Advisory Committee on Fishery Management

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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



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# 7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

## 7.1 The Fishery in 1993

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 52,588 t, which represents a decrease of 8 % compared with 1993 catches. This indicates a breaking in the increasing trend observed in the catches since 1991. The catch by country and by gear is shown in Table 7.1. It indicates that the drop is due to a decrease in the catches from Portuguese trawl and artisanal fleets. The proportion of the catches by gear has changed, decreasing trawl catches ( 27 %) and increasing ( 29 %) the purse seine catches. This increase was more evident in Spain, possibly due to the end of the sardine closed season for purse seiners in Sub-divisions VIIIc West and IXa North during the first quarter of the last three years. The closed season for sardine was also affecting the catches of horse mackerel.

In this area the catches of horse mackerel are relatively uniform over the year (Borges *et al.* 1995). Although the second and third quarters show relatively higher catches than the first and fourth (see Table 7.2).

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus*, 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 4.4).

Figure 7.1 shows the evolution of the catches from 1965 to 1994.

## 7.2 Effort and Catch per Unit Effort

Table 7.3 presents the commercial catch rates from the trawl fleet fishing in Sub-divisions of IXa Central North, 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 1994. In 1994 the catch rate of the trawl fleet in Sub-division VIIIc West was 32 % lower than the catch rate obtained in 1993. On the contrary, the Aviles trawl fleet operating in Sub-division VIIIc East presents a catch rate much higher (92 %) than in previous year being one of the highest in the series. These changes do not seem to be of higher magnitude than others registered in the past (Table 7.3). Horse mackerel trawl catch rates of 1992, 1993 and 1994 from the Portuguese trawl fleet fishing in Division IXa are not available, because the effort data series is under revision.

Table 7.4 indicates the catch rates from research vessel surveys in Kg per tow, for comparison with the total biomass trend. No data are available in 1994 from the Portuguese short series in winter time. The 1994 June-July survey indicates an biomass index higher than the previous year while in October in the Portuguese area the biomass index was shown to be much lower compared with 1993. This biomass index was confirmed to indicated an extremely high value as compared with the rest of the series. The Spanish October survey showed a similar level in the biomass since 1992. The Portuguese and Spanish area was covered at the same time of the year which was Sept./October in the Spanish northern Sub-divisions and October/November in the Portuguese southern Sub-divisions. The biomass indices estimated in the Portuguese area from the June/July survey series and, in the Spanish area, from the September/October survey series are in good agreement.

### 7.2.1 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 1994. The extremely strong 1982 year class is still very prominent in the data for both fleets at age group 12 (Table 7.5). In 1994 the 1986 and 1987 year classes were confirmed as being strong, giving high indices of abundance in both fleets. In the same way the 1988 and 1992 cohorts are noticeable too.

## 7.3 Fishery Independent Information

### 7.3.1 Trawl surveys

Table 7.6 shows the number at age per hour 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 IX a North (Spain) from 20-500 m depth and, Sub-divisions IX a 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 Anon. (1991). The Portuguese March survey is a new series started in 1992. Only data from 1992 and 1993 are available at present. 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 (Anon. 1993b). 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 1994 and the Portuguese October survey, from 1981-1994. Both are carried out during the recruitment season. In these surveys the recruitment (age 0) values in 1994 are very different with extremely high level in the Spanish survey whereas in the Portuguese survey it was the lowest one in the series. In the Spanish Sept./Oct. survey in 1994 the 1986 year class is confirmed to be a strong one (Table 7.6). In the Portuguese July survey the year classes posterior to that of 1986 are well represented in 1994. The 1982 year class is conspicuous in all the survey series but is stronger in the Spanish bottom trawl survey.

### 7.3.2 Egg surveys

Results of the Southern area egg Surveys are given in section 4.2.2. The provisional estimate of SSB from those surveys is very low, 46,450 tonnes and is considerably different from the 1992 DEPM estimate of 758,000 tonnes.

## 7.4 Catch in Numbers at Age

The catch in numbers at age for 1994 are presented by quarter and area, disaggregated by Sub-division in Table 7.7. Table 7.13 and Figure 7.2 presents the catch in numbers by year. The 1982 year class is well represented in the catch in numbers at age matrix. The 1986 year class is also strong but does not reach the level of the 1982 year class. The 1992 year class seems to be well represented in the catches too.

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 1.5. The data before 1985 have not yet been revised according to the approved ageing methodology.

## 7.5 Mean Length at Age and Mean Weight at Age

Tables 7.8 and 7.9 show the 1994 mean lengths and mean weights at age in the catch by quarter and Subdivision. Table 7.10 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. Figure 7.3 presents the weight at age over the period 1985-1994.

## 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 (Table 7.11).

## 7.7 Fishing Mortality and Tuning of the VPA

Fishing mortality coefficients were estimated using Extended Survivors Analysis (XSA) as shown in the following steps:

1. *To explore the exploitation patterns for the stock and obtain guidance on the age at which catchability is independent of age, separable VPAs were run using terminal S=1.2, and an arbitrary terminal F, which was set at the level of last year's assessment.*

   The exploitation pattern to which this stock is subject is complex, with high selection on the younger and older ages and a reduced availability of 4-6 years old fish. Therefore catchability was assumed to be independent of age for ages equal or greater than 9 years old.
2. *XSA shrunk to the mean with a standard error of 1.0 for the two fleets and three surveys altogether:*

   The two October survey series presented very high residuals in the analysis. The Spanish September/October Survey and the Portuguese October/November Surveys were therefore excluded from the analysis.
3. *XSA shrunk to the mean with standard error of 1.0 including the two Spanish trawl fleets and the Portuguese July Survey and collapsing the plus group at 13, 12 and 11 was run to analyse the sensitivity of the data:*

   Given the reduced availability of 4-6 years old fish, the plus group has to be set at the region where the older ages show constant catchability, allowing the model to shrunk towards the mean F of the oldest ages. By this reason the plus group was set at 12 age group, which is consistent with last year's assessment.

   Extended Survivors Analysis (XSA) runs with differing levels of shrinkage (0.5 and 1.0) were performed last year (Anon. 1995) revealing that the strength of shrinkage has a significant effect on the standard errors of the log catchability. Stronger shrinkage (lower cv's ) increased the standard errors for all fleets.

4. *Retrospective analysis for 1994 and 1993 (Figure 7.4) illustrates the results of the fishing mortality estimates using XSA shrunk to the mean with cv of 1.0, plus group at age 12, including the two Spanish trawl fleets and the Portuguese July Survey.*

   Retrospective analysis was also performed without including the short series of the Portuguese July Survey in the XSA assessment holding all the other parameters constant (Figure 7.5), which shows similar trends.

It may be seen that for the reference F bar (2-9) the estimate shows extremely close agreement between years. The residual patterns were also examined for F bar (0-3) and F bar (7-11) 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. At these ages the retrospective patterns show greater variation from year to year.

The F of the younger ages is generally underestimated by the assessment and F of the older ages over estimated. Taking a mean F over all the ages (2-9) averages the biases. As it was described in Anon. (1995b), strong shrinkage in XSA assessment will reduce the accuracy of the estimated parameters.

5. *Terminal Fishing mortality were derived from XSA, including the two Spanish trawl fleets and the Portuguese July Survey, shrunk to the mean at s.e. equal to 1.0 and plus group 12, which is consistent with last year's assessment. That was used has the final assessment.*

The tuning diagnostics and final results are given in Tables 7.12-7.16. Figure 7.6 indicates the fish stock summary trends over the period 1985-1994 according to the final assessment.

### 7.8 Recruitment

The October survey series which was carried out at the time of recruitment does not show any detectable relationship between the survey and cohort strength. In 1994 the Spanish October survey indicates high recruitment at age 0 and the Portuguese October Survey estimated low recruitment for the 1994 year class (Table 7.6). Therefore the recruitment of 0-group in 1995 was taken as the geometric mean of 1985-1992 period which corresponds to 1442 million fish.

### 7.9 Catch Predictions

The terminal population in 1994 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 1985-1994. For the prediction smoothed values of the weight-at-age of the catch were used taking the average from 1990-1994. The exploitation pattern was taken as the arithmetic mean of the last three years rescaled to the level of the 1994 F bar of the final Fishing mortality estimates (Table 7.14). Table 7.17 gives the input parameters and Tables 7.19a-c and Figure 7.7D show the results of the short term predictions of the catch and spawning stock biomass.

At $F_{status\ quo}$ (F94) the expected catch in weight for 1995 is 63, 866 tonnes. In 1996, assuming, the same recruitment level, the catch at $F_{status\ quo}$ is predicted to be 57, 844 tonnes. The spawning stock biomass would increase from 159 thousand tonnes in 1994 to 190 thousand tonnes in 1995 at F status quo level and to 188 thousand tonnes if the agreed TAC of 73 thousand tonnes is taken in 1995. The spawning stock biomass is expected to increase in 1996, at $F_{status\ quo}$ to 206 thousand tonnes. The spawning stock biomass increases because the 1993, 1992, 1991, 1987, 1986 year classes which are of good strength contribute to the biomass in the next years.

### 7.10 Short-Term and Medium Term Risk Analysis

An attempt was made to estimate the probability (risk) of stock biomass, catches and fishing mortality passing a certain level were to be carried out for this stock using the ICPROJ described in Patterson, (WD 1995). However problems were encountered when using the output files from the final XSA to start the risk analysis. These format problems could not be solved during this meeting. As there was insufficient time to properly evaluate other methods, it was not possible to present a medium term prediction for this stock.

### 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 7.17 are shown in Figure 7.7. Table 7.18 presents the yield per recruit summary table. $F_{0.1}$ at reference age (1-11) is estimated to be 0.09, and $F_{max}$ to be 0.19, which approximately corresponds to the level observed in 1994 (0.21).

The biological reference points were estimated and shown in Figure 7.8 which gives the plot of spawning stock biomass versus the following year recruitment at age 0, from the final VPA. The estimated $F_{med}$ value is 0.26 and $F_{high}$ corresponds to 0.45. The present level of $F_{status\ quo}$ of 0.21 is below the $F_{med}$ level.

### 7.12 Comments on Assessment

This assessment is consistent with last year's assessment. As explained in last year report (Anon.1995) the new diagnostics implemented for XSA showed much better than in previous years the effect of including or excluding each fleet. Because of this the two October Survey series which presented high residuals were not included and this improved the fit of the model to the data. Furthermore the peculiar exploitation pattern was well fitted by the VPA by adjusting the weight in the "shrinkage to the mean" of XSA. Taking a mean F over all ages averages the biases and the retrospective analysis show close agreement between years as indicated in Figures 7.4-7.5.

## 7.13 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 $F_{status\ quo}$ have been constant over recent years and showed a decrease in 1994. Table 7.20 summarizes several management options at: $F_{status\ quo}$, F corresponding to TAC constant equal to 73 thousand tonnes, F corresponding to TAC 1995 level, and $F_{med.}$

**Table 7.1** Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984-1994 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 |

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

**Table 7.2** 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 |
| 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 |

**Table 7.3** 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 |

**Table 7.4** 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[2] | 5.5[2] | - |
| 1980 | | 20.6[2] | 2.5[2] | - |
| 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[2] | 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[1] | 35.6[1] | 235.3[1] | 18.11[1] |
| 1994 | n.a. | 49.3[1] | 12.4[1] | 21.61[1] |

[1]Covering only part of Divisions IXa+VIIIc, area defined by 41°50' N - 08°00'W, and less than 200 m depth.
[2]Codend mesh size 40 mm.

## Table 7.5 CPUE at age from fleets

HOM-SOTH: Horse mackerel Southern Area (Fishing Areas 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 |

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HOM-SOTH: Horse mackerel Southern Area (Fishing Areas 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 |

## Table 7.6 CPUE at age from surveys

HOM-SOTH: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

FLT03: Oct Pt. Survey, Bottom trawl survey (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 |
|---|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 | 0.000 | 0.000 |
| 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 |

FLT04: Oct Sp. Survey,bottom trawl survey (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 |
|---|---|---|---|---|---|---|---|---|---|
| 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 |

| 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 |

PJS: Jul Pt. Survey, bottom trawl survey

| 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 |

| 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 |

Table 7.7 Catch in numbers ('000) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1994.

| 1994 | VIIIc East | VIIIc West | IXa North | IXa Centr- | IXa Centr- | IXa South | 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 | atch ('000 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1,232 | 8,980 | 8,865 | 2,713 | 4,628 | 261 | 26,679 |
| 2 | 7,782 | 7,671 | 6,663 | 15,134 | 16,317 | 3,231 | 56,798 |
| 3 | 1,012 | 386 | 691 | 13,912 | 6,572 | 1,287 | 23,860 |
| 4 | 161 | 127 | 70 | 3,778 | 866 | 279 | 5,281 |
| 5 | 362 | 386 | 139 | 996 | 528 | 82 | 2,493 |
| 6 | 1,515 | 1,947 | 352 | 522 | 338 | 38 | 4,712 |
| 7 | 2,113 | 2,475 | 449 | 258 | 153 | 16 | 5,464 |
| 8 | 3,036 | 2,590 | 787 | 295 | 166 | 19 | 6,893 |
| 9 | 971 | 464 | 356 | 318 | 151 | 51 | 2,311 |
| 10 | 410 | 243 | 135 | 240 | 106 | 74 | 1,208 |
| 11 | 38 | 2 | 17 | 237 | 95 | 73 | 462 |
| 12 | 1,161 | 605 | 368 | 134 | 48 | 64 | 2,380 |
| 13 | 45 | 7 | 1 | 110 | 39 | 62 | 264 |
| 14 | 6 | 1 | 0 | 111 | 38 | 85 | 241 |
| 15+ | 9 | 1 | 0 | 116 | 36 | 92 | 254 |
| Total | 19,853 | 25,885 | 18,893 | 38,874 | 30,081 | 5,714 | 139,300 |
| Tonnes | 2,892 | 2,367 | 1,227 | 2,516 | 1,456 | 446 | 10,904 |

| | VIIIc East | VIIIc West | IXa North | IXa Centr- | IXa Centr- | IXa South | 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 | atch ('000 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1,581 | 3,004 | 1,578 | 8,852 | 3,165 | 1,411 | 19,591 |
| 2 | 9,692 | 42,839 | 8,704 | 11,157 | 8,271 | 5,125 | 85,788 |
| 3 | 1,723 | 999 | 39 | 11,405 | 8,829 | 6,274 | 29,269 |
| 4 | 484 | 126 | 4 | 2,525 | 946 | 1,044 | 5,129 |
| 5 | 1,212 | 326 | 15 | 970 | 580 | 490 | 3,593 |
| 6 | 3,481 | 1,588 | 382 | 794 | 466 | 448 | 7,159 |
| 7 | 3,574 | 2,340 | 582 | 649 | 375 | 320 | 7,840 |
| 8 | 3,334 | 2,540 | 1,306 | 328 | 223 | 163 | 7,894 |
| 9 | 500 | 462 | 619 | 336 | 191 | 156 | 2,264 |
| 10 | 294 | 232 | 235 | 163 | 74 | 57 | 1,055 |
| 11 | 34 | 0 | 56 | 103 | 45 | 21 | 259 |
| 12 | 944 | 560 | 770 | 80 | 15 | 5 | 2,374 |
| 13 | 11 | 4 | 12 | 63 | 10 | 4 | 104 |
| 14 | 26 | 1 | 0 | 75 | 13 | 4 | 119 |
| 15+ | 0 | 2 | 0 | 110 | 15 | 4 | 131 |
| Total | 26,890 | 55,023 | 14,302 | 37,610 | 23,218 | 15,526 | 172,569 |
| Tonnes | 3,428 | 4,060 | 1,478 | 2,523 | 1,478 | 1,050 | 14,017 |

| | VIIIc East | VIIIc West | IXa North | IXa Centr- | IXa Centr- | IXa South | 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 | atch ('000 |
| 0 | 527 | 450 | 2,300 | 0 | 0 | 0 | 3,277 |
| 1 | 4,268 | 17,102 | 11,694 | 9,218 | 1,951 | 1,704 | 45,937 |
| 2 | 1,523 | 28,269 | 15,863 | 16,428 | 6,616 | 7,815 | 76,514 |
| 3 | 1,068 | 905 | 132 | 10,161 | 5,042 | 5,623 | 22,931 |
| 4 | 926 | 207 | 11 | 3,155 | 1,585 | 1,292 | 7,176 |
| 5 | 1,018 | 379 | 30 | 1,378 | 366 | 310 | 3,481 |
| 6 | 1,468 | 926 | 144 | 1,466 | 356 | 364 | 4,724 |
| 7 | 2,306 | 1,926 | 400 | 1,043 | 254 | 305 | 6,234 |
| 8 | 2,879 | 2,362 | 703 | 739 | 179 | 117 | 6,979 |
| 9 | 438 | 527 | 269 | 585 | 133 | 69 | 2,021 |
| 10 | 111 | 284 | 330 | 564 | 108 | 78 | 1,475 |
| 11 | 30 | 113 | 180 | 514 | 95 | 76 | 1,008 |
| 12 | 346 | 637 | 731 | 848 | 135 | 120 | 2,817 |
| 13 | 1 | 16 | 58 | 334 | 32 | 60 | 501 |
| 14 | 0 | 7 | 12 | 266 | 17 | 43 | 345 |
| 15+ | 1 | 16 | 69 | 302 | 10 | 42 | 440 |
| Total | 16,910 | 54,126 | 32,926 | 47,001 | 16,879 | 18,018 | 185,860 |
| Tonnes | 2,328 | 4,743 | 2,661 | 3,842 | 1,261 | 1,283 | 16,118 |

| | VIIIc East | VIIIc West | IXa North | IXa Centr- | IXa Centr- | IXa South | 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 | atch ('000 |
| 0 | 286 | 108 | 5,579 | 184 | 0 | 1 | 6,158 |
| 1 | 1,867 | 7,401 | 9,988 | 1,277 | 267 | 338 | 21,138 |
| 2 | 2,956 | 14,375 | 12,259 | 6,613 | 5,265 | 4,176 | 45,644 |
| 3 | 66 | 4,939 | 854 | 4,334 | 4,656 | 2,305 | 17,154 |
| 4 | 57 | 1,581 | 55 | 1,608 | 1,856 | 881 | 6,038 |
| 5 | 124 | 419 | 89 | 534 | 445 | 196 | 1,807 |
| 6 | 328 | 555 | 494 | 366 | 199 | 75 | 2,017 |
| 7 | 682 | 712 | 1,294 | 357 | 143 | 14 | 3,202 |
| 8 | 951 | 1,053 | 2,284 | 379 | 147 | 7 | 4,821 |
| 9 | 229 | 163 | 750 | 347 | 120 | 2 | 1,611 |
| 10 | 153 | 122 | 783 | 275 | 70 | 1 | 1,404 |
| 11 | 64 | 81 | 380 | 233 | 58 | 1 | 817 |
| 12 | 284 | 396 | 1,739 | 226 | 49 | 1 | 2,695 |
| 13 | 11 | 46 | 103 | 217 | 44 | 1 | 422 |
| 14 | 2 | 32 | 19 | 205 | 38 | 0 | 296 |
| 15+ | 9 | 49 | 104 | 191 | 32 | 0 | 385 |
| Total | 8,069 | 32,032 | 36,774 | 17,346 | 13,389 | 7,999 | 115,609 |
| Tonnes | 1,048 | 3,281 | 4,014 | 1,540 | 1,125 | 541 | 11,549 |

