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REPORT OF THE

WORKING GROUP ON THE ASSESSMENT OF MACKEREL, HORSE MACKEREL, SARDINE AND ANCHOVY

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PART 2 OF 2

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PART 2

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

7.1 The Fishery in 1996

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 44,690 t in 1996 which represents a decrease of 15% compared with the 1995 catches. The catch by country and gear is shown in Table 7.1.1. The Portuguese catches show a decrease of 21% and the Spanish catches indicate a decrease in a 12%, compared with the 1995 catches In 1996 the fall is due to the lower catches obtained by the Portuguese trawlers and by the Spanish purse seiners. The proportion of the catches by gear presents the same pattern than in 1995, being the purse seiner catches the most important ones in the Spanish area (65% of the catches) whereas in the Portuguese waters the trawler's catches are the majority, representing the 57% of the Portuguese total catch. In 1996 the artisanal Portuguese catches increased to the double of the 1995 catches.

In this area the catches of horse mackerel are relatively uniform over the year (Borges *et al.* 1995; Villamor *et al.* 1996). Although the second and third quarters show relatively higher catches than the first and fourth (see Table 7.1.2).

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus* in the area, not only *Trachurus trachurus* L. which is the species at present under assessment by this Working Group. The reported catch, therefore always has to be revised by the Working Group in order to eliminate species of horse mackerel other than *Trachurus trachurus* (see Section 1.5).

7.2 Effort and Catch per Unit Effort

Figure 7.2.1 shows the evolution of the commercial effort series from the Spanish trawl fleets fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Aviles) from 1984 to 1996. A significant decrease, compared with the 1995 effort levels, of 14% and 26% respectively was observed, being in the case of the Aviles trawl fleet the lowest level reached in the series.

Table 7.2.1 presents the commercial catch rates from the trawl fleet fishing in Sub-divisions IXa Central North, IXa Central South and South (Portugal) from 1979 to 1990 and trawl fleets from Spain fishing in Sub-division VIIIc West (La Coruña) and in Sub-division VIIIc East (Aviles) from 1983 to 1996. In 1996 the catch rates of the Spanish trawl fleet operating in Sub-division VIIIc West were 11% higher than the catch rate obtained in 1995. The Aviles trawl fleet operating in Sub-division VIIIc East (Cantabrian Sea) presents an increase of 27%. Horse mackerel trawl catch rates from the Portuguese trawl fleet fishing in Division IXa are not available since 1991, because the effort data series is under revision.

Table 7.2.2 indicates the catch rates from research vessel surveys in Kg per tow, for comparison with the total biomass trend. The biomass index from the Portuguese October survey was shown to be 23% higher than observed in 1995. The 1993 biomass index of that series was confirmed to indicate an extremely high value as compared with the rest of the series. The Spanish October survey has been showing an upward biomass trend since 1992 and increased 22% in 1996 as compared with the 1995. The Portuguese and Spanish areas were covered at the same time of the year which was September/October in the Spanish northern Sub-divisions and October/November in the Portuguese southern Sub-divisions.

Catch per unit effort at age

CPUE at age from the Galician (La Coruña) bottom trawl fleet (Sub-division VIIIc West) and from the Cantabrian (Aviles) trawl fleet fishing in Sub-division VIIIc East are available from 1984 to 1996. In the Galician trawl fleet an increase in the catch rates of the older ages was observed in 1996. The extremely strong 1982 year class is still very prominent in the data for both fleets at age group 14 (Table 7.2.3). In 1996, the 1986 and 1987 year classes were confirmed as being strong ones, giving high indices of abundance in both fleets.

7.3 Fishery Independent Information

7.3.1 Trawl surveys

Table 7.3.1 shows the number at age from the Spanish and Portuguese bottom trawl in the October surveys and from the Portuguese July survey. The two October surveys covered Sub-divisions VIIIc East, VIIIc West, IXa

North (Spain) from 20–500 m depth and, Sub-divisions IXa Central North, Central South and South, in Portugal, from 20–750 m depth. The same sampling methodology was used in both surveys but there were differences in the gear design, as described in ICES (1991/G:13). The Portuguese October and July survey indices and the Spanish September/October survey indices are estimated by strata for the range of distribution of horse mackerel in the area, which has been consistently sampled over the years. This corresponds to the 20–500 m strata boundaries. It was demonstrated that the horse mackerel off the Portuguese shelf are stratified by length according to the depth and spawning time (ICES 1993/Assess:19). This explains the special characteristics of the composition of the catches, the lower availability of fish after first maturing which creates a peculiar selection pattern.

The Spanish September/October survey series is available from 1985 to 1996 and the Portuguese October survey, from 1981–1996. Both are carried out during fourth quarter when the recruits have entered the area. In the Portuguese October survey the recruitment (age 0) observed in 1996 was high and it is comparable to the high level observed earlier in 1993 in the Portuguese area. In the Spanish area the October survey indicated the recruitment index at age 0 of a similar low level as the 1995 index. In the Spanish October survey in 1996 the strong 1986 and 1987 year classes were still abundant, an increase in the yields on the intermediate ages (3, 4 and 5) was evident (Table 7.3.1). In the Portuguese July survey there is a strong fall in the 1995 abundance index observed in all the ages compared with those obtained in 1994 despite using the same vessel, sampling and gear methodology was used. The 1982 year class is conspicuous in all the survey series but is stronger in the October Spanish bottom trawl survey.

7.3.2 Egg surveys

This was the first series of surveys carried out in the southern area for the Annual Egg Production Method (ICES 1996/H:2). The estimate of 1995 SSB for the southern horse mackerel from those surveys was 261,000 tonnes.

7.4 Catch in Numbers at Age

The catch in numbers at age for 1996 are presented by quarter and area, disaggregated by Sub-division VIIIc East, VIIIc West and IXa North (Table 7.4.1). In Sub-divisions IXa Central North, IXa Central South and IXa South only the catch in numbers from trawl catches were available disaggregated by Sub-division. The purse seine and artisanal catches were not sampled by Sub-division in the Portuguese area, so the catch in numbers from all gears and quarters is only available for the total Portuguese area, as it is shown in Table 7.4.1. Table 7.4.4 and Figure 7.4.1 present the catch in numbers by year. The 1982 year class is well represented in the catch in numbers at age matrix. The 1986 and 1987 year classes are strong but do not reach the extreme high level of the 1982 year class. The 1991 and 1992 year classes are shown as strong in the catches as 2, 3 and 4 age-groups.

Catch in numbers at age have been obtained by applying a quarterly ALK to each of the catch length distribution estimated from the samples of each Sub-division. The sampling intensity is discussed in Section 1.3. The data before 1985 have not yet been revised according to the approved ageing methodology. So, they have been considered inappropriate for a VPA and have not been included in the analytical assessment.

7.5 Mean Length at Age and Mean Weight at Age

Tables 7.5.1 and 7.5.2 show the 1996 mean lengths and mean weights at age in the catch by quarter and Sub-division for the Spanish data and by quarter and total area for the Portuguese data. Table 7.5.3 presents the weight at age in the stock and in the catch. The data before 1985 have not yet been revised according to the approved ageing methodology and should, therefore be considered only correct for ages 0 and 1, ages in which both methods were in agreement.

7.6 Maturity at Age

The proportions of fish mature at each age have been considered to be constant over the assessment period. The maturity ogive has been smoothed as ACFM requested in 1992.

Age Group

0	1	2	3	4	5	6	7	8	9	10	11	12
0.00	0.00	0.04	0.27	0.63	0.81	0.90	0.95	0.97	0.98	0.99	1.0	1.0

7.7 Stock Assessment

Fishing mortality coefficients were estimated using Extended Survivors Analysis (XSA). In accordance with last year's assessment, the XSA parameters were set at catchability independent of age for ages equal or greater than 9 years old, and the plus group at 12.

The strength of shrinkage has a significant effect on the standard errors of the log catchability (ICES 1995/Assess:2). Stronger shrinkage (lower CVs) increases the standard errors for all fleets. To compare the independent information provided by the different fleets XSA were run separately for each of the fleets, without shrinkage.

The external information used in the tuning were:

Fleet 1: *Catch per unit of effort of the trawl fleet from La Coruña (VIIIc West- North Galicia)*
Fleet 2: *Catch per unit of effort of the trawl fleet from Aviles (VIIIc East- Cantabrian Sea)*
Fleet 3: *Portuguese October Trawl Survey during the Recruitment season (Division IXa)*
Fleet 4: *Portuguese July Trawl Survey end of spawning season in Division IXa*
Fleet 5: *Spanish October trawl Survey during the recruitment season (Subdivision IXa North and Division VIIIc)*

The slopes of the linear regressions between log- catchability and log- population were analysed: Fleet 1, presented a negative slope at age 0, with low R_{square}, as did Fleet 2, at age 1 with a slightly higher R_{square}. These data were plotted and it was decided to not include those ages in the tuning, because they were not providing any information. For Fleet 2 it was considered also appropriate to eliminate the age range 0–4 because these ages presented very high standard errors. The same procedure was used for Fleet 5, age range 0–4, which did not perform well for young fish.

Figure 7.7.1 compares the SSB estimated for 1995 and 1996 by source of independent information. For the year 1995 it is also possible to compare the estimations provided by the fleets with the 1995 egg survey SSB.

The low SSB values were estimated from each of the two October surveys carried out during the recruitment season. The high values of SSB correspond to the estimations provided by the *Fleet 2* operating in the Cantabrian Sea during all the year and by the Portuguese July survey. The adults are more abundant in the area during the spawning season when the spawning aggregations occur. The 1995 egg survey estimation indicates a value in agreement with the 1995 SSB estimated by all the fleets. The assessment performed and accepted last year indicates a 1995 SSB close to the 1995 egg survey SSB and to the present assessment.

Comparison of the 1995 and 1996 assessments (Figure 7.7.2) from the final VPA of this year's assessment illustrates the results of the fishing mortality estimates using XSA for all the fleets and a shrinkage of 1.00. It may be seen that for the reference F bar (1–11) the estimate shows close agreement with last year's assessment. Given the pattern of exploitation this stock is subjected to high selection on the younger and older ages and a reduced availability of 4–6 years old fish in the catches the estimates at F bar (0–3) and F bar (7–11) were also compared with last year's assessment showing good agreement.

The F of the younger ages is generally under-estimated by the assessment and F of the older ages over-estimated. Taking a mean F over all the ages averages the biases.

Figure 7.7.3 illustrates the retrospective SSB estimates performed by the final VPA, and the 1995 egg survey estimate, which indicate a very good agreement among them.

The tuning diagnostics and final results are given in Tables 7.7.1–7.7.4. Figure 7.7.4 indicates the fish stock summary trends over the period 1985–1996 according to the final assessment.

7.8 Recruitment

The Portuguese October survey series which was carried out at the time of recruitment show in 1996 a detectable relationship between the survey and cohort strength, but the Spanish October survey did not show any information on the strength of the 1996 recruitment.

In 1994 the Spanish October survey indicated high recruitment at age 0 and the Portuguese October Survey estimated low recruitment for the 1994 year class (Table 7.3.1). In 1995 both surveys indicated a low level of 0 group abundance which is in agreement with the VPA estimate. The recruitment of 0-group in 1997 was taken as the geometric mean of (1985–1993). VPA estimates which corresponds to 1,369 million fish.

7.9 Catch Predictions

The terminal population in 1996 from the final VPA was used as input to the catch forecast for age groups 1 and older. Recruitment at age 0 was assumed to be the geometric mean of the period 1985–1993. The exploitation pattern was taken as the arithmetic mean of the last three years, without scaling to the last year, which is assumed to correspond to the most likely exploitation in the short term. Table 7.9.1 gives the input parameters and Tables 7.9.2a–c and Figure 7.9.1 show the results of the short term predictions of the catch and spawning stock biomass.

At $F_{status\ quo}$ (F96) the expected catch in weight for 1997 is 52,898 tonnes. In 1998 assuming, the same recruitment level, the catch at $F_{status\ quo}$ is predicted to be 58,715 tonnes. The spawning stock biomass is expected to decrease from 273 thousand tonnes in 1997 to 264 thousand tonnes in 1998 at $F_{status\ quo}$ level and to 247 thousand tonnes if the agreed TAC of 73 thousand tonnes is taken in 1997. The spawning stock biomass is expected to decrease in 1999, at $F_{status\ quo}$ to 256 thousand tonnes.

7.10 Short-Term and Medium-Term Risk Analysis

Due to technical problems it was not possible to perform a risk analysis.

7.11 Long-Term Yield

The long-term yield per recruit and spawning biomass-per-recruit curves, against F, derived using the input data in Table 7.9.1 are shown in Figure 7.11.1. Table 7.11.1 presents the yield per recruit summary table. $F_{0.1}$ is estimated to be 0.08, and F_{max} to be 0.16, at the reference age (1–11).

7.12 Comments on Assessment

This assessment is consistent with last year's assessment. The spawning stock biomass estimated from the 1995 egg surveys is in agreement with the 1995 SSB level estimated using the two October surveys, the July survey information and the two commercial fleets.

7.13 Reference Points for Management Purpose

The biological reference points were estimated and shown in Figure 7.13.1 which gives the plot of the recruitment at age 0 versus the spawning stock biomass in the same year, from the final VPA. The estimated F_{med} value is 0.19 and F_{high} corresponds to 0.32. The present level of $F_{status\ quo}$ of 0.167 is below the F_{med} level and close to F_{max}.

As can be seen from Figure 7.13.1, the range of SSBs is quite narrow, and no stock-dependent trend in the recruitment can be inferred from these observations. The extremely strong 1982 year class has contributed substantially to the SSB during the whole period 1985–1996. The lowest biomass attained during the period was 130,000 tonnes in 1985, which gave rise to a medium recruitment. This situation is similar to the situation for the NEA mackerel (see Section 3.4.10), and the same interpretation of the lowest experienced SSB applies here. If a similar stock-recruitment relation is also assumed, i.e. R independent of SSB at the geometric mean of the historic recruitments above the lowest SSB, and linearly decreasing towards 0 below this SSB, the F value corresponding to the replacement line through the assumed R and the lowest SSB would appear as F_{crash}. This F-value, which is 0.27, is well above F_{max}. Therefore, an exploitation which leads to a lower SSB than the lowest experienced cannot be justified on the grounds that it would increase the long term equilibrium catch.

The risk of reaching an SSB of 130,000 tonnes in a long term equilibrium (modelled as described in Section 3.4.10) at F_{max} is far below 5%. The precautionary range of Fs is therefore limited by the F_{max} and not by an F representing danger of recruitment failure. The Working Group therefore considers that the fishing mortality target should not exceed the F_{max}.

7.14 Management Measures and Considerations

The Working Group considers that the TAC should not be applied to *Trachurus* spp combined but only to *Trachurus trachurus*, the Atlantic horse mackerel. The F reference which was constant over recent years has shown a decrease in 1994 and 1995. Table 7.14.1 summarizes several management options at: $F_{status\ quo}$, F corresponding to the official TAC equal to 73 thousand tonnes, F corresponding to TAC 1995 level, and to F_{med} and F_{max}.

Table 7.1.1 Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984-1996 are Working Group estimates.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
1962	7,231	46,345	3,400	56,976	-	-	-	-	53,202	110,778
1963	6,593	54,267	3,900	64,760	-	-	-	-	53,420	118,180
1964	8,983	55,693	4,100	68,776	-	-	-	-	57,365	126,141
1965	4,033	54,327	4,745	63,105	-	-	-	-	52,282	115,387
1966	5,582	44,725	7,118	57,425	-	-	-	-	47,000	104,425
1967	6,726	52,643	7,279	66,648	-	-	-	-	53,351	119,999
1968	11,427	61,985	7,252	80,664	-	-	-	-	62,326	142,990
1969	19,839	36,373	6,275	62,487	-	-	-	-	85,781	148,268
1970	32,475	29,392	7,079	59,946	-	-	-	-	98,418	158,364
1971	32,309	19,050	6,108	57,467	-	-	-	-	75,349	132,816
1972	45,452	28,515	7,066	81,033	-	-	-	-	82,247	163,280
1973	28,354	10,737	6,406	45,497	-	-	-	-	114,878	160,375
1974	29,916	14,962	3,227	48,105	-	-	-	-	78,105	126,210
1975	26,786	10,149	9,486	46,421	-	-	-	-	85,688	132,109
1976	26,850	16,833	7,805	51,488	89,197	26,291	376[1]	-	115,864	167,352
1977	26,441	16,847	7,790	51,078	74,469	31,431	376[1]	-	106,276	157,354
1978	23,411	4,561	4,071	32,043	80,121	14,945	376[1]	-	95,442	127,485
1979	19,331	2,906	4,680	26,917	48,518	7,428	376[1]	-	56,322	83,239
1980	14,646	4,575	6,003	25,224	36,489	8,948	376[1]	-	45,813	71,037
1981	11,917	5,194	6,642	23,733	28,776	19,330	376[1]	-	48,482	72,235
1982	12,676	9,906	8,304	30,886	-[2]	-[2]	-[2]	-	28,450	59,336
1983	16,768	6,442	7,741	30,951	8,511	34,054	797	-	43,362	74,313
1984	8,603	3,732	4,972	17,307	12,772	15,334	884	-	28,990	46,297
1985	3,579	2,143	3,698	9,420	16,612	16,555	949	-	34,109	43,529
1986	-[2]	-[2]	-[2]	28,526	9,464	32,878	481	143	42,967	71,493
1987	11,457	6,744	3,244	21,445	-[2]	-[2]	-[2]	-[2]	33,193	54,648
1988	11,621	9,067	4,941	25,629	-[2]	-[2]	-[2]	-[2]	30,763	56,392
1989	12,517	8,203	4,511	25,231	-[2]	-[2]	-[2]	-[2]	31,170	56,401
1990	10,060	5,985	3,913	19,958	10,876	17,951	262	158	29,247	49,205
1991	9,437	5,003	3,056	17,497	9,681	18,019	187	127	28,014	45,511
1992	12,189	7,027	3,438	22,654	11,146	16,972	81	103	28,302	50,956
1993	14,706	4,679	6,363	25,747	14,506	16,897	124	154	31,681	57,428
1994	10,494	5,366	3,201	19,061	10,864	22,382	145	136	33,527	52,588
1995	12,620	2,945	2,133	17,698	11,589	23,125	162	107	34,983	52,681
1996	7,583	2,085	4,385	14,053	10,360	19,917	214	146	30,637	44,690

[1]Estimated value.
[2]Not available by gear.

Table 7.1.2 Southern horse mackerel catches by quarter and area.

Country/Sub-division	Spain 8c-E, 8c-W, 9a-N			Unit:tonnes	Total
Quarter/ Year	1	2	3	4	
1984	-	-	-	-	28990
1985	-	-	-	-	34116
1986	-	-	-	-	42967
1987	5179	8678	11067	8269	33193
1988	6445	7936	7918	8464	30763
1989	7824	7480	8011	7855	31170
1990	6827	7871	7766	6783	29247
1991	5369	7220	8741	6686	28016
1992	4065	8750	10042	5445	28302
1993	5546	9227	9823	7085	31681
1994	6486	8966	9732	8343	33527
1995	6050	10328	10969	7636	34983
1996	7188	8045	8211	7193	30637

Country/ Sub-division	Portugal 9a-CN, 9a-CS, 9a-S			Unit:tonnes	Total
Quarter/ Year	1	2	3	4	
1984	4669	6506	3577	2358	17110
1985	1226	3055	2946	2192	9419
1986	4627	8093	7542	8264	28526
1987	3902	5474	6654	3524	19554
1988	3069	7402	7554	7100	25125
1989	4074	9096	8543	3513	25226
1990	3341	5753	5873	4992	19959
1991	3101	5630	5094	3672	17497
1992	2516	5661	7196	7281	22654
1993	5455	6401	8384	5507	25747
1994	4418	5051	6386	3206	19061
1995	3240	4618	6038	3802	17698
1996	2649	3830	4068	3506	14053

Table 7.2.1 SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries.

Year	Division IXa (Portugal)	Division VIIIc (Spain)	
	Trawl	Trawl	
		Sub-div. VIIIc East Aviles	Sub-div. VIIIc West La Coruña
	kg/h	kg/Hp.day. 10^{-2}	kg/Hp.day.10^{-2}
1979	87.7	-	-
1980	69.3	-	-
1981	59.1	-	-
1982	56.2	-	-
1983	98.0	123.46	90.4
1984	55.9	142.94	135.87
1985	24.4	131.22	118.00
1986	41.6	116.90	130.84
1987	71.0	109.02	176.65
1988	91.1	88.96	146.63
1989	69.5	98.24	172.84
1990	98.9	125.35	146.27
1991	n.a.	106.42	145.09
1992	n.a.	73.70	163.12
1993	n.a.	71.47	200.50
1994	n.a.	137.56	136.75
1995	n.a.	130.44	124.11
1996	n.a.	145.64	156.50

Table 7.2.2 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

	Portugal IXa (20-500 m depth)			Spain (20-500m depth)
	Bottom trawl (20-mm codend)			
Year	Kg/h March	kg/h Jun-Jul	kg/h Oct	kg/30 minutes Sept-Oct
1979		12.2	5.5[1]	-
1980		20.6	2.5[1]	-
1981		11.6	1.8	-
1982		42.1	36.9	-
1983		79.1	24.6	37.97
1984		-	-	51.98
1985		9.5	3.8	20.93
1986		4.8	23.5	10.14
1987		-	6.9	-
1988		-	26.0	12.05
1989		14.9	11.7	15.48
1990		14.4	21.5	9.62
1991		11.8	16.9	4.92
1992	17.5	38.0	40.8	20.30
1993	100.24	35.6	235.3	18.11
1994	_	49.3	12.4	21.61
1995	_	9.8	18.9	21.99
1996	_	_	23.25	26.75

Table 7.2.3 CPUE at age from fleets

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT01: 8c West trawl fleet (La Coruna) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	32E3	1	356	644	124	38	38	8	87	30	42	5	6	1	6	3	12
1985	3E4	3	12	134	399	19	42	39	25	27	43	22	8	3	1	3	27
1986	27E3	3	79	58	118	400	40	31	22	15	15	41	16	6	10	2	33
1987	23E3	1	33	113	92	143	672	76	61	13	22	20	16	8	2	1	13
1988	28E3	5	167	258	58	58	51	408	40	29	22	11	11	16	4	2	9
1989	3E4	23	152	48	115	56	57	38	299	40	103	78	6	2	23	2	16
1990	3E4	1	84	128	37	71	17	27	39	394	21	27	5	6	6	7	15
1991	27E3	1	1	41	2	20	39	27	65	49	376	37	17	12	2	9	5
1992	26E3	0	191	60	10	9	54	99	48	46	51	361	12	6	3	0	8
1993	3E4	0	34	467	39	51	95	87	210	56	79	16	209	1	0	1	1
1994	26E3	2	79	270	12	8	20	92	146	165	34	18	4	45	1	0	1
1995	28E3	0	7	122	84	37	25	36	64	129	102	33	12	2	47	1	1
1996	24E3	0	1	29	14	65	89	51	62	41	125	108	36	15	14	59	3

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT02: 8c East trawl fleet (Aviles) (Catch: Millions)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1984	1E4	4	882	759	141	42	39	11	65	18	31	3	4	1	6	3	11
1985	9856	1	167	613	574	13	18	16	13	17	21	14	4	4	1	4	19
1986	11E3	36	223	271	174	527	42	19	14	10	8	9	2	1	1	0	2
1987	8309	1	244	350	166	48	396	40	19	7	9	6	5	3	1	1	4
1988	9047	181	264	53	23	18	19	148	14	17	22	15	12	22	6	5	27
1989	8063	65	275	62	105	50	42	18	100	13	38	35	1	1	18	2	15
1990	8492	1	726	373	257	72	19	21	24	192	10	13	3	4	4	4	9
1991	7677	39	495	882	41	85	51	10	12	9	67	3	2	1	1	1	1
1992	13E3	2	35	21	65	34	60	63	20	16	19	114	3	1	1	0	7
1993	7635	0	215	462	77	44	23	18	42	6	14	2	35	1	0	0	1
1994	9620	1	47	632	12	6	17	69	118	135	25	14	3	38	1	0	0
1995	6146	1	182	441	141	70	32	25	39	89	71	31	12	4	37	1	1
1996	4525	0	225	608	129	230	128	32	24	22	49	32	10	4	4	17	0

Table 7.3.1 CPUE at age from surveys

The SAS System 18:19 Thursday, September 11, 19

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT03: Oct Pt Survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1985	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	1	706.196	123.479	82.500	70.046	12.621	2.445	0.313	0.552
1987	1	95.243	24.377	29.541	12.419	9.802	5.673	1.163	0.519
1988	1	29.416	704.046	54.984	20.207	13.920	6.472	21.741	8.294
1989	1	377.665	93.538	40.406	20.064	6.196	3.956	3.847	2.395
1990	1	508.494	269.582	28.907	16.472	17.014	9.822	1.794	1.187
1991	1	336.245	97.414	14.704	13.411	14.272	6.571	3.895	2.275
1992	1	677.806	500.049	184.896	34.300	15.932	8.153	6.113	6.745
1993	1	1733.340	214.230	328.440	111.630	37.010	2.160	0.950	0.950
1994	1	4.217	9.499	75.879	44.908	19.693	5.142	2.013	1.022
1995	1	6.972	9.386	148.650	56.402	26.310	8.156	3.383	0.709
1996	1	1225.000	5.750	6.979	16.346	19.530	8.052	2.129	0.592

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.003
1986	0.370	0.238	0.189	0.286	0.181	0.126	0.051	0.115
1987	0.487	0.368	0.225	0.165	0.248	0.047	0.022	0.019
1988	1.834	0.878	0.298	0.030	0.001	0.001	0.001	0.001
1989	0.662	0.320	0.430	0.398	0.162	0.139	0.012	0.004
1990	3.577	2.600	1.532	0.624	0.770	0.266	0.239	0.179
1991	2.331	1.951	1.006	0.405	0.350	0.238	0.220	0.185
1992	4.196	3.251	3.805	0.497	0.702	0.178	0.082	0.086
1993	0.670	0.860	0.570	1.340	0.370	0.220	0.070	0.050
1994	0.850	0.534	0.234	0.189	0.126	0.089	0.053	0.030
1995	0.527	0.383	0.260	0.219	0.227	0.228	0.221	0.215
1996	0.209	0.135	0.106	0.062	0.047	0.031	0.005	0.005

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HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

FLT04: Oct Sp. Survey,bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1985	1	182.630	84.360	322.510	467.600	7.090	6.500	4.710	4.050
1986	1	289.420	44.600	12.640	7.000	41.810	4.920	5.150	11.110
1987	1	217.665	64.153	20.035	8.053	18.482	16.448	5.100	7.979
1988	1	145.910	14.650	14.220	9.000	5.130	8.170	54.990	5.050
1989	1	115.000	6.540	1.900	21.300	4.680	17.500	15.620	65.040
1990	1	26.620	17.790	2.730	2.680	15.920	5.680	7.630	6.090
1991	1	48.470	15.370	5.100	0.150	1.440	1.820	0.710	0.640
1992	1	85.470	44.810	0.740	1.050	0.350	2.080	4.470	4.360
1993	1	138.619	31.848	3.447	0.630	2.199	4.546	13.762	17.072
1994	1	937.761	64.849	20.936	1.332	1.510	2.535	4.887	9.632
1995	1	38.308	172.564	12.492	6.941	5.806	3.845	6.311	9.659
1996	1	43.288	47.240	26.844	19.573	35.014	19.058	6.602	11.004

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1985	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	4.680	7.200	8.540	3.050	1.310	0.800	0.980	3.840
1987	5.662	5.879	4.712	4.630	1.470	1.389	4.147	0.001
1988	5.730	6.850	4.800	2.600	7.030	1.650	2.410	17.550
1989	7.680	10.470	26.160	0.570	0.410	4.770	0.400	5.440
1990	73.350	3.050	4.730	0.860	0.810	0.600	0.770	1.670
1991	2.170	28.900	6.420	6.520	2.220	1.070	2.780	0.640
1992	5.730	5.090	47.600	5.060	1.620	0.600	0.180	3.550
1993	4.513	4.422	3.881	22.057	0.235	0.041	0.228	0.256
1994	11.578	2.473	1.530	0.911	4.512	0.361	0.194	0.433
1995	14.481	11.868	3.503	1.930	0.340	8.609	0.101	0.049
1996	2.733	21.892	7.012	1.079	1.723	0.033	3.657	0.078

Table 7.3.1 (cont.) CPUE at age from surveys

The SAS System 09:11 Friday, September 12, 19

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

PJS: Jul Pt. Survey, bottom trawl survey (Catch: Number)

Year	Fishing effort	Catch, age 0	Catch, age 1	Catch, age 2	Catch, age 3	Catch, age 4	Catch, age 5	Catch, age 6	Catch, age 7
1989	1	81.913	38.356	45.522	60.648	26.998	5.846	3.164	6.634
1990	1	82.175	51.605	69.397	26.157	12.393	5.588	3.670	3.515
1991	1	17.429	53.094	19.479	3.507	3.906	3.978	2.495	3.128
1992	1	109.178	1822.950	39.701	21.081	7.980	5.013	3.427	3.348
1993	1	1.810	263.390	263.800	150.040	20.840	39.560	89.150	31.340
1994	1	54.981	408.262	232.995	110.935	49.988	34.724	38.438	20.985
1995	1	5.410	38.571	16.132	23.071	26.699	12.233	5.577	2.071

Year	Catch, age 8	Catch, age 9	Catch, age 10	Catch, age 11	Catch, age 12	Catch, age 13	Catch, age 14	Catch, age 15
1989	3.042	3.716	1.440	0.793	0.613	0.214	0.157	0.244
1990	7.745	3.001	1.363	0.695	0.758	0.445	0.356	0.470
1991	3.566	7.637	3.537	3.574	2.288	2.491	0.508	0.413
1992	3.879	5.616	9.998	3.988	5.772	3.205	1.038	0.481
1993	22.690	9.530	0.520	0.640	0.050	0.020	0.000	0.000
1994	5.725	3.905	3.550	3.193	5.485	1.883	1.057	0.867
1995	0.540	0.270	0.223	0.158	0.263	0.115	0.091	0.103

Table 7.4.1 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1996.

1996	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0		0		0
1	3,014	1,241	284		1,647		6,186
2	8,228	16,953	3,252		2,746		31,179
3	671	2,341	2,933		5,945		11,890
4	1,254	1,837	1,844		5,649		10,584
5	901	1,732	635		2,058		5,326
6	245	584	172		1,037		2,038
7	366	747	301		513		1,927
8	339	707	189		497		1,732
9	818	1,753	513		621		3,705
10	779	1,763	923		500		3,965
11	270	625	336		406		1,637
12	108	249	115		317		789
13	135	288	118		320		861
14	496	1,048	587		297		2,427
15+	24	121	83		267		495
Total	17,647	31,989	12,285		22,820		84,741
Tonnes	1,726	3,693	1,768		2,649		9,836

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	0		0		0
1	228	173	0		287		688
2	1,201	3,659	37		1,334		6,231
3	2,356	1,551	627		3,602		8,136
4	5,442	3,269	869		4,392		13,972
5	4,417	2,839	333		1,534		9,123
6	910	751	126		1,236		3,023
7	773	795	256		1,224		3,048
8	1,000	800	118		1,059		2,977
9	1,985	1,872	437		1,180		5,474
10	1,760	1,829	856		810		5,255
11	604	631	314		869		2,418
12	268	285	126		1,186		1,865
13	278	289	90		601		1,258
14	1,013	1,017	489		680		3,199
15+	33	34	36		1,112		1,215
Total	22,268	19,794	4,714		21,106		67,882
Tonnes	3,672	3,311	1,061		3,830		11,874

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	0	0	11,964		614		12,578
1	717	2	788		1,285		2,792
2	2,724	2,395	493		2,897		8,509
3	3,414	3,076	645		5,155		12,290
4	5,527	4,740	857		6,265		17,389
5	2,778	2,175	367		3,275		8,595
6	1,167	985	153		2,095		4,400
7	1,685	1,171	187		1,219		4,262
8	461	525	183		624		1,793
9	2,651	1,924	588		451		5,614
10	879	855	531		548		2,813
11	225	167	156		480		1,028
12	318	312	184		899		1,713
13	8	23	24		695		750
14	515	459	292		824		2,090
15+	46	67	133		1,303		1,549
Total	23,115	18,876	17,545		28,629		88,165
Tonnes	3,746	3,263	1,203		4,068		12,280

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	43	10,685	8,534		6,505		25,767
1	1,679	8,684	13,382		2,042		25,787
2	4,382	3,426	2,725		644		11,177
3	773	5,506	1,092		1,470		8,841
4	1,006	6,179	1,533		2,339		11,057
5	602	2,140	714		1,373		4,829
6	319	465	357		978		2,119
7	440	656	410		635		2,141
8	130	326	249		1,177		1,882
9	824	1,111	910		1,423		4,268
10	325	333	572		1,076		2,306
11	59	63	199		898		1,219
12	67	296	243		921		1,529
13	5	72	41		936		1,054
14	164	316	467		908		1,855
15+	7	206	299		546		1,058
Total	10,825	40,466	31,727		23,871		106,889
Tonnes	1,291	3,588	2,314		3,506		10,699

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	1-4 Q	1-4 Q	1-4 Q	1-4 Q	1-4 Q	1-4 Q	1-4 Q
Age	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch('000)	catch ('000)
0	43	10,685	20,498	0	7,119	0	38,345
1	5,638	10,100	14,454	0	5,261	0	35,453
2	16,535	26,433	6,507	0	7,621	0	57,096
3	7,214	12,474	5,297	0	16,172	0	41,157
4	13,229	16,025	5,103	0	18,645	0	53,002
5	8,698	8,886	2,049	0	8,240	0	27,873
6	2,641	2,785	808	0	5,346	0	11,580
7	3,264	3,369	1,154	0	3,591	0	11,378
8	1,930	2,358	739	0	3,357	0	8,384
9	6,278	6,660	2,448	0	3,675	0	19,061
10	3,743	4,780	2,882	0	2,934	0	14,339
11	1,158	1,486	1,005	0	2,653	0	6,302
12	761	1,144	668	0	3,323	0	5,896
13	426	672	273	0	2,552	0	3,923
14	2,187	2,840	1,835	0	2,709	0	9,571
15+	110	428	551	0	3,228	0	4,317
Total	73,855	111,125	66,271	0	96,426	0	347,677
Tonnes	10,435	13,855	6,346	0	14,053	0	44,689

Table 7.4.2 Catch in numbers by year

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

CANUM: Catch in Numbers (Thousands)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
1981	53700	315700	136200	58800	20400	47800	34800	23000
1982	104700	122600	115000	77700	27000	22200	28000	28300
1983	182300	1109100	74800	24400	22600	31500	34900	20600
1984	12200	71100	459700	40700	3800	8900	21600	20000
1985	393697	297486	84887	79849	26197	14665	7075	7363
1986	615298	425659	96999	64701	122560	27584	13610	24346
1987	53320	618570	170015	66303	28789	81020	21825	10485
1988	121951	271052	94945	39364	22598	20507	92897	17212
1989	242537	158646	70438	93590	37363	25474	22839	52657
1990	48100	164206	100833	60289	35931	14307	11786	12913
1991	31786	69544	71451	24222	33833	28678	13952	14578
1992	45629	285197	107761	51971	21596	23308	24973	14167
1993	10719	101326	262637	95182	35647	23159	22311	35258
1994	9435	113345	264744	93214	23624	11374	18612	22740
1995	3512	161142	124731	93349	47507	15997	11235	13608
1996	38345	35453	57096	41157	53002	27873	11580	11378

Year	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	24100	0	0	0	0	0	0	0
1982	27600	0	0	0	0	0	0	0
1983	20200	0	0	0	0	0	0	0
1984	18000	0	0	0	0	0	0	0
1985	3981	6270	4614	3214	2702	1699	864	4334
1986	12080	6694	8198	6349	5838	3244	2023	2961
1987	5042	3795	2337	1999	1666	951	1029	1906
1988	11669	10279	7042	4523	6050	2514	1379	3717
1989	11308	14892	11182	2728	2243	4266	1456	3791
1990	76713	9463	6562	3481	2568	2017	2430	4409
1991	11948	64501	8641	5671	3933	1970	2113	2164
1992	11384	12496	52251	4989	4043	2480	1815	4045
1993	11881	15094	5813	36062	1653	879	823	2304
1994	26587	8207	5142	2546	10266	1291	1001	1210
1995	19931	16763	8550	5664	4846	11717	2367	2809
1996	8384	19061	14339	6302	5896	3923	9571	4317

Table 7.5.1 Length (cm) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1996.

1996	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q	1'st Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	16.3	16.8	15.7		14.6		15.9
2	17.5	18.7	19.5		18.3		18.4
3	23.4	22.3	22.5		21.0		21.8
4	25.6	25.6	24.3		22.7		23.8
5	27.1	27.6	26.0		24.8		26.2
6	29.3	29.6	30.9		26.0		27.8
7	31.1	31.1	32.2		27.7		30.4
8	30.0	29.8	30.9		30.7		30.2
9	30.6	30.7	32.3		32.0		31.1
10	31.3	31.6	33.2		32.4		32.0
11	31.9	31.9	34.1		33.9		32.8
12	31.4	31.5	34.5		35.2		33.4
13	32.0	31.5	33.9		35.6		33.4
14	31.9	32.7	34.6		36.7		33.5
15+	38.9	40.7	39.5		37.7		38.8
0-15+	21.3	22.9	24.9		23.1		22.9

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q	2'nd Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	0.0	0.0	0.0		0.0		0.0
1	15.3	14.5	17.5		16.3		15.5
2	19.5	19.9	20.7		19.2		19.7
3	23.7	23.0	23.6		21.4		22.5
4	26.0	26.3	24.5		23.7		25.3
5	27.2	27.4	25.4		25.7		26.9
6	28.5	29.0	31.9		27.3		28.3
7	30.6	31.0	32.5		29.0		30.2
8	29.2	29.6	31.8		30.1		29.7
9	30.2	30.6	32.7		31.1		30.7
10	30.8	31.5	33.6		32.4		31.7
11	31.1	31.8	34.1		33.6		32.6
12	31.0	31.8	34.7		35.1		34.0
13	30.8	31.3	33.4		35.9		33.5
14	31.7	32.1	34.7		36.7		33.3
15+	39.1	39.0	38.3		37.9		38.0
0-15+	27.2	26.9	29.9		27.2		27.3

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q	3'rd Q
Age	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length (cm)	length(cm)
0	0.0	0.0	8.6		14.0		8.9
1	18.5	21.5	13.9		16.2		16.1
2	21.8	23.6	22.7		20.9		22.1
3	25.6	25.8	25.6		22.2		24.2
4	26.9	26.7	26.3		23.4		25.6
5	28.0	27.8	28.1		24.8		26.7
6	30.2	30.3	31.2		26.2		28.4
7	29.6	29.7	31.2		27.2		29.0
8	29.4	30.1	32.3		28.6		29.6
9	29.5	30.0	33.0		29.7		30.1
10	30.5	31.7	34.5		31.8		31.9
11	31.5	32.4	37.2		32.1		32.8
12	28.5	29.0	35.0		32.8		31.5
13	38.3	39.1	35.7		35.0		35.2
14	30.8	31.7	36.8		36.9		34.2
15+	39.7	40.1	39.3		38.2		38.4
0-15+	27.0	27.6	14.7		25.1		24.1

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q	4'th Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	11.7	12.1	12.0		11.5		11.9
1	18.2	13.2	14.3		14.4		14.2
2	20.6	23.8	19.8		20.6		21.4
3	24.3	25.3	25.2		22.4		24.7
4	27.4	26.1	26.6		23.9		25.8
5	28.6	26.9	28.0		25.0		26.7
6	30.6	29.0	30.7		25.8		28.1
7	29.9	28.9	30.1		28.1		29.1
8	30.4	28.4	31.4		29.9		29.9
9	29.9	29.1	31.5		31.0		30.4
10	31.1	30.7	33.4		31.6		31.8
11	32.0	33.6	36.4		31.9		32.7
12	29.1	28.5	34.3		32.5		31.9
13	36.3	42.2	39.6		32.8		33.7
14	30.8	34.4	36.7		33.6		34.3
15+	38.8	41.3	40.0		35.6		38.0
0-15+	23.6	19.8	17.7		22.5		20.2

	VIIIc East	VIIIc West	IXa North		IXa CN+CS+S		All areas
	1-4 Q	1-4 Q	1-4 Q	1-4 Q	1-4 Q	1-4 Q	1-4 Q
Age	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)	length(cm)
0	11.7	12.1	10.0		11.7		10.9
1	17.1	13.7	14.3		15.0		14.7
2	19.2	20.0	19.9		19.6		19.7
3	24.6	24.6	23.6		21.6		23.3
4	26.4	26.3	25.4		23.3		25.2
5	27.5	27.4	27.0		25.0		26.7
6	29.6	29.6	31.0		26.3		28.2
7	30.0	30.2	31.4		28.0		29.6
8	29.5	29.6	31.6		29.8		29.8
9	29.9	30.2	32.2		31.0		30.5
10	30.9	31.5	33.6		32.0		31.9
11	31.4	32.0	35.0		32.8		32.7
12	29.8	30.1	34.6		33.8		32.6
13	31.4	32.8	34.7		34.5		33.9
14	31.5	32.5	35.5		35.7		33.8
15+	39.3	40.8	39.6		37.6		38.2
0-15+	25.2	23.3	19.1		24.4		23.2

Table 7.5.2 Weight (g) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1996.

1996 Age	VIIIc East 1'st Q weight(g)	VIIIc West 1'st Q weight(g)	IXa North 1'st Q weight(g)	1'st Q weight(g)	IXa CN+CS+S 1'st Q weight(g)	1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0		0		0
1	38	41	34		25		35
2	46	56	63		51		54
3	106	92	94		74		84
4	136	137	117		94		110
5	161	168	142		122		146
6	200	208	236		140		175
7	236	237	261		169		222
8	215	211	234		231		220
9	227	228	264		262		238
10	243	250	286		272		260
11	259	258	310		310		282
12	246	250	321		346		298
13	262	249	308		361		301
14	259	278	326		394		300
15+	446	512	470		430		458
0-15+	98	116	144		115		116

Age	VIIIc East 2'nd Q weight(g)	VIIIc West 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	2'nd Q weight(g)	IXa CN+CS+S 2'nd Q weight(g)	2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0		0		0
1	32	27	46		35		32
2	63	66	74		57		64
3	110	102	108		79		95
4	143	147	120		105		131
5	161	165	134		134		157
6	186	196	257		161		181
7	227	234	267		193		219
8	198	205	254		216		209
9	218	226	274		239		230
10	239	247	295		269		254
11	240	256	309		299		274
12	237	254	323		240		247
13	233	243	292		366		303
14	253	263	326		393		297
15+	457	452	428		433		434
0-15+	169	167	225		176		175

Age	VIIIc East 3'rd Q weight (g)	VIIIc West 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	3'rd Q weight (g)	IXa CN+CS+S 3'rd Q weight (g)	3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	0	0	6		25		7
1	54	82	25		35		37
2	89	107	99		74		90
3	135	138	135		87		116
4	157	153	147		102		136
5	176	173	182		122		155
6	218	221	243		144		184
7	206	208	243		161		195
8	205	219	269		185		209
9	203	216	286		209		217
10	227	253	319		258		258
11	249	272	397		264		282
12	190	201	343		281		256
13	436	463	350		340		345
14	236	258	388		401		327
15+	474	490	461		444		448
0-15+	164	173	68		144		141

Age	VIIIc East 4'th Q weight(g)	VIIIc West 4'th Q weight(g)	IXa North 4'th Q weight(g)	4'th Q weight(g)	IXa CN+CS+S 4'th Q weight(g)	4'th Q weight(g)	All areas 4'th Q weight(g)
0	15	16	16		14		15
1	52	21	27		24		26
2	74	111	68		71		84
3	120	131	131		90		123
4	166	144	153		109		140
5	187	156	178		124		154
6	226	196	230		136		179
7	211	192	217		177		196
8	226	185	249		213		214
9	212	198	250		235		224
10	240	231	294		250		257
11	259	303	377		258		280
12	201	189	328		272		262
13	371	565	477		283		310
14	233	337	389		307		326
15+	444	529	483		366		431
0-15+	120	89	73		129		96

Age	VIIIc East 1-4 Q weight(g)	VIIIc West 1-4 Q weight(g)	IXa North 1-4 Q weight(g)	1-4 Q weight(g)	IXa CN+CS+S 1-4 Q weight(g)	1-4 Q weight(g)	All areas 1-4 Q weight(g)
0	15	16	10		15		13
1	44	24	27		28		29
2	62	69	68		62		66
3	123	122	108		81		104
4	150	146	133		101		130
5	168	165	160		125		154
6	206	207	238		146		181
7	215	217	244		176		206
8	205	207	251		211		212
9	212	219	266		238		226
10	234	248	296		260		257
11	247	261	336		280		279
12	215	222	330		270		260
13	248	288	332		328		313
14	249	276	352		367		310
15+	461	512	472		426		441
0-15+	143	125	96		141		128

Table 7.5.3 Southern horse mackerel mean weight at age

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

WEST: Mean Weight in Stock (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1982	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1983	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1984	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1985	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1986	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1987	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1988	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1989	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1990	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1991	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1992	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1993	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1994	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1995	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1996	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381

HOM-SOTH: Southern horse mackerel (Divisions VIIIc and IXa)

WECA: Mean Weight in Catch (Kilograms)

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11	Age 12	Age 13	Age 14	Age 15
1981	0.023	0.040	0.067	0.097	0.174	0.254	0.292	0.341	0.407	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1982	0.020	0.033	0.082	0.115	0.152	0.226	0.261	0.296	0.363	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1983	0.013	0.028	0.061	0.125	0.159	0.225	0.267	0.294	0.361	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1984	0.015	0.025	0.049	0.080	0.124	0.178	0.246	0.275	0.331	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
1985	0.014	0.027	0.070	0.091	0.117	0.132	0.152	0.182	0.249	0.264	0.284	0.312	0.320	0.344	0.357	0.378
1986	0.016	0.029	0.055	0.076	0.104	0.137	0.185	0.194	0.209	0.290	0.301	0.319	0.329	0.339	0.349	0.349
1987	0.024	0.031	0.049	0.058	0.096	0.106	0.131	0.161	0.198	0.211	0.246	0.302	0.288	0.352	0.361	0.358
1988	0.027	0.036	0.066	0.082	0.111	0.126	0.156	0.156	0.202	0.239	0.249	0.275	0.314	0.333	0.327	0.355
1989	0.016	0.041	0.062	0.089	0.109	0.132	0.152	0.189	0.200	0.203	0.248	0.320	0.345	0.359	0.375	0.389
1990	0.016	0.035	0.047	0.076	0.124	0.130	0.155	0.170	0.182	0.214	0.260	0.272	0.316	0.345	0.368	0.388
1991	0.016	0.033	0.063	0.102	0.133	0.151	0.168	0.173	0.193	0.196	0.233	0.236	0.280	0.304	0.323	0.372
1992	0.018	0.029	0.048	0.078	0.105	0.141	0.162	0.173	0.182	0.191	0.214	0.240	0.278	0.313	0.341	0.387
1993	0.015	0.034	0.040	0.064	0.109	0.155	0.171	0.202	0.225	0.225	0.255	0.250	0.321	0.364	0.397	0.461
1994	0.021	0.036	0.058	0.069	0.097	0.142	0.182	0.205	0.226	0.250	0.276	0.299	0.295	0.343	0.363	0.391
1995	0.029	0.036	0.058	0.091	0.110	0.139	0.173	0.189	0.218	0.235	0.273	0.291	0.305	0.290	0.362	0.392
1996	0.013	0.029	0.066	0.104	0.130	0.154	0.181	0.206	0.212	0.226	0.257	0.279	0.260	0.313	0.310	0.441

Table 7.7.1 XSA diagnostics

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Lowestoft VPA Version 3.1

  15-Sep-97  19:07:21

Extended Survivors Analysis

S. horse mackerel (run: XSAABM15/X15)

CPUE data from file /users/fish/ifad/ifapwork/wgmhsa/hom_soth/FLEET.X15

Catch data for  12 years. 1985 to 1996. Ages  0 to  12.

     Fleet,           First, Last, First, Last, Alpha,  Beta
                      year, year,  age ,  age
FLT01: 8c West trawl,  1985, 1996,   0,    11,   .000,  1.000
FLT02: 8c East trawl,  1985, 1996,   0,    11,   .000,  1.000
FLT03: Oct Pt Survey,  1985, 1996,   0,    11,   .800,   .900
FLT04: Oct Sp. Surve,  1985, 1996,   0,    11,   .790,   .880
PJS: Jul Pt. Survey,,  1989, 1996,   0,    11,   .540,   .630


Time series weights :

     Tapered time weighting applied
     Power =    3 over  20 years


Catchability analysis :

     Catchability dependent on stock size for ages <    2

        Regression type = C
        Minimum of   5 points used for regression
        Survivor estimates shrunk to the population mean for ages <  2


     Catchability independent of age for ages >=    9


Terminal population estimation :

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

     S.E. of the mean to which the estimates  are shrunk =   1.000

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

     Prior weighting not applied


Tuning had not converged after   40 iterations


Total absolute residual between iterations
39 and  40 =     .00658

Final year F values
Age            ,     0,     1,     2,     3,     4,     5,     6,     7,     8,     9
Iteration 39,  .0243, .1002, .3215, .0804, .1009, .0428, .0585, .1003, .1040, .1751
Iteration 40,  .0242, .0996, .3183, .0795, .1011, .0428, .0585, .1002, .1039, .1749


