30			20	30	40	50	
		< 1000 cv	1000 ≤ < 1500 cv	≥ 1500 cv			offshore	inshore	
bottom trawl	TRF	TRS	TRM	TRB	TR2	TR3	TRO	TRI	TIN
midwater trawl	MWF	MWS	MWM	MWB	MW2	MW3	MWO	MWI	TIN
beam trawl	BEF	BES	BEM	BEB	BE2	BE3	BEO	BEI	TIN
dredging	DRF	DRS	DRM	DRB	DR2	DR3	DRO	DRI	TIN
fix net	FIF	FIS	FIM	FIB	FI2	FI3	FIO	FII	TIN
other	OTH	OTH	OTH	OTH	OTH	OTH	OTH	OTH	OTH

- Boulogne landings database : boat numbers, date of sale
- Total landings database : boat numbers, date of sale, area, fishing gears.

TR	Bottom Trawler
MW	Midwater Trawler
FI	Fix net
BE	Beam Trawler

DR	Dredging Trawler
I	Inshore
O	Offshore
H	High Sea

F	Freezer
OTH	Other
TIN	Type of boat unknown

Table 2 Correspondence between fleets in the old and in the new database

new / old	Freezer	Trawlers fishing for fresh HC species					Artisan		Other
		Fishing ports in Eastern Channel			Fishing ports in Brittany				
type	10	20 or 30			20	30	40	50	
		< 1000 cv	1000 ≤ < 1500 cv	≥ 1500 cv			offshore	inshore	
bottom trawl	TRF / TRF or TRV	TRS / TRS	TRM / TRM	TRB / TRB	TR2 / TRB	TR3 / TRB	TRO / TRC	TRI / TRC	TIN / FIX
midwater trawl	MWF / TRF or TRV	MWS / TRS	MWM / TRM	MWB / TRB			MWO / TRC	MWI / TRC	TIN / FIX
beam trawl							BEO / TRC	BEI / TRC	TIN / FIX
dredging							DRO / TRC	DRI / TRC	TIN / FIX
fix net							FIO / FIX	FII / FIX	TIN / FIX
other	OTH / FIX	OTH / FIX	OTH / FIX	OTH / FIX	OTH / FIX	OTH / FIX	OTH / FIX	OTH / FIX	OTH / FIX