Table 7.8 Length (cm) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1994.

| 1994 Age | VIIIc East 1'st Q length(cm) | VIIIc West 1'st Q length(cm) | IXa North 1'st Q length(cm) | IXa Centr- 1'st Q length(cm) | IXa Centr- 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 | 11.8 | 11.9 | 13.1 | 14.3 | 14.0 | 14.9 | 12.9 |
| 2 | 19.5 | 17.9 | 17.1 | 17.9 | 17.0 | 17.1 | 17.7 |
| 3 | 24.9 | 25.6 | 24.6 | 19.6 | 18.7 | 19.2 | 19.8 |
| 4 | 26.1 | 26.3 | 26.0 | 21.7 | 22.2 | 21.9 | 22.1 |
| 5 | 26.4 | 26.9 | 26.2 | 24.9 | 25.2 | 24.7 | 25.6 |
| 6 | 29.4 | 28.6 | 29.8 | 26.0 | 26.1 | 25.7 | 28.5 |
| 7 | 29.7 | 29.2 | 30.5 | 27.5 | 27.2 | 27.3 | 29.4 |
| 8 | 30.9 | 29.9 | 32.0 | 30.0 | 29.9 | 30.6 | 30.6 |
| 9 | 31.9 | 31.4 | 32.5 | 31.4 | 31.0 | 34.3 | 31.8 |
| 10 | 32.0 | 31.0 | 32.5 | 32.3 | 31.7 | 35.7 | 32.1 |
| 11 | 35.5 | 35.5 | 35.5 | 33.6 | 33.5 | 36.1 | 34.2 |
| 12 | 33.0 | 30.4 | 34.0 | 35.0 | 34.8 | 36.7 | 32.8 |
| 13 | 39.5 | 39.5 | 39.5 | 35.7 | 35.1 | 36.8 | 36.6 |
| 14 | 40.5 | 40.5 | 0.0 | 36.5 | 35.7 | 37.1 | 36.7 |
| 15+ | 41.9 | 42.2 | 0.0 | 37.1 | 36.0 | 37.2 | 37.2 |
| 0-15 | 24.8 | 19.9 | 17.5 | 19.6 | 17.7 | 19.6 | 19.7 |

| Age | VIIIc East 2'nd Q length(cm) | VIIIc West 2'nd Q length(cm) | IXa North 2'nd Q length(cm) | IXa Centr- 2'nd Q length(cm) | IXa Centr- 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 | 14.1 | 14.2 | 14.2 | 15.8 | 16.3 | 16.4 | 15.4 |
| 2 | 17.1 | 18.0 | 16.6 | 17.9 | 18.0 | 18.4 | 17.8 |
| 3 | 25.4 | 24.7 | 24.7 | 19.4 | 18.5 | 19.1 | 19.6 |
| 4 | 26.2 | 26.3 | 26.4 | 22.6 | 23.1 | 22.9 | 23.2 |
| 5 | 26.7 | 26.7 | 27.0 | 25.8 | 25.8 | 25.8 | 26.2 |
| 6 | 28.1 | 28.7 | 31.2 | 27.3 | 27.3 | 27.3 | 28.2 |
| 7 | 29.0 | 29.3 | 31.4 | 28.5 | 28.5 | 28.5 | 29.2 |
| 8 | 29.7 | 29.8 | 32.2 | 30.0 | 29.8 | 29.8 | 30.2 |
| 9 | 31.7 | 31.4 | 32.5 | 30.8 | 30.5 | 30.5 | 31.6 |
| 10 | 31.5 | 30.7 | 33.2 | 31.8 | 31.7 | 31.3 | 31.7 |
| 11 | 35.5 | 0.0 | 35.5 | 32.9 | 32.9 | 32.8 | 33.8 |
| 12 | 31.7 | 30.3 | 34.3 | 34.6 | 33.6 | 33.3 | 32.3 |
| 13 | 39.5 | 39.5 | 39.5 | 35.1 | 33.5 | 33.2 | 36.0 |
| 14 | 40.5 | 40.5 | 0.0 | 36.0 | 34.6 | 33.2 | 36.8 |
| 15+ | 0.0 | 41.8 | 0.0 | 36.9 | 34.8 | 33.4 | 36.6 |
| 0-15 | 23.6 | 19.6 | 20.8 | 19.2 | 19.0 | 19.8 | 20.2 |

| Age | VIIIc East 3'rd Q length (cm) | VIIIc West 3'rd Q length (cm) | IXa North 3'rd Q length (cm) | IXa Centr- 3'rd Q length (cm) | IXa Centr- 3'rd Q length (cm) | IXa South 3'rd Q length (cm) | All areas 3'rd Q length(cm) |
|---|---|---|---|---|---|---|---|
| 0 | 13.7 | 15.7 | 13.4 | 0.0 | 0.0 | 0.0 | 13.8 |
| 1 | 15.6 | 17.6 | 17.8 | 17.4 | 18.0 | 18.7 | 17.5 |
| 2 | 21.4 | 20.5 | 20.2 | 18.7 | 19.3 | 19.4 | 19.9 |
| 3 | 25.5 | 24.3 | 24.0 | 19.5 | 19.8 | 19.7 | 20.1 |
| 4 | 26.7 | 27.4 | 27.1 | 22.3 | 21.6 | 21.4 | 22.7 |
| 5 | 27.9 | 28.5 | 29.5 | 25.1 | 24.8 | 25.1 | 26.3 |
| 6 | 29.1 | 29.9 | 31.4 | 26.6 | 26.6 | 26.7 | 28.2 |
| 7 | 29.9 | 30.4 | 32.1 | 27.4 | 27.4 | 27.3 | 29.6 |
| 8 | 29.9 | 30.9 | 32.9 | 28.8 | 28.8 | 28.3 | 30.3 |
| 9 | 30.9 | 31.9 | 33.9 | 29.7 | 29.5 | 29.5 | 31.1 |
| 10 | 33.3 | 34.1 | 34.9 | 31.0 | 30.3 | 31.5 | 32.6 |
| 11 | 34.2 | 34.9 | 35.8 | 31.3 | 30.8 | 32.0 | 32.6 |
| 12 | 31.1 | 33.6 | 35.8 | 31.6 | 30.9 | 32.2 | 33.1 |
| 13 | 37.7 | 37.6 | 38.2 | 33.6 | 31.6 | 34.0 | 34.2 |
| 14 | 0.0 | 39.6 | 38.7 | 35.4 | 32.1 | 34.8 | 35.4 |
| 15+ | 38.9 | 39.2 | 39.3 | 36.8 | 33.1 | 35.4 | 37.1 |
| 0-15 | 24.5 | 21.1 | 20.2 | 20.6 | 20.4 | 20.4 | 21.0 |

| Age | VIIIc East 4'th Q length(cm) | VIIIc West 4'th Q length(cm) | IXa North 4'th Q length(cm) | IXa Centr- 4'th Q length(cm) | IXa Centr- 4'th Q length(cm) | IXa South 4'th Q length(cm) | All areas 4'th Q length(cm) |
|---|---|---|---|---|---|---|---|
| 0 | 13.1 | 16.2 | 12.8 | 14.6 | 0.0 | 13.3 | 13.0 |
| 1 | 17.5 | 17.7 | 16.5 | 16.6 | 19.5 | 18.3 | 17.1 |
| 2 | 20.9 | 21.6 | 21.4 | 19.6 | 19.9 | 19.3 | 20.8 |
| 3 | 24.7 | 24.9 | 24.2 | 21.2 | 21.3 | 21.1 | 22.4 |
| 4 | 27.4 | 25.9 | 25.9 | 22.6 | 22.5 | 22.5 | 23.5 |
| 5 | 28.7 | 27.5 | 30.5 | 25.0 | 24.3 | 24.2 | 25.9 |
| 6 | 30.3 | 28.6 | 31.5 | 26.2 | 25.9 | 25.3 | 28.8 |
| 7 | 30.9 | 30.1 | 32.1 | 28.1 | 27.9 | 26.3 | 30.7 |
| 8 | 31.4 | 29.9 | 32.6 | 28.9 | 28.8 | 26.8 | 31.4 |
| 9 | 32.3 | 32.1 | 33.6 | 30.3 | 29.9 | 26.9 | 32.3 |
| 10 | 34.0 | 35.2 | 34.7 | 31.9 | 30.8 | 27.6 | 33.9 |
| 11 | 35.1 | 36.8 | 35.5 | 32.1 | 30.8 | 27.6 | 34.3 |
| 12 | 34.2 | 35.4 | 35.6 | 32.9 | 31.3 | 29.0 | 35.1 |
| 13 | 38.2 | 38.5 | 37.8 | 33.4 | 31.7 | 29.5 | 35.0 |
| 14 | 40.2 | 40.8 | 38.8 | 33.9 | 32.0 | 0.0 | 34.8 |
| 15+ | 38.6 | 39.0 | 38.2 | 34.3 | 32.3 | 0.0 | 35.9 |
| 0-15 | 23.7 | 22.4 | 21.5 | 21.9 | 21.5 | 20.3 | 21.9 |

Table 7.9 Weight (g) at age by quarter and by sub-division of SOUTHERN HORSE MACKEREL in 1994.

| 1994 Age | VIIIc East 1'st Q weight(g) | VIIIc West 1'st Q weight(g) | IXa North 1'st Q weight(g) | IXa Centr- 1'st Q weight(g) | IXa Centr- 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 | 15 | 16 | 20 | 24 | 22 | 27 | 19 |
| 2 | 64 | 50 | 46 | 47 | 41 | 40 | 47 |
| 3 | 126 | 135 | 121 | 61 | 53 | 57 | 64 |
| 4 | 143 | 147 | 142 | 81 | 87 | 84 | 86 |
| 5 | 148 | 156 | 145 | 123 | 128 | 120 | 134 |
| 6 | 204 | 187 | 213 | 139 | 141 | 135 | 185 |
| 7 | 209 | 198 | 227 | 166 | 161 | 163 | 202 |
| 8 | 233 | 212 | 257 | 217 | 214 | 230 | 227 |
| 9 | 255 | 243 | 267 | 248 | 238 | 322 | 254 |
| 10 | 257 | 235 | 270 | 270 | 255 | 363 | 263 |
| 11 | 344 | 344 | 344 | 304 | 300 | 374 | 319 |
| 12 | 286 | 223 | 310 | 345 | 336 | 390 | 281 |
| 13 | 466 | 466 | 466 | 363 | 345 | 394 | 388 |
| 14 | 500 | 500 | 0 | 386 | 361 | 401 | 391 |
| 15+ | 553 | 562 | 0 | 406 | 372 | 406 | 407 |
| 0-15+ | 146 | 91 | 65 | 68 | 50 | 78 | 80 |

| Age | VIIIc East 2'nd Q weight(g) | VIIIc West 2'nd Q weight(g) | IXa North 2'nd Q weight(g) | IXa Centr- 2'nd Q weight(g) | IXa Centr- 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 | 25 | 26 | 26 | 32 | 35 | 35 | 31 |
| 2 | 49 | 51 | 40 | 47 | 47 | 50 | 49 |
| 3 | 133 | 122 | 122 | 59 | 51 | 56 | 63 |
| 4 | 145 | 145 | 148 | 93 | 98 | 97 | 101 |
| 5 | 152 | 153 | 158 | 137 | 137 | 137 | 144 |
| 6 | 178 | 189 | 241 | 162 | 161 | 162 | 180 |
| 7 | 194 | 200 | 244 | 183 | 184 | 183 | 198 |
| 8 | 208 | 210 | 262 | 213 | 209 | 209 | 218 |
| 9 | 251 | 242 | 269 | 231 | 225 | 223 | 247 |
| 10 | 246 | 227 | 285 | 253 | 252 | 243 | 252 |
| 11 | 344 | 0 | 344 | 282 | 281 | 279 | 303 |
| 12 | 256 | 220 | 317 | 326 | 299 | 290 | 270 |
| 13 | 466 | 466 | 466 | 344 | 296 | 287 | 369 |
| 14 | 500 | 500 | 0 | 372 | 331 | 288 | 394 |
| 15+ | 0 | 549 | 0 | 400 | 335 | 293 | 392 |
| 0-15+ | 129 | 74 | 103 | 65 | 60 | 68 | 81 |

| Age | VIIIc East 3'rd Q weight (g) | VIIIc West 3'rd Q weight (g) | IXa North 3'rd Q weight (g) | IXa Centr- 3'rd Q weight (g) | IXa Centr- 3'rd Q weight (g) | IXa South 3'rd Q weight (g) | All areas 3'rd Q weight(g) |
|---|---|---|---|---|---|---|---|
| 0 | 24 | 34 | 22 | 0 | 0 | 0 | 24 |
| 1 | 34 | 48 | 49 | 42 | 47 | 53 | 46 |
| 2 | 83 | 73 | 70 | 52 | 57 | 58 | 65 |
| 3 | 134 | 116 | 112 | 60 | 62 | 61 | 67 |
| 4 | 154 | 165 | 161 | 89 | 81 | 79 | 96 |
| 5 | 173 | 184 | 205 | 126 | 122 | 127 | 147 |
| 6 | 196 | 213 | 244 | 150 | 151 | 151 | 180 |
| 7 | 212 | 223 | 259 | 164 | 164 | 161 | 206 |
| 8 | 212 | 233 | 279 | 189 | 189 | 181 | 222 |
| 9 | 233 | 257 | 303 | 209 | 203 | 204 | 239 |
| 10 | 288 | 307 | 329 | 238 | 221 | 250 | 275 |
| 11 | 309 | 328 | 354 | 244 | 232 | 262 | 275 |
| 12 | 239 | 299 | 354 | 251 | 233 | 265 | 287 |
| 13 | 410 | 407 | 425 | 302 | 250 | 313 | 318 |
| 14 | 0 | 469 | 442 | 355 | 263 | 335 | 353 |
| 15+ | 449 | 459 | 461 | 399 | 303 | 352 | 404 |
| 0-15+ | 139 | 88 | 81 | 80 | 71 | 71 | 86 |

| Age | VIIIc East 4'th Q weight(g) | VIIIc West 4'th Q weight(g) | IXa North 4'th Q weight(g) | IXa Centr- 4'th Q weight(g) | IXa Centr- 4'th Q weight(g) | IXa South 4'th Q weight(g) | All areas 4'th Q weight(g) |
|---|---|---|---|---|---|---|---|
| 0 | 21 | 36 | 19 | 27 | 0 | 22 | 20 |
| 1 | 46 | 48 | 39 | 38 | 59 | 50 | 43 |
| 2 | 76 | 85 | 82 | 61 | 63 | 58 | 75 |
| 3 | 123 | 125 | 116 | 75 | 77 | 75 | 92 |
| 4 | 165 | 141 | 141 | 93 | 91 | 91 | 106 |
| 5 | 189 | 167 | 226 | 124 | 115 | 113 | 140 |
| 6 | 221 | 187 | 246 | 144 | 139 | 129 | 192 |
| 7 | 234 | 216 | 258 | 176 | 173 | 144 | 230 |
| 8 | 244 | 213 | 272 | 192 | 190 | 151 | 245 |
| 9 | 265 | 262 | 295 | 222 | 214 | 156 | 265 |
| 10 | 306 | 338 | 324 | 260 | 232 | 167 | 306 |
| 11 | 334 | 383 | 345 | 264 | 233 | 167 | 317 |
| 12 | 314 | 346 | 348 | 286 | 245 | 193 | 337 |
| 13 | 426 | 433 | 411 | 299 | 242 | 203 | 338 |
| 14 | 491 | 512 | 444 | 314 | 260 | 0 | 338 |
| 15+ | 439 | 450 | 424 | 322 | 266 | 0 | 364 |
| 0-15+ | 130 | 102 | 109 | 95 | 82 | 69 | 101 |

## Table 7.10 Southern horse mackerel mean weight at age

HOM-SOTH: Horse mackerel Southern Area (Fishing Areas 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 |

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HOM-SOTH: Horse mackerel Southern Area (Fishing Areas 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 |

## Table 7.11.- Proportion mature at year start

HOM-SOTH: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

MATPROP: Proportion Mature at Year Start

| 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 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1982 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1983 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1984 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1985 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1986 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1987 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1988 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1989 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1990 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1991 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1992 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1993 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1994 | 0.00 | 0.00 | 0.04 | 0.27 | 0.63 | 0.81 | 0.90 | 0.95 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