Age            ,    10,    11
Iteration 39,  .1781, .4161
Iteration 40,  .1778, .4154
```

Table 7.7.1 (cont.) XSA diagnostics

Regression weights

, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities

Age,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
0,	.041,	.140,	.257,	.049,	.014,	.028,	.009,	.020,	.008,	.024
1,	.499,	.288,	.257,	.262,	.089,	.154,	.075,	.122,	.508,	.100
2,	.419,	.123,	.106,	.244,	.165,	.182,	.196,	.271,	.182,	.318
3,	.238,	.151,	.162,	.118,	.080,	.164,	.230,	.093,	.136,	.080
4,	.155,	.112,	.198,	.082,	.085,	.090,	.153,	.077,	.060,	.101
5,	.084,	.150,	.169,	.102,	.082,	.074,	.125,	.063,	.065,	.043
6,	.185,	.124,	.235,	.104,	.130,	.091,	.089,	.133,	.078,	.058
7,	.108,	.207,	.091,	.191,	.172,	.179,	.169,	.117,	.129,	.100
8,	.104,	.160,	.193,	.176,	.256,	.187,	.213,	.176,	.135,	.104
9,	.177,	.299,	.298,	.231,	.208,	.438,	.380,	.211,	.152,	.175
10,	.124,	.540,	.580,	.195,	.323,	.246,	.353,	.202,	.334,	.178
11,	.102,	.353,	.390,	.335,	.244,	.296,	.253,	.242,	.338,	.415

XSA population numbers (Thousands)

	AGE								
YEAR ,	0,	1,	2,	3,	4,	5,	6,	7,	
1987 ,	1.42E+06,	1.70E+06,	5.35E+05,	3.38E+05,	2.16E+05,	1.08E+06,	1.39E+05,	1.10E+05,	5.53E+04, 2.52E+04,
1988 ,	1.01E+06,	1.17E+06,	8.87E+05,	3.03E+05,	2.29E+05,	1.59E+05,	8.58E+05,	9.94E+04,	8.50E+04, 4.29E+04,
1989 ,	1.15E+06,	7.55E+05,	7.55E+05,	6.75E+05,	2.24E+05,	1.76E+05,	1.18E+05,	6.52E+05,	6.96E+04, 6.23E+04,
1990 ,	1.08E+06,	7.67E+05,	5.02E+05,	5.84E+05,	4.94E+05,	1.58E+05,	1.28E+05,	8.01E+04,	5.13E+05, 4.94E+04,
1991 ,	2.54E+06,	8.85E+05,	5.08E+05,	3.39E+05,	4.47E+05,	3.92E+05,	1.23E+05,	9.94E+04,	5.70E+04, 3.70E+05,
1992 ,	1.80E+06,	2.16E+06,	6.97E+05,	3.71E+05,	2.69E+05,	3.53E+05,	3.11E+05,	9.30E+04,	7.21E+04, 3.80E+04,
1993 ,	1.25E+06,	1.51E+06,	1.59E+06,	5.00E+05,	2.71E+05,	2.12E+05,	2.82E+05,	2.45E+05,	6.69E+04, 5.15E+04,
1994 ,	5.17E+05,	1.06E+06,	1.20E+06,	1.13E+06,	3.42E+05,	2.00E+05,	1.61E+05,	2.22E+05,	1.78E+05, 4.65E+04,
1995 ,	4.72E+05,	4.36E+05,	8.09E+05,	7.91E+05,	8.85E+05,	2.72E+05,	1.62E+05,	1.21E+05,	1.70E+05, 1.28E+05,
1996 ,	1.73E+06,	4.03E+05,	2.26E+05,	5.80E+05,	5.94E+05,	7.17E+05,	2.20E+05,	1.29E+05,	9.16E+04, 1.28E+05,

Estimated population abundance at 1st Jan 1997

, .00E+00, 1.45E+06, 3.16E+05, 1.43E+05, 4.66E+05, 4.61E+05, 5.92E+05, 1.78E+05, 1.00E+05, 7.11E+04,

Taper weighted geometric mean of the VPA populations:

, 1.24E+06, 9.43E+05, 6.58E+05, 5.43E+05, 3.89E+05, 2.79E+05, 1.90E+05, 1.35E+05, 9.35E+04, 6.46E+04,

Standard error of the weighted Log(VPA populations) :

, .5550, .5238, .5327, .5098, .5758, .6118, .5740, .6402, .7197, .7615,

	AGE	
YEAR ,	10,	11,
1987 ,	2.16E+04,	2.23E+04,
1988 ,	1.82E+04,	1.64E+04,
1989 ,	2.74E+04,	9.11E+03,
1990 ,	3.98E+04,	1.32E+04,
1991 ,	3.37E+04,	2.82E+04,
1992 ,	2.59E+05,	2.10E+04,
1993 ,	2.11E+04,	1.74E+05,
1994 ,	3.03E+04,	1.27E+04,
1995 ,	3.24E+04,	2.13E+04,
1996 ,	9.49E+04,	2.00E+04,

Estimated population abundance at 1st Jan 1997

, 9.27E+04, 6.85E+04,

Taper weighted geometric mean of the VPA populations:

, 3.88E+04, 2.14E+04,

Standard error of the weighted Log(VPA populations) :

, .7718, .7795,

Table 7.7.1 (cont.) XSA diagnostics

Log catchability residuals.

Fleet : FLT01: 8c West trawl

Age	1985	1986
0	99.99	99.99
1	-.32	.43
2	.50	-.27
3	1.19	1.86
4	-.42	1.04
5	.12	.19
6	-.01	-.33
7	-.28	-.64
8	-.05	-.40
9	-.11	-.61
10	-.31	.34
11	-.35	-.07

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	-.37	.61	.97	.69	-1.45	.06	-.44	.36	.21	-.61
2	.55	.53	-1.05	.41	-.69	-.58	.52	.41	-.09	-.03
3	1.70	1.11	.94	-.07	-2.36	-.78	.19	-1.75	.52	-.83
4	2.04	.86	.83	.23	-.85	-1.11	.53	-1.48	-.96	.18
5	1.37	.55	.51	-.62	-.61	-.16	.82	-.60	-.74	-.29
6	.77	.40	.02	-.47	-.33	.06	-.10	.66	-.37	-.18
7	.21	-.26	-.24	-.13	.25	.05	.43	.25	-.02	.04
8	-.79	-.59	-.10	.18	.42	.12	.28	.48	.20	-.18
9	.13	-.54	.57	-.81	.14	.55	.54	-.17	-.17	.21
10	.16	-.27	1.24	-.36	.27	.50	-.18	-.38	.16	.36
11	-.11	-.25	-.31	-.88	-.37	-.37	.23	-1.00	-.43	.93

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

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-18.7876	-19.7652	-19.2551	-18.6906	-18.1641	-17.6291	-17.4867	-17.0590	-17.0590	-17.0590
S.E(Log q)	.5600	1.3373	1.0485	.6719	.4056	.2859	.3924	.4700	.4956	.5875

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.00	.000	.00	.00	0	.00	.00
1	.45	1.210	16.80	.36	12	.73	-20.49

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
2	.81	.648	17.79	.59	12	.47	-18.79
3	1.34	-.284	22.00	.08	12	1.89	-19.77
4	1.51	-.549	22.49	.12	12	1.64	-19.26
5	.84	.505	17.72	.55	12	.59	-18.69
6	.84	.815	17.20	.75	12	.35	-18.16
7	.92	.620	17.14	.86	12	.27	-17.63
8	.83	1.183	16.46	.85	12	.32	-17.49
9	.92	.418	16.58	.76	12	.45	-17.06
10	.84	.989	15.88	.81	12	.40	-16.92
11	.78	1.341	15.69	.81	12	.40	-17.30

Table 7.7.1 (cont.) XSA diagnostics

Fleet : FLT02: 8c East trawl

Age	1985	1986
0	99.99	99.99
1	99.99	99.99
2	99.99	99.99
3	99.99	99.99
4	99.99	99.99
5	-.58	.16
6	-.31	-.45
7	-.11	-.50
8	.28	-.24
9	-.05	-.69
10	.02	-.63
11	-.27	-1.60

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	.89	-.28	.54	-.23	-.06	-.30	-.22	-.72	.05	.76
6	.62	-.01	.04	.00	-.59	-.20	-.85	.85	.25	.49
7	-.23	-.47	-.33	.34	-.48	-.40	-.12	.75	.70	.45
8	-.72	-.32	-.26	.37	-.35	-.55	-.93	.96	1.01	.52
9	-.09	.24	.53	-.66	-.68	-.06	-.19	.18	.63	.58
10	-.37	.83	1.40	-.20	-1.34	-.27	-1.25	.03	1.27	.46
11	-.60	.62	-1.15	-.49	-1.60	-1.38	-.55	-.63	.74	.96

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

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	.0000	.0000	.0000	-17.7183	-17.6362	-17.3321	-17.1517	-16.7099	-16.7099	-16.7099
S.E(Log q)	.0000	.0000	.0000	.5035	.5208	.4851	.6658	.4877	.9049	1.0325

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.00	.000	.00	.00	0	.00	.00
1	.00	.000	.00	.00	0	.00	.00

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
2	.00	.000	.00	.00	0	.00	.00
3	.00	.000	.00	.00	0	.00	.00
4	.00	.000	.00	.00	0	.00	.00
5	.64	2.661	15.87	.87	12	.25	-17.72
6	1.10	-.291	18.18	.50	12	.60	-17.64
7	.95	.211	17.05	.66	12	.48	-17.33
8	.64	2.248	15.09	.82	12	.36	-17.15
9	.97	.146	16.53	.72	12	.50	-16.71
10	1.02	-.060	16.86	.41	12	.98	-16.71
11	1.05	-.110	17.51	.40	12	1.00	-17.18

Table 7.7.1 (cont.) XSA diagnostics

Fleet : FLT03: Oct Pt Survey

Age	1985	1986
0	99.99	-.26
1	99.99	.30
2	99.99	.73
3	99.99	1.41
4	99.99	-1.52
5	99.99	-.37
6	99.99	-1.78
7	99.99	-.34
8	99.99	.05
9	99.99	-.34
10	99.99	-.61
11	99.99	.38

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	-.36	-.37	.36	.46	-.54	.04	.71	-.37	-.12	.27
1	-1.01	.99	.39	.91	.17	.15	.04	-1.18	-.13	-.48
2	-.21	-.35	-.51	-.32	-1.08	1.15	.91	-.21	.79	-.88
3	-.38	.15	-.65	-.74	-.44	.48	1.42	-.42	.20	-.78
4	.14	.40	-.32	-.20	-.27	.35	1.24	.31	-.36	-.23
5	-1.33	.77	.19	1.15	-.17	.14	-.63	.24	.39	-.61
6	-.38	.68	1.02	.06	.90	.39	-1.37	-.02	.45	-.34
7	-.80	2.16	-1.06	.42	.84	2.00	-.94	-.82	-.56	-.83
8	-.17	.77	-.02	-.34	1.49	1.79	.05	-.72	-1.19	-1.52
9	.28	.72	-.66	1.61	-.71	2.27	.59	.07	-1.33	-2.35
10	-.10	.71	.70	1.27	1.12	.35	1.05	-.33	-.18	-2.29
11	-.46	-1.65	1.56	1.59	.32	.87	-.29	.35	.07	-1.06

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

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-9.1065	-9.5060	-9.8831	-10.6281	-11.0258	-11.2468	-11.2536	-11.1381	-11.1381	-11.1381
S.E(Log q)	.7824	.7890	.6519	.6848	.8616	1.1876	1.0632	1.3568	1.0749	1.0088

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.33	2.572	12.26	.65	11	.44	-8.67
1	.51	1.089	11.43	.38	11	.73	-9.19

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.58	1.673	10.93	.66	11	.41	-9.11
3	2.45	-.969	4.22	.05	11	1.94	-9.51
4	5.22	-2.952	-2.85	.06	11	2.50	-9.88
5	5.40	-3.094	2.11	.06	11	2.64	-10.63
6	1.01	-.018	11.01	.31	11	.92	-11.03
7	-9.28	-2.004	17.58	.00	11	9.53	-11.25
8	2.72	-1.318	10.84	.07	11	2.78	-11.25
9	-23.76	-2.116	10.04	.00	11	27.36	-11.14
10	1.87	-1.047	11.34	.15	11	1.98	-10.99
11	1.67	-.946	11.62	.20	11	1.67	-10.98

Table 7.7.1 (cont.) XSA diagnostics

Fleet : FLT04: Oct Sp. Surve

Age	1985	1986
0	99.99	99.99
1	99.99	99.99
2	99.99	99.99
3	99.99	99.99
4	99.99	99.99
5	.58	.31
6	.15	.04
7	.22	.93
8	.38	.55
9	-.08	.67
10	.00	.80
11	-.39	.34

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-.29	.99	1.66	.59	-1.47	-1.24	.10	-.48	-.37	.24
6	.12	.62	1.44	.53	-1.78	-.90	.32	-.11	.09	-.19
7	.21	-.06	.51	.33	-2.16	-.17	.22	-.30	.32	.37
8	.25	-.12	.40	.65	-.61	.07	-.07	-.14	.09	-.98
9	.65	.38	.43	-.63	-.41	.32	-.18	-.80	-.29	.34
10	.54	1.08	2.40	-.01	.57	.47	.56	-.85	.02	-.49
11	.47	.42	-.48	-.49	.70	.79	.11	-.47	-.16	-.61

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

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	.0000	.0000	.0000	-10.6141	-10.0502	-9.5258	-9.2258	-8.7446	-8.7446	-8.7446
S.E(Log q)	.0000	.0000	.0000	.9091	.8192	.7817	.4833	.5013	.9437	.5227

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.00	.000	.00	.00	0	.00	.00
1	.00	.000	.00	.00	0	.00	.00

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
2	.00	.000	.00	.00	0	.00	.00
3	.00	.000	.00	.00	0	.00	.00
4	.00	.000	.00	.00	0	.00	.00
5	2.91	-1.439	6.94	.06	12	2.51	-10.61
6	.91	.195	10.23	.37	12	.79	-10.05
7	.83	.494	9.91	.50	12	.68	-9.53
8	.89	.567	9.48	.75	12	.44	-9.23
9	1.30	-1.084	8.05	.61	12	.64	-8.74
10	1.35	-.716	7.56	.32	12	1.18	-8.35
11	.82	1.046	8.96	.79	12	.42	-8.73

Table 7.7.1 (cont.) XSA diagnostics

Fleet : PJS: Jul Pt. Survey,

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	99.99	99.99	3.41	3.17	-1.83	3.37	-7.08	2.80	-3.23	99.99
1	99.99	99.99	-.28	-.17	-.34	.26	-.21	.34	.34	99.99
2	99.99	99.99	-.25	.66	-.67	-.26	.81	1.01	-1.31	99.99
3	99.99	99.99	.46	-.26	-1.75	.00	1.70	.51	-.68	99.99
4	99.99	99.99	1.09	-.55	-1.60	-.38	.62	1.21	-.38	99.99
5	99.99	99.99	-.22	-.20	-1.46	-1.12	1.48	1.37	.02	99.99
6	99.99	99.99	-.50	-.51	-.84	-1.47	1.88	1.63	-.34	99.99
7	99.99	99.99	-1.36	.16	-.18	-.04	1.22	.88	-.82	99.99
8	99.99	99.99	.20	-.87	.60	.40	2.26	-.12	-2.46	99.99
9	99.99	99.99	.31	.29	-.80	1.30	1.49	.60	-3.12	99.99
10	99.99	99.99	.35	-.31	.89	-.15	-.54	.93	-1.83	99.99
11	99.99	99.99	.74	.21	1.03	1.47	-2.50	1.71	-1.75	99.99

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

Age	2	3	4	5	6	7	8	9	10	11
Mean Log q	-9.3169	-9.5929	-9.9103	-9.9077	-9.8017	-9.9940	-10.0370	-9.7756	-9.7756	-9.7756
S.E(Log q)	.8717	1.0882	1.0140	1.1374	1.2902	.8969	1.4697	1.6049	.9779	1.6644

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	2.63	-.522	5.15	.02	7	4.64	-10.57
1	.42	2.167	11.64	.75	7	.34	-8.64

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
2	.51	1.159	11.41	.54	7	.43	-9.32
3	.56	.713	11.22	.36	7	.64	-9.59
4	-10.65	-1.294	44.13	.00	7	10.21	-9.91
5	-.95	-1.734	14.75	.14	7	.93	-9.91
6	.62	.417	10.66	.20	7	.87	-9.80
7	1.27	-.379	9.46	.30	7	1.23	-9.99
8	-7.12	-1.696	23.27	.01	7	9.08	-10.04
9	-3.60	-1.825	16.44	.03	7	4.86	-9.78
10	1.01	-.023	9.87	.42	7	1.08	-9.88
11	-5.23	-2.148	12.13	.02	7	6.80	-9.67

Table 7.7.1 (cont.) XSA diagnostics

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1996

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	1907047.,	.484,	.000,	.00,	1,	.473,	.000
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
PJS: Jul Pt. Survey,,	1.,	.000,	.000,	.00,	0,	.000,	.000
P shrinkage mean ,	943478.,	.52,,,,				.414,	.037
F shrinkage mean ,	2245722.,	1.00,,,,				.114,	.016

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
1451865.,	.34,	.32,	3,	.962,	.024

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
FLT01: 8c West trawl,	171338.,	.864,	.000,	.00,	1,	.117,	.176
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	252245.,	.442,	.158,	.36,	2,	.444,	.123
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
PJS: Jul Pt. Survey,,	12395.,	5.309,	.000,	.00,	1,	.003,	1.296
P shrinkage mean ,	657659.,	.53,,,,				.340,	.049
F shrinkage mean ,	157095.,	1.00,,,,				.096,	.190

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
315990.,	.30,	.30,	6,	.987,	.100

Table 7.7.1 (cont.) XSA diagnostics

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	146099.,	.481,	.101,	.21,	2,	.278,	.309
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	86570.,	.403,	.204,	.51,	3,	.321,	.477
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
PJS: Jul Pt. Survey,,	200541.,	.377,	.181,	.48,	2,	.303,	.234
F shrinkage mean ,	239841.,	1.00,,,,				.098,	.200

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
142767.,	.24,	.16,	8,	.679,	.318

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
FLT01: 8c West trawl,	438606.,	.446,	.250,	.56,	3,	.228,	.083
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	509432.,	.345,	.476,	1.38,	4,	.373,	.072
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
PJS: Jul Pt. Survey,,	488851.,	.349,	.513,	1.47,	3,	.340,	.075
F shrinkage mean ,	252233.,	1.00,,,,				.059,	.141

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
465629.,	.21,	.22,	11,	1.049,	.080

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
FLT01: 8c West trawl,	546156.,	.418,	.207,	.50,	4,	.220,	.086
FLT02: 8c East trawl,	1.,	.000,	.000,	.00,	0,	.000,	.000
FLT03: Oct Pt Survey,	445461.,	.308,	.079,	.26,	5,	.414,	.105
FLT04: Oct Sp. Surve,	1.,	.000,	.000,	.00,	0,	.000,	.000
PJS: Jul Pt. Survey,,	421781.,	.330,	.286,	.87,	4,	.309,	.110
F shrinkage mean ,	502847.,	1.00,,,,				.057,	.093

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
461233.,	.20,	.10,	14,	.498,	.101

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
FLT01: 8c West trawl,	504492.,	.366,	.326,	.89,	5,	.229,	.050
FLT02: 8c East trawl,	1270650.,	.527,	.000,	.00,	1,	.133,	.020
FLT03: Oct Pt Survey,	446136.,	.286,	.205,	.72,	6,	.361,	.056
FLT04: Oct Sp. Surve,	751436.,	.951,	.000,	.00,	1,	.041,	.034
PJS: Jul Pt. Survey,,	773413.,	.363,	.182,	.50,	5,	.197,	.033
F shrinkage mean ,	302047.,	1.00,,,,				.039,	.082

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
591801.,	.18,	.14,	19,	.792,	.043

Table 7.7.1 (cont.) XSA diagnostics

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
FLT01: 8c West trawl,	109142.,	.285,	.199,	.70,	6,	.294,	.094
FLT02: 8c East trawl,	233346.,	.379,	.218,	.58,	2,	.184,	.045
FLT03: Oct Pt Survey,	280348.,	.278,	.196,	.71,	7,	.263,	.038
FLT04: Oct Sp. Surve,	136304.,	.637,	.092,	.14,	2,	.065,	.076
PJS: Jul Pt. Survey,,	191495.,	.321,	.321,	1.00,	6,	.165,	.055
F shrinkage mean ,	97584.,	1.00,,,,				.029,	.104

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
178427.,	.15,	.13,	24,	.841,	.058

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
FLT01: 8c West trawl,	86562.,	.208,	.134,	.64,	7,	.421,	.115
FLT02: 8c East trawl,	102976.,	.304,	.358,	1.18,	3,	.202,	.098
FLT03: Oct Pt Survey,	141626.,	.285,	.256,	.90,	8,	.171,	.072
FLT04: Oct Sp. Surve,	105741.,	.504,	.240,	.48,	3,	.074,	.095
PJS: Jul Pt. Survey,,	104157.,	.325,	.237,	.73,	7,	.109,	.097
F shrinkage mean ,	63551.,	1.00,,,,				.022,	.154

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
100342.,	.13,	.10,	29,	.734,	.100

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

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	78578.,	.188,	.182,	.97,	8,	.428,	.094
FLT02: 8c East trawl,	116248.,	.281,	.232,	.83,	4,	.189,	.065
FLT03: Oct Pt Survey,	50676.,	.281,	.189,	.67,	9,	.142,	.143
FLT04: Oct Sp. Surve,	43341.,	.360,	.325,	.90,	4,	.126,	.165
PJS: Jul Pt. Survey,,	63260.,	.325,	.368,	1.13,	7,	.095,	.116
F shrinkage mean ,	36368.,	1.00,,,,				.020,	.194

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
71125.,	.12,	.11,	33,	.930,	.104

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	100101.,	.176,	.115,	.66,	9,	.417,	.163
FLT02: 8c East trawl,	121210.,	.248,	.329,	1.32,	5,	.217,	.136
FLT03: Oct Pt Survey,	52151.,	.277,	.244,	.88,	10,	.131,	.292
FLT04: Oct Sp. Surve,	98640.,	.298,	.208,	.70,	5,	.161,	.165
PJS: Jul Pt. Survey,,	70187.,	.449,	.533,	1.19,	7,	.054,	.225
F shrinkage mean ,	54982.,	1.00,,,,				.019,	.279

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
92684.,	.11,	.11,	37,	.929,	.175

Table 7.7.1 (cont.) XSA diagnostics

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1986

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	87212.,	.171,	.102,	.59,	10,	.435,	.142
FLT02: 8c East trawl,	90064.,	.245,	.190,	.78,	6,	.215,	.138
FLT03: Oct Pt Survey,	36007.,	.296,	.238,	.80,	11,	.117,	.314
FLT04: Oct Sp. Surve,	48838.,	.289,	.172,	.60,	6,	.166,	.241
PJS: Jul Pt. Survey,,	43377.,	.489,	.567,	1.16,	7,	.045,	.267
F shrinkage mean ,	39114.,	1.00,,,,				.022,	.293

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
68494.,	.11,	.10,	41,	.864,	.178

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1985

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
FLT01: 8c West trawl,	13422.,	.176,	.128,	.73,	11,	.410,	.362
FLT02: 8c East trawl,	11175.,	.250,	.268,	1.08,	7,	.195,	.421
FLT03: Oct Pt Survey,	12338.,	.348,	.269,	.77,	11,	.099,	.388
FLT04: Oct Sp. Surve,	6978.,	.272,	.185,	.68,	7,	.215,	.609
PJS: Jul Pt. Survey,,	8222.,	.499,	.528,	1.06,	7,	.046,	.537
F shrinkage mean ,	44548.,	1.00,,,,				.035,	.123

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N,	Var, Ratio,	F
11376.,	.12,	.11,	44,	.896,	.415

Table 7.7.2 Final VPA rsults - Fishing mortality

Run title : S. horse mackerel (run: XSAABM15/X15)

At 15-Sep-97 19:08:18

Terminal Fs derived using XSA (With F shrinkage)

Table 8	Fishing mortality (F) at age	
YEAR,	1985,	1986,
AGE		
0,	.2911,	.2899,
1,	.4415,	.5526,
2,	.2199,	.2361,
3,	.0519,	.2456,
4,	.1197,	.0997,
5,	.0912,	.1690,
6,	.0701,	.1086,
7,	.1497,	.3427,
8,	.1084,	.3678,
9,	.1547,	.2531,
10,	.1831,	.2933,
11,	.3349,	.3873,
+gp,	.3349,	.3873,
FBAR 1-11,	.1750,	.2778,
FBAR 0- 3,	.2511,	.3311,
FBAR 7-11,	.1861,	.3288,

Table 8	Fishing mortality (F) at age										
YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	FBAR 94-96
AGE											
0,	.0415,	.1397,	.2573,	.0492,	.0136,	.0277,	.0093,	.0199,	.0080,	.0242,	.0174,
1,	.4989,	.2876,	.2569,	.2624,	.0885,	.1536,	.0752,	.1222,	.5081,	.0996,	.2433,
2,	.4191,	.1226,	.1060,	.2437,	.1645,	.1823,	.1955,	.2705,	.1818,	.3183,	.2569,
3,	.2376,	.1509,	.1618,	.1179,	.0802,	.1638,	.2296,	.0933,	.1361,	.0795,	.1030,
4,	.1554,	.1123,	.1979,	.0816,	.0851,	.0904,	.1530,	.0774,	.0596,	.1011,	.0794,
5,	.0840,	.1498,	.1691,	.1024,	.0821,	.0738,	.1255,	.0632,	.0654,	.0428,	.0571,
6,	.1855,	.1241,	.2346,	.1043,	.1304,	.0905,	.0890,	.1333,	.0779,	.0585,	.0899,
7,	.1083,	.2067,	.0910,	.1908,	.1720,	.1795,	.1689,	.1168,	.1291,	.1002,	.1154,
8,	.1035,	.1601,	.1927,	.1759,	.2562,	.1866,	.2126,	.1758,	.1349,	.1039,	.1382,
9,	.1770,	.2988,	.2977,	.2314,	.2081,	.4383,	.3800,	.2109,	.1518,	.1749,	.1792,
10,	.1242,	.5405,	.5802,	.1955,	.3233,	.2456,	.3528,	.2020,	.3343,	.1778,	.2380,
11,	.1015,	.3529,	.3895,	.3347,	.2443,	.2957,	.2526,	.2424,	.3376,	.4154,	.3318,
+gp,	.1015,	.3529,	.3895,	.3347,	.2443,	.2957,	.2526,	.2424,	.3376,	.4154,	
FBAR 1-11,	.1996,	.2278,	.2434,	.1855,	.1668,	.1909,	.2032,	.1553,	.1924,	.1520,	
FBAR 0- 3,	.2993,	.1752,	.1955,	.1683,	.0867,	.1318,	.1274,	.1265,	.2085,	.1304,	
FBAR 7-11,	.1229,	.3118,	.3102,	.2257,	.2408,	.2691,	.2734,	.1896,	.2175,	.1944,	

Table 7.7.3 Final VPA results - Stock number at age

Run title : S. horse mackerel (run: XSAABM15/X15)

At 15-Sep-97 19:08:18

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1985,	1986,
AGE		
0,	1679994,	2635210,
1,	898322,	1080734,
2,	463549,	497202,
3,	1703043,	320227,
4,	250369,	1391742,
5,	181417,	191191,
6,	112717,	142542,
7,	57098,	90452,
8,	41787,	42314,
9,	47145,	32273,
10,	29732,	34761,
11,	12173,	21310,
+gp,	36170,	46947,
TOTAL,	5513514,	6526905,

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	GMST
AGE												
0,	1415489,	1008373,	1152383,	1079896,	2543031,	1801251,	1245121,	516726,	472341,	1726088,	0,	13693
1,	1697306,	1168856,	754776,	766853,	884851,	2159317,	1508018,	1061741,	435997,	403290,	1451865,	11305
2,	535295,	887011,	754577,	502459,	507695,	697079,	1593952,	1203960,	808694,	225768,	315990,	6998
3,	337955,	303002,	675373,	584122,	338923,	370689,	500007,	1128267,	790642,	580331,	142767,	5240
4,	215596,	229369,	224276,	494471,	446826,	269242,	270839,	342055,	884630,	593908,	465629,	3410
5,	1084179,	158857,	176454,	158373,	392261,	353198,	211703,	200042,	272493,	717334,	461233,	2506
6,	138968,	857996,	117704,	128242,	123040,	311016,	282377,	160729,	161626,	219696,	591801,	1862
7,	110060,	99363,	652299,	80120,	99445,	92958,	244525,	222345,	121074,	128689,	178427,	1309
8,	55266,	85002,	69554,	512587,	56980,	72068,	66866,	177754,	170277,	91584,	100342,	824
9,	25213,	42890,	62336,	49375,	370018,	37958,	51468,	46530,	128329,	128068,	71125,	528
10,	21567,	18180,	27380,	39837,	33718,	258637,	21078,	30296,	32434,	94902,	92684,	346
11,	22314,	16395,	9115,	13192,	28201,	21005,	174135,	12749,	21305,	19984,	68494,	207
+gp,	61838,	49252,	39051,	43073,	50421,	51895,	27215,	68671,	81353,	74720,	53828,	
TOTAL,	5721050,	4924545,	4715280,	4452602,	5875405,	6496315,	6197308,	5171866,	4381197,	5004362,	3994184,	

Table 7.7.4 Final VPA results

Run title : S. horse mackerel (run: XSAABM15/X15)

At 15-Sep-97 19:08:18

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 1-11,	FBAR 0- 3,	FBAR 7-11,
1985,	1679994,	303460,	130722,	43530,	.3330,	.1750,	.2511,	.1861,
1986,	2635209,	342969,	186023,	71490,	.3843,	.2778,	.3311,	.3288,
1987,	1415490,	362376,	208957,	54650,	.2615,	.1996,	.2993,	.1229,
1988,	1008373,	358008,	211803,	56390,	.2662,	.2278,	.1752,	.3118,
1989,	1152383,	348933,	208948,	56396,	.2699,	.2434,	.1955,	.3102,
1990,	1079896,	352916,	222216,	49207,	.2214,	.1855,	.1683,	.2257,
1991,	2543030,	350822,	226418,	45511,	.2010,	.1668,	.0867,	.2408,
1992,	1801250,	391205,	220131,	50956,	.2315,	.1909,	.1318,	.2691,
1993,	1245121,	410107,	208733,	57428,	.2751,	.2032,	.1274,	.2734,
1994,	516727,	393666,	195538,	52588,	.2689,	.1553,	.1265,	.1896,
1995,	472341,	401838,	237731,	52681,	.2216,	.1924,	.2085,	.2175,
1996,	1726089,	386716,	264600,	44690,	.1689,	.1520,	.1304,	.1944,
Arith. Mean ,	1439659,	366918,	210152,	52960,	.2586,	.1975,	.0000,	.2392,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),				

Table 7.9.1 Input data for the predictions

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: 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
0	1369.000	0.1500	0.0000	0.2500	0.2500	0.000	0.0174	0.019
1	1451.865	0.1500	0.0000	0.2500	0.2500	0.032	0.2433	0.033
2	315.990	0.1500	0.0400	0.2500	0.2500	0.055	0.2569	0.054
3	142.767	0.1500	0.2700	0.2500	0.2500	0.075	0.1030	0.081
4	465.629	0.1500	0.6300	0.2500	0.2500	0.105	0.0794	0.110
5	461.233	0.1500	0.8100	0.2500	0.2500	0.127	0.0571	0.146
6	591.801	0.1500	0.9000	0.2500	0.2500	0.154	0.0899	0.174
7	178.427	0.1500	0.9500	0.2500	0.2500	0.176	0.1154	0.195
8	100.342	0.1500	0.9700	0.2500	0.2500	0.213	0.1382	0.213
9	71.125	0.1500	0.9800	0.2500	0.2500	0.240	0.1792	0.225
10	92.684	0.1500	0.9900	0.2500	0.2500	0.269	0.2380	0.255
11	68.494	0.1500	1.0000	0.2500	0.2500	0.304	0.3318	0.272
12+	53.828	0.1500	1.0000	0.2500	0.2500	0.318	0.3318	0.335
Unit	Millions	-	-	-	-	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
0	1369.000	0.1500	0.0000	0.2500	0.2500	0.000	0.0174	0.019
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.2433	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2569	0.054
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1030	0.081
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.0794	0.110
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0571	0.146
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0899	0.174
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1154	0.195
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1382	0.213
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1792	0.225
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2380	0.255
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.3318	0.272
12+	.	0.1500	1.0000	0.2500	0.2500	0.318	0.3318	0.335
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	1369.000	0.1500	0.0000	0.2500	0.2500	0.000	0.0174	0.019
1	.	0.1500	0.0000	0.2500	0.2500	0.032	0.2433	0.033
2	.	0.1500	0.0400	0.2500	0.2500	0.055	0.2569	0.054
3	.	0.1500	0.2700	0.2500	0.2500	0.075	0.1030	0.081
4	.	0.1500	0.6300	0.2500	0.2500	0.105	0.0794	0.110
5	.	0.1500	0.8100	0.2500	0.2500	0.127	0.0571	0.146
6	.	0.1500	0.9000	0.2500	0.2500	0.154	0.0899	0.174
7	.	0.1500	0.9500	0.2500	0.2500	0.176	0.1154	0.195
8	.	0.1500	0.9700	0.2500	0.2500	0.213	0.1382	0.213
9	.	0.1500	0.9800	0.2500	0.2500	0.240	0.1792	0.225
10	.	0.1500	0.9900	0.2500	0.2500	0.269	0.2380	0.255
11	.	0.1500	1.0000	0.2500	0.2500	0.304	0.3318	0.272
12+	.	0.1500	1.0000	0.2500	0.2500	0.318	0.3318	0.335
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MF2
Date and time: 16SEP97:11:35

Table 7.9.2 Prediction with managent option table

Southern horse mackerel (Divisions VIIIc and IXa)

Table 7.9.2a 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	0.1666	405869	273379	52898	0.0000	0.0000	409161	273907	0	475080	306485
.	.	.	.	.	0.1000	0.0167	.	272897	6411	467786	300830
.	.	.	.	.	0.2000	0.0333	.	271892	12694	460644	295312
.	.	.	.	.	0.3000	0.0500	.	270893	18852	453649	289925
.	.	.	.	.	0.4000	0.0666	.	269898	24889	446798	284667
.	.	.	.	.	0.5000	0.0833	.	268908	30807	440087	279532
.	.	.	.	.	0.6000	0.0999	.	267923	36610	433514	274518
.	.	.	.	.	0.7000	0.1166	.	266944	42299	427074	269622
.	.	.	.	.	0.8000	0.1333	.	265968	47878	420765	264839
.	.	.	.	.	0.9000	0.1499	.	264998	53349	414584	260166
.	.	.	.	.	1.0000	0.1666	.	264033	58715	408527	255600
.	.	.	.	.	1.1000	0.1832	.	263072	63978	402591	251139
.	.	.	.	.	1.2000	0.1999	.	262116	69141	396774	246779
.	.	.	.	.	1.3000	0.2165	.	261165	74206	391073	242516
.	.	.	.	.	1.4000	0.2332	.	260218	79175	385485	238350
.	.	.	.	.	1.5000	0.2498	.	259277	84050	380007	234276
.	.	.	.	.	1.6000	0.2665	.	258339	88834	374638	230292
.	.	.	.	.	1.7000	0.2832	.	257407	93529	369373	226397
.	.	.	.	.	1.8000	0.2998	.	256479	98137	364211	222586
.	.	.	.	.	1.9000	0.3165	.	255555	102659	359150	218858
.	.	.	.	.	2.0000	0.3331	.	254636	107099	354187	215211
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANMFB02
Date and time : 15SEP97:23:08
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1997 : F factors

Southern horse mackerel (Divisions VIIIc and IXa)

Table 7.9.2b 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
1.4339	0.2388	405869	269363	73000	0.0000	0.0000	386568	259408	0	451621	289895
.	.	.	.	.	0.1000	0.0167	.	258470	5989	444788	284629
.	.	.	.	.	0.2000	0.0333	.	257536	11860	438096	279488
.	.	.	.	.	0.3000	0.0500	.	256606	17616	431540	274467
.	.	.	.	.	0.4000	0.0666	.	255682	23260	425117	269564
.	.	.	.	.	0.5000	0.0833	.	254761	28795	418825	264774
.	.	.	.	.	0.6000	0.0999	.	253845	34223	412660	260095
.	.	.	.	.	0.7000	0.1166	.	252934	39546	406620	255524
.	.	.	.	.	0.8000	0.1333	.	252027	44767	400700	251056
.	.	.	.	.	0.9000	0.1499	.	251125	49889	394899	246690
.	.	.	.	.	1.0000	0.1666	.	250227	54914	389213	242423
.	.	.	.	.	1.1000	0.1832	.	249333	59843	383641	238251
.	.	.	.	.	1.2000	0.1999	.	248443	64680	378178	234172
.	.	.	.	.	1.3000	0.2165	.	247558	69426	372823	230184
.	.	.	.	.	1.4000	0.2332	.	246677	74084	367573	226283
.	.	.	.	.	1.5000	0.2498	.	245801	78655	362426	222468
.	.	.	.	.	1.6000	0.2665	.	244928	83141	357379	218736
.	.	.	.	.	1.7000	0.2832	.	244060	87545	352429	215085
.	.	.	.	.	1.8000	0.2998	.	243196	91868	347576	211512
.	.	.	.	.	1.9000	0.3165	.	242336	96113	342816	208015
.	.	.	.	.	2.0000	0.3331	.	241480	100280	338147	204593
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANMFB02
Date and time : 15SEP97:23:08
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1997 : TAC constraints

Table 7.9.2c

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Detailed tables

Year: 1997 F-factor: 1.0000 Reference F: 0.1666

						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
0	0.0174	21934	421	1369000	0	0	0	0	0
1	0.2433	292052	9579	1451865	46460	0	0	0	0
2	0.2569	66692	3601	315990	17379	12640	695	11417	628
3	0.1030	12992	1055	142767	10708	38547	2891	36184	2714
4	0.0794	33037	3641	465629	48891	293346	30801	276996	29085
5	0.0571	23788	3478	461233	58577	373599	47447	354748	45053
6	0.0899	47302	8221	591801	91137	532621	82024	501616	77249
7	0.1154	18085	3527	178427	31403	169506	29833	158624	27918
8	0.1382	12048	2561	100342	21373	97332	20732	90566	19290
9	0.1792	10860	2448	71125	17070	69703	16729	64196	15407
10	0.2380	18283	4662	92684	24932	91757	24683	83275	22401
11	0.3318	18034	4902	68494	20822	68494	20822	60721	18459
12+	0.3318	14173	4747	53828	17117	53828	17117	47720	15175
Total		589280	52843	5363185	405869	1801372	293774	1686063	273379
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1998 F-factor: 1.0000 Reference F: 0.1666

						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
0	0.0174	21934	421	1369000	0	0	0	0	0
1	0.2433	232936	7640	1157984	37055	0	0	0	0
2	0.2569	206784	11166	979757	53887	39190	2155	35400	1947
3	0.1030	19143	1554	210358	15777	56797	4260	53316	3999
4	0.0794	7865	867	110854	11640	69838	7333	65945	6924
5	0.0571	19092	2791	370180	47013	299846	38080	284716	36159
6	0.0899	29970	5209	374954	57743	337459	51969	317814	48943
7	0.1154	47189	9202	465574	81941	442295	77844	413901	72847
8	0.1382	16430	3493	136836	29146	132730	28272	123504	26306
9	0.1792	11485	2589	75218	18052	73713	17691	67890	16293
10	0.2380	10095	2574	51174	13766	50663	13628	45979	12368
11	0.3318	16556	4500	62878	19115	62878	19115	55743	16946
12+	0.3318	19893	6663	75555	24026	75555	24026	66981	21300
Total		659371	58670	5440320	409161	1640963	284373	1531188	264033
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.0000 Reference F: 0.1666

						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
0	0.0174	21934	421	1369000	0	0	0	0	0
1	0.2433	232936	7640	1157984	37055	0	0	0	0
2	0.2569	164928	8906	781438	42979	31258	1719	28234	1553
3	0.1030	59355	4820	652235	48918	176103	13208	165310	12398
4	0.0794	11589	1277	163336	17150	102902	10805	97166	10202
5	0.0571	4545	665	88130	11193	71385	9066	67783	8608
6	0.0899	24053	4180	300933	46344	270840	41709	255074	39281
7	0.1154	29898	5830	294979	51916	280230	49320	262240	46154
8	0.1382	42870	9114	357048	76051	346337	73770	322261	68642
9	0.1792	15662	3530	102573	24618	100522	24125	92580	22219
10	0.2380	10676	2722	54119	14558	53578	14412	48625	13080
11	0.3318	9141	2485	34717	10554	34717	10554	30778	9356
12+	0.3318	22513	7541	85506	27191	85506	27191	75803	24105
Total		650100	59131	5441999	408527	1553377	275880	1445854	255600
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 7.11.1 Yield per recruit summary table

Southern horse mackerel (Divisions VIIIc and IXa)

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	0	9828273	1390627	5167132	1188840	4976953	1145084
0.1000	0.0167	133800	22471	8938200	1149989	4369586	956353	4189471	915919
0.2000	0.0333	235738	36150	8260517	978583	3779911	792638	3609367	755245
0.3000	0.0500	317618	44795	7716543	849385	3319683	670699	3158231	636095
0.4000	0.0666	385791	50361	7263946	747994	2946808	576165	2793984	544118
0.5000	0.0833	444010	53954	6877713	666010	2636495	500659	2491856	470960
0.6000	0.0999	494658	56239	6541963	598185	2373077	438957	2236193	411416
0.7000	0.1166	539338	57635	6246027	541059	2146078	387621	2016539	362065
0.8000	0.1333	579176	58414	5982389	492254	1948170	344293	1825585	320565
0.9000	0.1499	614997	58761	5745554	450069	1774031	307293	1658025	285248
1.0000	0.1666	647424	58801	5531366	413258	1619670	275390	1509887	254898
1.1000	0.1832	676942	58624	5336600	380878	1482014	247660	1378115	228601
1.2000	0.1999	703935	58292	5158689	352203	1358644	223392	1260306	205656
1.3000	0.2165	728716	57851	4995555	326664	1247615	202031	1154533	185517
1.4000	0.2332	751541	57334	4845481	303805	1147341	183133	1059224	167750
1.5000	0.2498	772625	56766	4707031	283255	1056505	166343	973079	152006
1.6000	0.2665	792151	56164	4578988	264712	974006	151369	895009	138000
1.7000	0.2832	810276	55543	4460310	247923	898906	137970	824094	125497
1.8000	0.2998	827133	54913	4350094	232678	830406	125944	759545	114303
1.9000	0.3165	842841	54280	4247554	218796	767815	115124	700686	104253
2.0000	0.3331	857503	53652	4152000	206126	710533	105364	646926	95209
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YLDMFB01
Date and time : 15SEP97:23:21
Computation of ref. F: Simple mean, age 1 - 11
F-0.1 factor : 0.4966
F-max factor : 0.9647
F-0.1 reference F : 0.0827
F-max reference F : 0.1607
Recruitment : 1369 (Millions)

Table 7.14.1

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

F *status quo*

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.0000	0.1666	589280	52843	5363185	405869	1801372	293774	1686063	273379
1998	1.0000	0.1666	659371	58670	5440320	409161	1640963	284373	1531188	264033
1999	1.0000	0.1666	650100	59131	5441999	408527	1553377	275880	1445854	255600
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 15SEP97:23:02
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Single option prediction: Summary table

F corresponding to constant TAC

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.4356	0.2391	812279	73000	5363185	405869	1801372	293774	1665321	269348
1998	1.3782	0.2296	829575	73000	5234948	386486	1561502	269265	1440725	246819
1999	1.4290	0.2380	828965	73000	5108635	368641	1399535	248404	1284656	226647
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 15SEP97:23:02
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : TAC constraints

Single option prediction: Summary table

F corresponding to TAC 1996

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.4356	0.2391	812289	73001	5363185	405869	1801372	293774	1665320	269347
1998	1.4356	0.2391	859302	75641	5234938	386485	1561498	269265	1438165	246314
1999	1.4356	0.2391	826508	72648	5081290	365663	1389064	246493	1274848	224871
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 16SEP97:11:35
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Table 7.14.1 (cont.)

Southern horse mackerel (Divisions VIIIc and IXa)

Single option prediction: Summary table

F med

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.1512	0.1917	668804	60020	5363185	405869	1801372	293774	1678822	271970
1998	1.1512	0.1917	733695	65036	5367027	401076	1612760	278997	1498002	257689
1999	1.1512	0.1917	716968	64430	5310473	392890	1493597	265177	1383368	244348
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 16SEP97:12:02
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

Single option prediction: Summary table

F max

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	0.9647	0.1607	570378	51139	5363185	405869	1801372	293774	1687760	273709
1998	0.9647	0.1607	641205	57104	5457750	411082	1647646	285649	1539079	265545
1999	0.9647	0.1607	633536	57790	5473739	412302	1567783	278461	1460957	258324
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : MF2
Date and time : 16SEP97:11:35
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

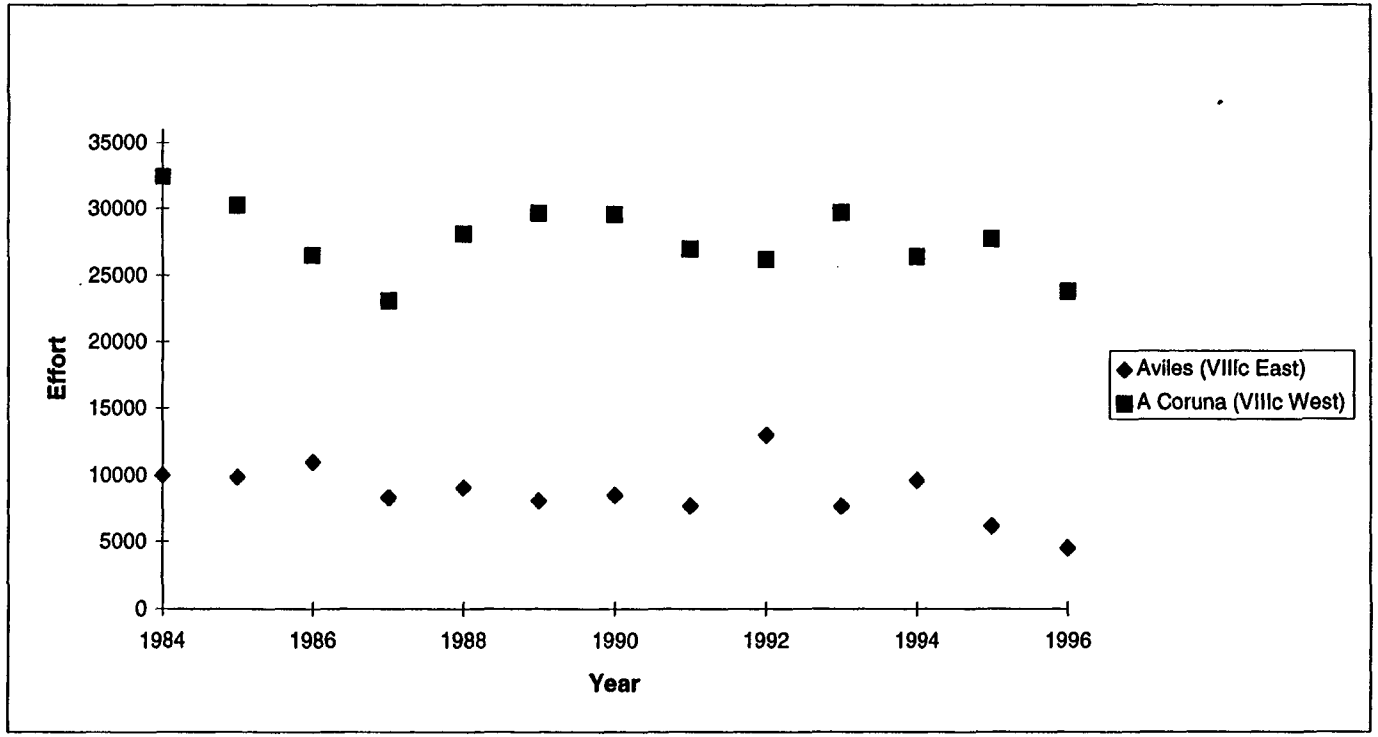


Figure 7.2.1.- Effort series from Spanish commercial bottom trawl fleets

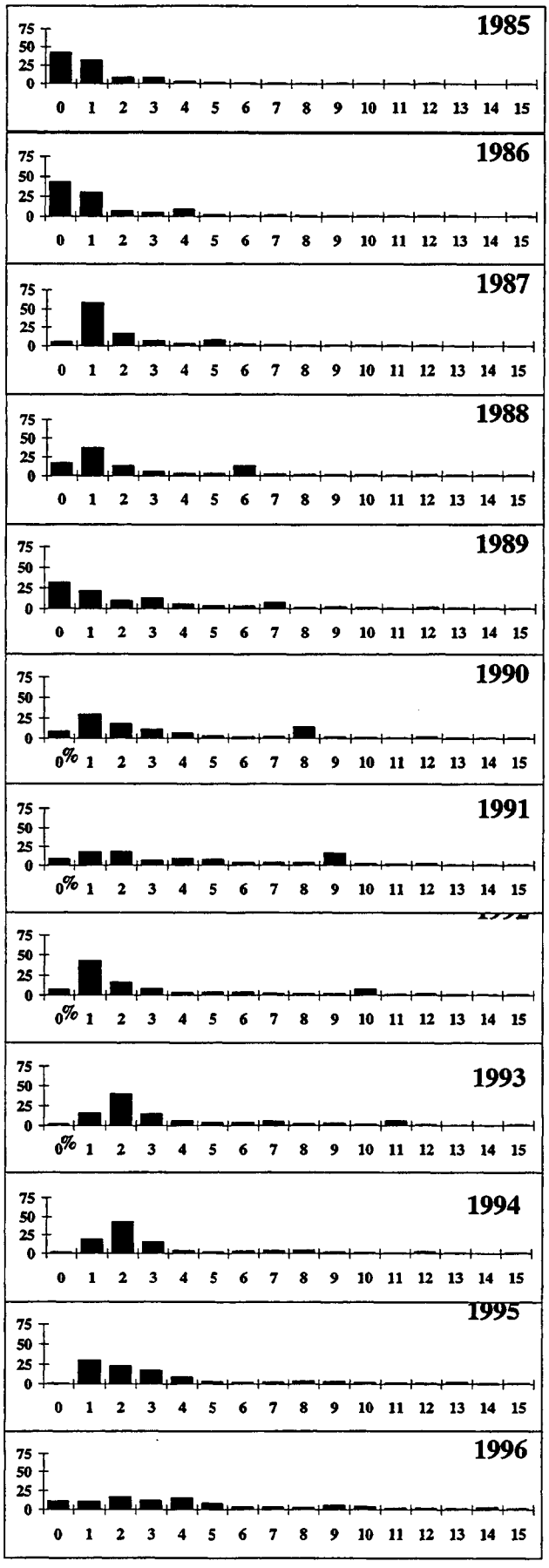


Figure 7.4.1 The age composition of southern horse mackerel in the international catches from 1985-1996. Age 15 is a plus group.

e:\ocfm\wgmhsc98\F-741.xls

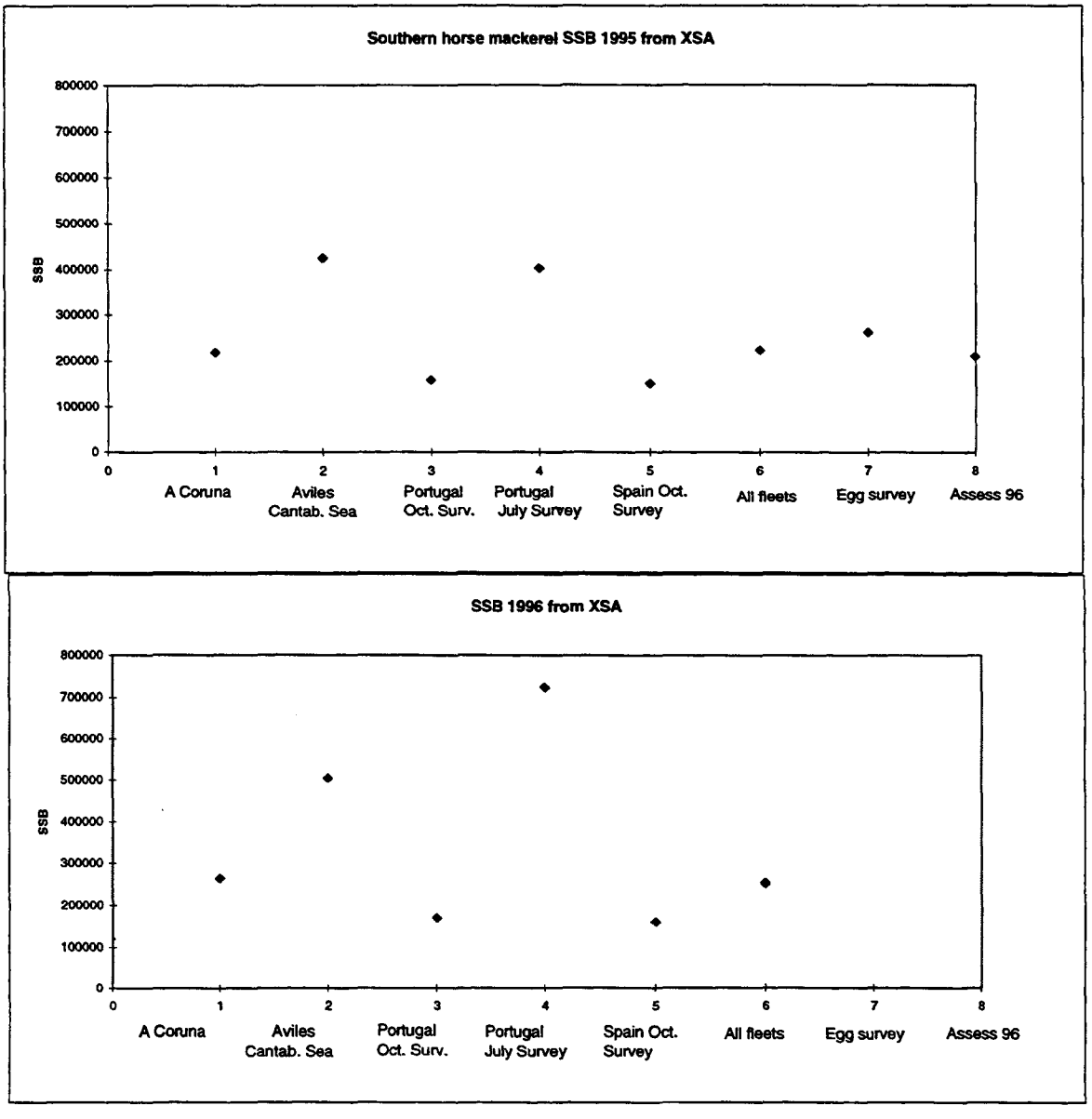


Figure 7.7.1.- SSB estimates in 1995 and 1996 by source of independent information and comparison with the last year assessment (Assess 96)

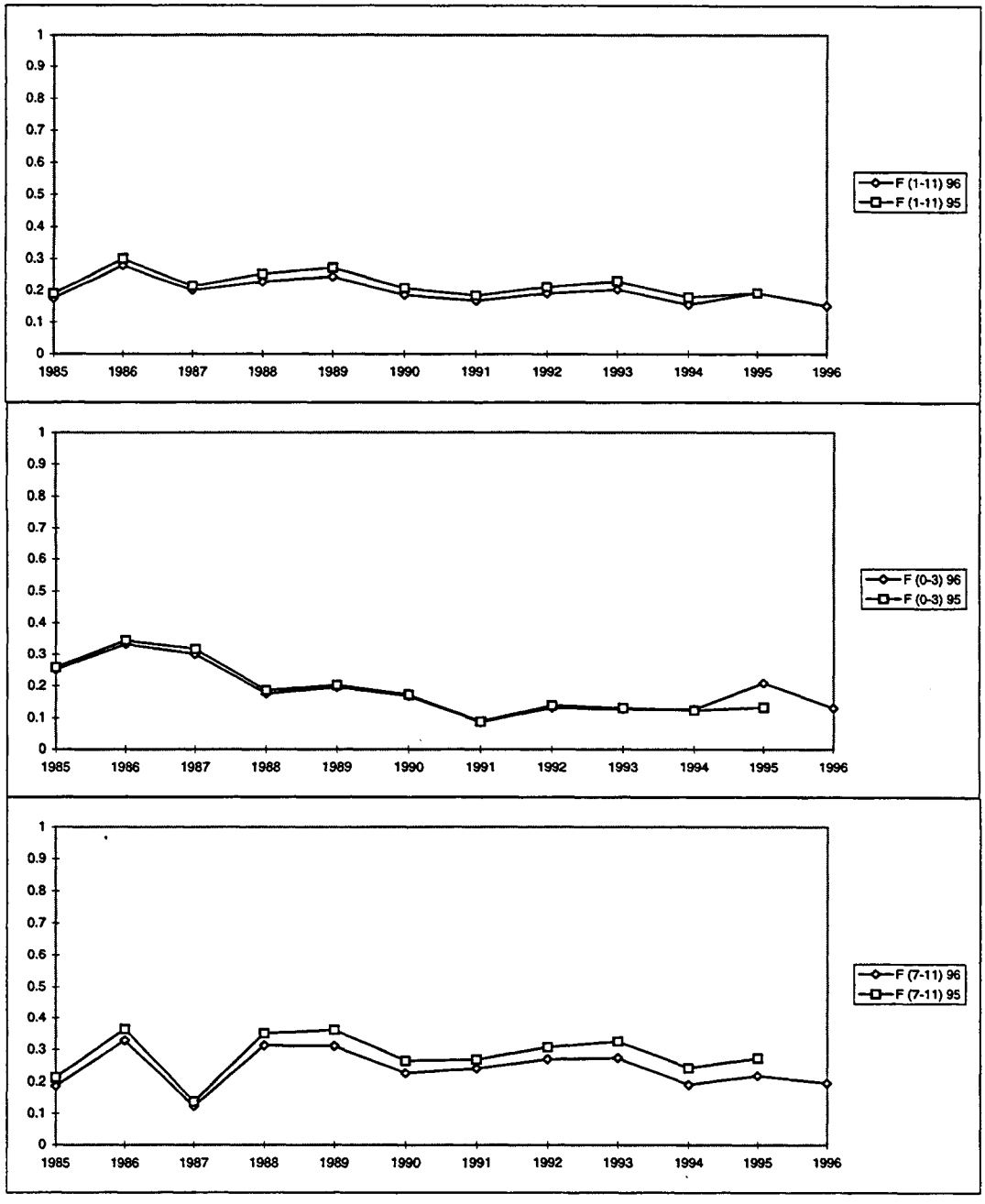


Figure 7.7.2.- Comparison of the 1995 and 1996 assessments for different F's bar from the final VPA

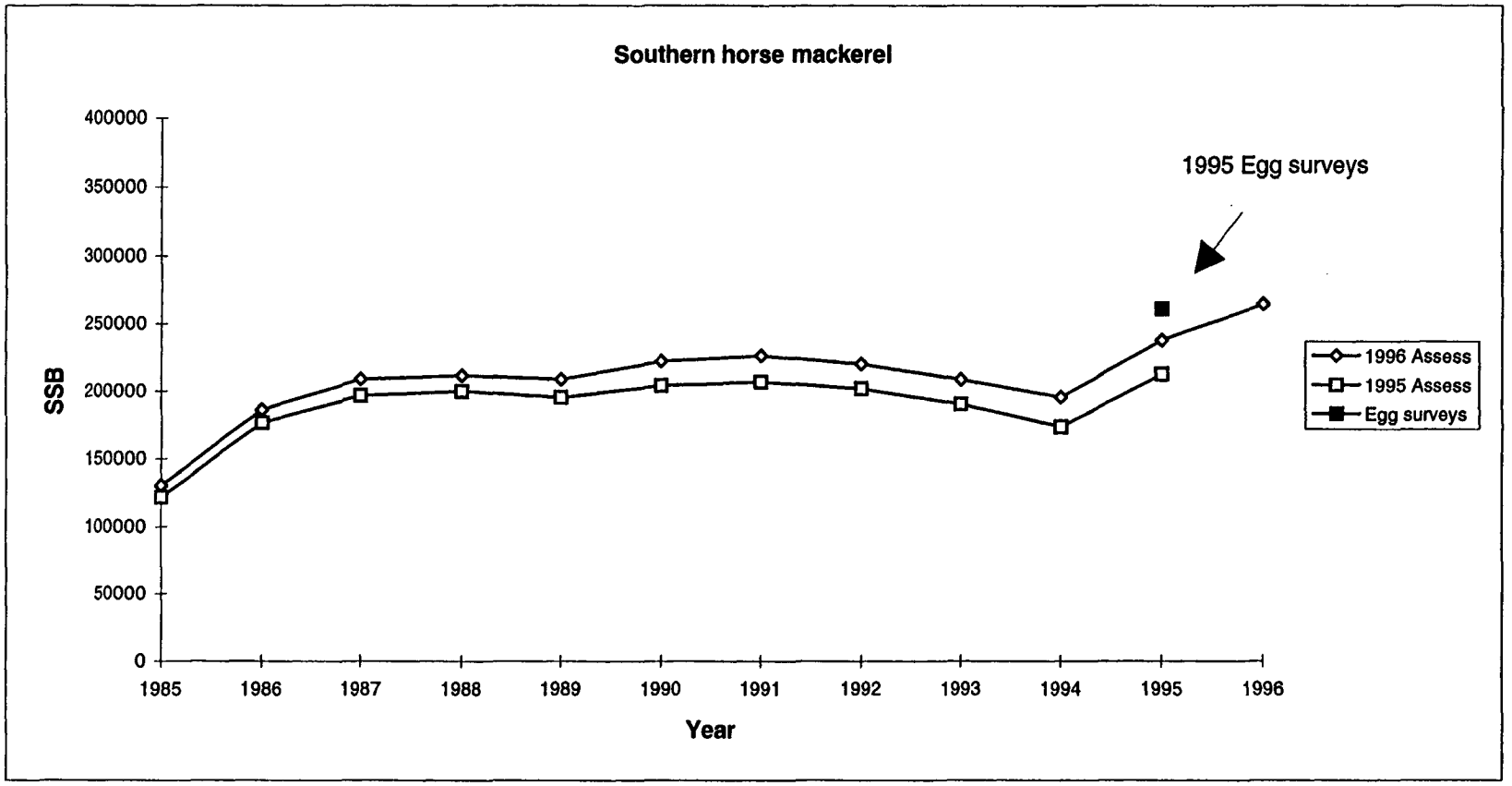
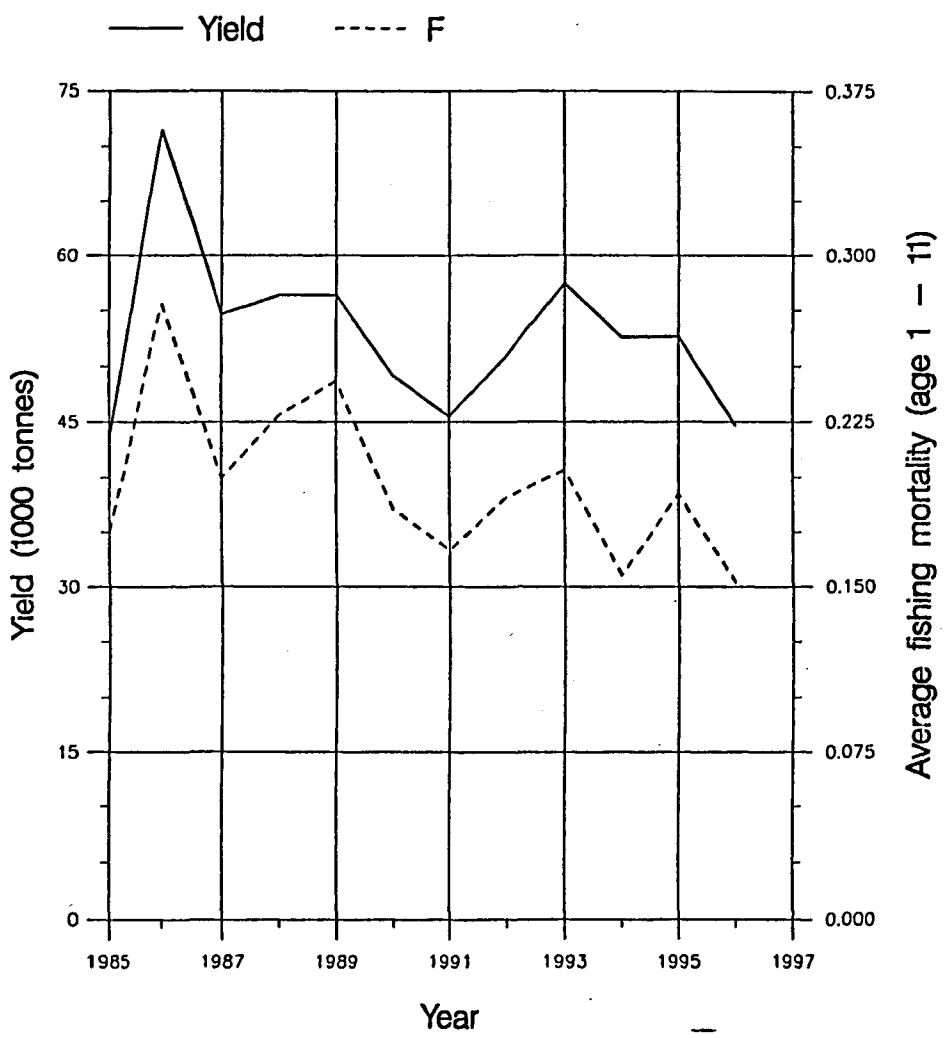


Fig 7.7.3.- Comparison of the SSB estimates from the 1995 and 1996 analytical assessments and the 1995 egg surveys

Figure 7.7.4

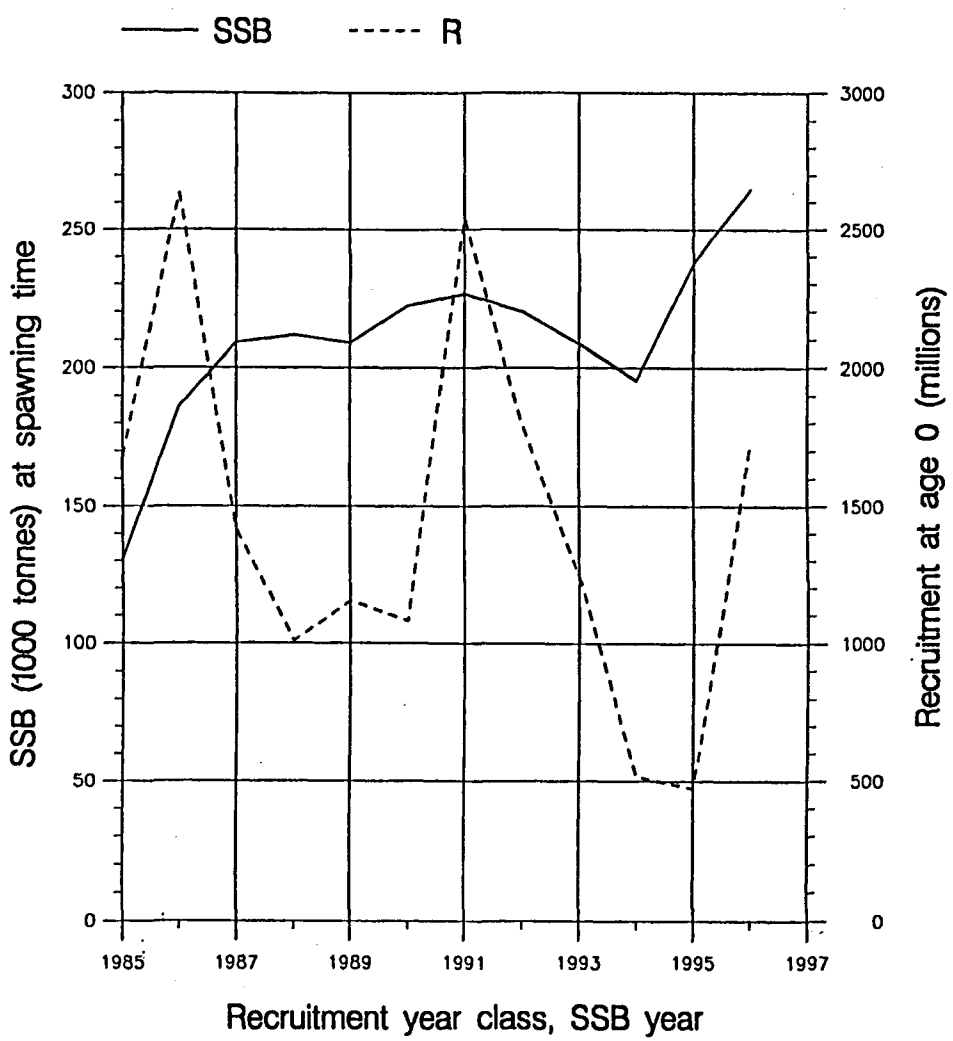
Fish Stock Summary
Southern horse mackerel (Divisions VIIIc and IXa)
13 – 9 – 1997

Yield and fishing mortality



(run: XSAABM15) A

Spawning stock and recruitment

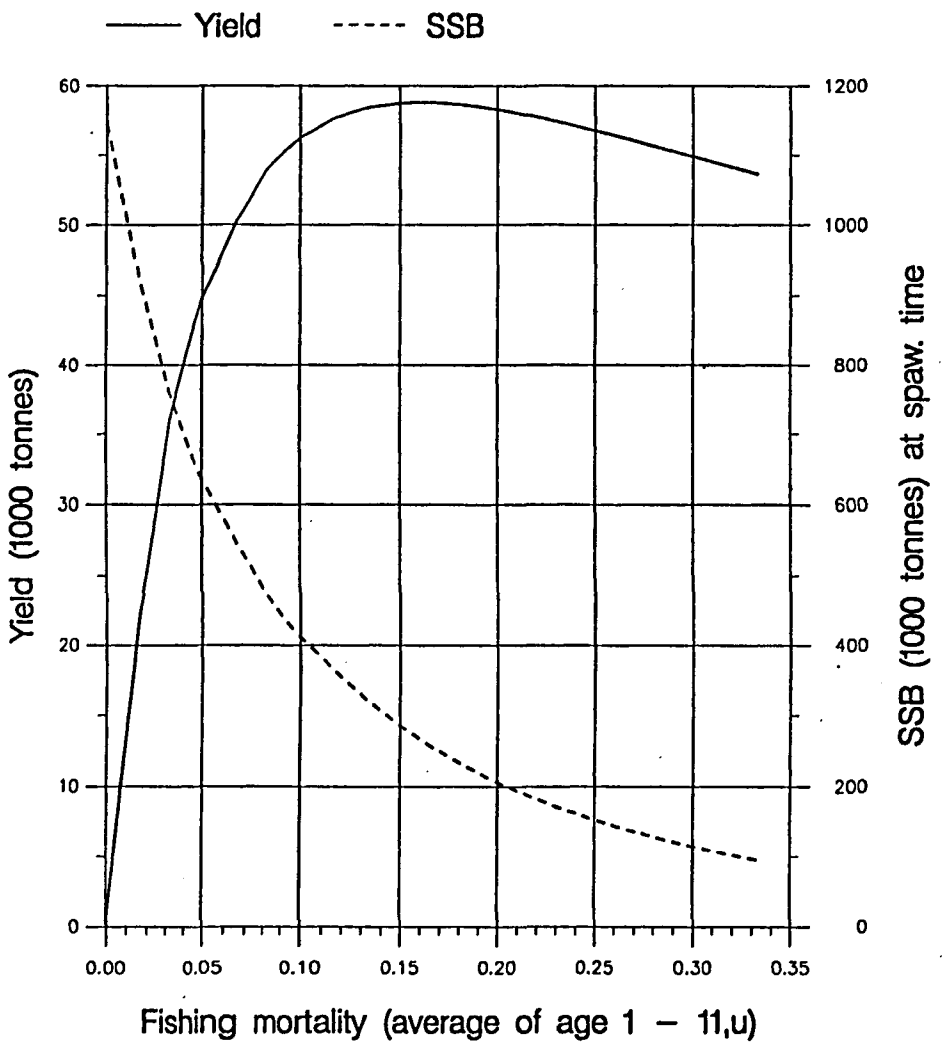


(run: XSAABM15) B

Figure 7.9.1

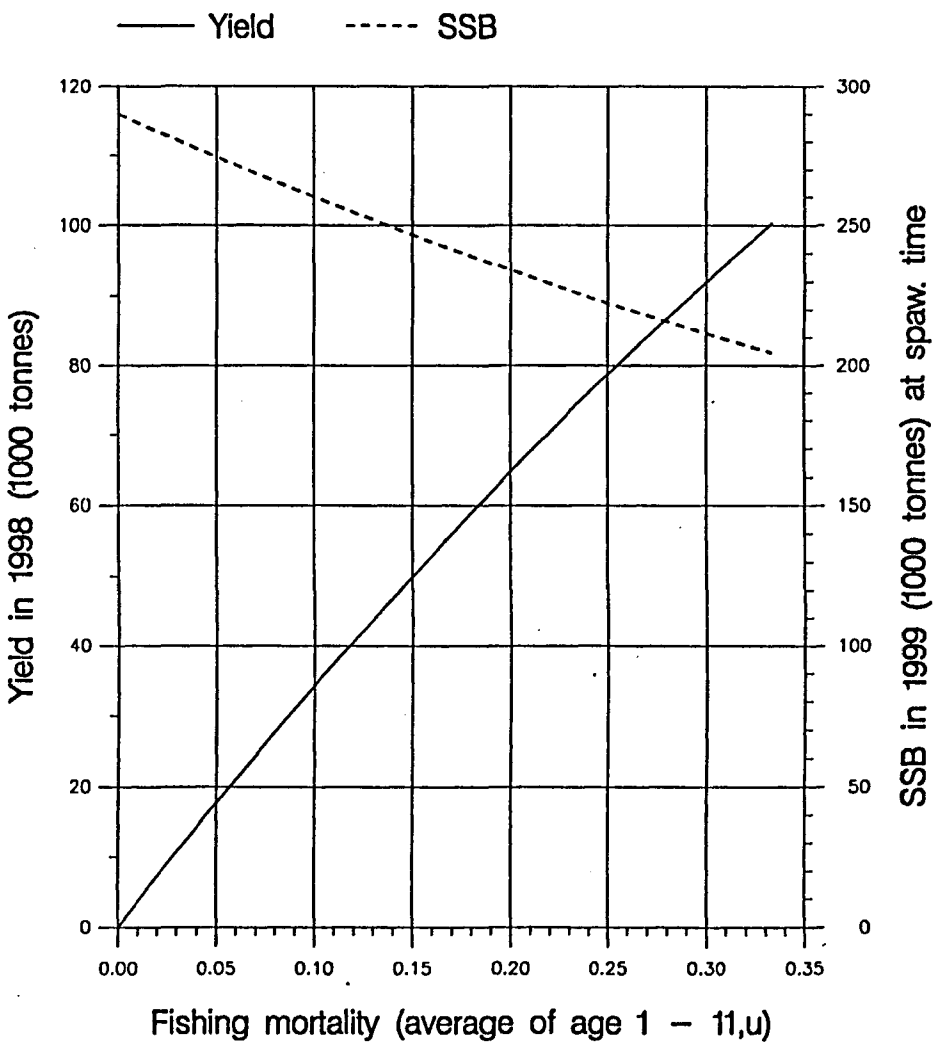
- Fish Stock Summary
Southern horse mackerel (Divisions VIIIc and IXa)
15 – 9 – 1997

Long term yield and spawning stock biomass



(run: YLDMFB01) C

Short term yield and spawning stock biomass



(run: MANMFB02) D

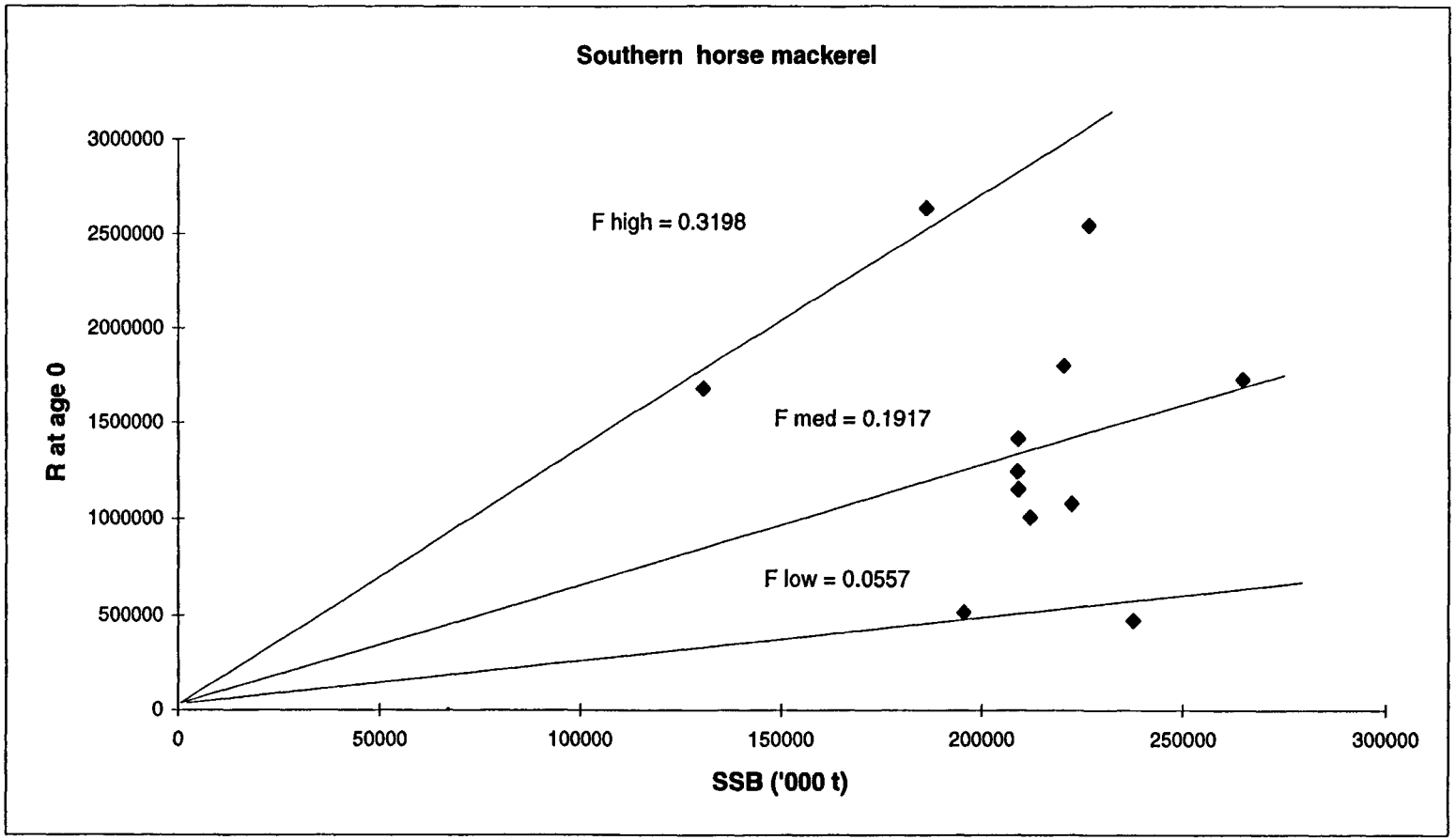


Fig. 7.13.1.- Recruits (age 0) versus Spawning Stock Biomass

8 SARDINE

8.1 Otolith Workshop

From the sardine otolith exchange between Spain and Portugal, carried out during 1996, problems were found in the interpretation and ageing of otoliths from the youngest sardines and those caught in the middle of the year (i.e. June-July). In addition, the otoliths of sardines caught in the Southern areas of the Iberian Peninsula are different from those of the northernmost areas, mainly from those of Subdivision VIIIc. Their structure is more complex, showing several false rings, hyaline rings narrower than those observed in the otoliths of the northern areas and also a higher calcification.

In order to clear up these questions, a Workshop on Sardine Otolith Age Reading was held at the Instituto Español de Oceanografía (IEO) in Vigo, Spain from 17–21 February 1997 (ICES 1997/H:7). Following the recommendations of the 1996 ICES Annual Science Conference (C.Res. 1997/2:39), this Workshop aimed to:

a) analyse the otolith structure and define the yearly growth pattern of otolith from different areas;
b) report on the main problems resulting from the applied ageing criteria, and on agreement between readers;
c) establish a protocol for age determination using diagrams and photographs to illustrate age reading criteria.

This Workshop was sponsored by the European Commission (DG XIV) within the framework of programme FAIR.

Two samples of otoliths collected in different areas and seasons off the Atlantic-Iberian coasts were analysed by nine readers of Portugal and Spain. Six readers are involved in the annual production of Age-Length Keys (ALK) for assessment purposes. One sample was taken from the Spanish Spring acoustic surveys carried out in 1988 and 1990–1993 (ICES Sub-areas IXa North, VIIIc East and West) and the other from sardines caught around the main fishing area in July (ICES Sub-areas VIIIc West, IXa North, Central North and Central South).

A comparative analysis of age readings was made in order to check out discrepancies between readers. Two indices of precision, Average Percent Error - APE (Hoenig *et al.*, 1994), were calculated for each reader and sample. Trends in both within and among readers were tested using a test of symmetry (Bowker, 1948). An analysis of the percentage of agreement and plots of the average age of each age reader against modal age were also made. Finally, the Non Parametric Wilcoxon Matched-pair Signed-Rank test was also performed (Zar, 1984).

From the analysis of readings on the first sample it was found that consistency within readers was in general good. The agreement among the best readers reached 70%. Considering the best readers, this agreement was higher when age 7 and older were excluded from the analysis (80%).

General trends for each reader are shown in Figure 8.1.1. Main disagreements seemed to be related to the younger and older ages. Despite the differences among readers, which were significant, the percentage of agreement was high, especially among the experienced readers and it may be concluded that there were no differences, at least for this exercise, in the ageing criteria and Age Length Keys (ALK) performed in both countries were rather similar.

The second sample was analysed in order to check out the problems of misinterpretation of the general structure of the otoliths caught in the southern peninsular areas, and of the edge of those otoliths caught in the middle of the year. This sample corresponded to a subset of otoliths used in the previous exchange, coming from the main fishery area and caught at the middle of the year.

The analysis of the readings on this sample showed that general agreement between readers was lower than in the first one (47%). Unlike to the first sample, there was no significant improvement in the agreement when the less experienced readers were excluded from the analysis. The agreement was independent of fish age, except for those fish older than 7 years. Nevertheless, the percentage of agreement between readings varied with the geographical area being higher in ICES Subdivision VIIIc and reaching the lowest value in Subdivision IXa C-S. Most of the problems consisted of misinterpretation of the hyaline/opaque edge of the otoliths.

General trends against the modal age for each reader and all age readers for this sample are shown in Figure 8.1.2. There was a general trend to allocate the younger fish (ages 1 to 3) into older age groups, whereas the trend was inverse for fish older than 3.

Both analyses showed a good consistency between readings. It was also concluded that the readings of the reader who is responsible for the age length keys in Spain were the most consistent and that there was a reasonably good agreement with those readings performed by the most experienced Portuguese readers.

A special effort should be made in order to clarify the growth pattern and the allocation of the otoliths of the southern areas into age groups.

The Workshop issued several recommendations for the improvement of otolith readings:

1. Regular exchange of otolith samples for the purpose of checking and improving the precision of all the readers involved in sardine age determination in the Ibero-Atlantic area;

2. Monitor annulus deposition patterns along the entire Ibero-Atlantic area throughout each year. There are three ways to achieve this task:

   b) Research surveys should be carried out simultaneously in the shelf areas to collect otolith material without the obscuring effect of sardine migration;

   c) Monthly samples covering all age groups should be collected in the different sub-divisions to monitor the monthly progression of the marginal increments of the otoliths. The exercise aims at determining the exact times of annulus completion in the entire distributional range of the stock;

   d) The investigation of the ring deposition patterns should be paralleled by a simultaneous investigation of the reproductive biology of the species which quantifies the monthly changes in the spawning activity.

3. Development of an age determination guide must be developed in order to assist individual readers with the correct interpretation of the ring deposition structures and to determine ages precisely. The guide should have photographs which explicitly give the various otolith types and the suspected time of ring completion in the various shelf regions.

4. In order to determine the origin of the different growth patterns of this species in the adjacent areas of France and Morocco it is recommended to study samples from these countries.

5. It is strongly recommended that the daily ring counting technique is employed to validate the annuli of at least the first few age groups. The study will also help to discriminate between false rings and true annuli. This study is essential for an accurate age determination which will aid accurate stock assessment methods. It also should be a useful tool to quantify individual growth rate variation in juveniles and to estimate the time of annulus deposition accurately, following the South African example (Kerstan, 1995).

The proposed recommendations necessitate continuous sampling and monitoring which requires a dedicated project.

The Workshop also adopted a protocol with the criteria for the standardisation of sardine age determination and for improvement of age estimations (ICES 1997/H:7). It is also planned that this protocol will be complemented with a future guide that will assist the otolith readers.

8.2 The Fishery in 1996

Landings from Sub-Areas IV, VII, VIII, and IX were reported by Denmark, UK (England and Wales), France, Spain and Portugal (Table 8.2.1). During 1996, 9,807 tonnes were also reported in Sub-Area VII.

Table 8.2.2 shows the annual landings of sardine by Sub-area (IV–IX) and Division in 1981–1996. There was a decreasing trend from 1981 to 1991. In 1994 the landings increased to about 163 thousand tonnes and in 1996 they decreased to 130 thousand tonnes.

In Sub-Area VII the sardine catches increased from 1,100 tonnes in 1990 to about 17 thousand tonnes in 1995, decreasing to about 10,000 tonnes in 1996. In Sub-Area VIII, the catches have decreased since 1988 from 49,000 tonnes to about 23,000 tonnes in 1996. Concerning Sub-Area IX, where sardine catches have reached the highest levels in this century, it is noticed that during the 1984–1996 period, they have oscillated between 179 thousand tonnes in 1984 and 97 thousand tonnes in 1996.

Table 8.2.3 gives the catch by country for the period 1976 to 1996 from the unit stock area (Divisions VIIIc and IXa). Since 1984 the Spanish landings show a sharp decrease from about 108 thousand tonnes to 26 thousand tonnes in 1996. The Portuguese landings have oscillated between 112 thousand tonnes in 1985 and 86 thousand tonnes in 1996. Total landings for 1996 (111,431 tonnes) were lower than in 1995 (121,384 tonnes). The Portuguese catch decreased by around 2,061 t and the Spanish by 7,900 t, mainly in Division IXa. As in previous years, about 97% of the total catch in the stock in 1996 was taken by the purse seine fleets from Spain and Portugal (Table 8.2.4). About 74% of the total catch of the stock in 1996 comes from catches made by the Portuguese purse seine fleet off the Western coast of Portugal.

All the available catch data from 1940-1996 for these Divisions are shown in Figure 8.2.1. After a period of near-stable catches of around 200,000 t during the period 1980–1985, the total catch began to decrease from 1986. The highest landings occurred in 1961 (250,000 t) and the lowest in 1949 (67,000 t), which caused a severe crisis in both the Portuguese purse-seine fishery and Portuguese fishing industry generally. Catches split by country in Divisions VIIIc and IXa are shown in Figure 8.2.2. The trend in the catches of both Portugal and Spain are quite similar. Nevertheless, after a period of high catches from 1980 to 1985, the Spanish catches show a decreasing trend since 1987, whereas the Portuguese catches have remained quite stable at around 100,000 t per year.

Figure 8.2.3 shows the Spanish sardine landings by Division (VIIIc and IXa) in 1960–1996. From this Figure it can be concluded that the above mentioned decreasing trend in the Spanish landings are due to a decrease in landings in Division IXa, as in Division VIIIc they were quite stable in that period.

During 1996 the seasonal pattern of landings by the two countries was the same as reported in previous years with about 61% of the annual catches being landed in the second half of the year (Table 8.2.4).

8.3 Distribution of the Sardine Fishery

Table 8.3.1 shows the total nominal catches of sardine by quarters and areas in Divisions VIIIc and IXa in 1996. The distribution of catches in 1996 by quarter and area in Divisions VIIIc and IXa was similar to that in recent years, with about 59% of the total catches from Sub-Division IXa Central North and Central South (Table 8.3.1). As in previous years, the catches in Division VIIIc East were the lowest.

Sardine monthly catches in the Gulf of Cadiz (Division IXa, South of Spain) during 1978-1996 are presented in Table 8.3.2. The highest catches occurred in 1987 (8,870 t) and the lowest in 1981 (2,384 t). The 1996 catches in this area were close to 1986 and 1990 catch level. Practically all the catches came from purse-seiners (99,9%) and were mainly undertaken in the second half of the year (70%), as in the whole stock.

8.4 Effort and Catch per Unit Effort

Table 8.4.1 gives the historical series of effort, in fishing days and the catch per unit effort (tonnes/fishing day) for four different purse seine fleets, from Spain and Portugal.

The fishing effort of the Portuguese purse seine fleet remained at the same level during the last three years and the CPUE shows a slight decrease.

8.5 Fishery-Independent Information

Considering the sharp decrease of sardine stock abundance which has occurred in the last years, it was recommended by this Working Group that the spawning biomass of this stock should be estimated in 1997 by the Daily Egg Production Method (DEPM).

During spring 1997 a joint DEPM survey was undertaken by both countries in the area covering the stock distribution and the southern part of the French coast in the Bay of Biscay (Anon. 1997). This survey occurred simultaneously with acoustic surveys for the estimation of sardine stock abundance.

Four different ships were involved: the Spanish R/V "Cornide de Saavedra" (ichthyoplankton) and R/V "Thalassa" (acoustics) and the Portuguese R/V "Capricórnio" (ichthyoplankton) and R/V "Noruega" (acoustics). IPIMAR (Portugal) surveyed the Gulf of Cadiz and the Portuguese coast and IEO (Spain) covered the NW-N coast of the Iberian Peninsula and the Gulf of Biscay (up to 45°N). The sampling of adult sardine was undertaken during the acoustic surveys.

8.5.1 Acoustic Surveys

The joint acoustic survey (Anon. 1997) covered the whole distribution area of the Atlantic Iberian sardine stock. Main goals were to determine the geographic distribution of sardine and to investigate its behaviour and to estimate the sardine abundance (in numbers and biomass) by length class and age group. Besides, in order to obtain the parameters needed for the application of Daily Egg Production Method (DEPM), to undertake biological sampling of sardine.

The survey strategy and the methodology followed were those adopted by the "Planning Group for Acoustic Surveys in ICES Sub-areas VIII and IX" (ICES 1997/H:1).

R/V "Thalassa" surveyed the northern area (Division VIIIc and Sub-Division IXa-North) from 11 to 31 March and R/V "Noruega" covered the southern area (Sub-Division IXa Central-North, Central-South and South, including the Gulf of Cadiz) from 3 to 27 March. R/V "Thalassa" also surveyed the southern area of the French continental shelf.

The acoustic survey grids and the sardine sampling stations are shown in Figure 8.5.1. The sardine relative abundance (Sa) distributions are shown in Figure 8.5.2.

The sardine abundance estimated by age classes are presented in Table 8.5.1. Figure 8.5.3 shows the age distribution in percentage of the modal value of each area of sardine by geographical area, country and stock.

The sardine abundance estimated for the Spanish coast was lower than that estimated in 1996. There was an abundance increase in East Cantabric (more than 70%) and a decrease in biomass in all the other Spanish areas in relation to the results of the March 1996 survey. Age 2 was about 50% in number in East Cantabric. In West Cantabric age 4 and in South Galicia age 1 were the most abundant.

As in previous years the bulk of this population is located in the Portuguese waters with 78% of the estimated total stock biomass. A general increase was observed in the estimated biomass in relation to previous surveys undertaken in this area in February and June 1996. The most important increase was observed in the Northern West coast, which was more than six times than that estimated in February 1996. The highest percentage of age 1 fish in relation to the total number of individuals was located in the Northern West coast (61%) and Cadiz (50%). On the other hand, in Algarve only 4% of the individuals were age 1 fish. The estimated abundance of age group 1 in this survey was much higher (more than four times the average) than that found in the February 1996 survey, particularly in the area of Cadiz. This probably indicates that the 1996 recruitment was higher than that of 1995.

The high abundance of sardines (age groups I and II) both in Cadiz and in the East Cantabrian Sea and the similar age composition of sardine in this area and in the coast of France, may indicate the existence of preferential areas of distribution of sardines, at least in relative terms, of which there is no previous notice. This can be due to a change in the area of distribution of adults.

The acoustic surveys results continue to indicate a decrease in the abundance of this stock since 1991 in the northern part of the distribution area. These results also point to changes in the sardine distribution and behaviour. Sardine distributed very near the coast in well separated schools and not so expanded as it was when the stock was more abundant. Eggs showed the same coastal distribution pattern (Figure 8.5.4).

It is necessary to intensify the study of this resource in the French coast and in the Gulf of Cadiz and also to sample these areas in future surveys in order to understand the population dynamics of sardine.

8.5.2 Daily Egg Production Method (DEPM) surveys

The assessment of this stock applying the Daily Egg Production Method (DEPM) was undertaken during the peak of the sardine spawning which occurs predominantly from November to March/April in Portuguese waters

(Pestana, 1989; Ré *et al.*, 1990) and in the Cantabrian sea between October and July with the highest intensity in April-May (Pérez *et al.*, 1985 ; Solá *et al.*, 1990). Two egg surveys were carried out by Portugal and Spain covering all the spawning area from Gibraltar to Arcachon (45°N) (Anon. 1997). Sardines were sampled in the simultaneous acoustic surveys for the estimation of spawning parameters. Sea temperature and salinity were obtained by means of CTD and the observations were recorded.

The egg production survey design was based on the information from the previous DEPM cruises carried out by Portugal and Spain during the years 1988 and 1990 (Cunha *et al.*, 1992, Perez *et al.*, 1992, Garcia *et al.*, 1991).

The 1997 DEPM survey was conducted in Portuguese waters from the 1–25 March and in the Spanish and French waters from 4 March to 2 April. In the Portuguese survey 373 plankton sampling stations with CalVET net, spaced 7x7.5 nm apart were undertaken. In the Spanish survey a total of 655 plankton sampling stations (3 nautical miles distance between stations) over transects equally spaced 15 nautical miles apart and perpendicular to the coast were accomplished. When the sardine eggs started to appear in the Cantabrian sea the grid of sampling stations was increased with an extra transect of 7x7.5 nautical miles. The eggs were collected using a 150 µm mesh CalVET net vertically operating in 150 m depth or 5 m above the bottom in the shallow waters.

In the Portuguese area no sardine eggs were found in the region North of Oporto. Sardine eggs started to appear south of Oporto although in low concentrations. There were two interruptions to the continuity of the distribution of eggs on the continental coast of Portugal. One was found off the region of Nazaré and the other in front of the mouth of the Tejo River (Lisbon). South of this area to the Strait of Gibraltar sardine eggs were distributed almost continuously over the continental shelf . The heaviest concentration was localised at the Cape S. Vicente (Figure 8.5.4).

The egg distribution found in this area agrees well with the adult distribution observed during the acoustic surveys (Figures 8.5.2 and 8.5.4).

The spawning area for sardine in Spanish waters in 1997 has been reduced almost exclusively to the coastal regions, where the major concentrations of eggs are found. There are two centres of major egg concentration on the coast of Asturias (110 eggs/0.05 m^2) and the Basque Country (248 egg/0.05 m^2) (Figure 8.5.4). This reproductive behaviour contrasts with that observed in previous years (1988 and 1990), during which the spawning area was considerably more extensive, reaching oceanic waters, but with considerably lower abundance values: 80/0.05 m^2 (Perez *et al.*, 1989) and 30/0.05 m^2 (Garcia *et al.*, 1991) (Anon. 1997, Cunha *et al.*, 1997).

8.5.2.1 Adult parameters

During the March 1997 acoustic survey, sardine was sampled in order to estimate the adult parameters by the DEPM (W-Average weight of mature females; F-Batch fecundity; S-Spawning fraction and R-Sex ratio) (Anon. 1997 WD).

Adult parameters were estimated by the DEPM in 1988, 1991 and 1997 by Spain and Portugal (Anon. 1997). Those of 1997 were estimated to be W=69.72 g; F=26.4 (10^3 eggs); S=0.18 (day^{-1}); R=0.52 in the Spanish area. In the Portuguese area some of the estimated parameters are still provisional as they are based on the results of the DEPM undertaken in March 1988 (Cunha *et al.*, 1997 WD). Their values are W=41.96 g; F=15.4 (10^3 eggs); S=0.13 (day^{-1}); R=0.57.

8.6 Length Compositions by Fleet and by Country

In 1996 the quarterly and annual catch length compositions by fleet were provided by UK (England and Wales) in Division VIIe (Table 8.6.1), Portugal and Spain in Divisions VIIIc and IXa (Tables 8.6.2 and 8.6.3). Table 8.6.3 shows the purse seine quarterly catch length composition from Gulf of Cadiz (Spain, IXa-South).

As in previous years, the largest fish were caught in the northernmost Divisions VIIIc and VIIe.

8.7 Catch in Number at Age

Based on data submitted by Working Group members, the 1996 catch in number at age data were compiled by quarter and sub-divisions of Divisions VIIIc and IXa (Table 8.10.1).

The Portuguese data (catch in number, length composition, age length/key) were collected on a quarterly basis by sub-division. The Spanish data were collected on a quarterly basis, using the length composition by quarter and the two half year age/length keys.

The 1996 catches of O group fish were notably higher than those in 1995, increasing from 30.5 million to 276.9 million fish. The oldest ages (above age group 6) mainly occurred in the catches of Division VIIIc, especially in the Eastern part (Table 8.7.1).

The annual catch in number at age for the period 1977 to 1996 is presented in Table 8.10.1. Age group 4 was dominant in the 1996 catches, while age group 3 dominated in 1995, confirming the good recruitment of 1992 and the non occurrence of good recruitments since that year.

8.8 Mean Length at Age and Mean Weight at Age

The 1996 mean lengths and mean weight at age in the catches by quarter were provided by Spain (Division VIIIc East, West and Division IXa North) and Portugal (Division IXa Central-North, Central-South and South) (Tables 8.8.1 and 8.10.1). The mean values were based on Spanish and Portuguese biological sampling.

Table 8.10.1 also shows the mean weights at age in the catch and in the stock for the period 1976–1996. The mean weights at age in the stock have been calculated from commercial sampling during the period December 1995–January 1996.

8.9 Maturity at Age

The maturity ogive for 1996 (Table 8.10.1) was based on the fourth and first quarters data from Portuguese and Spanish biological sampling. From 1,294 fish examined 1,218 were mature. The percentage of mature fish at age 1 increased in the last years (1994–1996).

8.10 Stock Assessment

The available data for fitting the assessment model are given in Table 8.10.1. As in previous years a value of M=0.33 was used for all ages and all the years and the proportion of M and F before spawning was taken to be 0.25.

The fishery independent data used in this model comes from the Spanish Spring surveys (1988-1997) and Portuguese Spring acoustic surveys (1986-1997) which are shown in the same Table 8.10.1. Moreover, the Gulf of Cadiz Spring acoustic index, from 1995 until 1997 is also available.

The model, which was already used and explained in the 1995 assessment (ICES 1995/Assess:2), was constructed using the usual separable model assumptions, but in addition:

- Populations were fitted from ages 0 to 11, with the assumption of negligible catches between ages 6 and 11.
- Age-disaggregated acoustic surveys by Portugal and Spain were included in the fit.
- Catch at age observations from ages 0 to 5 in all years were included in the fit, but also observations at age 6 from 1989 onwards, on account of a desaggregation of plus group.
- Catch at age observations at other loci in the matrix were replaced with arbitrary low values and assigned a very small weight in the analysis.
- Acoustic surveys were assumed to provide a proportionate index of stock abundance.

This model assumes the differential age pattern structure which was already described in ICES (1995/Assess:2) and provides for the emigration of fish from the main catching area.

Relative weights were set to 0.5 for age 0 and 1 for age 1 to all real catch-at-age observations. For ages between the last real age in the catch at age matrix, an arbitrary catch value of 1 million fish was used but was down-weighted by assigning corresponding lambda values to 0.01.

In order to check whether if the inclusion of the Gulf of Cadiz acoustic surveys as a new index could improve the assessment, a preliminary run was performed using the three fleets. The assessment using the three fleet indices

gave similar results to that performed with that made with only the two fleets (Spanish and Portuguese spring surveys). As the fishery information from the Gulf of Cadiz was neither included in the catch at age matrix nor in the total landings, the Working Group decided to be consistent with the previous assessments and, therefore, keep the same input data to those used in the last assessment.

Parameter estimates and fitted populations are given in Table 8.10.1 and are illustrated in Figure 8.10.1a), b) and c). Age residuals are low except for age 7 whereas year residuals appear positive over the last six years. Catchabilities of index 1 (Spanish acoustic surveys) agree quite well with the fitted linear model except for age groups 7 to 9. For the same index, the predictions for the stock size, age groups 1 to 4 gave expected values which are different from those of the population, whereas the older age group fitted better. On the contrary, the index prediction for the Portuguese acoustic surveys (index 2), match better for the younger age groups, in spite of the fact that the catchabilities seem to fit worse to the linear model than those of the index 1. This pattern in the stock numbers and the index predictions agree with the general knowledge of this stock, whose younger age groups are mainly distributed in the Portuguese waters and the older ones are located in the Cantabrian sea. The combination of both indices give a good perception of the dynamic of this stock.

Age 7 residuals seem to be related to the fact that in previous years age group 6 was taken as a plus group and their catches in the catch-at-age matrix are slightly higher than the true value. As in the last assessment, confidence intervals for both fishing mortality and exploitation pattern are high and these may be explained for the level of residuals. Nevertheless, results obtained last year, compared with those estimated by this assessment are quite similar and they are shown in Figure 8.10.2. Trends in the overall population are similar and estimates of recruitment are almost the same. $Fbar_{(2-5)}$ series appear to be lower than those estimated the last year but the trend is similar. From this assessment, since 1991 $Fbar_{(2-5)}$ varies around 0.5. Estimated SSB follows a decline trend since 1985, with a slight recovery from 1991 to 1993. Estimated value for 1996 is the lowest in the time series.

8.11 Recruitment

The recruitment index is also shown in Figure 8.10.2. The estimated recruitments at age 0 show a decreasing trend since 1983 and the series of lower recruitments from 1993 to 1995 seems to be confirmed. Moreover, the estimated value for 1995 is the lowest recruitment in the time series. The recruitmens of 1991 and 1992 seem to be reasonably good and their strength, compared with that of the forthcoming ones, seems to be reflected in the change of the exploitation pattern in the fishery. From Carrera (1997, WD), taking into account the level of catches of 0-group in Vigo harbour, the predicted recruitment value for 1996, which is around 5 thousand million fish, seems to be correct. The acoustic surveys performed this year in March agree with this value.

8.12 Catch Predictions

As in the last assessment, the catch forecasts have been performed for different scenarios. For short term predictions two levels of fixed recruitment have been chosen, the historical geometric mean of the last ten year's recruitment as an intermediate value and the geometric mean of the three poorest recruitment in the time series, as a pessimistic scenario. These values are 4901 and 2004 million fish respectively.

The input data for the short term deterministic catch forecasts are given in Tables 8.13.1a and b, assuming two different levels of constant recruitment. Besides, the F values were calculated using the mean F for the last six years. A terminal population obtained from the assessment with the modified recruitment value was used as starting population on 1st January 1997. Mean catch weights, stock weights and maturity at age over the period 1991–1996 were used.

Tables 8.13.2a and b summarizes the predictions carried out for the period 1997–1999. For F_{sq}, predicted catch at a low level of recruitment will be about 64,000 t in both 1997 and 1998. For a higher recruitment, the catches will be about 67,000 t in 1997 and 77,000 t in 1998. In the first case the spawning stock biomass will decrease from 161,000 t in 1996 to 150,000 t at the beginning of 1999, whereas in the second case SSB will increase up to 237,000 t on January 1999.

8.13 Short-Term and Medium-Term Risk Analysis

Short-term and medium-term stock projection with variance estimates were computed using ICPROJ version 2.0 and VPRO (Patterson, WD 1995). The analysis was based on the results of the assessment described in Section

8.10. All input data at age were disaggregated up to 11 years old. Forthcoming recruitments were estimated by fitting a Beverton & Holt Stock-Recruitment relationship with autocorrelated errors. Fitted model and their residuals are shown in Figure 8.13.1. As it was pointed out in the last working group there are several potential sources of variability in recruitment, especially in pelagic species of short-medium life cycle, such as migration patterns, oceanographic and climatic conditions, but for this stock part of the variability on recruitment levels appears to be explained by the variability found in the stock size. In addition, this relationship would give a more realistic scenario than the assumption of fixed geometric mean recruitment or a fixed low value. Moreover, the forthcoming predicted recruitment from this model at F_{sq} ranged from 3360 to 2000 millions fish which are slightly higher than the geometric mean value of the three poorest recruitment.

The projections were performed under different scenarios of fishing mortality. In short term, F multipliers of 0.001, 0.4, 0.8, 1, 1.4, 1.8 and 2 of F_{sq} have been carried out over four years. Figure 8.13.2 represents the expected median SSB along this time series for the different scenarios. Only for F values lower than 0.8 of that of 1997 the expected SSB will increase after four years. Values higher than 0.8 will definitively fall the SSB. The same perception is seen when the expected SSB are compared with the size of SSB who gave the last good recruitment which was around 240,000 tonnes. In this case, the probability of SSB falling below this value, which is shown in Figure 8.13.3, is higher than 50% for F values higher than 0.7 of that of 1997.

In medium term projections, simulation was performed for 0.4 of the F_{bar} and for increasing exploitation level from 0.6, 0.8 and 1. Percentiles of 5, 25, 75 and 95 of total landings, fishing mortality, recruitment and stock size for each exploitation level are shown in Figure 8.13.4. Scenarios with a $Fbar_{(2-5)}$ higher than 0.4 times of that of 1996 gave a low probability of recovery the stock. Trends in landings are similar, with an expected decreasing in landings for exploitation pattern higher than 0.6 of $Fbar_{(2-5)}$ in 1996.

The Beverton & Holt stock-recruitment function relates the recruitment to the declining spawning stock biomass. This has still uncertainties but probably it is more realistic than assuming constant recruitment which would give a different trend in both Stock size and Fishing mortality. Comparing these medium term predictions made this year with those from last year, reveals that the perception of the future development of this stock is very sensitive of the input of prediction from the assessment, and the results from these two year's predictions are quite different. Therefore, the medium-term predictions should be considered highly uncertain.

8.14 Long-Term Yield

Yield per recruit has been performed for 2004 and 4901 million fish as recruitment values. Input values are shown in Table 8.14.1. Long-term trends in yield per recruit and spawning stock biomass against the average fishing mortality (ages 2-5) are given in Table 8.14.2 a,b and Figure 8.14.1a,b. Because recruitment is likely to be dependent on stock size, management considerations should not be dependent on yield per recruit calculation. This deterministic projections agree quite well with the image done by stochastic projections made at short- and medium-term.

8.15 Comments on the Assessment

The principal cause for concern in the assessment of this stock is the declining stock size and the shrinking of the area of distribution. In addition during the last two years there is a change in the exploitation pattern in both Portuguese and Spanish fisheries. Historically, the Portuguese fishery was supported mainly by young fish (age groups 0, 1 and 2) whereas the Spanish fishery was supported by older fish (Porteiro *et al.*, 1986, Anon. 1989, Porteiro *et al.*, 1993, Dias *et al.*, WD 1996). Nevertheless in 1995 and 1996 the Portuguese fishery was supported by sardines older than 3 years; in addition the proportion of sardines older than 7 years has also decreased in the Spanish catch at age. The same pattern can be observed from the Spanish and Portuguese acoustic surveys carried out in Spring. This phenomenon could be the result of a series of low recruitments in recent years whereas the lack of older sardines could be also related to a change in the distribution area.

Recruitment predictions made using the fitted Beverton & Holt relationship are considered the most appropriate ones for management purposes at present. As is pointed out in Section 8.13, this model assumes a further decline in the recruitment due to the declining spawning stock biomass, giving a low probability of recovery. Moreover, it does no take into account the influence of the environmental conditions.

The Atlantic Iberian waters suffered a temperature increase during the last years (Lavin *et al.* 1996, Dias *et al.* 1996). This increase can also be noticed from the analysis of the temperature data from the period 1988-1997

(Anon. 1997). The intensification of frequency of the northern winds during winter implies the offshore larval transportation away from favourable feeding areas and increasing their mortality (Dias, 1994).

These hydroclimatic changes may have a negative influence on the larval survival, reflecting in a failure of the recruitment which added to a high and continuous exploitation have caused the decrease of the spawning stock biomass. These could have also been the cause of the changes in the species distribution area. There is a major occurrence of age II in the margin areas of the stock (East Cantabrian and French waters). The same situation is found in the Gulf of Cadiz.

Nevertheless the stochastic prediction includes uncertainty in the stock-recruitment model and hence, 5% and 95% percentiles for each scenario gave an idea of the total variability.

8.16 Reference Points for Management Purposes

This stock has been declining steadily over many years, both in terms of biomass and of recruitment. It is not clear to what extent the decline in recruitment is due to reduction of the biomass, or that recruitment has declined from other reasons. The relationship between SSB and recruitment appears to be almost linear (Figure 8.16.1), with an intercept not far above the origin. If this is representative of the stock dynamics in the range in question, the stock-recruitment relation will be almost parallel to a replacement line, corresponding to a fishing mortality representing the transition between further deterioration of the stock and rebuilding of the stock.

Furthermore, the selection pattern is very uncertain for this stock, both because different fleets exploit different ages, and because migrations may influence the accessibility of sardine for the various fleets. How this will influence the perception of the stock-recruit relationship has not been investigated at this meeting.

Because the stock-recruitment relation is almost linear, there is nothing to suggest a certain level where the recruitment would start to decline. Hence, it is not possible to define a B_{lim}, and management advise has to be related to other references.

The fishing mortality corresponding to the slope of the stock-recruitment curve would represent F_{crash}, which is an obvious candidate for F_{lim}. This fishing mortality is estimated at 0.34. Figure 8.16.2 shows the development of the stock and the catch in the SSB-catch plane, and how this relates to the Y/SSB ratio corresponding to F=0.34. With the exception of a few years with good incoming year classes, the trend has been declining both in SSB and Catch and the trajectory is well above the F_{lim} line.

The immediate need for rebuilding the stock calls for a reduction of F below F_{lim}. Even if an F of 0.34 on average would stabilize the SSB at the recent level, a far lower F is needed to ensure a proper rebuilding of the stock. A possible alternative is to use half this F, i.e. 0.17.

Future targets for rebuilding the stock are less obvious. The $F_{0.1}$ of 0.55 is clearly not appropriate for this stock, being far above F_{crash}. A possible choice of B_{pa} would be the stock size when the stock apparently was stable and the fishing mortality below the F_{lim}. According to the present assessment, this would be around 600,000 tonnes. A suggestion for F_{pa} would be F corresponding to the replacement line through 600,000 tonnes SSB and the geometric mean recruitment in the years before the stock started to decline. The assessment is quite uncertain for this period, however, due to the discrepancy between the separable fishing pattern and that generated by the VPA. Also, since work on the relationship between stock dynamics and climatic changes is in progress, and since the present need is a further reduction of F, definitive estimates of these reference points for the situation where the stock has recovered may be postponed.

8.17 Management Considerations

The immediate target, in order to stop the declining trend in the stock, obviously is to reduce the F such as to have a high probability of F being below F_{lim}. Future targets for rebuilding the stock are less obvious, in particular because it is unclear to which extent the recruitment is influenced by climatic changes.

Since work on this aspect is in progress, and the immediate need is to reduce the fishing mortality, further specification of future targets are postponed for the time being.

Table 8.2.1 - Landings (tonnes) of SARDINE by country (Data provided by the Working Group members)

SARDINE VII

COUNTRY	1981	1982	1983	1984	1985	1986	1987	1988
Denmark								
France	1,124	907	803	809	2,089	2,570	965	2,586
UK (Eng.& Wales)								
TOTAL	**1,124**	**907**	**803**	**809**	**2,089**	**2,570**	**965**	**2,586**

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996
Denmark				17,843		17,327	10,068	2,921
France	1,141	1,107	1,957	1,769	585	272		
UK (Eng.& Wales)			3,011	4,494	4,917	2,061	6,852	6,886
Netherlands				42				
TOTAL	**1,141**	**1,107**	**4,968**	**24,148**	**5,502**	**19,660**	**16,920**	**9,807**

SARDINE VIII

COUNTRY	1981	1982	1983	1984	1985	1986	1987	1988
France	9,676	5,928	6,467	4,491	8,169	10,229	7,708	7,808
Spain	33,550	31,756	32,374	27,970	25,907	39,195	36,377	40,944
UK (Eng.& Wales)								
TOTAL	**43,226**	**37,684**	**38,841**	**32,461**	**34,076**	**49,424**	**44,085**	**48,752**

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996
France	8,976	8,485	9,637	8,713	5,329	7,283		8,706
Spain	29,856	27,500	20,735	26,160	24,486	22,181	19,538	14,423
UK (Eng.& Wales)				1		-	-	-
TOTAL	**38,832**	**35,985**	**30,372**	**34,874**	**29,815**	**29,464**	**19,538**	**23,129**

SARDINE IX

COUNTRY	1975	1976	1977	1978	1979	1980	1981	1982
Portugal	95,877	79,649	79,819	86,553	91,294	106,302	113,253	100,859
Spain	12,236	10,140	9,782	12,915	43,876	49,593	65,330	71,889
TOTAL	**108,113**	**89,789**	**89,601**	**99,468**	**135,170**	**155,895**	**178,583**	**172,748**

COUNTRY	1983	1984	1985	1986	1987	1988	1989	1990
Portugal	85,922	95,110	111,709	103,451	90,214	93,591	91,091	92,404
Spain	62,843	79,606	66,491	37,960	42,234	24,005	16,179	19,253
TOTAL	**148,765**	**174,716**	**178,200**	**141,411**	**132,448**	**117,596**	**107,270**	**111,657**

COUNTRY	1991	1992	1993	1994	1995	1996
Portugal	92,638	83,315	90,404	94,468	87,818	85,757
Spain	14,383	16,579	23,905	16,151	13,928	11,251
TOTAL	**107,021**	**99,894**	**114,309**	**110,619**	**101,746**	**97,008**

Table 8.2.2 - Annual landings (tonnes) of SARDINE by Division and Sub-area

DIVISION	1981	1982	1983	1984	1985	1986	1987	1988
VIId	172	59	211	147	465	512	67	29
VIIe	952	828	590	661	1,624	2,058	682	438
VIIf	-	20	-	-				
VIIg		-	-	1	-			
VIIh			2	-			216	2,119
total VII	**1,124**	**907**	**803**	**809**	**2,089**	**2,570**	**965**	**2,586**
VIIIa	8,482	5,928	6,013	4,472	8,090	10,186	7,631	7,770
VIIIb	1,194		454	19	79	77	77	38
VIIIc	35,550	31,756	32,374	27,970	25,907	39,195	36,377	40,944
VIIId								
total VIII	**45,226**	**37,684**	**38,841**	**32,461**	**34,076**	**49,458**	**44,085**	**48,752**
IXa	178,583	172,748	148,765	174,716	178,200	141,411	132,448	117,596
TOTAL YEAR	**224,933**	**211,339**	**188,409**	**207,986**	**214,365**	**193,439**	**177,498**	**168,934**

DIVISION	1989	1990	1991	1992	1993	1994	1995	1996
IVc			-	8	19	-	-	0
VIa			-	1	-	-	-	-
VIb						49	24	
VIId	93	64	170	153	127	2,086	1,621	179
VIIe	91	808	4,687	19,299	5,298	20,985	13,787	8,278
VIIf				336	6			0
VIIg				0		0		
VIIh	957	235	110	4	71	-	1,439	1,350
VIIj				0				
total VII	1,141	1,107	4,968	19,793	5,502	23,071	16,846	9,807
VIIIa	8,885	8,381	9,113	8,565	4,703	7,164		8,180
VIIIb	85	104	482	141	548	119		526
VIIIc	29,862	27,500	20,735	26,166	24,486	22,181	19,538	14,423
VIIId			42	2	78	0		
total VIII	**38,832**	**35,985**	**30,372**	**34,874**	**29,815**	**29,464**	**19,538**	**23,129**
IXa	**107,270**	**111,657**	**107,021**	**99,894**	**114,309**	**110,619**	**101,746**	**97,008**
TOTAL YEAR	**147,243**	**148,749**	**142,361**	**154,569**	**149,645**	**163,154**	**138,130**	**129,944**

Sub-area VII - 1981-1990 only French data was available
(a) - In Div VIIe, 1992 17,507t were caught by Denmark
(-) Unknown catches

Table 8.2.3 - Annual landings (t) of SARDINE in Divisions VIIIc and IXa by country.

COUNTRY	1976	1977	1978	1979	1980	1981	1982
Portugal	79,649	79,819	83,553	91,294	106,302	113,253	100,859
Spain	62,041	45,931	56,437	62,147	85,380	100,880	103,645
Total	**141,690**	**125,750**	**139,990**	**153,441**	**191,682**	**214,133**	**204,504**

COUNTRY	1983	1984	1985	1986	1987	1988	1989
Portugal	85,922	95,110	111,709	103,451	90,214	93,591	91,091
Spain	95,217	107,576	92,398	77,155	78,611	64,949	46,035
Total	**181,139**	**202,686**	**204,107**	**180,606**	**168,825**	**158,540**	**137,126**

COUNTRY	1990	1991	1992	1993	1994	1995	1996
Portugal	92,404	92,638[1]	83,315	90,404	94,468	87,818	85,757
Spain	46,753	35,118	42,739	48,391	38,332	33,566	25,674
Total	**139,157**	**127,756**	**126,054**	**138,795**	**132,800**	**121,384**	**111,431**

[1] Discards included

Table 8.2.4 - SARDINE (VIIIC+IXa). Quarterly catches (t) by gear by country and fleets in 1996 (Provided by the WG members)

Country/Quarter	1st Q	2nd Q	3rd Q	4th Q	Year
Total	**18,565**	**25,340**	**38,801**	**28,725**	**111,431**
Spain (VIIIc+IXa): Purse seine	6,936	7,698	7,156	3,883	25,674
Portugal (IXa):	11,629	17,642	31,645	24,842	85,757
Purse-seine	11,059	17,273	30,893	23,728	82,953
Artisanal	186	198	604	196	1,183
Trawl	384	171	148	919	1,622

Table 8.3.1 - SARDINE (VIIIC+IXa). Total nominal catches (t) by quarter and areas of Divisions VIIIc and IXa during 1996

Area	1st Q	2nd Q	3rd Q	4th Q	Total 1996
VIIIc East	2,622	859	1,360	997	5,838
VIIIc West	1,493	2,865	2,734	1,493	8,585
IXa North	2,821	3,975	3,063	1,393	11,251
IXa Central-North	988	6,002	15,275	12,496	34,762
IXa Central-South	6,505	7,185	9,646	7,781	31,117
IXa South (>7º24')	4,136	4,454	6,723	4,565	19,878
Total	**18,565**	**25,340**	**38,801**	**28,725**	**111,431**

Table 8.3.2 - 1978-1996: Sardine monthly catches (tonnes) in Division IXa-South, Gulf of Cadiz (Spain)

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1978	304	474	254	506	663	403	335	431	501	938	389	421	5,619
1979	620	439	243	54	164	250	373	470	420	326	281	159	3,800
1980	394	155	238	113	174	125	377	329	347	447	283	137	3,120
1981	139	220	134	45	130	84	97	451	227	498	125	237	2,384
1982	294	203	131	66	22	185	228	123	329	417	332	114	2,442
1983	152	83	250	253	183	159	123	428	300	294	319	143	2,688
1984	554	367	348	273	387	136	85	119	289	545	179	38	3,319
1985	274	162	331	274	125	107	322	686	506	712	681	152	4,333
1986	493	863	264	58	212	433	393	898	962	1,084	590	507	6,757
1987	790	703	415	235	200	266	545	806	1,018	1,851	1,111	931	8,870
1988	34	52	274	331	100	130	143	265	317	610	615	120	2,990
1989	51	39	673	274	299	319	395	476	506	564	188	52	3,835
1990	244	1,166	530	191	298	404	350	588	650	794	1,189	98	6,503
1991	49	107	347	371	425	444	356	574	481	637	868	175	4,834
1992	325	218	509	435	417	374	173	432	608	383	236	87	4,196
1993	262	201	617	486	362	152	74	122	415	291	521	163	3,664
1994	299	302	243	362	330	257	353	283	336	500	343	173	3,782
1995	904	781	924	244	120	72	84	235	119	158	160	193	3,996
1996	202	241	169	454	206	343	291	515	469	1,140	842	433	5,304

Table 8.4.1 - SARDINE (Divisions VIIIc + IXa). Effort (fishing day) and CPUE (ton/fishing day) series in commercial fisheries (P. seine)

YEAR	Spain						Portugal			
	VIIIc East(Santona)		VIIIc West (Sada)		IXa N(Vigo+Riveira)		IXa Central+South			
	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-day	t/f day	f-No.boat	t/boat
1982					7,685	4.87			184	340
1983					7,867	4.01			196	312
1984					8,369	4.65			192	329
1985					5,731	4.86			192	527
1986					3,541	4.23			198	517
1987			4,455	2.07	4,099	4.71			196	437
1988			4,192	2.34	3,601	2.75	22,080	3.91	180	495
1989	314	4.10	4,008	1.95	3,059	2.45	21,432	3.93	223	383
1990	389	3.65	3,465	1.55	3,488	2.80	25,740	3.50	221	394
1991	394	3.13	2,891	0.93	3,279	2.44	21,798	3.56	206	377
1992	570	1.63	2,619	1.42	3,790	2.44	26,418	2.97	206	381
1993	498	1.70	2,054	2.07	4,758	2.66	24,678	3.43	180	470
1994	274	4.00	2,029	2.03	4,452	2.28	21,896	4.15	148	614
1995	459	4.08	1,580	2.05	3,911	2.43	20,132	4.14	141	590
1996	297	2.78	1,346	1.97	1,654	4.46	21,294	3.70	148	538

Table 8.5.1 - Sardine joint acoustic survey - March 1997. Numbers (millions), biomass (t), mean length (cm) and weight (g) by age groups.

(VIIIc-E)
EAST CANTABRIAN

Age Group	No	Biomass	Mean length	Mean weight
I	19	729	16,6	37,0
II	246	14987	19,8	60,7
III	96	7065	21,2	73,6
IV	85	6775	21,8	79,1
V	42	3595	22,4	85,9
VI	22	1959	22,7	88,7
VII	6	561	23,6	98,6
VIII	5	515	24,0	104,1
IX	0	36	23,8	100,8
X				
XI				
TOTAL	521	36222		

(VIIIc-W)
WEST CANTABRIAN

Age Group	No	Biomass	Mean length	Mean weight
I	1	27	17,6	43,4
II	4	246	19,7	60,1
III	12	946	21,6	77,8
IV	21	1657	21,9	79,9
V	10	825	22,3	84,8
VI	7	629	22,7	88,3
VII	4	319	22,6	88,0
VIII	1	119	24,1	104,4
IX		37	24,3	106,8
X				
XI				
TOTAL	59	4806		

(IXa-N)
SOUTH GALICIA

Age Group	No	Biomass	Mean length	Mean weight
I	36	1100	15,3	29,7
II	13	713	19,3	56,1
III	18	1331	21,1	72,6
IV	17	1357	21,8	79,7
V	14	1190	22,4	85,7
VI	9	838	22,9	90,6
VII	3	300	23,0	92,3
VIII	1	143	24,1	104,6
IX	3	373	24,3	106,8
X				
XI				
TOTAL	115	7345		

Table 8.5.1 - (Cont'd)

IXa C-N

Age Group	No	Biomass	Average Length	AverageWeight
I	2791	62575	14.4	22.4
II	234	9981	18.0	42.7
III	736	37076	19.1	50.4
IV	536	33137	20.4	61.9
V	263	18817	21.4	71.4
VI	-	-	-	-
TOTAL	4560	161586		

IXa C-S

Age Group	No	Biomass	Average Length	AverageWeight
I	1397	38363	15.5	27.5
II	1393	44481	16.3	31.9
III	464	22563	18.9	48.7
IV	707	41870	20.1	59.2
V	723	46695	20.7	64.6
VI	110	8159	21.7	73.8
TOTAL	4794	202131		

Algarve - IXa South

Age Group	No	Biomass	Average Length	AverageWeight
I	111	2340	14.2	21.1
II	810	26273	16.5	32.4
III	355	16685	18.6	47.0
IV	482	26467	19.6	54.9
V	850	50922	20.2	59.9
VI	129	8903	21.2	68.9
TOTAL	2737	131590		

Cádiz (España) -IXa South

Age Group	No	Biomass	Average Length	Average Weight
I	2033	56704	15.6	27.9
II	1627	52399	16.4	32.2
III	319	14782	18.5	46.3
IV	58	3367	20.0	57.6
V	16	1139	21.3	69.2
TOTAL	4054	128391		

Table 8.5.1 - (Cont'd)

Stock (VIIIc+IXa) (without Cadiz)

Age Group	No	Biomass	Average Length	Average Weight
I	4355	105134		
II	2700	96681		
III	1681	85666		
IV	1848	111263		
V	1902	122044		
VI	277	20488		
VII	13	1180		
VIII	7	777		
IX	3	446		
X				
XI				
TOTAL	12786	543679		

FRANCE

Age Group	No	Biomass	Mean length	Mean weight
I	67	2704	17,7	40,3
II	1649	88320	19,4	53,4
III	426	31285	21,4	73,0
IV	666	51603	21,8	77,2
V	271	23035	22,5	84,5
VI	239	23840	23,7	98,8
VII	67	6732	23,8	100,6
VIII	42	4494	24,3	106,6
IX	7	643	23,3	93,5
X	51	5859	24,9	115,1
XI				
TOTAL	3485	238514		

(Without Cadiz)

SPAIN

Age Group	No	Biomass	Mean length	Mean weight
I	56	1855	15,8	32,3
II	263	15945	19,8	60,5
III	126	9342	21,3	73,9
IV	123	9789	21,8	79,3
V	65	5610	22,4	85,7
VI	38	3427	22,7	89,1
VII	13	1180	23,2	93,9
VIII	7	776	24,0	104,2
IX	4	446	24,2	106,3
X				
XI				
TOTAL	696	48372		

Table 8.5.1 - (Cont'd)

PORTUGAL

Age Group	No	Biomass	Average Length	Average Weight
I	**4056**	97387	14.7	24.0
II	2625	84157	16.3	32.1
III	1552	75846	18.9	48.9
IV	1768	103090	20.0	58.3
V	1810	114653	20.6	63.3
VI	280	20174	21.5	71.9
TOTAL	**12092**	**495307**		

Table 8.6.1 - SARDINE in Division VIIe. Catch length distribution ('000 fish) from trawl fishery (England and Walles) during 1996

L (cm)	ENGLAND & WALLES 1st Q	2nd Q	3rd Q	4th Q	TOTAL
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17	368				368
18	592				592
19	1,770			102	1,871
20	2,655			1,061	3,716
21	1,390			3,548	4,939
22	3,699			4,761	8,460
23	8,338			4,541	12,880
24	11,040			3,797	14,837
25	7,261			1,755	9,016
26	1,624			367	1,991
27	497			147	644
28	140				140
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
TOTAL	39,375	0	0	20,078	59,453
Fish measured	517			228	745
No.of samples	4			2	6
No. aged	0			0	0
Catch(t) - VIIe	4,635	3	9	1,796	6,443

Table 8.6.2 - SARDINE in Divisions VIIIc and IXa. Purse seine catch length distribution ('000 fish) by country, Division and quarter in 1996

L (cm)	QUARTER 1				QUARTER 2				QUARTER 3				QUARTER 4				YEAR 1995				L (cm)
	Portugal IXa	Spain IXa	Spain VIIIc	TOTAL	Portugal IXa	Spain IXa	Spain VIIIc	TOTAL	Portugal IXa	Spain IXa	Spain VIIIc	TOTAL	Portugal IXa	Spain IXa	Spain VIIIc	TOTAL	Portugal IXa	Spain IXa	Spain VIIIc	TOTAL	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6.5
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.5
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.5
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.5
10	24	0	0	24	0	0	0	0	0	2	0	2	893	0	0	893	917	2	0	920	10
10.5	0	0	0	0	0	0	0	0	422	18	0	440	2,978	0	0	2,978	3,400	18	0	3,418	10.5
11	71	0	0	71	507	0	0	507	2,516	311	7	2,834	3,750	18	0	3,768	6,844	328	7	7,180	11
11.5	48	0	0	48	489	0	0	489	7,526	289	44	7,859	5,849	27	30	5,906	13,912	316	74	14,302	11.5
12	62	0	1	62	412	0	0	412	20,336	771	355	21,461	10,778	80	125	10,982	31,587	850	480	32,917	12
12.5	26	0	3	29	227	4	0	231	20,379	790	740	21,909	12,028	62	246	12,336	32,660	852	989	34,501	12.5
13	213	0	9	222	919	4	0	923	18,434	641	534	19,610	9,574	43	190	9,807	29,140	684	734	30,558	13
13.5	73	5	16	94	2,124	0	17	2,141	15,877	335	474	16,686	8,144	95	146	8,385	26,219	451	653	27,323	13.5
14	358	15	11	384	3,014	0	0	3,014	7,376	625	316	8,317	9,976	231	65	10,272	20,724	870	392	21,986	14
14.5	578	22	9	609	1,550	0	59	1,609	5,435	938	200	6,573	10,784	525	27	11,336	18,347	1,544	295	20,186	14.5
15	1,062	133	4	1,199	1,442	0	157	1,599	2,868	970	99	3,936	16,087	802	20	16,909	21,459	2,062	280	23,801	15
15.5	816	379	5	1,201	1,533	0	206	1,738	834	645	33	1,512	14,643	767	7	15,417	17,826	1,997	251	20,074	15.5
16	820	394	14	1,228	1,922	4	436	2,362	513	649	48	1,210	10,455	543	30	11,028	13,710	2,022	529	16,261	16
16.5	976	517	22	1,514	3,595	22	649	4,266	1,156	268	31	1,455	4,499	198	32	4,729	10,226	1,632	734	12,592	16.5
17	2,382	987	25	3,394	5,591	60	906	6,557	2,572	194	4	2,770	8,407	103	9	8,518	18,952	2,190	944	22,086	17
17.5	5,909	843	48	6,801	13,752	128	1,112	14,992	15,545	117	12	15,675	7,462	94	54	7,611	42,669	2,167	1,227	46,063	17.5
18	14,421	2,113	788	17,322	26,429	1,085	1,397	28,911	37,436	543	23	38,001	20,578	134	34	20,746	98,863	4,187	2,241	105,291	18
18.5	21,390	2,372	641	24,403	52,700	2,076	1,114	55,890	74,626	1,367	103	76,097	39,533	241	224	39,998	188,249	5,093	2,083	195,425	18.5
19	38,154	3,189	1,191	42,534	57,924	5,301	869	64,094	91,570	3,886	347	95,803	30,439	338	383	31,160	218,087	8,282	2,790	229,159	19
19.5	30,607	4,243	2,009	36,859	55,339	7,618	1,089	64,045	88,009	5,371	903	94,282	60,549	495	606	61,650	234,503	11,197	4,607	250,307	19.5
20	39,427	5,865	4,641	49,933	42,435	12,400	2,197	57,032	68,999	6,726	1,692	77,417	45,588	1,342	921	47,851	196,449	16,131	9,451	222,031	20
20.5	23,855	5,693	6,922	36,470	24,228	9,435	4,348	38,011	40,820	5,155	2,964	48,938	49,466	943	1,448	51,857	138,368	16,138	15,681	170,188	20.5
21	13,693	5,869	10,054	29,616	13,201	8,286	7,121	28,608	22,530	5,367	6,304	34,201	27,966	1,767	2,713	32,446	77,391	20,124	26,192	123,707	21
21.5	4,183	3,520	11,246	18,949	5,602	3,960	9,660	19,222	11,072	3,800	10,055	24,927	15,343	2,014	4,191	21,549	36,201	18,994	35,152	90,347	21.5
22	1,807	4,659	8,227	14,693	1,512	3,187	7,522	12,221	3,312	2,835	9,862	16,009	10,755	2,546	5,674	18,974	17,386	17,561	31,285	66,232	22
22.5	422	1,642	4,976	7,040	784	749	4,791	6,324	881	1,578	6,434	8,893	3,047	2,260	4,312	9,620	5,134	10,272	20,513	35,919	22.5
23	101	619	2,156	2,876	189	255	1,503	1,947	358	411	3,255	4,024	602	1,126	2,490	4,218	1,250	3,659	9,404	14,313	23
23.5	0	141	859	1,001	0	38	400	438	20	50	836	906	328	254	952	1,534	348	845	3,048	4,241	23.5
24	0	57	444	501	18	33	281	333	0	0	382	382	373	138	680	1,191	391	477	1,786	2,655	24
24.5	0	16	191	207	0	0	34	34	0	0	108	108	0	0	69	69	0	50	402	452	24.5
25	0	0	117	117	0	0	50	50	0	0	54	54	0	0	94	94	0	50	315	365	25
25.5	0	0	78	78	0	0	0	0	0	0	7	7	0	0	44	44	0	0	130	130	25.5
26	0	0	43	43	0	0	0	0	0	0	0	0	0	0	4	4	0	0	47	47	26
26.5	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	2	26.5
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
27.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27.5
TOTAL	201,476	43,292	54,752	299,521	317,439	54,645	45,919	418,003	561,421	44,653	46,226	652,299	440,876	17,185	25,820	483,881	1,521,211	151,049	172,717	1,844,977	TOTAL
Fish measured	8,708	4,623	6,200	19,531	8,866	5,859	1,538	16,263	8,151	5,621	6,427	20,199	6,512	2,445	3,051	12,008	32,237	18,548	17,216	68,001	Fish measured
No.of samples	88	39	69	196	111	55	13	179	109	55	80	244	84	25	39	148	392	174	201	767	No.of samples
no. aged	785				811			811	723			723	754			754				0	No. aged
Catch(t)	11,059	2,820	4,117	17,995	17,273	3,975	859	22,107	30,893	3,063	4,093	38,050	23,728	1,393	2,490	27,611	82,953	11,251	11,559	105,763	Catch(t)

TABLE 8.6.3 - SARDINE - Purse seine catch length compostion from Gulf of Cadiz (Spain) by quarter during 1996

Unit: '000 fish

Length (cm)	1 Q.	2 Q.	3 Q.	4 Q.*	TOTAL
9					0
9.5		109			109
10		272			272
10.5		109	190		299
11			190		190
11.5		109	253		362
12			717	104	821
12.5		109	1970	1555	3634
13			1774	4040	5814
13.5	56		524	5169	5749
14	56	382	393	5977	6808
14.5		66	295	5900	6261
15	56	713	319	7335	8423
15.5	113	522	472	6624	7731
16		1055	575	4769	6399
16.5		2606	1599	3061	7266
17	305	3459	4388	2203	10355
17.5	538	3911	4782	3020	12251
18	1042	4524	5254	3475	14295
18.5	2040	4849	3790	3082	13761
19	2595	2253	2639	2014	9501
19.5	2311	736	974	1276	5297
20	1217	59	312	846	2434
20.5	368		63		431
21	99	3			102
21.5	85				85
22					0
22.5					0
23					0
23.5					0
24					0
24.5					0
25					0
TOTAL	**10882**	**25846**	**31474**	**60450**	**128652**
Fish measured	394	534	628	599	**2155**
No. of samples	3	4	6	4	**17**
no.aged	50	222	161	176	**609**
Catch (t)	612	1003	1274	2415	**5304**

*there are no samples in December

Table 8.7.1 Catch in numbers ('000) at age by quarter and by sub-division of SARDINE in 1996

1996 Age	VIIIc East 1'st Q catch('000)	VIIIc West 1'st Q catch('000)	IXa North 1'st Q catch('000)	IXa Centr-N 1'st Q catch('000)	IXa Centr-S 1'st Q catch('000)	IXa South 1'st Q catch('000)	All areas 1'st Q catch ('000)
0	0	0	0	0	0	0	0
1	588	178	4,176	462	2,386	709	8,499
2	4,002	980	9,851	2,225	6,818	15,921	39,797
3	3,948	1,983	5,050	2,440	12,573	12,857	38,851
4	13,614	8,140	13,774	7,039	58,807	36,756	138,129
5	9,871	6,457	8,683	4,318	36,090	3,519	68,937
6	1,055	576	653	840	5,124	0	8,247
7	1,193	692	718	527	658	0	3,789
8	250	173	128	0	0	0	551
9	411	110	147	0	0	0	668
10	258	118	91	0	0	0	467
11	38	11	6	0	0	0	55
12	85	19	14	0	0	0	118
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	35,313	19,437	43,291	17,850	122,455	69,761	308,108
Tonnes	2,623	1,494	2,820	988	6,505	4,136	18,566

1996 Age	VIIIc East 2'nd Q catch('000)	VIIIc West 2'nd Q catch('000)	IXa North 2'nd Q catch('000)	IXa Centr-N 2'nd Q catch('000)	IXa Centr-S 2'nd Q catch('000)	IXa South 2'nd Q catch('000)	All areas 2'nd Q catch ('000)
0	0	0	0	0	0	0	0
1	2,983	344	2,072	7,800	7,734	446	21,379
2	3,036	2,117	12,696	16,981	13,758	38,189	86,778
3	753	3,476	8,060	18,985	49,861	20,672	101,807
4	2,688	13,831	19,464	41,225	48,230	23,913	149,351
5	2,150	10,891	10,691	26,684	15,627	403	66,446
6	291	925	768	7,545	1,775	24	11,328
7	323	1,165	566	245	159	0	2,458
8	64	271	108	0	0	0	443
9	99	179	171	0	0	0	449
10	68	198	41	0	0	0	307
11	18	14	4	0	0	0	36
12	20	18	3	0	0	0	41
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	12,493	33,429	54,644	119,465	137,144	83,647	440,822
Tonnes	859	2,864	3,975	6,002	7,185	4,455	25,341

1996 Age	VIIIc East 3'rd Q catch('000)	VIIIc West 3'rd Q catch('000)	IXa North 3'rd Q catch('000)	IXa Centr-N 3'rd Q catch('000)	IXa Centr-S 3'rd Q catch('000)	IXa South 3'rd Q catch('000)	All areas 3'rd Q catch ('000)
0	13	2,898	7,931	82,665	43,883	304	137,693
1	259	1,164	5,257	16,633	2,232	6,682	32,227
2	986	2,839	8,003	59,340	34,132	22,927	128,227
3	1,160	2,910	3,113	93,635	44,586	53,499	198,902
4	5,657	13,083	13,237	80,907	70,283	18,171	201,338
5	3,619	7,230	6,060	7,016	7,643	2,930	34,498
6	663	749	366	1,366	0	654	3,798
7	396	708	381	1,000	0	0	2,485
8	690	489	189	0	0	0	1,368
9	420	293	114	0	0	0	827
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	13,863	32,363	44,651	342,561	202,760	105,166	741,364
Tonnes	1,360	2,733	3,063	15,275	9,646	6,724	38,801

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Table 8.7.1 (continued)

1996 Age	VIIIc East 4'th Q catch('000)	VIIIc West 4'th Q catch('000)	IXa North 4'th Q catch('000)	IXa Centr-N 4'th Q catch('000)	IXa Centr-S 4'th Q catch('000)	IXa South 4'th Q catch('000)	All areas 4'th Q catch ('000)
0	54	951	3,644	103,320	31,059	179	139,207
1	470	417	871	6,940	20,700	5,423	34,820
2	990	1,212	1,515	29,871	20,876	15,124	69,588
3	786	1,283	1,176	74,461	47,251	21,927	146,884
4	3,861	6,228	5,577	55,820	44,638	21,912	138,036
5	2,443	3,746	3,180	3,790	6,649	4,172	23,981
6	429	537	415	2,581	526	51	4,539
7	236	381	292	1,257	0	0	2,166
8	488	610	328	0	0	0	1,426
9	322	377	186	0	0	0	885
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
Total	10,079	15,742	17,184	278,040	171,698	68,789	561,532
Tonnes	997	1,493	1,393	12,496	7,781	4,565	28,725

1996 Age	VIIIc East 1-4 Q catch('000)	VIIIc West 1-4 Q catch('000)	IXa North 1-4 Q catch('000)	IXa Centr-N 1-4 Q catch('000)	IXa Centr-S 1-4 Q catch('000)	IXa South 1-4 Q catch('000)	All areas 1-4 Q catch ('000)
0	67	3,849	11,575	185,985	74,942	483	276,901
1	4,300	2,103	12,376	31,835	33,053	13,259	96,925
2	9,014	7,148	32,065	108,416	75,585	92,161	324,390
3	6,647	9,652	17,399	189,521	154,271	108,955	486,444
4	25,820	41,282	52,052	184,991	221,957	100,752	626,854
5	18,083	28,324	28,614	41,808	66,009	11,024	193,862
6	2,438	2,787	2,202	12,331	7,424	729	27,911
7	2,148	2,946	1,957	3,030	817	0	10,897
8	1,492	1,543	753	0	0	0	3,788
9	1,252	959	618	0	0	0	2,829
10	326	316	132	0	0	0	774
11	56	25	10	0	0	0	91
12	105	37	17	0	0	0	159
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0		0
Total	71,748	100,971	159,770	757,916	634,057	327,363	2,051,826
Tonnes	5,839	8,584	11,251	34,762	31,117	19,878	111,431

Table 8.8.1 Length (cm) at age by quarter and by sub-division of SARDINE in 1996.

1996 Age	VIIIc East 1'st Q length(cm)	VIIIc West 1'st Q length(cm)	IXa North 1'st Q length(cm)	IXa Centr-N 1'st Q length(cm)	IXa Centr-S 1'st Q length(cm)	IXa South 1'st Q length(cm)	All areas 1'st Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	18.9	16.9	17.6	16.2	14.7	15.8	16.6
2	19.8	20.4	19.2	18.5	17.6	18.7	18.8
3	21.0	21.4	20.5	19.2	19.1	19.4	19.7
4	21.4	21.6	21.1	19.9	19.8	20.2	20.3
5	21.8	21.9	21.5	20.7	19.9	21.1	20.7
6	22.6	22.4	21.7	21.3	20.5	0.0	21.1
7	22.8	22.6	22.3	21.7	20.7	0.0	22.1
8	22.5	22.1	22.3	0.0	0.0	0.0	22.3
9	23.7	22.1	21.8	0.0	0.0	0.0	23.0
10	23.8	23.0	23.0	0.0	0.0	0.0	23.4
11	24.3	24.3	24.3	0.0	0.0	0.0	24.3
12	24.2	23.9	24.0	0.0	0.0	0.0	24.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	21.4	21.7	20.4	19.9	19.6	19.7	20.1

1996 Age	VIIIc East 2'nd Q length(cm)	VIIIc West 2'nd Q length(cm)	IXa North 2'nd Q length(cm)	IXa Centr-N 2'nd Q length(cm)	IXa Centr-S 2'nd Q length(cm)	IXa South 2'nd Q length(cm)	All areas 2'nd Q length(cm)
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	17.1	18.0	19.0	15.6	14.1	15.1	15.6
2	18.4	20.2	19.7	18.0	17.7	18.6	18.5
3	20.9	21.3	20.4	18.4	19.5	19.1	19.3
4	21.7	21.6	20.8	19.6	20.2	19.5	20.2
5	21.9	21.9	21.1	20.3	20.9	21.4	20.9
6	23.1	22.4	20.9	20.7	21.9	23.0	21.1
7	22.9	22.5	21.7	21.8	22.7	0.0	22.3
8	22.7	22.2	22.0	0.0	0.0	0.0	22.2
9	23.6	22.2	21.4	0.0	0.0	0.0	22.2
10	23.3	23.0	23.0	0.0	0.0	0.0	23.1
11	24.3	24.3	24.3	0.0	0.0	0.0	24.3
12	24.1	23.8	23.8	0.0	0.0	0.0	23.9
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	19.9	21.6	20.5	19.2	19.4	19.0	19.6

1996 Age	VIIIc East 3'rd Q length (cm)	VIIIc West 3'rd Q length (cm)	IXa North 3'rd Q length (cm)	IXa Centr-N 3'rd Q length (cm)	IXa Centr-S 3'rd Q length (cm)	IXa South 3'rd Q length (cm)	All areas 3'rd Q length(cm)
0	18.3	13.5	14.5	12.8	13.5	13.6	13.2
1	20.4	20.5	19.8	17.7	18.1	17.8	18.2
2	21.6	21.2	20.0	18.8	19.1	18.5	19.0
3	22.0	21.7	20.9	19.9	19.7	19.1	19.7
4	22.2	21.8	21.0	20.4	20.5	19.7	20.5
5	22.4	21.9	21.3	20.8	21.3	20.3	21.3
6	23.0	22.4	22.1	21.6	0.0	20.8	21.9
7	22.4	22.1	21.9	22.4	0.0	0.0	22.2
8	23.5	22.6	22.5	0.0	0.0	0.0	23.0
9	23.8	22.4	22.1	0.0	0.0	0.0	23.1
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	22.3	21.0	19.6	18.0	18.6	19.0	18.6

Table 8.8.1 (continued)

1996 Age	VIIIc East 4'th Q length(cm)	VIIIc West 4'th Q length(cm)	IXa North 4'th Q length(cm)	IXa Centr-N 4'th Q length(cm)	IXa Centr-S 4'th Q length(cm)	IXa South 4'th Q length(cm)	All areas 4'th Q length(cm)
0	17.8	13.6	15.4	14.2	12.5	14.5	13.8
1	19.9	20.4	19.8	16.9	15.8	17.3	16.5
2	20.8	21.4	20.8	19.4	18.3	18.5	19.0
3	21.8	21.9	21.6	20.4	19.8	19.5	20.1
4	22.0	22.0	21.8	20.9	20.7	19.9	20.8
5	22.3	22.2	22.1	21.8	21.3	21.0	21.7
6	23.0	22.8	22.8	22.0	23.5	22.7	22.4
7	22.4	22.3	22.3	23.2	0.0	0.0	22.9
8	23.6	23.5	23.1	0.0	0.0	0.0	23.4
9	23.9	23.8	23.2	0.0	0.0	0.0	23.7
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	22.0	21.6	20.4	18.0	18.1	19.3	18.5

1996 Age	VIIIc East 1-4 Q length(cm)	VIIIc West 1-4 Q length(cm)	IXa North 1-4 Q length(cm)	IXa Centr-N 1-4 Q length(cm)	IXa Centr-S 1-4 Q length(cm)	IXa South 1-4 Q length(cm)	All areas 1-4 Q length(cm)
0	17.9	13.5	14.8	13.6	13.1	13.9	13.5
1	17.9	19.8	18.9	17.0	15.5	17.4	16.9
2	19.6	20.8	19.7	18.8	18.5	18.6	18.8
3	21.3	21.5	20.6	19.9	19.6	19.2	19.7
4	21.7	21.7	21.0	20.3	20.3	19.9	20.4
5	22.0	21.9	21.4	20.6	20.4	20.8	21.0
6	22.8	22.5	21.7	21.1	21.0	21.0	21.4
7	22.7	22.4	22.0	22.6	21.1	0.0	22.3
8	23.3	22.8	22.7	0.0	0.0	0.0	23.0
9	23.8	22.9	22.2	0.0	0.0	0.0	23.1
10	23.7	23.0	23.0	0.0	0.0	0.0	23.3
11	24.3	24.3	24.3	0.0	0.0	0.0	24.3
12	24.2	23.9	24.0	0.0	0.0	0.0	24.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-15+	21.4	21.4	20.2	18.3	18.8	19.2	19.0

Table 8.8.2 Weight (g) at age by quarter and by sub-division of SARDINE in 1996.

1996 Age	VIIIc East 1'st Q weight(g)	VIIIc West 1'st Q weight(g)	IXa North 1'st Q weight(g)	IXa Centr-N 1'st Q weight(g)	IXa Centr-S 1'st Q weight(g)	IXa South 1'st Q weight(g)	All areas 1'st Q weight(g)
0	0	0	0	0	0	0	0
1	51	37	42	31	24	32	36
2	58	64	54	45	39	51	50
3	69	73	65	50	49	57	57
4	74	76	71	56	55	63	62
5	77	78	74	62	55	72	64
6	87	85	77	68	60	0	67
7	89	86	83	70	62	0	80
8	85	81	83	0	0	0	84
9	99	81	77	0	0	0	91
10	101	91	91	0	0	0	96
11	106	106	106	0	0	0	106
12	30	101	102	0	0	0	50
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	74	76	65	55	53	59	60

1996 Age	VIIIc East 2'nd Q weight(g)	VIIIc West 2'nd Q weight(g)	IXa North 2'nd Q weight(g)	IXa Centr-N 2'nd Q weight(g)	IXa Centr-S 2'nd Q weight(g)	IXa South 2'nd Q weight(g)	All areas 2'nd Q weight(g)
0	0	0	0	0	0	0	0
1	41	48	57	29	21	28	31
2	51	69	63	41	40	50	49
3	77	81	71	44	52	54	54
4	86	85	76	53	57	57	62
5	89	88	79	58	63	74	69
6	105	95	77	62	72	92	69
7	103	97	86	72	81	0	92
8	100	93	91	0	0	0	93
9	113	93	83	0	0	0	93
10	108	103	104	0	0	0	105
11	123	123	123	0	0	0	123
12	120	115	115	0	0	0	118
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	68	85	72	50	52	53	57

1996 Age	VIIIc East 3'rd Q weight (g)	VIIIc West 3'rd Q weight (g)	IXa North 3'rd Q weight (g)	IXa Centr-N 3'rd Q weight (g)	IXa Centr-S 3'rd Q weight (g)	IXa South 3'rd Q weight (g)	All areas 3'rd Q weight(g)
0	53	20	25	16	18	25	17
1	74	74	67	39	42	52	48
2	88	83	69	47	49	59	52
3	93	89	80	55	53	64	58
4	96	91	81	59	60	71	65
5	99	93	84	63	67	77	79
6	107	99	94	70	0	83	87
7	98	95	92	77	0	0	88
8	115	102	100	0	0	0	108
9	119	99	95	0	0	0	109
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	98	84	68	45	48	64	52

Table 8.8.2 (continued)

Age	VIIIc East 4'th Q weight (g)	VIIIc West 4'th Q weight(g)	IXa North 4'th Q weight(g)	IXa Centr-N 4'th Q weight(g)	IXa Centr-S 4'th Q weight(g)	IXa South 4'th Q weight(g)	All areas 4'th Q weight(g)
0	49	20	31	21	15	25	20
1	70	76	69	35	29	46	35
2	81	88	81	51	44	57	52
3	95	95	92	59	55	68	60
4	97	97	94	63	62	73	68
5	102	101	99	72	67	87	84
6	113	110	109	74	89	113	87
7	103	101	101	86	0	0	93
8	123	120	114	0	0	0	120
9	127	125	116	0	0	0	124
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	98	94	80	45	45	66	51

Age	VIIIc East 1-4 Q weight(g)	VIIIc West 1-4 Q weight(g)	IXa North 1-4 Q weight(g)	IXa Centr-N 1-4 Q weight(g)	IXa Centr-S 1-4 Q weight(g)	IXa South 1-4 Q weight(g)	All areas 1-4 Q weight(g)
0	50	20	27	19	17	25	19
1	47	67	57	36	27	48	38
2	62	77	63	47	45	54	51
3	77	84	72	55	53	62	58
4	84	87	78	59	58	65	64
5	86	89	81	61	60	79	71
6	99	97	86	66	65	85	74
7	94	95	89	79	66	0	87
8	112	105	102	0	0	0	107
9	114	106	94	0	0	0	107
10	102	99	95	0	0	0	100
11	111	115	113	0	0	0	113
12	47	108	105	0	0	0	67
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15+	0	0	0	0	0	0	0
0-15+	81	85	70	46	49	61	54

Table 8.10.1: Input data and results output of the sardine assessment

Sardine South (run: ICAPCL03/I03)

Catch in number

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	844.0	854.0	643.0	842.0	1021.0	60.0	1061.0	109.0	258.0	238.0	1401.0	439.0
1	2421.0	2145.0	1479.0	1997.0	1920.0	769.0	553.0	3289.0	527.0	702.0	512.0	979.0
2	954.0	913.0	935.0	1542.0	1720.0	1854.0	838.0	470.0	2343.0	987.0	615.0	525.0
3	110.0	281.0	423.0	372.0	666.0	701.0	795.0	488.0	457.0	903.0	520.0	428.0
4	22.0	127.0	187.0	155.0	192.0	350.0	322.0	295.0	290.0	322.0	521.0	303.0
5	3.0	40.0	93.0	47.0	102.0	130.0	140.0	176.0	197.0	194.0	147.0	291.0
6	1.0	16.0	36.0	30.0	76.0	129.0	139.0	116.0	101.0	166.0	170.0	189.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0	1.0

Thousands

Catch in number

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	244.0	234.0	1574.0	490.0	88.0	121.0	31.0	276.9
1	512.0	562.0	456.0	985.0	562.0	61.0	186.0	96.9
2	895.0	488.0	404.0	423.0	1051.0	527.0	273.0	324.4
3	381.0	680.0	380.0	317.0	502.0	1059.0	798.0	486.4
4	215.0	275.0	256.0	175.0	245.0	261.0	440.0	626.9
5	198.0	142.0	72.0	108.0	111.0	107.0	67.0	193.9
6	183.0	104.0	26.0	19.0	66.0	35.0	29.0	27.9
7	61.0	142.0	79.0	61.0	52.0	36.0	35.5	18.5
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Thousands

Predicted Catch in Number

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	220.7	462.7	320.8	306.6	357.8	791.2	472.9	144.5	135.8	65.5	340.3
1	386.4	339.1	791.9	443.4	549.5	390.8	908.6	820.8	171.5	187.1	116.7
2	696.0	513.3	494.3	925.1	658.1	498.5	381.4	1331.3	822.8	201.1	278.5
3	1157.2	686.8	544.0	413.5	957.4	414.0	350.4	401.0	952.6	698.2	211.8
4	396.0	671.9	423.1	258.6	241.4	328.2	164.6	212.1	161.3	463.3	419.3
5	256.3	196.9	353.8	170.8	128.4	69.4	110.5	85.0	72.1	66.7	237.1
6	145.5	141.1	114.4	157.8	93.0	40.8	25.9	62.9	32.0	33.0	37.5
7	28.7	26.2	27.6	17.1	30.3	9.9	5.0	5.0	7.8	4.9	6.5
8	1.5	2.3	2.4	2.0	1.6	1.7	.6	.5	.3	.6	.5
9	1.5	1.3	2.4	2.0	2.2	1.1	1.2	.6	.3	.3	.6
10	1.0	.7	.6	.9	1.0	.7	.4	.6	.2	.1	.1

Thousands

Weights at age in the catches (Kg)

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700	.01700
1	.03400	.03400	.03400	.03400	.03400	.03400	.03400	.03400	.03400	.03400	.03400	.03400
2	.05200	.05200	.05200	.05200	.05200	.05200	.05200	.05200	.05200	.05200	.05200	.05200
3	.06000	.06000	.06000	.06000	.06000	.06000	.06000	.06000	.06000	.06000	.06000	.06000
4	.06800	.06800	.06800	.06800	.06800	.06800	.06800	.06800	.06800	.06800	.06800	.06800
5	.07200	.07200	.07200	.07200	.07200	.07200	.07200	.07200	.07200	.07200	.07200	.07200
6	.07900	.07900	.07900	.07900	.07900	.07900	.07900	.07900	.07900	.07900	.07900	.07900
7	.09300	.09300	.09300	.09300	.09300	.09300	.09300	.09300	.09300	.09300	.09300	.09300

8	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
9	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
10	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
11	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000

Units

Table 8.10.1: (cont'd)

Weights at age in the catches (Kg)

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	.01300	.02400	.02000	.01800	.01700	.02000	.02500	.01900
1	.03500	.03200	.03100	.04500	.03700	.03600	.04700	.03800
2	.05200	.04700	.05800	.05500	.05100	.05800	.05900	.05100
3	.05900	.05700	.06300	.06600	.05800	.06200	.06600	.05800
4	.06600	.06100	.07300	.07000	.06600	.07000	.07100	.06400
5	.07100	.06700	.07400	.07900	.07100	.07600	.08200	.07100
6	.08700	.07000	.08700	.08300	.08100	.08700	.09100	.07400
7	.09300	.09600	.09700	.09100	.09300	.09300	.09100	.08700
8	.10000	.10000	.10000	.10000	.10000	.10000	.09100	.08700
9	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.09700
10	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.09700
11	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000

Units

Weights at age in the stock (Kg)

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
1	.01500	.01500	.01500	.01500	.01500	.01500	.01500	.01500	.01500	.01500	.01500	.01500
2	.03800	.03800	.03800	.03800	.03800	.03800	.03800	.03800	.03800	.03800	.03800	.03800
3	.05000	.05000	.05000	.05000	.05000	.05000	.05000	.05000	.05000	.05000	.05000	.05000
4	.06400	.06400	.06400	.06400	.06400	.06400	.06400	.06400	.06400	.06400	.06400	.06400
5	.06700	.06700	.06700	.06700	.06700	.06700	.06700	.06700	.06700	.06700	.06700	.06700
6	.07700	.07700	.07700	.07700	.07700	.07700	.07700	.07700	.07700	.07700	.07700	.07700
7	.08600	.08600	.08600	.08600	.08600	.08600	.08600	.08600	.08600	.08600	.08600	.08600
8	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
9	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
10	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
11	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000

Units

Weights at age in the stock (Kg)

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
1	.01500	.01500	.01900	.02700	.02200	.03100	.02900	.03600
2	.03800	.03800	.04200	.03600	.04500	.04000	.05000	.04700
3	.05000	.05000	.05000	.05000	.05700	.04900	.06200	.06100
4	.06400	.06400	.06400	.06200	.06400	.06000	.07200	.06900
5	.06700	.06700	.07100	.06900	.07300	.06700	.07900	.07500
6	.07700	.07900	.07500	.07600	.07600	.07000	.08000	.08400
7	.08600	.08600	.08800	.09100	.09100	.08500	.09200	.10000
8	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
9	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
10	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000
11	.10000	.10000	.10000	.10000	.10000	.10000	.10000	.10000

Units

Natural Mortality (per year)

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
1	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
2	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
3	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
4	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
5	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
6	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000

7	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
8	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
9	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
10	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
11	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000

Units

Natural Mortality (per year)

Table 8.10.1: (cont'd)

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
1	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
2	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
3	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
4	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
5	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
6	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
7	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
8	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
9	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
10	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000
11	.33000	.33000	.33000	.33000	.33000	.33000	.33000	.33000

Units

Proportion of fish spawning

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500	.6500
2	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Units

Proportion of fish spawning

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.2300	.6000	.7400	.7900	.4700	.8000	.7300	.8300
2	.8300	.8100	.9100	.9100	.9300	.8900	.9800	.8900
3	.9100	.8800	.9600	.9500	.9400	.9600	.9700	.9200
4	.9200	.8900	.9700	.9800	.9700	.9600	.9900	.9600
5	.9400	.9400	1.0000	1.0000	.9900	.9700	1.0000	1.0000
6	.9700	.9700	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Units

AGE - STRUCTURED INDICES

ACUSP: Portuguese Spring AS (Catch: Unkn

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	2343.9	1.0	7743.0	1.0	1.0	1.0	1.0	1.0	1.0	228.4	1294.6	4299.0
2	4024.7	1.0	2684.2	1.0	1.0	1.0	1.0	1.0	1.0	237.1	1153.7	2437.0
3	1544.5	1.0	1617.2	1.0	1.0	1.0	1.0	1.0	1.0	2110.9	933.6	1555.0

4	517.5	1.0	1446.9	1.0	1.0	1.0	1.0	1.0	1.0	2949.0	2213.0	1725.0
5	470.6	1.0	804.1	1.0	1.0	1.0	1.0	1.0	1.0	729.7	303.8	1836.0
6	21.3	1.0	425.3	1.0	1.0	1.0	1.0	1.0	1.0	128.2	4.6	239.0

Thousands

Table 8.10.1: (cont'd)

ACUST: Spanish Spring AS (Catch: Unknown

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	221.00	73.00	69.00	25.00	168.00	239.00	1.00	18.30	10.64	56.13
2	63.00	304.00	56.00	208.00	77.00	427.00	1.00	16.70	54.25	262.79
3	72.00	66.00	274.00	164.00	88.00	136.00	1.00	97.40	90.55	126.03
4	64.00	96.00	55.00	401.00	31.00	126.00	1.00	80.60	363.96	123.03
5	858.00	76.00	88.00	62.00	117.00	146.00	1.00	19.10	221.32	65.26
6	175.00	906.00	134.00	76.00	25.00	418.00	1.00	8.50	14.74	38.41
7	310.00	156.00	249.00	52.00	21.00	48.00	1.00	5.50	7.23	12.52
8	342.00	177.00	70.00	352.00	12.00	103.00	1.00	1.00	2.81	7.43
9	53.00	97.00	49.00	26.00	54.00	108.00	1.00	1.00	1.00	4.19
10	18.00	42.00	46.00	60.00	3.00	330.00	1.00	1.00	1.00	1.00
11	1.00	11.00	23.00	8.00	8.00	112.00	1.00	1.00	1.00	1.00

Thousands

Fishing Mortality (per year)

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.08342	.07544	.04863	.06139	.10760	.00834	.05460	.01437	.04848	.05105	.05549	.06816
1	.36970	.36415	.20834	.24098	.22304	.12664	.11327	.27515	.10217	.10905	.11852	.14559
2	.27474	.26824	.31025	.40665	.39320	.40639	.22825	.15273	.37540	.21939	.23845	.29289
3	.05619	.13929	.22131	.22537	.35930	.31969	.35591	.23277	.25176	.37538	.40799	.50114
4	.01929	.09730	.14886	.13530	.20041	.37958	.27572	.25010	.24409	.42085	.45741	.56185
5	.00431	.05046	.10987	.05790	.14225	.23420	.29765	.27624	.30591	.41295	.44882	.55130
6	.00207	.03252	.06695	.05360	.14359	.31153	.49385	.50637	.29284	.45582	.49542	.60854
7	.00259	.00288	.00288	.00268	.00256	.00284	.00398	.00650	.00805	.14511	.15771	.19372
8	.00325	.00361	.00407	.00402	.00374	.00357	.00397	.00557	.00911	.01653	.01796	.02206
9	.00508	.00454	.00504	.00563	.00568	.00523	.00499	.00554	.00936	.01961	.02131	.02618
10	.00649	.00710	.00634	.00706	.00788	.00795	.00732	.00838	.00776	.01097	.01192	.01464
11	.00649	.00710	.00634	.00706	.00788	.00795	.00732	.00838	.00776	.01097	.01192	.01464

Units

Fishing Mortality (per year)

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	.06808	.09008	.07224	.05958	.07487	.06419	.06348	.08265
1	.14541	.19242	.15431	.12726	.15992	.13711	.13559	.17655
2	.29254	.38711	.31044	.25601	.32173	.27583	.27278	.35518
3	.50054	.66235	.53117	.43804	.55049	.47195	.46673	.60771
4	.56117	.74259	.59551	.49111	.61718	.52912	.52327	.68133
5	.55063	.72863	.58432	.48188	.60558	.51918	.51344	.66853
6	.60780	.80429	.64499	.53191	.66846	.57309	.56675	.73794
7	.19349	.25604	.20533	.16933	.21280	.18244	.18042	.23492
8	.02204	.02916	.02339	.01929	.02424	.02078	.02055	.02676
9	.02615	.03460	.02775	.02288	.02876	.02465	.02438	.03175
10	.01463	.01936	.01552	.01280	.01609	.01379	.01364	.01776
11	.01463	.01936	.01552	.01280	.01609	.01379	.01364	.01776

Units

Population Abundance (1 January)

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	12352.	13770.	15883.	16575.	11716.	8477.	23406.	8964.	6392.	5198.	10050.	5706.
1	9105.	8170.	9180.	10877.	11207.	7564.	6044.	15933.	6352.	4378.	3551.	6835.
2	4628.	4523.	4081.	5359.	6145.	6446.	4791.	3880.	8699.	4123.	2822.	2267.
3	2360.	2528.	2486.	2151.	2565.	2982.	3087.	2741.	2394.	4297.	2380.	1598.
4	1352.	1604.	1581.	1433.	1234.	1288.	1557.	1555.	1562.	1338.	2122.	1138.
5	819.	953.	1046.	979.	900.	726.	633.	850.	870.	880.	632.	966.
6	568.	587.	651.	674.	664.	561.	413.	338.	463.	461.	418.	290.
7	454.	408.	408.	438.	459.	414.	295.	181.	146.	249.	210.	183.

8	362.	326.	292.	293.	314.	329.	297.	212.	129.	104.	155.	129.
9	232.	259.	233.	209.	210.	225.	236.	212.	151.	92.	74.	109.
10	181.	166.	186.	167.	150.	150.	161.	169.	152.	108.	65.	52.
11	181.	166.	186.	167.	150.	148.	177.	141.	152.	108.	99.	81.

Thousands

Table 8.10.1: (cont'd)

Population Abundance (1 January)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	5459.	4864.	13302.	9584.	2347.	2559.	1249.	5025.	5377.
1	3832.	3667.	3195.	8897.	6492.	1566.	1726.	843.	3326.
2	4248.	2382.	2175.	1969.	5632.	3977.	981.	1083.	508.
3	1216.	2279.	1163.	1146.	1096.	2935.	2170.	537.	546.
4	696.	530.	845.	491.	532.	454.	1316.	978.	210.
5	466.	286.	181.	335.	216.	206.	192.	561.	356.
6	400.	193.	99.	73.	149.	85.	88.	83.	207.
7	113.	157.	62.	37.	31.	55.	34.	36.	28.
8	109.	67.	87.	36.	23.	18.	33.	21.	20.
9	91.	76.	47.	61.	26.	16.	13.	23.	14.
10	76.	64.	53.	33.	43.	18.	11.	9.	16.
11	81.	61.	76.	92.	74.	86.	87.	67.	53.

Thousands

Weighting factors for the catches in number

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100
8	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100
9	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100
10	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100

Units

Predicted Age-Structured Index Values

ACUSP: Portuguese Spring AS (Catch: UnknPredicted

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	3070.2	1.0	4743.1	1.0	1.0	1.0	1.0	1.0	1.0	1201.0	579.4	2287.5
2	4534.8	1.0	2441.0	1.0	1.0	1.0	1.0	1.0	1.0	1062.7	1145.4	536.8
3	5003.9	1.0	1794.9	1.0	1.0	1.0	1.0	1.0	1.0	2461.2	584.8	594.4
4	2559.7	1.0	2089.7	1.0	1.0	1.0	1.0	1.0	1.0	2444.1	1735.2	373.0
5	1253.8	1.0	1322.5	1.0	1.0	1.0	1.0	1.0	1.0	266.4	742.2	471.0
6	176.2	1.0	106.0	1.0	1.0	1.0	1.0	1.0	1.0	32.7	29.2	72.8

Thousands

ACUST: Spanish Spring AS (Catch: UnknownPredicted

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	119.10	66.77	63.03	55.54	155.85	112.65	1.00	30.16	14.55	57.44
2	129.07	241.85	131.93	123.16	113.28	317.93	1.00	56.19	60.56	28.38
3	155.37	118.24	211.44	112.04	113.46	104.99	1.00	213.05	50.62	51.45
4	186.83	114.32	82.57	137.37	82.35	85.90	1.00	218.51	155.13	33.35
5	302.83	146.31	85.06	56.32	107.16	66.74	1.00	61.00	169.96	107.86
6	149.38	206.20	94.15	50.52	38.30	75.32	1.00	46.02	41.09	102.54
7	128.21	79.32	107.59	43.36	26.33	21.35	1.00	24.15	24.87	19.67
8	90.53	76.22	47.06	61.16	25.59	15.91	1.00	23.05	14.47	14.34
9	48.63	40.40	33.93	20.89	27.30	11.43	1.00	5.60	10.28	6.43
10	17.94	26.38	21.89	18.29	11.33	14.84	1.00	3.85	3.04	5.55

11	5.44	5.45	4.12	5.13	6.22	4.95	1.00	5.84	4.49	3.59

Thousands

Fitted Selection Pattern

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	.3036	.2812	.1567	.1510	.2736	.0205	.2392	.0941	.1292	.2327	.2327	.2327
1	1.3456	1.3575	.6715	.5926	.5673	.3116	.4963	1.8015	.2722	.4971	.4971	.4971
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	.2045	.5193	.7133	.5542	.9138	.7867	1.5593	1.5241	.6707	1.7110	1.7110	1.7110
4	.0702	.3627	.4798	.3327	.5097	.9340	1.2080	1.6375	.6502	1.9183	1.9183	1.9183
5	.0157	.1881	.3541	.1424	.3618	.5763	1.3040	1.8087	.8149	1.8822	1.8822	1.8822
6	.0075	.1212	.2158	.1318	.3652	.7666	2.1636	3.3155	.7801	2.0777	2.0777	2.0777
7	.0094	.0108	.0093	.0066	.0065	.0070	.0174	.0425	.0214	.6614	.6614	.6614
8	.0118	.0135	.0131	.0099	.0095	.0088	.0174	.0364	.0243	.0753	.0753	.0753
9	.0185	.0169	.0163	.0138	.0144	.0129	.0219	.0363	.0249	.0894	.0894	.0894
10	.0236	.0265	.0204	.0174	.0200	.0196	.0321	.0549	.0207	.0500	.0500	.0500
11	.0236	.0265	.0204	.0174	.0200	.0196	.0321	.0549	.0207	.0500	.0500	.0500

Units

Fitted Selection Pattern

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	.2327	.2327	.2327	.2327	.2327	.2327	.2327	.2327
1	.4971	.4971	.4971	.4971	.4971	.4971	.4971	.4971
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.7110	1.7110	1.7110	1.7110	1.7110	1.7110	1.7110	1.7110
4	1.9183	1.9183	1.9183	1.9183	1.9183	1.9183	1.9183	1.9183
5	1.8822	1.8822	1.8822	1.8822	1.8822	1.8822	1.8822	1.8822
6	2.0777	2.0777	2.0777	2.0777	2.0777	2.0777	2.0777	2.0777
7	.6614	.6614	.6614	.6614	.6614	.6614	.6614	.6614
8	.0753	.0753	.0753	.0753	.0753	.0753	.0753	.0753
9	.0894	.0894	.0894	.0894	.0894	.0894	.0894	.0894
10	.0500	.0500	.0500	.0500	.0500	.0500	.0500	.0500
11	.0500	.0500	.0500	.0500	.0500	.0500	.0500	.0500

Units

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield/ SSB ratio	Mean F Ages 2- 5	SoP (%)
1977	12352240	750289	619231	125750	.2031	.0886	123
1978	13769980	759192	628073	139990	.2229	.1388	117
1979	15883360	763313	624829	153441	.2456	.1976	102
1980	16575250	804765	646282	191682	.2966	.2063	105
1981	11716230	842091	668464	214133	.3203	.2738	111
1982	8476990	802573	645284	204504	.3169	.3350	102
1983	23406060	713376	584388	181139	.3100	.2894	94
1984	8964010	794856	614588	202686	.3298	.2280	103
1985	6391710	810539	654500	204107	.3119	.2943	104
1986	5197550	679808	553952	180606	.3260	.3571	101
1987	10049550	547179	442867	168825	.3812	.3882	97
1988	5705500	481295	369772	158540	.4287	.4768	95
1989	5459370	431719	292600	137126	.4686	.4762	102
1990	4863680	368099	252719	139157	.5506	.6302	95
1991	13302000	316365	242215	127756	.5274	.5054	99
1992	9583950	453161	340960	126054	.3697	.4168	99
1993	2347120	539096	371516	138795	.3736	.5237	100
1994	2559410	416842	322598	132800	.4117	.4490	100
1995	1248740	368158	290475	121384	.4179	.4441	99
1996	5025100	246037	186657	111431	.5970	.5782	100

IFAP run code: I03

No of years for separable analysis : 11

Table 8.10.1: (cont'd)