## Table 7.12 XSA diagnostics

```
Extended Survivors Analysis

Horse mackerel South (run: FATIMAB7/B09)

CPUE data from file /users/fish/ifad/ifapwork/wgmhsa/hom_soth/FLEET.B09

Catch data for  10 years. 1985 to 1994. Ages  0 to  12.

     Fleet,           First, Last, First, Last, Alpha,  Beta
                       year, year,  age ,  age
FLT01: 8c West trawl,  1985, 1994,   0,    11,   .000,  1.000
FLT02: 8c East trawl,  1985, 1994,   0,    11,   .000,  1.000
PJS: Jul Pt. Survey,,  1989, 1994,   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   50 iterations


Total absolute residual between iterations
49 and  50 =     .00314

Final year F values
Age            ,      0,      1,      2,      3,      4,      5,      6,      7,      8,      9
Iteration 49,  .0127,  .0840,  .3065,  .0784,  .2239,  .1125,  .1068,  .1387,  .1653,  .2947
Iteration 50,  .0127,  .0839,  .3069,  .0784,  .2221,  .1124,  .1067,  .1388,  .1655,  .2948


Age            ,     10,     11
Iteration 49,  .2645,  .5787
Iteration 50,  .2644,  .5788
```

## Table 7.12 XSA diagnostics

Regression weights

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

Fishing mortalities

| Age, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0, | .301, | .286, | .044, | .127, | .313, | .078, | .012, | .031, | .007, | .013 |
| 1, | .457, | .581, | .488, | .313, | .229, | .341, | .147, | .135, | .083, | .084 |
| 2, | .234, | .248, | .455, | .119, | .118, | .211, | .230, | .335, | .168, | .307 |
| 3, | .055, | .266, | .253, | .168, | .156, | .132, | .068, | .247, | .525, | .078 |
| 4, | .133, | .107, | .171, | .121, | .226, | .079, | .097, | .076, | .252, | .222 |
| 5, | .109, | .192, | .091, | .168, | .185, | .120, | .079, | .085, | .103, | .112 |
| 6, | .080, | .133, | .216, | .135, | .270, | .115, | .156, | .087, | .104, | .107 |
| 7, | .168, | .402, | .136, | .250, | .100, | .228, | .193, | .221, | .160, | .139 |
| 8, | .132, | .428, | .127, | .209, | .244, | .196, | .322, | .215, | .276, | .165 |
| 9, | .196, | .323, | .217, | .386, | .423, | .314, | .238, | .619, | .462, | .295 |
| 10, | .242, | .399, | .168, | .739, | .903, | .314, | .495, | .292, | .623, | .264 |
| 11, | .481, | .575, | .150, | .529, | .678, | .757, | .463, | .562, | .317, | .579 |

## Table 7.12 XSA diagnostics

XSA population numbers (Thousands)

| YEAR | AGE 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1985 | 1.63E+06 | 8.73E+05 | 4.38E+05 | 1.60E+06 | 2.26E+05 | 1.53E+05 | 9.98E+04 | 5.14E+04 | 3.47E+04 | 3.79E+04 |
| 1986 | 2.67E+06 | 1.04E+06 | 4.76E+05 | 2.99E+05 | 1.30E+06 | 1.70E+05 | 1.18E+05 | 7.93E+04 | 3.74E+04 | 2.62E+04 |
| 1987 | 1.32E+06 | 1.73E+06 | 5.01E+05 | 3.20E+05 | 1.97E+05 | 1.01E+06 | 1.21E+05 | 8.87E+04 | 4.57E+04 | 2.10E+04 |
| 1988 | 1.10E+06 | 1.09E+06 | 9.12E+05 | 2.74E+05 | 2.14E+05 | 1.43E+05 | 7.92E+05 | 8.39E+04 | 6.67E+04 | 3.46E+04 |
| 1989 | 9.73E+05 | 8.34E+05 | 6.84E+05 | 6.97E+05 | 1.99E+05 | 1.63E+05 | 1.04E+05 | 5.96E+05 | 5.62E+04 | 4.65E+04 |
| 1990 | 6.90E+05 | 6.12E+05 | 5.71E+05 | 5.24E+05 | 5.13E+05 | 1.37E+05 | 1.17E+05 | 6.83E+04 | 4.64E+05 | 3.79E+04 |
| 1991 | 2.86E+06 | 5.49E+05 | 3.75E+05 | 3.98E+05 | 3.95E+05 | 4.08E+05 | 1.04E+05 | 8.93E+04 | 4.68E+04 | 3.28E+05 |
| 1992 | 1.63E+06 | 2.43E+06 | 4.08E+05 | 2.56E+05 | 3.20E+05 | 3.08E+05 | 3.25E+05 | 7.69E+04 | 6.34E+04 | 2.92E+04 |
| 1993 | 1.78E+06 | 1.36E+06 | 1.83E+06 | 2.51E+05 | 1.72E+05 | 2.55E+05 | 2.44E+05 | 2.56E+05 | 5.31E+04 | 4.40E+04 |
| 1994 | 8.07E+05 | 1.52E+06 | 1.08E+06 | 1.33E+06 | 1.28E+05 | 1.15E+05 | 1.98E+05 | 1.89E+05 | 1.88E+05 | 3.47E+04 |

Estimated population abundance at 1st Jan 1995

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | .00E+00 | 6.87E+05 | 1.20E+06 | 6.83E+05 | 1.06E+06 | 8.87E+04 | 8.88E+04 | 1.53E+05 | 1.42E+05 | 1.37E+05 |

Taper weighted geometric mean of the VPA populations:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1.38E+06 | 1.10E+06 | 6.49E+05 | 4.62E+05 | 2.80E+05 | 2.24E+05 | 1.75E+05 | 1.19E+05 | 7.30E+04 | 4.32E+04 |

Standard error of the weighted Log(VPA populations) :

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | .4814 | .4770 | .5183 | .6704 | .6594 | .6585 | .6752 | .7535 | .8220 | .7781 |

| YEAR | AGE 10 | 11 |
|---|---|---|
| 1985 | 2.31E+04 | 9.08E+03 |
| 1986 | 2.68E+04 | 1.56E+04 |
| 1987 | 1.63E+04 | 1.55E+04 |
| 1988 | 1.45E+04 | 1.19E+04 |
| 1989 | 2.03E+04 | 5.97E+03 |
| 1990 | 2.62E+04 | 7.07E+03 |
| 1991 | 2.38E+04 | 1.65E+04 |
| 1992 | 2.23E+05 | 1.25E+04 |
| 1993 | 1.35E+04 | 1.43E+05 |
| 1994 | 2.39E+04 | 6.24E+03 |

Estimated population abundance at 1st Jan 1995

| | | |
|---|---|---|
| | 2.22E+04 | 1.58E+04 |

Taper weighted geometric mean of the VPA populations:

| | | |
|---|---|---|
| | 2.62E+04 | 1.37E+04 |

Standard error of the weighted Log(VPA populations) :

| | | |
|---|---|---|
| | .8230 | .9465 |

## Table 7.12 XSA diagnostics

Log catchability residuals.

Fleet : FLT01: 8c West trawl

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -.67 | -1.58 | 2.75 | -1.98 | -7.13 | 4.18 | 2.55 | 99.99 | 99.99 | 1.40 |
| 1 | -.52 | .46 | -.48 | .73 | .89 | .90 | -1.45 | -.01 | -.47 | -.04 |
| 2 | .43 | -.35 | .50 | .38 | -1.07 | .14 | -.48 | -.11 | .24 | .40 |
| 3 | 1.00 | 1.69 | 1.51 | .96 | .66 | -.20 | -2.78 | -.62 | .76 | -2.17 |
| 4 | -.64 | .77 | 1.80 | .60 | .63 | -.15 | -1.05 | -1.62 | .69 | -.76 |
| 5 | .04 | .05 | 1.19 | .40 | .34 | -.72 | -.92 | -.28 | .36 | -.28 |
| 6 | -.04 | -.27 | .77 | .34 | .01 | -.52 | -.30 | -.14 | -.10 | .29 |
| 7 | -.28 | -.61 | .32 | -.19 | -.26 | -.07 | .25 | .13 | .25 | .30 |
| 8 | .00 | -.39 | -.74 | -.47 | -.01 | .14 | .50 | .11 | .39 | .27 |
| 9 | -.12 | -.61 | .09 | -.53 | .68 | -.75 | .03 | .65 | .49 | -.08 |
| 10 | -.27 | .41 | .22 | -.20 | 1.44 | -.14 | .45 | .43 | .14 | -.35 |
| 11 | -.24 | .09 | .04 | -.09 | .00 | -.31 | .03 | .03 | .21 | -.38 |

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 | -18.6587 | -19.5138 | -18.9193 | -18.4306 | -18.0162 | -17.5073 | -17.3392 | -16.8160 | -16.8160 | -16.8160 |
| S.E(Log q) | .5112 | 1.5437 | 1.0500 | .6143 | .3729 | .3081 | .3993 | .5205 | .5813 | .2028 |

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 | -3.38 | -1.454 | -16.79 | .02 | 8 | 4.05 | -23.22 |
| 1 | .56 | .739 | 17.36 | .28 | 10 | .82 | -20.11 |

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 | .77 | .851 | 17.45 | .66 | 10 | .40 | -18.66 |
| 3 | 2.77 | -.780 | 30.98 | .03 | 10 | 4.39 | -19.51 |
| 4 | 1.07 | -.110 | 19.36 | .26 | 10 | 1.20 | -18.92 |
| 5 | .75 | 1.056 | 16.88 | .70 | 10 | .46 | -18.43 |
| 6 | .86 | .810 | 17.20 | .83 | 10 | .33 | -18.02 |
| 7 | .96 | .282 | 17.27 | .87 | 10 | .31 | -17.51 |
| 8 | .89 | .734 | 16.65 | .85 | 10 | .36 | -17.34 |
| 9 | .95 | .235 | 16.48 | .72 | 10 | .52 | -16.82 |
| 10 | .92 | .386 | 16.06 | .74 | 10 | .52 | -16.60 |
| 11 | .87 | 2.865 | 15.93 | .99 | 10 | .12 | -16.88 |

## Table 7.12 XSA diagnostics

Fleet : FLT02: 8c East trawl

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -1.56 | .43 | -1.31 | 2.54 | 2.08 | -.67 | .57 | -1.34 | 99.99 | -.93 |
| 1 | .30 | .00 | -.67 | -.16 | .04 | -.16 | .15 | .31 | -.32 | .49 |
| 2 | 1.31 | .33 | .89 | -1.84 | -1.28 | .69 | 2.08 | -2.19 | -.17 | .50 |
| 3 | .56 | 1.05 | 1.19 | -.75 | -.06 | 1.06 | -.43 | .05 | .87 | -3.09 |
| 4 | -1.03 | .82 | .61 | -.56 | .69 | -.01 | .53 | -.69 | .78 | -1.16 |
| 5 | -.43 | .25 | .93 | -.20 | .59 | -.11 | -.14 | -.20 | -.45 | -.18 |
| 6 | -.18 | -.24 | .78 | .08 | .19 | .10 | -.41 | -.24 | -.69 | .63 |
| 7 | .01 | -.33 | .00 | -.28 | -.23 | .52 | -.36 | -.19 | -.17 | .93 |
| 8 | .48 | -.08 | -.51 | -.05 | -.02 | .49 | -.11 | -.40 | -.66 | .90 |
| 9 | .07 | -.56 | -.01 | .38 | .76 | -.47 | -.66 | .17 | -.11 | .40 |
| 10 | .18 | -.44 | -.18 | 1.02 | 1.72 | .16 | -1.03 | -.22 | -.80 | .18 |
| 11 | -.03 | -1.32 | -.32 | .91 | -.71 | .20 | -1.08 | -.86 | -.44 | .12 |

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 | -16.8960 | -17.5851 | -17.7946 | -17.6824 | -17.6406 | -17.3379 | -17.1607 | -16.5933 | -16.5933 | -16.5933 |
| S.E(Log q) | 1.4146 | 1.3231 | .7858 | .4429 | .4601 | .4289 | .5002 | .4658 | .8351 | .768 |

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 | .71 | .238 | 19.14 | .10 | 9 | 1.64 | -21.18 |
| 1 | -.52 | -5.717 | 12.00 | .66 | 10 | .37 | -17.55 |

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 | 2.83 | -.658 | 23.33 | .02 | 10 | 4.15 | -16.90 |
| 3 | 20.38 | -1.484 | 105.62 | .00 | 10 | 25.20 | -17.59 |
| 4 | .70 | 1.037 | 16.22 | .62 | 10 | .55 | -17.79 |
| 5 | .75 | 1.502 | 16.36 | .84 | 10 | .31 | -17.68 |
| 6 | 1.06 | -.212 | 17.95 | .66 | 10 | .52 | -17.64 |
| 7 | .99 | .041 | 17.29 | .76 | 10 | .45 | -17.34 |
| 8 | .73 | 2.041 | 15.56 | .89 | 10 | .31 | -17.16 |
| 9 | 1.32 | -1.196 | 18.49 | .66 | 10 | .60 | -16.59 |
| 10 | 1.16 | -.374 | 17.57 | .42 | 10 | 1.02 | -16.54 |
| 11 | 1.18 | -.580 | 18.25 | .60 | 10 | .82 | -16.95 |

## Table 7.12 XSA diagnostics

Fleet : PJS: Jul Pt. Survey,

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 99.99 | 99.99 | 99.99 | 99.99 | -.41 | .02 | -.37 | -1.00 | 1.58 | .15 |
| 1 | 99.99 | 99.99 | 99.99 | 99.99 | -.35 | .11 | .18 | .15 | -.08 | -.01 |
| 2 | 99.99 | 99.99 | 99.99 | 99.99 | -.52 | .14 | -.70 | -.01 | .29 | .77 |
| 3 | 99.99 | 99.99 | 99.99 | 99.99 | .14 | -.43 | -2.20 | .14 | 2.28 | .05 |
| 4 | 99.99 | 99.99 | 99.99 | 99.99 | .89 | -.92 | -1.81 | -.89 | .79 | 1.94 |
| 5 | 99.99 | 99.99 | 99.99 | 99.99 | -.23 | -.14 | -1.60 | -1.09 | 1.18 | 1.85 |
| 6 | 99.99 | 99.99 | 99.99 | 99.99 | -.44 | -.50 | -.75 | -1.61 | 1.95 | 1.31 |
| 7 | 99.99 | 99.99 | 99.99 | 99.99 | -1.51 | .10 | -.31 | -.08 | .92 | .81 |
| 8 | 99.99 | 99.99 | 99.99 | 99.99 | -.13 | -1.34 | .26 | -.03 | 1.95 | -.75 |
| 9 | 99.99 | 99.99 | 99.99 | 99.99 | -.15 | -.22 | -1.49 | .85 | .87 | .12 |
| 10 | 99.99 | 99.99 | 99.99 | 99.99 | .01 | -.64 | .51 | -.80 | -.76 | .38 |
| 11 | 99.99 | 99.99 | 99.99 | 99.99 | .51 | .25 | .87 | 1.32 | -3.09 | 1.80 |

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 | -8.9445 | -9.3096 | -9.5737 | -9.8044 | -9.7112 | -9.7485 | -9.4621 | -8.9509 | -8.9509 | -8.9509 |
| S.E(Log q) | .5397 | 1.4419 | 1.4267 | 1.3223 | 1.3591 | .8782 | 1.1236 | .8738 | .6429 | 1.7810 |

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 | -.65 | -2.021 | 16.41 | .28 | 6 | .99 | -10.45 |
| 1 | .41 | 3.444 | 11.69 | .90 | 6 | .22 | -8.57 |

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 | .64 | 1.627 | 10.57 | .84 | 6 | .30 | -8.94 |
| 3 | 2.16 | -.487 | 4.94 | .04 | 6 | 3.38 | -9.31 |
| 4 | -.68 | -4.861 | 14.41 | .68 | 6 | .41 | -9.57 |
| 5 | -1.21 | -1.876 | 15.22 | .15 | 6 | 1.31 | -9.80 |
| 6 | .65 | .383 | 10.51 | .24 | 6 | .98 | -9.71 |
| 7 | 1.51 | -.674 | 8.63 | .31 | 6 | 1.41 | -9.75 |
| 8 | 11.63 | -2.246 | -11.87 | .01 | 6 | 9.68 | -9.46 |
| 9 | 5.96 | -3.296 | -.73 | .10 | 6 | 3.00 | -8.95 |
| 10 | 1.28 | -.774 | 8.84 | .66 | 6 | .80 | -9.17 |
| 11 | -3.59 | -3.733 | 12.74 | .14 | 6 | 3.31 | -8.68 |

## Table 7.12 XSA diagnostics

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1994

| Fleet, | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
|---|---|---|---|---|---|---|---|
| FLT01: 8c West trawl, | 2789331., | 4.334, | .000, | .00, | 1, | .008, | .000 |
| FLT02: 8c East trawl, | 269505., | 1.823, | .000, | .00, | 1, | .045, | .000 |
| PJS: Jul Pt. Survey,, | 798644., | 1.076, | .000, | .00, | 1, | .129, | .000 |
| P shrinkage mean , | 1096620., | .48,,,, | | | | .666, | .008 |
| F shrinkage mean , | 94918., | 1.00,,,, | | | | .152, | .088 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 686962., | .39, | .45, | 5, | 1.151, | .013 |

Age 1 Catchability dependent on age and year class strength

Year class = 1993

| Fleet, | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
|---|---|---|---|---|---|---|---|
| FLT01: 8c West trawl, | 1148723., | .871, | .000, | .00, | 1, | .056, | .088 |
| FLT02: 8c East trawl, | 1968778., | .424, | .000, | .00, | 1, | .235, | .052 |
| PJS: Jul Pt. Survey,, | 1281111., | .293, | .337, | 1.15, | 2, | .492, | .079 |
| P shrinkage mean , | 649173., | .52,,,, | | | | .171, | .150 |
| F shrinkage mean , | 509238., | 1.00,,,, | | | | .046, | .188 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 1202070., | .21, | .22, | 6, | 1.074, | .084 |

## Table 7.12 XSA diagnostics

Age 2 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, | 815356., | .458, | .384, | .84, | 2, | .174, | .263 |
| FLT02: 8c East trawl, | 504928., | .366, | .206, | .56, | 3, | .258, | .396 |
| PJS: Jul Pt. Survey,, | 718426., | .260, | .300, | 1.16, | 3, | .517, | .294 |
| F shrinkage mean , | 1034253., | 1.00,,,, | | | | .051, | .213 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 683120., | .19, | .15, | 9, | .793, | .307 |

Age 3 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, | 1051220., | .444, | .415, | .93, | 4, | .195, | .079 |
| FLT02: 8c East trawl, | 967146., | .406, | .614, | 1.51, | 4, | .217, | .086 |
| PJS: Jul Pt. Survey,, | 1224976., | .257, | .078, | .31, | 4, | .538, | .068 |
| F shrinkage mean , | 340266., | 1.00,,,, | | | | .050, | .226 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 1059800., | .19, | .19, | 13, | .994, | .078 |

Age 4 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, | 62306., | .461, | .325, | .71, | 5, | .194, | .301 |
| FLT02: 8c East trawl, | 60725., | .374, | .391, | 1.05, | 5, | .295, | .308 |
| PJS: Jul Pt. Survey,, | 123639., | .263, | .303, | 1.15, | 5, | .426, | .163 |
| F shrinkage mean , | 139229., | 1.00,,,, | | | | .086, | .146 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 88709., | .20, | .19, | 16, | .959, | .222 |

Age 5 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, | 75946., | .372, | .245, | .66, | 6, | .254, | .130 |
| FLT02: 8c East trawl, | 92407., | .308, | .226, | .73, | 6, | .391, | .108 |
| PJS: Jul Pt. Survey,, | 96475., | .267, | .285, | 1.07, | 6, | .302, | .104 |
| F shrinkage mean , | 87019., | 1.00,,,, | | | | .053, | .114 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 88791., | .18, | .13, | 19, | .723, | .112 |

## Table 7.12 XSA diagnostics

Age 6 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, | 173093., | .267, | .267, | 1.00, | 7, | .346, | .095 |
| FLT02: 8c East trawl, | 157955., | .246, | .222, | .90, | 7, | .380, | .104 |
| PJS: Jul Pt. Survey,, | 129101., | .262, | .290, | 1.11, | 6, | .243, | .126 |
| F shrinkage mean , | 109274., | 1.00,,,, | | | | .031, | .147 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 153458., | .15, | .14, | 21, | .923, | .107 |

Age 7 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, | 137660., | .208, | .173, | .83, | 8, | .481, | .143 |
| FLT02: 8c East trawl, | 151957., | .220, | .251, | 1.14, | 8, | .396, | .130 |
| PJS: Jul Pt. Survey,, | 133356., | .431, | .454, | 1.05, | 6, | .097, | .147 |
| F shrinkage mean , | 106202., | 1.00,,,, | | | | .027, | .181 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 141720., | .14, | .13, | 23, | .929, | .139 |

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

Year class = 1986

| Fleet, | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
|---|---|---|---|---|---|---|---|
| FLT01: 8c West trawl, | 148224., | .188, | .122, | .65, | 9, | .517, | .154 |
| FLT02: 8c East trawl, | 134781., | .208, | .185, | .89, | 9, | .394, | .168 |
| PJS: Jul Pt. Survey,, | 96209., | .539, | .452, | .84, | 6, | .063, | .228 |
| F shrinkage mean , | 86174., | 1.00,,,, | | | | .026, | .252 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 136982., | .13, | .10, | 25, | .761, | .165 |

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

Year class = 1985

| Fleet, | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
|---|---|---|---|---|---|---|---|
| FLT01: 8c West trawl, | 23495., | .188, | .108, | .57, | 10, | .489, | .281 |
| FLT02: 8c East trawl, | 20103., | .209, | .138, | .66, | 10, | .401, | .321 |
| PJS: Jul Pt. Survey,, | 31387., | .509, | .360, | .71, | 6, | .075, | .217 |
| F shrinkage mean , | 14882., | 1.00,,,, | | | | .035, | .413 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 22203., | .13, | .09, | 27, | .634, | .295 |

## Table 7.12 XSA diagnostics

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

Year class = 1984

| Fleet, | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
|---|---|---|---|---|---|---|---|
| FLT01: 8c West trawl, | 16176., | .187, | .124, | .66, | 10, | .478, | .258 |
| FLT02: 8c East trawl, | 15165., | .207, | .115, | .56, | 10, | .362, | .274 |
| PJS: Jul Pt. Survey,, | 21087., | .444, | .176, | .40, | 6, | .120, | .204 |
| F shrinkage mean , | 6851., | 1.00,,,, | | | | .040, | .528 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 15760., | .13, | .08, | 27, | .598, | .264 |

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

Year class = 1983

| Fleet, | Estimated, Survivors, | Int, s.e, | Ext, s.e, | Var, Ratio, | N, | Scaled, Weights, | Estimated F |
|---|---|---|---|---|---|---|---|
| FLT01: 8c West trawl, | 2604., | .205, | .120, | .59, | 10, | .637, | .646 |
| FLT02: 8c East trawl, | 3161., | .267, | .125, | .47, | 10, | .222, | .558 |
| PJS: Jul Pt. Survey,, | 2926., | .487, | .413, | .85, | 6, | .076, | .592 |
| F shrinkage mean , | 10994., | 1.00,,,, | | | | .065, | .195 |

Weighted prediction :

| Survivors, at end of year, | Int, s.e, | Ext, s.e, | N, | Var, Ratio, | F |
|---|---|---|---|---|---|
| 3012., | .16, | .11, | 27, | .676, | .579 |

Table 7.13 Catch in numbers by year

HOM-SOTH: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

CANUM: Catch in Numbers (Millions)

| Year | Age 0 | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 | Age 7 |
|---|---|---|---|---|---|---|---|---|
| 1981 | 53.700 | 315.700 | 136.200 | 58.800 | 20.400 | 47.800 | 34.800 | 23.000 |
| 1982 | 104.700 | 122.600 | 115.000 | 77.700 | 27.000 | 22.200 | 28.000 | 28.300 |
| 1983 | 182.300 | 1109.10 | 74.800 | 24.400 | 22.600 | 31.500 | 34.900 | 20.600 |
| 1984 | 12.200 | 71.100 | 459.700 | 40.700 | 3.800 | 8.900 | 21.600 | 20.000 |
| 1985 | 393.697 | 297.486 | 84.887 | 79.849 | 26.197 | 14.665 | 7.075 | 7.363 |
| 1986 | 615.298 | 425.659 | 96.999 | 64.701 | 122.560 | 27.584 | 13.610 | 24.346 |
| 1987 | 53.320 | 618.570 | 170.015 | 66.303 | 28.789 | 81.020 | 21.825 | 10.485 |
| 1988 | 121.951 | 271.052 | 94.945 | 39.364 | 22.598 | 20.507 | 92.897 | 17.212 |
| 1989 | 242.537 | 158.646 | 70.438 | 93.590 | 37.363 | 25.474 | 22.839 | 52.657 |
| 1990 | 48.100 | 164.206 | 100.833 | 60.289 | 35.931 | 14.307 | 11.786 | 12.913 |
| 1991 | 31.786 | 69.544 | 71.451 | 24.222 | 33.833 | 28.678 | 13.952 | 14.578 |
| 1992 | 45.629 | 285.197 | 107.761 | 51.971 | 21.596 | 23.308 | 24.973 | 14.167 |
| 1993 | 10.719 | 101.326 | 262.637 | 95.182 | 35.647 | 23.159 | 22.311 | 35.258 |
| 1994 | 9.435 | 113.345 | 264.744 | 93.214 | 23.624 | 11.374 | 18.612 | 22.740 |

| Year | Age 8 | Age 9 | Age 10 | Age 11 | Age 12 | Age 13 | Age 14 | Age 15 |
|---|---|---|---|---|---|---|---|---|
| 1981 | 24.100 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1982 | 27.600 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1983 | 20.200 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1984 | 18.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1985 | 3.981 | 6.270 | 4.614 | 3.214 | 2.702 | 1.699 | 0.864 | 4.334 |
| 1986 | 12.080 | 6.694 | 8.198 | 6.349 | 5.838 | 3.244 | 2.023 | 2.963 |
| 1987 | 5.042 | 3.795 | 2.337 | 1.999 | 1.666 | 0.951 | 1.029 | 1.906 |
| 1988 | 11.669 | 10.279 | 7.042 | 4.523 | 6.050 | 2.514 | 1.379 | 3.717 |
| 1989 | 11.308 | 14.892 | 11.182 | 2.728 | 2.243 | 4.266 | 1.456 | 3.791 |
| 1990 | 76.713 | 9.463 | 6.562 | 3.481 | 2.568 | 2.017 | 2.430 | 4.409 |
| 1991 | 11.948 | 64.501 | 8.641 | 5.671 | 3.933 | 1.970 | 2.113 | 2.164 |
| 1992 | 11.384 | 12.496 | 52.251 | 4.989 | 4.043 | 2.480 | 1.815 | 4.045 |
| 1993 | 11.881 | 15.094 | 5.813 | 36.062 | 1.653 | 0.879 | 0.823 | 2.304 |
| 1994 | 26.587 | 8.207 | 5.142 | 2.546 | 10.266 | 1.291 | 1.001 | 1.210 |

HOM-SOTH: Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

CATON: Landings (Tonnes)

| Year | Total |
|---|---|
| 1981 | 72235 |
| 1982 | 59336 |
| 1983 | 74313 |
| 1984 | 46297 |
| 1985 | 43535 |
| 1986 | 71258 |
| 1987 | 52747 |
| 1988 | 55888 |
| 1989 | 56396 |
| 1990 | 49207 |
| 1991 | 45511 |
| 1992 | 50956 |
| 1993 | 57428 |
| 1994 | 52588 |

Run title : Horse mackerel South (run: XSA1/OUT)

## Table 7.14

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

| YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, | FBAR 92-94 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 0, | .3008, | .2862, | .0445, | .1275, | .3128, | .0783, | .0124, | .0312, | .0067, | .0126, | .0168, |
| 1, | .4579, | .5814, | .4893, | .3133, | .2300, | .3409, | .1471, | .1398, | .0853, | .0863, | .1038, |
| 2, | .2341, | .2485, | .4557, | .1194, | .1178, | .2120, | .2299, | .3358, | .1750, | .3153, | .2754, |
| 3, | .0554, | .2661, | .2536, | .1687, | .1570, | .1327, | .0682, | .2464, | .5269, | .0821, | .2852, |
| 4, | .1335, | .1071, | .1715, | .1214, | .2265, | .0788, | .0971, | .0759, | .2519, | .2232, | .1837, |
| 5, | .1095, | .1921, | .0908, | .1682, | .1852, | .1200, | .0791, | .0851, | .1034, | .1123, | .1003, |
| 6, | .0796, | .1333, | .2165, | .1354, | .2705, | .1158, | .1561, | .0870, | .1041, | .1072, | .0994, |
| 7, | .1679, | .4021, | .1365, | .2504, | .1003, | .2282, | .1941, | .2222, | .1614, | .1391, | .1742, |
| 8, | .1323, | .4285, | .1268, | .2096, | .2448, | .1968, | .3224, | .2161, | .2777, | .1666, | .2201, |
| 9, | .1967, | .3234, | .2172, | .3860, | .4243, | .3143, | .2388, | .6204, | .4647, | .2969, | .4607, |
| 10, | .2425, | .4007, | .1683, | .7405, | .9047, | .3155, | .4972, | .2929, | .6249, | .2667, | .3948, |
| 11, | .4822, | .5776, | .1504, | .5311, | .6807, | .7596, | .4659, | .5657, | .3186, | .5829, | .4891, |
| +gp, | .4822, | .5776, | .1504, | .5311, | .6807, | .7596, | .4659, | .5657, | .3186, | .5829, | |
| FBAR 1-11, | .2083, | .3328, | .2251, | .2858, | .3220, | .2559, | .2269, | .2625, | .2813, | .2162, | |
| FBAR 0- 3, | .2621, | .3455, | .3108, | .1822, | .2044, | .1910, | .1144, | .1883, | .1985, | .1241, | |
| FBAR 7-11, | .2443, | .4265, | .1598, | .4235, | .4710, | .3629, | .3437, | .3835, | .3694, | .2904, | |

Run title : Horse mackerel South (run: XSA1/OUT)

## Table 7.15

Terminal Fs derived using XSA (With F shrinkage)

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

| YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, | 1995, |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | | |
| 0, | 1633363, | 2665091, | 1319467, | 1098242, | 973275, | 688567, | 2771827, | 1600367, | 1728577, | 812117, | 0, |
| 1, | 872786, | 1040599, | 1723026, | 1086208, | 832126, | 612693, | 548030, | 2356245, | 1335117, | 1477857, | 690204, |
| 2, | 438337, | 475223, | 500750, | 909147, | 683441, | 569035, | 375009, | 407175, | 1763449, | 1055142, | 1171800, |
| 3, | 1597894, | 298527, | 319038, | 273269, | 694425, | 522895, | 396226, | 256485, | 250484, | 1274155, | 665268, |
| 4, | 225912, | 1301241, | 196919, | 213086, | 198685, | 510870, | 394127, | 318563, | 172543, | 127289, | 1016813, |
| 5, | 152425, | 170141, | 1006284, | 142781, | 162440, | 136346, | 406375, | 307840, | 254154, | 115438, | 87996, |
| 6, | 99716, | 117589, | 120851, | 790951, | 103867, | 116180, | 104081, | 323165, | 243336, | 197267, | 88837, |
| 7, | 51342, | 79263, | 88583, | 83769, | 594593, | 68211, | 89063, | 76640, | 254982, | 188743, | 152705, |
| 8, | 34630, | 37360, | 45635, | 66517, | 56132, | 462919, | 46729, | 63132, | 52821, | 186755, | 141401, |
| 9, | 37857, | 26113, | 20949, | 34601, | 46425, | 37823, | 327268, | 29136, | 43777, | 34441, | 136180, |
| 10, | 23095, | 26767, | 16265, | 14510, | 20245, | 26143, | 23775, | 221842, | 13484, | 23676, | 22051, |
| 11, | 9056, | 15597, | 15433, | 11832, | 5956, | 7051, | 16413, | 12447, | 142465, | 6213, | 15627, |
| +gp, | 26860, | 34282, | 42743, | 35465, | 25426, | 22903, | 29266, | 30649, | 22247, | 33325, | 19003, |
| TOTAL, | 5203276, | 6287792, | 5415941, | 4760377, | 4397036, | 3781635, | 5528188, | 6003682, | 6277438, | 5532418, | 4207882, |

Run title : Horse mackerel South (run: XSA1/OUT)

## Table 7.16

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, | 1633363, | 274314, | 112109, | 43535, | .3883, | .2083, | .2621, | .2443, |
| 1986, | 2665090, | 310083, | 162041, | 71258, | .4398, | .3328, | .3455, | .4265, |
| 1987, | 1319466, | 328142, | 180950, | 52747, | .2915, | .2251, | .3108, | .1598, |
| 1988, | 1098242, | 324486, | 184560, | 55888, | .3028, | .2858, | .1822, | .4235, |
| 1989, | 973275, | 317790, | 180995, | 56396, | .3116, | .3220, | .2044, | .4710, |
| 1990, | 688567, | 315960, | 191482, | 49207, | .2570, | .2559, | .1910, | .3629, |
| 1991, | 2771827, | 302556, | 196103, | 45511, | .2321, | .2269, | .1144, | .3437, |
| 1992, | 1600367, | 347458, | 191738, | 50956, | .2658, | .2625, | .1883, | .3835, |
| 1993, | 1728578, | 367814, | 180934, | 57428, | .3174, | .2813, | .1985, | .3694, |
| 1994, | 812117, | 359776, | 159476, | 52588, | .3298, | .2162, | .1241, | .2904, |
| Arith. Mean , | 1529089, | 324838, | 174039, | 53551, | .3136, | .2617, | .0000, | .3475, |
| Units, | (Thousands), | (Tonnes), | (Tonnes), | (Tonnes), | | | | |