```
Age range in the analysis          :  0 11
Year range in the analysis         :  1977 1996
Number of indices of SSB           :  0
Number of age-structured indices   :  2
Parameters to estimate             :  58
Number of observations             :  250

 Conventional single selection vector model to be fitted.

-----------------------------------------------------------------
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PARAMETER ESTIMATES

Parm No.		Maximum Likelih. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. distrib.
Separable Model: Reference F by year								
1	1986	.2194	21	.1445	.3331	.1773	.2715	.2244
2	1987	.2384	19	.1618	.3513	.1957	.2906	.2432
3	1988	.2929	18	.2033	.4219	.2431	.3528	.2980
4	1989	.2925	18	.2042	.4191	.2435	.3515	.2975
5	1990	.3871	18	.2706	.5538	.3225	.4647	.3936
6	1991	.3104	19	.2108	.4572	.2548	.3783	.3166
7	1992	.2560	19	.1733	.3783	.2098	.3124	.2611
8	1993	.3217	19	.2186	.4735	.2642	.3919	.3280
9	1994	.2758	21	.1826	.4166	.2235	.3404	.2820
10	1995	.2728	22	.1752	.4248	.2176	.3419	.2798
11	1996	.3552	26	.2102	.6002	.2718	.4642	.3681
Separable Model: Selection (S) by age								
12	0	.2327	19	.1575	.3437	.1907	.2839	.2374
13	1	.4971	16	.3630	.6807	.4234	.5835	.5035
	2	1.0000			Fixed : Reference age			
14	3	1.7110	15	1.2534	2.3357	1.4598	2.0054	1.7327
15	4	1.9183	19	1.2997	2.8314	1.5727	2.3398	1.9565
16	5	1.8822	33	.9793	3.6176	1.3487	2.6269	1.9898
17	6	2.0777	62	.6109	7.0658	1.1127	3.8797	2.5250
18	7	.6614	135	.0463	9.4497	.1703	2.5688	1.6605
19	8	.0753	149	.0040	1.4161	.0169	.3365	.2309
20	9	.0894	149	.0047	1.6872	.0200	.4001	.2749
	10	.0500			Fixed : last true age			
Separable Model: Populations in year 1996								
21	0	5025106	47	1972673	12800741	3118577	8097183	5630759
22	1	842534	31	453242	1566190	614061	1156015	885757
23	2	1083284	26	650552	1803860	835126	1405181	1120574
24	3	537100	24	331922	869109	420158	686590	553539
25	4	978266	27	572868	1670548	744534	1285374	1015415
26	5	560715	36	276367	1137621	390822	804461	598459
27	6	82771	54	28406	241179	47963	142839	96057
28	7	35980	94	5640	229508	13979	92607	56252
29	8	20637	112	2284	186401	6714	63431	38764
30	9	23114	118	2279	234399	7088	75367	46475
31	10	8811	118	864	89832	2694	28809	17773
Separable Model: Populations at age 10								
32	1986	107694	359	93	123908252	2954	3925372	69189797
33	1987	65021	267	345	12246984	4491	941363	2312632
34	1988	51987	152	2622	1030552	11326	238628	166025
35	1989	76436	137	5182	1127262	19364	301709	196179
36	1990	63507	115	6546	616125	19922	202449	124360
37	1991	53018	115	5550	506475	16763	167685	102879
38	1992	32797	117	3290	326917	10147	106006	65267
39	1993	43007	121	3952	467919	12724	145357	90279
40	1994	17936	129	1417	226956	4913	65477	41478
41	1995	11162	122	1005	123849	3269	38105	23719

Age-structured index catchabilities

ACUSP: Portuguese Spring AS (Catch: Unkn

Linear model fitted. Slopes at age:

42	1	Q	.7966	43 .5266	2.854	.7966	1.887	1.345
43	2	Q	1.290	42 .8579	4.533	1.290	3.015	2.158
44	3	Q	1.429	43 .9420	5.165	1.429	3.405	2.424
45	4	Q	2.378	46 1.515	9.556	2.378	6.086	4.249
46	5	Q	1.768	56 1.030	9.363	1.768	5.453	3.639
47	6	Q	.4802	78 .2268	4.848	.4802	2.290	1.423

ACUST: Spanish Spring AS (Catch: Unknown

Linear model fitted. Slopes at age:

48	1	Q	.2000E-01	41	.1341E-01	.6862E-01	.2000E-01	.4600E-01	.3308E-01
49	2	Q	.6820E-01	41	.4574E-01	.2336	.6820E-01	.1567	.1127
50	3	Q	.1237	42	.8225E-01	.4352	.1237	.2894	.2071
51	4	Q	.2126	45	.1372	.8216	.2126	.5300	.3726
52	5	Q	.4049	54	.2399	2.035	.4049	1.205	.8107
53	6	Q	.6766	76	.3240	6.553	.6766	3.138	1.956
54	7	Q	.8143	108	.2883	20.01	.8143	7.084	4.311
55	8	Q	.7775	120	.2447	27.47	.7775	8.644	5.354
56	9	Q	.4940	121	.1531	18.28	.4940	5.668	3.522
57	10	Q	.3814	122	.1171	14.53	.3814	4.463	2.779
58	11	Q	.7446E-01	42	.4932E-01	.2653	.7446E-01	.1757	.1254

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.076	1.108	.314	-.228	-.425	.688	.036	-.496	-.115	-.749	-.206
1	.597	.412	.212	.144	.022	.154	.081	-.379	-1.034	-.006	-.186
2	.349	.181	.060	-.033	-.299	-.210	.103	-.236	-.446	.306	.152
3	-.248	-.278	-.240	-.082	-.342	-.086	-.100	.225	.106	.134	.831
4	-.207	-.254	-.334	-.185	.130	-.248	.061	.144	.481	-.052	.402
5	-.279	-.292	-.196	.148	.101	.036	-.023	.266	.394	.004	-.201
6	.132	.186	.502	.148	.112	-.451	-.310	.049	.089	-.130	-.296
7	-3.357	-3.266	-3.319	1.273	1.543	2.078	2.505	2.334	1.527	1.990	1.054
8	-.196	-.852	-.875	-.701	-.498	-.541	.523	.770	1.163	.564	.767
9	-.423	-.283	-.877	-.691	-.795	-.090	-.166	.477	1.108	1.355	.485
10	-.001	.421	.440	.056	-.037	.363	1.034	.536	1.564	2.049	2.024

Units

AGE - STRUCTURED INDEX RESIDUALS

ACUSP: Portuguese Spring AS (Catch: Unkn

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-.270	-1.000	.490	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.660	.804	.631
2	-.119	-1.000	.095	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.500	.007	1.513
3	-1.176	-1.000	-.104	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-.154	.468	.962
4	-1.599	-1.000	-.368	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	.188	.243	1.531
5	-.980	-1.000	-.498	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1.008	-.893	1.360
6	-2.112	-1.000	1.389	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	1.368	-1.837	1.189

Units

ACUST: Spanish Spring AS (Catch: Unknown

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	.618	.089	.091	-.798	.075	.752	-1.000	-.499	-.313	-.023
2	-.717	.229	-.857	.524	-.386	.295	-1.000	-1.213	-.110	2.226
3	-.769	-.583	.259	.381	-.254	.259	-1.000	-.783	.582	.896
4	-1.071	-.175	-.406	1.071	-.977	.383	-1.000	-.997	.853	1.305
5	1.041	-.655	.034	.096	.088	.783	-1.000	-1.161	.264	-.502
6	.158	1.480	.353	.408	-.427	1.714	-1.000	-1.689	-1.025	-.982
7	.883	.676	.839	.182	-.226	.810	-1.000	-1.479	-1.236	-.451
8	1.329	.843	.397	1.750	-.757	1.868	-1.000	-3.138	-1.638	-.658
9	.086	.876	.367	.219	.682	2.246	-1.000	-1.723	-2.330	-.426
10	.003	.465	.743	1.188	-1.328	3.102	-1.000	-1.349	-1.111	-1.714
11	-1.694	.703	1.720	.444	.252	3.119	-1.000	-1.765	-1.501	-1.278

Units

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1986 to 1996

Variance	:	.0994
Skewness test statistic	:	.0853
Kurtosis test statistic	:	5.1763
Partial chi-square	:	.6803
Significance in fit	:	.0000
Degrees of freedom	:	80

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ACUSP: Portuguese Spring AS (Catch: Unkn

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6
Variance	:	.1713	.1901	.1067	.2138	.2030	.5436
Skewness test stat.	:	-.9064	.0180	-.3177	-.0917	.3347	-.3763
Kurtosis test stat.	:	-.2590	-.2397	-.3895	-.3241	-.7851	-.8265
Partial chi-square	:	.0489	.0562	.0297	.0620	.0613	.1951
Significance in fit	:	.0003	.0004	.0001	.0005	.0005	.0045
Number of data	:	5	5	5	5	5	5
Degrees of freedom	:	4	4	4	4	4	4
Weight in analysis	:	.1667	.1667	.1667	.1667	.1667	.1667

DISTRIBUTION STATISTICS FOR ACUST: Spanish Spring AS (Catch: Unknown

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6	7	8	9	10
Variance	:	.0222	.0937	.0344	.0798	.0434	.1192	.0750	.2582	.1710	.2223
Skewness test stat.	:	-.0001	1.2966	-.0999	.1787	-.1698	.1593	-.6725	-.7167	-.3444	.8846
Kurtosis test stat.	:	-.4756	.3992	-.8557	-.9400	-.4653	-.6522	-.7099	-.4508	-.2646	-.2306
Partial chi-square	:	.0160	.0702	.0239	.0556	.0299	.0849	.0573	.2030	.1480	.1933
Significance in fit	:	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Number of data	:	9	9	9	9	9	9	9	9	9	9
Degrees of freedom	:	8	8	8	8	8	8	8	8	8	8
Weight in analysis	:	.0909	.0909	.0909	.0909	.0909	.0909	.0909	.0909	.0909	.0909

ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

Variance		SSQ	Data	Params	d.f.	
	Total for Model	249.0266	250	58	192	1.2970
	Catches at Age	92.9495	121	41	80	1.1619
Aged Indices						
ACUSP: Portuguese Spring AS (Catch: Unk		34.2846	30	6	24	1.4285
ACUST: Spanish Spring AS (Catch: Unknow		121.7925	99	11	88	1.3840

Weighted Statistics

Variance		SSQ	Data	Params	d.f.	
	Total for Model	9.9129	250	58	192	.0516
	Catches at Age	7.9540	121	41	80	.0994
Aged Indices						
ACUSP: Portuguese Spring AS (Catch: Unk		.9523	30	6	24	.0397
ACUST: Spanish Spring AS (Catch: Unknow		1.0065	99	11	88	.0114

Table 8.13.1a

18:59 Monday, September 15, 1997

Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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
0	2004000.0	0.2500	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	3498000.0	0.2500	0.7300	0.2500	0.2500	0.027	0.1485	0.039
2	538000.00	0.2500	0.9200	0.2500	0.2500	0.043	0.3022	0.055
3	569000.00	0.2500	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	217000.00	0.2500	0.9700	0.2500	0.2500	0.065	0.5955	0.069
5	356000.00	0.2500	0.9930	0.2500	0.2500	0.072	0.6042	0.076
6	196000.00	0.2500	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	24000.000	0.2500	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	17000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	11000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	12000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	58000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
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
0	2004000.0	0.2500	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	.	0.2500	0.7300	0.2500	0.2500	0.027	0.1485	0.039
2	.	0.2500	0.9200	0.2500	0.2500	0.043	0.3022	0.055
3	.	0.2500	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	.	0.2500	0.9700	0.2500	0.2500	0.065	0.5955	0.069
5	.	0.2500	0.9930	0.2500	0.2500	0.072	0.6042	0.076
6	.	0.2500	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	.	0.2500	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
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
0	2004000.0	0.2500	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	.	0.2500	0.7300	0.2500	0.2500	0.027	0.1485	0.039
2	.	0.2500	0.9200	0.2500	0.2500	0.043	0.3022	0.055
3	.	0.2500	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	.	0.2500	0.9700	0.2500	0.2500	0.065	0.5955	0.069
5	.	0.2500	0.9930	0.2500	0.2500	0.072	0.6042	0.076
6	.	0.2500	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	.	0.2500	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANPCL02
Date and time: 15SEP97:20:20

Table 8.13.1b

18:59 Monday, September 15, 1997

Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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
0	4901000.0	0.2500	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	3498000.0	0.2500	0.7300	0.2500	0.2500	0.027	0.1485	0.039
2	538000.00	0.2500	0.9200	0.2500	0.2500	0.043	0.3022	0.055
3	569000.00	0.2500	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	217000.00	0.2500	0.9700	0.2500	0.2500	0.065	0.5955	0.069
5	356000.00	0.2500	0.9930	0.2500	0.2500	0.072	0.6042	0.076
6	196000.00	0.2500	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	24000.000	0.2500	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	17000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	11000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	12000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	58000.000	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
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
0	4901000.0	0.2500	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	.	0.2500	0.7300	0.2500	0.2500	0.027	0.1485	0.039
2	.	0.2500	0.9200	0.2500	0.2500	0.043	0.3022	0.055
3	.	0.2500	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	.	0.2500	0.9700	0.2500	0.2500	0.065	0.5955	0.069
5	.	0.2500	0.9930	0.2500	0.2500	0.072	0.6042	0.076
6	.	0.2500	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	.	0.2500	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
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
0	4901000.0	0.2500	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	.	0.2500	0.7300	0.2500	0.2500	0.027	0.1485	0.039
2	.	0.2500	0.9200	0.2500	0.2500	0.043	0.3022	0.055
3	.	0.2500	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	.	0.2500	0.9700	0.2500	0.2500	0.065	0.5955	0.069
5	.	0.2500	0.9930	0.2500	0.2500	0.072	0.6042	0.076
6	.	0.2500	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	.	0.2500	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	.	0.2500	1.0000	0.2500	0.2500	0.100	0.0151	0.100
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANPCL02
Date and time: 15SEP97:20:20

Table 8.13.2a

18:59 Monday, September 15, 1997

Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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	0.5059	217065	161025	63786	0.0000	0.0000	209935	178146	0	251833	216810
.	.	.	.	.	0.1000	0.0506	.	176632	7481	244977	208581
.	.	.	.	.	0.2000	0.1012	.	175135	14685	238384	200755
.	.	.	.	.	0.3000	0.1518	.	173653	21624	232043	193309
.	.	.	.	.	0.4000	0.2023	.	172187	28311	225942	186221
.	.	.	.	.	0.5000	0.2529	.	170737	34757	220069	179473
.	.	.	.	.	0.6000	0.3035	.	169303	40973	214414	173044
.	.	.	.	.	0.7000	0.3541	.	167883	46969	208967	166918
.	.	.	.	.	0.8000	0.4047	.	166479	52755	203718	161079
.	.	.	.	.	0.9000	0.4553	.	165090	58339	198660	155509
.	.	.	.	.	1.0000	0.5059	.	163715	63731	193782	150196
.	.	.	.	.	1.1000	0.5564	.	162355	68939	189078	145125
.	.	.	.	.	1.2000	0.6070	.	161009	73971	184539	140283
.	.	.	.	.	1.3000	0.6576	.	159677	78834	180158	135659
.	.	.	.	.	1.4000	0.7082	.	158360	83536	175929	131240
.	.	.	.	.	1.5000	0.7588	.	157056	88083	171844	127016
.	.	.	.	.	1.6000	0.8094	.	155766	92481	167898	122976
.	.	.	.	.	1.7000	0.8599	.	154489	96737	164085	119112
.	.	.	.	.	1.8000	0.9105	.	153226	100857	160398	115415
.	.	.	.	.	1.9000	0.9611	.	151976	104846	156834	111875
.	.	.	.	.	2.0000	1.0117	.	150739	108710	153386	108484
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANPCL02
Date and time : 15SEP97:20:20
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1997 : F factors

Table 8.13.2b

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Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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	0.5059	217065	161025	67189	0.0000	0.0000	267481	217610	0	384553	320508
.	.	.	.	.	0.1000	0.0506	.	215950	8903	376224	310471
.	.	.	.	.	0.2000	0.1012	.	214306	17511	368178	300872
.	.	.	.	.	0.3000	0.1518	.	212679	25837	360400	291687
.	.	.	.	.	0.4000	0.2023	.	211069	33895	352881	282894
.	.	.	.	.	0.5000	0.2529	.	209475	41694	345607	274473
.	.	.	.	.	0.6000	0.3035	.	207897	49247	338569	266404
.	.	.	.	.	0.7000	0.3541	.	206334	56564	331756	258669
.	.	.	.	.	0.8000	0.4047	.	204787	63654	325158	251251
.	.	.	.	.	0.9000	0.4553	.	203256	70527	318767	244134
.	.	.	.	.	1.0000	0.5059	.	201740	77192	312574	237302
.	.	.	.	.	1.1000	0.5564	.	200239	83657	306570	230741
.	.	.	.	.	1.2000	0.6070	.	198753	89931	300747	224438
.	.	.	.	.	1.3000	0.6576	.	197281	96022	295099	218380
.	.	.	.	.	1.4000	0.7082	.	195824	101935	289617	212555
.	.	.	.	.	1.5000	0.7588	.	194382	107680	284296	206951
.	.	.	.	.	1.6000	0.8094	.	192953	113262	279128	201559
.	.	.	.	.	1.7000	0.8599	.	191539	118687	274108	196367
.	.	.	.	.	1.8000	0.9105	.	190138	123962	269230	191366
.	.	.	.	.	1.9000	0.9611	.	188752	129092	264489	186547
.	.	.	.	.	2.0000	1.0117	.	187378	134083	259878	18[illegible]3
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANPCL02
Date and time : 15SEP97:20:20
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1997 : F factors

Table 8.14.1a

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Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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
0	2004.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	.	0.3300	0.7267	0.2500	0.2500	0.027	0.1485	0.039
2	.	0.3300	0.9183	0.2500	0.2500	0.043	0.3022	0.055
3	.	0.3300	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	.	0.3300	0.9717	0.2500	0.2500	0.065	0.5955	0.069
5	.	0.3300	0.9933	0.2500	0.2500	0.072	0.6042	0.076
6	.	0.3300	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	.	0.3300	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0151	0.100
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDPCL03
Date and time: 15SEP97:19:47

Table 8.14.1b

18:59 Monday, September 15, 199

Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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
0	4901.000	0.3300	0.0000	0.2500	0.2500	0.000	0.0692	0.020
1	.	0.3300	0.7267	0.2500	0.2500	0.027	0.1485	0.039
2	.	0.3300	0.9183	0.2500	0.2500	0.043	0.3022	0.055
3	.	0.3300	0.9500	0.2500	0.2500	0.055	0.5215	0.062
4	.	0.3300	0.9717	0.2500	0.2500	0.065	0.5955	0.069
5	.	0.3300	0.9933	0.2500	0.2500	0.072	0.6042	0.076
6	.	0.3300	1.0000	0.2500	0.2500	0.077	0.7080	0.084
7	.	0.3300	1.0000	0.2500	0.2500	0.091	0.2086	0.092
8	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0269	0.096
9	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0314	0.100
10	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0151	0.100
11+	.	0.3300	1.0000	0.2500	0.2500	0.100	0.0151	0.100
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDPCL03
Date and time: 15SEP97:19:47

Table 8.14.2a

18:59 Monday, September 15, 1997

Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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	0	7129738	278092	4592386	260447	4228722	239823
0.0500	0.0253	74910	4534	6904919	260173	4371770	242723	4008065	222486
0.1000	0.0506	142425	8526	6702543	244250	4173502	226988	3809676	207100
0.1500	0.0759	203455	12048	6519831	230064	3994809	212985	3630807	193411
0.2000	0.1012	258789	15162	6354377	217394	3833287	200493	3469074	181203
0.2500	0.1265	309110	17920	6204094	206048	3686854	189320	3322411	170288
0.3000	0.1518	355015	20367	6067172	195859	3553702	179299	3189023	160505
0.3500	0.1770	397021	22544	5942036	186684	3432259	170288	3067347	151712
0.4000	0.2023	435576	24485	5827316	178398	3321161	162162	2956028	143787
0.4500	0.2276	471074	26219	5721823	170894	3219218	154813	2853880	136626
0.5000	0.2529	503856	27771	5624516	164077	3125394	148149	2759873	130137
0.5500	0.2782	534222	29164	5534489	157867	3038786	142087	2673106	124239
0.6000	0.3035	562432	30416	5450950	152193	2958602	136557	2592790	118865
0.6500	0.3288	588714	31546	5373205	146992	2884152	131498	2518237	113952
0.7000	0.3541	613271	32567	5300647	142213	2814832	126856	2448842	109450
0.7500	0.3794	636277	33491	5232744	137807	2750110	122585	2384074	105312
0.8000	0.4047	657888	34330	5169026	133734	2689520	118643	2323468	101498
0.8500	0.4300	678239	35093	5109082	129958	2632651	114996	2266613	97974
0.9000	0.4553	697452	35789	5052548	126448	2579143	111612	2213147	94707
0.9500	0.4806	715632	36425	4999104	123176	2528676	108463	2162750	91672
1.0000	0.5059	732874	37007	4948466	120118	2480968	105526	2115139	88845
1.0500	0.5311	749261	37542	4900383	117253	2435769	102780	2070063	86205
1.1000	0.5564	764867	38033	4854631	114562	2392858	100205	2027301	83734
1.1500	0.5817	779757	38485	4811012	112029	2352038	97785	1986654	81416
1.2000	0.6070	793992	38903	4769349	109638	2313133	95506	1947946	79235
1.2500	0.6323	807622	39289	4729485	107378	2275986	93355	1911020	77181
1.3000	0.6576	820696	39647	4691278	105237	2240459	91321	1875734	75240
1.3500	0.6829	833255	39978	4654602	103203	2206425	89393	1841962	73404
1.4000	0.7082	845337	40286	4619343	101269	2173772	87562	1809591	71664
1.4500	0.7335	856976	40573	4585400	99427	2142398	85821	1778519	70011
1.5000	0.7588	868204	40840	4552678	97668	2112214	84162	1748654	68439
1.5500	0.7841	879047	41089	4521097	95986	2083136	82578	1719913	66941
1.6000	0.8094	889532	41321	4490579	94377	2055089	81065	1692220	65511
1.6500	0.8347	899681	41538	4461057	92833	2028007	79616	1665508	64144
1.7000	0.8599	909514	41742	4432469	91351	2001828	78227	1639714	62837
1.7500	0.8852	919051	41932	4404756	89926	1976496	76893	1614782	61584
1.8000	0.9105	928310	42111	4377869	88555	1951960	75612	1590659	60381
1.8500	0.9358	937305	42278	4351759	87233	1928173	74379	1567300	59226
1.9000	0.9611	946052	42435	4326383	85959	1905093	73192	1544659	58116
1.9500	0.9864	954565	42583	4301701	84728	1882680	72047	1522699	57046
2.0000	1.0117	962854	42721	4277676	83538	1860899	70942	1501382	56016
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YLDPCL03
Date and time : 15SEP97:19:47
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : 1.0849
F-max factor : Not found
F-0.1 reference F : 0.5488
F-max reference F : Not found
Recruitment : 2004 (Millions)