## Table 7.17 Input data for the predictions

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

Single option prediction: Input data

| Year: 1995 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Stock size | Natural mortality | Maturity ogive | Prop.of F bef.spaw. | Prop.of M bef.spaw. | Weight in stock | Exploit. pattern | Weight in catch |
| 0 | 1442.555 | 0.1500 | 0.0000 | 0.2500 | 0.2500 | 0.000 | 0.0143 | 0.017 |
| 1 | 690.204 | 0.1500 | 0.0000 | 0.2500 | 0.2500 | 0.032 | 0.0886 | 0.034 |
| 2 | 1171.800 | 0.1500 | 0.0400 | 0.2500 | 0.2500 | 0.055 | 0.2350 | 0.051 |
| 3 | 665.268 | 0.1500 | 0.2700 | 0.2500 | 0.2500 | 0.075 | 0.2434 | 0.078 |
| 4 | 1016.813 | 0.1500 | 0.6300 | 0.2500 | 0.2500 | 0.105 | 0.1568 | 0.114 |
| 5 | 87.996 | 0.1500 | 0.8100 | 0.2500 | 0.2500 | 0.127 | 0.0856 | 0.144 |
| 6 | 88.837 | 0.1500 | 0.9000 | 0.2500 | 0.2500 | 0.154 | 0.0848 | 0.167 |
| 7 | 152.705 | 0.1500 | 0.9500 | 0.2500 | 0.2500 | 0.176 | 0.1487 | 0.185 |
| 8 | 141.401 | 0.1500 | 0.9700 | 0.2500 | 0.2500 | 0.213 | 0.1878 | 0.202 |
| 9 | 136.180 | 0.1500 | 0.9800 | 0.2500 | 0.2500 | 0.240 | 0.3932 | 0.215 |
| 10 | 22.051 | 0.1500 | 0.9900 | 0.2500 | 0.2500 | 0.269 | 0.3369 | 0.248 |
| 11 | 15.627 | 0.1500 | 1.0000 | 0.2500 | 0.2500 | 0.304 | 0.4174 | 0.259 |
| 12+ | 19.003 | 0.1500 | 1.0000 | 0.2500 | 0.2500 | 0.329 | 0.4174 | 0.342 |
| Unit | Millions | - | - | - | - | Kilograms | - | Kilograms |

| Year: 1996 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Recruit-ment | Natural mortality | Maturity ogive | Prop.of F bef.spaw. | Prop.of M bef.spaw. | Weight in stock | Exploit. pattern | Weight in catch |
| 0 | 1442.555 | 0.1500 | 0.0000 | 0.2500 | 0.2500 | 0.000 | 0.0143 | 0.017 |
| 1 | . | 0.1500 | 0.0000 | 0.2500 | 0.2500 | 0.032 | 0.0886 | 0.034 |
| 2 | . | 0.1500 | 0.0400 | 0.2500 | 0.2500 | 0.055 | 0.2350 | 0.051 |
| 3 | . | 0.1500 | 0.2700 | 0.2500 | 0.2500 | 0.075 | 0.2434 | 0.078 |
| 4 | . | 0.1500 | 0.6300 | 0.2500 | 0.2500 | 0.105 | 0.1568 | 0.114 |
| 5 | . | 0.1500 | 0.8100 | 0.2500 | 0.2500 | 0.127 | 0.0856 | 0.144 |
| 6 | . | 0.1500 | 0.9000 | 0.2500 | 0.2500 | 0.154 | 0.0848 | 0.167 |
| 7 | . | 0.1500 | 0.9500 | 0.2500 | 0.2500 | 0.176 | 0.1487 | 0.185 |
| 8 | . | 0.1500 | 0.9700 | 0.2500 | 0.2500 | 0.213 | 0.1878 | 0.202 |
| 9 | . | 0.1500 | 0.9800 | 0.2500 | 0.2500 | 0.240 | 0.3932 | 0.215 |
| 10 | . | 0.1500 | 0.9900 | 0.2500 | 0.2500 | 0.269 | 0.3369 | 0.248 |
| 11 | . | 0.1500 | 1.0000 | 0.2500 | 0.2500 | 0.304 | 0.4174 | 0.259 |
| 12+ | . | 0.1500 | 1.0000 | 0.2500 | 0.2500 | 0.329 | 0.4174 | 0.342 |
| Unit | Millions | - | - | - | - | Kilograms | - | Kilograms |

| Year: 1997 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Recruit-ment | Natural mortality | Maturity ogive | Prop.of F bef.spaw. | Prop.of M bef.spaw. | Weight in stock | Exploit. pattern | Weight in catch |
| 0 | . | 0.1500 | 0.0000 | 0.2500 | 0.2500 | 0.000 | 0.0143 | 0.017 |
| 1 | . | 0.1500 | 0.0000 | 0.2500 | 0.2500 | 0.032 | 0.0886 | 0.034 |
| 2 | . | 0.1500 | 0.0400 | 0.2500 | 0.2500 | 0.055 | 0.2350 | 0.051 |
| 3 | . | 0.1500 | 0.2700 | 0.2500 | 0.2500 | 0.075 | 0.2434 | 0.078 |
| 4 | . | 0.1500 | 0.6300 | 0.2500 | 0.2500 | 0.105 | 0.1568 | 0.114 |
| 5 | . | 0.1500 | 0.8100 | 0.2500 | 0.2500 | 0.127 | 0.0856 | 0.144 |
| 6 | . | 0.1500 | 0.9000 | 0.2500 | 0.2500 | 0.154 | 0.0848 | 0.167 |
| 7 | . | 0.1500 | 0.9500 | 0.2500 | 0.2500 | 0.176 | 0.1487 | 0.185 |
| 8 | . | 0.1500 | 0.9700 | 0.2500 | 0.2500 | 0.213 | 0.1878 | 0.202 |
| 9 | . | 0.1500 | 0.9800 | 0.2500 | 0.2500 | 0.240 | 0.3932 | 0.215 |
| 10 | . | 0.1500 | 0.9900 | 0.2500 | 0.2500 | 0.269 | 0.3369 | 0.248 |
| 11 | . | 0.1500 | 1.0000 | 0.2500 | 0.2500 | 0.304 | 0.4174 | 0.259 |
| 12+ | . | 0.1500 | 1.0000 | 0.2500 | 0.2500 | 0.329 | 0.4174 | 0.342 |
| Unit | Millions | - | - | - | - | Kilograms | - | Kilograms |

Notes: Run name : 801
Date and time: 160CT95:22:38

## Table 7.18 Yield per recruit summary table

Horse mackerel 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 | 10356336 | 1432713 | 5444757 | 1220085 | 5244359 | 1175179 |
| 0.1000 | 0.0216 | 157606 | 29119 | 9307964 | 1146804 | 4466225 | 941109 | 4274840 | 899690 |
| 0.2000 | 0.0432 | 268666 | 45025 | 8569759 | 958548 | 3794554 | 759382 | 3611788 | 721114 |
| 0.3000 | 0.0649 | 353376 | 54234 | 8007116 | 824058 | 3295348 | 631044 | 3120810 | 595630 |
| 0.4000 | 0.0865 | 421397 | 59725 | 7555652 | 722507 | 2904414 | 535298 | 2737722 | 502476 |
| 0.5000 | 0.1081 | 477972 | 63020 | 7180424 | 642723 | 2586987 | 460994 | 2427768 | 430531 |
| 0.6000 | 0.1297 | 526222 | 64960 | 6860646 | 578154 | 2322445 | 401604 | 2170337 | 373291 |
| 0.7000 | 0.1513 | 568139 | 66037 | 6583050 | 524696 | 2097675 | 353043 | 1952329 | 326696 |
| 0.8000 | 0.1730 | 605066 | 66549 | 6338682 | 479637 | 1903865 | 312620 | 1764944 | 288071 |
| 0.9000 | 0.1946 | 637954 | 66686 | 6121221 | 441107 | 1734825 | 278483 | 1602007 | 255583 |
| 1.0000 | 0.2162 | 667498 | 66570 | 5926029 | 407772 | 1586042 | 249314 | 1459017 | 227928 |
| 1.1000 | 0.2378 | 694226 | 66282 | 5749599 | 378652 | 1454122 | 224146 | 1332596 | 204152 |
| 1.2000 | 0.2594 | 718547 | 65878 | 5589204 | 353004 | 1336447 | 202253 | 1220138 | 183541 |
| 1.3000 | 0.2811 | 740785 | 65395 | 5442677 | 330260 | 1230949 | 183076 | 1119590 | 165547 |
| 1.4000 | 0.3027 | 761206 | 64859 | 5308264 | 309970 | 1135966 | 166181 | 1029303 | 149743 |
| 1.5000 | 0.3243 | 780024 | 64289 | 5184518 | 291776 | 1050141 | 151218 | 947932 | 135790 |
| 1.6000 | 0.3459 | 797423 | 63699 | 5070233 | 275388 | 972348 | 137909 | 874363 | 123415 |
| 1.7000 | 0.3675 | 813554 | 63098 | 4964388 | 260569 | 901641 | 126025 | 807664 | 112395 |
| 1.8000 | 0.3892 | 828549 | 62494 | 4866110 | 247121 | 837220 | 115377 | 747045 | 102549 |
| 1.9000 | 0.4108 | 842520 | 61891 | 4774647 | 234877 | 778401 | 105808 | 691833 | 93724 |
| 2.0000 | 0.4324 | 855565 | 61294 | 4689347 | 223698 | 724592 | 97184 | 641447 | 85792 |
| - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : YIELDREC
Date and time : 16OCT95:17:31
Computation of ref. F: Simple mean, age 1 - 11
F-0.1 factor : 0.4112
F-max factor : 0.8977
F-0.1 reference F : 0.0889
F-max reference F : 0.1941
Recruitment : 1443 (Millions)

## Table 7.19 Prediction with management option table

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

### Table 7.19a Prediction with management option table

| Year: 1995 | | | | | Year: 1996 | | | | | Year: 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F Factor | Reference F | Stock biomass | Sp.stock biomass | Catch in weight | F Factor | Reference F | Stock biomass | Sp.stock biomass | Catch in weight | Stock biomass | Sp.stock biomass |
| 1.0000 | 0.2162 | 374665 | 190246 | 63866 | 0.0000 | 0.0000 | 374289 | 215906 | 0 | 453329 | 274351 |
| . | . | . | . | . | 0.1000 | 0.0216 | . | 214868 | 6379 | 445920 | 267913 |
| . | . | . | . | . | 0.2000 | 0.0432 | . | 213837 | 12616 | 438680 | 261671 |
| . | . | . | . | . | 0.3000 | 0.0649 | . | 212812 | 18715 | 431604 | 255618 |
| . | . | . | . | . | 0.4000 | 0.0865 | . | 211794 | 24680 | 424688 | 249747 |
| . | . | . | . | . | 0.5000 | 0.1081 | . | 210783 | 30514 | 417928 | 244052 |
| . | . | . | . | . | 0.6000 | 0.1297 | . | 209778 | 36221 | 411319 | 238526 |
| . | . | . | . | . | 0.7000 | 0.1513 | . | 208780 | 41804 | 404857 | 233164 |
| . | . | . | . | . | 0.8000 | 0.1730 | . | 207788 | 47267 | 398538 | 227959 |
| . | . | . | . | . | 0.9000 | 0.1946 | . | 206803 | 52613 | 392359 | 222906 |
| . | . | . | . | . | 1.0000 | 0.2162 | . | 205824 | 57844 | 386315 | 218000 |
| . | . | . | . | . | 1.1000 | 0.2378 | . | 204851 | 62965 | 380403 | 213235 |
| . | . | . | . | . | 1.2000 | 0.2594 | . | 203885 | 67977 | 374620 | 208606 |
| . | . | . | . | . | 1.3000 | 0.2811 | . | 202925 | 72885 | 368961 | 204110 |
| . | . | . | . | . | 1.4000 | 0.3027 | . | 201971 | 77690 | 363425 | 199740 |
| . | . | . | . | . | 1.5000 | 0.3243 | . | 201023 | 82395 | 358006 | 195493 |
| . | . | . | . | . | 1.6000 | 0.3459 | . | 200081 | 87003 | 352704 | 191365 |
| . | . | . | . | . | 1.7000 | 0.3675 | . | 199145 | 91516 | 347513 | 187351 |
| . | . | . | . | . | 1.8000 | 0.3892 | . | 198216 | 95937 | 342432 | 183448 |
| . | . | . | . | . | 1.9000 | 0.4108 | . | 197292 | 100268 | 337457 | 179651 |
| . | . | . | . | . | 2.0000 | 0.4324 | . | 196374 | 104512 | 332587 | 175958 |
| - | - | Tonnes | Tonnes | Tonnes | - | - | Tonnes | Tonnes | Tonnes | Tonnes | Tonnes |

Notes: Run name : FB2
Date and time : 16OCT95:22:17
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1995 : F factors

Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

### Table 7.19b Prediction with management option table

| Year: 1995 | | | | | Year: 1996 | | | | | Year: 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F Factor | Reference F | Stock biomass | Sp.stock biomass | Catch in weight | F Factor | Reference F | Stock biomass | Sp.stock biomass | Catch in weight | Stock biomass | Sp.stock biomass |
| 1.1688 | 0.2527 | 374455 | 188376 | 73000 | 0.0000 | 0.0000 | 363126 | 208490 | 0 | 441442 | 265038 |
| . | . | . | . | . | 0.1000 | 0.0216 | . | 207495 | 6131 | 434289 | 258853 |
| . | . | . | . | . | 0.2000 | 0.0432 | . | 206505 | 12128 | 427299 | 252856 |
| . | . | . | . | . | 0.3000 | 0.0649 | . | 205523 | 17992 | 420466 | 247040 |
| . | . | . | . | . | 0.4000 | 0.0865 | . | 204546 | 23729 | 413787 | 241398 |
| . | . | . | . | . | 0.5000 | 0.1081 | . | 203576 | 29340 | 407257 | 235924 |
| . | . | . | . | . | 0.6000 | 0.1297 | . | 202612 | 34831 | 400873 | 230611 |
| . | . | . | . | . | 0.7000 | 0.1513 | . | 201655 | 40204 | 394629 | 225455 |
| . | . | . | . | . | 0.8000 | 0.1730 | . | 200703 | 45462 | 388524 | 220450 |
| . | . | . | . | . | 0.9000 | 0.1946 | . | 199758 | 50608 | 382552 | 215589 |
| . | . | . | . | . | 1.0000 | 0.2162 | . | 198819 | 55645 | 376710 | 210869 |
| . | . | . | . | . | 1.1000 | 0.2378 | . | 197886 | 60576 | 370995 | 206284 |
| . | . | . | . | . | 1.2000 | 0.2594 | . | 196959 | 65404 | 365403 | 201830 |
| . | . | . | . | . | 1.3000 | 0.2811 | . | 196037 | 70132 | 359931 | 197502 |
| . | . | . | . | . | 1.4000 | 0.3027 | . | 195122 | 74762 | 354577 | 193295 |
| . | . | . | . | . | 1.5000 | 0.3243 | . | 194213 | 79296 | 349336 | 189207 |
| . | . | . | . | . | 1.6000 | 0.3459 | . | 193309 | 83738 | 344206 | 185231 |
| . | . | . | . | . | 1.7000 | 0.3675 | . | 192411 | 88089 | 339184 | 181365 |
| . | . | . | . | . | 1.8000 | 0.3892 | . | 191519 | 92352 | 334268 | 177605 |
| . | . | . | . | . | 1.9000 | 0.4108 | . | 190632 | 96529 | 329454 | 173948 |
| . | . | . | . | . | 2.0000 | 0.4324 | . | 189751 | 100622 | 324739 | 170389 |
| - | - | Tonnes | Tonnes | Tonnes | - | - | Tonnes | Tonnes | Tonnes | Tonnes | Tonnes |

Notes: Run name : FB1
Date and time : 16OCT95:21:52
Computation of ref. F: Simple mean, age 1 - 11
Basis for 1995 : TAC constraints

## Table 7.19c

Single option prediction: Detailed tables

Year: 1995 F-factor: 1.0000 Reference F: 0.2162

| | | | | | | 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 | 0.0143 | 19023 | 328 | 1442555 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.0886 | 54404 | 1823 | 690204 | 22087 | 0 | 0 | 0 | 0 |
| 2 | 0.2350 | 228559 | 11726 | 1171800 | 64449 | 46872 | 2578 | 42571 | 2341 |
| 3 | 0.2434 | 133872 | 10411 | 665268 | 49895 | 179622 | 13472 | 162797 | 12210 |
| 4 | 0.1568 | 137299 | 15606 | 1016813 | 106765 | 640592 | 67262 | 593296 | 62296 |
| 5 | 0.0856 | 6711 | 966 | 87996 | 11175 | 71277 | 9052 | 67200 | 8534 |
| 6 | 0.0848 | 6714 | 1125 | 88837 | 13681 | 79953 | 12313 | 75395 | 11611 |
| 7 | 0.1487 | 19630 | 3624 | 152705 | 26876 | 145070 | 25532 | 134631 | 23695 |
| 8 | 0.1878 | 22535 | 4543 | 141401 | 30118 | 137159 | 29215 | 126052 | 26849 |
| 9 | 0.3932 | 41314 | 8895 | 136180 | 32683 | 133456 | 32030 | 116510 | 27962 |
| 10 | 0.3369 | 5881 | 1456 | 22051 | 5932 | 21830 | 5872 | 19329 | 5199 |
| 11 | 0.4174 | 4978 | 1291 | 15627 | 4751 | 15627 | 4751 | 13560 | 4122 |
| 12+ | 0.4174 | 6053 | 2072 | 19003 | 6253 | 19003 | 6253 | 16490 | 5426 |
| Total | | 686973 | 63866 | 5650440 | 374665 | 1490462 | 208329 | 1367830 | 190246 |
| Unit | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Year: 1996 F-factor: 1.0000 Reference F: 0.2162

| | | | | | | 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 | 0.0143 | 19023 | 328 | 1442555 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.0886 | 96478 | 3233 | 1223990 | 39168 | 0 | 0 | 0 | 0 |
| 2 | 0.2350 | 106047 | 5440 | 543694 | 29903 | 21748 | 1196 | 19752 | 1086 |
| 3 | 0.2434 | 160451 | 12479 | 797352 | 59801 | 215285 | 16146 | 195120 | 14634 |
| 4 | 0.1568 | 60614 | 6890 | 448895 | 47134 | 282804 | 29694 | 261924 | 27502 |
| 5 | 0.0856 | 57058 | 8215 | 748169 | 95017 | 606017 | 76964 | 571353 | 72562 |
| 6 | 0.0848 | 5255 | 880 | 69525 | 10707 | 62573 | 9636 | 59006 | 9087 |
| 7 | 0.1487 | 9030 | 1667 | 70246 | 12363 | 66734 | 11745 | 61932 | 10900 |
| 8 | 0.1878 | 18052 | 3639 | 113274 | 24127 | 109876 | 23404 | 100978 | 21508 |
| 9 | 0.3932 | 30601 | 6588 | 100867 | 24208 | 98849 | 23724 | 86297 | 20711 |
| 10 | 0.3369 | 21099 | 5224 | 79105 | 21279 | 78314 | 21066 | 69339 | 18652 |
| 11 | 0.4174 | 4316 | 1119 | 13551 | 4119 | 13551 | 4119 | 11759 | 3575 |
| 12+ | 0.4174 | 6254 | 2141 | 19635 | 6461 | 19635 | 6461 | 17038 | 5606 |
| Total | | 594279 | 57844 | 5670858 | 374289 | 1575385 | 224156 | 1454497 | 205824 |
| Unit | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Year: 1997 F-factor: 1.0000 Reference F: 0.2162

| | | | | | | 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 | 0.0143 | . | . | . | . | . | . | . | . |
| 1 | 0.0886 | 96478 | 3233 | 1223990 | 39168 | 0 | 0 | 0 | 0 |
| 2 | 0.2350 | 188062 | 9648 | 964173 | 53030 | 38567 | 2121 | 35028 | 1927 |
| 3 | 0.2434 | 74446 | 5790 | 369957 | 27747 | 99888 | 7492 | 90532 | 6790 |
| 4 | 0.1568 | 72648 | 8258 | 538020 | 56492 | 338953 | 35590 | 313927 | 32962 |
| 5 | 0.0856 | 25190 | 3627 | 330296 | 41948 | 267540 | 33978 | 252237 | 32034 |
| 6 | 0.0848 | 44677 | 7483 | 591126 | 91033 | 532013 | 81930 | 501683 | 77259 |
| 7 | 0.1487 | 7067 | 1305 | 54976 | 9676 | 52227 | 9192 | 48469 | 8531 |
| 8 | 0.1878 | 8304 | 1674 | 52107 | 11099 | 50544 | 10766 | 46451 | 9894 |
| 9 | 0.3932 | 24514 | 5278 | 80803 | 19393 | 79186 | 19005 | 69131 | 16591 |
| 10 | 0.3369 | 15628 | 3869 | 58592 | 15761 | 58006 | 15604 | 51358 | 13815 |
| 11 | 0.4174 | 15485 | 4016 | 48612 | 14778 | 48612 | 14778 | 42183 | 12824 |
| 12+ | 0.4174 | 5994 | 2052 | 18816 | 6191 | 18816 | 6191 | 16328 | 5373 |
| Total | | 578492 | 56231 | 4331469 | 386315 | 1584353 | 236646 | 1467327 | 218000 |
| Unit | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

(cont.)

## Table 7.20

Horse mackerel Southern Area (Fishing Areas 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 |
| 1995 | 1.0000 | 0.2162 | 686973 | 63866 | 5650440 | 374665 | 1490462 | 208329 | 1367830 | 190246 |
| 1996 | 1.0000 | 0.2162 | 594279 | 57844 | 5670858 | 374289 | 1575385 | 224156 | 1454497 | 205824 |
| 1997 | 1.0000 | 0.2162 | 578492 | 56231 | 4331469 | 386315 | 1584353 | 236646 | 1467327 | 218000 |
| Unit | - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : B01
Date and time : 16OCT95:22:38
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

### 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 |
| 1995 | 1.1633 | 0.2515 | 786509 | 73000 | 5650440 | 374665 | 1490462 | 208329 | 1357130 | 188610 |
| 1996 | 1.3529 | 0.2925 | 759129 | 73000 | 5579147 | 363681 | 1526336 | 216900 | 1388838 | 195937 |
| 1997 | 1.4933 | 0.3228 | 774869 | 73000 | 4100679 | 357536 | 1447982 | 215385 | 1316709 | 194436 |
| Unit | - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : MF1
Date and time : 16OCT95:23:04
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : TAC constraints

### F corresponding to $F_{TAC\ 1994}$

| | | | | | | | 1 January | | Spawning time | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | F Factor | Reference F | Catch in numbers | Catch in weight | Stock size | Stock biomass | Sp.stock size | Sp.stock biomass | Sp.stock size | Sp.stock biomass |
| 1995 | 1.1633 | 0.2515 | 750922 | 69712 | 5650440 | 374665 | 1490462 | 208329 | 1323621 | 183953 |
| 1996 | 1.1633 | 0.2515 | 575444 | 55337 | 5185487 | 329071 | 1381080 | 196258 | 1235372 | 174458 |
| 1997 | 1.1633 | 0.2515 | 528925 | 48239 | 4976859 | 304588 | 1223956 | 182345 | 1098921 | 162753 |
| Unit | - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : MF2
Date and time : 16OCT95:23:49
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

### $F_{max}$

| | | | | | | | 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 |
| 1995 | 0.8977 | 0.1941 | 594465 | 55334 | 5650440 | 374665 | 1490462 | 208329 | 1340647 | 186558 |
| 1996 | 0.8977 | 0.1941 | 474132 | 46314 | 5321916 | 344869 | 1454101 | 207072 | 1314889 | 186316 |
| 1997 | 0.8977 | 0.1941 | 443176 | 41830 | 5171453 | 329640 | 1345590 | 201327 | 1220086 | 181649 |
| Unit | - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : MF2
Date and time : 16OCT95:23:56
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

### $F_{med}$

| | | | | | | | 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 |
| 1995 | 1.2000 | 0.2594 | 771906 | 71635 | 5650440 | 374665 | 1490462 | 208329 | 1321289 | 183597 |
| 1996 | 1.2000 | 0.2594 | 588318 | 56453 | 5167215 | 326962 | 1371323 | 194817 | 1224822 | 172891 |
| 1997 | 1.2000 | 0.2594 | 539592 | 48982 | 4951420 | 301338 | 1208167 | 179893 | 1083291 | 160330 |
| Unit | - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : MF2
Date and time : 17OCT95:00:11
Computation of ref. F: Simple mean, age 1 - 11
Prediction basis : F factors

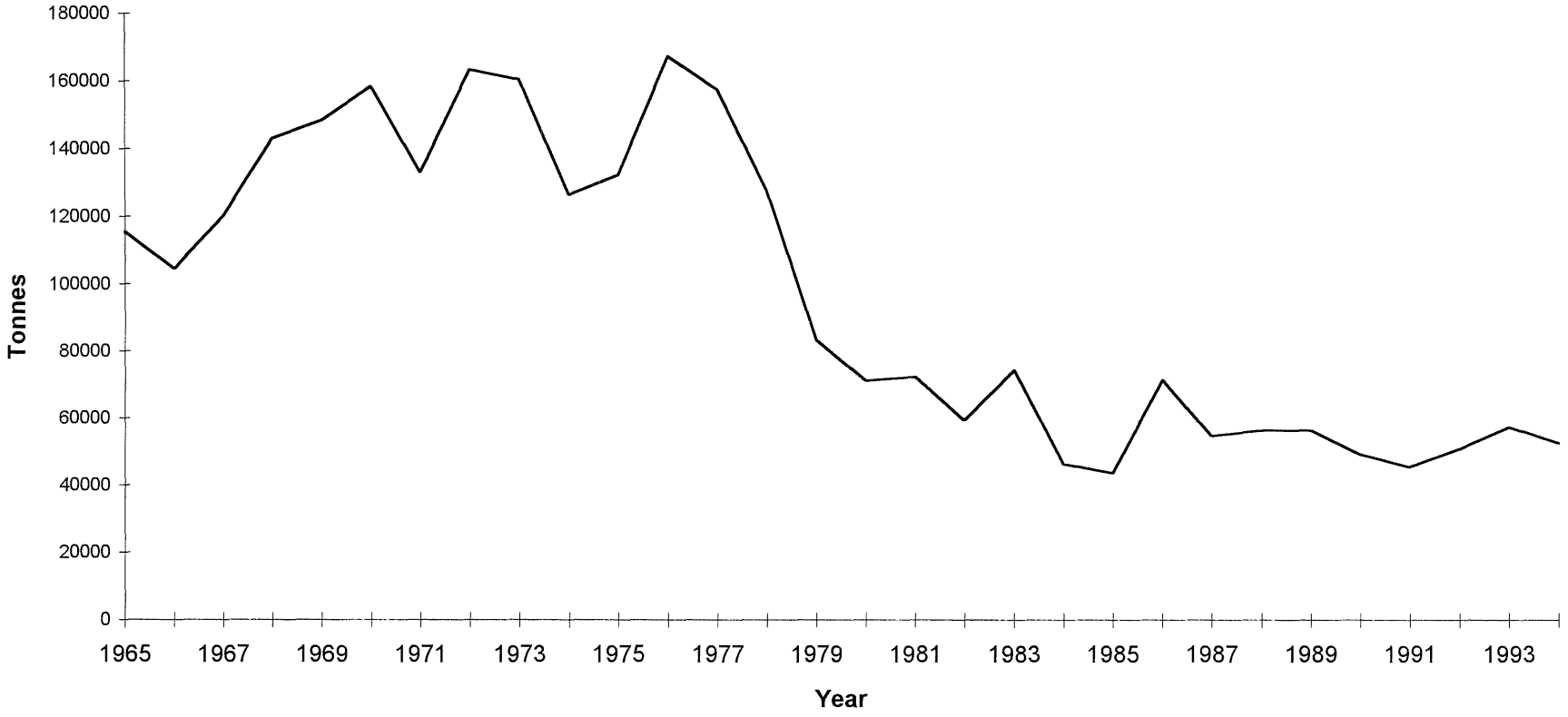



**Figure 7.1 Evolution of the Southern Horse Mackerel Catches (Divisions VIIIc and IXa)**

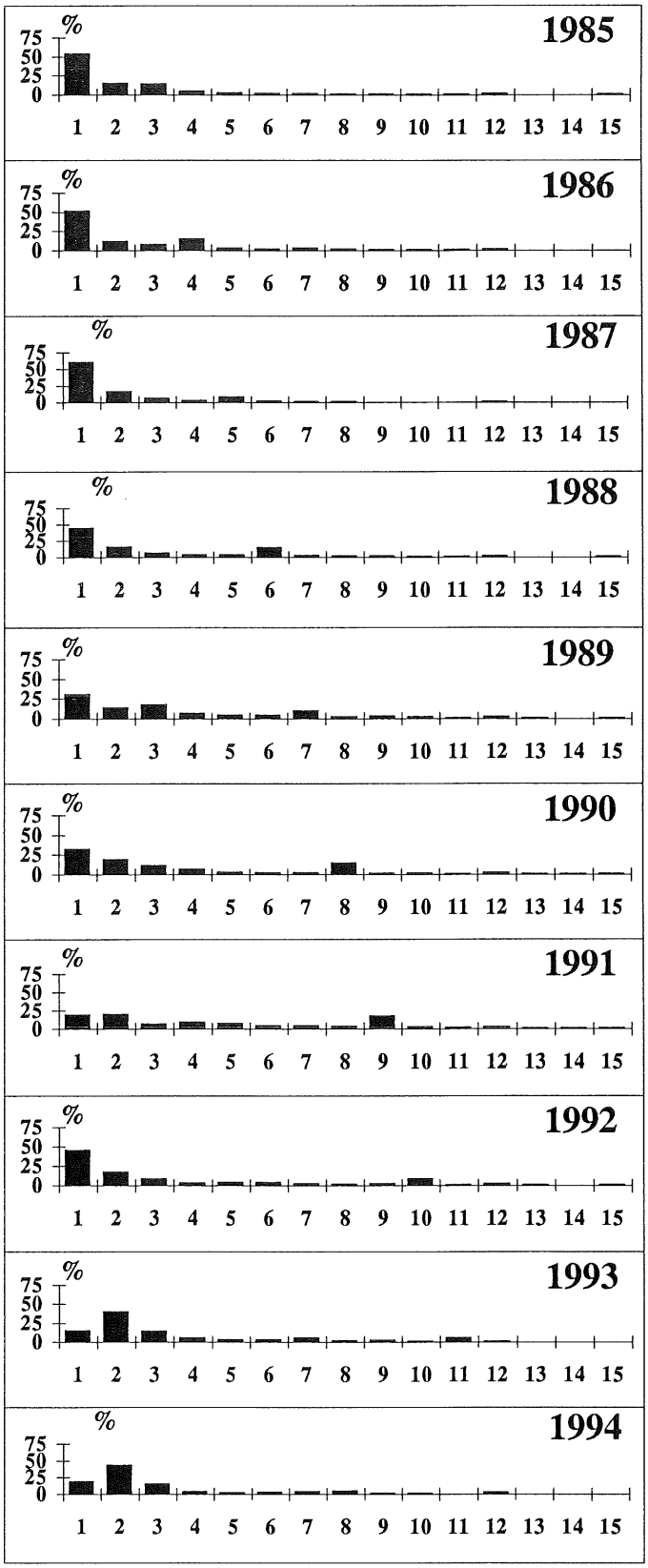



**Figure7.2** The age composition of southern horse mackere in the international catches from 1985-1994. Age 15 is a plus group.

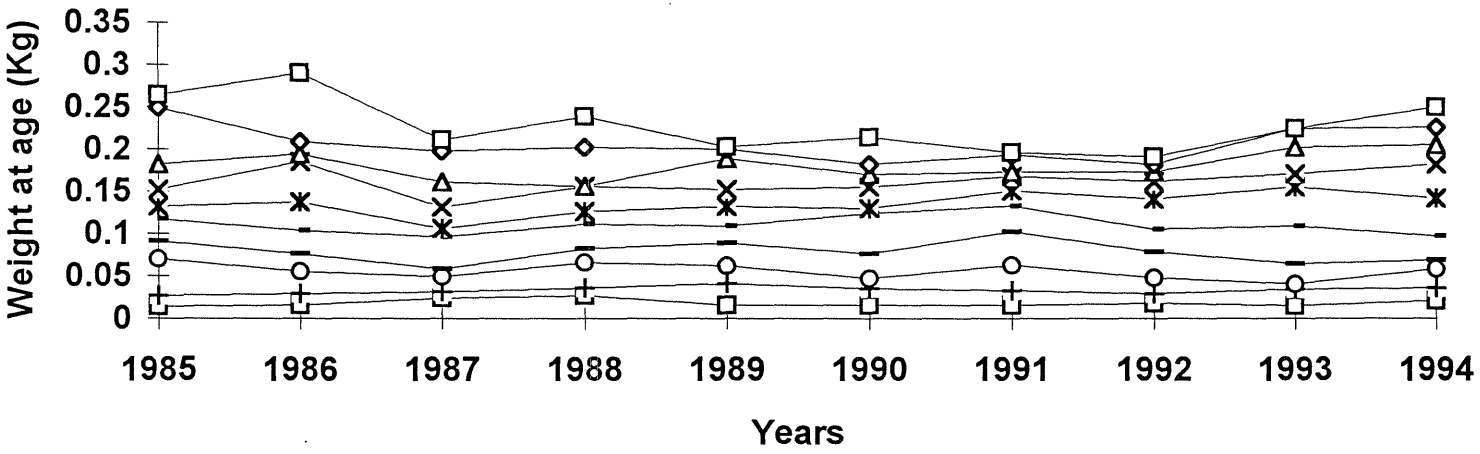



Fig. 7.3 Southern Horse Mackerel weight at age (ages: 1-9)

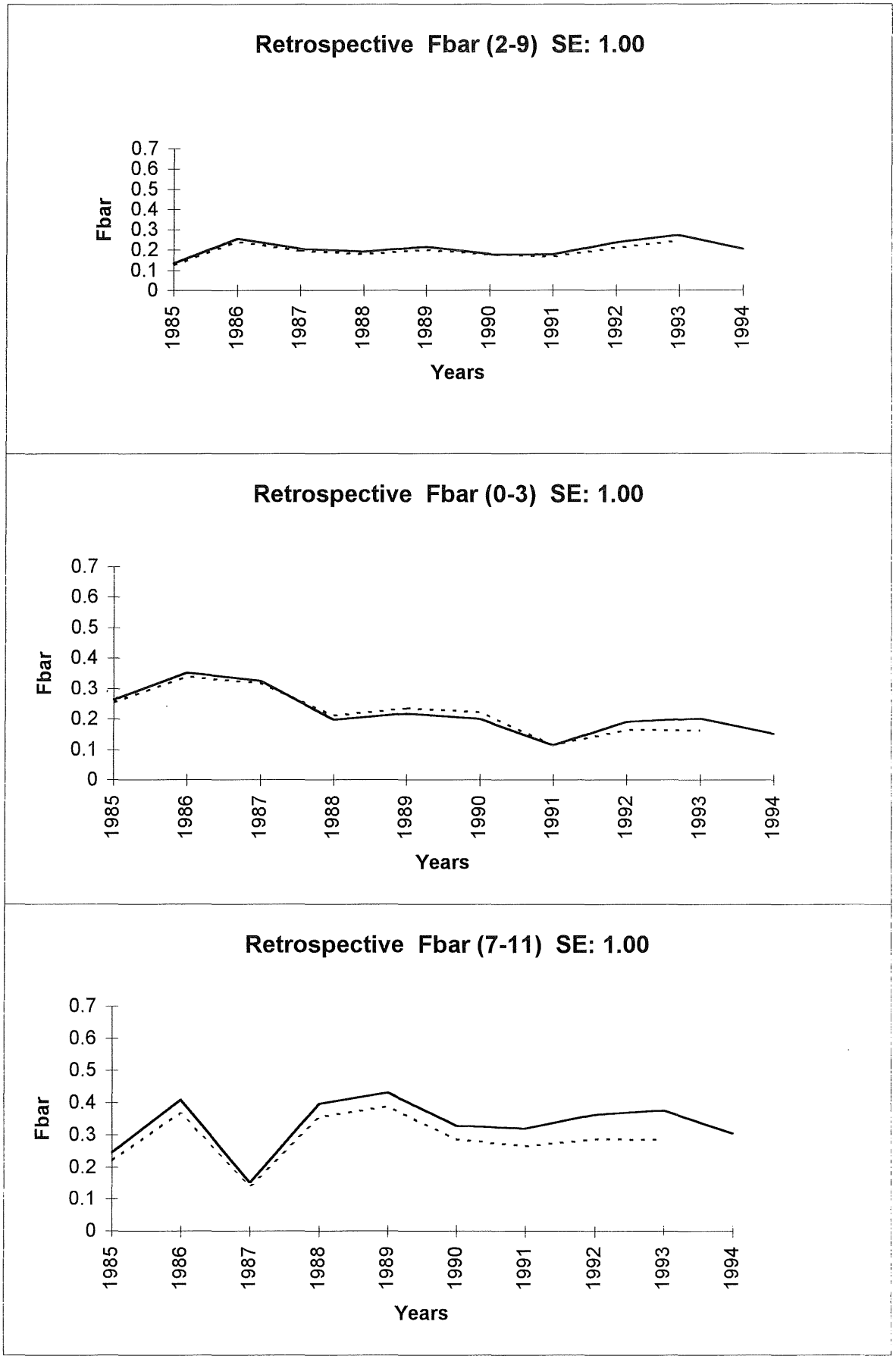



Figure 7.4 Rectrospective analysis for different F´s bar.