Table 8.14.2b

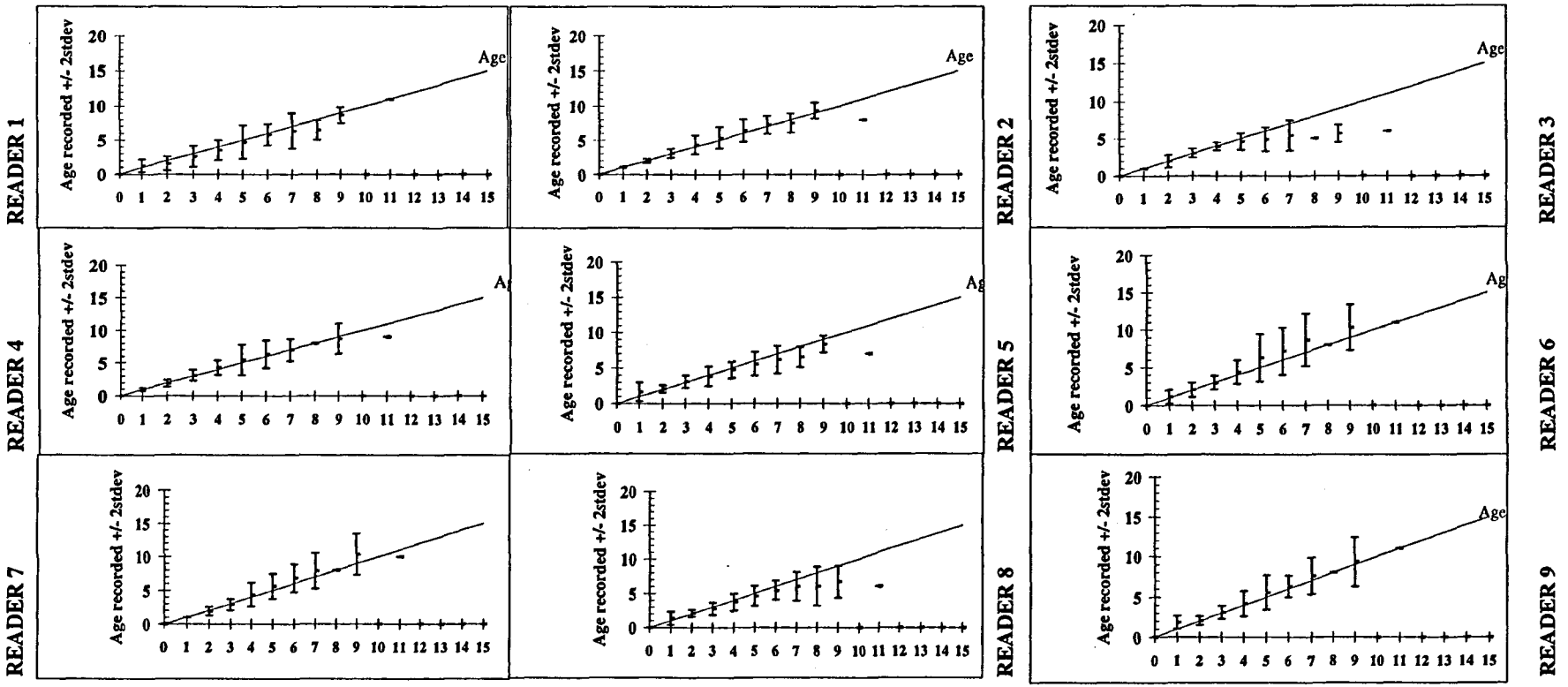
18:59 Monday, September 15, 1997

Sardine in the Southern Area (Fishing Areas VIIIc and IXa)

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	0	17436549	680104	11231180	636952	10341799	586512
0.0500	0.0253	183202	11088	16886731	636282	10691640	593604	9802159	544115
0.1000	0.0506	348317	20852	16391797	597340	10206754	555123	9316977	506485
0.1500	0.0759	497572	29466	15944955	562648	9769740	520878	8879533	473007
0.2000	0.1012	632896	37080	15540320	531662	9374721	490327	8483998	443152
0.2500	0.1265	755963	43825	15172788	503913	9016603	463001	8125318	416459
0.3000	0.1518	868229	49811	14837929	478994	8690965	438495	7799102	392532
0.3500	0.1770	970957	55135	14531894	456556	8393964	416458	7501532	371028
0.4000	0.2023	1065249	59881	14251336	436292	8122261	396585	7229287	351648
0.4500	0.2276	1152063	64120	13993340	417939	7872949	378613	6979475	334134
0.5000	0.2529	1232236	67916	13755366	401268	7643492	362313	6749570	318264
0.5500	0.2782	1306497	71323	13535195	386081	7431681	347488	6537371	303841
0.6000	0.3035	1375488	74387	13330891	372204	7235583	333965	6340950	290696
0.6500	0.3288	1439765	77149	13140758	359486	7053509	321592	6158622	278683
0.7000	0.3541	1499821	79645	12963310	347797	6883978	310240	5988909	267672
0.7500	0.3794	1556085	81905	12797244	337022	6725693	299795	5830513	257552
0.8000	0.4047	1608936	83957	12641415	327061	6577513	290156	5682295	248225
0.8500	0.4300	1658708	85824	12494816	317826	6438435	281236	5543249	239605
0.9000	0.4553	1705695	87526	12356557	309241	6307575	272959	5412491	231617
0.9500	0.4806	1750157	89081	12225853	301239	6184152	265259	5289239	224195
1.0000	0.5059	1792324	90505	12102013	293761	6067477	258076	5172802	217281
1.0500	0.5311	1832399	91812	11984419	286754	5956939	251359	5062565	210825
1.1000	0.5564	1870565	93014	11872528	280173	5851995	245061	4957986	204781
1.1500	0.5817	1906981	94120	11765853	273978	5752164	239144	4858580	199111
1.2000	0.6070	1941793	95142	11663962	268132	5657018	233571	4763915	193779
1.2500	0.6323	1975128	96086	11566470	262605	5566172	228310	4673607	188754
1.3000	0.6576	2007101	96960	11473031	257368	5479286	223335	4587310	184008
1.3500	0.6829	2037815	97771	11383336	252395	5396052	218620	4504718	179518
1.4000	0.7082	2067363	98524	11297107	247666	5316195	214143	4425551	175262
1.4500	0.7335	2095829	99225	11214093	243159	5239468	209885	4349562	171220
1.5000	0.7588	2123287	99878	11134071	238857	5165649	205827	4276524	167374
1.5500	0.7841	2149806	100487	11056834	234745	5094535	201954	4206234	163710
1.6000	0.8094	2175447	101055	10982200	230808	5025945	198252	4138509	160214
1.6500	0.8347	2200267	101587	10910001	227033	4959713	194709	4073181	156872
1.7000	0.8599	2224315	102084	10840084	223408	4895689	191312	4010099	153674
1.7500	0.8852	2247640	102550	10772311	219924	4833736	188051	3949124	150609
1.8000	0.9105	2270282	102986	10706555	216570	4773730	184918	3890130	147669
1.8500	0.9358	2292282	103396	10642700	213339	4715557	181903	3833001	144844
1.9000	0.9611	2313674	103780	10580641	210221	4659112	178999	3777633	142128
1.9500	0.9864	2334492	104141	10520278	207211	4604299	176198	3723926	139513
2.0000	1.0117	2354765	104480	10461523	204301	4551030	173496	3671793	136993
-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : YLDPCL03
Date and time : 15SEP97:19:47
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : 1.0849
F-max factor : Not found
F-0.1 reference F : 0.5488
F-max reference F : Not found
Recruitment : 4901 (Millions)



Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	1.25	1.96	2.95	4.05	5.21	6.06	6.91	7.06	8.59	-	8.78	-	-	-	-
2*stdev	-	0.94	0.75	0.96	1.46	2.26	2.29	2.97	2.32	3.52	-	4.22	-	-	-	-

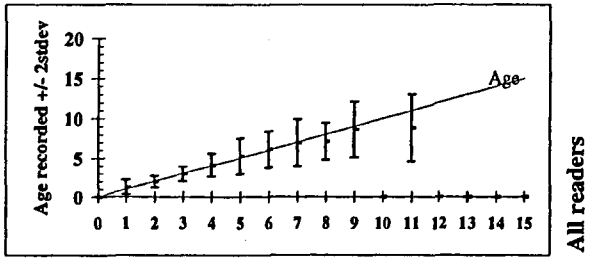
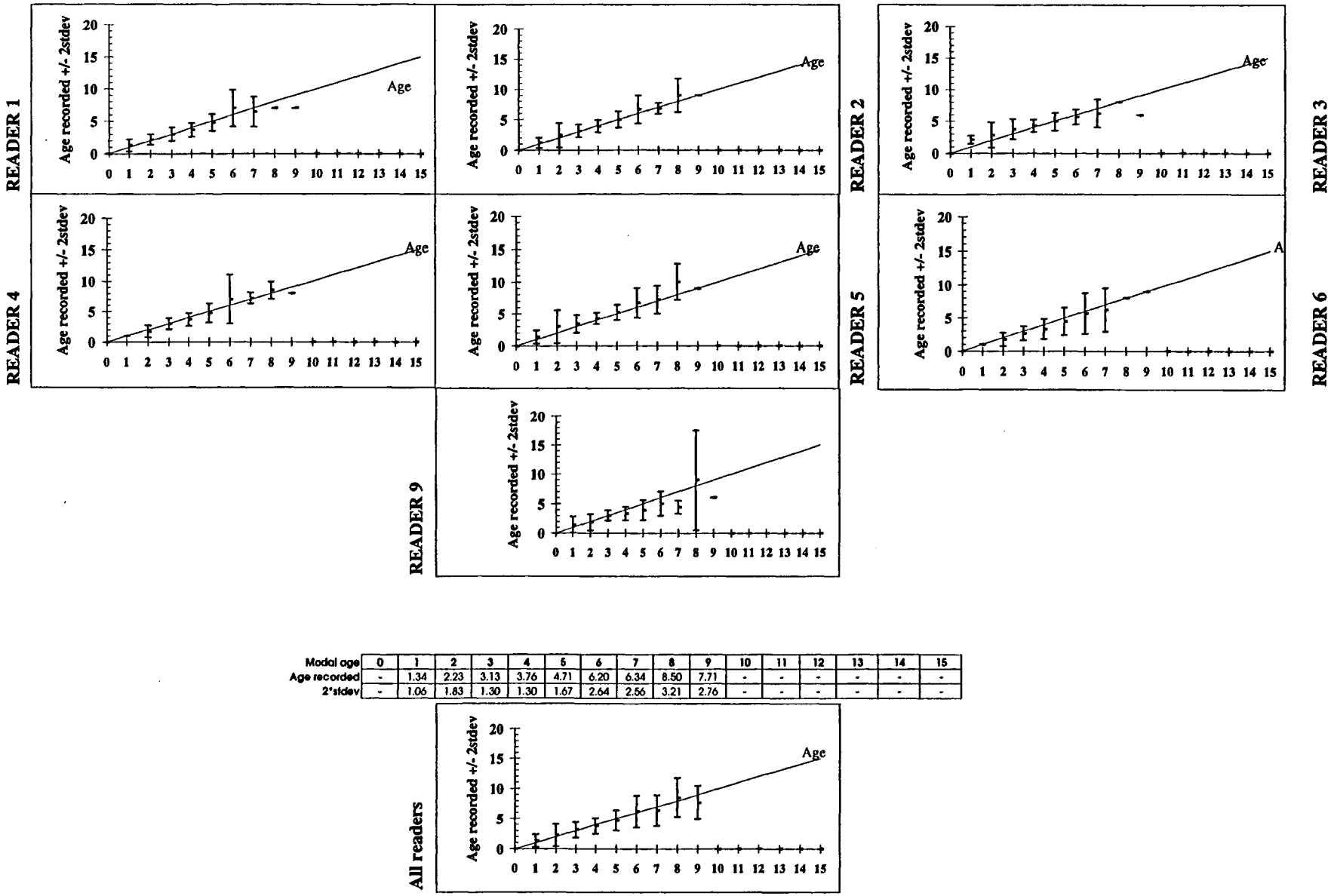


Figure 8.1.1 - Sample 1: Age bias plots average age +/- 2stdev of each age reader and all age readers is plotted against modal age.



Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	1.34	2.23	3.13	3.76	4.71	6.20	6.34	8.50	7.71	-	-	-	-	-	-
2*stdev	-	1.06	1.83	1.30	1.30	1.67	2.64	2.56	3.21	2.76	-	-	-	-	-	-

Figure 8.1.2 - Sample 2: age bias plot average age +/- 2stdev of each reader and all age readers is plotted against modal age.

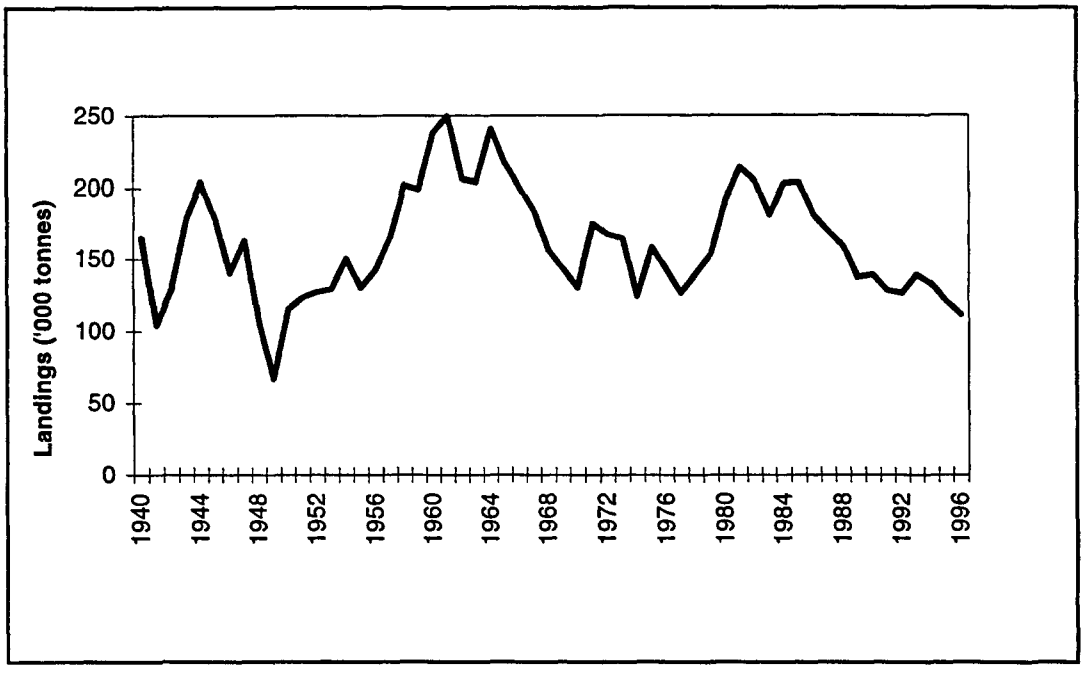


Figure 8.2.1 - Total landings of sardine in Divisions VIIIc and IXa from 1940-1996

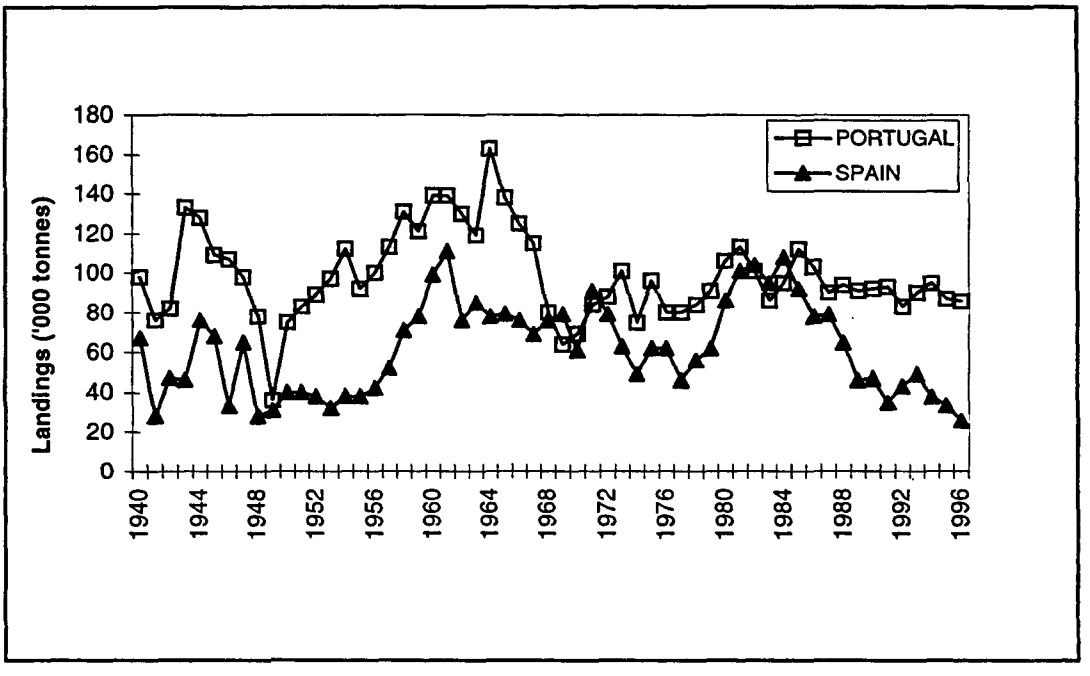


Figure 8.2.2 - Landings of sardine in Divisions VIIIc and IXa by country during 1940-1996

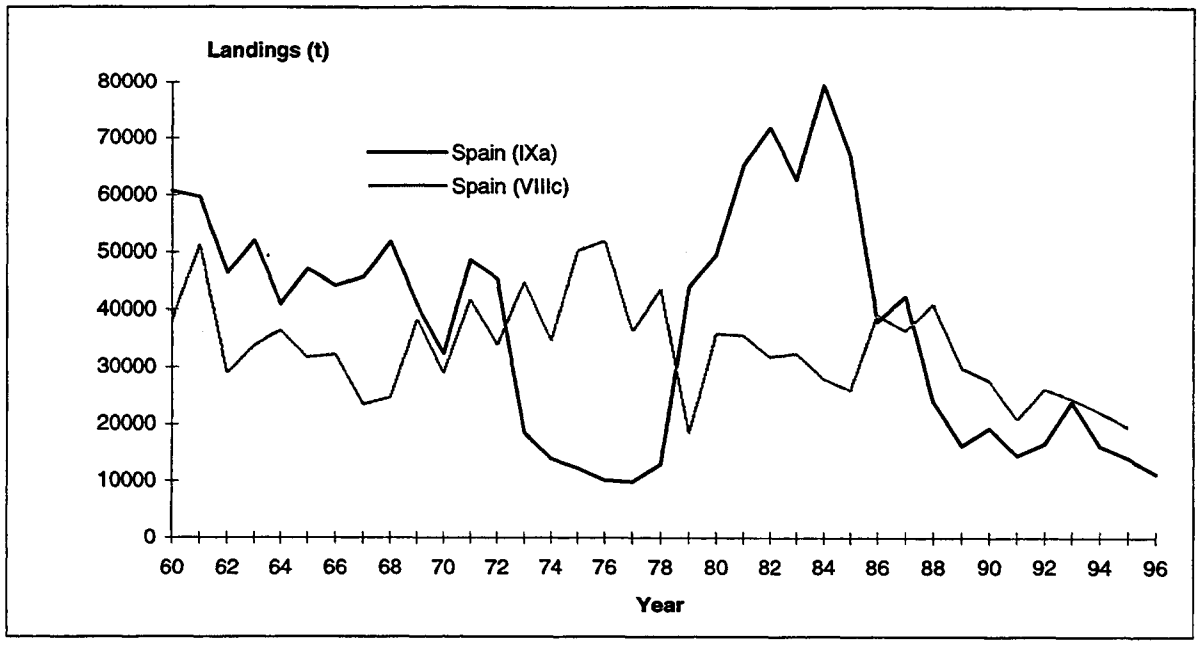


Figure 8.2.3 - Annual Spanish landings by ICES Division.

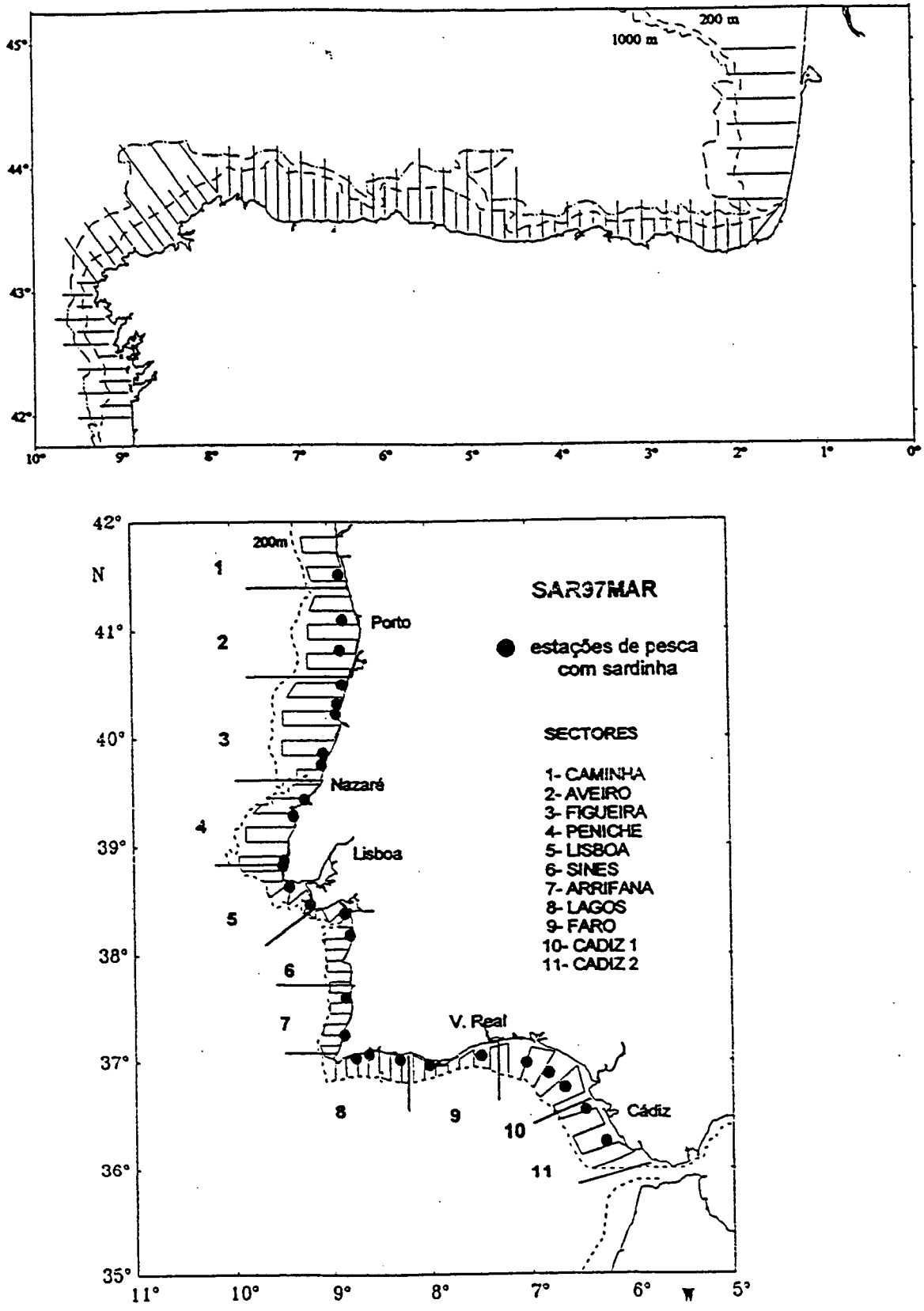


Figure 8.5.1 - Sardine - March 1997 acoustic surveys. Survey track and fishing sampling stations.

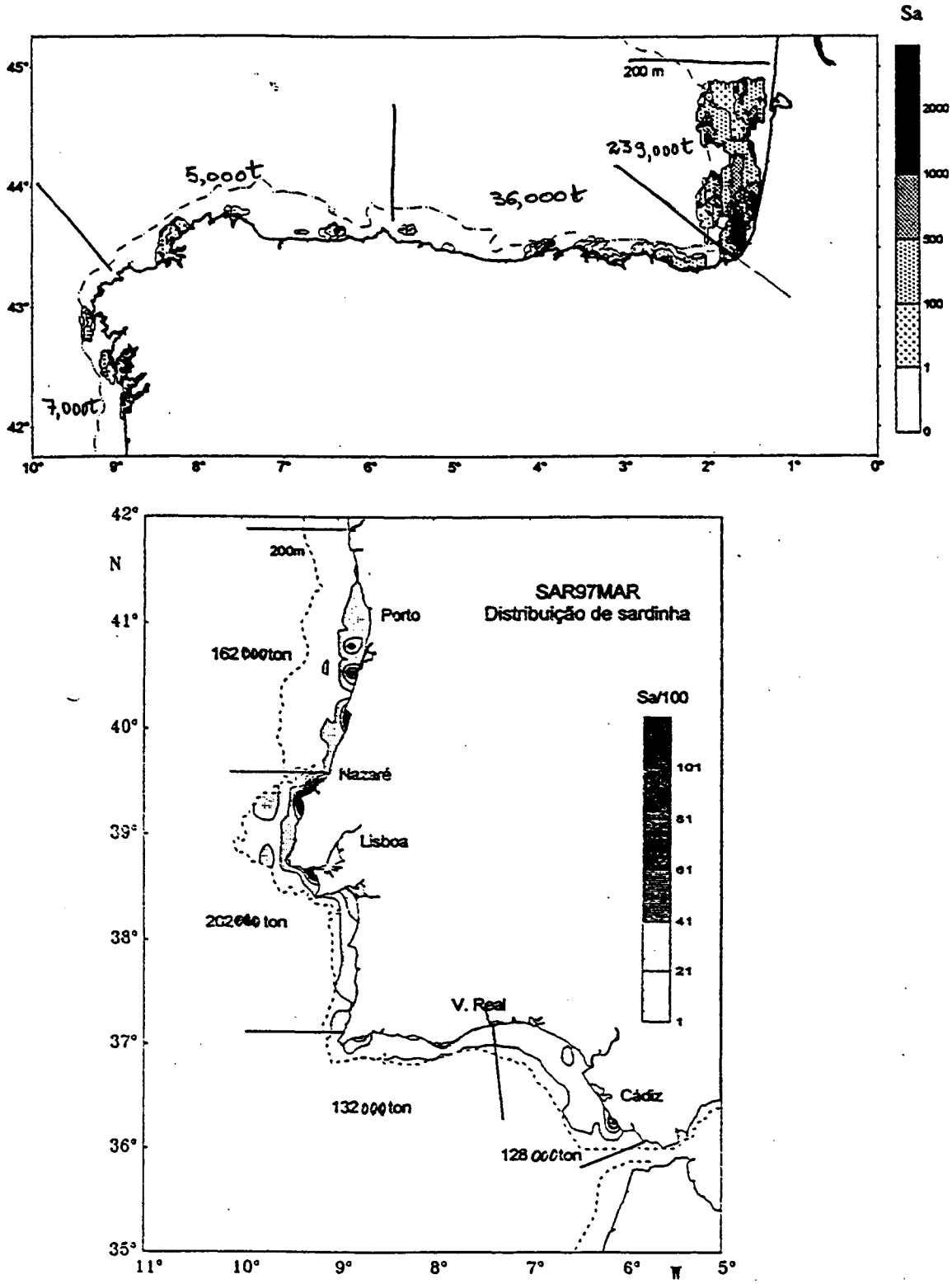


Figure 8.5.2 - Sardine - March 1997 acoustic surveys. Relative abundance distribution.

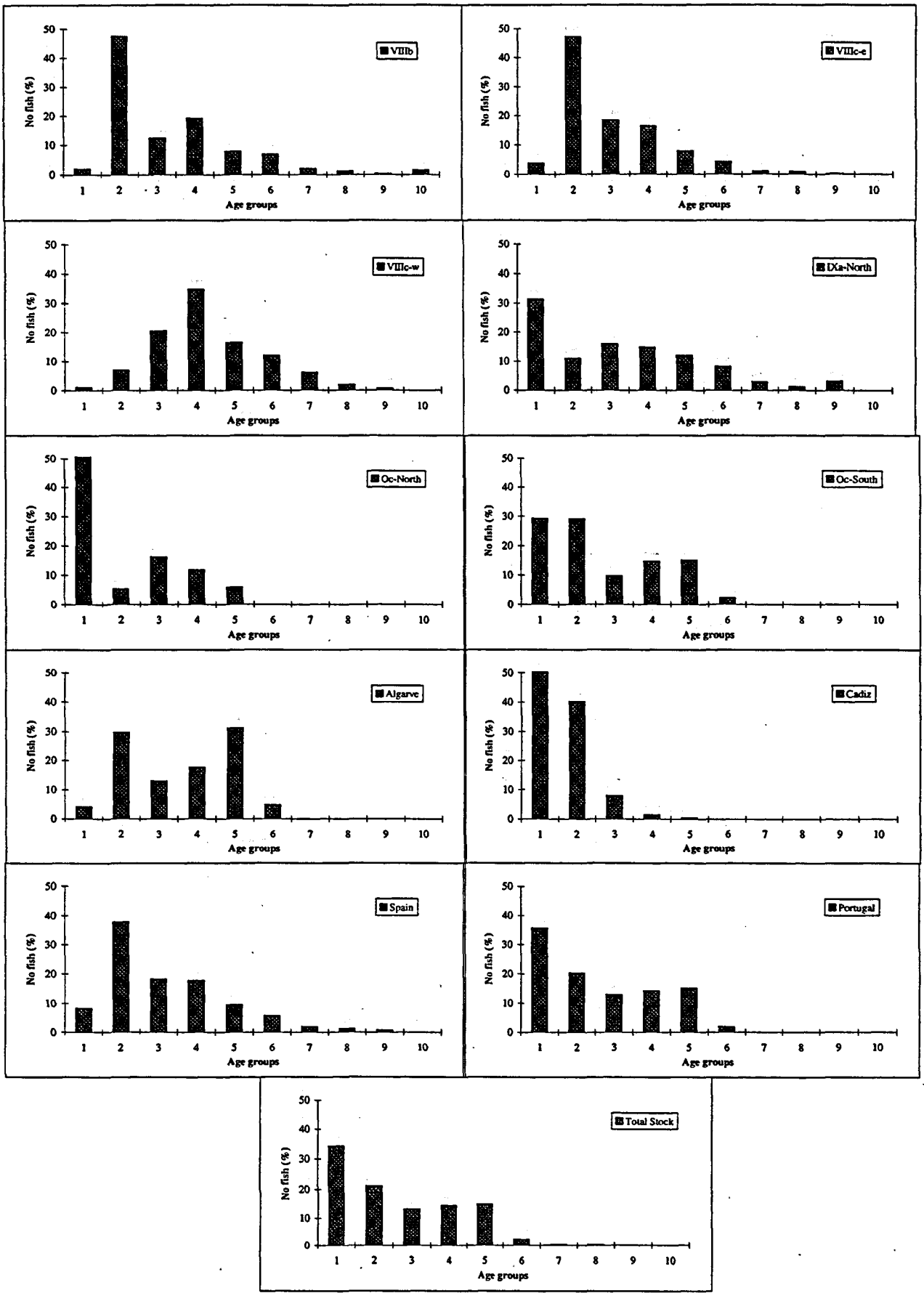


Figure 8.5.3: Age distribution of sardine by geographical area (%) and total by country and stock

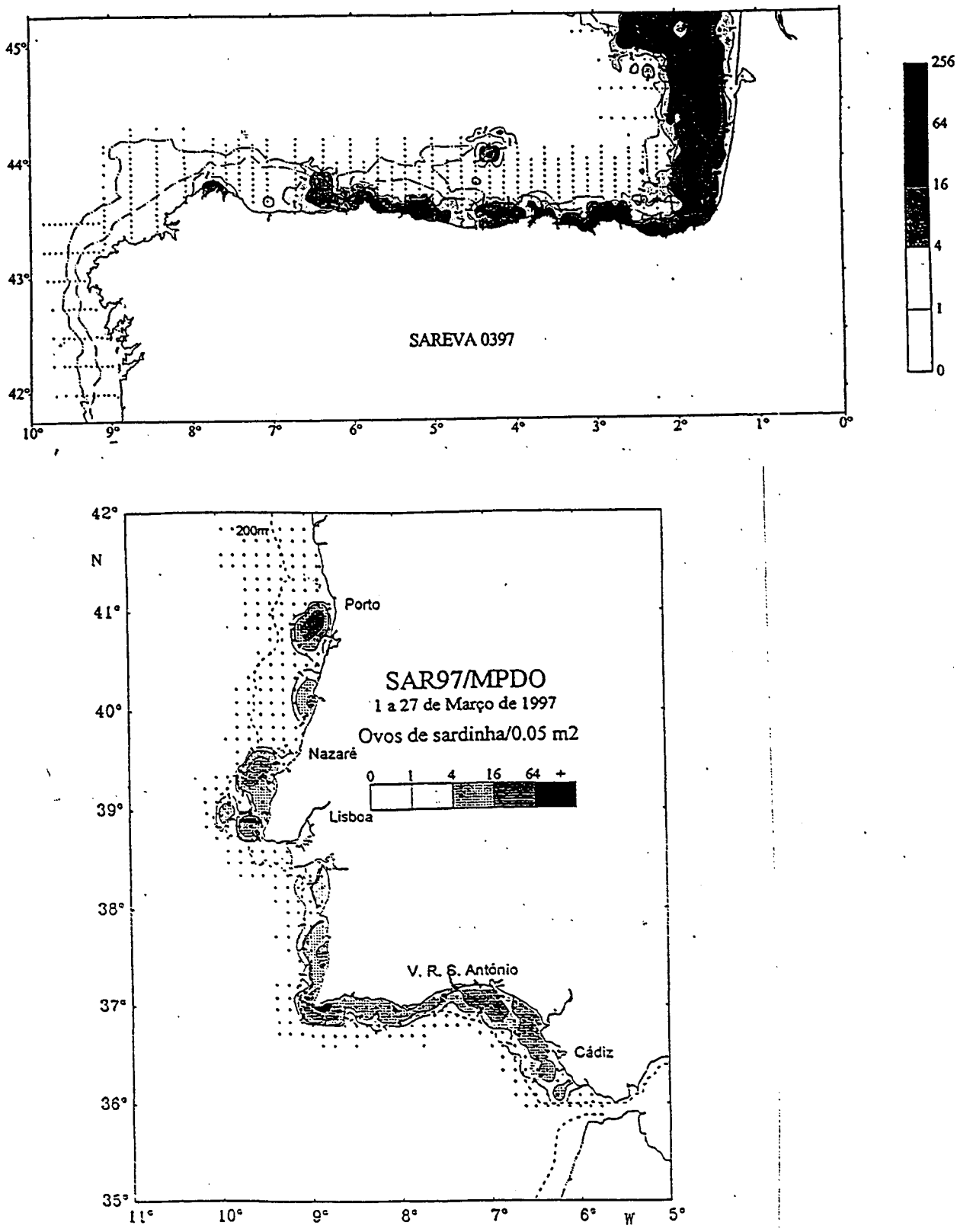


Figure 8.5.4 - Sardine - March 1997 DEPM surveys. Eggsdistribution.

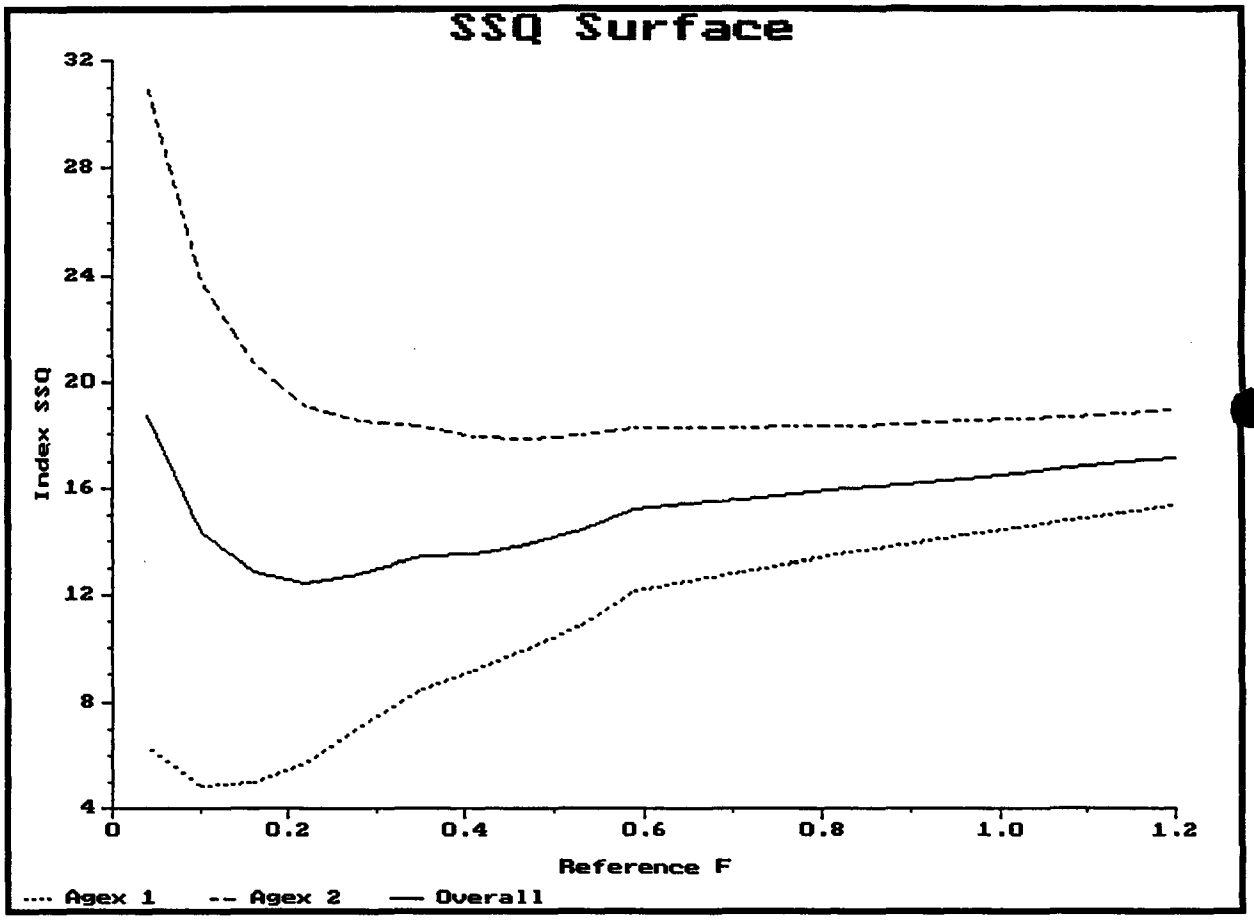
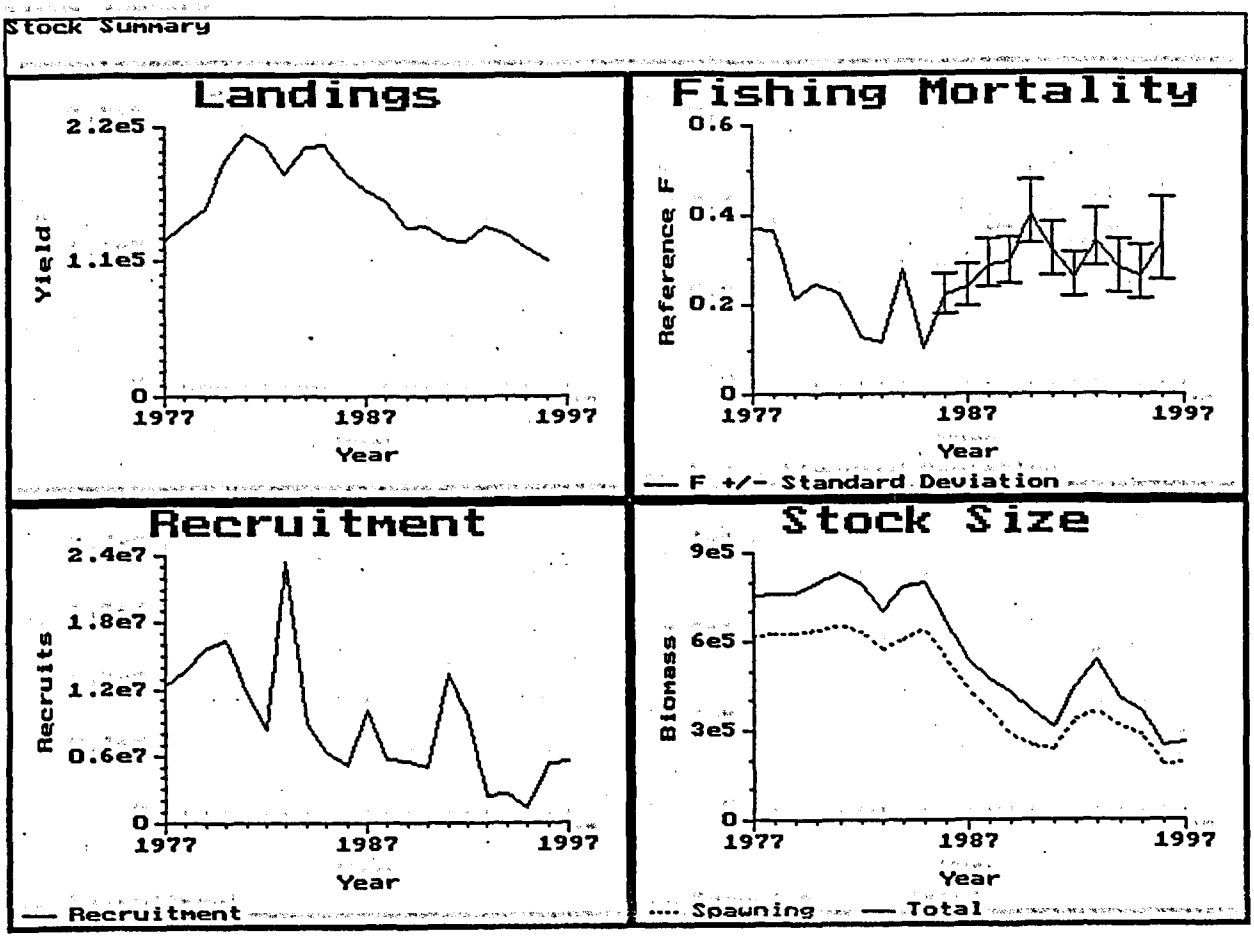


Figure 8.10.1a

Figure 8.101a (cont'd)



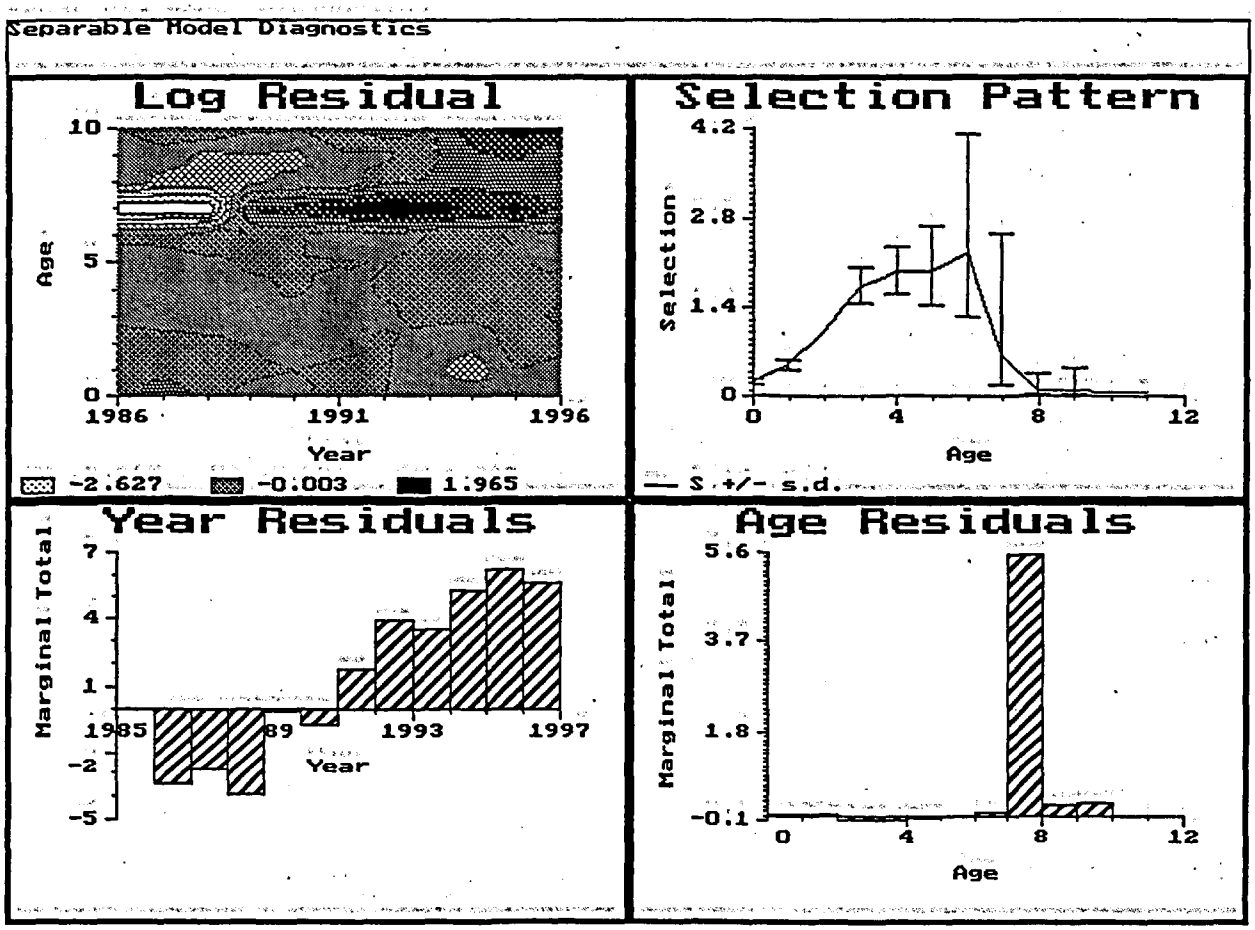
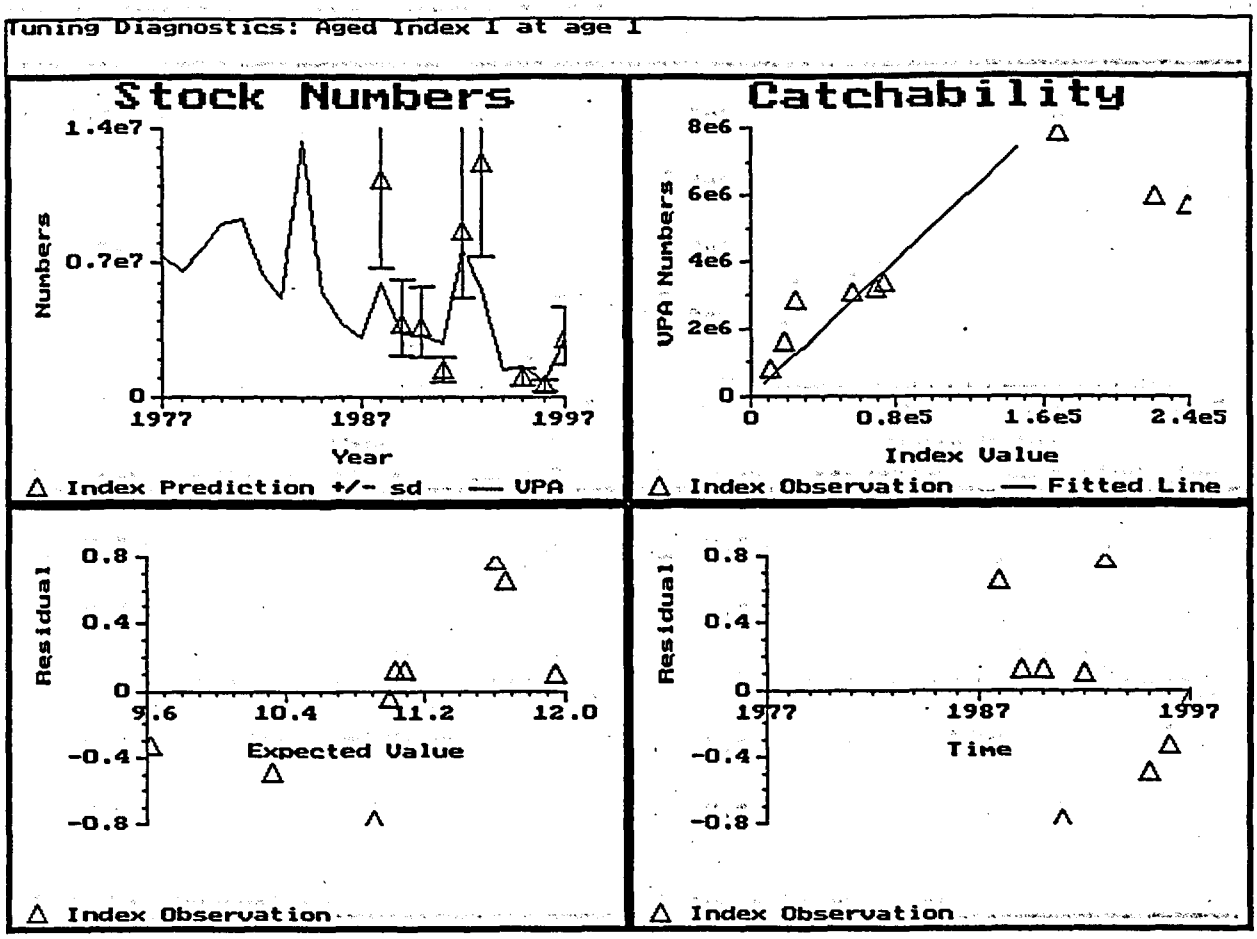


Figure 8.10.1b



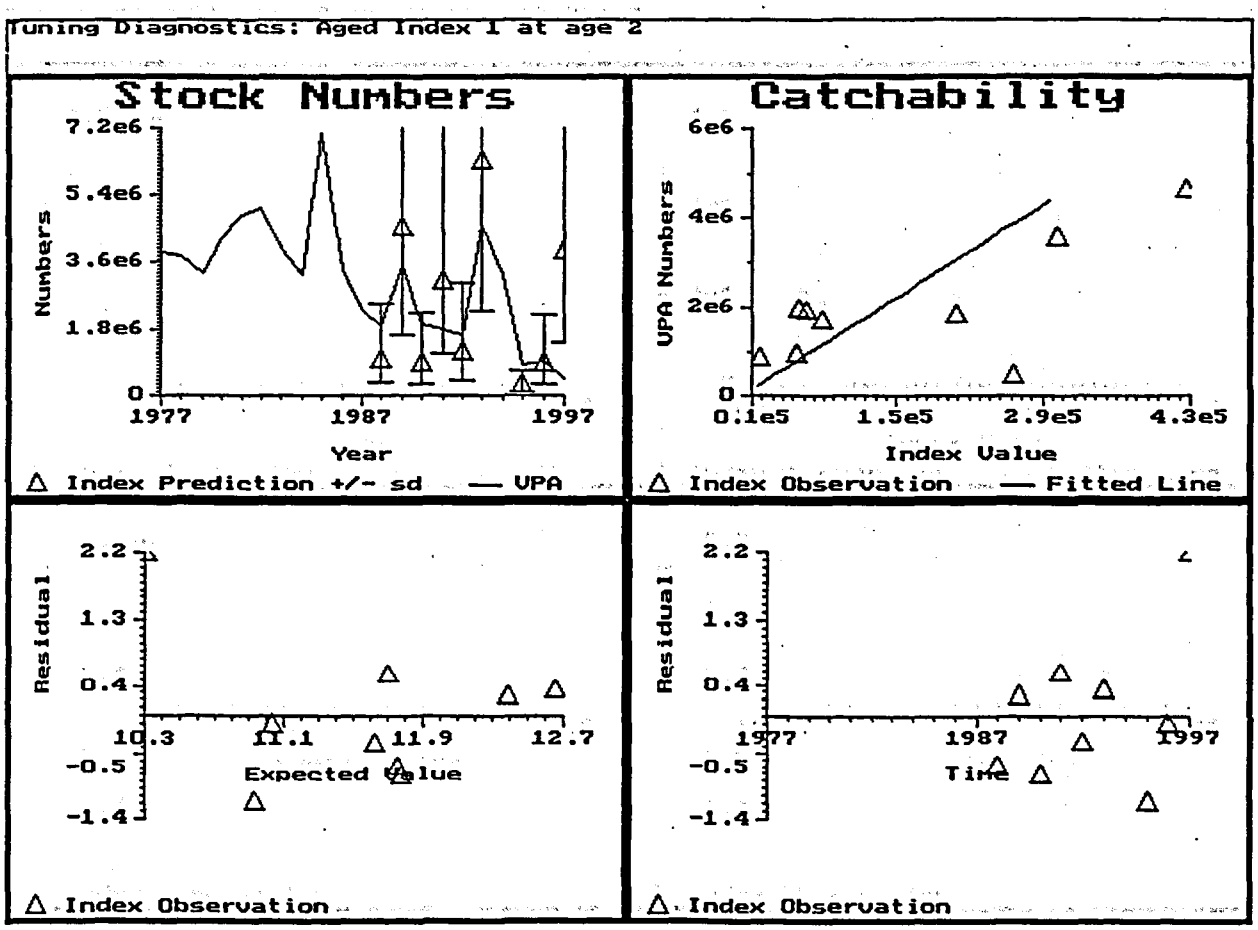
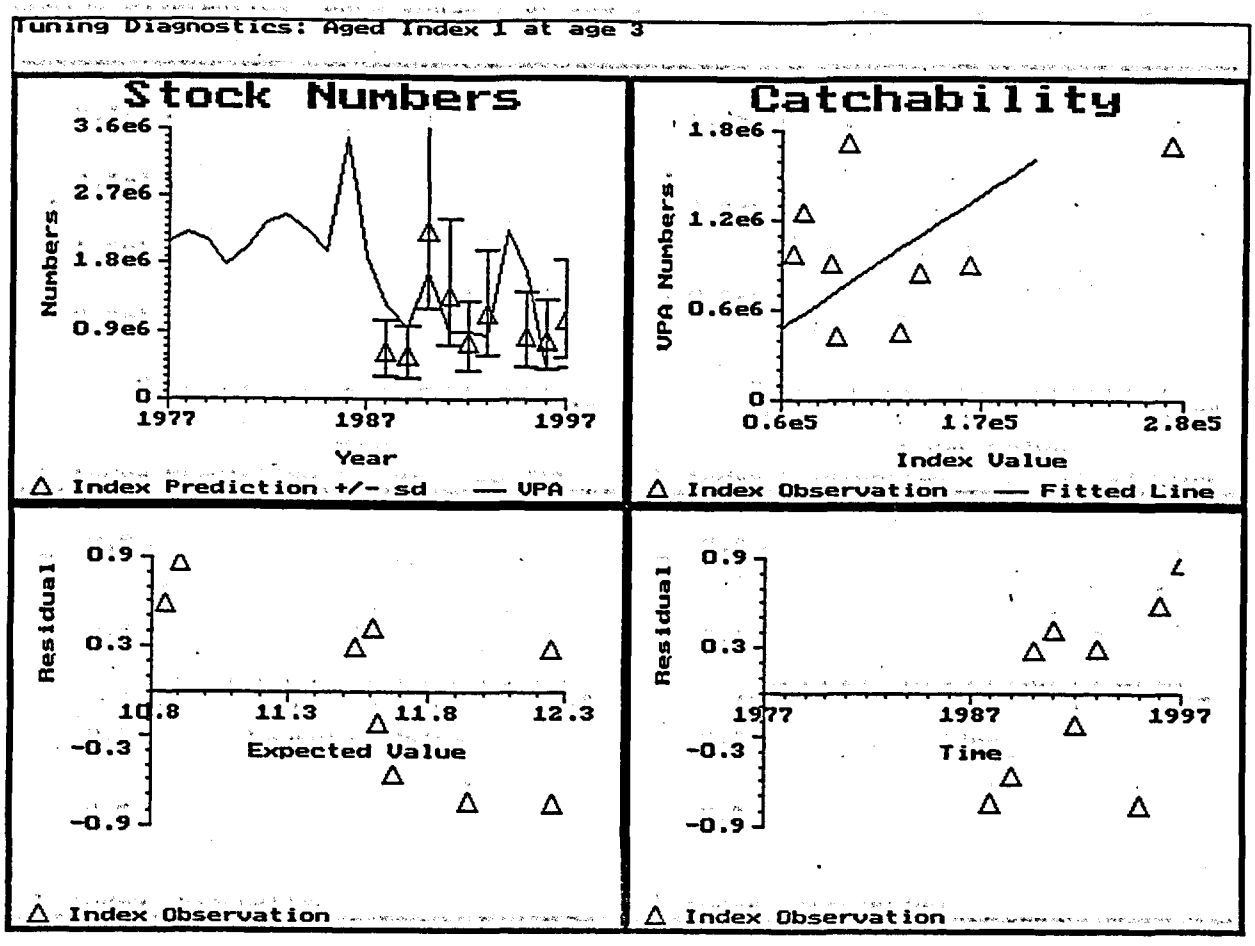
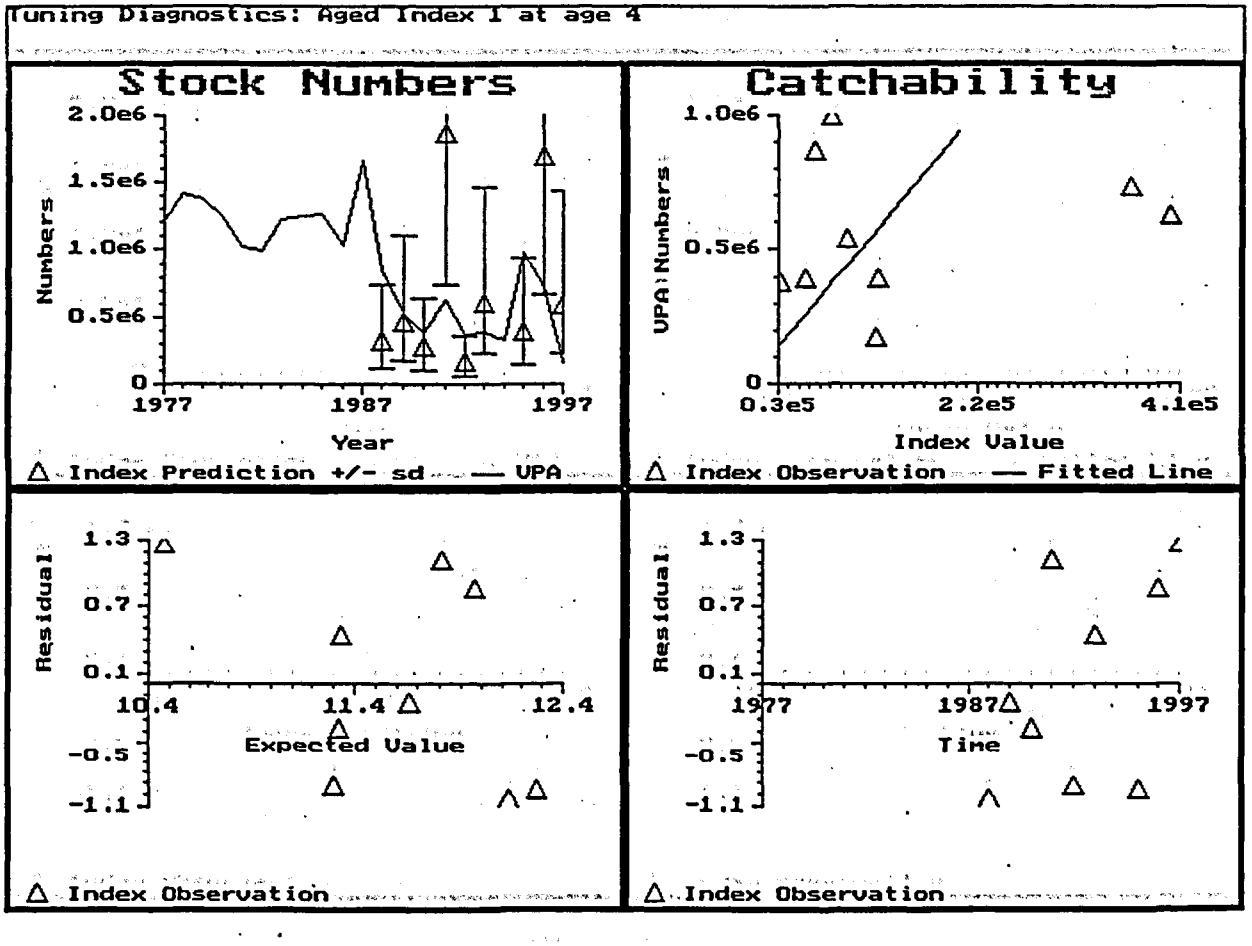


Figure 8.10.1b (Cont'd)





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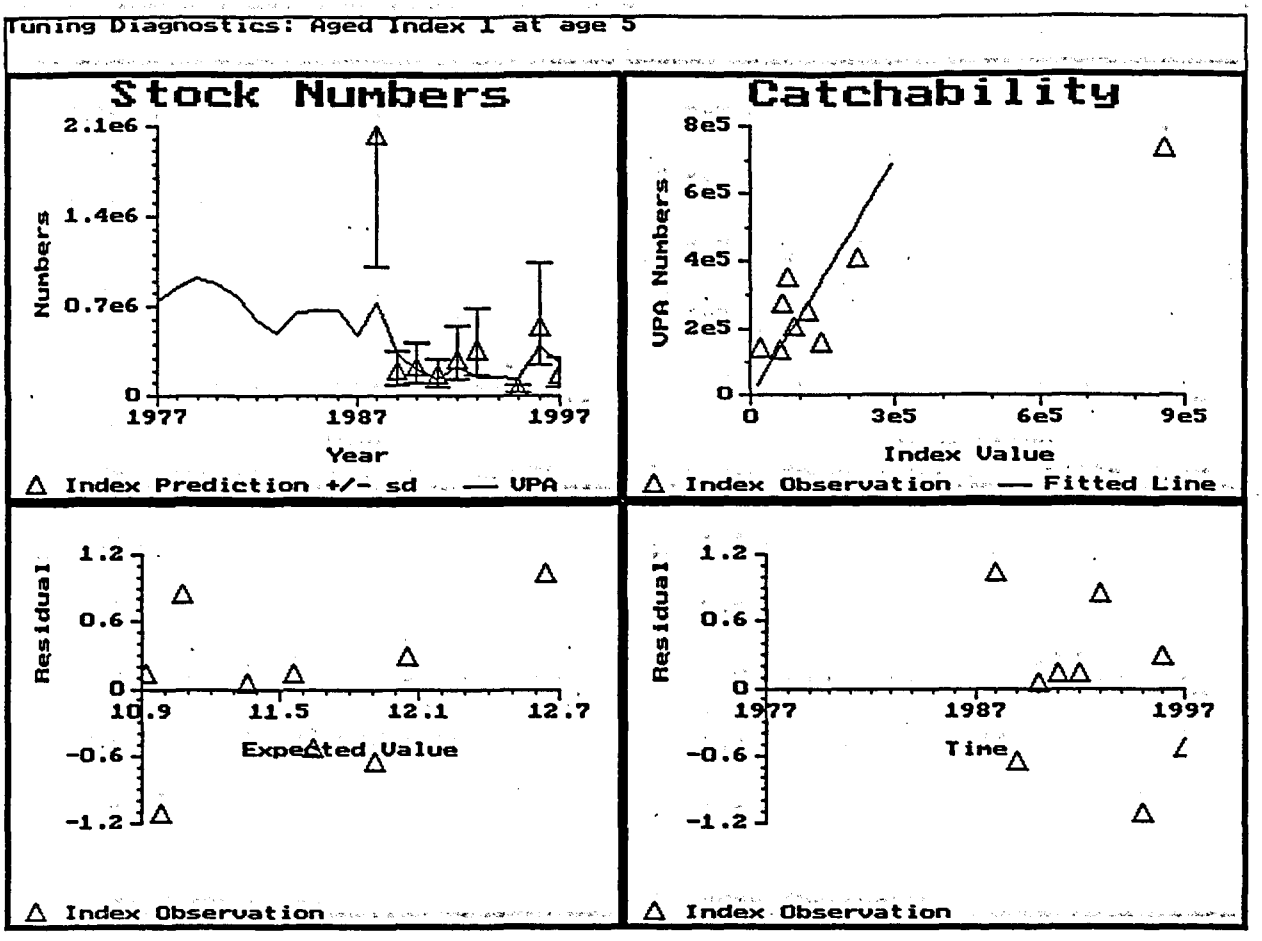

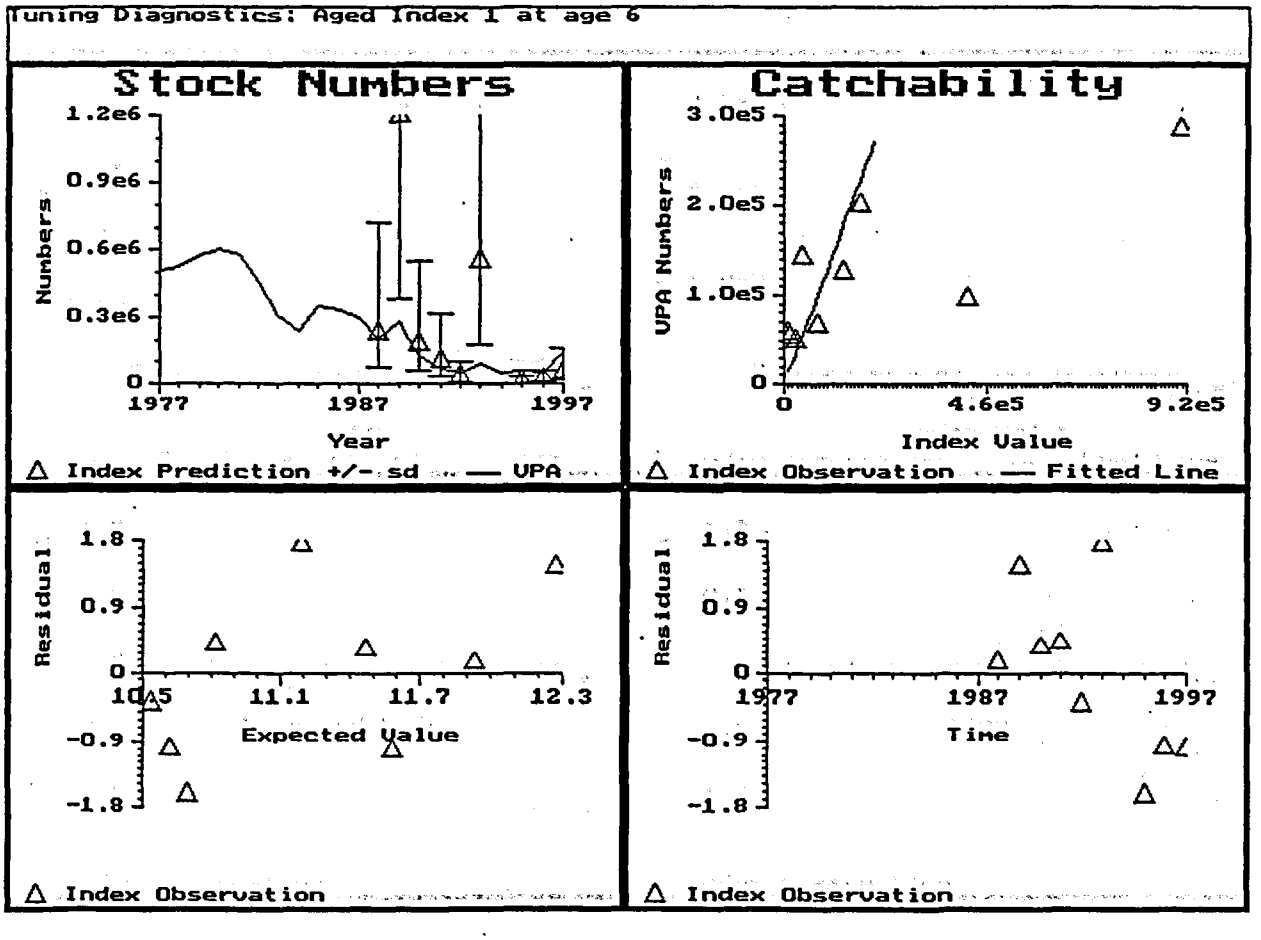

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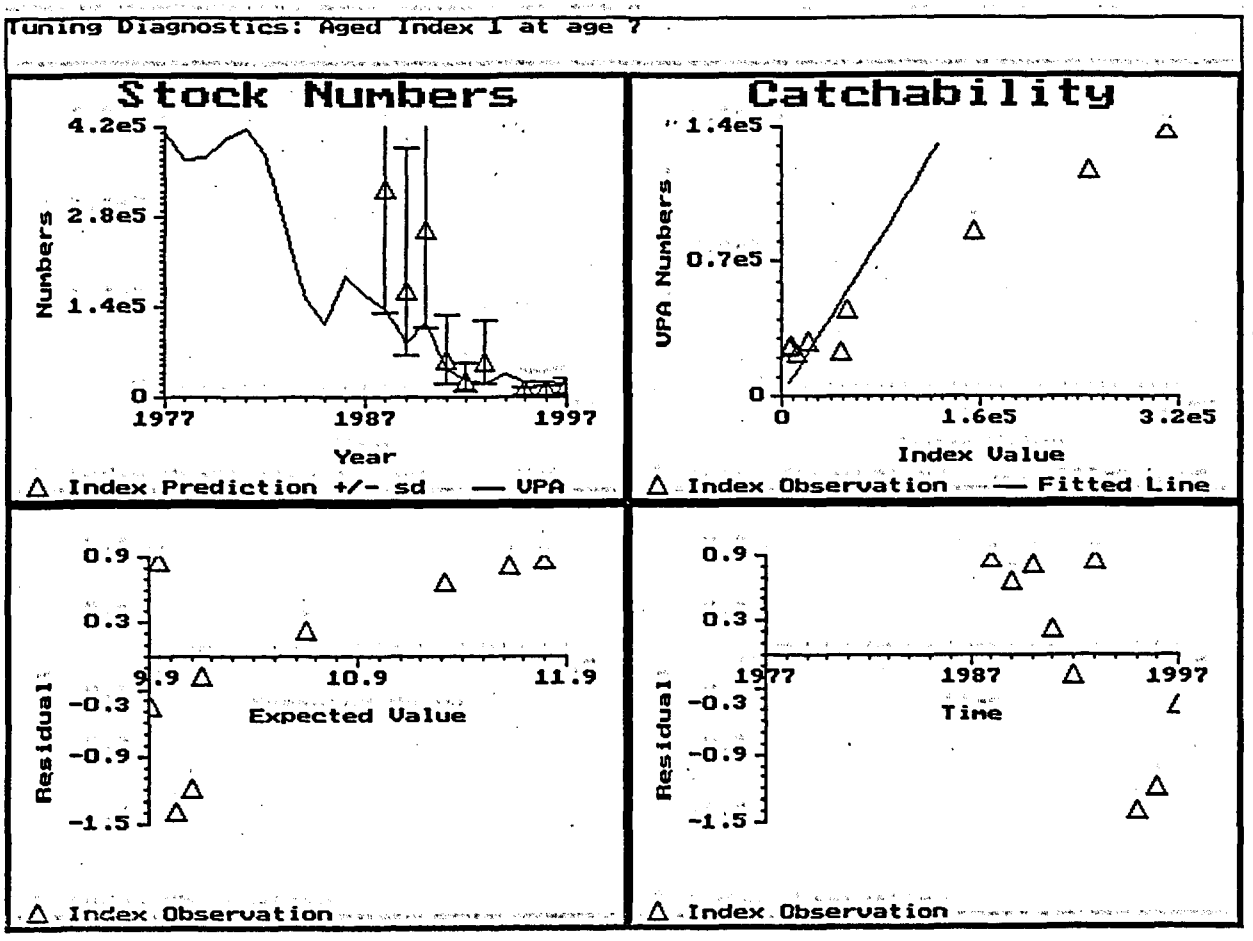


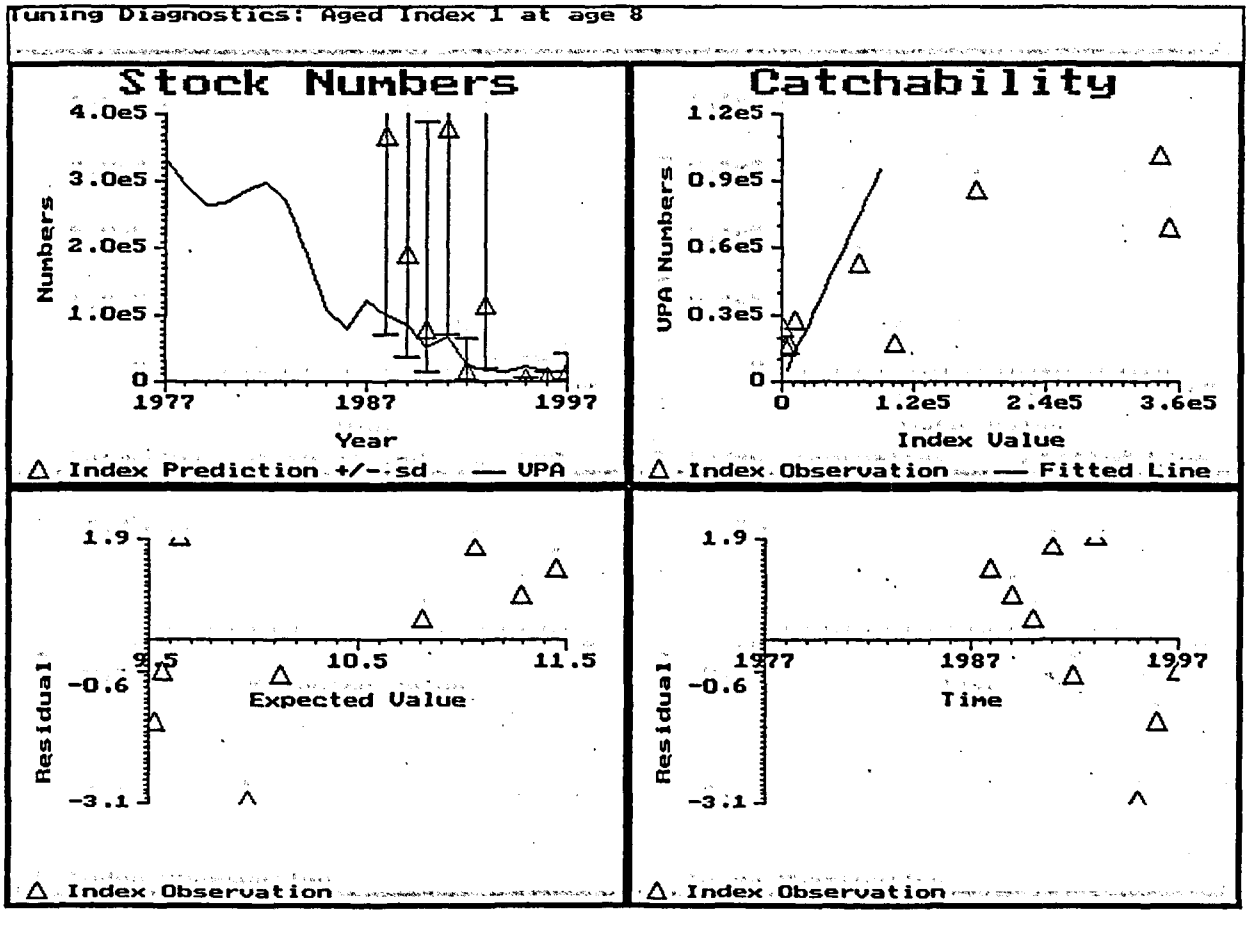
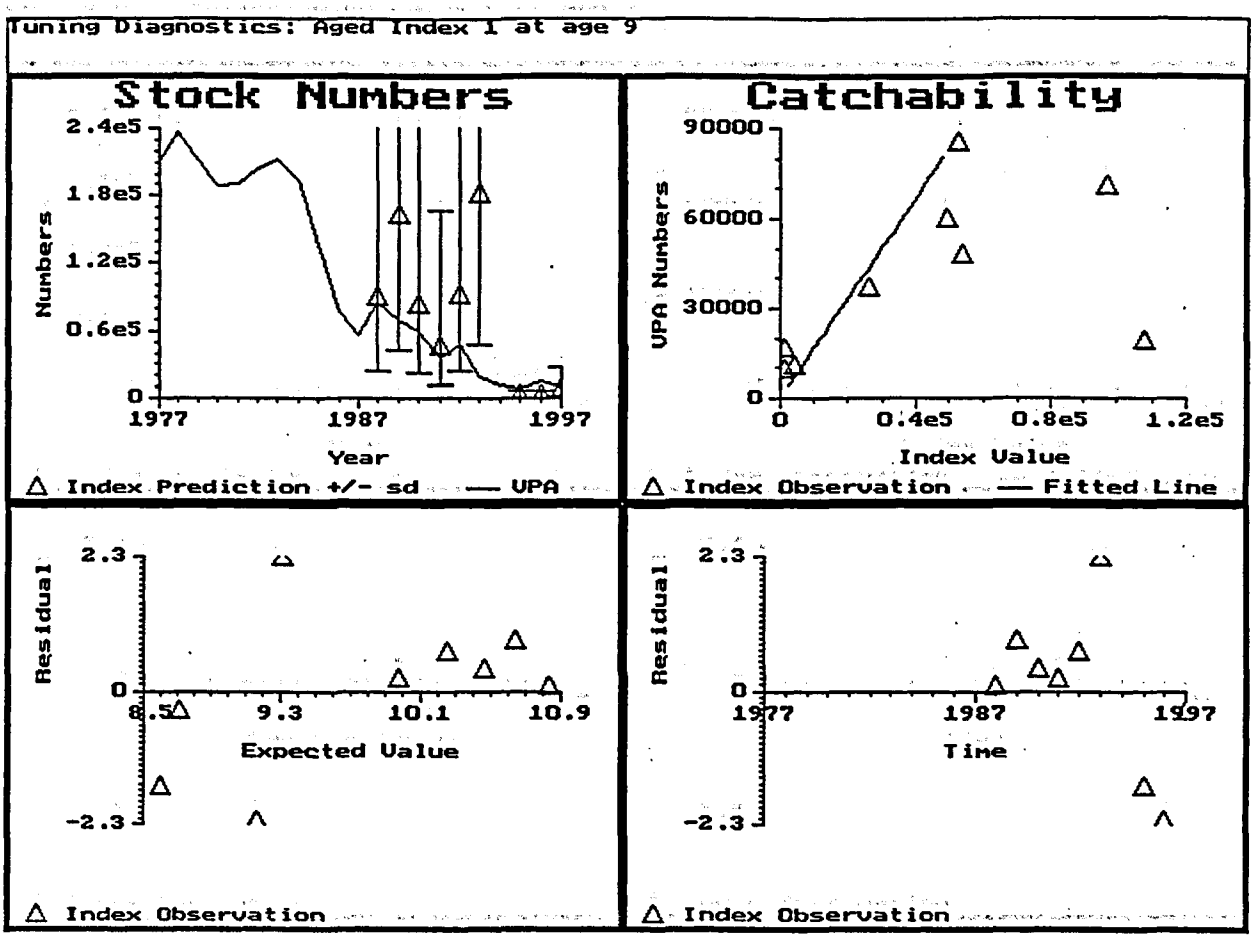