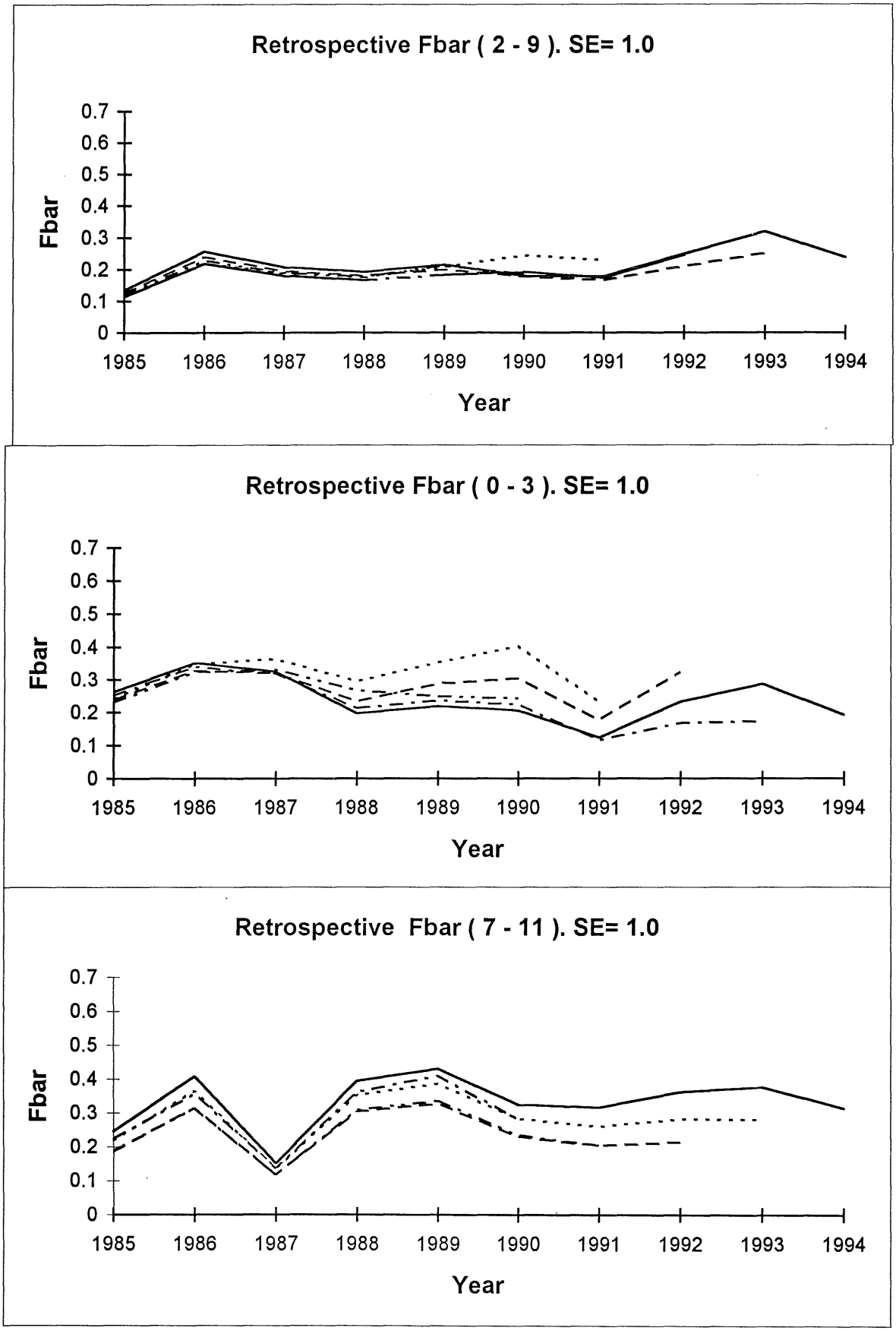


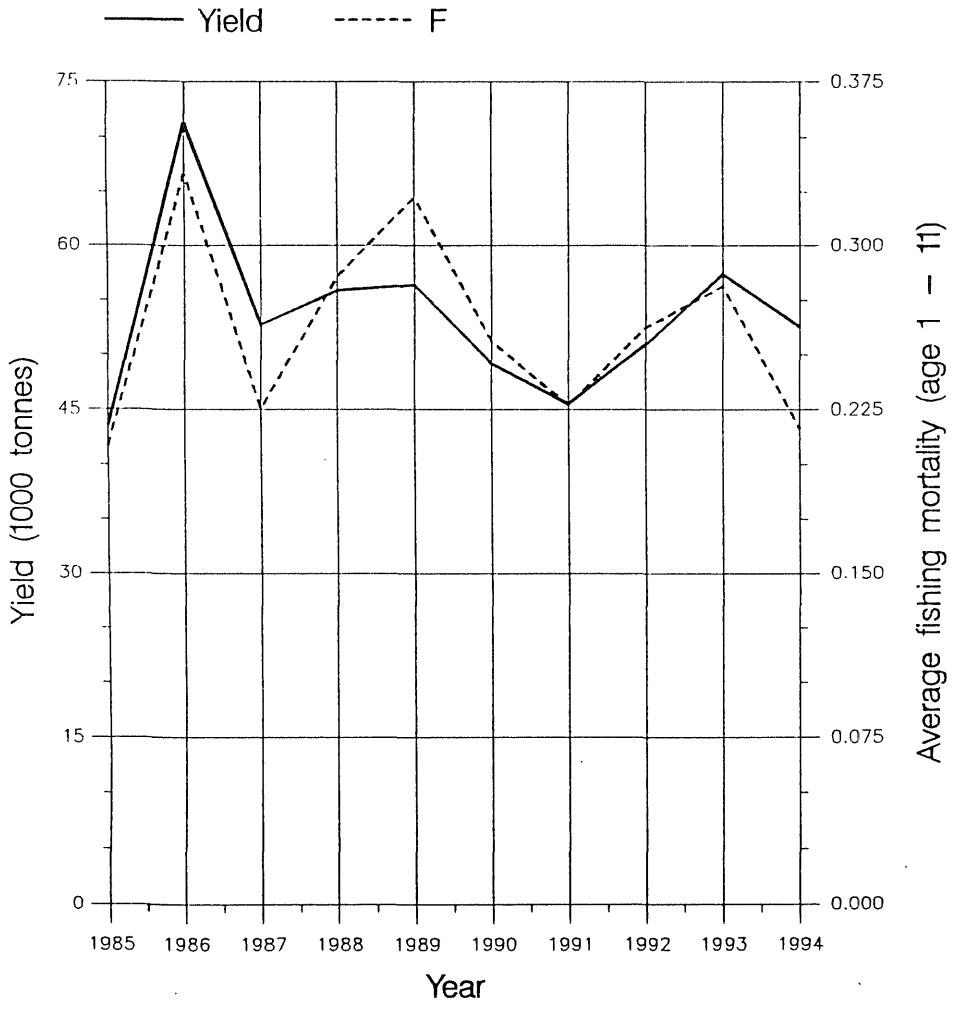

Figure 7.5 Retrospective analysis for different F's bar.

# Fish Stock Summary

## Fig. 7.6 Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

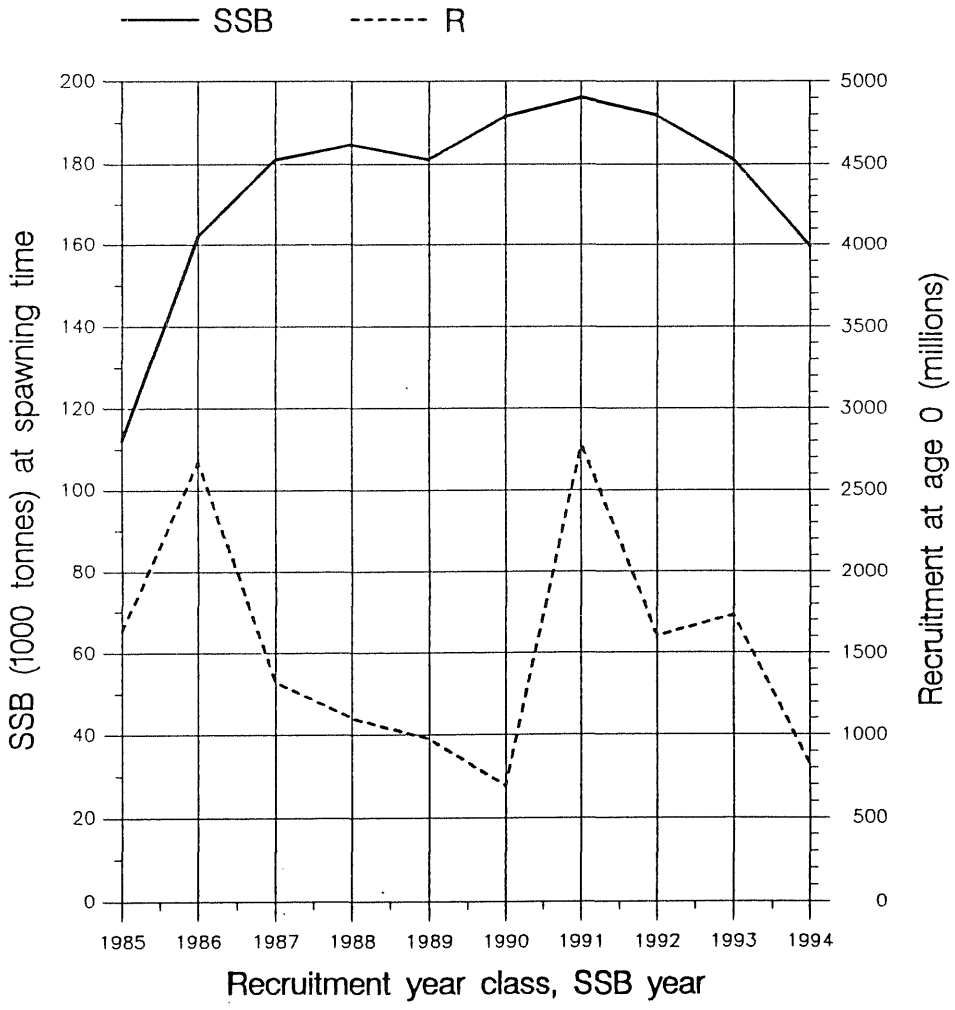
12 – 10 – 1995

Yield and fishing mortality




(run: XSA1) A

Spawning stock and recruitment



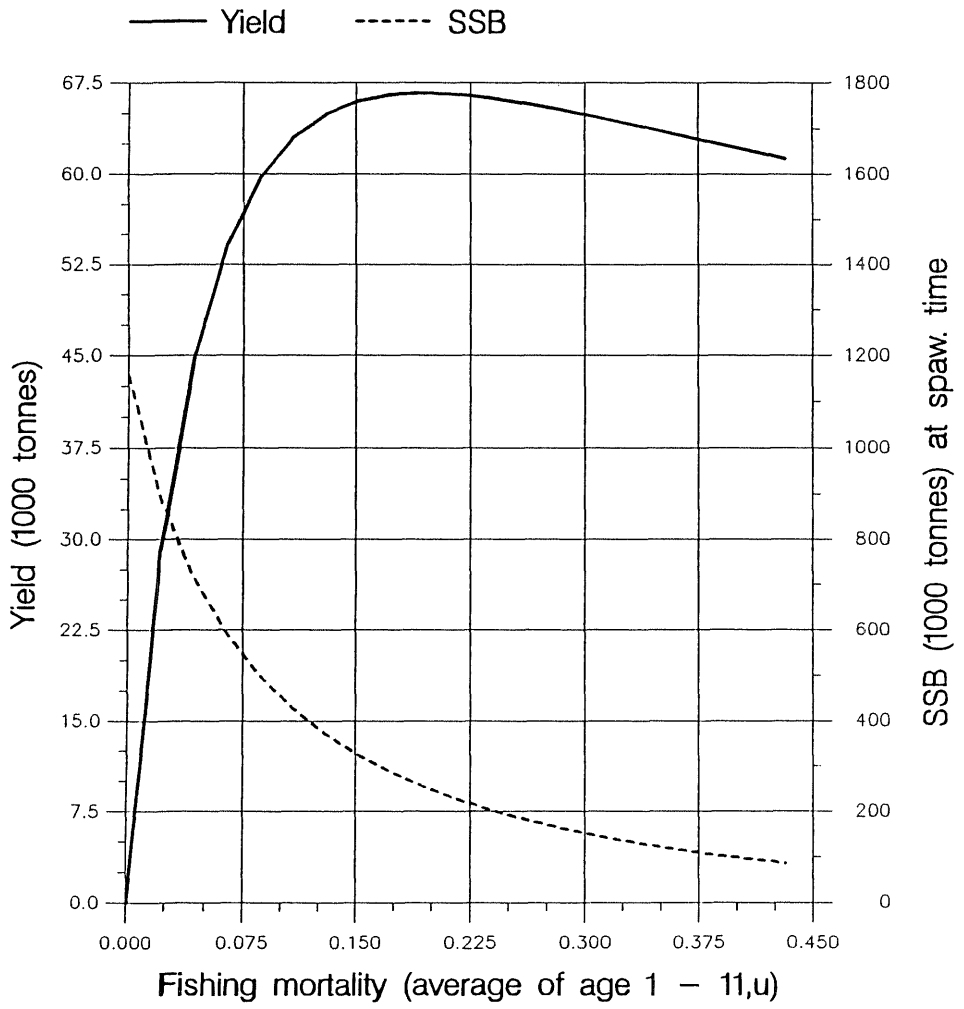

(run: XSA1) B

# Fish Stock Summary

## Fig. 7.7 Horse mackerel Southern Area (Fishing Areas VIIIc and IXa)

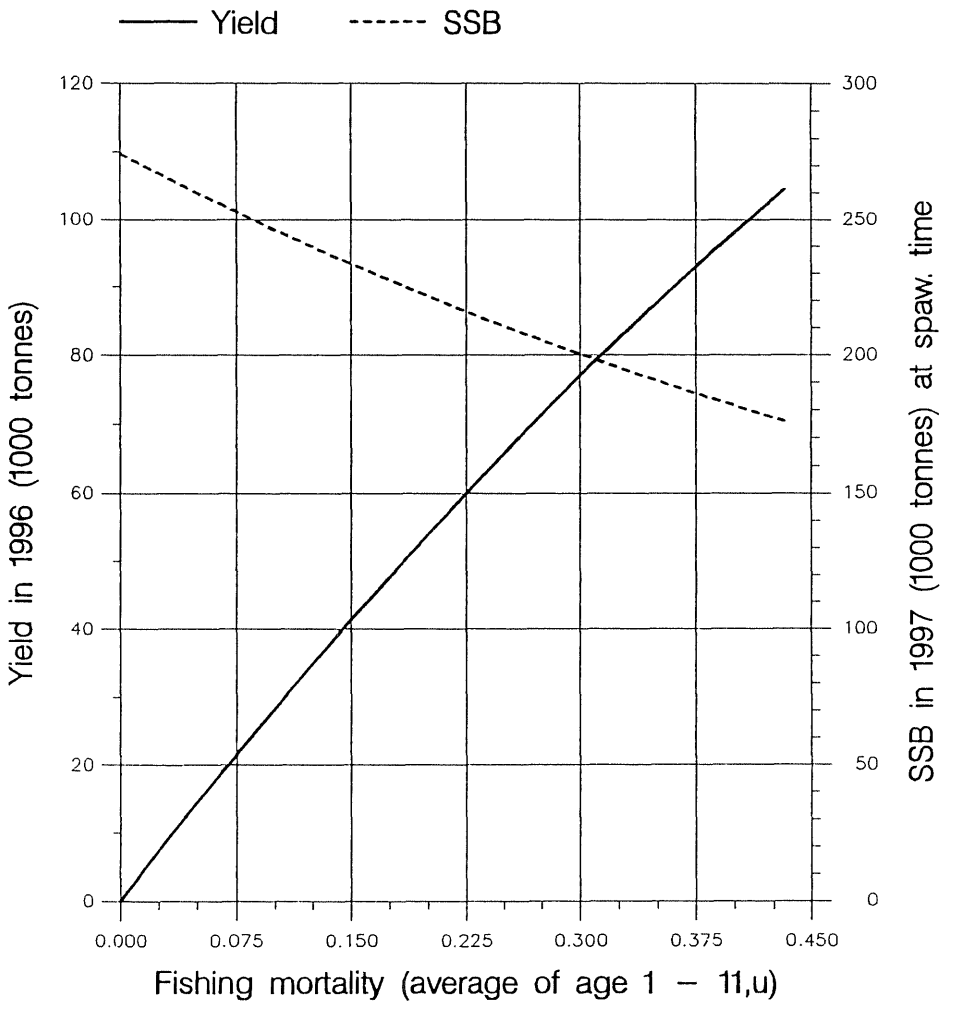
## 14−10−1995

Long term yield and spawning stock biomass




(run: YIELDREC) C

Short term yield and spawning stock biomass




(run: HS1) D

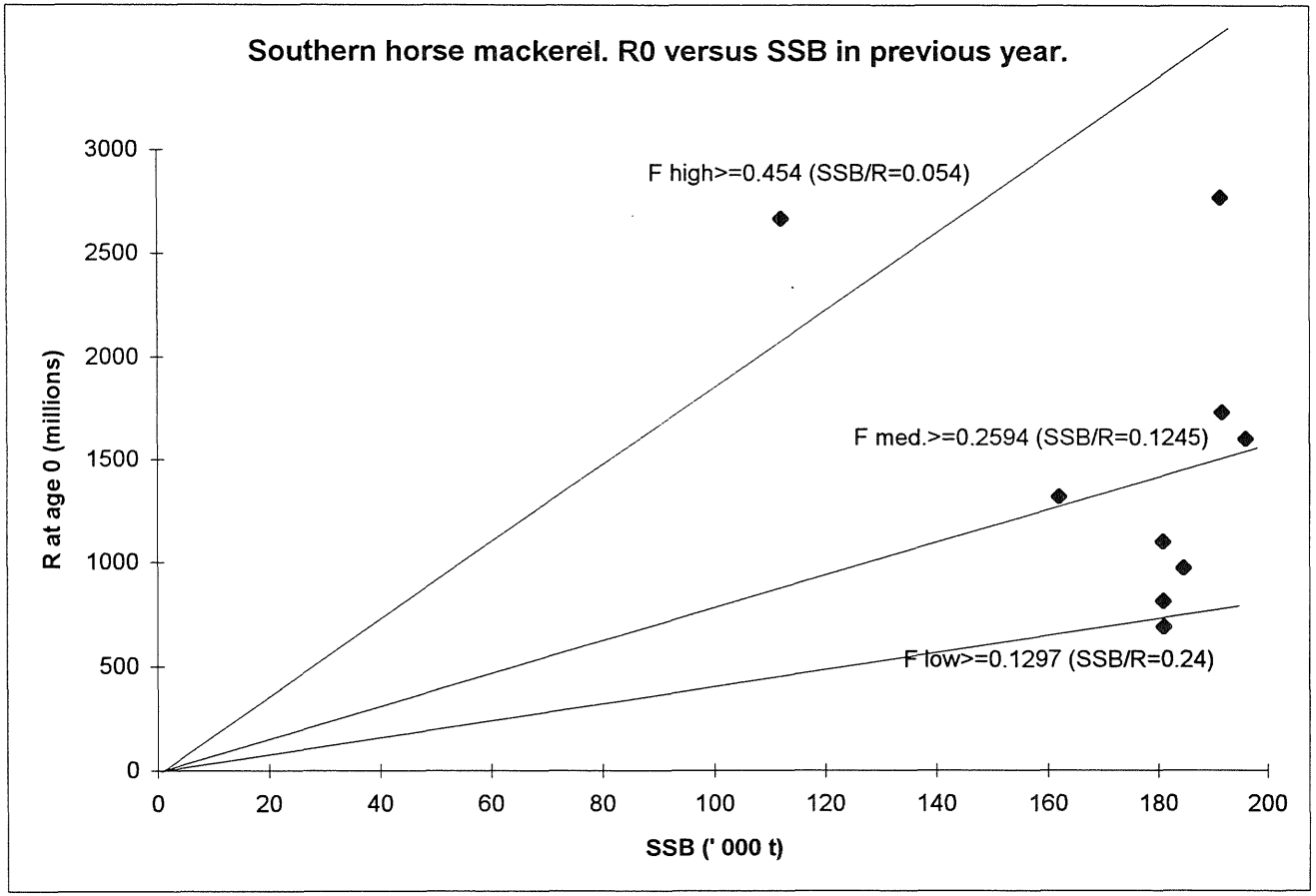



Fig. 7.8 Recruits (age 0) versus Spawning Stock Biomass in previous year.