Figure 8.10.1b (Cont'd)



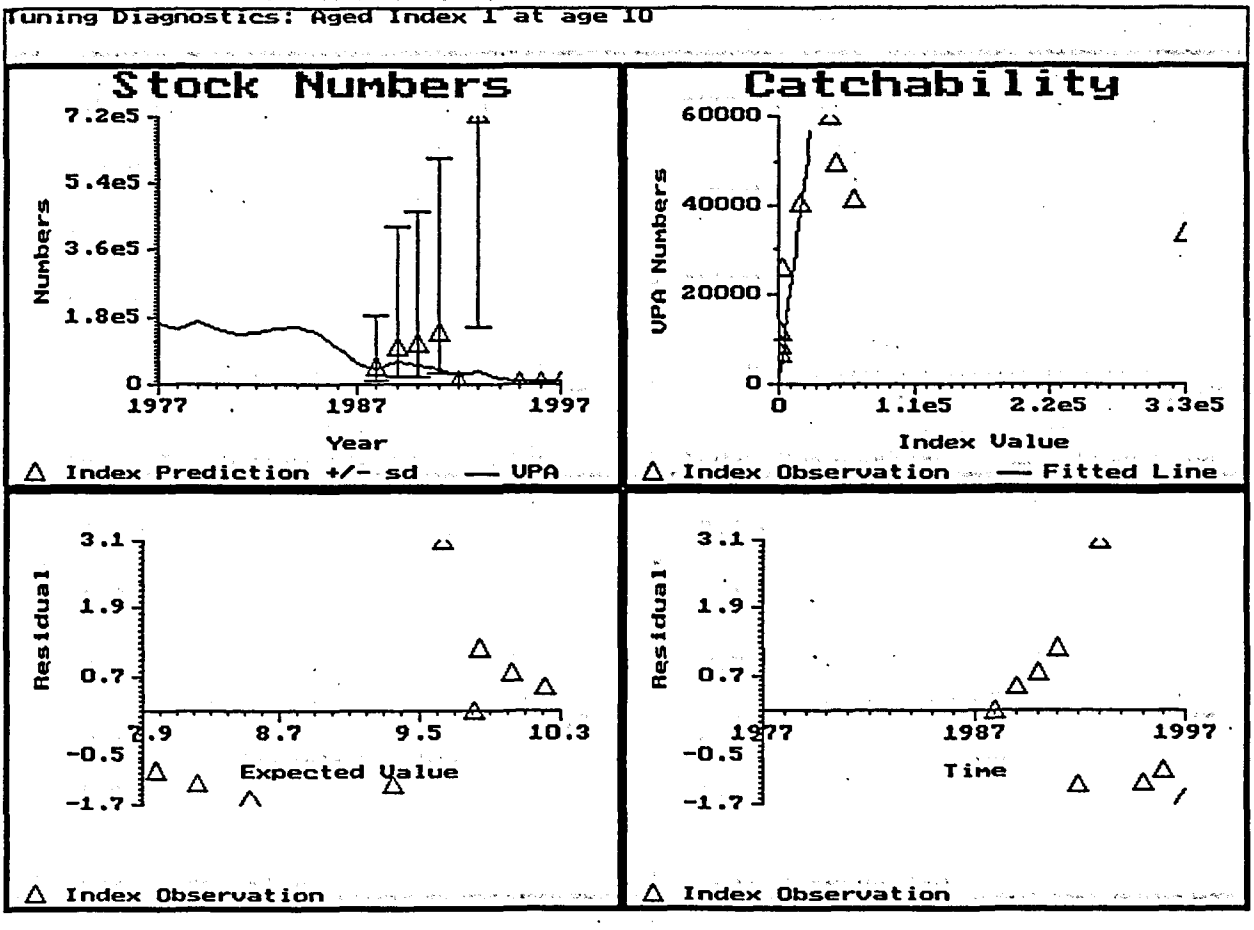
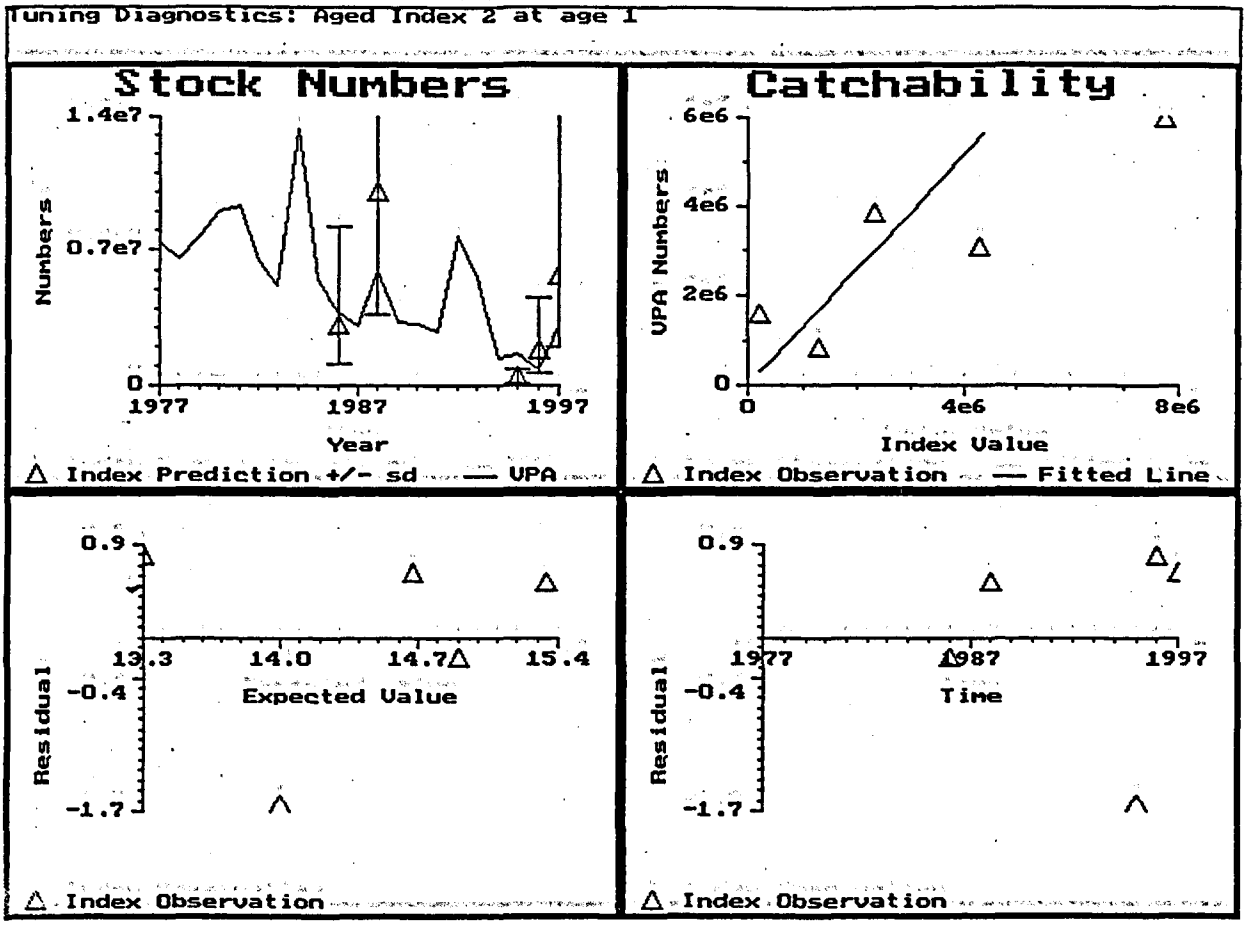
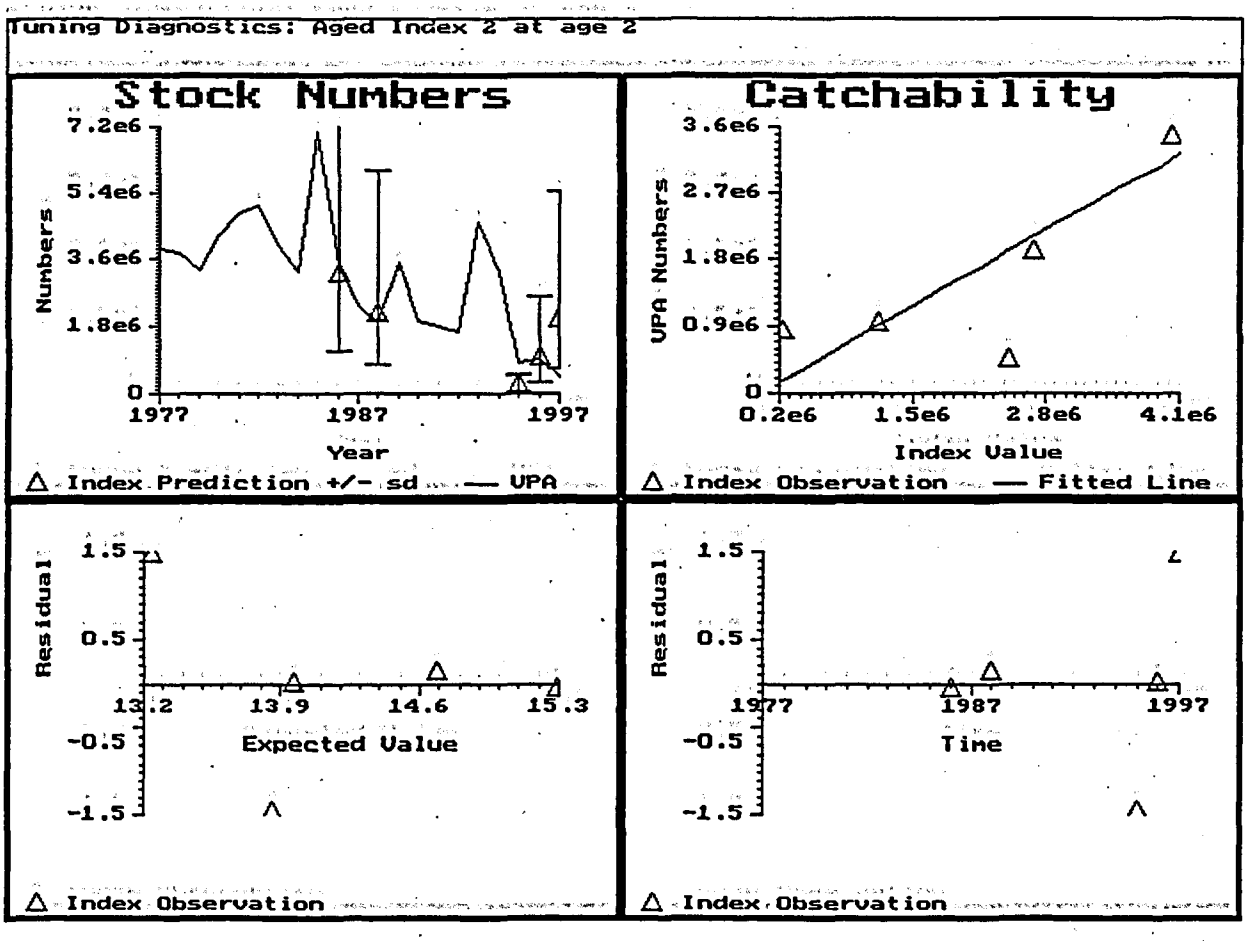


Figure 8.10.1c





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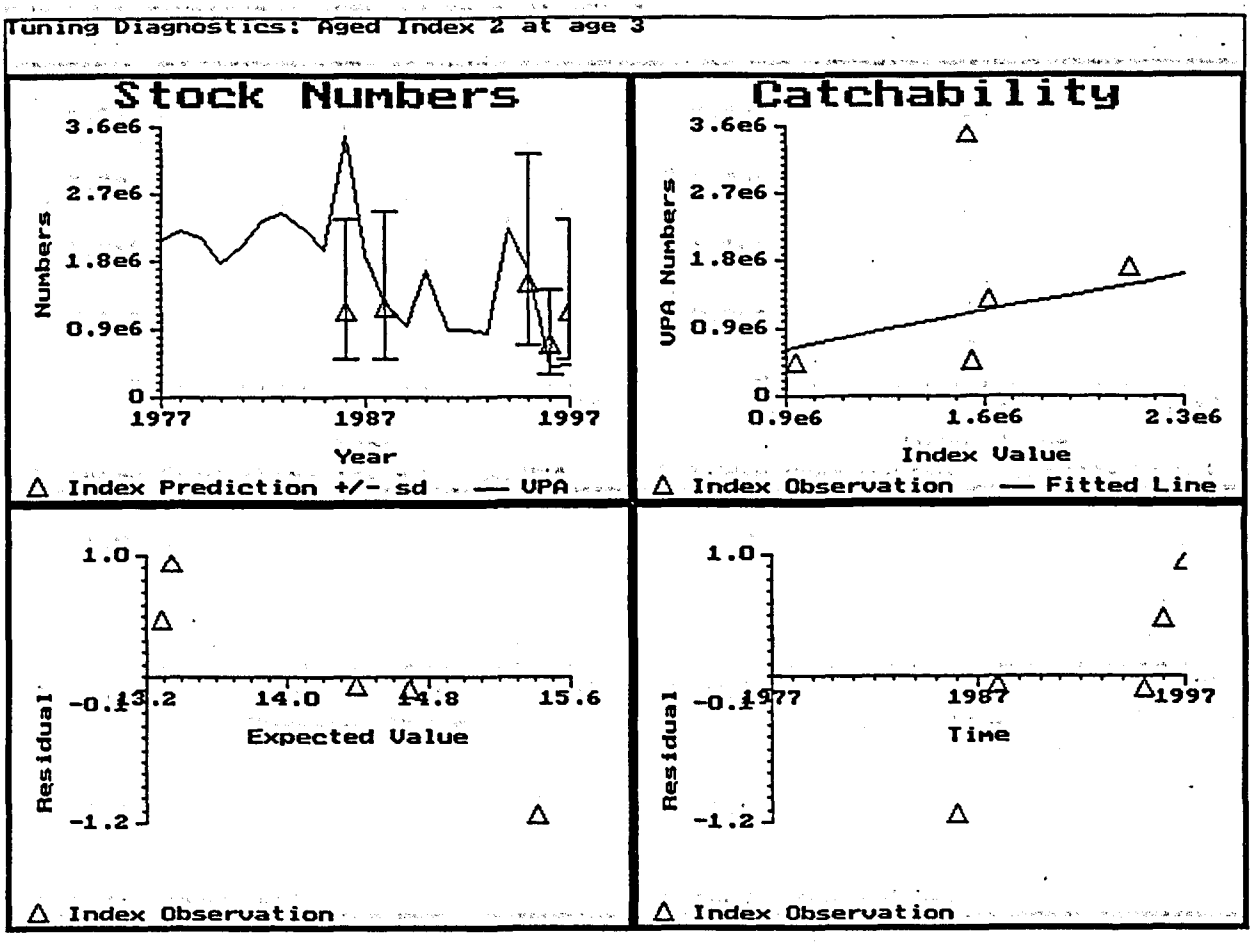

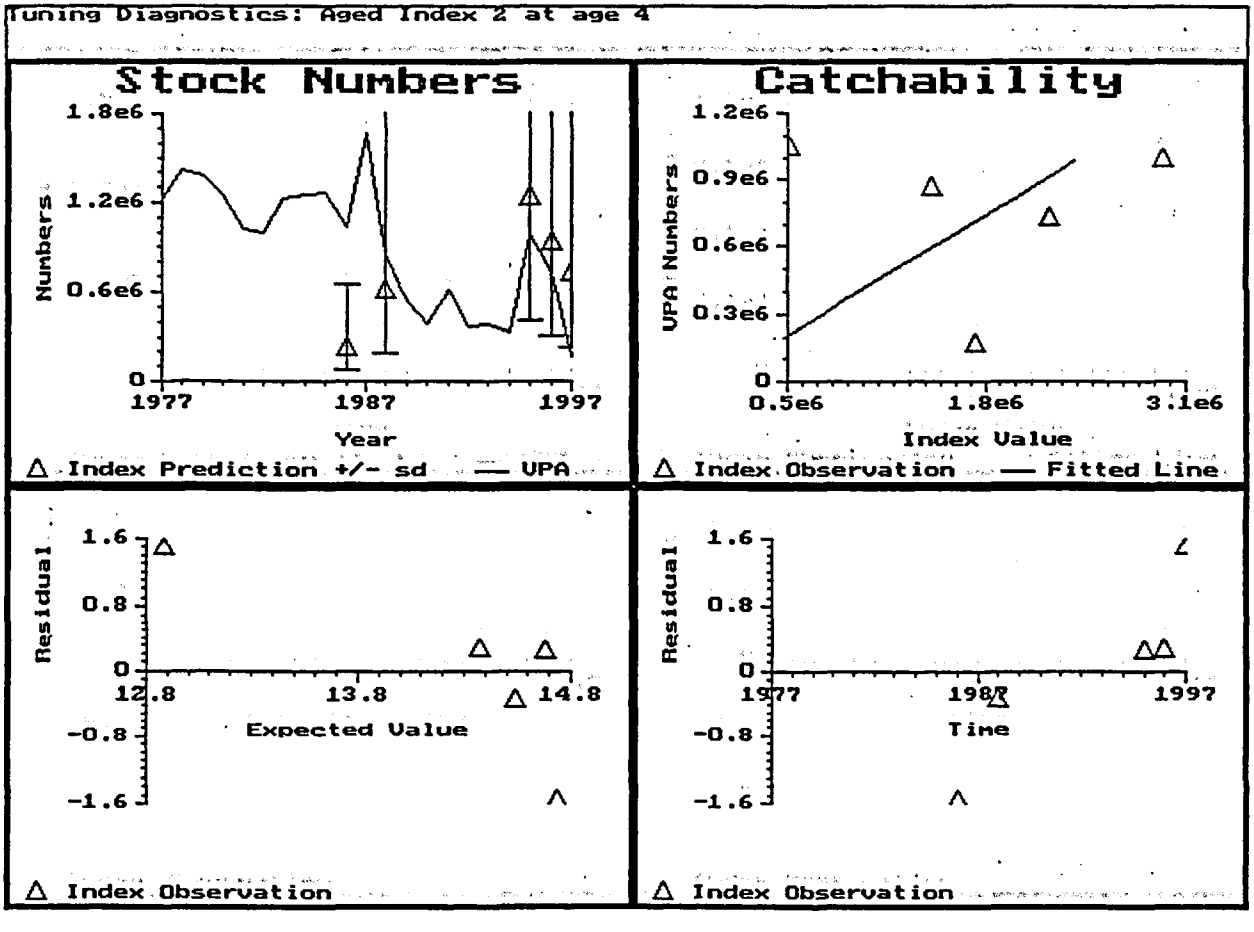

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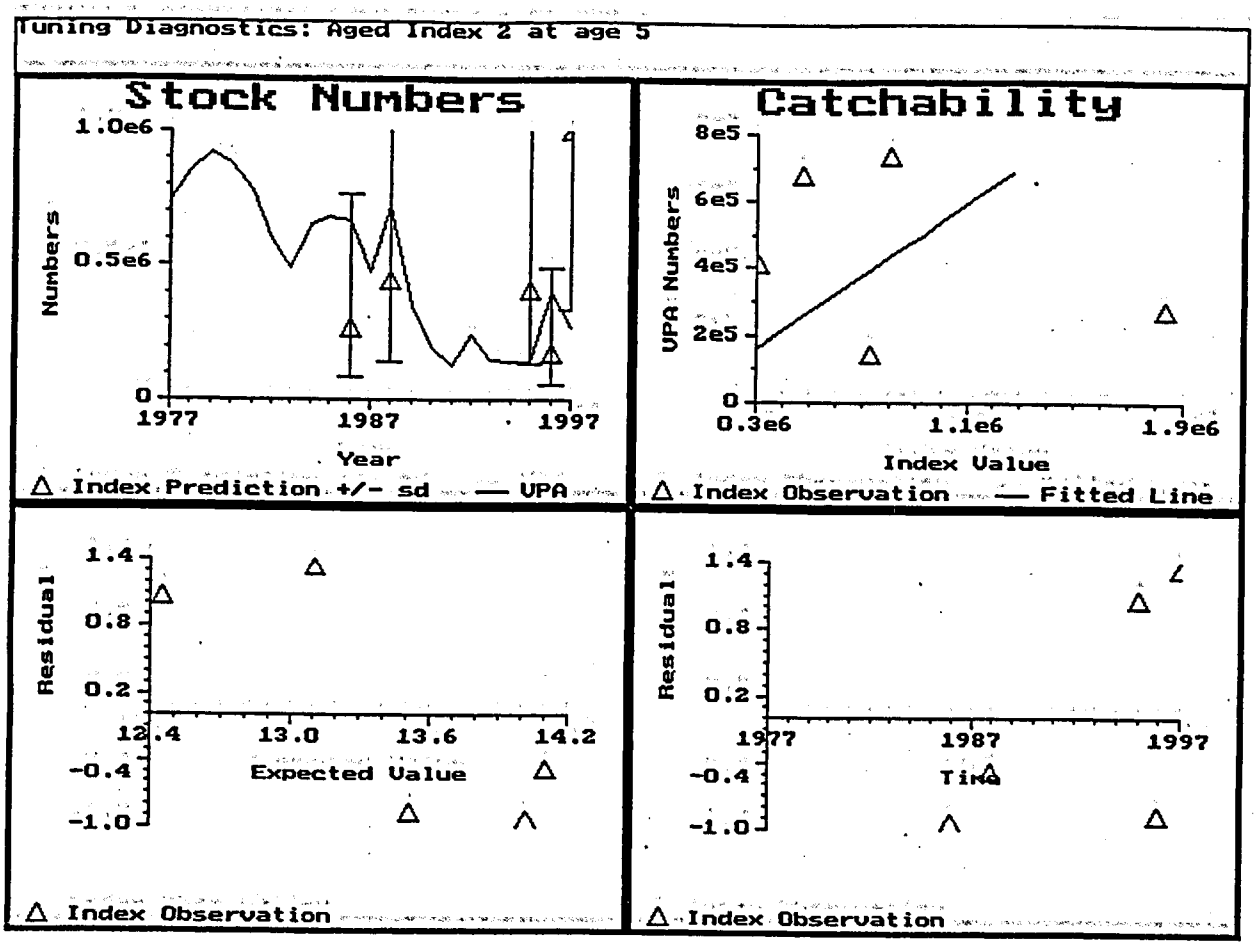
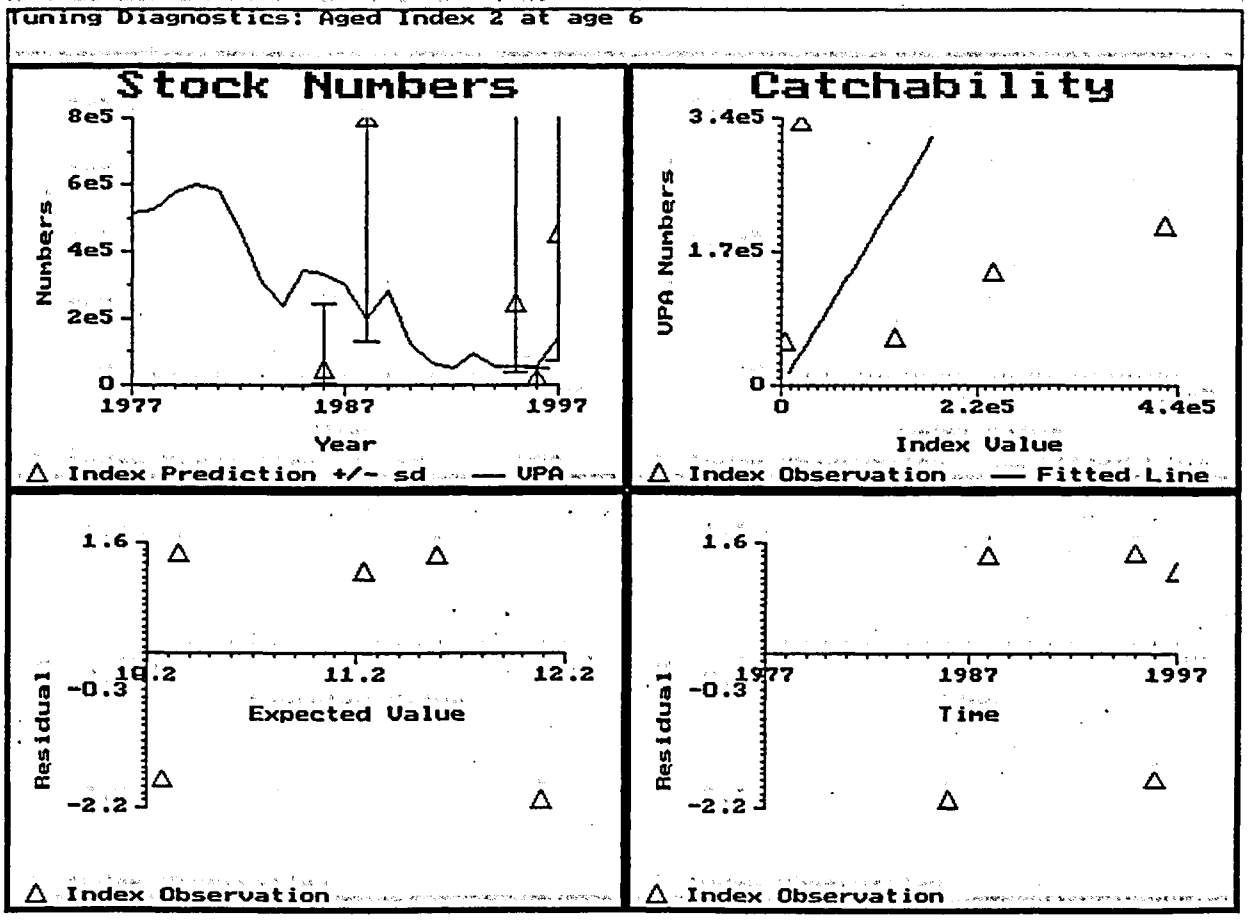




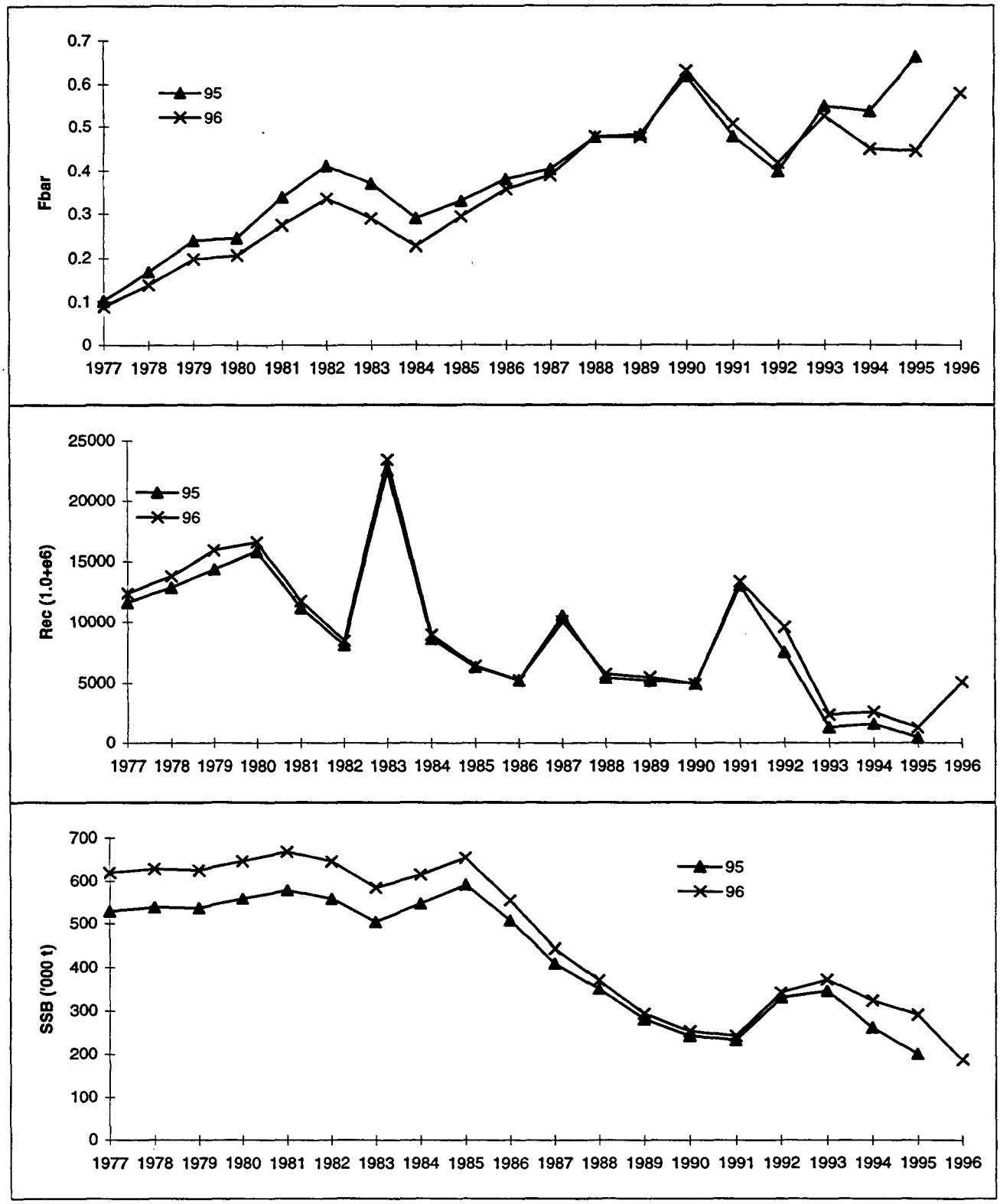
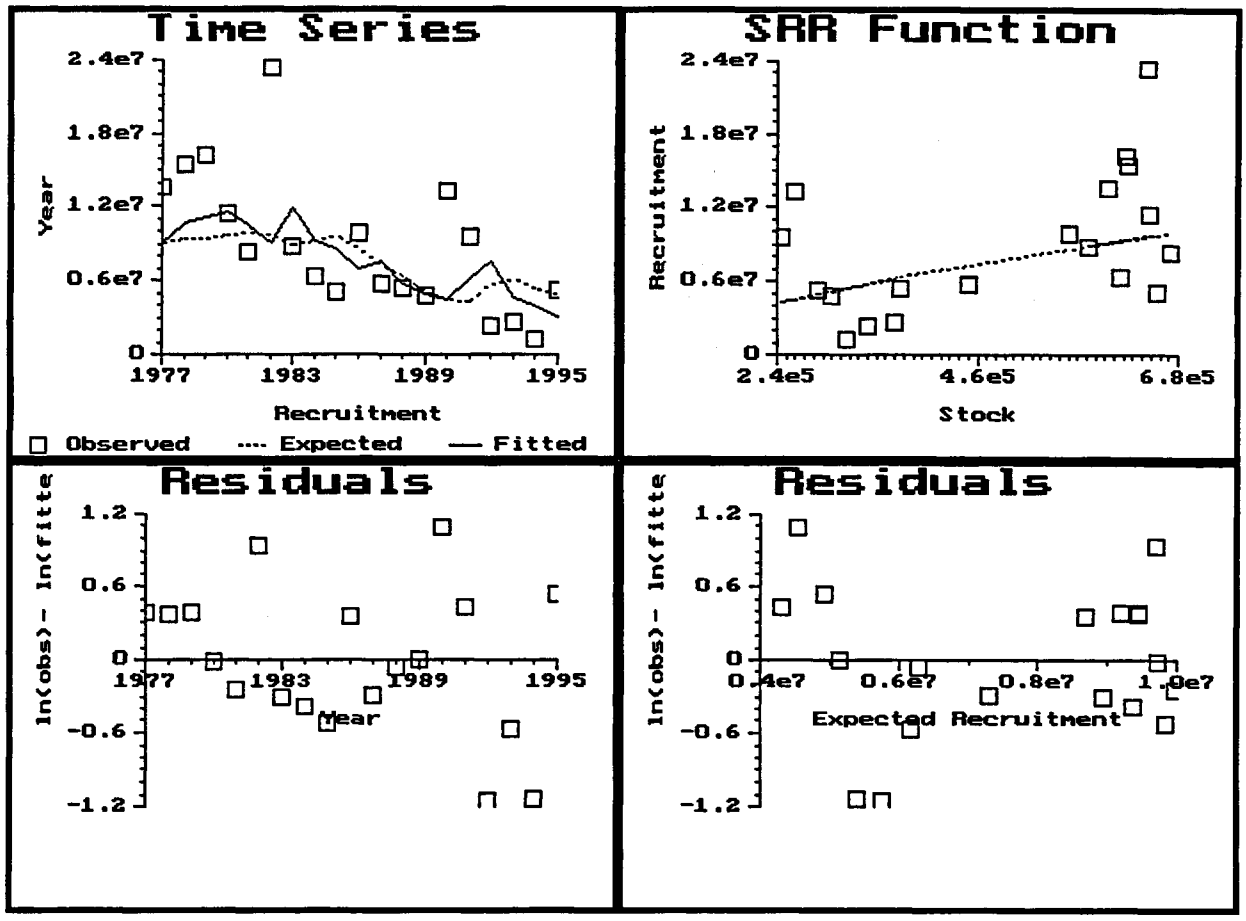


Figure 8.10.2: Fbar, Recruitment and SSB predicitons in 1996 and 1997 assessments

e:\acfm\wgmhsa98\F-8102.xls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1.2e7
0.6e7
0
Year
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1983
1989
1995
Recruitment
Observed
Expected
Fitted
SRR Function
2.4e7
1.8e7
1.2e7
0.6e7
0
Recruitment
2.4e5
4.6e5
6.8e5
Stock
Residuals
1.2
0.6
0
-0.6
-1.2
ln(obs)- ln(fitte
1977
1983
1989
1995
Year
Residuals
1.2
0.6
0
-0.6
-1.2
ln(obs)- ln(fitte
0.4e7
0.6e7
0.8e7
1.0e7
Expected Recruitment

Figure 8.13.1

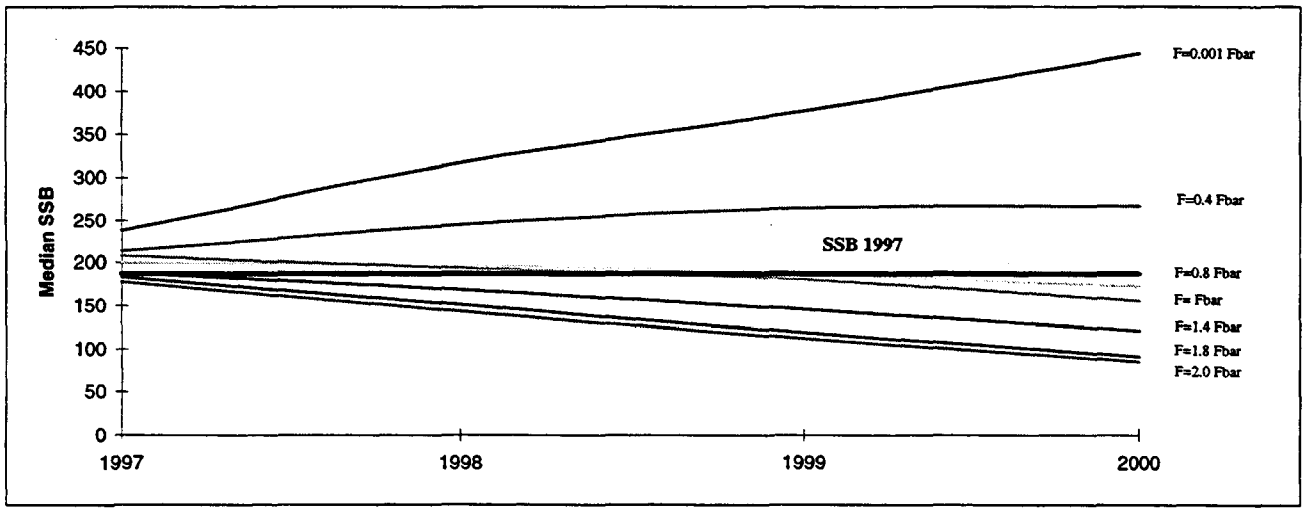


Figure 8.13.2: Expected median Spawning Stock Biomass for different scenarios of F level. Thick line represents the estimated SSB of 1997

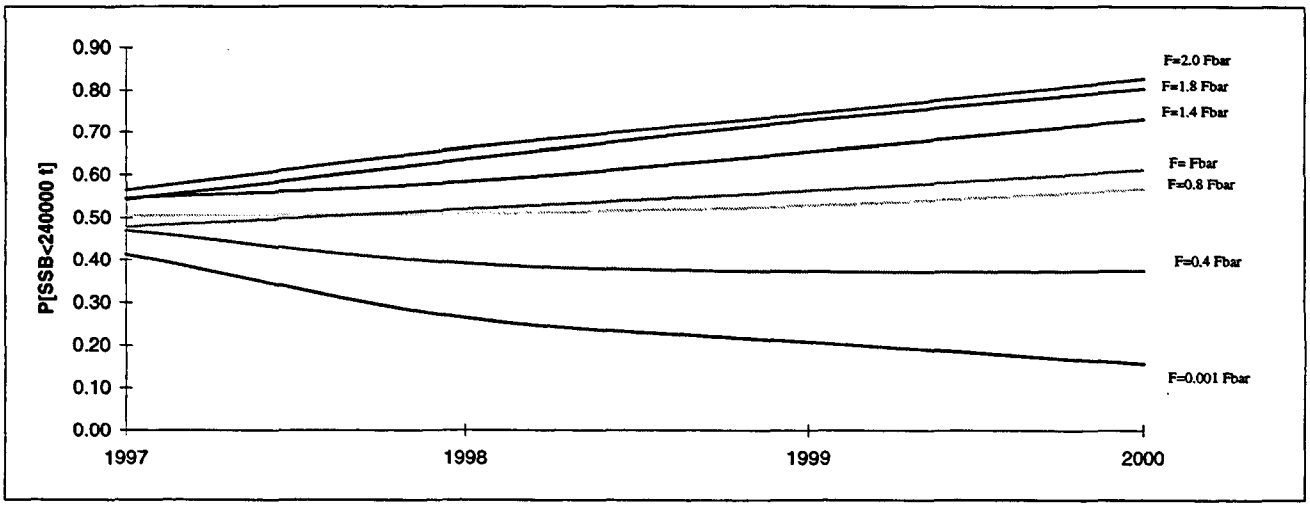
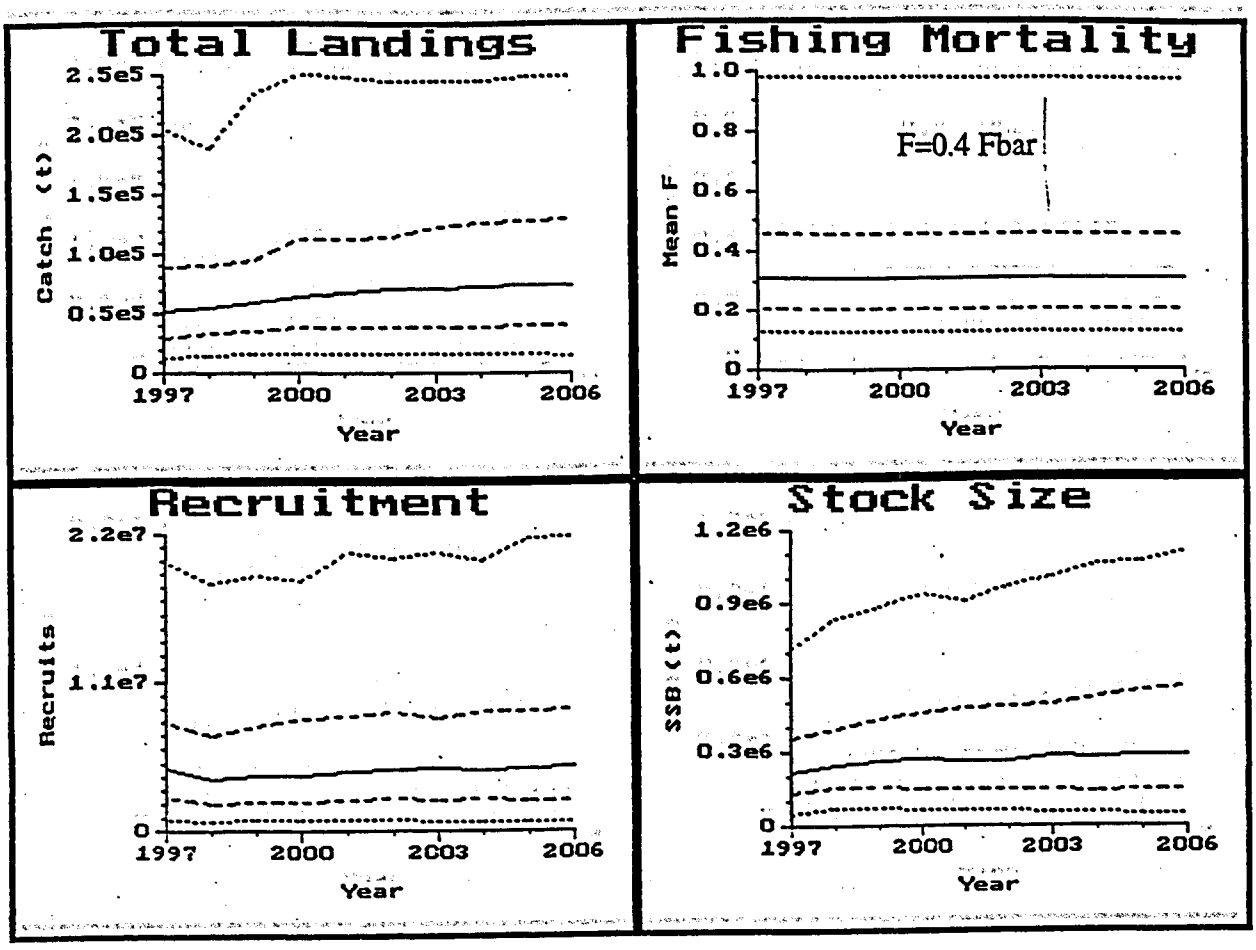


Figure 8.13.3: Probability of SSB falling below 240000 tonnes with increasing exploitation level

Figure 8.13.4


Total Landings
Catch (t)
2.5e5
2.0e5
1.5e5
1.0e5
0.5e5
0
1997
2000
2003
2006
Year
Fishing Mortality
Mean F
1.0
0.8
0.6
0.4
0.2
0
F=0.4 Fbar
Recruitment
Recruits
2.2e7
1.1e7
Stock Size
SSB (t)
1.2e6
0.9e6
0.6e6
0.3e6

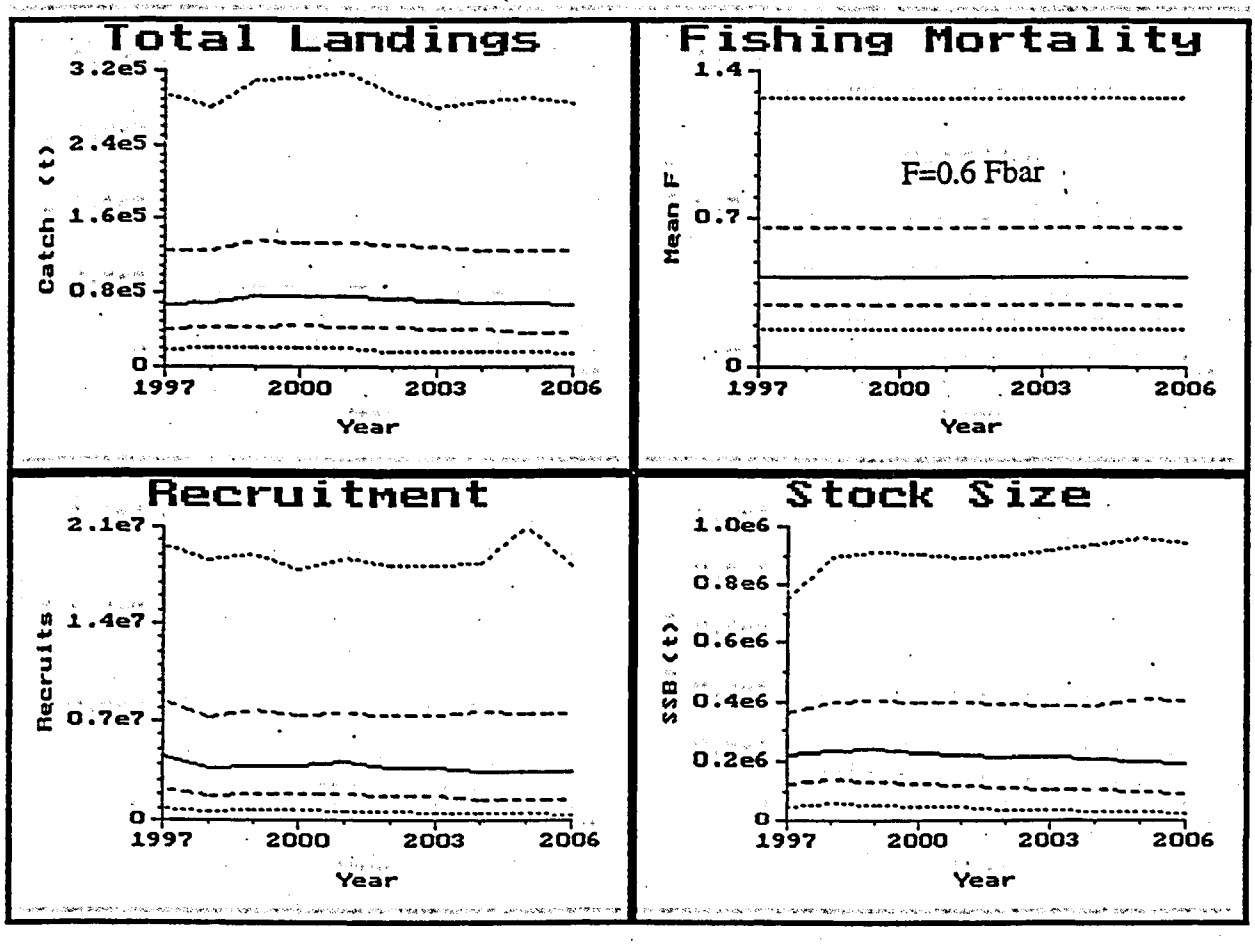
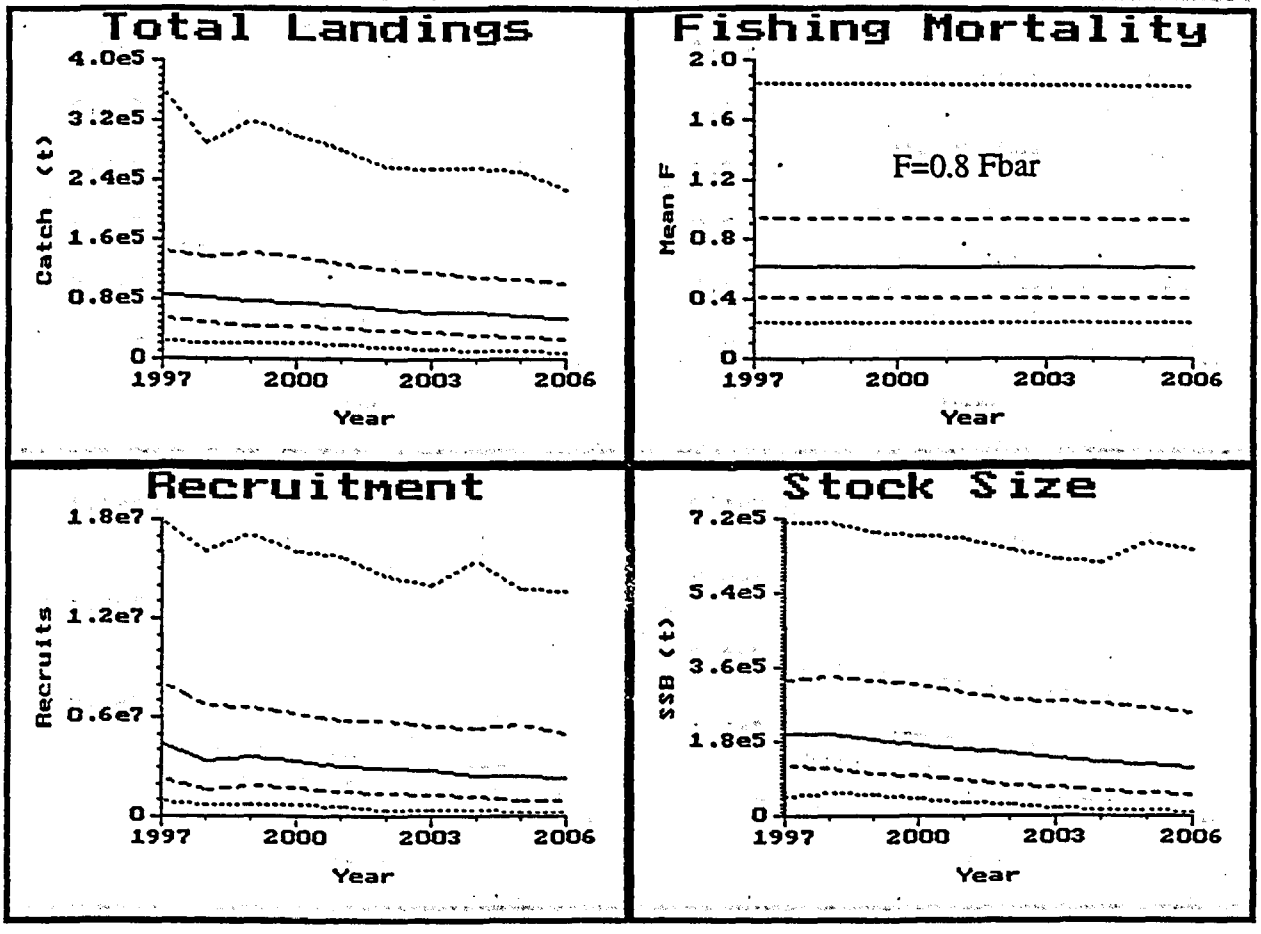

Total Landings
Catch (t)
3.2e5
2.4e5
1.6e5
0.8e5
0
1997
2000
2003
2006
Year
Fishing Mortality
Mean F
1.4
0.7
0
F=0.6 Fbar
Recruitment
Recruits
2.1e7
1.4e7
0.7e7
Stock Size
SSB (t)
1.0e6
0.8e6
0.6e6
0.4e6
0.2e6

Figure 8.13.4 (Cont'd)



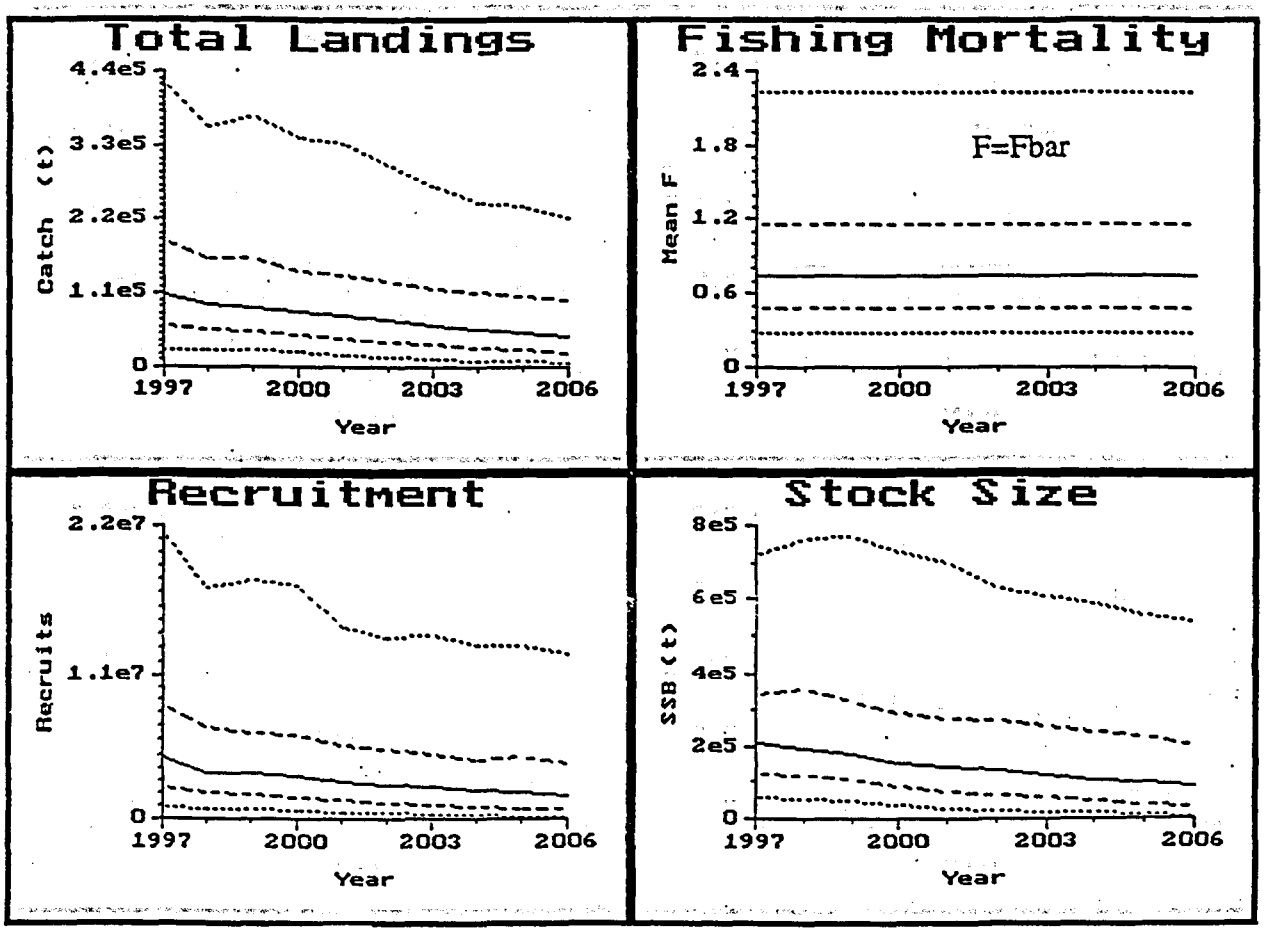
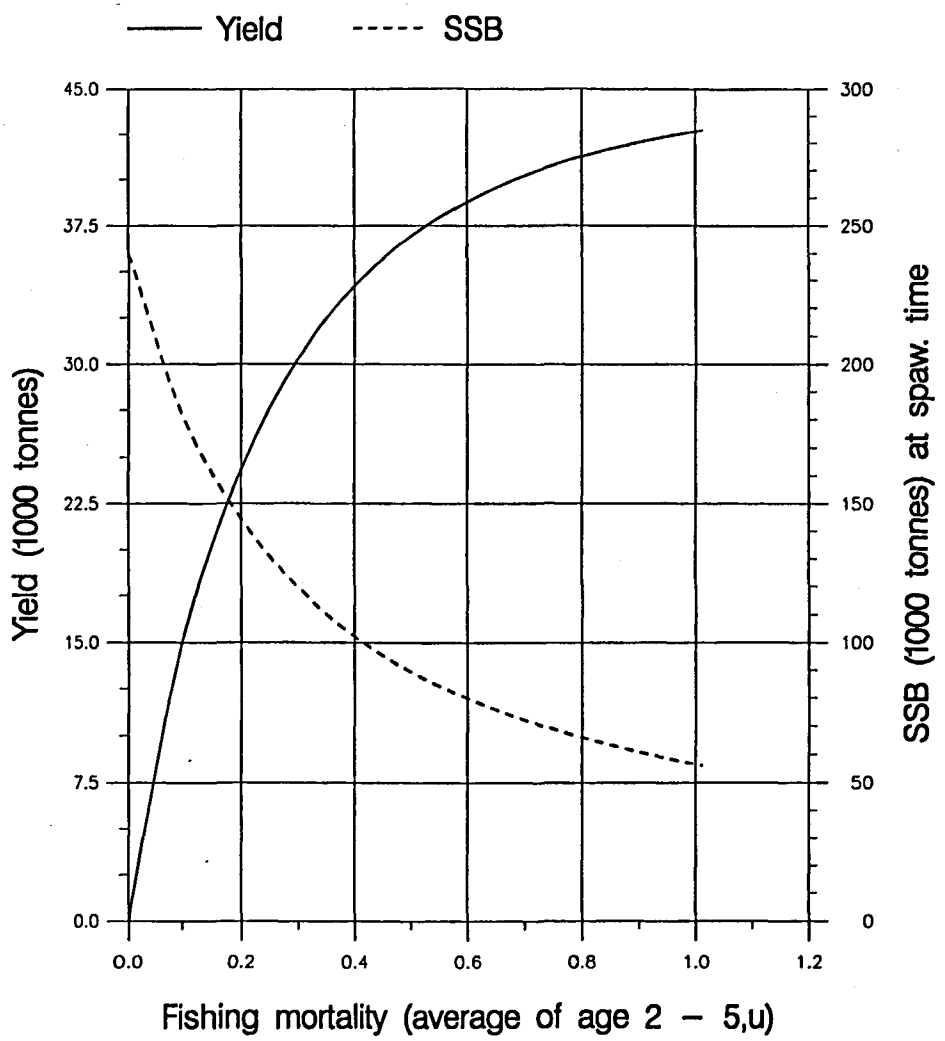


Figure 8.14.1a

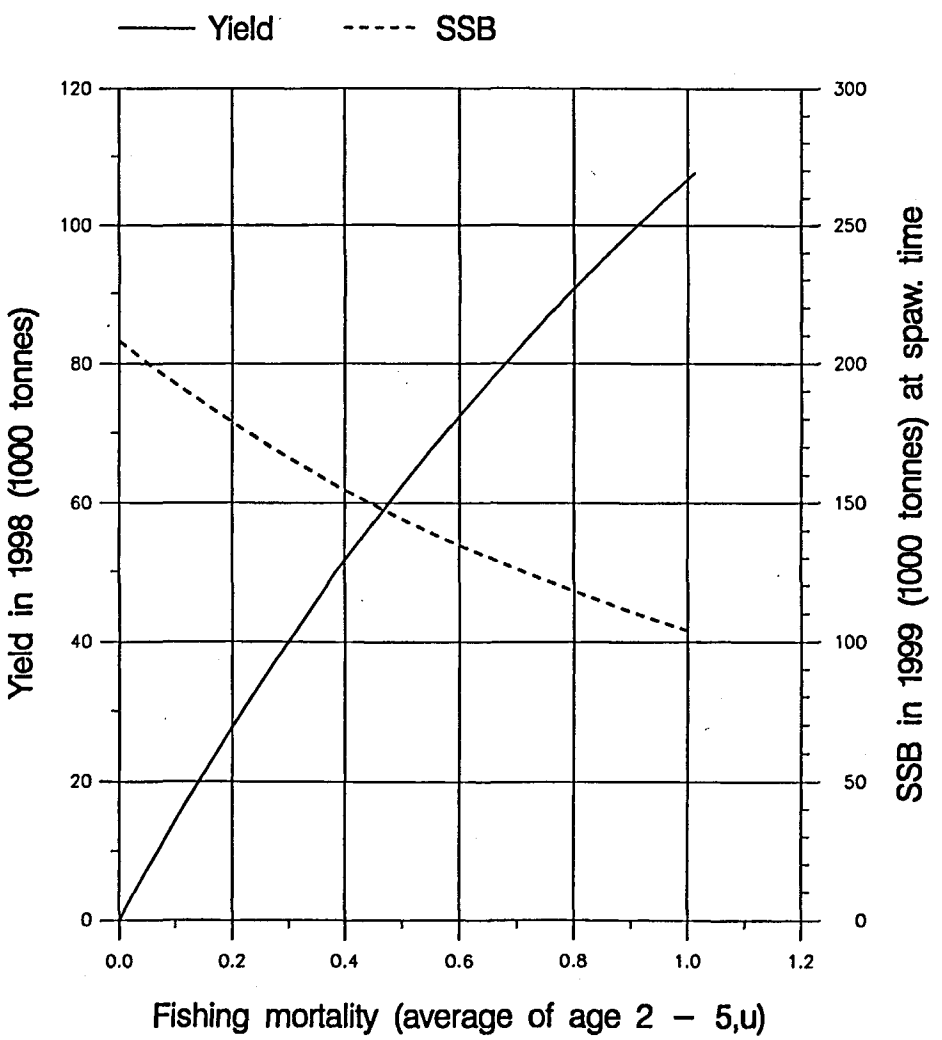
Fish Stock Summary
Sardine in the Southern Area (Fishing Areas VIIIc and IXa)
15 – 9 – 1997

Long term yield and spawning stock biomass



(run: YLDPCL03) C

Short term yield and spawning stock biomass

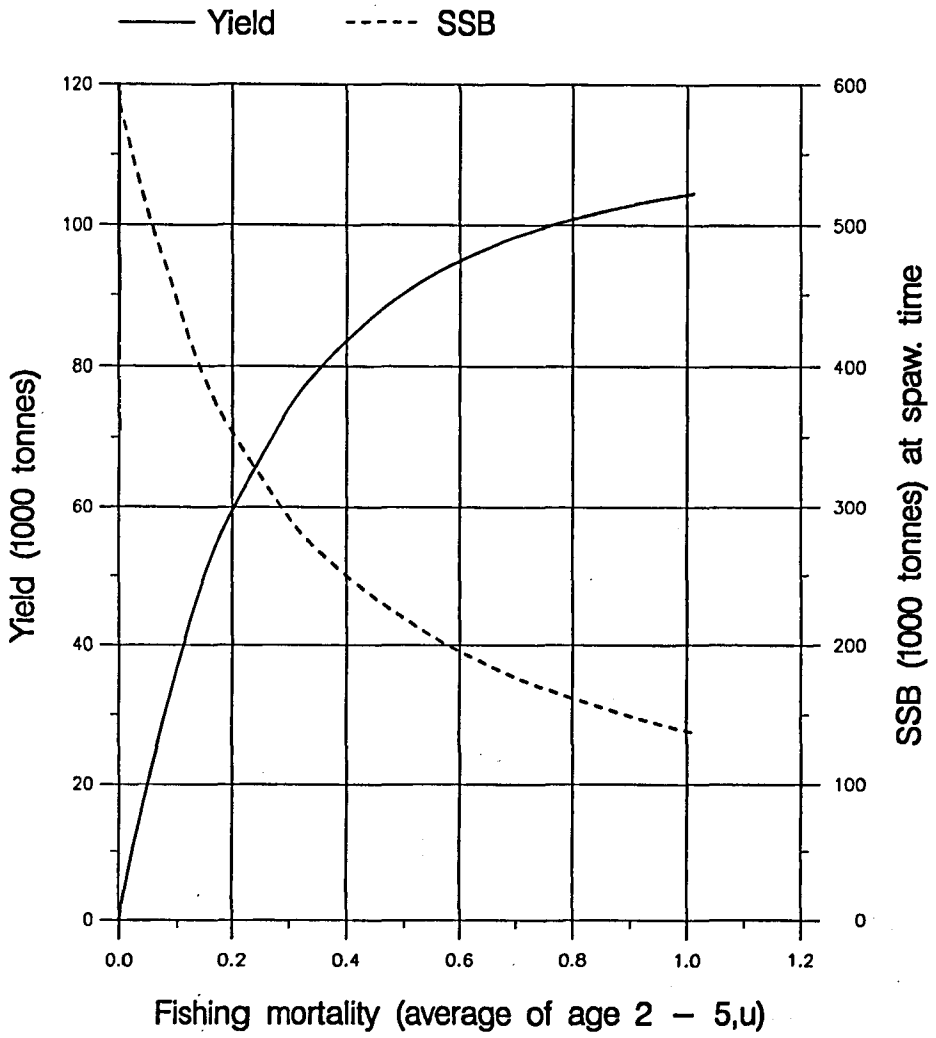


(run: MANPCL02) D

Figure 8.14.1b

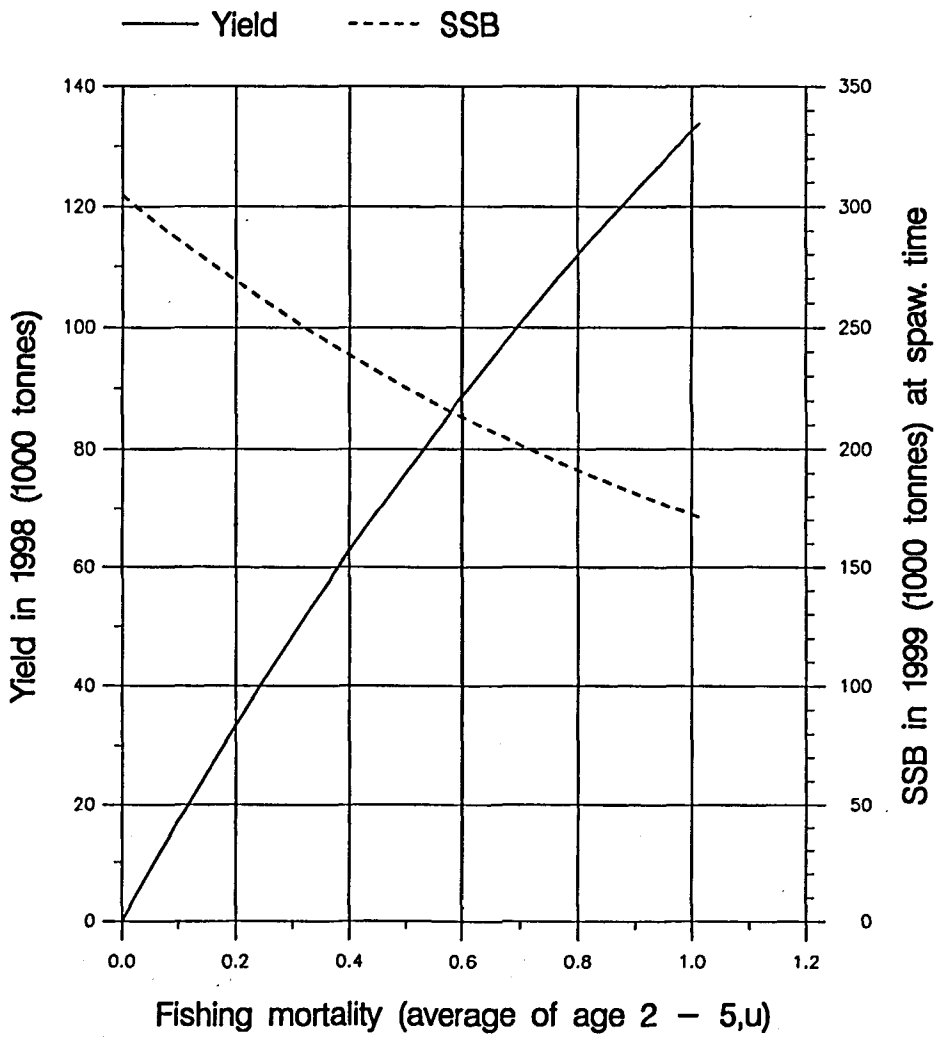
Fish Stock Summary
Sardine in the Southern Area (Fishing Areas VIIIc and IXa)
15 – 9 – 1997

Long term yield and spawning stock biomass



(run: YLDPCL03) C

Short term yield and spawning stock biomass



(run: MANPCL02) D

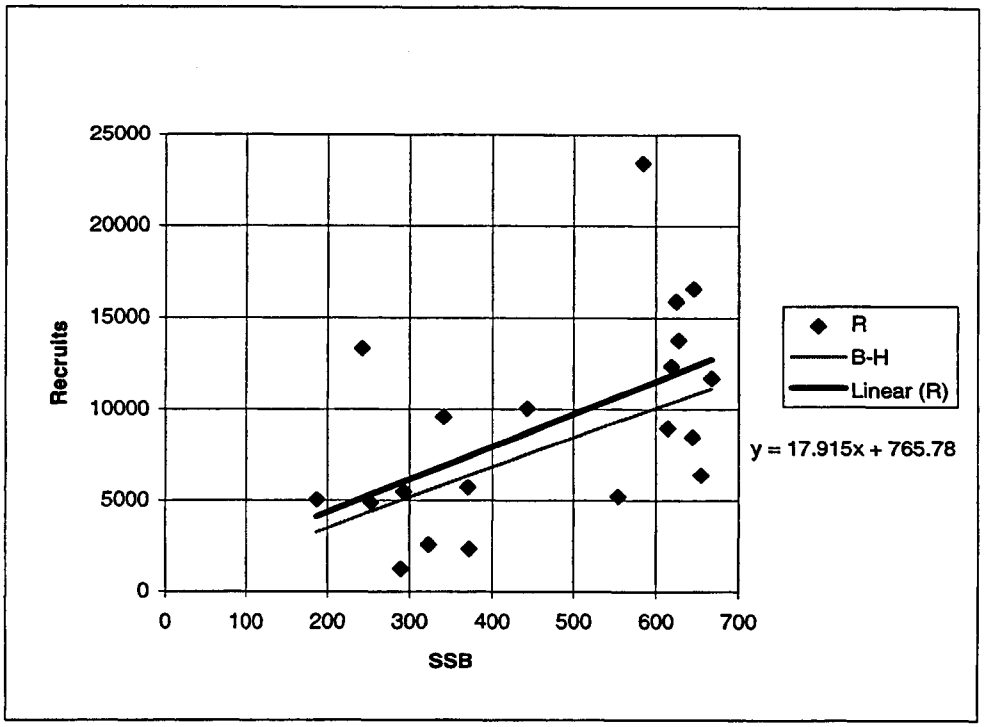


Figure 8.16.1
Stock-recruit plot for sardine
Beverton-Holt line and a linear regression line indicated.

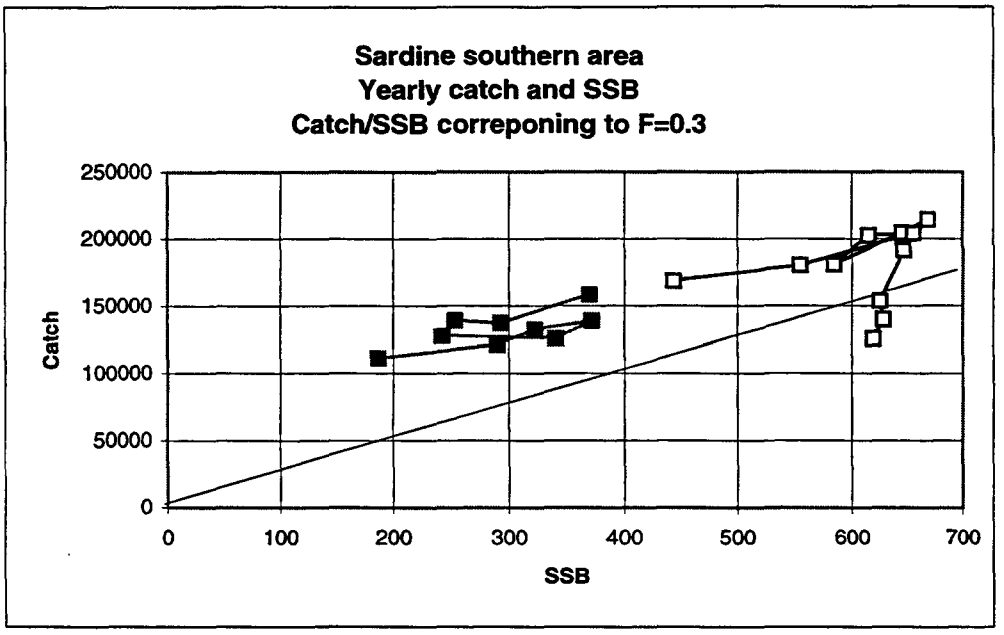


Figure 8.16.2
Yearly SSB and catch.
Open symbols : Before 1985
Filled symbols: After 1985 - assumed separable selection pattern

9 ANCHOVY - GENERAL

9.1 Unit Stocks

The Working Group reviewed the basis for the discrimination of the stocks in Sub-area VIII and Division IXa. No detailed study has been made to discriminate sub-populations along the whole European Atlantic distribution of the anchovy. Morphological studies have shown large variability among samples of anchovies coming from different areas from the central part of the Bay of Biscay to the West of Galicia (Prouzet and Metuzals, 1994, and Junquera 1993). These authors explain that the variability is reflecting the different environments which surround the development of larvae and juveniles at several recruitment zones in the studied areas. They suggest that the population may be structured by some sub-populations or groups with a certain degree of reproductive isolation. Several considerations, like the well defined spawning areas of the anchovy at the South-east corner of the Bay of Biscay (Motos *et al.*, 1996), and the complementary seasonality of the fisheries along the coasts of the Bay of Biscay (showing a general migration pattern) (Prouzet *et al.* 1991 and 1994), makes the Working Group consider that the anchovy in this area has to be dealt with as a single management unit for assessment purposes.

The connections between the population of the anchovy in the Bay of Biscay and anchovies from other areas, either to the North or to the South is not clear. Junquera (1993) suggested that the anchovy in the Central and Western part of Division VIIIc may be more closely related to the anchovy found off Western Galician coasts than with the anchovy at the South-east corner of the Bay of Biscay (where the major fishery takes place). Morphological studies, as mentioned previously, are influenced by environmental conditions and further investigations, especially on genetic characteristics are necessary in order to be more certain. The Working Group considers that for assessment and management purposes the anchovy population along the Atlantic Iberian coasts (Division IXa) should be dealt with as a management unit independent of the one in the Bay of Biscay. A further increase in the fisheries in these areas would allow a better study of the dynamics of the anchovy in this area and its connection or not with anchovies from other areas.

9.2 Distribution of the Anchovy Fisheries

Figures 9.2.1a–d gives the distribution of the fisheries directed on anchovy in Sub-area VIII and Division IXa for 1996. In Sub-area VIII during the first quarter, the main fishery (predominantly the French fleet) is located around the Gironde estuary from 44°N up to 47°N. During the second quarter, the main landings (predominantly Spanish) were caught off the Southern part of the Bay of Biscay (south of 45°N), mainly in the Sub-areas VIIIb and VIIIc. During the second half of the year, the major fishery is located in the North of the Bay of Biscay (Division VIIIa,b) whereas along the Spanish coast only small catches are obtained by the Spanish fleet, with some noticeable catches from July to November in the central and eastern part of Division VIIIc.

In Division IXa, in 1996 a decrease in catches was recorded, especially in IXa North. Two distinct fisheries were observed: the first one was situated off North Portugal and the second one is located in the Bay of Cadiz. Most of the catches are landed during the first and last quarter in the IXa Central North whereas, in the Bay of Cadiz, the principal landings appear during the last three quarters.

Table 9.2.1 shows the distribution of catches of anchovy by quarters in the period 1991–1996. We can see that the distribution of the Sub-area VIII fishery is rather constant during this period: the main fishing areas are VIIIc East, VIIIb and VIIIa. The distributions of catches in Division IXa mainly in 1995, but also in 1996 are different from the 1991–1994 period. The total catches in Division IXa have increased substantially in the central areas of the Atlantic coasts (Sub-divisions IXa Central North) in 1995 and in 1996; increased sharply in 1995, but decreased in the Northern areas in 1996 (IXa North). Catches from Subdivision IXa South which sharply reduced in 1995 increased in 1996 to the same level as in 1993. Since the anchovy tends to be fished as heavily as possible because of its high price at market, in both cases the changes in the landings will probably be reflecting changes in the abundance of the anchovy resources in those areas (Pestana WD 1996). Historically, catches to the West of the Iberian peninsula (from Sub-divisions IXa Central and North) have showed episodic increases (Junquera, 1986 and Pestana WD 1996), probably due to environmental favorable conditions (Uriarte *et al.* 1996).

9.3 Length Compositions by Fleet and by Country

Tables 9.3.1a and b show the anchovy length distributions in 1996 in Sub-area VIII and in Division IXa by quarter and Sub-divisions.

Annual length compositions of landings of the Bay of Biscay anchovy (Sub-area VIII) are provided by France and Spain and those from Division IXa, only by Spain. Portugal have not provided the 1996 length distributions of landings in Division IXa.

The length distributions in Sub-area VIII are plotted in Figure 9.3.1. The length of the anchovies landed ranges mainly from 12 and 16 cm during the first half of the year. France presents some reduction in the size of a part of the anchovies landed in the second quarter. This is due to the fact that pelagic trawlers retired from the fishery up to the first of June and the French landings mainly correspond to the purse seiners which can fish small anchovy close to the shore . On the other hand, the Spanish catches of the second quarter are characterised by bigger anchovies. This is due to the normal pattern of availability of anchovy to the purse seine Spanish fishery according to size over the Spring fishing season (Uriarte & Motos, 1993). For the second half of the year , the fleets continued to catch mainly medium size or big anchovies found in Spring, except for some Spanish catches from the fourth quarter that are partly based on small anchovy (0 age group).

In Division IXa (Figure 9.3.2), the mean length and weight in the catch in Sub-division IXa south are smaller than those recorded from Sub-area VIII. As in previous years, a large number of juveniles are captured (individuals with a length of less than 10 cm) in Sub-division IXa South during the first and the second halves of the year (see Tables 9.3.1a and b). The length distributions of catches seem to reflect the growth of the 1 year old anchovies during the first half of the year and to record the entry of new recruits in the fishery during the second half of the year.

Table 9.2.1 Catch (t) distribution of ANCHOVY fisheries by quarters and total in the period 1991-1996.

QUARTER 1	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	1049	2	6	1	126	0	36	2797	1259	-
1992	1125	0	26	0	0	187	756	3666	958	-
1993	767	0	3	1	0	69	1605	4147	1143	-
1994	690	0	0	0	0	5	62	4601	786	27
1995	185	1	203	12	0	0	35		2380	
1996	41	0.4	1289	11	116	61	9	2345	0	-

QUARTER 2	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	3692	0	10	14	90	295	5848	3923	650	-
1992	1368	0	10	0	11	457	17532	2538	275	-
1993	921	0	6	0	25	24	10157	6230	658	-
1994	2055	0	0	0	1	79	11326	6090	163	75
1995	80	7	1989	1233	23	36	14843		6153	
1996	807	1	227	6	1	404	9366	8723	0	-

QUARTER 3	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	703	0	0	0	24	15	145	386	1744	-
1992	499	0	4	27	192	390	632	191	4108	-
1993	167	0	0	0	1	8	1206	1228	6902	-
1994	210	8	29	1	61	6	1358	2341	3703	15
1995	148	52	1817	4043	1	10	55		3620	
1996	586	0	189	22	134	146	1362	171	6930	-

QUARTER 4	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	274	0	171	0	205	692	148	91	805	-
1992	4	1	96	6	8	18	204	27	5533	-
1993	105	1	13	0	0	0	574	1005	5106	-
1994	80	0	198	116	6	13	895	341	2520	14
1995	157	271	2716	42	398	148	18		2080	
1996	398	12	1002	5	21	12	158	204	4016	-

TOTAL	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	5717	3	187	15	445	1003	6177	7197	4458	-
1992	2996	1	136	33	211	1053	19122	6422	10874	-
1993	1960	1	22	1	26	101	13542	12609	13809	-
1994	3035	8	227	117	68	103	13641	13373	7172	130
1995	571	331	6725	5329	421	194	14951		14233	
1996	1831	13	2707	44	272	623	10895	11442	10946	-

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Table 9.3.1a: Length distribution ('000) of ANCHOVY in Divisions VIIIa,b,c and IXa by country, gear, quarters and Sub-divisions in 1996.

	QUARTER 1						
	SUB-AREA VIII				DIVISION IXa		
Length (cm)	FRANCE Total VIIIab	SPAIN Seine VIIIb	SPAIN Seine VIIIc East	SPAIN Seine VIIIc Central & West	SPAIN Seine IXa North	PORTUGAL Total IXa C,CN,S	SPAIN Seine IXa South
3.5						-	
4						-	
4.5						-	
5						-	
5.5						-	
6						-	
6.5						-	285
7						-	1355
7.5						-	1996
8						-	4349
8.5						-	4135
9						-	1640
9.5	11			15		-	428
10	33			15		-	72
10.5	733			45		-	73
11	2068		18	91		-	3
11.5	6074	97	40	167		-	3
12	5987	212	88	182		-	1
12.5	6319	215	77	363		-	1
13	11249	315	84	462	5	-	
13.5	11604	229	99	266	8	-	
14	15285	102	46	395	50	-	
14.5	8860	43	51	1063	74	-	
15	9777	12	19	2235	94	-	
15.5	14432	8	0	2087	78	-	
16	11741	18	19	1213	69	-	
16.5	5848	1	6	250	50	-	
17	3773	1		27	35	-	
17.5	2097	1		0	8	-	
18	541			38	3	-	
18.5	19					-	
19	8					-	
19.5						-	
20						-	
20.5						-	
21						-	
21.5						-	
22						-	
22.5						-	
Total N	116459	1253	548	8915	473	-	14342
Catch (t)	2287	18	9	177	11	1290	41
L avg (cm)	14.5	13.2	13.4	15.0	15.6	-	8.4
W avg (g)	19.6	14.2	15.6	19.9	22.5	-	2.8

	QUARTER 2						
	SUB-AREA VIII				DIVISION IXa		
Length (cm)	FRANCE Total VIIIab	SPAIN Seine VIIIb	SPAIN Seine VIIIc East	SPAIN Seine VIIIc Central & West	SPAIN Seine IXa North	PORTUGAL Total IXa C,CN,S	SPAIN Seine IXa South
3.5						-	
4						-	
4.5						-	
5						-	
5.5						-	
6						-	
6.5						-	453
7						-	2153
7.5						-	3173
8						-	6913
8.5						-	6573
9						-	2893
9.5	192					-	837
10	816					-	1619
10.5	3395					-	5790
11	5971	71	1482	141		-	16921
11.5	8660	876	7211	253		-	21418
12	13966	3484	14874	523		-	16632
12.5	6671	8524	25105	645		-	7871
13	9272	19462	34938	1522	3	-	2664
13.5	9968	22588	41803	2444	4	-	827
14	8566	24857	50820	5881	28	-	454
14.5	8983	23043	47955	4188	41	-	157
15	13806	29993	55864	2924	52	-	
15.5	9182	29048	42974	1989	43	-	
16	5763	34397	35777	614	38	-	
16.5	2698	24424	21968	612	28	-	
17	2364	21694	16802	151	20	-	
17.5	611	8944	8446	137	4	-	
18	143	6851	8092	13	1	-	
18.5	65	5699	3002	22		-	
19	39	2728	2489	237		-	
19.5	26	132	1084			-	
20	13	15	686			-	
20.5			317			-	
21			194			-	
21.5			55			-	
22			0			-	
22.5			28			-	
Total N	111170	266831	421967	22297	264	-	97351
Catch (t)	1863	6799	9366	405	6	229	796
L avg (cm)	13.8	15.5	14.9	14.6	15.6	-	11.0
W avg (g)	16.8	25.5	22.2	18.2	22.5	-	8.2

- Not available

Table 9.3.1b: Length distribution ('000) of ANCHOVY in Divisions VIIIa,b,c and IXa by country, gear, quarters and Sub-divisions in 1996.

	QUARTER 3						
	SUB-AREA VIII				DIVISION IXa		
Length (cm)	FRANCE Total VIIIab	SPAIN Seine VIIIb	SPAIN Seine VIIIc East	SPAIN Seine VIIIc Central & West	SPAIN Seine IXa North	PORTUGAL Total IXa C,CN,S	SPAIN Seine IXa South
3.5						-	3386
4						-	20883
4.5						-	80798
5						-	90142
5.5						-	64695
6						-	38823
6.5						-	27917
7						-	19364
7.5						-	11044
8						-	2118
8.5						-	454
9			83			-	200
9.5	1297		1221	154		-	63
10	47		816	616		-	182
10.5	5180	6	1044	1915		-	191
11	2809	17	811	3675		-	221
11.5	4226	83	937	2771		-	440
12	10642	111	2733	3194		-	753
12.5	4155	157	4254	2311		-	1791
13	26922	332	5652	1043		-	1291
13.5	31714	606	5898	418		-	973
14	35803	726	7614	540	143	-	791
14.5	36322	631	6807	1669	199	-	692
15	36617	681	8332	1192	192	-	546
15.5	36582	411	7848	705	74	-	438
16	37190	466	4695	656	98	-	141
16.5	27258	196	2946	244	63	-	
17	14371	176	2466	190	37	-	
17.5	5120	230	1844	136	60	-	
18	900	150	391	34	12	-	
18.5	643	144	209	11	17	-	
19	771	65	182	23		-	
19.5	386	28	137	17		-	
20	129		1			-	
20.5	129					-	
21	129					-	
21.5						-	
22						-	
22.5						-	
Total N	319339	5215	66923	21514	896	-	368338
Catch (t)	6838	127	1362	280	22	189	501
L avg (cm)	14.9	15.2	14.6	12.7	15.6	-	5.8
W avg (g)	21.4	24.4	20.4	13.0	24.2	-	1.4

	QUARTER 4						
	SUB-AREA VIII				DIVISION IXa		
Length (cm)	FRANCE Total VIIIab	SPAIN Seine VIIIb	SPAIN Seine VIIIc East	SPAIN Seine VIIIc Central & West	SPAIN Seine IXa North	PORTUGAL Total IXa C,CN,S	SPAIN Seine IXa South
3.5						-	
4						-	
4.5						-	
5						-	
5.5						-	
6			23			-	
6.5			70			-	134
7			129			-	327
7.5			229			-	1579
8			462			-	6184
8.5			596			-	13497
9			499			-	15461
9.5			619	11		-	9178
10			668	40		-	4291
10.5		274	542	105		-	1430
11		584	904	231		-	577
11.5		798	1000	213		-	140
12		1374	1507	343		-	250
12.5	1069	2131	1307	400		-	27
13	13395	2324	1464	446		-	
13.5	20324	1728	890	158		-	
14	15425	1697	878	86	36	-	
14.5	16004	1035	1324	264	21	-	
15	15575	497	422	101	36	-	
15.5	19905	194	207	54	31	-	
16	22512	221	183	47	21	-	
16.5	17369	85	7		10	-	
17	11912	44	2		12	-	
17.5	4478	66	5		22	-	
18	1787	19	2		8	-	
18.5	659	36	2		3	-	
19	420	18			1	-	
19.5	379					-	
20	126					-	
20.5	132					-	
21	132					-	
21.5						-	
22						-	
22.5						-	
Total N	161603	13125	13944	2500	202	-	53074
Catch (t)	3825	204	158	33	5	1064	219
L avg (cm)	15.4	13.4	12.2	13.0	15.9	-	9.2
W avg (g)	23.7	15.5	11.3	13.2	25.7	-	4.1

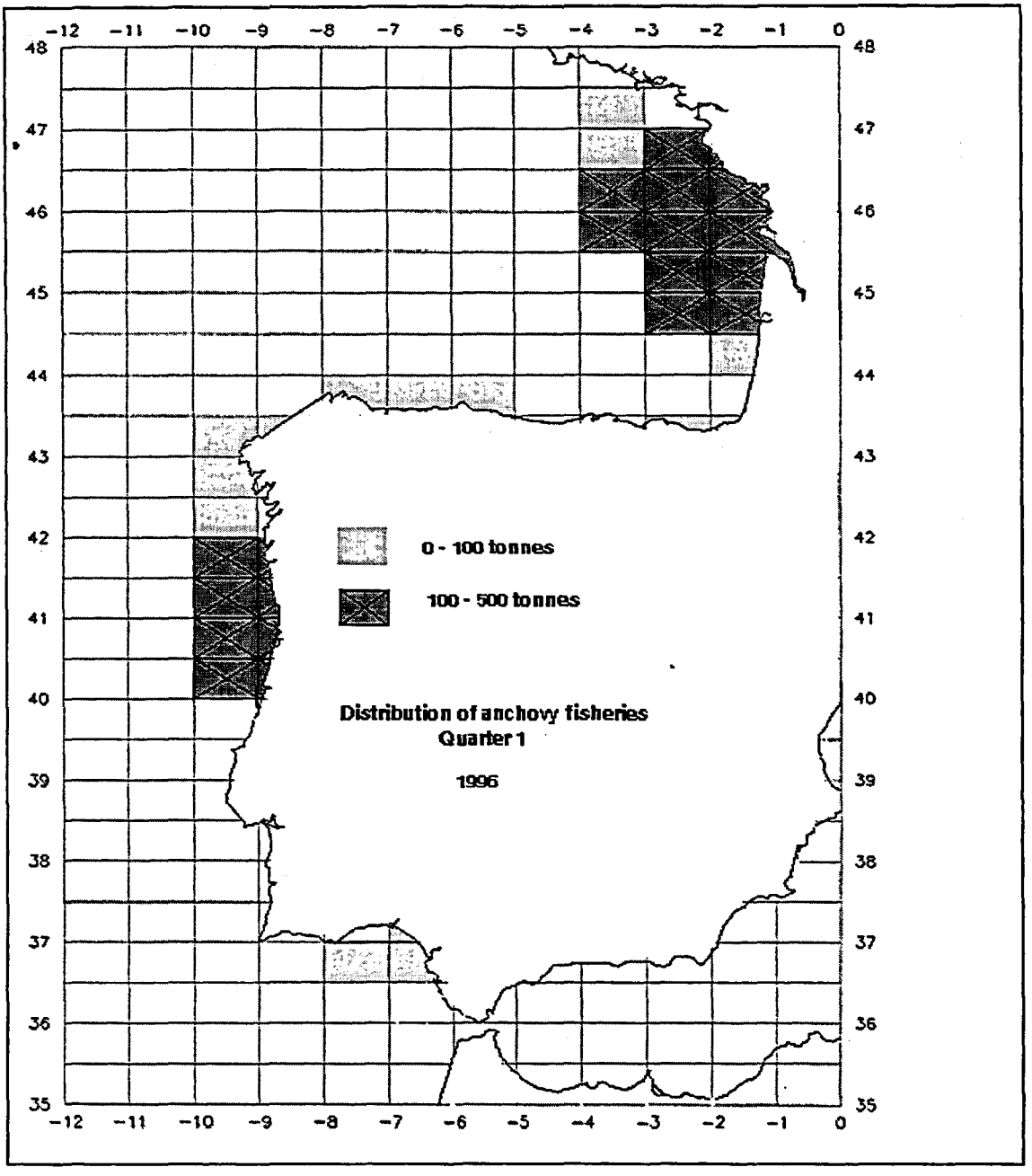


Figure 9.2.1a : Distribution of anchovy fisheries in 1996 for the first quarter

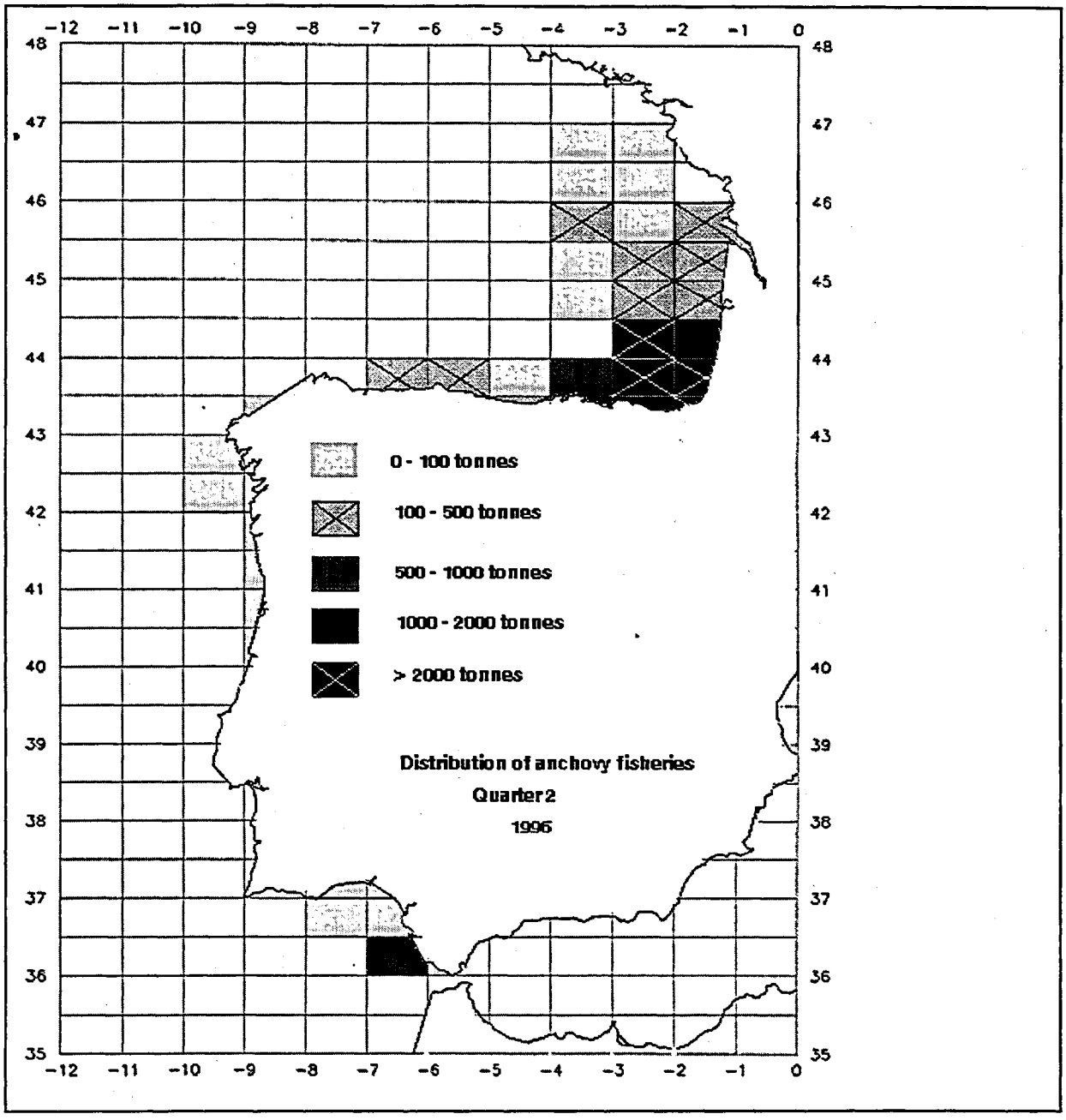


Figure 9.2.1b : Distribution of anchovy fisheries in 1996 for the second quarter

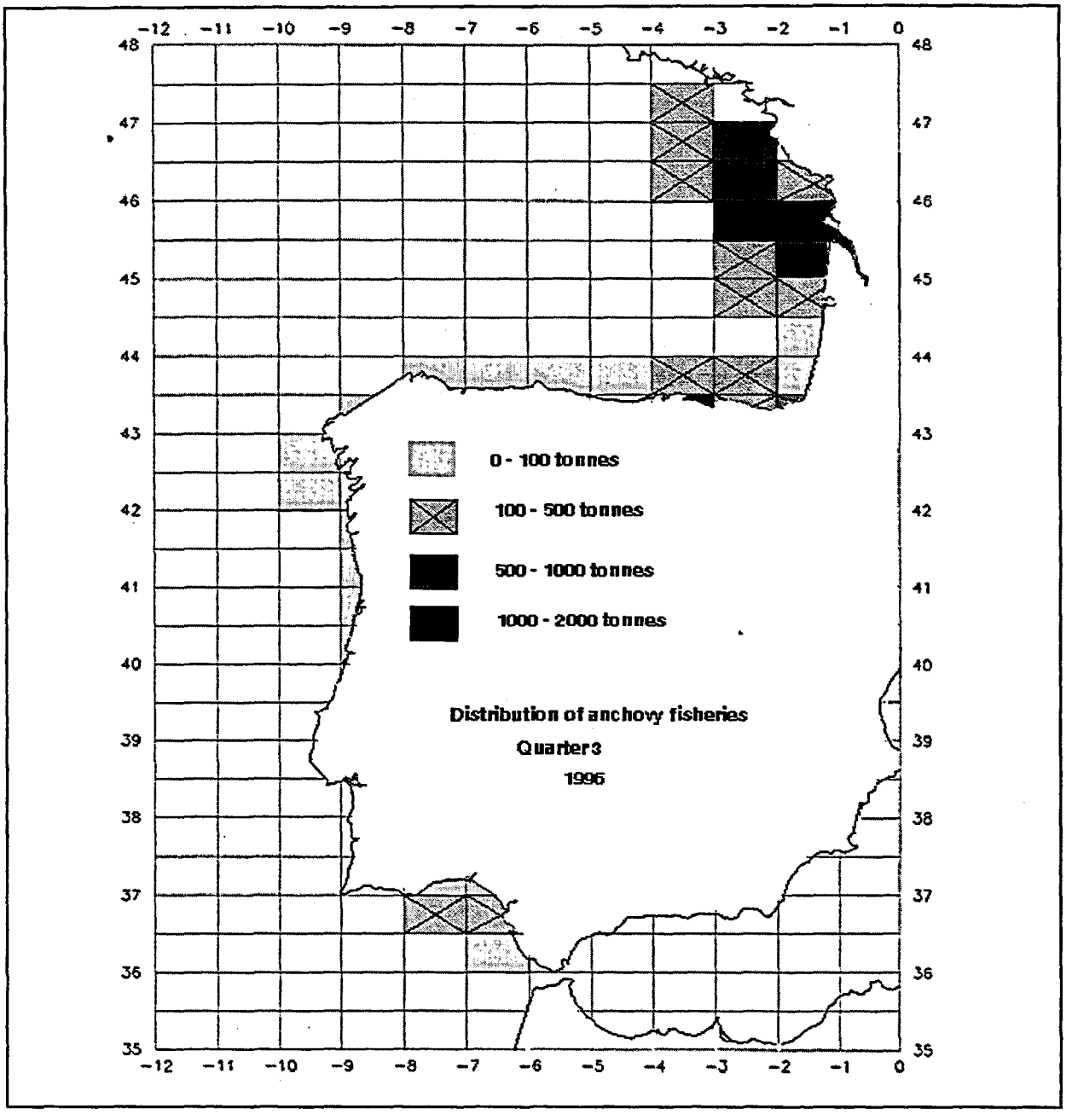


Figure 9.2.1c : Distribution of anchovy fisheries for the third quarter

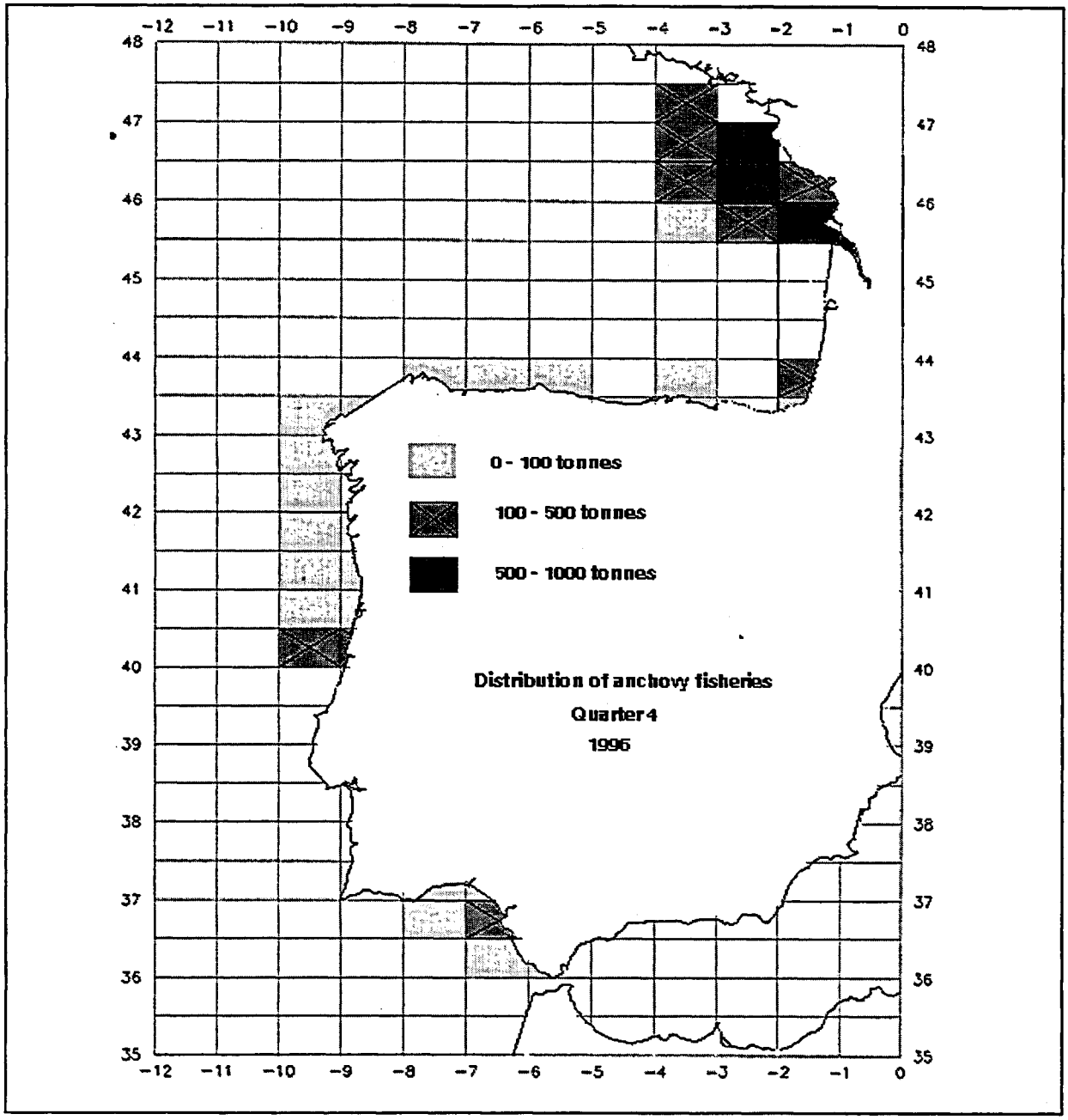


Figure 9.2.1d : Distribution of anchovy fisheries for the fourth quarter

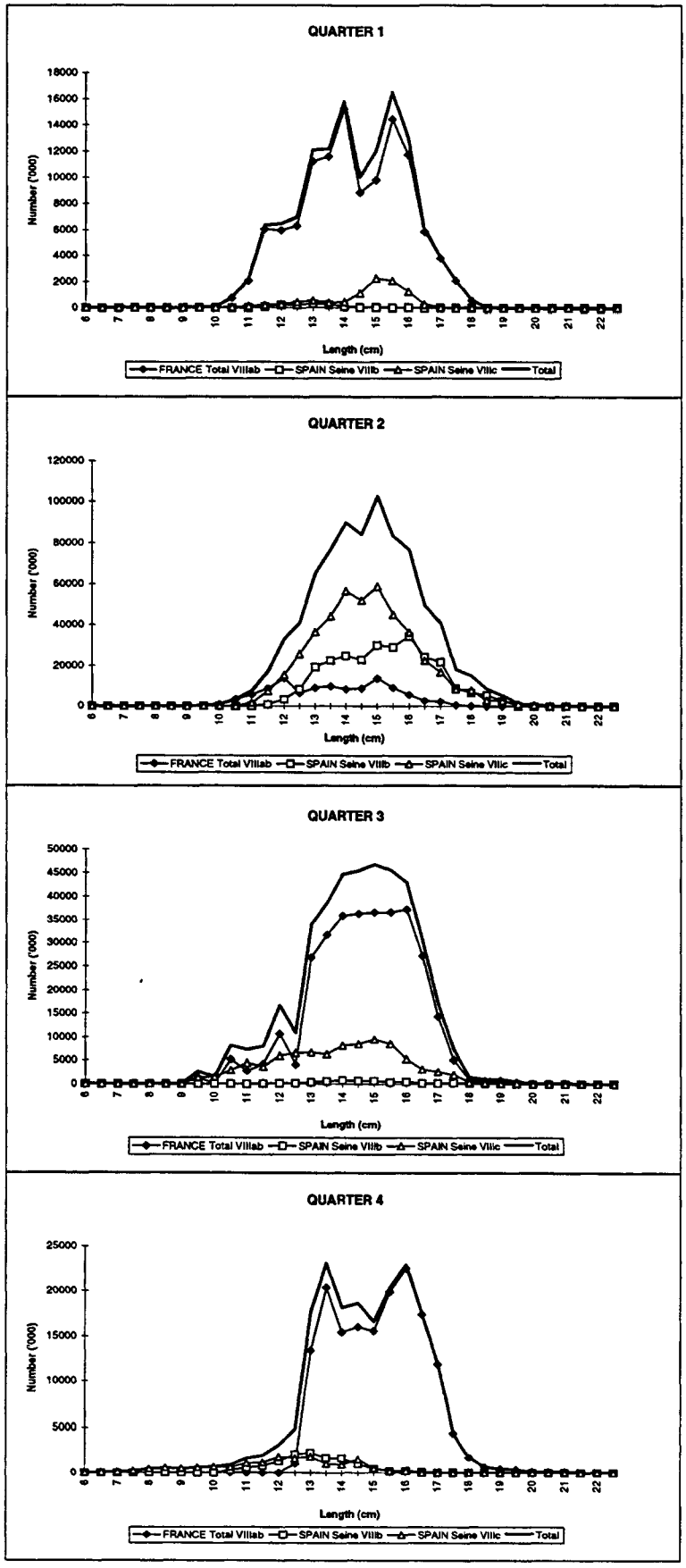
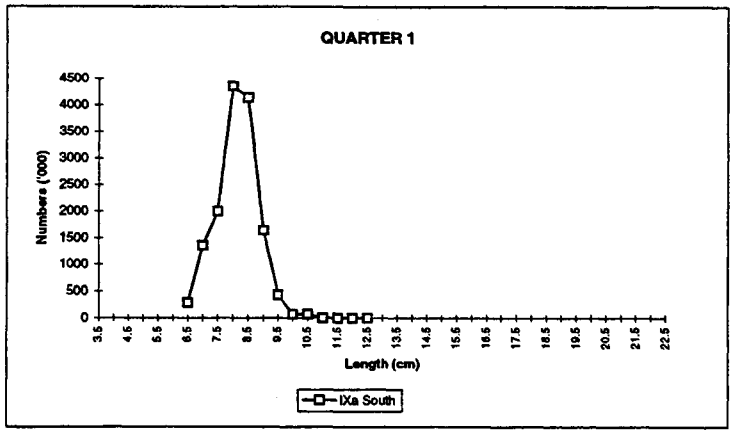
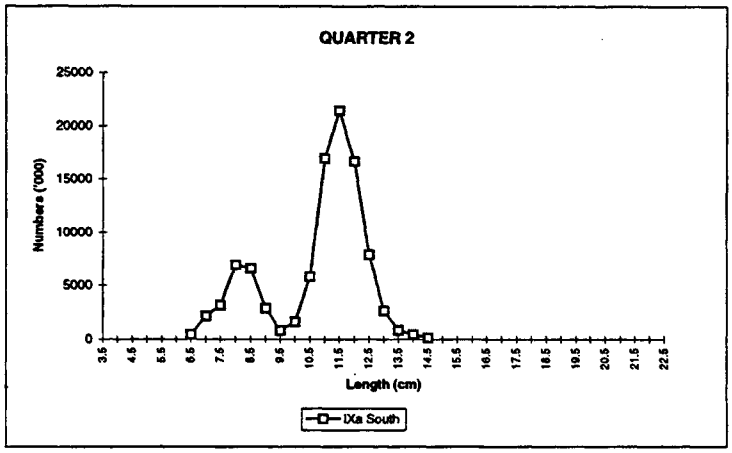
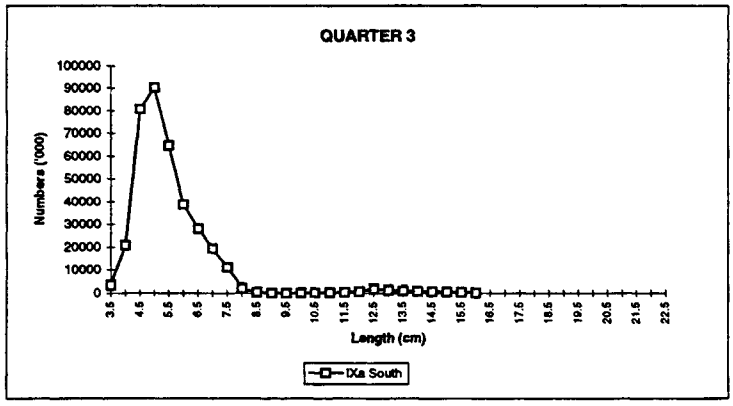


Figure 9.3.1: Length distributions ('000) of landings of Bay of Biscay ANCHOVY in Divisions VIIIa,b and c by quarters in 1996.

e:\acfm\wgmhsa98\F-931.xls







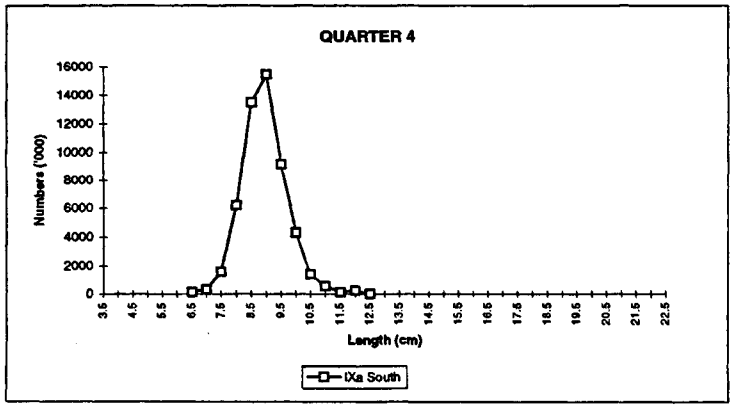


Figure 9.3.2: Length distribution ('000) of landings of ANCHOVY in Sub-division IXa South (Gulf of Cadiz) by quarte:

10 ANCHOVY - SUB-AREA VIII

10.1 The Anchovy Fishery in 1996

10.1.1 Fleets, scheme of fishing and regulation

Two fleets operate on anchovy in the Bay of Biscay:

Spanish purse seine fleet: Operative mainly in the spring, when more than 80% of the annual catches of Spain are usually taken. This spring fishery operates at the south-eastern corner of the Bay of Biscay in Divisions VIIIc and b. Until 1995, the Spanish purse-seiners were allowed to fish anchovy in Sub-division VIIIb only during the Spring season and under a system of fishing licences (Anon. 1988), while Division VIIIa was closed to them for the whole year. Since 1996 this fleet can fish anchovy throughout the year in Sub-area VIII with the same system of fishing licences.

French Pelagic Trawlers: Operative in summer, autumn and winter. Until 1992, they also operated in the Spring season, but due to a bilateral agreement between France and Spain the spring is not presently used as fishing season by the pelagic trawlers. The major fishing areas are the VIIIa and b in the first half of the year and VIIIa, mainly, during the second half. The VIIIc area is prohibited to the French pelagic fleet.

There are also some French purse-seiners located in the Basque country and in the southern part of Brittany. They fish mainly in the spring season in VIIIb.

Since the 1980s, the TAC of 30,000 t (33,000 t in 1995) has been agreed but often exceeded or not reached. The formula for allocation is 10% for France (3,300 t) and 90% for Spain (29,700 t). However, since 1992, a bilateral agreement between France and Spain modifies every year the allocation between the two countries. More precisely, 6,000 t from the Spanish quota are allocated to the French fleet for the second half of the year, if the French mid-water pelagic activity for anchovy stop during the main Spanish fishery in spring (from 20 March to 1 June). In addition to this 6,000 t of the Portuguese quota from XIa were exchanged between Portugal and France, whereas all the French catches are made in the Bay of Biscay (Division VIII) and as such reported to this Working Group.

10.1.2 Landings in Sub-area VIII

Under these circumstances, total international landings in Sub-area VIII amounted to 34,175 t in 1996 (Table 10.1.1 and Figure 10.1.1), higher than the catch level of 1995 (29,842) and of the same level as those of 1994. The French catches increased from 10,892 t in 1995 to 15,238 t in 1996 and the Spanish catch remained stable (18,950 t in 1995 and 18,937 t in 1996). As in previous years, the main Spanish fishery took place in spring (87.5%) and the main French fishery in the second half of the year (72.1%) (Table 10.1.2) (Figure 10.1.2).

No discards were observed in the Spanish fishery and the discards have not been recorded in the French fishery, although the reported French landings include the catches not sold at harbours.

During the first half of 1997, total international catches reached 8,350 t (preliminary data), which is lower than the level recorded at the same period in 1996 (18,758 t).

10.1.3 Landings by Divisions

In 1996, the Spanish and French fisheries were well separated temporally and spatially as in previous years. More than 85% of the Spanish landings were caught in Division VIIIc and VIIIb in spring, while the French landings were caught in Divisions VIIIb in winter (15.3%) or in summer in Division VIIIa (71.8%) (Table 10.1.3).

10.1.4 Landings by EU categories

The distribution of Spanish and French landings by EU market category in Sub-area VIII by quarter for 1996 are given in Table 10.1.4. As usual, the main landed category is T2 (30–50 fish per kg) for both countries (about 60% of the total catch).

10.1.5 Effort and catch per unit effort

The evolution of the fishing fleets during recent years is shown in Table 10.1.5 and Figure 10.1.3. The French mid-water trawlers involved in the anchovy fishery has increased continuously up to 1994. Afterwards this fleet slightly in 1995 (1996 are preliminary data). Therefore, it seems that after the rapid increase of the French fishing effort since 1984, we observe a certain stabilisation of the fishing effort for the last two years, according to the slight decrease in the number of vessels involved in the fishery. The main fishing effort is concentrated in the Central and North part of the Bay of Biscay in the second half of the year for the French fishery whereas for the Spanish one, the main fishing season takes place during the first half of the year in the South-eastern part of the Bay.

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different. The current effort may be at the level that existed in this fishery at the beginning of the 1970s (ICES 1996/Assess:2).

The CPUE of the Spanish purse-seiners during the spring fishery for anchovy is shown in Table 10.1.6. This index is spatially linked with the anchovy abundance in the southern area of the Bay of Biscay and also, although less closely, to the evolution of the biomass of the whole population in the Bay of Biscay, as measured by the daily egg production method (Uriarte and Villamor, WD 1993). The preliminary index for the first half of 1997 shows a CPUE for the total catch mainly lower than the one recorded in 1996 (at about half of that level), suggesting that this age group may have diminished in comparison with previous years. However, the fact that the size of anchovies were rather small, has interfered with the normal development of the fishery in this year, because the Spanish markets are not interested in buying anchovies of a grain superior to 45–50 individuals per kg. In this way the fishing effort on the anchovy may have been decreased and disturbed and so the CPUE.

10.2 Fishery-Independent Information

10.2.1 Egg surveys

Egg surveys to estimate the spawning stock biomass (SSB) of the Bay of Biscay anchovy through the Daily Egg Production Method (DEPM) have been implemented from 1987 to 1997, with a gap in 1993 (Table 10.2.1). In 1996 a new egg survey was carried out in the Bay of Biscay, but due to insufficient economic support the DEPM was not applied entirely and only the estimation of the total Egg production was obtained. In 1997, within the framework of a EU contract, a new survey for the assessment of the Spawning Biomass of anchovy was performed using the DEPM, although to date only the total daily egg production has been calculated for the Working Group.

The series of surveys between 1987 and 1994 showed a positive relationship between spawning area and biomass (Motos & Uriarte 1994) and this is also found between the total Daily egg production and the Biomass (Motos *et al.* WD 1997) (Figure 10.2.1). Both relationships may be used to obtain estimates of the SSB for the years 1996 and 1997 (Motos *et al.* WD 1997, see text table below). However they are not independent indexes due to the fact that the Daily Egg production of the population is a function of the positive Spawning area and the estimated Daily Egg production per unit area. Because of this and in order to come up with some estimate of Biomass for the years 1996 and 1997 based on the available information from the egg cruises, the following log linear model has been applied:

$$LN(SSB) = a_1 LN(A+) + a_2 LN(Po) + \xi$$

with SSBi: Biomass in tonnes estimated by the DEPM
A+ : positive spawning area in km²
Po : Daily egg production per surface unit (in number of eggs per 0.05m²/day)
and a1 and a2 are coefficient factors, parameters of the linear model and ξ is the term of error.

The values included for the multiple regression are those of Table 10.2.1 concerning the surveys from 1987 to 1995. The logarithm transformation was used to have a better distribution of the residuals and to transform the multiplicative model into an additive one.

The following equation was obtained for the extrapolation of the 1996 and 1997 biomasses :

$$LN(Bio) = 0.9148*LN(Spa) + 0.8655*LN(Dep) + \xi$$

with R = 0.96 and % of variance explained = 91.
The fitted model and residuals are plotted in Figure 10.2.2.

In these conditions, we estimate the biomasses for 1996 at 39,499 tonnes and for 1997 at 51,819 tonnes.

Year / Basis	Positive Area	Daily Egg Production	Combined log linear model
1996 SSB estimate	41618	36633	39499
1997 SSB estimate	73342	48523	51819

The discrepancies between the different ways of obtaining the estimates are important in the case of the 1997 although not for 1996.

The DEPM surveys are considered to be unbiased and to produce absolute figures of biomass whenever the methodology is fully applied. The composition of the population was derived for the surveys from 1987 to 1994, based on the adult sampling performed during these surveys. However, in 1987 and 1988 the adult sampling did not cover the whole spawning area of anchovy and therefore some assumptions about the composition of the population in the unsampled area were to be made. Because of this, the age compositions for the DEPM surveys in 1987 and 1988 are less reliable.

The surveys have shown that the major fraction of the population is always the one year old anchovies and therefore the population is driven year after year by the recruitment at age 1.

10.2.2 Acoustic surveys

The French acoustic surveys aimed at estimating the abundance of the Bay of Biscay anchovy were stopped in 1992. The results of the surveys between 1983 and 1992 appear in Table 10.2.2. The figures for 1991 and 1992 were revised and updated for a FAR programme on anchovy (Cendrero ed. 1994). In 1993, 1994 and 1995, only observations concerning the ecology of anchovy, especially located close to the Gironde estuary (one of the major spawning areas for anchovy in the Bay of Biscay), were made. In 1997, a new acoustic survey has been performed for anchovy in the French waters, mainly to study the behaviour of the species in the central part of the Bay (close to the Gironde estuary) and to investigate the relationships between ecology of anchovy and its environment.

According to the discussion which took place in 1993 (ICES 1993/Assess:7) the acoustic values are considered to be relative indexes of abundance and the values of 1983 and 1984 seems to be underestimated.

The general trend in the estimates of anchovy biomass from the acoustic and DEPM methods is comparable between 1989 and 1992 although a large discrepancy was observed in 1991. Both methods however, indicate similar trends in the variations of the population at age 1.

10.3 Catch in Number at Age

10.3.1 Catch at age in 1996

In 1996, the age distribution of the international catches of anchovy (in numbers) in the first half of the year consisted mainly of 1-year-old anchovies, making up 72% (Table 10.3.1). This percentage slightly increases during the second half of the year (75%). On an annual basis, both countries have got a similar percentage of catches of anchovy at age 1 (about 73%). Approximately 25% of the catches of anchovy (in numbers) consisted of immature fish prior to their first spawning in May.

The catches of anchovy corresponding to the Spanish live bait fishery for tuna fishing for the period 1987–1996 are given in Table 10.3.2. Live bait catches of anchovy are rather variable depending on the availability of the different small pelagic species and not only on anchovy.

Table 10.3.3 records the age composition of the international catches since 1987, on a half-yearly basis. 1-year-old anchovies predominate in the catches during the both halves of most of the years. A few catches of immature, 0 age group, appear during the second half of the year.

10.3.2 Revision of the catch matrix at age

In the framework of the EU contract undertaken by France and Spain to estimate fishing and natural mortality from direct estimation methods of abundance of small pelagic species (EU study project 95/018) a revision of the catch matrix at age for the French and Spanish fisheries has been made.

The principal modifications concerned the period 1987 to 1989 (cf. Uriarte *et al.* WD 1997). In 1987, additional biological samples gathered by AZTI were used to improve the age distribution of the Spanish catches for the second half of the year. In 1988, for Spain a review of the age distribution in the catches was made using the reading scheme of AZTI (Uriarte in preparation). Moreover, some biological samples of otoliths were used to improve the age distribution of the catches during the second half of the year.

The age composition of the French catches at age were unknown for the years 1987 and 1988 and they had been previously assumed to be similar to the Spanish ones. The revision made of the French catches of 1987 and 1988 consisted in the collection of new information concerning the distribution of commercial catch categories, which was used to stratify the landings. Using this information and the available biological sampling from the monitoring of the Spanish fishery, the age composition of the French catches have been estimated by the first time.

In 1989, for Spain, the modifications concerned the age distribution of Cantabrian landings during August. For France, a revision of the age distribution was made taking into account some biological information from the Spanish catches (otolith samples) and the seasonality of this fishery.

In 1990 and 1991, for Spain, only the age distribution of catches of the live bait boats in tuna fishing have been revised. For France, some landings were added and some otolith samples from Spain were used to improve the age distribution.

For the period 1992 to 1995, no noticeable changes have been made for Spain and for France some small landings not previously recorded were added.

In summary, for Spain the largest differences appear among the data in the second half of the 1987-1989 period and the previous ones. The age composition was modified and we observed an increase of the proportion of 1 year old anchovies and a large decrease of the proportion of the oldest age groups. In 1988, the changes for the first half of the year are the consequence of the adoption of AZTI ageing criteria for the totality of Spanish landings. For France, the major changes occur in the period 1987-1989 due to the new or first estimates obtained for those years. An increase of the 1 year-old catches is also observed. We have to notice an increase in catches of anchovies from the 1988 year class, the abundance of which was estimated in 1989 by DEPM and acoustic surveys. The level of the biomass of the 1988 year class was considered low. In these conditions, the new estimates do not seem to be in agreement with the direct evaluations made in 1989, unless those ones were underestimated, which may be the case (Santiago and Sanz, 1992). In any case, it is important to consider that the precision of the estimations obtained on age 2 and mainly on age 3 are generally low because these age groups constitute a small fraction of the landings (Table 10.3.4).

10.4 Mean Weight at Age

Mean weight at age of the anchovies caught by the commercial fishery are shown in Table 10.4.1. The French mean weights at age in the catches were based on biological sampling from scientific survey and commercial catches. Spanish mean weights at age were calculated from routine biological sampling of commercial catches.

Large differences are observed between the mean weight of age groups caught by the Spanish and the French fleets over the past year 1996. These differences can be explained by the different seasons and fishing grounds of the two fleets. For instance, during the first half of the year the French landings were made during the first three months while the Spanish ones were made during the last three months. On the other hand, during the second quarter, the French catches are mainly landed by small purse seiners that fish small size anchovies close to the coast, while the Spanish purse seine boats fish bigger anchovies on offshore grounds. In the second half of the year, the French landings were caught in Divisions VIIIa and b, whereas the Spanish ones were mainly caught in VIIIc.

Annual mean weight at age in the fishery and in the stock are shown in Table 10.6.1 (see Sub-Section 10.6). The values for the fishery represent the weighted averages of the half year values per country, according to their respective catches in numbers at age. The values for the stock are the ones estimated for the spawners during the DEPM surveys of 1990-1995 (reported in Cendrero ed., 1994 and Motos *et al.* 1995).

10.5 Maturity at Age

As reported in previous years' reports, anchovies are fully mature as soon as they are 1 year old, at the following Spring after they were spawned. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Motos 1994).

10.6 Stock Assessment

An Integrated Catch at Age analysis, which assumes a separable model of fishing mortality, has been used for the assessment of the anchovy in the Bay of Biscay from 1987 to 1996 (with the ICA package, Patterson and Melvin 1996). The assessment is similar to the one implemented in 1996 for the period 1987-1995 in this Working Group. Inputs are summarised in Table 10.6.1. The assessment uses as tuning data the DEPM (1987-1997) and the Acoustic (1989-92) figures as biomass and as population numbers at age estimates. For 1996 and 1997, the biomass estimates used in the DEPM SSB tuning data are the ones obtained from the combined log-linear model of spawning area and Daily egg production per unit area for the prediction of biomass (see Section 10.2.1 and Motos *et al.* WD 1997). The Acoustic and DEPM estimates are considered as relative and absolute estimates respectively. The assessment assumes a constant natural mortality of 1.2, around the average value estimated earlier at this working group (ICES 1995/Assess:2). The assessment starts in 1987 when the DEPM began to be applied. However the catch data of years 1987 and 1988 is down-weighted in the analysis because for those years, although now revised, the French catch at age data are considered to be more unreliable than for the rest of the years. In addition, the DEPM population as numbers at age estimates for those years, were not as reliable as for the following ones. Ages 4 and 5 are heavily down-weighted due to the small fraction of the catch they represent and to the large imprecision of the estimates. Results are presented in Tables 10.6.1. and Figures 10.6.1.

The model was fitted by a non linear minimisation of the following objective function:

$$\sum_{a=0}^{a=4}\sum_{y=87}^{y=96}\lambda_{a,y}\left(\mathrm{Ln}\left(C_{a,y}\right)-\mathrm{Ln}\left(F_y\cdot S_a.\overline{N}_{a,y}\right)\right)^2+\sum_{y=87}^{y=97}\left[\ \mathrm{Ln}\left(SSB_{DEPM}\right)-\mathrm{Ln}\left(\sum_{a=1}^{4}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2$$

$$+\sum_{y=87}^{96}\sum_{a=1}^{3+}\left[\mathrm{Ln}\left(SP_{DEPM,a,y}\right)-\mathrm{Ln}\left(N_{a,y}\cdot O_a.W_{a,y}\cdot\exp\left(-P_F\cdot F_y\cdot S_a-P_M\cdot M\right)\right)\right]^2+$$

$$\sum_{y=1989,91,92}\left[\mathrm{Ln}\left(SSB_{acoustic}\right)-\mathrm{Ln}\left(Q_{acoustic}\sum_{a=1}^{4}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(\ -P_F F_Y\cdot S_a-P_M.M\ \right)\right)\right]^2+$$

$$\sum_{y=89,91,92}\sum_{a=1}^{2+}\left[\mathrm{Ln}\left(SP_{acoustic}\right)-\mathrm{Ln}\left(Q_{a,y}\cdot N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(-P_F\cdot F_Y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

with constraints on : $S_2 = S_4 = 1$ and $F_{97} = F_{96}$

and $\overline{N}$: average exploited abundance over the year.

N : population abundance on the first of January.

O : maturity ogive, percentage of maturity.

M : Natural Mortality.

F_Y : Annual fishing mortality for the separable model.

S_a : selection at age for the separable model.

P_F and P_M : respectively proportion of *F* and *M* occurring until mid spawning time.

$C_{a,Y}$: catches at age *a* the year *Y*.

O_a and $Q_{a,Y}$: catchability.

SSB_{DEPM} and SSB_{acoust} : Spawning Biomass estimates from DEPM and Acoustic methods.

SP_{DEPM} and SP_{acoust} : Spawning populations at age from DEPM and acoustic methods.

$\lambda_{a,Y}$: weighting factor for the catches at age.

The results show (as in previous years) that the sum of squares curve has not a well defined minimum when plotted against fishing mortality in the last year of the analysis (see Figure 10.6.1). Nevertheless the assessment seems to be driven by the Spawning Biomass estimates by the DEPM which is the longest and most consistent independent

estimate of the population in absolute terms. This index shows a defined minimum at the converged level of fishing mortality in the analysis. The log-variance of the populations estimates from the model versus the tuning indices seems reasonable, but the strong variations in abundance from year to year suggested by the direct DEPM estimates are not followed in parallel by the model (Figures 10.6.1). The separable model presents rather big level of absolute residuals both across years and ages (Figure 10.6.1), performing the best for age 1 (the most important age group in catches). Figure 10.6.2 compares the series of recruitment, Fishing mortality and Spawning Biomass obtained from the assessments calculate these last two years. The output levels of fishing mortality although about 10 % lower than those resulting from the past year assessment show similar trends along the period, increasing in 1991 and dropping later on to the same level as inferred for the 1987–1990 period (at a $Fbar_{1-3}$ between 0.55 and 0.7) increasing slightly in the last year. The reason for this drop is not clear, and probably reflects the uncertainty associated with this assessment. The recruitment and spawning biomass estimates in 1996 are similar to the ones calculated in this assessment (Figure 10.6.2) The Working Group considers that this assessment shows reasonably well the recent trends in population abundance and fishing mortality according to the information available. From the output stock summary the only reference about the stock size has to be the spawning biomass and not the total stock size because the latter includes the biomass of the age 0 group at the beginning of every year (when it does not exist). The stock summary of this assessment is presented in Figure 10.6.3.

10.7 Recruitment and environment

The prior assessment, in agreement with the direct estimates of the population, clearly shows that the anchovy spawning population heavily depends upon the strength of the recruitment at age 1 produced every year (see Figure 10.6.3). This means that the dynamics of the population directly follow those of recruitment with very small buffer.

Figure 10.7.1 plots the estimates of the population at age 1 provided by the assessment in comparison with the available indexes of abundance of anchovy at age 1 coming from the fishery as well as from independent sources of information. The Egg and Acoustic surveys that have been used to tune the assessment show a strong parallel variation of the estimates of the population at age 1, although their variations are more intense than that provided by the assessment itself. The concordance of the Year Class Cumulative Catches (YCCC) with the assessed population at age 1 is obviously very high, since the information obtained in that index is the same as contained in the Catch at age data used to tune the separable model of the assessment. Catch per Unit Effort of 1 year old anchovies of the Spanish purse seine fleet in Spring (CPUE1) shows a rather similar tendency to the one produced by the assessment, in spite of not having been included as tuning data. In general, the fluctuations of the indexes are rather concordant on the period 1987-1995 and indicate relevant changes between years.

The scatter plot between the Spawning biomass and the number of recruits (1-year-olds) obtained from the assessment does not show any defined relationship for this stock, (Figure 10.7.2). This is not either shown using the DEPM estimates of biomass and populations at age (ICES 1997/Assess:3). However nothing is known about the dynamic of recruitment at very low levels of SSB, when depensatory relationships may appear.

Borja *et al.* (1996a and b) noted that oceanographic environment produced by Northern and Eastern winds of medium and low intensity blowing in Spring and early summer in the Bay of Biscay seem to induce good levels of recruitment to the anchovy population. This result was initially established for the period 1967-1989, relating an Index of Recruitment obtained from the fishery (Uriarte, 1993) with an upwelling index obtained from wind strength and direction from satellite data over the major spawning areas of the anchovy in the Bay of Biscay. Borja *et al.* (1996b) confirmed those results up to 1994.

Borja *et al.* (WD 1997) have supplied this Working Group with the estimate of the upwelling index for the most recent years, at the same time that expanded the relationship up to 1995 (Figure 10.7.3). The upwelling index explains about 59% of the inter-annual variability of the recruitment index in the period 1967–1995 (n = 29). The relationship of this upwelling index with the recruitment estimates provided by the DEPM surveys or by the current analytical assessment is also significant ($R^2 = 51$ % , n=10, Figure 10.7.4).

The potential use of the above relationship between the upwelling index and subsequent recruitment for the prediction of the recruitment is evident since theoretically it may be estimated after each spawning season because the upwelling index is measured for the period : March-July. In the current case where the upwelling index for 1996 and 1997 have been provided (Borja *et al.* WD 1997), the index may be used to help for the selection of likely levels of recruitments in these years which will be the basis for any provisions of catch option for the next coming year.

Stock size is at a greatly reduced level compared to the 1950s and 1960s. There is the possibility that the larger fleet which existed in those years could have led to over-fishing, but it cannot be proved. The possibility that environmental factors have caused the reduction of the stock has also been considered (Junquera, 1986). The association between the upwelling index and recruitment seems to endorse the latter hypothesis and links the dynamics of the anchovy population with that of the environment and climate regimes in the Bay of Biscay. Nevertheless, the likely role of the average level of the parental stock on the recruitment, and thus that of the fishing factor, should not be neglected, but further studied.

10.8 Catch Forecast

A deterministic catch forecast based on the number of fish at the beginning of 1997 estimated by the ICA assessment and a recruitment at age 0, equal to the geometric mean of those estimated since 1987, have been made. The projections at F *status quo* suggest catches around 33 thousands tonnes in 1998 and a spawning biomass at a level of 45,000 t in 1998 as well as in 1999. The assumptions for 1997 are only approximate. On the one hand the spawning biomass predicted for 1997 is about 54,000 t at a similar level of biomass to the one indicated by the DEPM survey performed in this year. On the other hand the catches predicted for 1997 (36,000 t) seem to be too high due to the fact that the Spanish spring fishery which usually accounts for about 50 % of the international fishery, has only got 6,350 t (as mentioned earlier in § 10.1.5. This is probably due to the small size of anchovies caught this year and not bought by the Spanish canneries).

The uncertainties associated to this projection are very high, specially linked to the strong dependency of the fishery on the level of the 1 year old recruits and to the high variability associated to the recruitment itself, apart from all the uncertainties of the parameters estimated by the ICA model.

The use of the upwelling index may help to improve the accuracy of this catch options. In this case the upwelling index suggest a level of recruitment at age 0 in 1997 higher than the geometric mean, and therefore higher levels of catches might be expected in 1998 (about 35 % higher) if those predictions become true. However, the approach followed in this forecast has been the adoption of the geometric mean as a conservative rule in order to avoid risking situations for the stock in case of the recruitment being worse than the level the upwelling index suggests. At the moment the Working Group considers it appropriate to check the performance of the forecast based on the upwelling index by making some simulations with retrospective analysis or Monte-Carlo simulations before providing quantitative advice on its basis.

Short- and medium-term considerations

If medium-term projections refers to the period between the assessment and the time when the most recently assessed year classes will not contribute any more to the catches of the fishery, then for the Bay of Biscay anchovy this period is probably two years including the current one. For that reason a probabilistic forecast of the fishery in 1997 and 1998 has been performed. in order to check the risk for the spawning stock of falling below the B_{lim} of about 18,000 t. These has been done with a simulation using the same inputs as the deterministic short term forecast (putting in this case stochastic recruitment at the geometric mean of the period 1987 to 1996 estimated with the ICA package). Two options have been made: catch constraint with a TAC equal to 33,000 tonnes and a stochastic F equal to that of 1996 whose CV was estimated with the ICA program used for the assessment. The Table 10.10.1 shows the main result obtained. For the 2 options mentioned above, the stocks would be around 55,000 and 48,000 tonnes, during the spawning season, in 1997 and 1998 respectively. The catches with the TAC options would be constrained at 33,000 tonnes in 1997 and 1998 and with the other option around 37,000 and 33,000 tonnes in 1997 and 1998 respectively. This is all in a general agreement with the above deterministic projection.

On the 500 trajectories performed to calculate the spawning stock biomass only 5% of the values are below 24,070 tonnes in 1997 and 19,310 tonnes in 1998. That means that under the hypothesis of mean recruitment and constant natural mortality, the probability to be below the B_{lim} was very low in 1998 (approximately less than 5%). These estimated probabilities are calculated on the assumption of constant natural mortality, although there is evidence that this may have been variable in the past. Therefore results presented here capture only a part of the variability in stock dynamics and estimates of the risk uncertainty could therefore be underestimated.

The above exercise is the first probabilistic projection made for the fishery of anchovy in the Bay of Biscay, the implementation of the guidelines for the precautionary approach suggested below will require some more complete projection of the fishery including for each management option a) the risk of falling below the Precautionary

Spawning Biomass (B_{pre}) in the year of the Management and b) the risk of falling below the B_{lim} at *status quo* the next year after the management.

10.9 Comments on Assessment

The estimates of the fishing mortality provided by the previous assessment are mostly dependent on the accuracy of the direct estimates of biomass of the DEPM, since this is the most complete series of surveys in the period assessed and it is driving the assessment. In general the ratio of catches to this direct estimates of biomass are setting the average level of the fishing mortality estimated for the fishery. Improvement of the mortality estimates could be made by taking into account the errors associated with the SSB estimates.

The current levels of fishing mortality (Fbar for the ages 1–3 at about 0.7) are below the likely 1.2 value for natural mortality. The exploitation pattern indicates a negligible exploitation of the 0 group and a moderate fishing pressure on the age 1, far below the one exerted over the two and older years-old anchovies. Although the population consists mainly of 1 year-old anchovy that reach their first maturity in May-June, more than half of the fishing mortality on this age group takes place during and after the spawning season and therefore a high percentage of the population is able to spawn. On the basis of this considerations it can be said that the current exploitation pattern regarding 1 year old anchovies is generally conservative. Figure 10.10.1 shows the yield and spawning biomass per recruit compared with the Virgin state using the fishing mortality at age estimated for 1996, increased and decreased by 1 standard deviation. This figure shows that in the current situation the biomass per recruit of the population is close to be reduced (but not yet) to about half of that expected without any fishery.

The high fishing mortality recorded in 1991, when the stock was at a very low level may indicate that the catchability of the fleets may increase at decreasing trends in the stock abundance, making the stock susceptible of over-fishing in period of low abundance (Pitcher 1995).

The analysis of catch data at age shows a decrease of the mean age of anchovies in the catch since 1987. This fact associated with the increasing fishing effort seems to indicate an increasing tendency in the fishing mortality on that species in the recent years. The prior assessment has shown it up to 1991 but afterwards the fishing mortality drops down to the same level as that in 1987–90. This recent decrease may due to the higher levels of the population recorded in the recent years 1992–1994 and to the stabilisation of the French fleet fishing for anchovy and reduction of its fishing season to the first half of the year, before the spawning season (see bilateral agreement between Spain and France since 1992).

10.10 Reference Points for Management Purposes

10.10.1 MBAL, B_{lim} and B_{pa}

B_{lim}: For anchovy this level of biomass should be set at the minimum biomass below which the stock has a high probability of collapse. Preliminarily, it could be defined as the lowest estimated spawning stock biomass (from the assessment) over the past ten years (18,000 tonnes, in 1989, see Table 10.6.1). Although in this year a good recruitment was produced, this level of Spawning Biomass is so close to 0 that it should not be expected good recruitments at lower biomasses. Therefore, this level of Spawning Biomass should be considered as B_{lim}, below which there is a serious risk of stock collapse. The definition is consistent with the definition of MBAL previously accepted for this stock (set between 15,000 to 20,000 t at the lowest DEPM estimates of Biomass, in 1989 and 1991, see Table 10. 2.1).

B_{pre}: A useful reference for the precautionary approach on levels of biomass should be the definition of a precautionary biomass (B_{pre}), slightly different of B_{pra} for management purposes. It is the Spawning Biomass which allows, under poor recruitment conditions, to obtain a minimum Spawning Biomass for the following year at the level of B_{lim}. In this way, the management would preserve a minimum SSB, in the next year, at least around to B_{lim} to prevent as soon as possible the collapse of the fishery. The past experience shows that a SSB between 30,000 tonnes or 40,000 tonnes give a biomass of 2 years old that allows, with a small recruitment, to have in the next Spring a biomass at the B_{lim} level. Using the Separable model of the assessment, a fishing mortality *status quo* at the 1996 level and the poorest recruitment at age 0 estimated by the model (3641 millions in 1988), a Spawning Biomass of about 39,000 t would be required in the year of management to sustain a spawning Biomass at B_{lim} in the following year. Taking into account these considerations and given the uncertainties in the assessment and the natural variability of this fishery we suggest to take a B_{pre} at a level doubled of the B_{lim}: 36,000 t.

10.10.2 Fishing mortality targets

The exploitation of pelagic species should be undertaken with special care, keeping the exploitation of the stock at a moderate level of fishing mortality provided the risks of overfishing at low levels of biomass of this species and taking into account the historical collapses of several of these stocks (Ulltang 1980, Csirke 1988, Pitcher 1995). In this sense Macer and Sissenwine (1993) state that the higher the natural mortality the bigger should be kept the percentage of spawning biomass per recruit in relation to the Virgin state (without fishing) (the criteria of %SBR). They also indicate that the small pelagic species could be poor resistant to exploitation and for these species the %SBR corresponding with the F_{med} can be as high as 40% or even in some cases 60%. Patterson (1992) suggest that a moderate and sustainable rate of exploitation could be reached at 0.67 M. However one problem associated to these reviews is that they are based on the knowledge acquired on medium size and not too short living species compared with the anchovy. Nevertheless, at the current state of knowledge on this species they may be taken as an indication about sustainable levels of fishing mortality.

The current assessment suggests that average fishing mortality on ages 1 to 3 (0.7) meets the criteria of Patterson (1992). In addition, the % SBR obtained for this population is slightly above 50% (Figure 10.10.1) what satisfies the criteria %SBR of Macer and Sissenwine (1993) for pelagic species. Therefore, the pattern of fishing mortality of this fishery could be sustainable from a long term point of view, provided that the risk of over-fishing at low levels of abundance is avoided by a close monitoring of the fishery coupled with an adaptative and fast managing system.

A reference F_{pa} for this population can be suggested at the level of 50 %SBR what seems to be, with the current fishing pattern, at an Fbar for ages 1–3 at about 1 to 1.2, so just at or below the average natural mortality. The current fishing levels seems to be below the F_{pa} (see Figure 10.10.1)and therefore not at a dangerous level. However, taking into account a) the likely variability of the natural mortality, b) the uncertainties of the assessment (specially for the latest levels of F) and c) the risk in the fisheries of small pelagics of increasing the catchability at low levels of biomass, it seems that it could be difficult to manage from mortality targets to a given mortality value. In addition the changes of fishing mortality by changing the fishing effort are hardly to be implemented. Because of this, for managing purposes the references given for spawning biomass levels seems more practical and suitable.

10.11 Management Measures and Consideration

The anchovy occurring in the Bay of Biscay is a short-living species that attains 100% maturity at 1 year old. Although the Bay of Biscay anchovy constitute a small stock, catches from this resource are economically very valuable. In the last 10 years, there has been a large increase in fishing effort and the catches have been recently exceeding the average level since 1960. The history of the Spanish purse seine fishery shows that a large fleet strongly dependent on anchovy and operating during a long period may not be economically profitable in the long term. Therefore, the need to regulate the fishery is clear.

The above assessment suggests that the current level of fishing mortality could be sustained provided that steps towards a more conservative approach is taken when the stock is at a low level. Therefore, a close monitoring of the fishery coupled with an adaptative and fast reactive managing procedure should be implemented.

According to the possible tools for monitoring the stock (DEPM surveys in May, acoustics at the end or beginning of every year and the upwelling index) the following scenarios for quantitative management are presented for consideration.

2.1 + Submission of Advice on the level of allowable catches within safe biological limits on the basis of the DEPM estimates of biomass and numbers at age. This scenario does not include an estimate of recruitment for the year at the start of the season. Therefore, to reduce the risks of over-exploitation in years of poor recruitment, a more conservative approach to management needs to be taken.

2.2 + Submission of Advice on the level of allowable catches within safe biological limits using a predictor of the new recruitment such as the upwelling index of the year prior to the management, and the survivors expected from the previous year. The DEPM would provide absolute estimates of spawning biomass every year and would serve as starting point to estimate the survivors for the next years. This approach should allow, with suitable estimates, a less conservative approach to management. In this year we have been in the position of giving options of catches according to the DEPM and upwelling index obtained in 1997. By the moment the Working Group considers convenient checking the performance of the forecast based on the upwelling index by making some simulations with retrospective analysis or Monte-Carlo simulations before providing a quantitative advice on its basis. The upwelling

index suggested higher level of catch options for 1998 than the geometric mean, therefore the current approach has been conservative.

2.3 + Submission of Advice on the level of allowable catches within safe biological limits making use of an estimate of coming recruitment obtained by means of an acoustic survey. The DEPM would complement the system providing estimates of absolute levels of spawning biomass every year and would be use to forecast the survivors for the next year. The frequency of the DEPM surveys could be relaxed once the management approach has proved to be satisfactory. This strategy would also allow a less conservative approach to be taken.

The benefits and costs of management approaches based on more or less precise information on coming recruitment, as has just been described, should be tested by simulation studies using assessment models. The relative benefits of 2.2 and 2.3 would depend on the precision and accuracy of the upwelling index as a predictor of recruitment, and the recruitment survey. This should also be investigated by simulation studies.

In order to implement a rigorous management of the Bay of Biscay Anchovy, precise information on the abundance of the stock provided on regular basis is absolutely necessary. The assessment and scientific advice for a species like anchovy rely heavily on this direct methods. It is therefore necessary that the countries involved on the fishery guarantees sufficient support to the stock direct monitoring (i.e. by Acoustic or DEPM methods), in order to come out with an optimal management of the fishery.

Table 10.1.1: Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII) As estimated by the Working Group members.

COUNTRY	FRANCE	SPAIN	INTERNATIONAL
YEAR	VIIIab	VIIIbc	VIII
1960	1,085	57,000	58,085
1961	1,494	74,000	75,494
1962	1,123	58,000	59,123
1963	652	48,000	48,652
1964	1,973	75,000	76,973
1965	2,615	81,000	83,615
1966	839	47,519	48,358
1967	1,812	39,363	41,175
1968	1,190	38,429	39,619
1969	2,991	33,092	36,083
1970	3,665	19,820	23,485
1971	4,825	23,787	28,612
1972	6,150	26,917	33,067
1973	4,395	23,614	28,009
1974	3,835	27,282	31,117
1975	2,913	23,389	26,302
1976	1,095	36,166	37,261
1977	3,807	44,384	48,191
1978	3,683	41,536	45,219
1979	1,349	25,000	26,349
1980	1,564	20,538	22,102
1981	1,021	9,794	10,815
1982	381	4,610	4,991
1983	1,911	12,242	14,153
1984	1,711	33,468	35,179
1985	3,005	8,481	11,486
1986	2,311	5,612	7,923
1987	4,899	9,863	14,762
1988	6,822	8,266	15,088
1989	2,255	8,174	10,429
1990	10,598	23,258	33,856
1991	9,708	9,573	19,281
1992	15,217	22,468	37,685
1993	20,914	19,173	40,087
1994	16,934	17,554	34,487
1995	10,892	18,950	29,842
1996	15,238	18,937	34,175
1997	2,000	6,350	8,350 (*)
AVERAGE (1960-96)	4,780	29,575	34,360

(*) Preliminary data for the first half of the year

Actualizacion: Completa hasta 1996 inclusive el 29 de Julio del 97 por I. Rico

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Table 10.1.2 Monthly catches of the Bay of Biscay anchovy by country (Sub-area VIII)

COUNTRY: FRANCE Units: t.

YEAR\MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	0	1113	1560	268	148	582	679	355	107	87	4899
1988	0	0	14	872	1386	776	291	1156	2002	326	0	0	6822
1989	704	71	11	331	648	11	43	56	70	273	9	28	2255
1990	0	0	16	1331	1511	127	269	1905	3275	1447	636	82	10598
1991	1318	2135	603	808	1622	195	124	419	1587	557	54	285	9708
1992	2062	1480	942	783	57	11	335	1202	2786	3165	2395	0	15217
1993	1636	1805	1537	91	343	1439	1315	2640	4057	3277	2727	47	20914
1994	1972	1908	1442	172	770	1730	663	2125	3276	2652	223	0	16934
1995	620	958	807	260	844	1669	389	1089	2150	1231	855	22	10892
1996	1084	630	614	206	150	1568	1243	2377	3352	2666	1349	0	15238
Average 87-96	940	899	599	596	889	779	482	1355	2323	1595	835	55	11348
In percentage	8.3%	7.9%	5.3%	5.3%	7.8%	6.9%	4.2%	11.9%	20.5%	14.1%	7.4%	0.5%	100%
Average 92-96	1475	1356	1068	302	433	1283	789	1886	3124	2598	1510	14	15839
In percentage	9.3%	8.6%	6.7%	1.9%	2.7%	8.1%	5.0%	11.9%	19.7%	16.4%	9.5%	0.1%	100%

COUNTRY: SPAIN

YEAR\MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	4133	3677	514	81	54	28	457	202	265	9864
1988	6	0	28	786	2931	3204	292	98	421	118	136	246	8266
1989	2	2	25	258	4295	795	90	510	116	198	1610	273	8173
1990	79	6	2085	1328	9947	2957	1202	3227	2278	123	16	10	23258
1991	100	40	23	1228	5291	1663	91	60	34	265	184	596	9573
1992	360	384	340	3458	13068	3437	384	286	505	63	94	89	22468
1993	102	59	1825	3169	7564	4488	795	340	198	65	546	23	19173
1994	0	9	149	5569	3991	5501	1133	181	106	643	198	74	17554
1995	0	0	35	5707	11485	1094	50	9	6	152	48	365	18951
1996	48	17	138	1628	9613	5329	1206	298	266	152	225	17	18937
Average 87-96	70	52	510	2726	7186	2898	532	506	396	224	326	196	15622
In percentage	0.4%	0.3%	3.3%	17.5%	46.0%	18.6%	3.4%	3.2%	2.5%	1.4%	2.1%	1.3%	100%
Average 92-96	102	94	497	3906	9144	3970	714	223	216	215	222	114	19417
In percentage	0.5%	0.5%	2.6%	20.1%	47.1%	20.4%	3.7%	1.1%	1.1%	1.1%	1.1%	0.6%	100%

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Table 10.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 1996

COUNTRIES	DIVISIONS	QUARTERS 1	2	3	4	CATCH (t) ANNUAL	%
SPAIN	VIIIa	0	0	0	0	0	0.0%
	VIIIb	18	6799	127	204	7148	37.7%
	VIIIC	186	9771	1642	191	11790	62.3%
	TOTAL	203	16570	1769	394	18937	100.0%
	%	1.1%	87.5%	9.3%	2.1%	100.0%	
FRANCE	VIIIa	0	0	6930	4016	10946	71.8%
	VIIIb	2327	1924	44	0	4295	28.2%
	VIIIC	0	0	0	0	0	0.0%
	TOTAL	2327	1924	6974	4016	15240	100.0%
	%	15.3%	12.6%	45.8%	26.3%	100.0%	
INTERNATIONAL	VIIIa	0	0	6930	4016	10946	32.0%
	VIIIb	2345	8723	171	204	11442	33.5%
	VIIIC	186	9771	1642	191	11790	34.5%
	TOTAL	2530	18494	8743	4410	34178	100.0%
	%	7.4%	54.1%	25.6%	12.9%	100.0%	

Table 10.1.4: Bay of Biscay ANCHOVY catches (t) by country and EU market categories in 1996

		QUARTERS					
COUNTRY	**EEC CAT.**	**1**	**2**	**3**	**4**	**ANNUAL**	**%**
SPAIN	**T1**	0	1,302	2	0	1,304	6.9%
	T2	0	11,735	784	49	12,568	66.4%
	T3	44	3,100	678	211	4,034	21.3%
	T4	160	433	305	134	1,032	5.4%
	TOTAL	203	16,570	1,769	394	18,937	100.0%
FRANCE	**T1**	7	47	430	439	923	6.1%
	T2	1,224	1,026	3,863	2,389	8,503	55.8%
	T3	1,083	417	2,668	1,187	5,355	35.1%
	T4	12	434	11	0	457	3.0%
	TOTAL	2,327	1,924	6,972	4,016	15,238	100.0%
INTERN.	**T1**	7	1,349	432	439	2,227	6.5%
	T2	1,224	12,761	4,647	2,438	21,071	61.7%
	T3	1,127	3,517	3,346	1,398	9,388	27.5%
	T4	172	866	317	134	1,489	4.4%
	TOTAL	2,530	18,494	8,741	4,410	34,176	100.0%

T1 : <== 30 anchovies/Kg.
T2 : between 31 and 50 per Kg.
T3 : between 51 and 83 per Kg.
T4 : more than 84 per Kg.

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Table 10.1.5: Evolution of the French and Spanish fleet for ANCHOVY in Subarea VIII (from Working Group members). Units: Numbers of boats.

	France			Spain	
Year	P. seiner	P. trawl	Total	P. seiner	total
1960	52	0 (1)	52	571	623
1972	35	0 (1)	35	492	527
1976	24	0 (1)	24	354	378
1980	14	n/a (1)	14	293	307
1984	n/a	4 (1)	4	306	310
1987	9	36 (1)	45	282	327
1988	10	61 (1)	71	278	349
1989	2	51 (1)	53	215	268
1990	30	80 (2)	110	266	376
1991	30	115 (2)	145	250	395
1992	13	123 (2)	136	244	380
1993	21	138 (2)	159	253	412
1994	26	150 (2)	176	257	433
1995	26	120 (2)	146	257	403
1996	26	120 (2)	146	251	397
1997	26	n/a (2)	26	273	299

(1) Only St. Jean de Luz and Hendaya.
(2) Maximun number of potential boats; the number of pelagic trawling gears is roughly half of this number due to the fishing in pairs of mid-water trawlers.
n/a = Not available.

TABLE 10.1.6 Catch per unit effort of anchovy from the Spanish Spring fishery in the Bay of Biscay
(Average catches per boat and fishing day) (From WG members)

YEAR	87	88	89	90	91	92	93	94	95	96 (Provisional)	97
CPUE/PERIOD	03-06	03-06	04-06	04-06	04-06	04-06	04-06	04-06	04-06	04-06	04-06
CPUE (t)	0.9	0.7	0.8	1.5	1.2	2.5	1.7	1.6	2.6	2.2	0.8
CPUE 1 (#)	13.8	19.7	16.1	63.4	29.3	86.3	46.7	26.5	52.6	69.6	30.7
CPUE 2 (#)	12.2	5.8	13.7	4.4	20.2	16.6	29.7	32.6	29.6	21.2	9.3
CPUE 3 (#)	2.8	0.7	1.2	0.8	0.4	1.3	0.1	4.6	8.2	1.9	0.1
CPUE 4+ (#)	2.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.3	0.0
CPUE 2+ (#)	17.5	6.6	14.9	5.3	20.6	17.9	29.8	37.2	38.3	23.4	9.4
CPUE 3+ (#)	5.3	0.9	1.2	0.8	0.4	1.3	0.1	4.6	8.8	2.1	0.1

in thousands

* CPUE values for the years 1988-89 are updapted acording to the revised catches at age of Spring from Uriarte et al. WD 1997

TABLE 10.2.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
(from MOTOS & URIARTE WD1993, MOTOS et al. 1995 and MOTOS et al. WD 1997)

YEAR		1987	1988	1989(*)	1990	1991	1992	1993	1994	1995	1996	1997 (Preliminary)
Period of year		2 - 7 June	21 - 28 May	10 - 21 May	4 - 15 May	16May-07Jun	16May-13Jun	No survey	17 May-3June	11 - 25 May	18 - 30 May	9 - 21 May
Positive area (km2)		23850	45384	17546	59757	24264	67796		48735	31189	28448	50133
Surveyed area (km2)		34934	59840	37930	79759	84032	92782		60330	51698	34294	59587
Po (Egg per 0.005 m^2)		4.6	5.52	2.08	3.78	2.55	3.12		4.39	5.21	4.01	3.015
Daily egg production		2.20	5.01	0.73	5.02	1.24	5.81		4.48	3.25	2.28	3.02
Exp(-12)	C.V.	0.39	0.24	0.4	0.15	0.06	0.14		0.14	0.09	0.09	0.215
											SSB Indirect Estimates	
SSB (t)		29365	63500	11861	97239	19276	90720	--	70940	63208	39499(**)	51819(**)
	C.V.	0.48	0.31	0.41	0.17	0.14	0.2		0.16	0.12		
TOTAL #		1129	2675	470	5843	965.6	5797	--	3516			
	C.V.					0.14	0.25		0.18			
No/age:	1	656	2349	246	5613	670.5	5571		2457			
	C.V.					0.16	0.26		0.23			
(millions)	2	331	258	206	190	290.3	209.3		1005			
	C.V.					0.17	0.22		0.19			
	3+	142	68	18	40	4.8	16.7		54			
	C.V.					0.42	0.51		0.28			

(*) Likely subestimate according to authors (Motos &Santiago,1989)
(**) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area)

Table 10.2.2 Evaluation of abundance index from French acoustic surveys

	1983 20/4-25/4	1984 30/4-13/5	1989 (2) 23/4-2/5	1990 12/4-25/4	1991 6/4-29/4	1992 13/4-30/4
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2,440
Density (t/nm(**2))	15.4	10.3	3,0	14.5-32.2 (4)	23.6	32.8
Biomass (t)	50,000	38,500	15,500	60-110,000 (4)	64,000	89,000
Number (10**(-6))	2,600	2,000	805	4,300-7,500 (4)	3,173	9,342
Number of 1-group(10**(-6))	1,800 (1)	600	400	4,100-7,500 (4)	1,873	9,072

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) Must be revised

Table 10.3.1 ANCHOVY catch at age in thousands for 1996 by country, division and quarter (without the catches from the live bait tuna fishing boats).

QUARTERS AND MAIN DIVISIONS
units: thousands

SPAIN	QUARTERS / AGE	1 VIIIbc	2 VIIIbc	3 VIIIbc	4 VIIIbc	Annual total VIIIbc
	0	0	0	19,410	24,726	44,136
	1	9,748	532,379	62,007	4,656	608,790
	2	727	162,283	11,697	184	174,890
	3	241	14,220	497	2	14,960
	4	0	2,213	42	0	2,255
	TOTAL(n)	10,715	711,095	93,652	29,568	845,031
	W MED.	19.09	23.19	18.84	13.80	22.33
	CATCH. (t)	203.5	16,570.0	1,769.5	394.4	18,937.4
	SOP	204.5	16,491.5	1,761.9	408.4	18,866.3
	VAR. %	100.51%	99.53%	99.57%	103.55%	99.62%

FRANCE	AGE	VIIIab	VIIIab	VIIIab	VIIIab	VIIIab
	0	0	0	12,055	44,881	56,936
	1	41,655	99,227	280,857	102,543	524,282
	2	58,143	11,942	26,488	14,265	110,838
	3	16,630	1	0	0	16,631
	4	0	0	0	0	0
	TOTAL(n)	116,428	111,170	319,400	161,689	708,687
	W MED.	19.99	17.30	21.83	24.84	21.50
	CATCH. (t)	2,326.9	1,923.8	6,971.8	4,015.7	15,238.1
	SOP	2,235.4	2,134.5	7,282.3	3,686.5	15,338.7
	VAR. %	96.07%	110.95%	104.45%	91.80%	100.66%

TOTAL	QUARTERS / AGE	1 VIIIbc	2 VIIIbc	3 VIIIbc	4 VIIIbc	Annual total VIIIbc
Sub-area VIII	0	0	0	31,464	69,607	101,071
	1	51,403	631,606	342,864	107,199	1,133,072
	2	58,870	174,225	38,185	14,449	285,729
	3	16,871	14,221	497	2	31,591
	4	0	2,213	42	0	2,255
	TOTAL(n)	127,144	822,264	413,053	191,257	1,553,718
	W MED.	19.91	22.40	21.15	23.13	21.95
	CATCH. (t)	2,530	18,494	8,741	4,410	34,176
	SOP	2,440	18,626	9,044	4,095	34,205
	VAR. %	96.43%	100.71%	103.47%	92.85%	100.09%

Table 10.3.2

Spanish half - yearly catches of anchovy (2nd semester) by age in ('000) of Bay of Biscay anchovy from the live bait tuna fishing boats.

(from ANON 1996 and Uriarte et al. WD1997)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	10,020	97,581	6,114	11,999	12,716	2,167	3,557	7,872	10,154	8,102
1	24,675	17,353	6,320	21,540	13,736	14,268	20,160	5,753	10,885	6,100
2	1,461	203	1,496	139	0	0		477	209	522
3	912	3	0	0	0	0		0	0	0
Total	37,068	115,140	13,930	33,677	26,452	16,435	23,717	14,102	21,248	14,724
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5
meanW (g)	14.7	4.3	13.3	12.4	13.3	12.1	12.9	10.2	15.8	13.4

Table 10.3.3 : Catches at age of anchovy of the fishery in the Bay of Biscay on half year basis as reported up to 1996 to ICES WGs.
Units: Thousands The catches at age are equal to the addition of the age composition of landing and live bait catches of anchovy
(From Uriarte et al., 1997 WD)

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994		1995		1996	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	38,140	0	150,338	0	180,085	0	16,984	0	86,647	0	38,434	0	63,499	0	59,934	0	49,771	0	109,173
1	218,670	120,098	318,181	190,113	152,612	27,085	847,627	517,690	323,877	116,290	1,001,551	440,134	794,055	611,047	494,610	355,663	522,361	189,081	683,009	456,164
2	157,665	13,534	92,621	13,334	123,683	10,771	59,482	75,999	310,620	12,581	193,137	31,446	439,655	91,977	493,437	54,867	282,301	21,771	233,095	53,156
3	31,362	1,664	9,954	596	18,096	1,986	8,175	4,999	29,179	61	16,960	1	5,336	0	61,667	1,325	76,525	90	31,092	499
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0	4,096	7	2,213	42
5	8,920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	431,448	173,494	398,971	529,130	294,445	219,927	915,283	615,671	663,677	215,579	1,211,647	510,015	1,239,046	766,523	1,049,714	471,789	885,283	260,719	949,408	619,034
Internat Catche	11,718	3,590	10,003	5,579	7,153	3,460	19,386	14,886	15,025	4,610	26,381	11,504	24,058	16,334	23,214	11,417	23,479	6,637	21,024	13,349
Var. SOP	100.7%	100.4%	98.3%	101.9%	98.5%	99.3%	100.7%	99.1%	97.6%	98.5%	99.6%	99.9%	101.1%	99.5%	101.0%	100.2%	101.5%	98.2%	99.5%	100.4%
Remarks																				

SPAIN

Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	35,452	0	141,918	0	174,803	0	11,999	0	81,536	0	13,121	0	63,499	0	59,022	0	31,101	0	52,238
1	134,390	40,172	210,641	47,480	110,276	13,165	719,678	234,021	210,686	21,113	751,056	72,154	578,219	75,865	257,050	47,065	367,924	17,611	542,127	72,763
2	119,503	7,787	61,609	2,690	92,707	9,481	47,266	43,204	139,327	1,715	131,221	5,916	266,612	11,904	315,022	24,971	206,387	1,333	163,010	12,403
3	27,336	1,664	7,710	596	8,232	1,986	8,139	4,999	2,657	61	10,067	1	967	0	44,622	1,325	57,214	90	14,461	499
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0	4,096	7	2,213	42
5	8,920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	304,980	85,134	281,414	192,684	211,270	199,435	775,083	294,222	352,670	104,425	892,344	91,192	845,798	151,268	616,694	132,383	635,621	50,142	721,810	137,945
Catch Spain	8,777	1,632	6,955	1,804	5,377	2,981	16,401	7,273	8,343	1,583	21,047	1,621	17,206	2,272	15,219	2,478	18,322	902	16,774	2,361
Var. SOP	100.7%	99.7%	97.9%	100.6%	97.1%	99.5%	100.9%	99.5%	94.7%	98.2%	99.3%	100.5%	100.8%	100.2%	101.3%	99.6%	102.1%	100.1%	99.5%	100.4%

FRANCE

Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	2,688	0	8,419	0	5,282	0	4,985	0	5,111	0	25,313	0	0	0	912	0	18,670	0	56,936
1	84,280	79,925	107,540	142,634	42,336	13,919	127,949	283,669	113,191	95,177	250,495	367,980	215,836	535,182	237,560	308,598	154,437	171,470	140,882	383,401
2	38,162	5,747	31,012	10,644	30,976	1,290	12,216	32,795	171,293	10,866	61,916	25,530	173,043	80,073	178,415	29,896	75,914	20,438	70,085	40,753
3	4,026	0	2,245	0	9,863	0	36	0	26,522	0	6,893	0	4,369	0	17,045	0	19,311	0	16,631	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	126,468	88,360	140,797	161,697	83,175	20,492	140,200	321,449	311,007	111,154	319,303	418,823	393,248	615,255	433,020	339,406	249,662	210,578	227,598	481,089
Catch France	2,941	1,958	3,048	3,775	1,776	479	2,985	7,613	6,682	3,027	5,334	9,883	6,851	14,062	7,994	8,939	5,157	5,735	4,251	10,987
Var. SOP	100.4%	101.0%	99.0%	102.5%	102.6%	97.8%	99.2%	98.7%	101.3%	98.6%	100.5%	99.8%	101.6%	99.4%	100.3%	100.4%	99.4%	97.9%	102.8%	99.8%
Remarks																				

Table 10.3.4 Catch at age in numbers (millions) of Anchovy in the Bay of Biscay (1).

Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0	0	0	0	0	0	0	0	0	0	0	0
1	776	0	156	31	0	1	14	3	0	388	161
2	602	861	1322	1687	1307	405	688	0	25	166	813
3	0	77	262	435	574	535	267	330	133	69	309
4	0	0	0	0	7	7	0	0	0	10	46
5+	0	0	0	0	0	0	0	0	0	0	0
Total	1378	938	1740	2153	1888	948	969	333	158	633	1329
Catch	31,117	26,302	37,261	48,191	45,219	26,349	22,102	10,815	4,991	14153	35179

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	0	0	38.1	150.3	180.1	17.0	86.6	38.4	63.5	59.9	49.8	109.2
1	53	52	338.8	508.3	179.7	1365.3	440.2	1441.7	1405.1	850.3	711.4	1139.2
2	105	80	171.2	106.0	134.5	135.5	323.2	224.6	531.6	548.3	304.1	286.3
3	177	63	33.0	10.6	20.1	13.2	29.2	17.0	5.3	63.0	76.6	31.6
4	4	54	14.9	1.4	0.1	0.0	0.0	0.0	0.0	0.0	4.1	2.3
5+	0	0	8.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	339	249	604.9	776.6	514.4	1531.0	879.3	1721.7	2005.6	1521.5	1146.0	1568.4
Catch (t)	7923	14762	15,308	15,581	10,614	34,272	19,635	37,885	40,392	34,631	30,116	34,373

(1) before 1983 some ageing errors could have occurred
(2) Since 1987 the catches of anchovy used as live bait in the Spanish Tuna fishing are included

Table 10.4.1 Half-year mean weight at age in the catches of the Bay of Biscay anchovy in 1996.

Units: g.

Country	Spain	France	Spain	France	Total		
Semester	1	1	2	2	1	2	Annual
Area	VIIIcb	VIIIab	VIIIcb	VIIIab	VIII	VIII	VIII
Age							
0	0.00	0.00	11.63	12.70	0.00	11.99	11.99
1	19.93	15.80	19.40	23.90	19.08	23.17	20.72
2	31.95	23.30	29.16	27.30	29.35	27.69	29.04
3	40.23	30.50	35.73	0.00	35.02	35.73	35.04
4	46.08	0.00	39.66	0.00	46.08	39.66	45.96
Total	23.13	19.20	17.63	22.80	22.18	21.60	21.95

Table 10.6.1

Output Generated by ICA version 1.3

THIS IS A BETA TEST EDITION OF V1.3

Anchovy Biscay VIII (run: ICAAND07/I07)

Catch in number

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	38.1	150.3	180.1	17.0	86.6	38.4	63.5	59.9	49.8	109.2
1	338.8	508.3	179.7	1365.3	440.2	1441.7	1405.1	850.3	711.4	1139.2
2	171.2	106.0	134.5	135.5	323.2	224.6	531.6	548.3	304.1	286.3
3	33.0	10.6	20.1	13.2	29.2	17.0	5.3	63.0	76.6	31.6
4	14.9	1.4	1.0	1.0	1.0	1.0	1.0	1.0	4.1	2.3
5	8.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Thousands

Predicted Catch in Number

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	26.1	11.6	86.1	26.4	235.7	144.1	48.8	45.8	62.4	84.2
1	275.2	373.6	196.7	1081.4	748.1	1909.2	1323.5	745.1	716.1	962.4
2	197.7	144.4	222.5	85.3	880.6	150.4	569.5	712.3	392.5	349.5
3	37.8	21.1	17.7	18.2	14.9	20.4	7.3	61.7	73.6	35.8
4	57.8	8.5	5.4	3.1	6.2	.9	2.3	1.7	13.4	14.4

Thousands

Weights at age in the catches (Kg)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.012000	.005000	.013000	.007000	.014000	.013000	.012000	.015000	.015000	.012000
1	.021000	.022000	.020000	.022000	.020000	.021000	.018000	.020000	.024000	.021000
2	.032000	.030000	.029000	.028000	.025000	.031000	.027000	.027000	.032000	.029000
3	.038000	.035000	.031000	.043000	.028000	.038000	.031000	.031000	.036000	.035000
4	.041000	.038000	.027000	.042000	.032000	.038000	.031000	.031000	.037000	.046000
5	.042000	.049000	.040000	.042000	.032000	.038000	.031000	.031000	.038000	.046000

Units

Weights at age in the stock (Kg)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000
1	.016000	.016000	.016000	.016000	.017000	.015000	.016000	.017000	.016000	.016000
2	.029000	.029000	.029000	.030000	.028000	.032000	.027000	.026000	.027000	.027000
3	.033000	.033000	.033000	.035000	.034000	.032000	.033000	.032000	.033000	.033000
4	.037000	.037000	.037000	.037000	.037000	.037000	.037000	.037000	.037000	.037000
5	.041000	.041000	.041000	.041000	.041000	.041000	.041000	.041000	.041000	.041000

Units

Natural Mortality (per year)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
1	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
2	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
3	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
4	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
5	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Units

Table 10.6.1 (Cont'd)

Proportion of fish spawning

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Units

INDICES OF SPAWNING BIOMASS

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	29365.	63500.	15000.	97239.	19276.	90720.	999990.	70940.	63208.	39499.	51819.

Units

INDEX2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	999990.	999990.	15500.	999990.	64000.	89000.	999990.	999990.	999990.	999990.	999990.

Units

AGE - STRUCTURED INDICES

FLT01: DEPM SURVEYS (Catch: Unknown) (Ef

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	656.0	2349.0	246.0	5613.0	670.5	5571.0	1.0	2457.0
2	331.0	258.0	206.0	190.0	290.3	209.3	1.0	1005.0
3	142.0	68.0	18.0	40.0	4.8	16.7	1.0	54.0

Thousands

FLT02: ACOUSTIC SURVEYS (Catch: Unknown)

Age	1989	1990	1991	1992
1	400.0	*******	1873.0	9072.0
2	405.0	*******	1300.0	270.0

Units

Fishing Mortality (per year)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.0054	.0055	.0067	.0061	.0144	.0089	.0058	.0064	.0073	.0085
1	.2863	.2902	.3556	.3198	.7594	.4675	.3064	.3371	.3870	.4484
2	.7887	.7995	.9798	.8810	2.0921	1.2881	.8443	.9286	1.0663	1.2354
3	.5633	.5710	.6998	.6292	1.4943	.9200	.6030	.6632	.7616	.8824
4	.7887	.7995	.9798	.8810	2.0921	1.2881	.8443	.9286	1.0663	1.2354
5	.7887	.7995	.9798	.8810	2.0921	1.2881	.8443	.9286	1.0663	1.2354

Units

Table 10.6.1 (Cont'd)

Population Abundance (1 January)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	8267.	3641.	21990.	7506.	28271.	28003.	14455.	12335.	14650.	17065.	12100.
1	1847.	2477.	1091.	6579.	2247.	8393.	8360.	4329.	3692.	4380.	5096.
2	577.	418.	558.	230.	1439.	317.	1584.	1853.	931.	755.	843.
3	143.	79.	57.	63.	29.	54.	26.	205.	221.	97.	66.
4	169.	24.	13.	8.	10.	2.	6.	4.	32.	31.	12.
5	26.	3.	3.	3.	2.	2.	3.	3.	2.	2.	3.

Thousands

Weighting factors for the catches in number

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.0500	.0500	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
1	.5000	.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	.5000	.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	.5000	.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	.0050	.0050	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0100

Units

Predicted SSB Index values

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	30391.	29905.	17783.	63438.	29569.	71262.	999990.	65521.	46672.	47189.	53504.

Units

INDEX2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	999990.	999990.	23663.	999990.	39347.	94826.	999990.	999990.	999990.	999990.	999990.

Units

Predicted Age-Structured Index Values

FLT01: DEPM SURVEYS (Catch: Unknown) (EfPredicted

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	911.6	1220.2	520.9	3196.2	886.0	3801.4	1.0	2085.7
2	224.5	161.6	198.1	85.7	301.3	97.1	1.0	674.3
3	137.6	44.7	28.6	30.6	10.5	20.8	1.0	87.2

Thousands

FLT02: ACOUSTIC SURVEYS (Catch: Unknown)Predicted

Age	1989	1990	1991	1992
1	792.5	*******	1452.5	5904.5
2	535.3	*******	906.3	293.0

Units

Table 10.6.1 (Cont'd)

Fitted Selection Pattern

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.0069	.0069	.0069	.0069	.0069	.0069	.0069	.0069	.0069	.0069
1	.3630	.3630	.3630	.3630	.3630	.3630	.3630	.3630	.3630	.3630
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	.7142	.7142	.7142	.7142	.7142	.7142	.7142	.7142	.7142	.7142
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Units

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield/ SSB ratio	Mean F Ages 1- 3	SoP (%)
1987	8267160	165794	30391	15308	.5037	.5461	99
1988	3640960	102704	29905	15581	.5210	.5536	100
1989	21990040	321970	17782	10614	.5969	.6784	99
1990	7506070	189858	63438	34272	.5402	.6100	100
1991	28271470	503988	29569	19635	.6640	1.4486	96
1992	28002550	473938	71261	37885	.5316	.8919	101
1993	14454910	351201	95497	40392	.4230	.5846	100
1994	12334950	313626	65521	34631	.5285	.6430	100
1995	14650390	268551	46671	30116	.6453	.7383	101
1996	17065410	299677	47188	34373	.7284	.8554	101

IFAP run code: I07

No of years for separable analysis : 10
Age range in the analysis : 0 5
Year range in the analysis : 1987 1996
Number of indices of SSB : 2
Number of age-structured indices : 2
Parameters to estimate : 30
Number of observations : 90

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm No.		Maximum Likelih. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. distrib.
Separable Model: Reference F by year								
1	1987	.7887	32	.4167	1.4929	.5696	1.0922	.8316
2	1988	.7995	28	.4558	1.4022	.6002	1.0649	.8330
3	1989	.9798	21	.6382	1.5043	.7873	1.2194	1.0035
4	1990	.8810	22	.5635	1.3774	.7014	1.1066	.9042
5	1991	2.0921	15	1.5570	2.8113	1.7994	2.4325	2.1160
6	1992	1.2881	22	.8278	2.0044	1.0280	1.6141	1.3213
7	1993	.8443	24	.5224	1.3645	.6608	1.0786	.8700
8	1994	.9286	25	.5662	1.5231	.7214	1.1953	.9587
9	1995	1.0663	29	.5989	1.8987	.7944	1.4313	1.1135
10	1996	1.2354	41	.5443	2.8043	.8132	1.8770	1.3483
Separable Model: Selection (S) by age								
11	0	.0069	44	.0029	.0166	.0044	.0108	.0076
12	1	.3630	18	.2546	.5174	.3029	.4349	.3689
	2	1.0000			Fixed : Reference age			
13	3	.7142	19	.4893	1.0424	.5889	.8662	.7276
	4	1.0000			Fixed : last true age			
Separable Model: Populations in year 1996								
14	0	17065410	48	6594144	44164671	10505669	27721053	19196602
15	1	4380346	33	2261502	8484374	3126245	6137533	4636741
16	2	755036	31	408849	1394352	552137	1032496	792934
17	3	96505	38	45320	205495	65625	141914	103954

Table 10.6.1 (Cont'd)

18	4	31016	46	12416	77479	19441	49481	34591

Separable Model: Populations at age 4

19	1987	168946	119	16247	1756724	51155	557960	344896
20	1988	24478	70	6144	97513	12092	49550	31388
21	1989	13447	37	6461	27985	9252	19544	14421
22	1990	8461	33	4368	16389	6038	11855	8956
23	1991	10127	30	5564	18431	7461	13746	10611
24	1992	1940	40	868	4334	1288	2924	2110
25	1993	6420	40	2891	14257	4273	9646	6975
26	1994	4334	39	1996	9412	2918	6438	4687
27	1995	31821	36	15615	64847	22130	45757	33991

SSB Index catchabilities

INDEX1

Used as absolute estimator.

No fitted catchability for this index.

INDEX2

28	2	Q	1.331	24 1.050	2.764	1.331	2.181	1.756

Age-structured index catchabilities

FLT01: DEPM SURVEYS (Catch: Unknown) (Ef

Absolute estimator: No fitted catchability.

FLT02: ACOUSTIC SURVEYS (Catch: Unknown)

Linear model fitted. Slopes at age:

29	1	Q	.1141E-02	28 .8651E-03	.2679E-02	.1141E-02	.2031E-02	.1587E-02
30	2	Q	.1585E-02	28 .1202E-02	.3725E-02	.1585E-02	.2824E-02	.2206E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	.379	2.558	.738	-.442	-1.001	-1.322	.263	.269	-.226	.260
1	.208	.308	-.090	.233	-.530	-.281	.060	.132	-.007	.169
2	-.144	-.309	-.503	.463	-1.002	.401	-.069	-.262	-.255	-.199
3	-.135	-.691	.126	-.322	.676	-.184	-.327	.021	.040	-.125
4	-1.356	-1.799	-1.679	-1.143	-1.824	.081	-.837	-.511	-1.186	-1.831

Units

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-.034	.753	-.170	.427	-.428	.241	-1.000	.079	.303	-.178	-.032

Units

INDEX2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	-1.000	-1.000	-.423	-1.000	.486	-.063	-1.000	-1.000	-1.000	-1.000	-1.000

Units

AGE - STRUCTURED INDEX RESIDUALS

FLT01: DEPM SURVEYS (Catch: Unknown) (Ef

Table 10.6.1. (Cont'd)

Age	1987	1988	1989	1990	1991	1992	1993	1994
1	-.329	.655	-.750	.563	-.279	.382	-1.000	.164
2	.388	.468	.039	.797	-.037	.768	-1.000	.399
3	.032	.420	-.463	.267	-.778	-.219	-1.000	-.479

Units

FLT02: ACOUSTIC SURVEYS (Catch: Unknown)

Age	1989	1990	1991	1992
1	-.684	-1.000	.254	.429
2	-.279	-1.000	.361	-.082

Units

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1987 to 1996

Variance	:	.1852
Skewness test statistic	:	-2.2663
Kurtosis test statistic	:	2.4112
Partial chi-square	:	.3715
Significance in fit	:	.0000
Degrees of freedom	:	23

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance.
Last age is a plus-group.

Variance	:	.1152
Skewness test statistic	:	1.5137
Kurtosis test statistic	:	.0194
Partial chi-square	:	.1097
Significance in fit	:	.0000
Number of observations	:	10
Degrees of freedom	:	10
Weight in the analysis	:	1.0000

DISTRIBUTION STATISTICS FOR INDEX2

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

Variance	:	.2098
Skewness test statistic	:	.1764
Kurtosis test statistic	:	-.5303
Partial chi-square	:	.0405
Significance in fit	:	.0000
Number of observations	:	3
Degrees of freedom	:	2
Weight in the analysis	:	1.0000

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FLT01: DEPM SURVEYS (Catch: Unknown) (Ef

Index used as absolute measure of abundance.

Age	:	1	2	3
Variance	:	.1588	.1672	.1282
Skewness test stat.	:	.0534	1.4526	-1.0928
Kurtosis test stat.	:	-.7487	-.5826	-.5695

Table 10.6.1 (Cont'd)

Partial chi-square :	.0797	.0998	.0899
Significance in fit :	.0000	.0000	.0000
Number of data :	7	7	7
Degrees of freedom :	7	7	7
Weight in analysis :	.6667	.6667	.6667

DISTRIBUTION STATISTICS FOR FLT02: ACOUSTIC SURVEYS (Catch: Unknown)

Linear catchability relationship assumed.

Age :	1	2
Variance :	.2687	.0805
Skewness test stat. :	-.4522	.3042
Kurtosis test stat. :	-.5303	-.5303
Partial chi-square :	.0751	.0245
Significance in fit :	.0369	.0122
Number of data :	3	3
Degrees of freedom :	2	2
Weight in analysis :	.7500	.7500

ANALYSIS OF VARIANCE TABLE

Unweighted Statistics

	SSQ	Data	Params	d.f.	
Variance					
Total for Model	39.7349	90	30	60	.6622
Catches at Age	32.4623	50	27	23	1.4114
SSB Indices					
INDEX1	1.1519	10	0	10	.1152
INDEX2	.4196	3	1	2	.2098
Aged Indices					
FLT01: DEPM SURVEYS (Catch: Unknown) (E	4.7698	21	0	21	.2271
FLT02: ACOUSTIC SURVEYS (Catch: Unknown	.9313	6	2	4	.2328

Weighted Statistics

	SSQ	Data	Params	d.f.	
Variance					
Total for Model	8.4749	90	30	60	.1412
Catches at Age	4.2596	50	27	23	.1852
SSB Indices					
INDEX1	1.1519	10	0	10	.1152
INDEX2	.4196	3	1	2	.2098
Aged Indices					
FLT01: DEPM SURVEYS (Catch: Unknown) (E	2.1199	21	0	21	.1009
FLT02: ACOUSTIC SURVEYS (Catch: Unknown	.5238	6	2	4	.1310

Table 10.8.1a

Anchovy in the Bay of Biscay (Fishing Area VIII)

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
0	13316.000	1.2000	0.0000	0.4000	0.3750	12.700	0.0085	11.800
1	5096.000	1.2000	1.0000	0.4000	0.3750	16.140	0.4484	20.870
2	843.000	1.2000	1.0000	0.4000	0.3750	28.390	1.2354	29.100
3	66.000	1.2000	1.0000	0.4000	0.3750	33.120	0.8824	34.550
4	12.000	1.2000	1.0000	0.4000	0.3750	37.000	1.2354	36.270
5+	3.000	1.2000	1.0000	0.4000	0.3750	41.000	1.2354	38.820
Unit	Millions	-	-	-	-	Grams	-	Grams

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
0	13316.000	1.2000	0.0000	0.4000	0.3750	12.700	0.0085	11.800
1	.	1.2000	1.0000	0.4000	0.3750	16.140	0.4484	20.870
2	.	1.2000	1.0000	0.4000	0.3750	28.390	1.2354	29.100
3	.	1.2000	1.0000	0.4000	0.3750	33.120	0.8824	34.550
4	.	1.2000	1.0000	0.4000	0.3750	37.000	1.2354	36.270
5+	.	1.2000	1.0000	0.4000	0.3750	41.000	1.2354	38.820
Unit	Millions	-	-	-	-	Grams	-	Grams

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	13316.000	1.2000	0.0000	0.4000	0.3750	12.700	0.0085	11.800
1	.	1.2000	1.0000	0.4000	0.3750	16.140	0.4484	20.870
2	.	1.2000	1.0000	0.4000	0.3750	28.390	1.2354	29.100
3	.	1.2000	1.0000	0.4000	0.3750	33.120	0.8824	34.550
4	.	1.2000	1.0000	0.4000	0.3750	37.000	1.2354	36.270
5+	.	1.2000	1.0000	0.4000	0.3750	41.000	1.2354	38.820
Unit	Millions	-	-	-	-	Grams	-	Grams

Notes: Run name : MANAND01
Date and time: 16SEP97:17:46

Table 10.8.1b

The SAS System 17:18 Tuesday, September 16, 1997

Anchovy in the Bay of Biscay (Fishing Area VIII)

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	0.8554	278048	54343	36596	0.0000	0.0000	263930	60458	0	278570	69793
.	.	.	.	.	0.2000	0.1711	.	57218	8352	273243	62700
.	.	.	.	.	0.4000	0.3422	.	54196	15718	268663	56803
.	.	.	.	.	0.6000	0.5132	.	51373	22253	264700	51853
.	.	.	.	.	0.8000	0.6843	.	48735	28085	261252	47660
.	.	.	.	.	1.0000	0.8554	.	46267	33319	258233	44074
.	.	.	.	.	1.2000	1.0265	.	43955	38042	255576	40978
.	.	.	.	.	1.4000	1.1976	.	41788	42323	253226	38282
.	.	.	.	.	1.6000	1.3686	.	39754	46222	251137	35913
.	.	.	.	.	1.8000	1.5397	.	37844	49788	249273	33812
.	.	.	.	.	2.0000	1.7108	.	36049	53062	247602	31935
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAND01
Date and time : 16SEP97:17:46
Computation of ref. F: Simple mean, age 1 - 3
Basis for 1997 : F factors

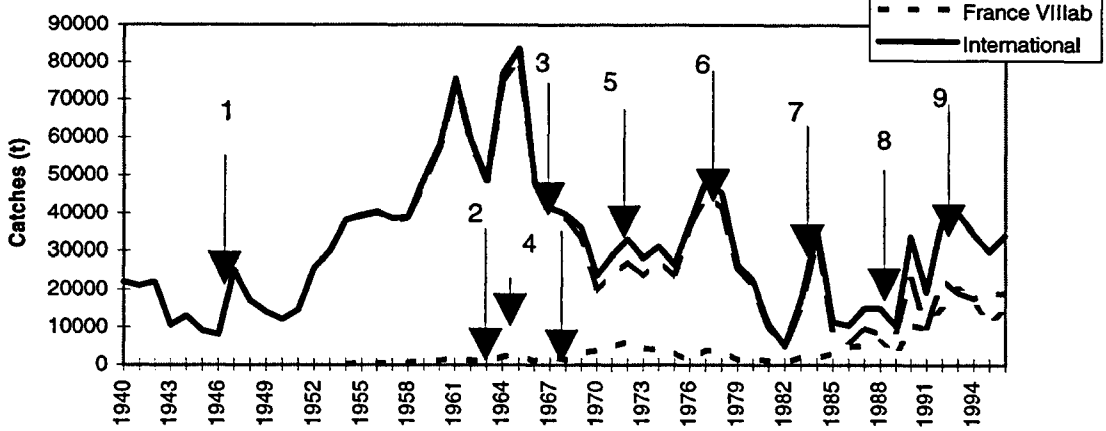
Table 10.10.1: Short term considerations for 1997 and 1998 for anchovy in the Bay of Biscay

Year		TAC = 33,000 tonne	$F_{stoch.} = F_{1996}$
1997	Stock $_{size}$	55,850 tonnes	54,163 tonnes
	Stock $_{5\%}$	24313 tonnes	24,070 tonnes
	Stock $_{50\%}$	52,431 tonnes	53,762 tonnes
	Stock $_{75\%}$	72,411 tonnes	75,411 tonnes
	Catch $_{5\%}$	19,781 tonnes	15,633 tonnes
	Catch $_{50\%}$	39,007 tonnes	38,775 tonnes
	Catch $_{75\%}$	53,646 tonnes	58,534 tonnes
1998	Stock $_{size}$	47,595 tonnes	46,046 tonnes
	Stock $_{5\%}$	19,484 tonnes	19,309 tonnes
	Stock $_{50\%}$	48,706 tonnes	50,733 tonnes
	Stock $_{75\%}$	67,566 tonnes	71,339 tonnes
	Catch $_{5\%}$	17,375 tonnes	15876 tonnes
	Catch $_{50\%}$	37,110 tonnes	37,140 tonnes
	Catch $_{75\%}$	49,855 tonnes	51,756 tonnes

$F_{stoch.}$: Fstochastic with a CV estimated with the ICA assessment

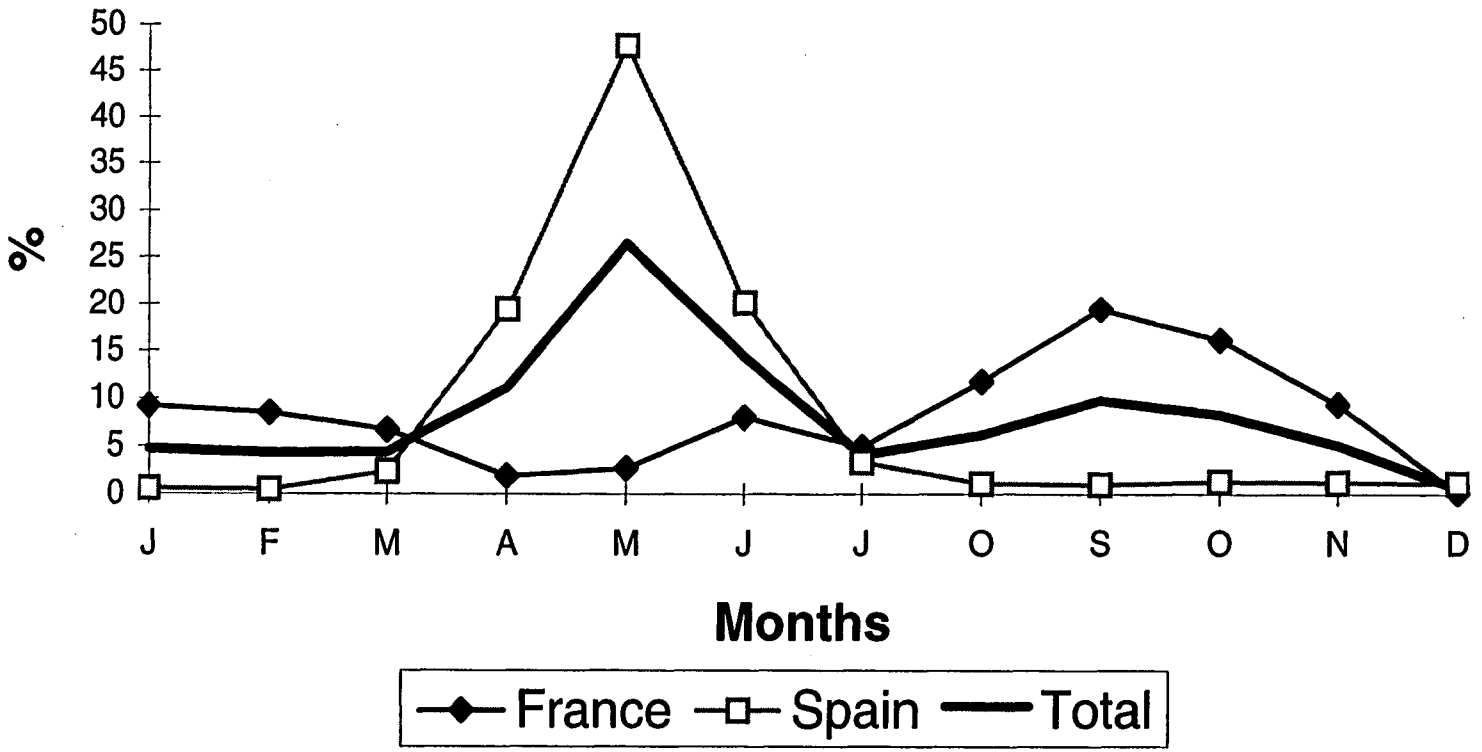
These estimated probabilities are calculated on the assumption of constant natural mortality, although there is evidence this may have been variable in the past. Therefore results presented here capture only a part of the variability in stock dynamics and estimates of uncertainty and risk could underestimated.

Figure 10.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940



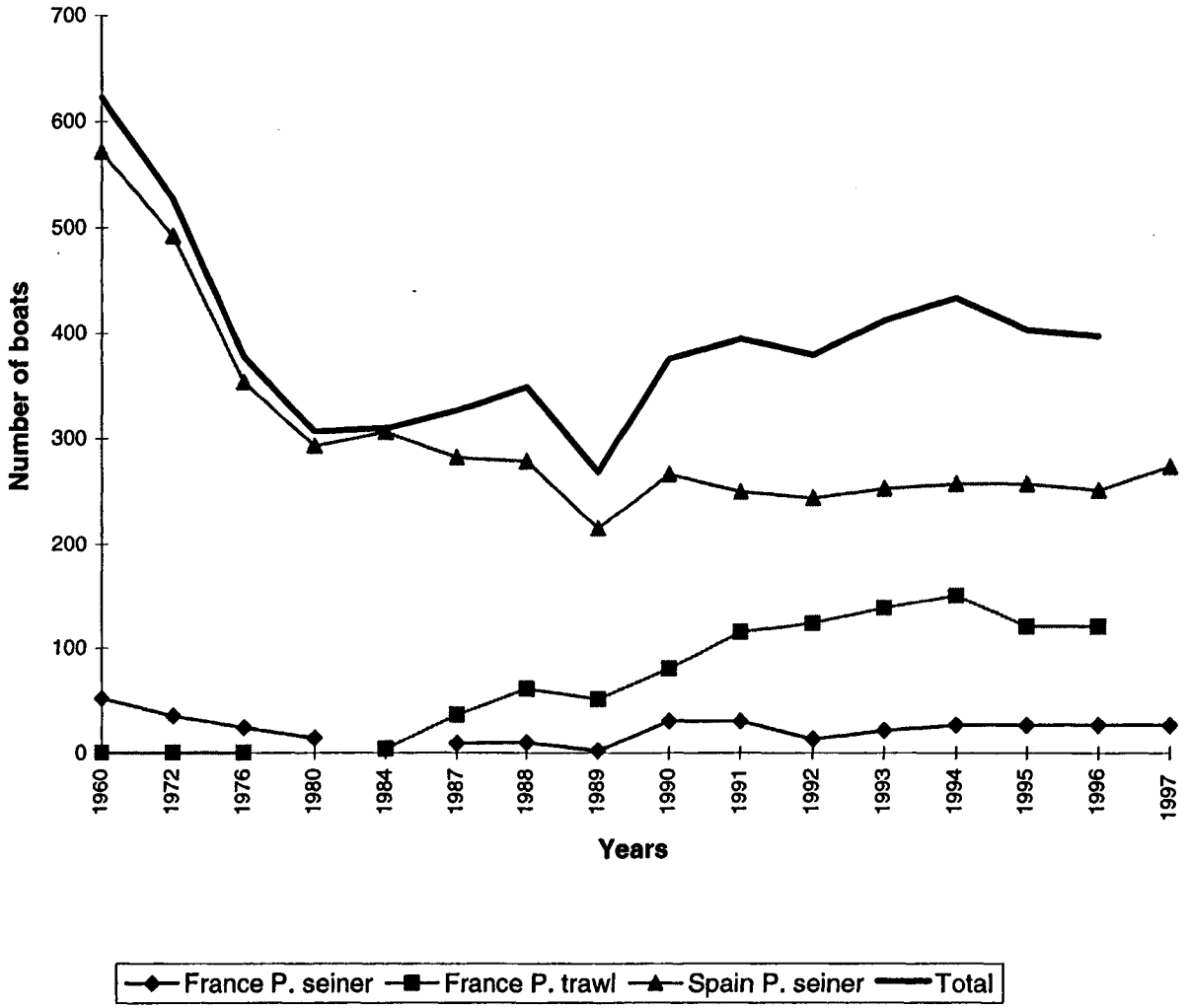
1. Goniometer
2. Echosounder;anchovy disappear from the coast of Galicia
3. Minimun length size: 9 cm
4. Power block
5. 8 tonnes per boat and 5 days per week for the spanish fleet; the spanish fleet is not allowed to come into the french 6 nautical miles
6. Radar and sonar
7. 6 tonnes per boat for the spanish fleet
8. Minimun landing size 12 cm: increase of the french pelagic fleet
9. Bilateral agreement between Spain and France: the pelagic fleet is not allowed to fish anchovy from the end of March to the end of June

Figure 10.1.2: Mean monthly catches (1992-1996) for the French and Spanish anchovy fisheries in Sub-area VIII



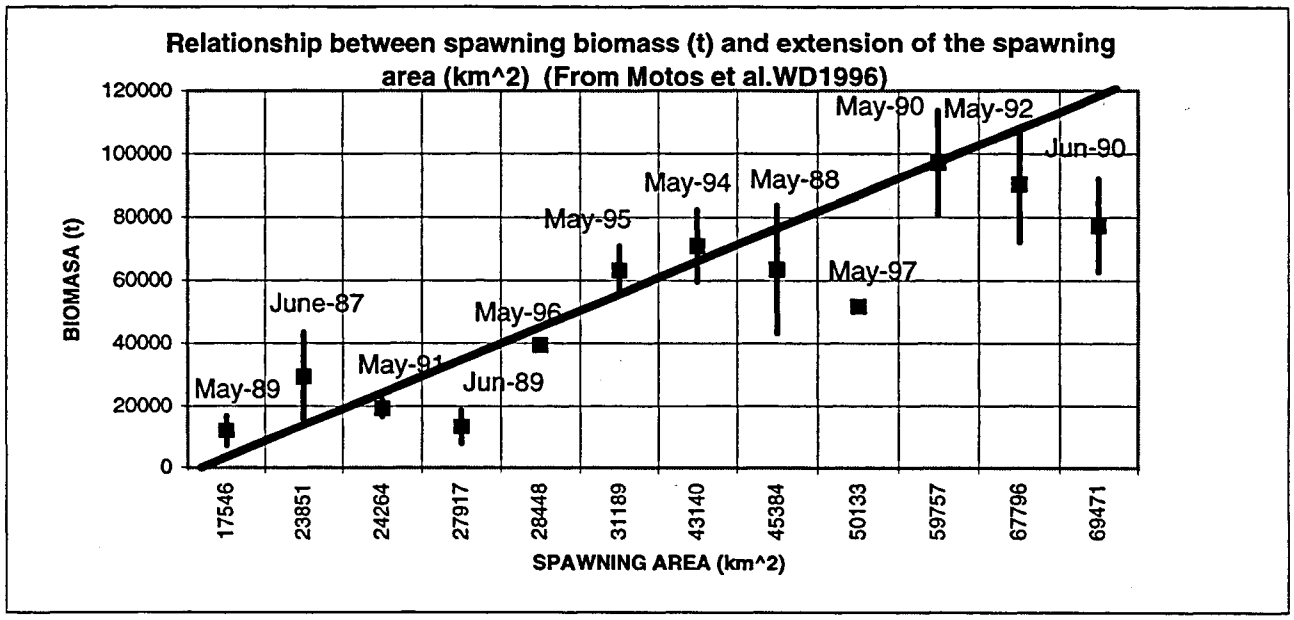
e:\acfm\wgmhsa98\F-1012.xls

Figure 10.1.3: Evolution of the fleets fishing for anchovy in the Bay of Biscay



e:\acfm\wgmhsa98\F-1013.xls

Figure 10.2.1: Relationship between spawning biomass (t) and extension of the spawning area (km^2) and DEP for the Bay of Biscay anchovy population.



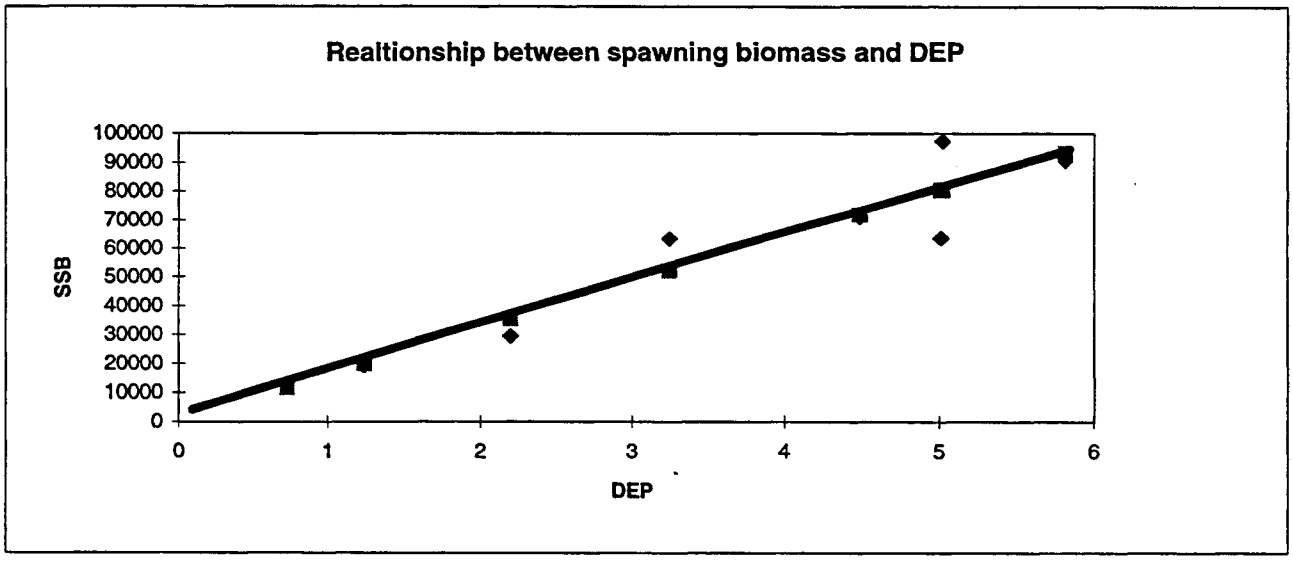


Figure: 10.2.2:Relationship among spawning biomass and the spawning area and the DEP.

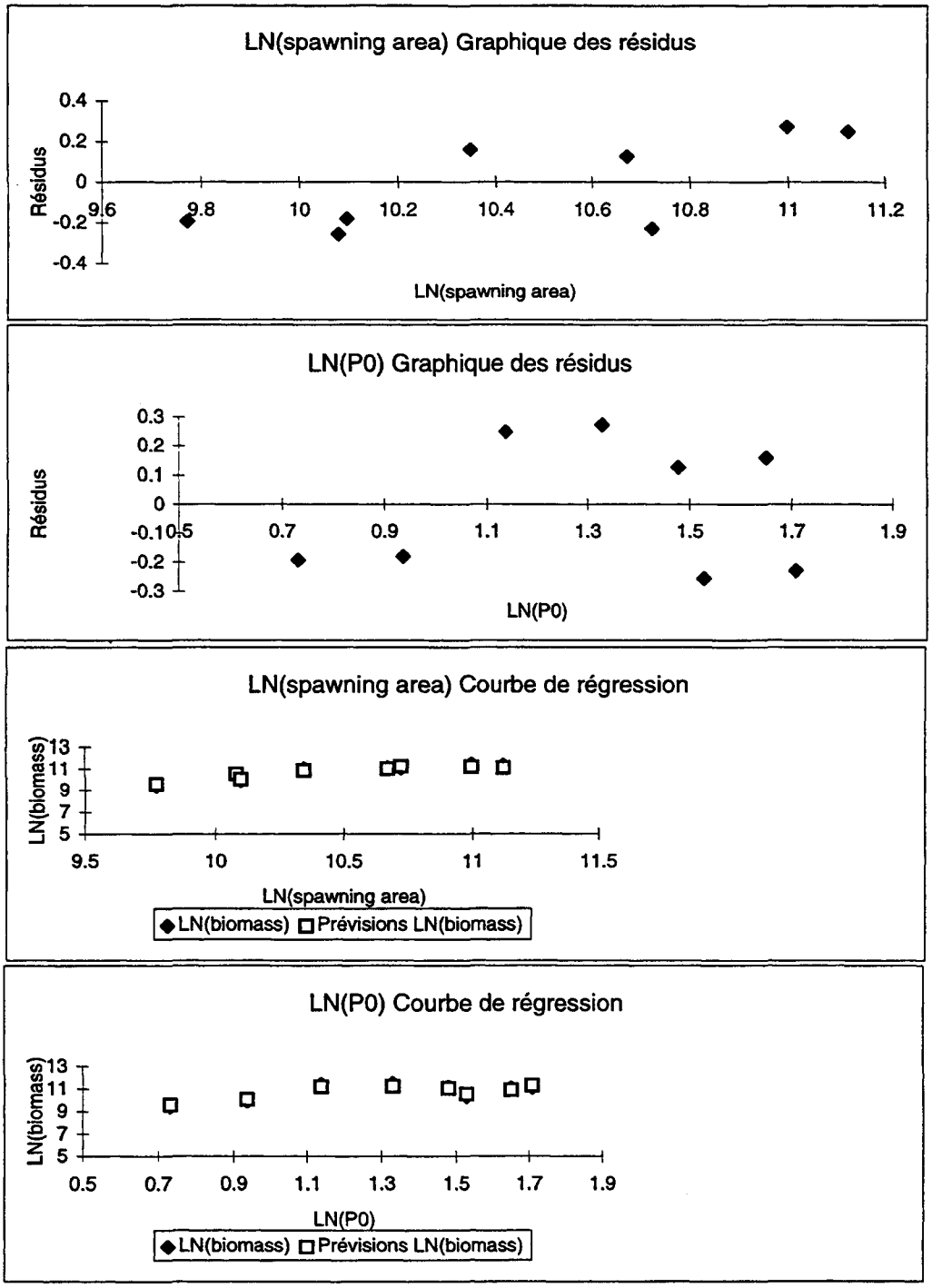


Figure 10.6.1

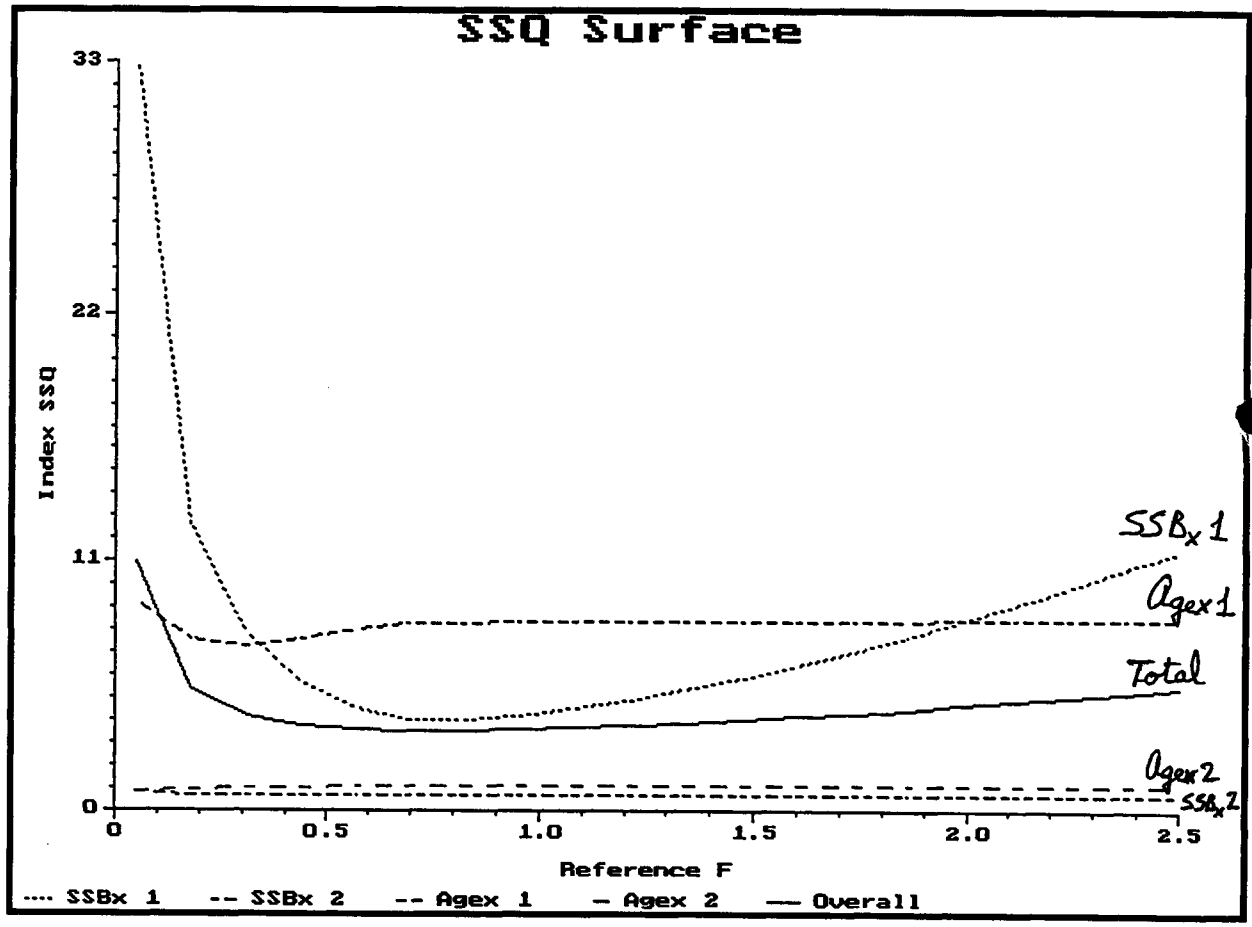

SSQ Surface
33
22
11
0
Index SSQ
0
0.5
1.0
1.5
2.0
2.5
Reference F
SSBx 1
Agex 1
Total
Agex 2
SSBx 2
···· SSBx 1
-- SSBx 2
-- Agex 1
– Agex 2
—— Overall

Figure 10.6.1 (Cont'd)

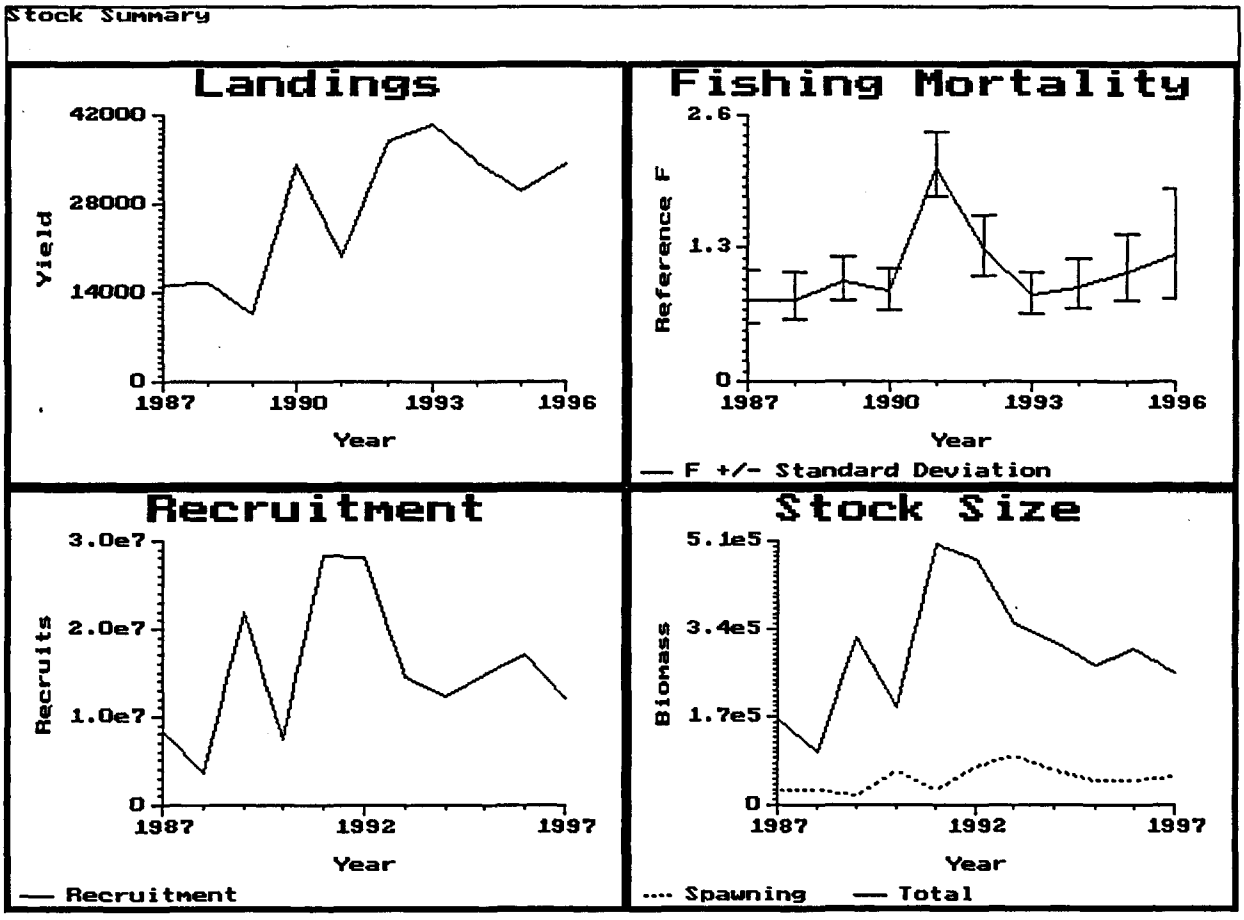


Figure 10.6.1 (Cont'd)

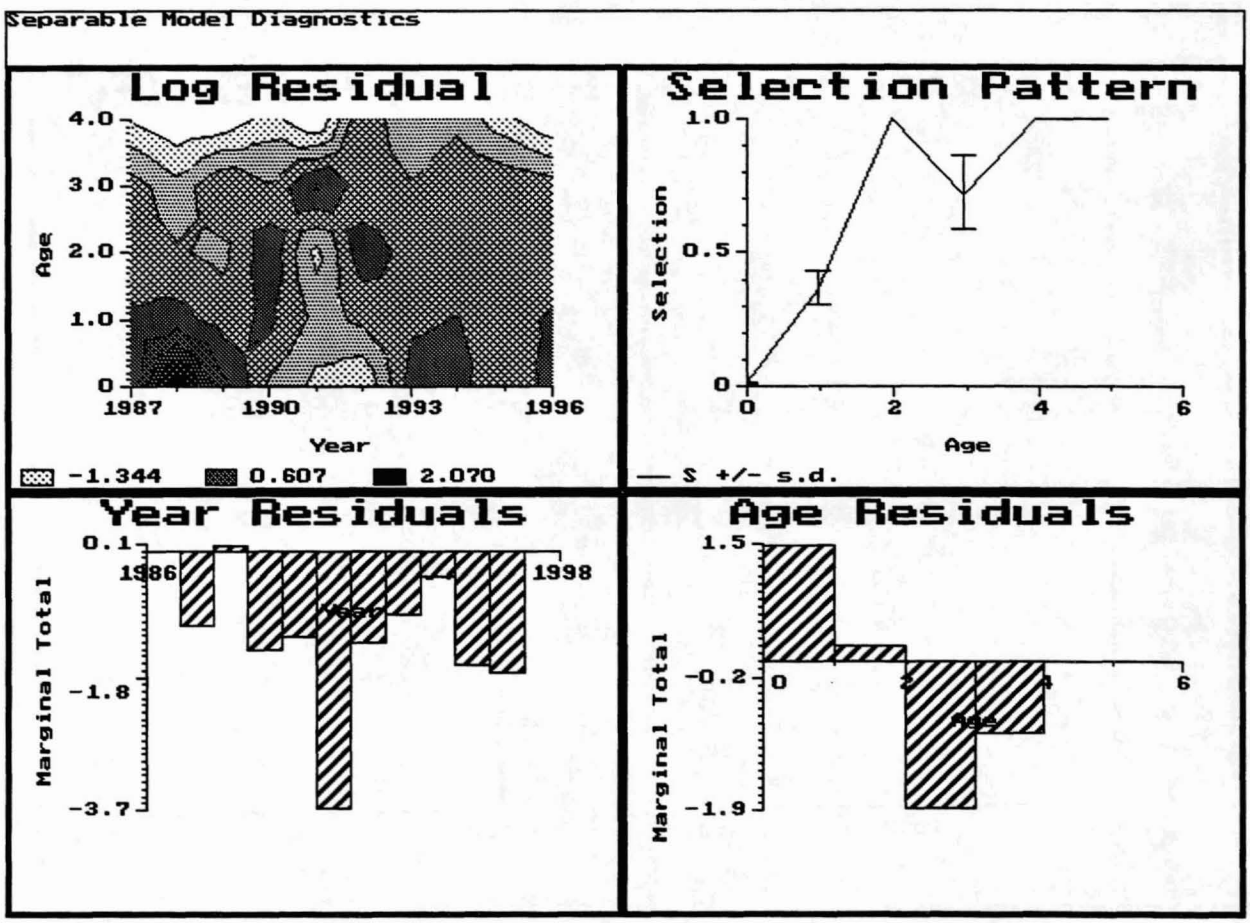


Figure 10.6.1 (Cont'd)

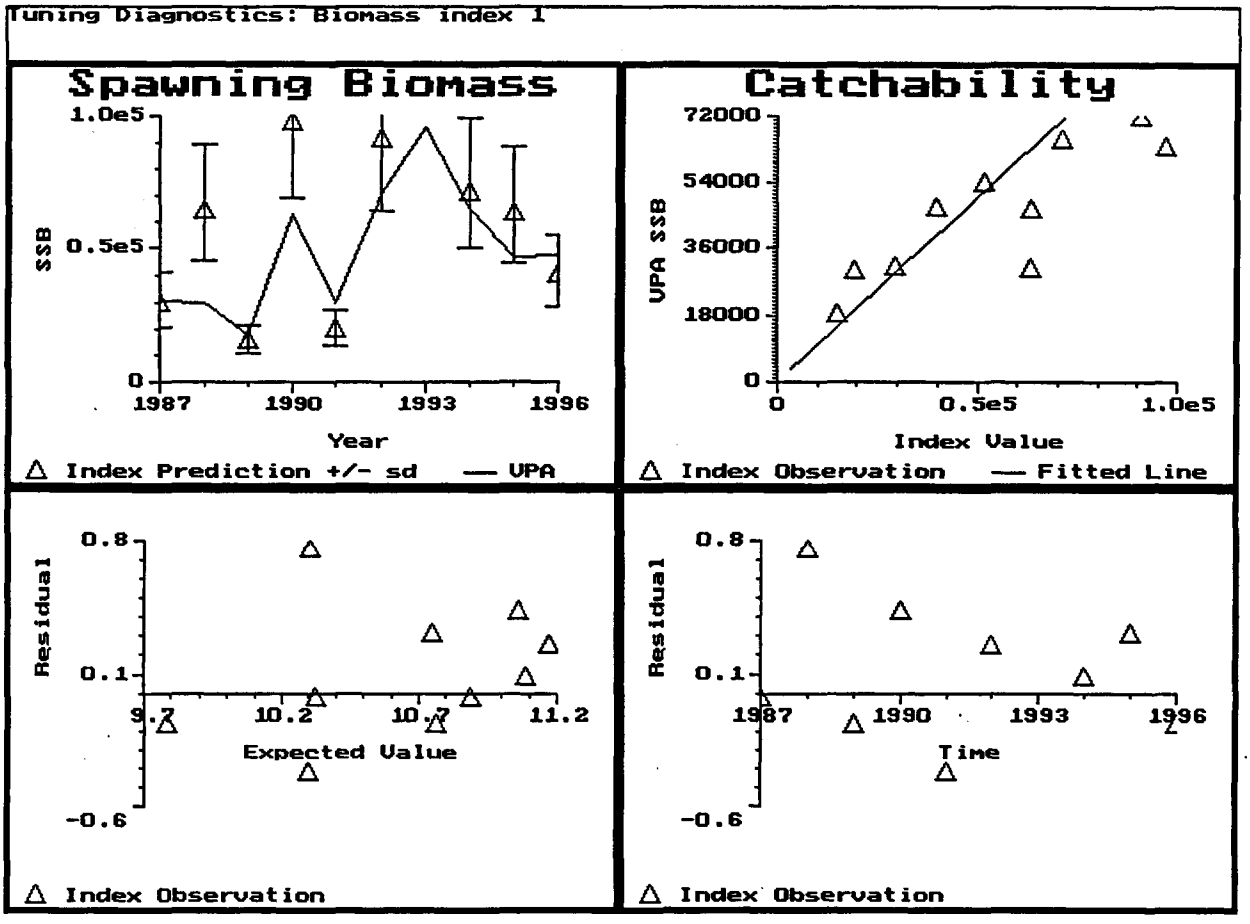


Figure 10.6.1 (Cont'd)

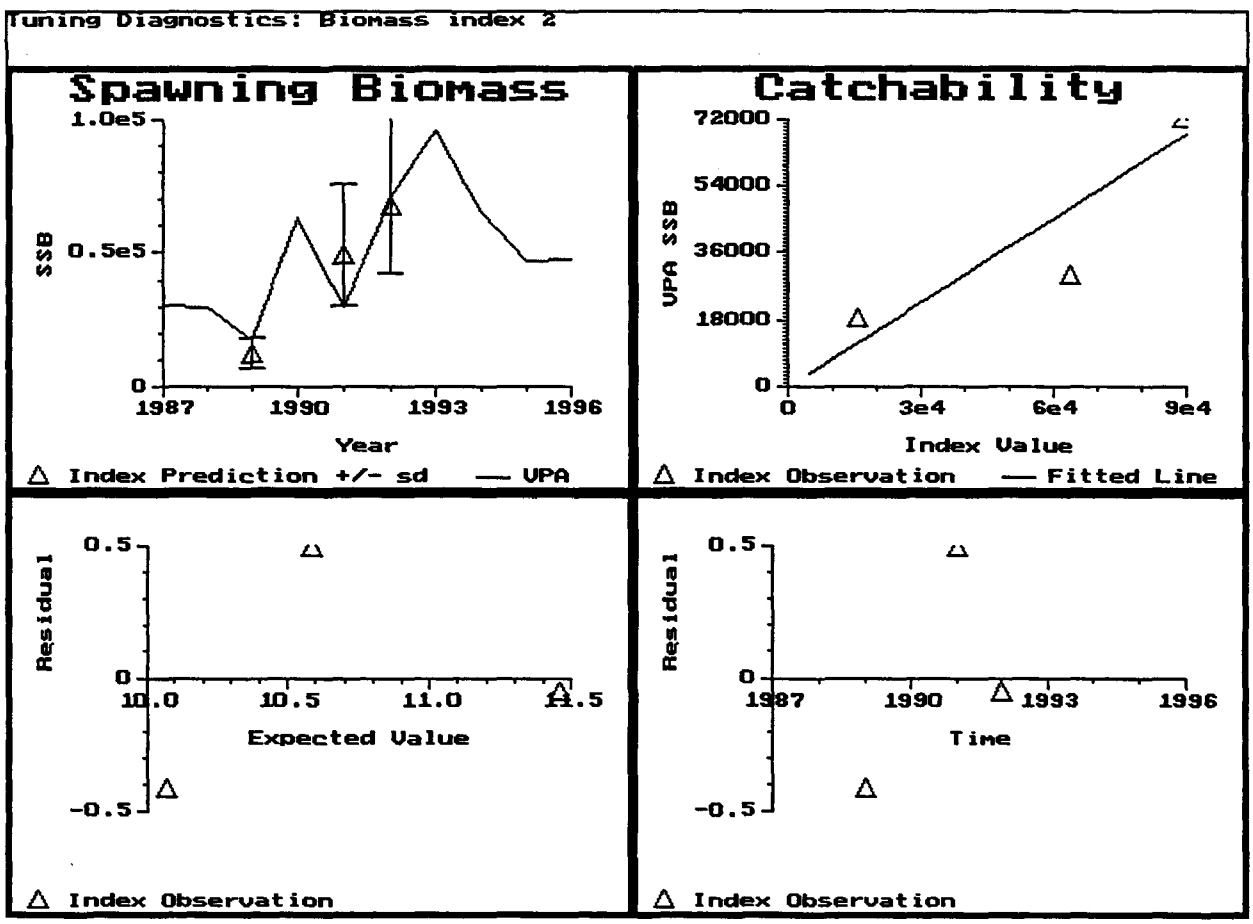


Figure 10.6.1 (Cont'd)

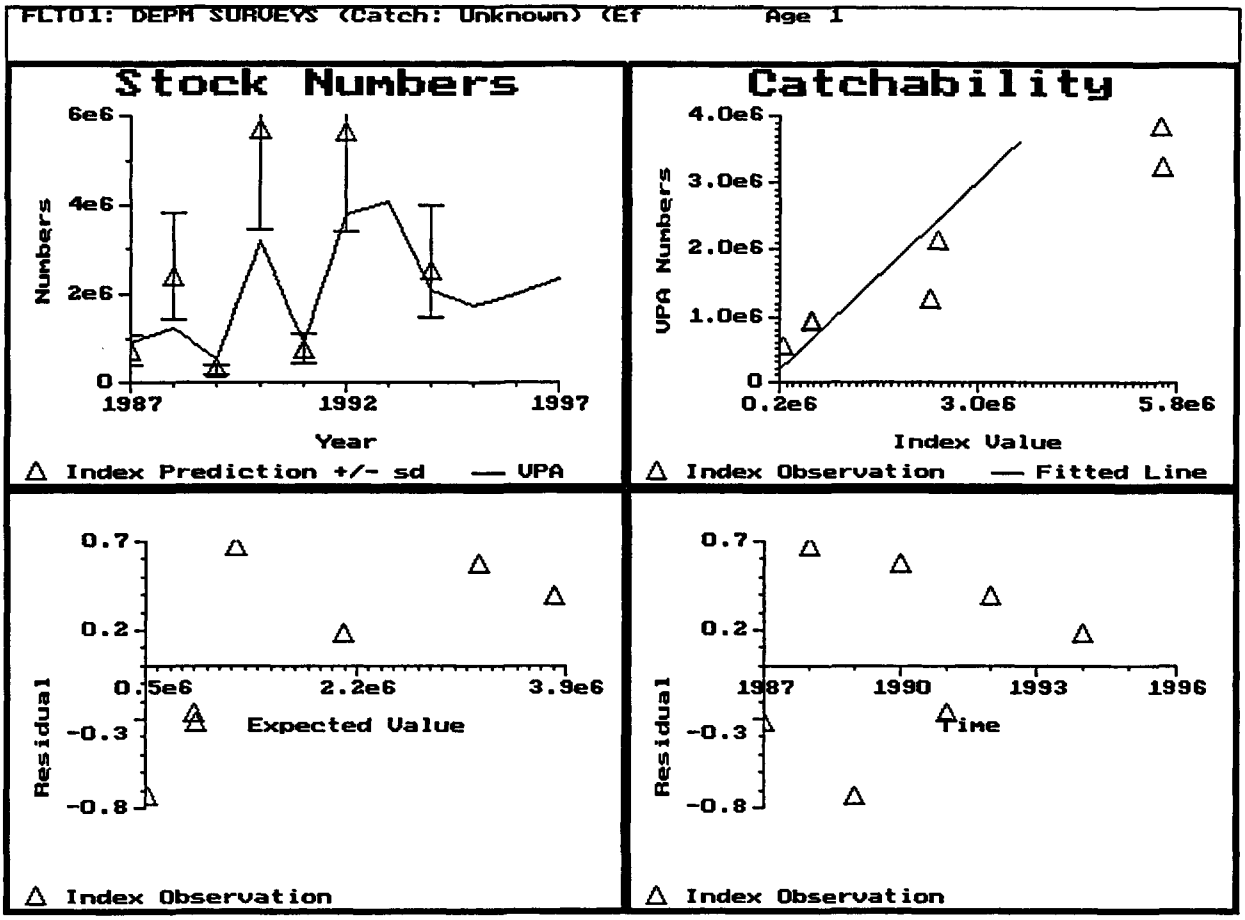


Figure 10.6.1 (Cont'd)

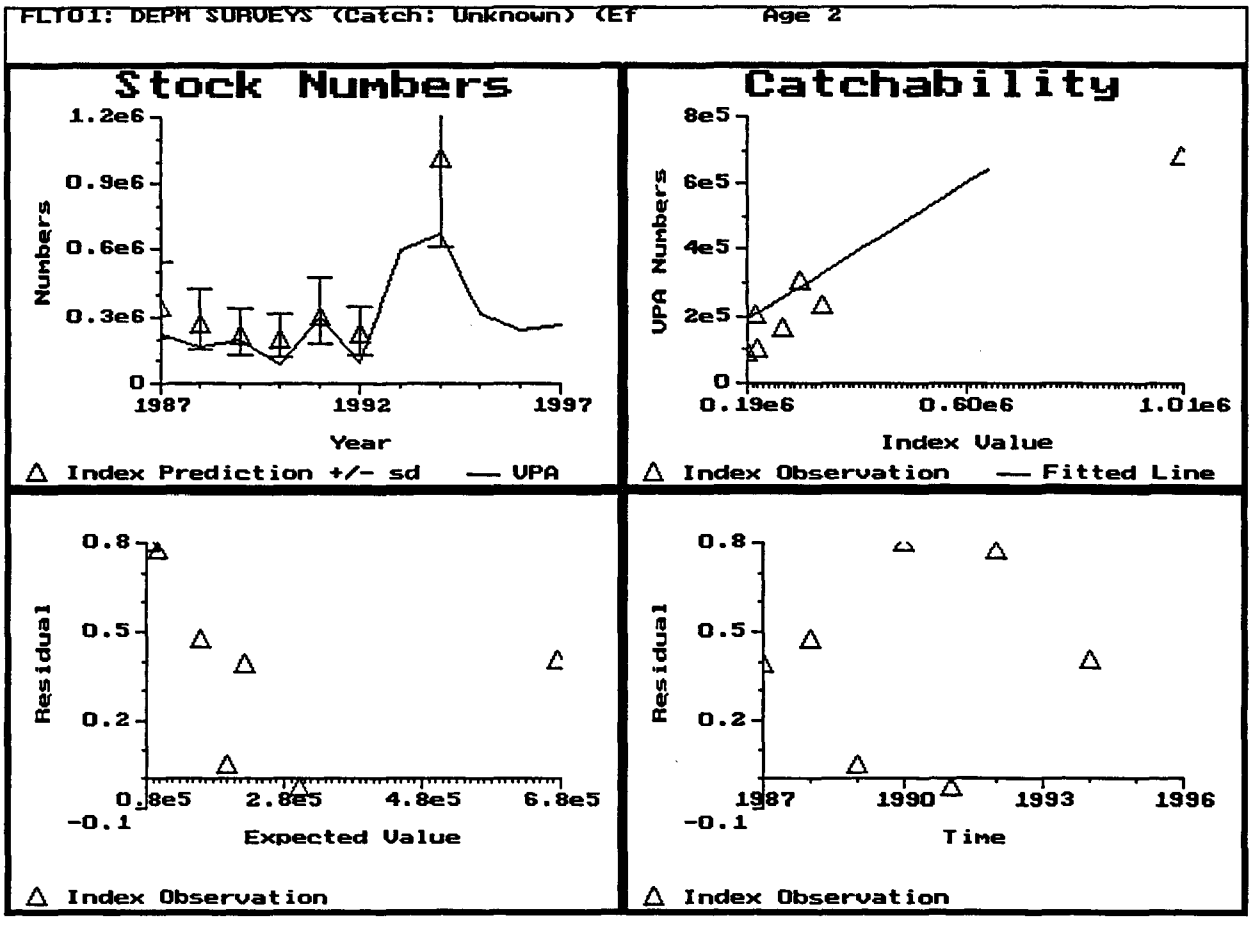


Figure 10.6.1 (Cont'd)

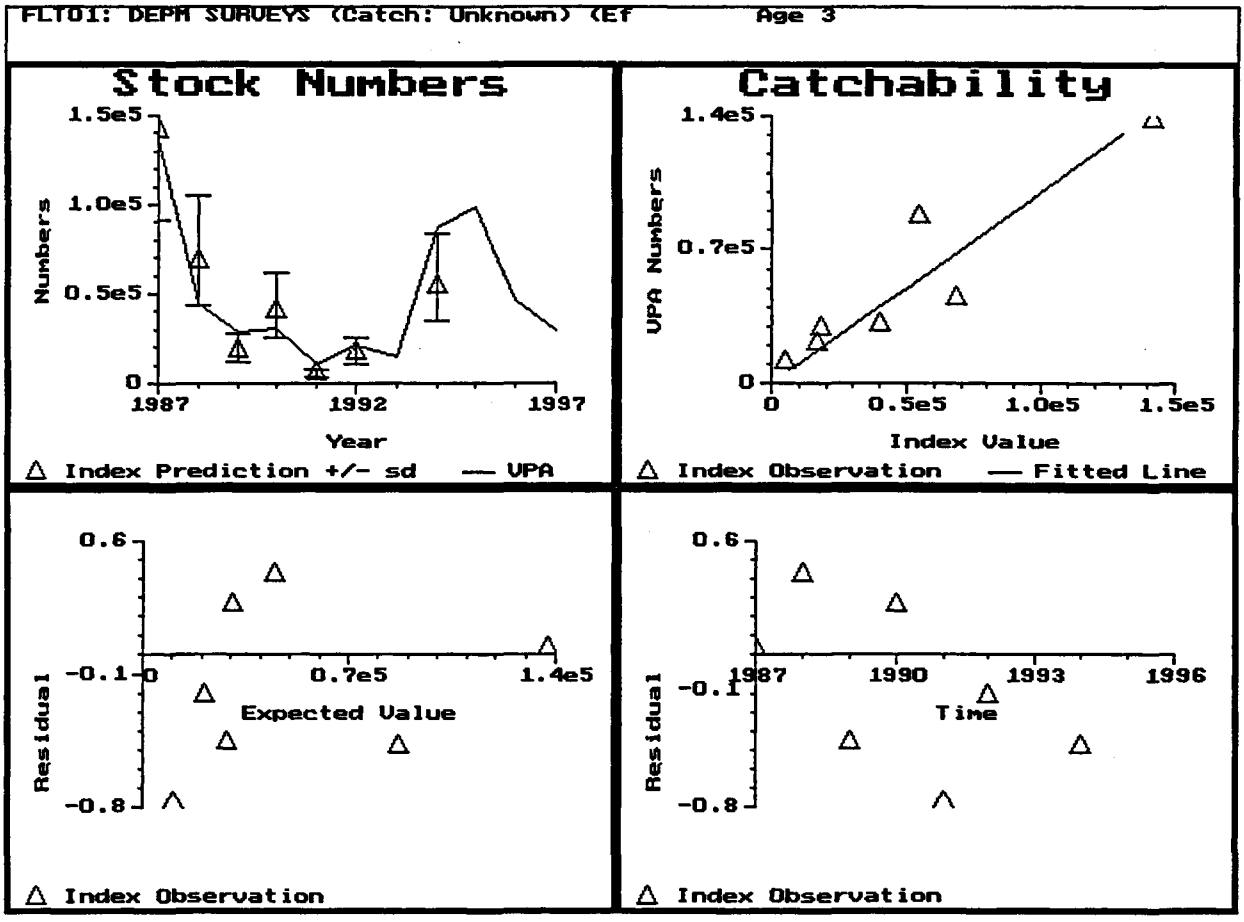


Figure 10.6.1 (Cont'd)

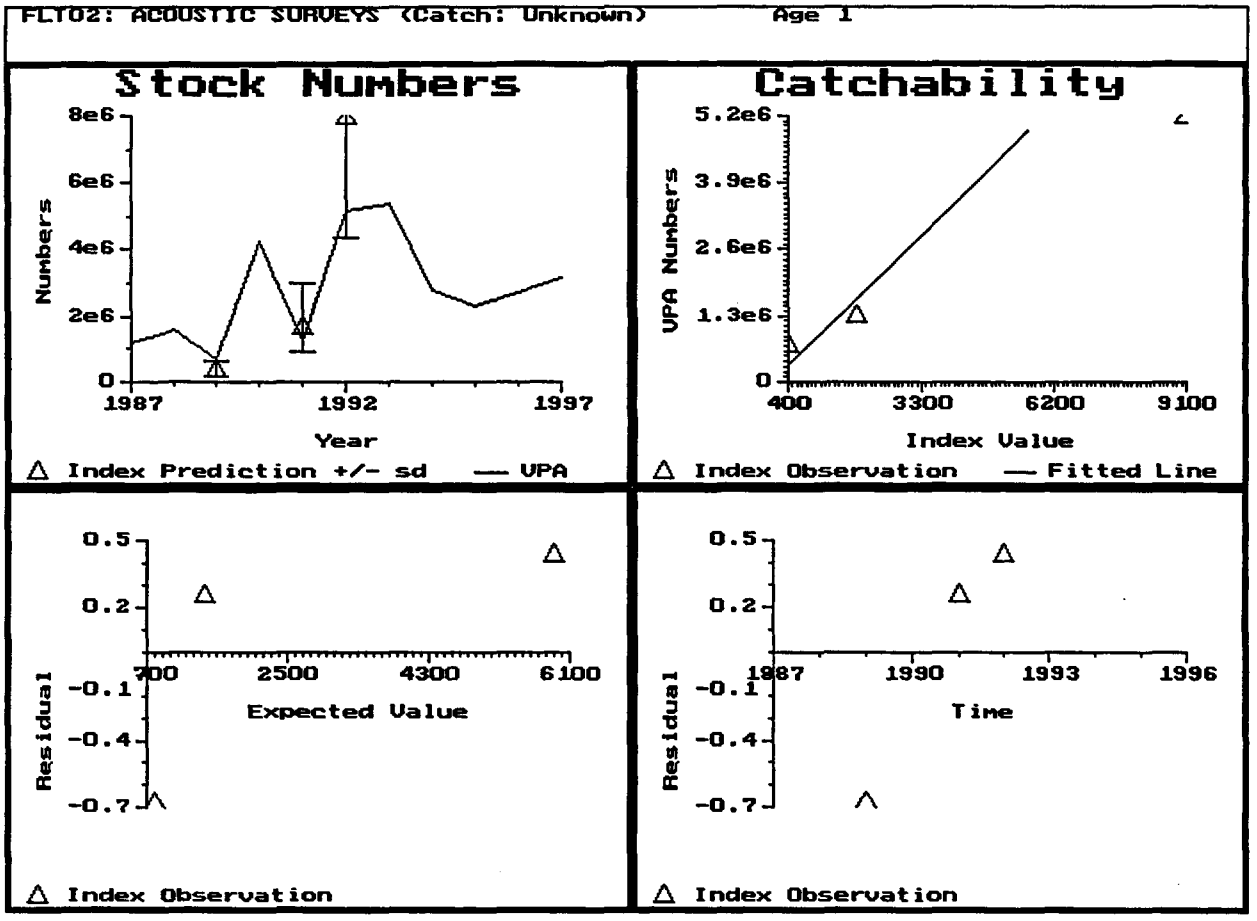


Figure 10.6.1 (Cont'd)

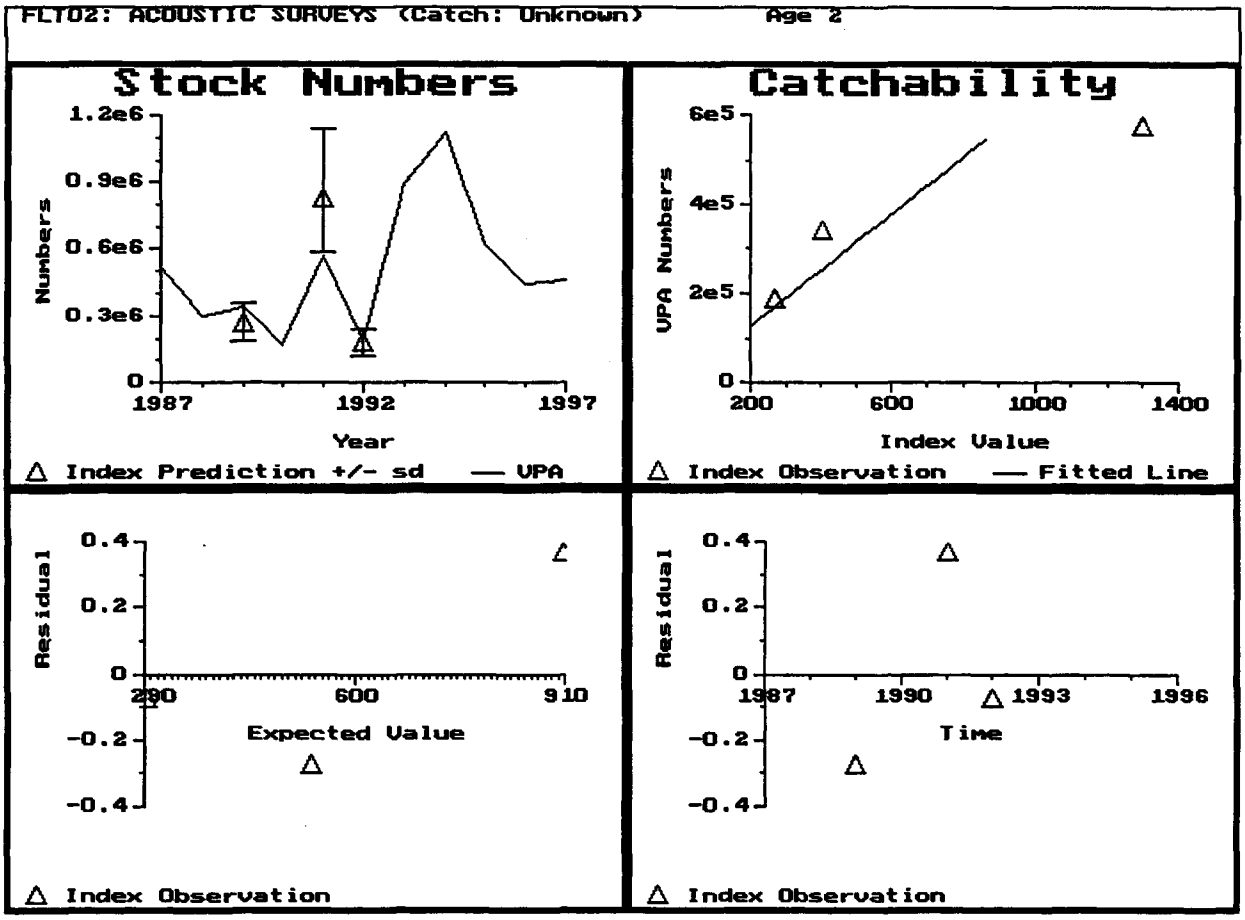
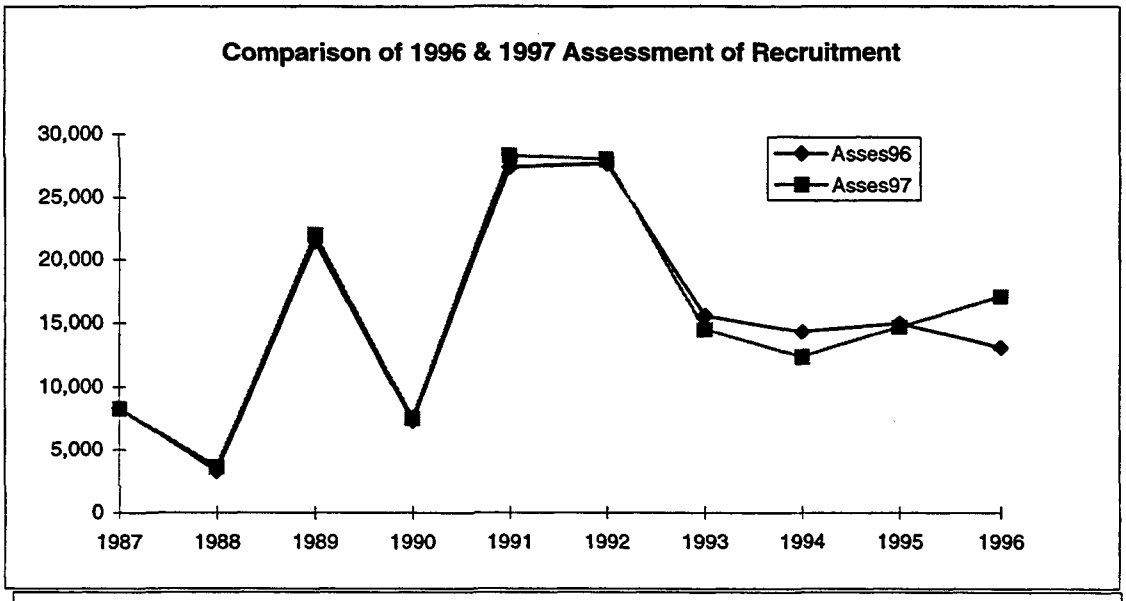
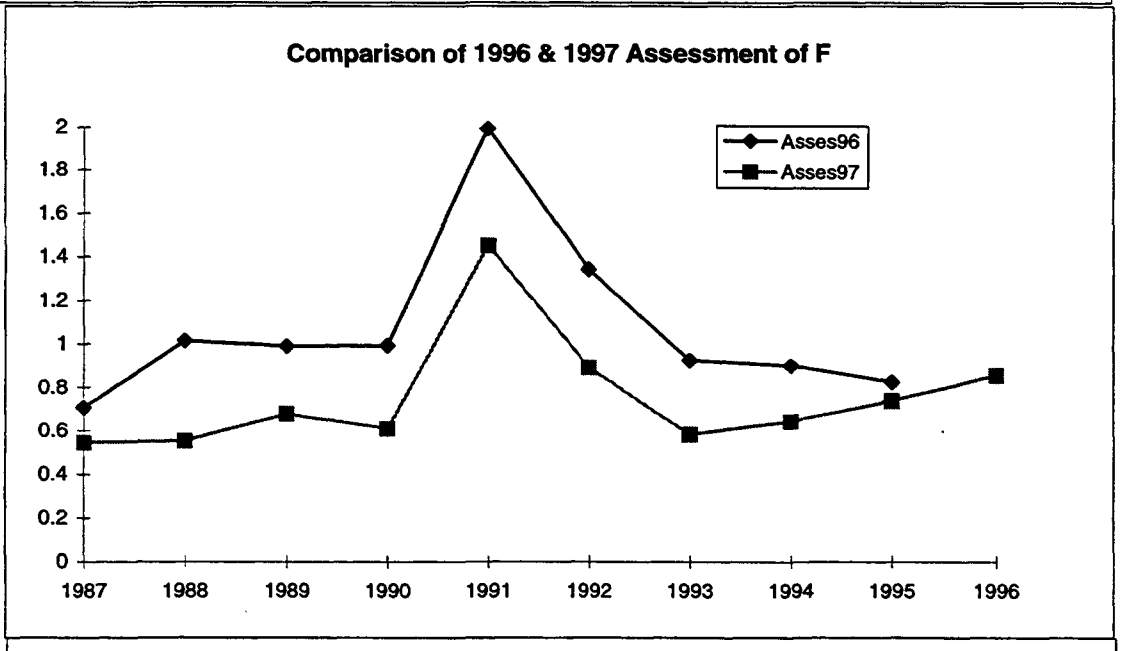


Figure 10.6.2: Comparison of 1996 & 1997 of the anchovy assessment in Subarea VIII





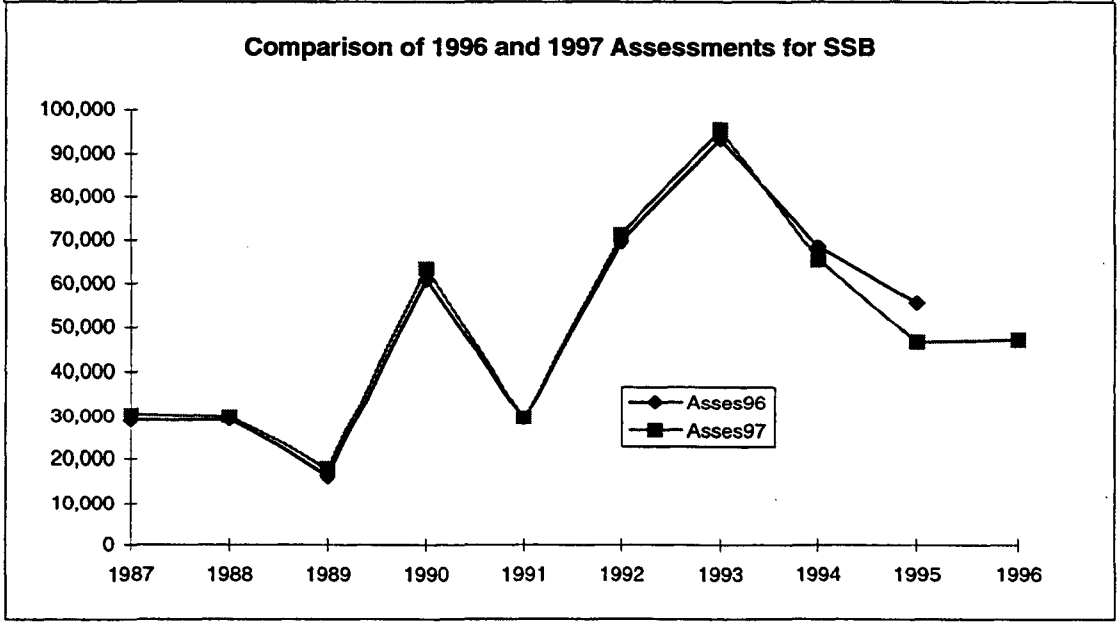


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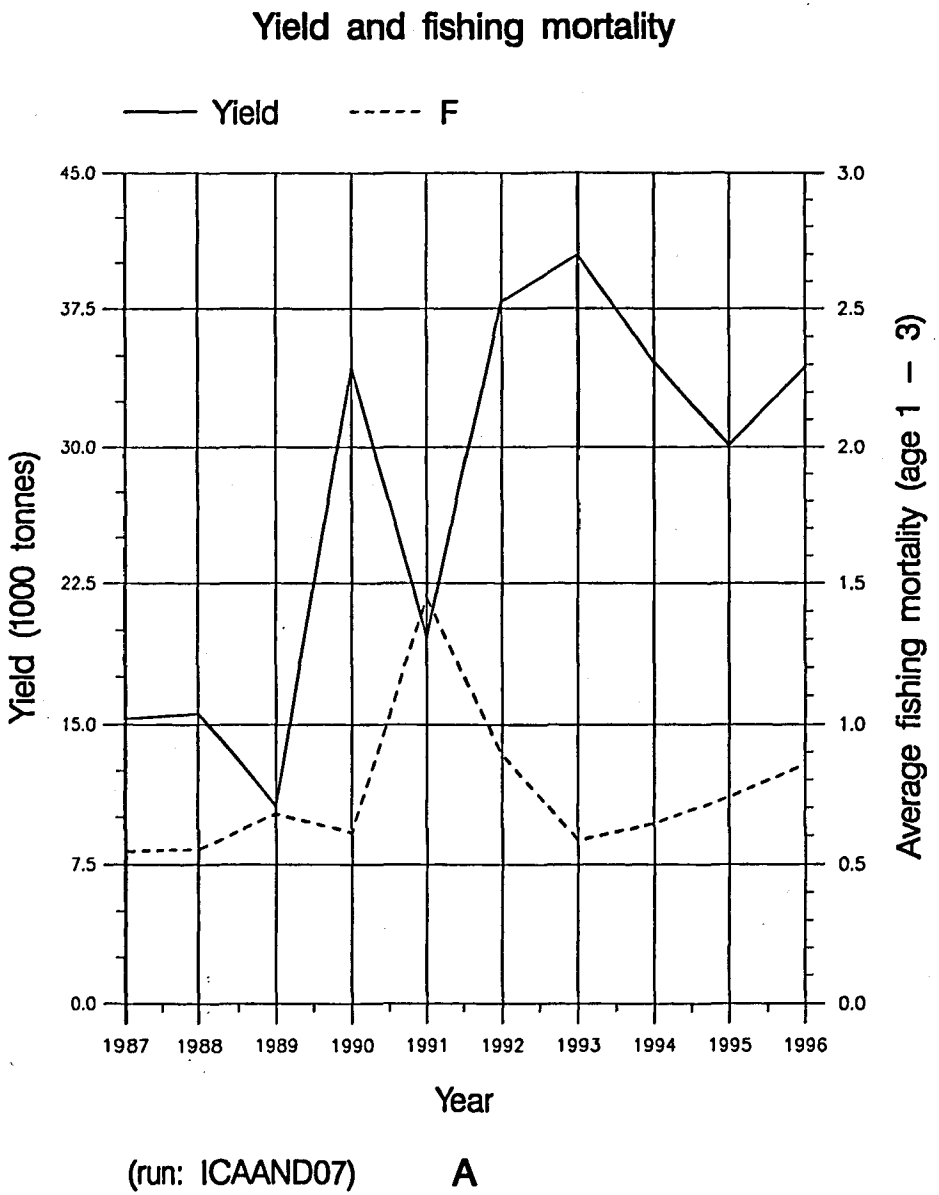
Figure 10.6.3

Fish Stock Summary
Anchovy in the Bay of Biscay (Fishing Area VIII)
14–9–1997



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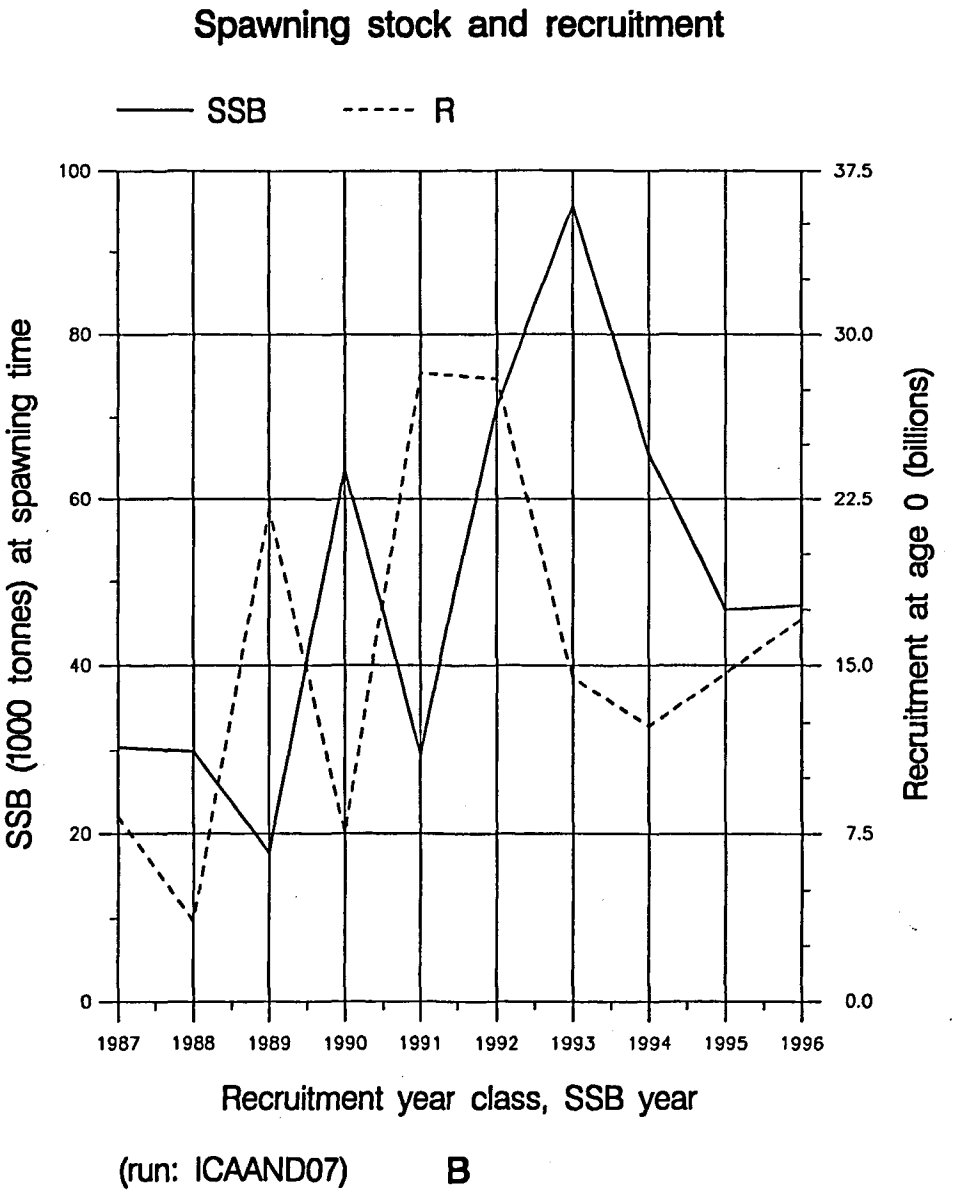

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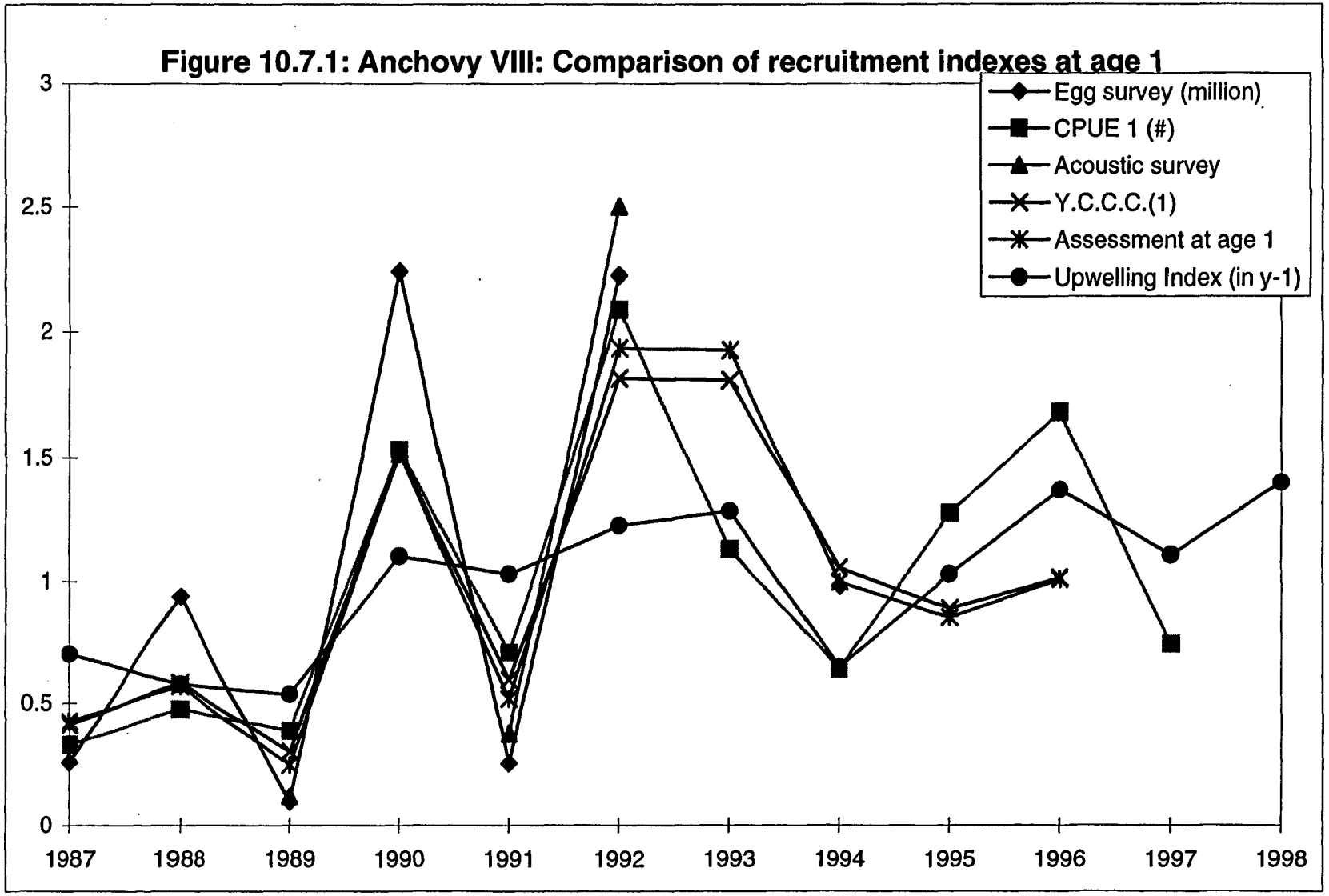
Figure 10.7.1: Anchovy VIII: Comparison of recruitment indexes at age 1
Egg survey (million)
CPUE 1 (#)
Acoustic survey
Y.C.C.C.(1)
Assessment at age 1
Upwelling Index (in y-1)
3
2.5
2
1.5
1
0.5
0
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998

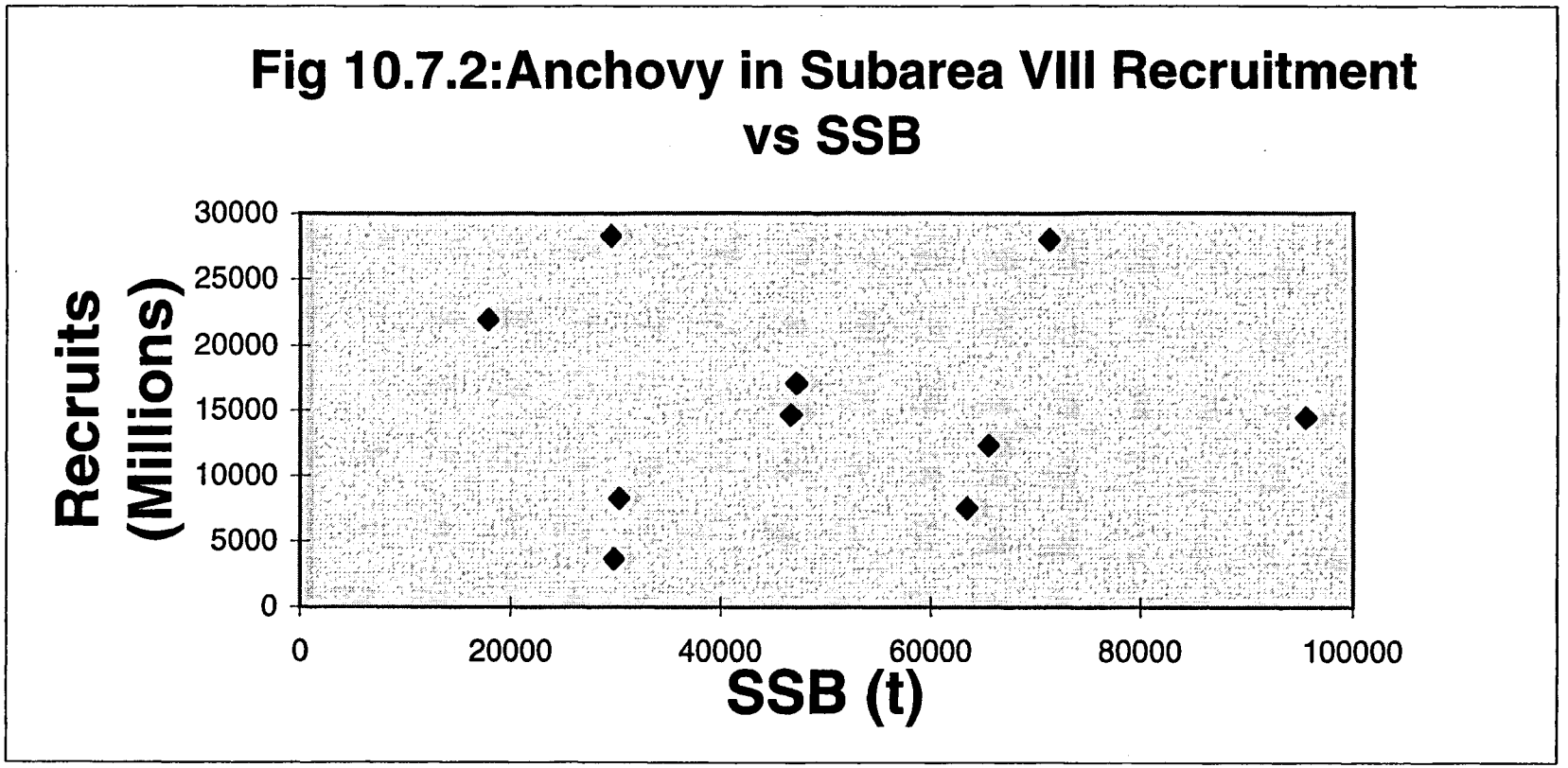

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Figure 10.7.3: Comparison of the Series of anchovy index of Recruitment and the Upwelling Index in the Bay of Biscay

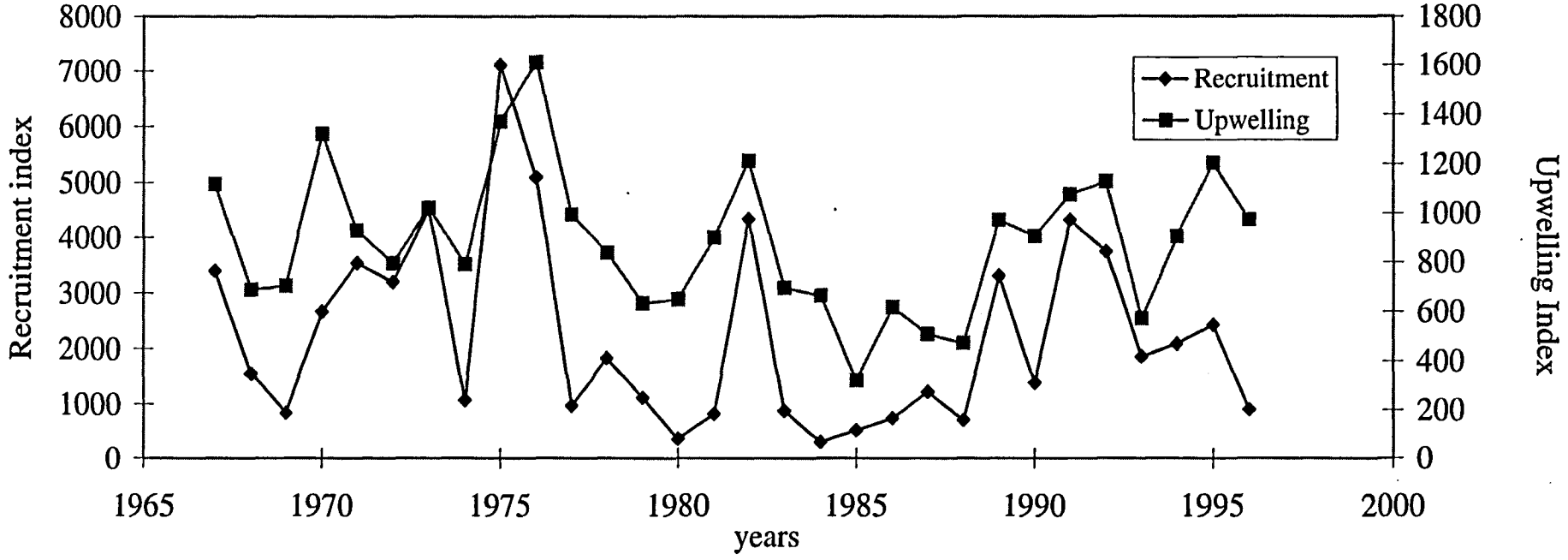

Figure 10.7.4: Relationship between Recruitment at age_0 estimated by the assessment and the Upwelling index in the same year

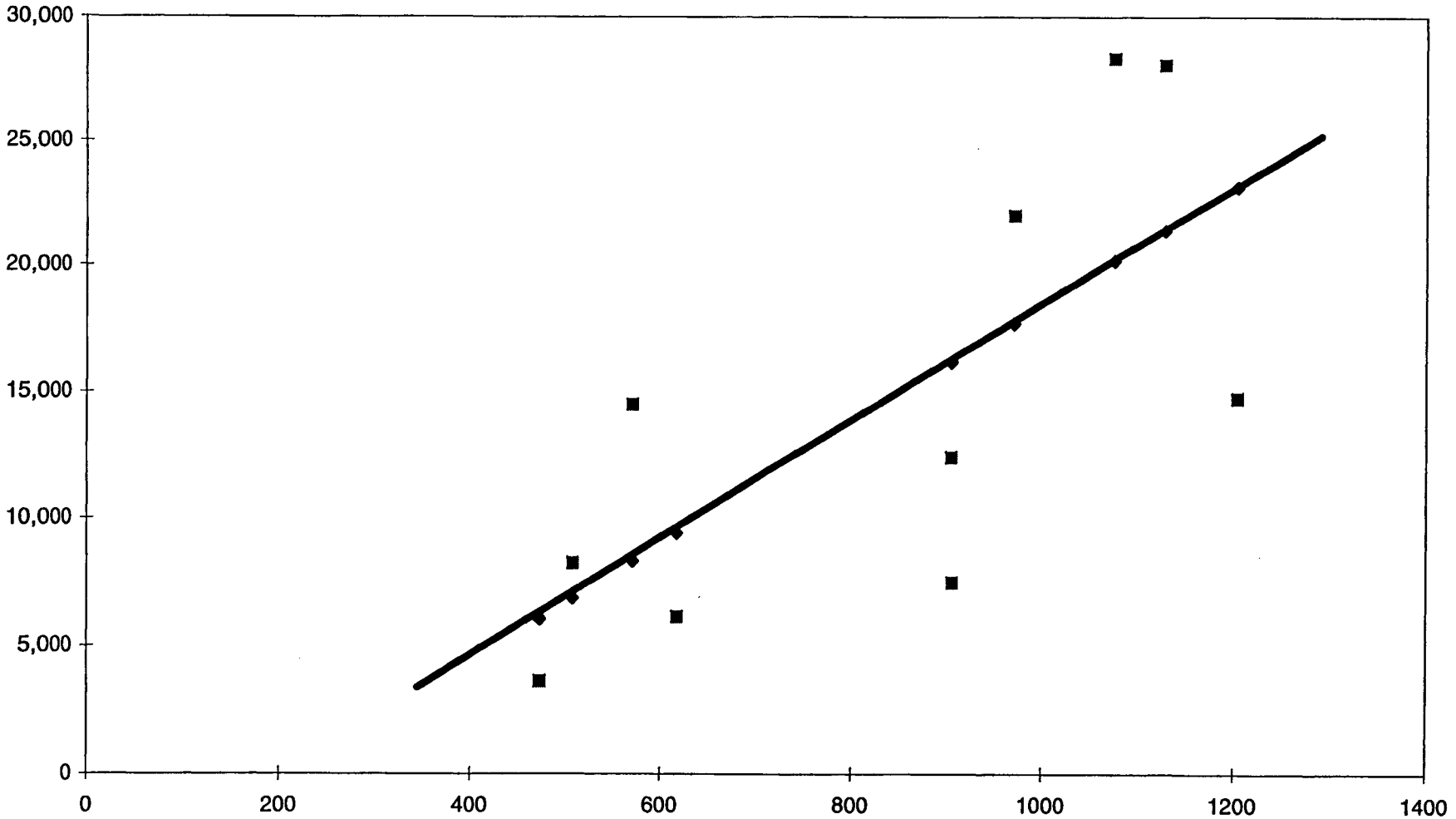

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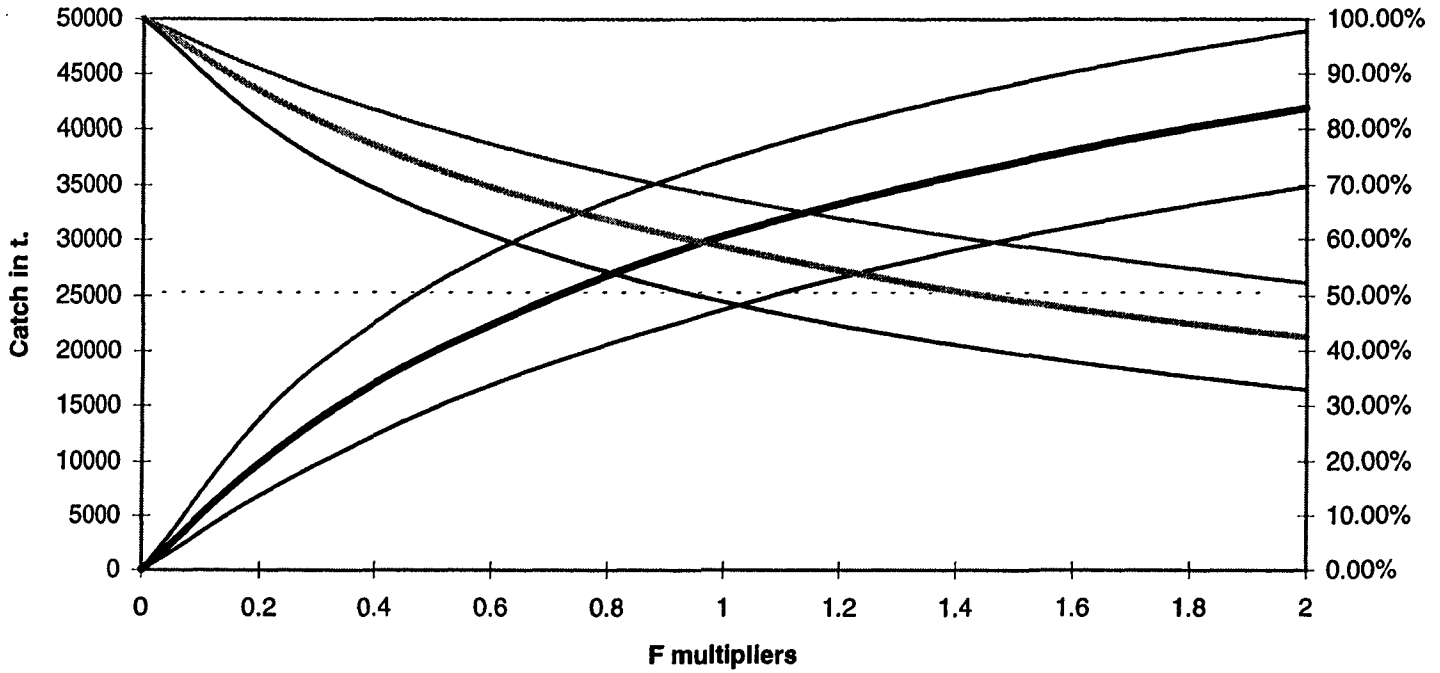
Figure 10. 10.1 Long term yield and %SSBR with R=Geometric mean considering the uncertainties in the estimates of the separable annual F (+/- 1 s.e.)



11 ANCHOVY IN DIVISION IXa

11.1 The Fishery in 1996

In 1996 the anchovy fishery in Division IXa was situated as in previous years (1988 to 1994) in the Gulf of Cadiz, anchovy being the target species of the Spanish fleet in this area. Due to the market height prices in the northern part of Division IXa, anchovy is the target species of the Spanish and Portuguese purse seine fleets when abundance is high, as occurred in 1995. This increase in anchovy abundance in this area in 1995 may have been due to a variation in thermohaline conditions in the coastal waters northwest of the Iberian Peninsula, less saline and warmer than in preceding years (ICES 1997/C:3), creating more favourable conditions for reproduction and larval survival. In 1996 a change in the previously described trend came about, with lower temperatures and increased salinity being registered (ICES 1997/C:3). In 1996 anchovy abundance in the northern part of Division IXa was low, as is usual in this area.

The Spanish fleet in the Gulf of Cadiz is mainly made up of purse-seiners (ICES 1992/Assess:17) though currently there is another kind of fleet in the form of trawlers whose usual target species is the prawn. Some of these trawlers switch to targeting anchovy in years when the yield of prawns is low. The Spanish fleet in the west of Galicia is composed of purse seiners. The Portuguese fleet is made up, in the main, of purse-seiners, some trawlers and artisanal ships, which catch a very small quantity of anchovies.

11.1.1 Landings in Division IXa

The total catch in 1996 was 4,595 t, a great fall with respect to 1995 (12,956 t). The catch in 1996 was lower in both countries with respect to 1995 owing to the fall in the catch in the northern part of Division IXa. Nevertheless, the Spanish catch in Division IXa South (Gulf of Cadiz) increased with respect to 1995, although catch levels remain low with respect to the period from 1988 to 1994. (Table 11.1.1 and Figure 11.1.1).

Table 11.1.2 shows the catch by fishing gear and by country. In both countries the main part of the catch was taken using purse-seine, this gear accounting for 90% in the Spanish and 95% in the Portuguese fisheries. In 1996 in the Gulf of Cadiz, the trawl catch increased with respect to 1995. As previously mentioned, these catches depend on the greater or lesser abundance of prawns, the target species of the trawl fleet.

From 1943 to 1987 data of catches were only provided by Portugal, and during this period catches varied between 23 t and 12610 t (Table 11.1.1). The Portuguese annual landings alternate between periods of high catches (1936–1940, 1942–1948, 1955–1957, 1962–1966 and 1995) and periods of very low catch levels (1927–1936, 1966–1976, 1979–1984 and 1987–1994) (Pestana, 1996). Data of Spanish catches in the Gulf of Cadiz (Sub-division IXa South) for this period cannot be given since they have been combined with anchovy catches in the area of Morocco, and catches in Galician waters (Sub-division IXa North) are not available.

11.1.2 Landings by Sub-division

The distribution of Spanish catches in 1996 was similar to that of the years 1988-1994 (ICES 1992/Assess:17; ICES 1993/Assess:19; ICES 1995/Assess:2 and ICES 1996/Assess:7) and completely different to that of 1995 (ICES 1997/Assess:3). In 1996, the greatest catches (98%) were found in Sub-division IXa South (Gulf of Cadiz), and the rest (2%) in Sub-division IXa North (West of Galicia). Catches in the Gulf of Cadiz come about throughout the whole year, increasing in spring and summer (Table 11.1.3).

The greatest contribution to Portuguese annual landings came from IXa South during the period 1943–1967 (mean value 4,526 t). After this period the landings decreased to 386 t (mean value) from 1968 to 1983 and to 32 t (mean value) from 1984 to 1991. In the last 5 years the landings were less than 1 tonne. In Sub-division IXa Central-North there were alternate periods of relatively high and low landings. After 1984 landings of Sub-division IXa Central-North made the greatest contribution to the total annual landings (mean value 1,116 t). The mean percentage of the landings by Sub-division (1970–1995) is 70% of the total in IXa Central-North, 5% in IXa Central-South and 20% in IXa South. The same landing pattern occurs in Sub-divisions IXa Central-North and Central-South during the period from 1970–1994 and in 1995. (Pestana, 1996). In 1996, catches in Sub-division IXa Central-North and Central-South fell but maintained the same pattern of catches as that of the period 1970–1995.

Most of the Portuguese landings are taken from May to October (mean 1927–1994). The 1995 landings show different evolution with two very important periods from April to June and from August to December (Pestana, 1996). In 1996 catches are taken mainly in the first and fourth quarter (Table 11.1.3).

11.2 Effort and Catch per Unit Effort

The data provided of fishing effort and CPUE indices of anchovy in Division IXa refer to the Spanish purse-seine fleet in the Bay of Cadiz from 1988 to 1996 and to the Spanish purse-seine fleet in Sub-division IXa North in 1995 and 1996 (Tables 11.2.1 and 11.2.2). No Portuguese data are available.

Effort measured as the number of effective fishing trips made by the five fleets of the Gulf of Cadiz and the CPUE series shows a declining trend to 1995 in all fleets, with a small increase in 1996 (Figure 11.2.1).

11.3 Catch in Number at Age

Catches at age of anchovy in Sub-division IXa North are not available for 1996 due to the catch being insignificant, thus rendering it impossible to carry out biological sampling of commercial catches. As in previous years, catches at age are not available for anchovy in the Gulf of Cadiz, due to problems in the interpretation of the otolith readings for this area.

11.4 Acoustic surveys

An acoustic survey was carried out in the Gulf of Cadiz (Sub-division IXa South) in 1993, to estimate anchovy abundance, and the total biomass estimated was 6,569 t (ICES 1995/Assess:2).

11.5 Management Measures and Considerations

The regulatory measures were the same as for the previous year and are summarised by Millan and Villamor (WD 1992). In 1996, the purse-seine fleet in the Bay of Cadiz stopped operating voluntarily in February and March 1996.

Given the reduced knowledge of the biology and dynamic of this population, it is suggested that the TAC at the level of recent catches would be appropriate to avoid an increase in effort.

Table 11.1.1: Portuguese and Spanish annual landings of ANCHOVY in Division IXa.
(From Pestana, 1989 and 1996 and Working Group members).

	Portugal				Spain			
Year	IXa C-N	IXa C-S	IXa South	Total	IXa North	IXa South	Total	TOTAL
1943	7121	355	2499	9975	-	-	-	-
1944	1220	55	5376	6651	-	-	-	-
1945	781	15	7983	8779	-	-	-	-
1946	0	335	5515	5850	-	-	-	-
1947	0	79	3313	3392	-	-	-	-
1948	0	75	4863	4938	-	-	-	-
1949	0	34	2684	2718	-	-	-	-
1950	31	30	3316	3377	-	-	-	-
1951	21	6	3567	3594	-	-	-	-
1952	1537	1	2877	4415	-	-	-	-
1953	1627	15	2710	4352	-	-	-	-
1954	328	18	3573	3919	-	-	-	-
1955	83	53	4387	4523	-	-	-	-
1956	12	164	7722	7898	-	-	-	-
1957	96	13	12501	12610	-	-	-	-
1958	1858	63	1109	3030	-	-	-	-
1959	12	1	3775	3788	-	-	-	-
1960	990	129	8384	9503	-	-	-	-
1961	1351	81	1060	2492	-	-	-	-
1962	542	137	3767	4446	-	-	-	-
1963	140	9	5565	5714	-	-	-	-
1964	0	0	4118	4118	-	-	-	-
1965	7	0	4452	4460	-	-	-	-
1966	23	35	4402	4460	-	-	-	-
1967	153	34	3631	3818	-	-	-	-
1968	518	5	447	970	-	-	-	-
1969	782	10	582	1375	-	-	-	-
1970	323	0	839	1162	-	-	-	-
1971	257	2	67	326	-	-	-	-
1972	-	-	-	-	-	-	-	-
1973	6	0	120	126	-	-	-	-
1974	113	1	124	238	-	-	-	-
1975	8	24	340	372	-	-	-	-
1976	32	38	18	88	-	-	-	-
1977	3027	1	233	3261	-	-	-	-
1978	640	17	354	1011	-	-	-	-
1979	194	8	453	655	-	-	-	-
1980	21	24	935	980	-	-	-	-
1981	426	117	435	978	-	-	-	-
1982	48	96	512	656	-	-	-	-
1983	283	58	332	673	-	-	-	-
1984	214	94	84	392	-	-	-	-
1985	1893	146	83	2122	-	-	-	-
1986	1892	194	95	2181	-	-	-	-
1987	84	17	11	112	-	-	-	-
1988	338	77	43	458	-	4263	4263	4721
1989	389	85	22	496	118	5336	5454	5950
1990	424	93	24	541	220	5911	6131	6672
1991	187	3	20	210	15	5696	5711	5921
1992	92	46	0	138	33	2995	3028	3166
1993	20	3	0	23	1	1960	1961	1984
1994	231	5	0	236	117	3036	3153	3389
1995	6724	332	0	7056	5329	571	5900	12956
1996	2707	13	51	2771	44	1780	1824	4595

(-) Not available
(0) Less than 1 tonne

Table 11.1.2. ANCHOVY IXa. Catches (t) by gear and by country in 1988-1996.

Country/Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823
Purse seine IXa North		118	220	15	33	1	117	5329	44
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556
Trawl IX a South	0.0	0.0	0.0	0.0	0.0	330	152	75	224
PORTUGAL	458	496	541	210	275	23	237	7056	2771
Trawl					4	9	1		56
Purse seine	458	496	541	210	270	14	233	7056	2621
Artisanal					1	1	3		94
Total	4721	5950	6672	5921	3303	1984	3390	12956	4595

* Portugal data without separate the catch by gear

Table 11.1.3: Anchovy catches (t) in Division IXa by country and Subdivisions in 1996.

COUNTRY	SUBDIVISIONS	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANUAL	
		C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
SPAIN	IXa North	11	24.5	6	13.6	22	49.9	5	12.0	44	2.4
	IXa South	41	2.3	807	45.3	585	32.9	348	19.5	1780	97.6
	TOTAL	52	2.8	812	44.6	607	33.3	353	19.3	1824	
PORTUGAL	IXa Central North	1289	47.6	227	8.4	189	7.0	1002	37.0	2707	97.7
	IXa Central South	0.4	3.2	1	6.9	0	0.0	12	89.9	13	0.5
	IXa South	0	0.0	0.64	1.2	0.51	1.0	50.02	97.8	51.16	1.8
	TOTAL	1290	46.5	229	8.3	189	6.8	1064	38.4	2771	
TOTAL	IXa North	11	24.5	6	13.6	22	49.9	5	12.0	44	0.9
	IXa Central North	1289	47.6	227	8.4	189	7.0	1002	37.0	2707	58.9
	IXa Central South	0	3.2	1	6.9	0	0.0	12	89.9	13	0.3
	IXa South	41	2.2	807	44.1	586	32.0	398	21.7	1831	39.9
	TOTAL	1341	29.2	1041	22.7	796	17.3	1417	30.8	4595	

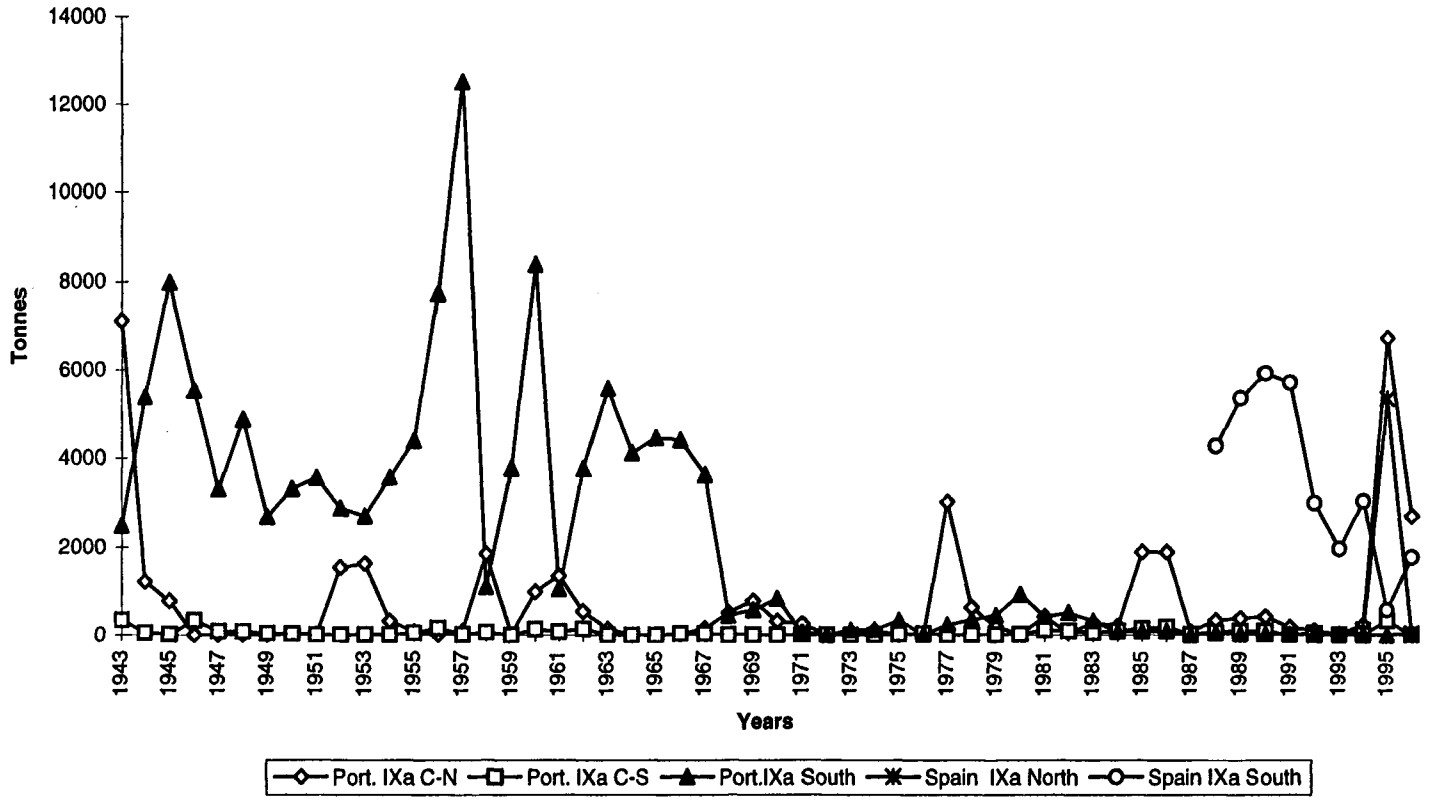
Table 11.2.1 ANCHOVY in Division IXa. Effort data : Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) num fishing trips.

	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
Year	BARBATE Single purpose	BARBATE Multi purpose	SAN LUCAR Multi purpose	I. CRISTINA Single purpose	I.CRISTINA Multi purpose	VIGO	RIVEIRA
	No. fishing trip					No. fishing trip	
1988	3958	17	210	-	-	-	-
1989	4415	39	234	-	-	-	-
1990	4622	92	660	-	-	-	-
1991	3981	40	919	-	-	-	-
1992	3450	116	583	-	-	-	-
1993	2152	5	225	-	-	-	-
1994	1625	69	899	196	28	-	-
1995	528	17	377	22	17	1537	252
1996	1595	89	1659	76	55	32	3

Table 11.2.2 ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) and Spain IXa North (Galician South) CPUE series in fisheries

	SUB-DIVISION IXa SOUTH					SUB-DIVISION IXa NORTH	
	PURSE SEINE					PURSE SEINE	
Year	BARBATE Single purpose	BARBATE Multi purpose	SAN LUCAR Multi purpose	I. CRISTINA Single purpose	I.CRISTINA Multi purpose	VIGO	RIVEIRA
	kg/No. fishing trip					kg/No. fishing trip	
1988	1047	461	420	-	-	-	-
1989	1139	534	943	-	-	-	-
1990	1128	287	643	-	-	-	-
1991	1312	339	456	-	-	-	-
1992	819	173	300	-	-	-	-
1993	641	268	225	-	-	-	-
1994	1326	262	398	204	174	-	-
1995	377	134	166	52	25	2509	2286
1996	497	315	246	137	157	847	4

Figure 11.1.1: Portuguese and Spanish annual landings of ANCHOVY in Division IXa since 1943.



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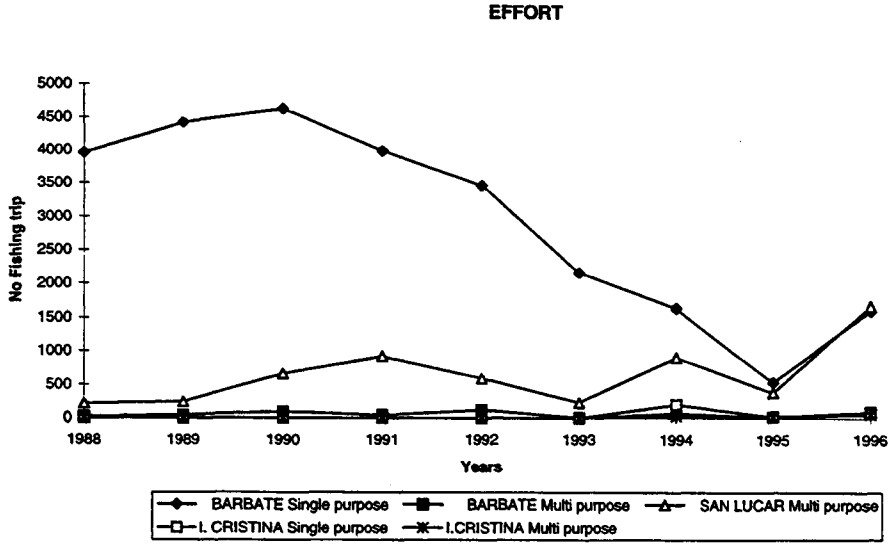

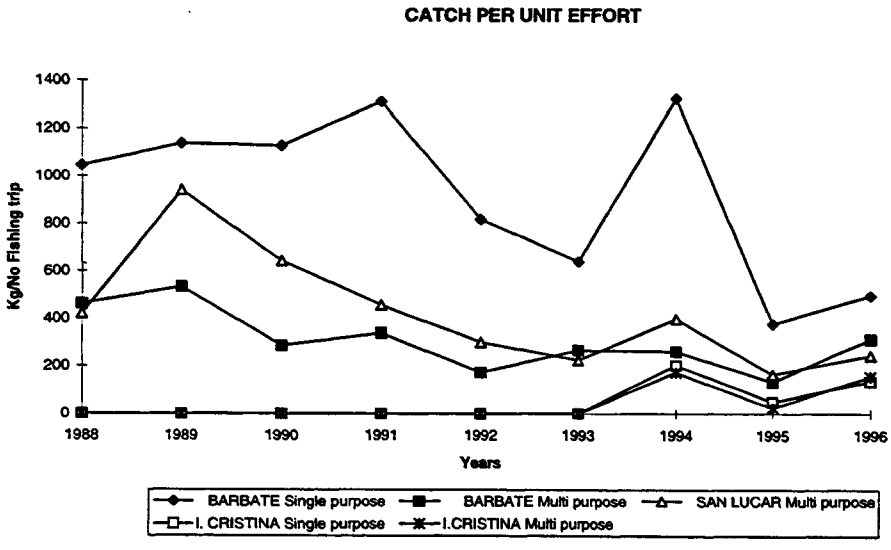

Figure 11.2.1 ANCHOVY in Division IXa. Spain IXa South (Bay of Cadiz) Effort ar series in comercial fisheries.

12 DATA REQUESTED BY THE MULTISPECIES WORKING GROUP

12.1 Mackerel

The catch of mackerel belonging to the North Sea stock has been included in the catches of the western stock since 1987.

While the total catch of mackerel in Sub-area IV declined in 1996 (206,675 tonnes) compared with 1995 (317,806 tonnes) no notable changes have taken place in the fishery in Division IIIa in 1996 (6,164 tonnes) compared with 1995 (5,756 tonnes). Results of egg surveys carried out in 1996 (ICES 1997/H:4) confirmed that the stock is close to an historically low level. The total catch of North Sea stock mackerel was again assumed to be 10,000 tonnes or 4.7% of the total 1996 catch.

12.1.1 Catch in numbers at age by quarter for the North Sea mackerel stock

The total catch in numbers of the North Sea stock for 1996 was calculated assuming a North Sea stock component of 10,000 tonnes and a mean weight in the catch equal to that of mackerel in Sub-area IV and Division IIIa (Tables 2.8 and 2.12) with additional mean weight at age data in the 2nd and 3rd quarter (Sub-area IV and Division IIIa) obtained from the 1996 egg survey (Table 12.1). The catch in numbers was partitioned across quarters in the same proportions observed for mackerel in Sub-area IV and Division IIIa, and across ages using the proportion at age observed in samples taken during the 1996 egg survey (Table 12.2).

12.1.2 Weight at age in the stock

New data from egg surveys (ICES 1997/H:4) on weight at age in the stock for the second and third quarter of 1996 are presented (Table 12.1). Remaining data are given in 1997 (ICES 1997/Assess:3).

12.1.3 Stock distribution by quarter

Although there appears to be some evidence suggesting a change in the distribution of mackerel in the North Sea, the working group did not have sufficient information to justify altering the distributions presented (Table 12.3) in previous reports (ICES 1997/Assess:3).

12.2 Horse Mackerel

12.2.1 Catch in numbers and weight at age by quarter for the North Sea horse mackerel stock

Since 1995 the proportion of North Sea horse mackerel taken for human consumption has risen above 70%. Details of the catch in numbers and the weight at age are given in Table 5.3.1.

12.2.2 Stock distribution by quarter

The North Sea Horse Mackerel stock are known to migrate south to the Channel during the 4th quarter and to be back in the North Sea by the 2nd quarter of each year. The Working Group therefore considers that 50% and 10 % of the stock are in the North Sea during the 4th and 1st quarter respectively.

There is still no information about the numbers of western horse mackerel which migrate into the northern North Sea during the 3rd and 4th quarters of the year. From 1982 to 1986 catches of horse mackerel in Division IVa were low (<1,000 tonnes) indicating very little migration. However, since then catches have increased to a maximum of 113,000t in 1990, which was about 30% of the total western stock catch. Since 1994 catches have declined and in 1996 the provisional catch in Division IVa was about 18,000 t (Table 4.3.1) or 4.6% of the total western stock catch.

Due to decreasing catches by Norway in Division IVa and a reduction in the modelled inflow of Atlantic water to the North Sea in 1996 (Iversen *et al.* WD 1997) the Working Group considers that 10% of the adult stock of the Western Horse Mackerel is available in Division IVa in the forth quarter, and 1% in the first quarters of the year (Table 12.4).

The Working Group noted the termination of the Multispecies Working Group in 1997.

Table 12.1 North Sea Mackerel: Mean weight at age (g) in 2nd and 3rd quarter of 1996 in Sub-area IV and Division IIIa.

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
Wt (g)	117	194	333	456	469	415	547	600	630	650	642	-	-	680	673

Table 12.2 Estimated catch in numbers ('000) of North Sea mackerel stock in 1989-1986 by quarter. (This table is on the following page)

Table 12.3 Percentage of each mackerel stock assumed to be present in the North Sea, by quarter, in 1996.

	North Sea Stock (%)				Western Stock (%)			
Quarter	1	2	3	4	1	2	3	4
1	100	100	100	100	-	20	30	30
2	80	100	100	80	10	10	50	70
>2	90	100	50	70	10	+	50	70

Table 12.4 Percentage of each horse mackerel stock assumed to be present in the North Sea, by quarter, in 1996.

	North Sea Stock (%)				Western Stock (%)			
Quarter	1	2	3	4	1	2	3	4
1-4	10	100	100	50	0	0	0	0
5+	10	100	100	50	1	0	0	10

Table 12.2 Estimated catch in numbers ('000) of North Sea mackerel (Sub-area IV and Division IIIa) by quarter, 1989 -1996.

1989	Q1	Q2	Q3	Q4	
Age	5.5%	0.6%	36.4%	57.5%	Sum
1	115	13	746	1,206	2,080
2	449	49	2,969	4,689	8,156
3	445	49	2,947	4,654	8,095
4	129	14	854	1,349	2,346
5	73	8	482	760	1,323
6	16	1	103	162	282
7	62	7	411	649	1,129
8	37	4	245	387	673
9	41	4	270	426	741
10	2		13	20	35
11	21	2	142	223	388
12	5	1	32	51	89
13	1		7	10	18
14	3		21	36	60
15	27	3	178	280	488

1990	Q1	Q2	Q3	Q4	
Age	13.2%	0.6%	22.8%	63.4%	Sum
1	172	8	297	825	1,302
2	571	26	986	2,740	4,323
3	2,795	127	4,829	13,429	21,180
4	744	34	1,286	3,576	5,640
5	216	10	374	1,040	1,640
6	121	6	209	581	917
7	26	1	44	123	194
8	105	5	181	503	794
9	60	3	104	291	458
10	70	3	121	335	529
11	2	0	4	12	18
12	35	2	60	168	265
13	7	0	12	34	53
14	0	0	0	1	1
15	51	2	89	246	388

1991	Q1	Q2	Q3	Q4	
Age	31.7%	0.3%	23.6%	44.4%	Sum
1	153	1	114	222	490
2	3,841	37	2,856	5,077	11,811
3	4,112	40	3,058	5,871	13,081
4	1,995	19	1,485	2,896	6,395
5	443	4	330	644	1,421
6	172	2	128	250	552
7	394	4	293	572	1,263
8	0	0	0	0	0
9	148	1	110	215	474
10	172	2	128	250	552
11	123	1	92	179	395
12	49	0	37	72	158
13	49	0	37	72	158
14	25	0	18	36	79
15	98	1	93	143	335

1992	Q1	Q2	Q3	Q4	
Age	19.3%	0.4%	18.3%	62.1%	Sum
1	747	15	608	2,404	3,774
2	3,005	61	3,443	9,667	16,176
3	2,444	49	1,987	7,863	12,343
4	573	12	480	1,890	2,955
5	359	7	292	1,154	1,812
6	112	2	91	361	566
7	45	1	37	145	228
8	22	0	18	72	112
9	0	0	0	0	0
10	0	0	0	0	0
11	15	0	12	48	75
12	37	1	30	120	188
13	15	0	12	48	75
14	0	0	0	0	0
15	82	2	67	264	415

1993	Q1	Q2	Q3	Q4	
Age	17.6%	0.3%	16.6%	65.5%	Sum
1	331	6	312	1,242	1,891
2	1,323	23	1,247	4,960	7,553
3	2,315	40	2,183	8,681	13,219
4	1,693	29	1,596	6,149	9,467
5	562	10	530	2,108	3,210
6	132	2	125	496	755
7	40	1	37	149	227
8	26	0	25	99	150
9	20	0	19	74	113
10	0	0	0	0	0
11	0	0	0	0	0
12	7	0	6	25	38
13	26	0	25	99	150
14	13	0	12	50	75
15	126	2	119	471	718

1994	Q1	Q2	Q3	Q4	
Age	21.2%	0.5%	26.9%	51.3%	Sum
1	217	6	276	525	1,024
2	870	23	1,103	2,099	4,095
3	1,522	39	1,931	3,674	7,166
4	1,092	28	1,384	2,635	5,139
5	370	10	469	892	1,741
6	87	2	110	210	409
7	26	1	33	63	123
8	17	0	22	42	81
9	13	0	17	31	61
10	0	0	0	0	0
11	4	0	6	10	20
12	9	0	11	21	41
13	22	1	28	52	103
14	13	0	17	31	61
15	87	2	110	210	409

1995	Q1	Q2	Q3	Q4	
Age	32.2%	0.3%	19.7%	47.8%	Sum
1	369	4	226	548	1,147
2	1,475	16	905	2,191	4,587
3	2,582	27	1,584	3,835	8,028
4	1,844	19	1,131	2,739	5,733
5	627	7	385	931	1,950
6	148	2	91	219	460
7	44	0	27	66	137
8	30	0	18	44	92
9	22	0	14	33	69
10	0	0	0	0	0
11	7	0	5	11	23
12	15	0	9	22	46
13	37	0	23	55	115
14	22	0	14	33	69
15	148	2	91	219	460

1996	Q1	Q2	Q3	Q4		
Age	26.5%	0.4%	31.4%	41.8%	Sum	%
1	650	9	769	1,023	2,451	10.2%
2	760	10	900	1,198	2,869	12.0%
3	1,993	27	2,359	3,139	7,519	31.3%
4	1,142	16	1,351	1,798	4,307	17.9%
5	1,234	17	1,460	1,943	4,655	19.4%
6	111	2	131	174	418	1.7%
7	239	3	282	376	900	3.8%
8	24	0	28	37	89	0.4%
9	24	0	28	37	89	0.4%
10	24	0	28	37	89	0.4%
11	57	1	68	90	216	0.9%
12	0	0	0	0	0	0.0%
13	0	0	0	0	0	0.0%
14	6	0	8	10	24	0.1%
15	102	1	121	160	384	1.6%
Total	6,364	88	7,532	10,023	24,006	100.0%

13 REQUEST FROM THE MACKEREL/HORSE MACKEREL EGG SURVEY WORKING GROUP

13.1 Sampling for Maturity during Egg Surveys in 1998

The Mackerel/Horse Mackerel Egg Survey Working Group requested information on the distribution of 1, 2 and 3 year old mackerel and horse mackerel to be made available to this Working Group (ICES 1997/H:4). At this meeting charts should be made, which show where trawl hauls should be distributed over the egg survey area and the juvenile area for sampling fish for constructing maturity ogives based on histological analysis of the ovaries, because of uncertainties in the proportion mature of especially the younger age groups (see Section 1.4).

Based on available data on the distribution of eggs and on the presented information on the distribution of 1, 2 and 3 year old fish the following sampling scheme was accepted. Half of the total samples per species should be collected relatively close to the edge of the continental shelf, while the sampling was chosen to reflect the distribution of adults (based on egg distribution). The other half of the samples should be taken in shallower water where relatively more juveniles are present and the sampling was chosen to reflect the distribution of the 1, 2 and 3 year olds.

For mackerel a minimum of 20 samples of 100 fish each should be collected distributed over the western and southern area. For horse mackerel 14 samples of 100 fish each should be taken in the western and another 14 in the southern area (ICES 1997/H:4). The scheme below is made for sampling in the western and southern area, and in the adult and juvenile area around peak spawning time. Communications between countries / cruise leaders remain necessary to obtain this sampling scheme:

	MACKEREL	
AREA	Adult	Juvenile
Western	8	7
Southern	2	3

	HORSE MACKEREL	
AREA	Adult	Juvenile
Western	7	7
Southern	7	7

Figures 13.1 and 13.2 show the charts where the trawl hauls should approximately be taken.

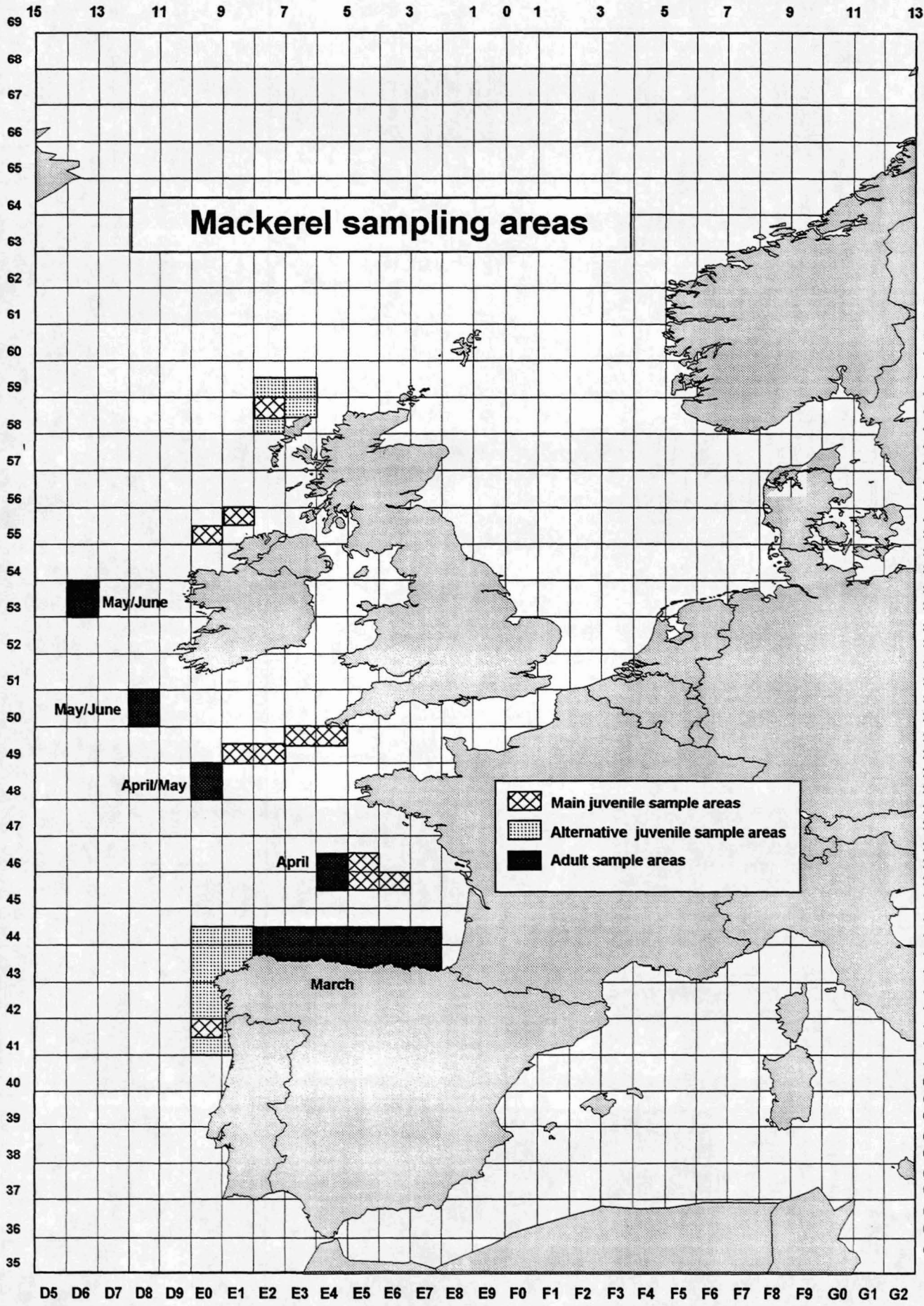

Figure 13.1.1 Proposed mackerel trawl sampling areas for egg surveys 1998

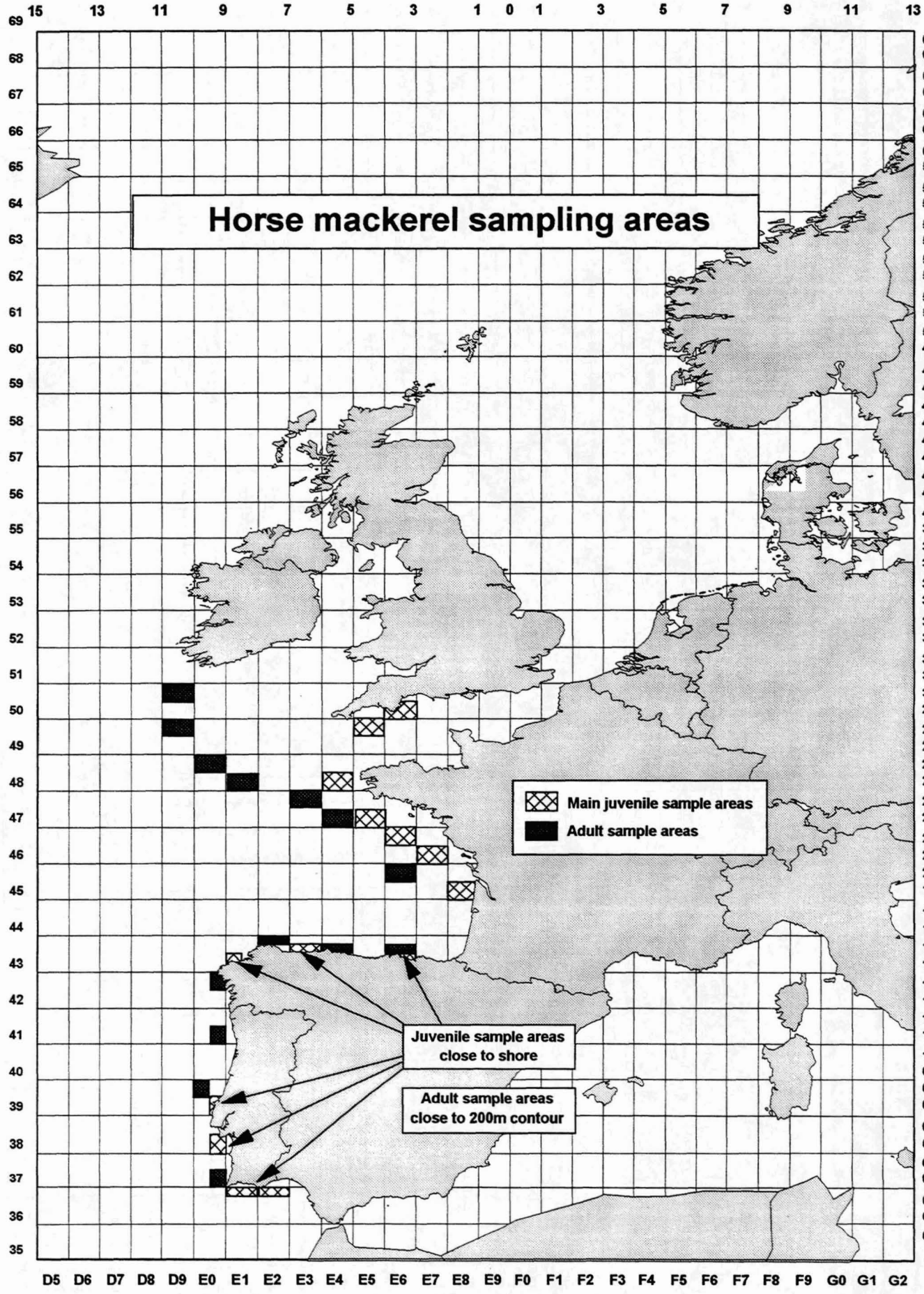

Figure 13.1.2 Proposed horse mackerel trawl sampling areas for egg surveys 1998

14 REQUEST FOR NEAFC ADVICE

NEAFC has requested this Working Group to:

> *Indicate the seasonal and area distribution of mackerel in the NEAFC area for juvenile as well as parental components.*

Seasonal and areal distributions for mackerel has changed over time. There were little fishery independent data available for the Working Group. The fishery for 1996 is described in Sections 2.5 and 2.6, of this report and reflects to some extent the distribution of mackerel. Table 2.1.1 gives the catch by stock (1969–1996) and Table 2.5.1 catches by Divisions and Sub-areas by quarters in 1996. Figures 2.5.1a-d give the distributions of commercial catches by quarters and rectangles in 1996. The mapped distributions are given in a fairly coarse class resolution. These figures and tables includes all age groups (0-15+) which are taken in the fisheries. Since the fishery is restricted both by quotas, closed areas etc. the catch distribution are not reflecting the accurate distribution of mackerel. There are also mackerel outside the fished areas, but due to low abundance no fishery are carried out in such areas. There are also some misreporting by areas from different fleets. However Table 2.1.1 and Table 2.5.1 are to some extent adjusted for this by Working Group members. Similar tables and maps are given in Working Group reports from previous years.

There are also some fishery independent information of distribution of 0, 1, 2 & 3 groups from bottom trawl surveys. These have been assembled in a database under the EU SEFOS programme and are described in Section 2.4 (Figures 2.4.1 and 2.4.2 for 1996/97 and Figures 2.4.3 and 2.4.4 for the time series). As mentioned above each year the Working Group assembles data on the distribution of commercial catches by quarter and rectangle. Under SEFOS, in years of the triennial egg surveys 1995, 92, 89 *et seq.* these data were entered into a database, assembled by rectangle and quarter.

Several egg surveys have been carried out both in the North Sea and in the western and southern areas. The results from these surveys have been used for estimating the spawning stock biomass. They also give accurate information about the spawning areas. The last surveys in the western and southern areas were carried out in 1993 (ICES 1994:H4) and in 1995 (ICES 1996/H:2) and in the North Sea in 1990 (Iversen *et al.* 1991) and 1996 (ICES 1997/H:4).

Two ICES reports, ICES 1988/H:17 and ICES 1990/H:5 from an EEC-Norwegian joint scientific group are describing stock and catch distribution of mackerel. These reports are dealing with data from 1972 to 1988.

15 REQUEST FROM EU AND NORWAY

EU and Norway have requested a series of medium-term simulations and long-term equilibrium computations of yield and biomass for mackerel. Because of the extent of the task, and because the percentiles specified requires technical modifications of the standard software, the Working Group decided to leave the task to a subgroup, which will provide the requested material to ACFM by October 1997.

16 RECOMMENDATIONS

16.1 Mackerel

The Working Group recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. This observer programme should be commenced as soon as possible.

The Working Group recommends that the Mackerel weight at age data set collected by Ireland during March and April be examined to assess its potential use as a source of stock weight at age values.

The Working Group reiterates last years recommendation to investigate the distribution pattern of overwintering mackerel in the North Sea on VIa (N).

The Working Group recommends that the next mackerel egg survey of the North Sea should be carried out in 1999. This is particularly important in view of the uncertainty about the origin of the exceptionally high numbers of 1996 year class observed in the North Sea as "0" groups in 1996 and also as 1 year olds early in 1997.

The Working Group recommends further modelling work should be undertaken in order the explore further the use of distributional models for improving the use of the juvenile surveys for prediction of recruitment. Preliminary work indicates good prospects for deriving a robust index of abundance from the mackerel survey data, and the Working Group recommends that the surveys be continued.

16.2 Horse Mackerel

The Working Group strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.

The Working Group recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. This observer programme should be commenced as soon as possible.

The Working Group recommends that a horse mackerel otolith workshop be held in 1998 to improve the quality of age readings.

The Working Group recommends that more research be carried out on North Sea horse mackerel.

The Working Group recommends to develop further studies in relation to stock identity problems and/or possible migration patterns especially for the Southern horse mackerel.

16.3 Sardine

The Working Group recommends to continue to carry out joint acoustic surveys covering the entire distribution area of the sardine stock each year, during spring (March-April). In order to understand the population dynamics of sardine these surveys would also investigate the adjacent areas mainly French coast.

The Working Group recommends to undertake the Planning Group for Acoustic Surveys in Sub-areas VIII and IX in order to prepare in advance the acoustic surveys.

The Working Group recommends to apply the following references established in the 1997 Workshop on Sardine Otolith Age Reading:

- Regular exchange of otolith samples for the purpose of checking and improving the precision of all the readers involved in sardine age determination in the Ibero-Atlantic area.
- Monitor annulus deposition patterns along the entire Ibero-Atlantic area throughout each year.
- Development of an age determination guide must be developed in order to assist individual readers with the correct interpretation of the ring deposition structures and to determine ages precisely.
- In order to determine the origin of the different growth patterns of this species in the adjacent areas of France and Morocco it is recommended to study samples from these countries.
- It is strongly recommended that the daily ring counting technique is employed to validate the annuli of at least the first few age groups.

16.4 Anchovy

The Working Group recommends to develop further studies in the Gulf of Cadiz (Division IXa) for the interpretation of the otolith readings and to investigate alternative ageing methods.

The Working Group recommends to collect all anchovy information available from the Portuguese and French acoustic surveys carried out in the Gulf Cadiz and in the Gulf of Biscay respectively.

The Working Group recommends to collect the information available on physiology of anchovy in relation to its post spawning mortality (e.g. fat contents).

The Working Group recommends to collect all the information available on the influence of environmental conditions on the ecology of the fish.

16.5 General

The Working Group again strongly recommended that all countries should make effort to provide reliable statistics.

The Working Group supports the recommendation of the Egg Survey Working Group that they should meet in Hamburg 13–19 April 1999, and that the relevant assessment biologists should attend the last two days of that meeting. The Working Group will calculate the SSB for the North-east Atlantic mackerel, Western Horse mackerel and Southern Horse mackerel based on egg production estimates and adult parameters from the 1998 surveys. The assessment biologist will use those estimates of SSB to retune the VPA estimates of stock size in time for the May meeting of ACFM.

The Working Group recommends and encourages the prosecution environmental studies aimed to understand the connections between the climatic regimes and oceanographic conditions of the waters with the recruitments of the medium- and small size pelagics species assessed by this Working Group.

16.6 ICES

All Working Group members are requested to bring catch data to the meeting in a standard format (EXCEL spreadsheet format) to be prepared by M. Keatinge from Fisheries Research Centre, Dublin.

The Working Group recommends that the Working Group reports be made available as a complete set over the whole time series for quick consultation during the Working Group meetings (also the Mackerel and Sardine Working Group reports).

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APPENDIX 1

Implementation of Bayesian VPA and catch forecasting using Markov Chain Monte Carlo.

Conventional Bayesian analysis relies on an evaluation of the posterior probability P(Q|X) of a certain set of assumptions Q, given prior belief P(Q) about those assumptions, a set of new information X, and a likelihood function allowing the evaluation of P(X|Q). The conditional probability can be expressed as

$$P(\Theta \mid X) = \frac{P(X \mid \Theta)\, P(\Theta)}{\int P(X \mid \Theta)\, P(\Theta)\, d\Theta}$$

Conventionally the Θ are usually a vector of input parameters to a model M, which is assumed to be correct, and upon which the likelihood function is predicated.

Most Bayesian stock assessments in the published literature have relied either on direct-mapping approaches (e.g. Hilborn and Walters, 1992) or sampling/importance resampling (e.g. McAllister and Pikitch, 1997). The former approach becomes extremely difficult to implement for computational reasons if there are more than a few parameters, and the latter method requires the specification of an importance function which, for efficiency, should approximate reasonably closely to the posterior distribution. Choice of such an importance function is not trivial: McAllister and Ianelli (1997) describe eight separate steps in the development of an importance function, each of which requires considerable expertise.

A simpler approach is the Markov Chain Monte Carlo method to generating samples from posterior probability distributions, described accessibly by Gilks *et al.* (1996). Essentially, this relies on setting up a very long Markov chain of model parameter vector Q with transition probabilities defined as the conditional posterior probability of each element of Q, depending on the other elements. So, for the transition from iteration k-1 to iteration k in the chain, element i of Q is replaced with a new value drawn from the distribution of $P(Q_{i,k} \mid Q_{j,\, j<i,\, k-1})$. The distribution to be sampled has p.d.f.: L(Data|Q) Pr(Q), i.e. the product of the likelihood function and the prior. The form of this conditional likelihood is generally not known analytically and it is computationally expensive to evaluate. However, samples can be taken from it by constructing upper and lower envelope functions (constructed on simple geometric rules) from which it is easy to sample. The form of adaptive rejection sampling procedure used here can be summarised as:

1) Take a sample from the upper envelope function (X)
2) Evaluate the likelihood L(X) at the sampled point
3) Test whether to accept the sampled value:

   if accepted, proceed to next Markov chain iteration otherwise update the envelope function with the new information X, L(X) Iterate

In the present case, the upper envelope function used is a simple series of rectangular approximations between evaluated points and estimate of the maximum of the curve (Appendix Figure 1), which is a modification of that proposed by Gilks (1996). Although computationally less efficient, this algorithm was robust to structural bound-constraints (such as a restriction of a maximum 100% maturity) which this assessment model should logically contain. A Metropolis step was added to ensure robustness of the method to non-log-concave conditional probability distributions (i.e. cases where the conditional probability may emerge above the upper envelope function).

Clearly the adjacent values of Q_k in the Markov Chain will be very strongly correlated, and this correlation will decrease the further apart in the chain that pairs of values are drawn. For most purposes it is required to draw virtually uncorrelated samples from the chain; a method proposed by Raftery and Lewis (see Gilks *et al.*, 1996) allows calculation of the appropriate intervals from which to take to take samples from the chain so that they have less than a specified correlation. This process is sometimes known as 'thinning' the chain.

The chain will also clearly be sensitive to starting conditions, and one will wish to discard a certain number of initial iterations, after which the chain is effectively uninfluenced by the starting values for Q. This is sometimes known as the 'burn-in' period.

For a considerably more complex VPA-based assessment model with more parameters and strong parameter correlations used for Norwegian Spring-Spawning herring the Raftery and Lewis method suggested a 'burn-in' length of 600 iterations and 'thinning' the chain by taking one sample each 76 iterations (Patterson, 1997), for 5% accuracy in the posterior distributions. For Western Horse Mackerel such values were not formally estimated but a burn-in period of 1000 iterations was used and the chain was thinned by taking one sample each 100 iterations. A visual check of the parameters in the chain suggested independence of starting parameters appeared to have been achieved after a few hundred iterations. The chain was run for over 400000 iterations and 4000 samples taken to construct the posterior distributions for the assessment.

Values of Q' were saved from the single run of the chain in order to re-evaluate the outcome of various future catch scenarios without incurring the computational burden of re-evaluating the entire chain. In these scenarios, parameters from 750 iterations were taken and catch projections calculated from each iteration in the conventional way. Confidence limits were constructed from the distribution percentiles of quantities derived from these projections such as catch, the fishing/natural mortality ratio, and spawning biomass.

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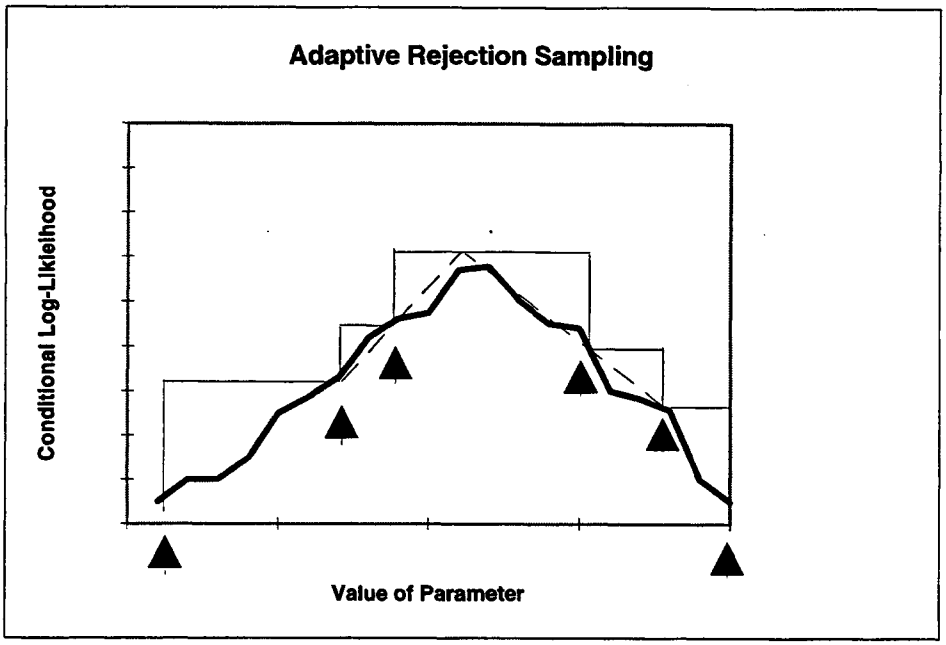

Appendix Figure 1. Construction of upper envelope function for adaptive rejection sampling. Bold line, conditional probability distribution of unknown form. Fine lines, constructed upper envelope function. Dashed line, construction lines. Arrows show the points at which the function has been evaluated. New points are added and the envelope readjusted until a sample has been taken from the conditional distribution, which typically takes 5 to 8 function evaluations.

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