# 8 SARDINE

## 8.1 Unit Stocks

For assessment purposes the sardines in Divisions VIIIc and IXa is regarded as one stock unit. The catches of sardine in Divisions VIIIa-b were not included in the assessment, nor were the catches from sub-areas IV and VII.

## 8.2 The Fishery in 1994

From Sub-Areas IV, VII, VIII, and IX landings were reported by Denmark, UK (England and Wales), France, Spain and Portugal (Table 8.1). During 1994 19,660 tonnes were also reported in Sub-Area VII, which was at the same level as in 1992.

Table 8.2 shows the annual landings of sardine by Sub-area (IV-IX) and Division 1981-1994. After a decreasing trend from 1981 to 1991, the sardine landings began to increase, and by 1994 they had reached the same level as the catch in 1988 (around 165 thousand tonnes).

Table 8.3 gives the catch by country for the period 1975 to 1994 and the first half of 1995 from the unit stock area (Divisions VIIIc and IXa). Total landings for 1994 were lower than in 1993, but higher than 1991-1992. Whereas Portugal has increased its catch, the Spanish catch decreased by around 10,000 t, mainly in Division IXa. As in previous years, about 97% of the total catch in the stock in 1994 was taken by the purse seine fleets from Spain and Portugal (Table 8.4).

All the available catch data from 1940-1994 for these Divisions is shown in Figure 8.1. 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. 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.

During 1994 the seasonal pattern of landings by the two countries was the same as reported in previous years with about 68% of the annual catches being landed in the second half of the year (Table 8.4).

## 8.3 Distribution of the Sardine Fishery

Figures 8.3a-d show the distribution of catches by quarter during 1994. For the last three years sardine landings by rectangle have been reported by countries for Sub-area VII and IV and Divisions VIIIa-b.

The distribution of catches in 1994 by quarter and area in Divisions VIIIc and IXa was similar to that in recent years, with 60% of the total catches from Sub-Division IXa Central North and Central South (Table 8.5). As in previous years, the catches in Division VIIIc East were the lowest.

## 8.4 Effort and Catch per Unit Effort

Table 8.6 gives the effort in fishing days and the catch per unit effort (tonnes/fishing day) for four different purse seine fleets, from Spain and Portugal.

The CPUE trends for the fleets of Portugal (Division IXa Central+South) and Santonia (VIIIc East) indicate a decrease from 1987 to 1991, with an increase since 1993. In 1994 this increase was very high for the Santonia fleet (from 1.7 to 4). The fleet of Vigo-Riveira (IXa North) shows a slight increase in 1993 but in 1994 it decreased to the lowest level of the reported series. The CPUE of the Sada fleet (VIIIc West) decreased from 1987 to 1991, after which it increased slightly until 1993 and then decreased again 1994.

The effort trends for the fleets in Division VIIIc show a decrease, especially for the Sada fleet which, in 1994, reached only 50% of the 1987 level.

## 8.5 Fishery Independent Information

From 5 May to 4 June, a Spanish-Portuguese acoustic survey covering the ICES Divisions VIIIc and IXa, "IBERSAR-95", was carried out. The survey strategy, methods and subsequent calculations followed those which were adopted by the Planning Group for the Acoustic Surveys in ICES Sub-areas VIII and IX (Anon. 1986).

The surveyed area was limited by the 20 m and 200 m isobaths. The survey track consisted of parallel transects perpendicular to the coast line equally spaced about 15 nautical miles apart.

The total biomass for the whole area in May 1995 was estimated to be 632 thousand tonnes, corresponding to 12,324 million fish. In Divisions VIIIc and IXa (Portugal and North Spain) a biomass of 399 thousand tonnes (7081 million fish) was estimated. 232 thousand tonnes (5244 million fish) were estimated in IXa (South Spain, Gulf of Cádiz). Table 8.7 shows the number of fish (millions), biomass (tonnes), mean length, mean weight and percentage in number and in weight by age group and area. The highest concentrations of sardine were detected in the southern part of Division IXa South (Figure 8.4), where young fish (1-group) were mainly distributed and represented 70% of the total abundance in number and 63% of the total biomass. The

estimated abundance in North Spain (VIIIc and IXa North) was extremely low, with only 17 thousand tonnes (246 million fish), representing only 2.7% of the total biomass estimated. In Division VIIIc sardine were distributed in isolated patches, close to the coast. This did not allow *in situ* sardine samples to be taken and, therefore, commercial samples had to be used. These samples were collected along the coast, but for age determination, samples were taken in North and South Galicia together using a pelagic trawl.

Ages 3 and 4 were dominant in most areas, comprising 69% of the total abundance and 72% of the total biomass, thus indicating that the recruitment, of both the 1991 and 1992 year classes, is better than that of the 1993 and 1994 year classes.

Results in the Spanish area are not consistent with those found in previous surveys. The low abundance and biomass estimated, especially in Division VIIIc, could be related to the low density of coverage (15 n.m. between transects). Sardine seemed to be distributed in this area in small, isolated patches, close to the coast, whereas in Portugal they were distributed further offshore and were more concentrated. This different pattern of distribution in the Spanish area could reduce the probability of sardine being found with this survey track and could lead to an underestimation of the total abundance. Furthermore such a low density of coverage would give a low precision to the biomass estimate as shown by Porteiro *et al.* (1995, in press). The same problem occurred in the 1986 and 1987 surveys, which also had a low density of coverage. In that case the analysis of the Spanish survey data showed that tracks with more than 10 nautical miles between transects produced a relative standard error between 23% to 40%.

The lack of older ages in Division VIIIc East was attributed to the lack of positive fishing stations in this area and the high abundance of 3 and 4 year olds found in the samples taken in North Galicia, which was the closest one to this area.

On the other hand, the high abundance of horse mackerel detected during this survey in the Cantabrian waters, as well as the presence of high concentrations of anchovy in Division IXa Central North, could also explain the apparent anomalous behaviour of the sardine.

Results of the acoustic survey carried out in 1995 are shown in Table 8.8a. Table 8.8b gives the abundance estimates of sardine from acoustic surveys form 1986 to 1993 carried out by Spain and Portugal, the total biomass (B) from these acoustic surveys and the annual catches by country.

From all the available distribution areas of sardine on the different acoustic survey carried out by both countries (Anon. 1993. Porteiro *et al.* 1993, Dias *et al.* WD 1993 and Marques *et al.* WD, 1995), it seems that the area of distribution of the sardine stock along the coast is shrinking. During the first surveys, sardine shows a continuos distribution along the Atlantic waters of the Iberian Peninsula and were either concentrated close to shallow waters or spread out to the 200 m isobath (Anon. 1993b). Since 1993, large areas, especially in Divisions IXa North and VIIIc, appear to be without sardine or with sardine distributed only in small patches.

### 8.6 Length Compositions by Fleet and by Country

In 1994 the quarterly and annual catch length compositions by fleet were provided by Portugal and Spain in Divisions VIIIc and IXa (Table 8.9) and were provided by UK (England and Wales) in Division VIIe (Table 8.10) for the 1st quarter.

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

### 8.7 Catch in Number at Age

Based on data submitted by Working Group members, the 1994 catch in number at age data were compiled by quarter and sub-divisions of Divisions VIIIc and IXa (Table 8.11).

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 1994 catches of 0-group were higher than those in 1993, and were double the catches of 1-group fish. They were distributed in almost all sub-divisions. The oldest ages (above age group 6) occurred mainly in the catches of Division VIIIc, especially in the eastern part (Table 8.11).

The annual catch in number at age for the period 1976 to 1994 is presented in Table 8.12 and Figure 8.5 shows the annual catch in number at age from 1980 to 1994. The strongest year classes (1983, 1987 and 1991) can be easily followed. Nevertheless there seems to be an inconsistency in the age groups 2 and 3 in the 1986 distribution. In 1984 and 1985 the 1983 year class was the strongest, comprising more than 50% of the total catch, while the 1984 year class was poorly represented. However, in 1986 the 1984 year class appeared to be bigger than the 1983 year class.

### 8.8 Mean Length at Age and Mean Weight at Age

The 1994, mean lenghts 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) (Table 8.13).

The mean weights at age in the catch in 1994 were based on Spanish and Portuguese biological sampling. Table 8.14 shows the mean weight at age by subdivision and quarter. The 1994 mean weights at age in the catch are slightly higher than in 1993 (Table 8.15). Table 8.16 shows the mean weights at age in the stock for the period 1976-1994. The mean weights at age in the stock have been calculated from commercial sampling during the period December 1993-January 1994. It seems that there are differences in the mean weight at age in the stock in 1994, which are lower than in 1993 but similar to previous years. Mean weight for 1-group was the highest one in the time series. Mean weight for 2-group during the Spanish-Portuguese acoustic survey 1995 "IBERSAR 95" was also high, especially in Division VIIIc (Marques *et al.* WD, 1995).

### 8.9 Maturity at Age

The maturity ogive for 1994 was estimated using the first quarter data from Portuguese and Spanish biological sampling (Table 8.17). Of a total of 1,573 individuals examined 1,461 were mature. The percentage of mature at age 1 in 1994 (80%) is higher than for the same age in 1993 (47%), but similar to that of 1992 (79%). For ages older than 1 the percentage of mature is similar to that in recent years.

### 8.10 Stock Assessment

The available data for tuning the current VPA are given in Table 8.18. 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. Catch at age data for ages 0 to 6+ were available from the fishery (Table 8.12).

The fishery independent data used for tuning the current VPA was (1) Spanish Spring acoustic surveys (1988-1995) and Portuguese Winter acoustic surveys (1984-1995) ( Table 8.18).

Catches from this stock are mostly from the Portuguese coastal region and are comprised of fish less than six years old. Portuguese acoustic surveys find fish of a similar range of ages, but Spanish acoustic surveys in the Cantabrian Sea have reported significant abundances of fish aged up to 12 years.

The fish in Divisions VIIIc and IXa are believed to comprise a unit stock. Few young fish are found in Division VIIIc and IXa North, yet the cohort strength in this area reflects the cohort strengths in the Portuguese fishery and survey in previous years. The evidence that the sardine migrate out of Division IXa into Division VIIIc at older ages was first described in Porteiro *et al.* (1986) using the age distribution from acoustic surveys and fisheries along the Iberian Peninsula. The different age structure along the Atlantic water was later confirmed by Porteiro *et al.* (1993) from the analysis of the Spanish spring acoustic surveys 1986-1994 and by Marques *et al.* (WD 1995). The strongest year classes, 1983, 1987 and 1991, during this period were firstly found in Division IXa, at young ages (Anon. 1995). Subsequently, these age groups were mainly distributed, at ages older than 6, in the Eastern part of the Cantabrian waters (Division VIIIc East).

Such migration out of the main fishing area violates the conventional VPA assumption that there is no emigration from the exploited stock. Exploratory analyses carried out by the Working Group in 1994 indicated that separable model fits completed over the age-range of the catches were strongly sensitive to assumptions made about terminal selection. VPA methods also show this sensitivity.

In this years' assessment the Working Group attempted to formulate a population model that would allow for emigration from the exploited area, and would include the observations from Spanish surveys on the abundance of the older fish. It should also allow for declining selection on the older ages in the catch at age matrix. The model 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 change in the age-reading criteria applied.
- 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 structure provides for the known emigration of fish from the main catching area.

With conventional notation, (Population abundance at the time of the survey $N^*$, fishing mortality F, selection pattern S, age a, year y, Portuguese acoustic survey APO, Spanish acoustic survey ASP, catch at age observations C, weighting factor lambda, catchability by surveys QSP and QPO), the model parameters (Fishing mortality at reference age 2, terminal populations, and selection at age) were obtained by a minimisation of:

$$\sum_{a,y} \lambda_{a,y} \left(\ln(C_{a,y}) - \ln(\hat{C}_{a,y})\right)^2 +$$

$$\sum_{a,y} \left(\ln(ASP_{a,y}) - \ln(QSP_a \cdot N^*_{a,y})\right)^2 +$$

$$\sum_{a,y} \left(\ln(APO_{a,y}) - \ln(QPO_a \cdot N^*_{a,y})\right)^2$$

Values of lambda were arbitrarily set to 0.5 for age 0 and to age 1 for 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.
The Spanish survey observations in 1986 and 1987 were removed from the analysis as coverage by the surveys in those years has been incomplete.

The combined Spanish-Portuguese survey in 1995 was included in the assessment by constraining fishing mortality in 1995 equal to that in 1994. The Spanish part of the survey (Division VIIIc) was treated as consistent with the previous Spanish survey observations, and the Portuguese part of the survey (Divisions IXa Central and IXa South). This latter assumption was made despite the difference in the timing between the usual Portuguese survey in June and the combined survey in November. Sensitivity of the model fit to removing the Portuguese part of the combined survey was tested, and found to have only a small effect on the recruitment estimates. The survey information was therefore retained. Sampling from the combined survey was poor for the older ages in 1995 and these observations were treated as missing.

Parameter estimates and fitted populations are given in Table 8.19. and are illustrated in Figure 8.6a-f . The fishing mortalities estimated by this assessment method are intermediate between those in the two options presented in Anon. (1995b), and the overall population trends are similar. Fishing mortality appears to have been rather stable at about 0.3 in recent years, which is slightly less than the estimated natural mortality. Recent recruitment appears to have been low, and the spawning stock size appears to have been declining.

The fitted QSP and QPO parameters for the two surveys agree well with current perceptions of migrations in the stocks (Figure 8.7). This shows rather clearly the higher availability of the younger fish in the Portuguese surveys and of the older fish in the Spanish surveys. At each age, the summed catchability for the two surveys is close to unity, which one would expect if the surveys are made with appropriate target-strength estimates and record absolute measures of stock size. The comparison of the two age-specific QSP and QPO parameters suggests that fish migrate from the Portuguese to the Spanish area between about their third and sixth years of life.

### 8.11 Recruitment

Trends in recruitment are shown in Figure 8.6a. The estimates of recruitment at age 0 from the model fit was high in 1983 and 1991 but very low since 1993.

### 8.12 Catch Predictions

The input data for the deterministic catch forecast are given in Table 8.20, assuming the mean F for the years 1991-1994 from the model fit for ages 2-5 ($F_{status\ quo}$). A terminal population obtained from the assessment was used as starting populations on 1 January 1995. Recruitment for 1995 was the estimated value from the assessment, and values for 1996 and 1997 were the geometric mean estimated from the time series (1976-1994). Mean catch weights, stock weights and maturity at age over the period 1991-1994 were used.

Table 8.21 summarises the predictions carried out for the period 1995-1997. For the $F_{status\ quo}$ the catch predicted will be about 94,000 t in 1995 and 67,000 t in 1996. The spawning stock biomass will decrease from 220,000 t in 1995 to 135,000 t in 1996.

### 8.13 Short-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. Recruitment varied around the geometric mean with autocorrelated errors. The value selected for MBAL was the estimated SSB in 1995, which was the lowest estimated since 1976.

Results of deterministic projections obtained using ICPROJ were compared with the ones obtained using the traditional methodology. Predicted catches by the two methods for 1995 and 1996 showed differences that were below 1% for runs under same conditions of exploitation pattern and recruitment.

Under $F_{status\ quo}$ conditions, predicted catches using the deterministic traditional projections fall within the 25th and 75th percentiles of the predicted catches using stochastic projections. The population projections were also performed for 1996 to 1997 for catches increasing from 0 to 250,000 tonnes. The estimated probability of falling below MBAL in 1996 is above 40% for all catch levels including the case of fishery closure (Figure 8.9a). For a similar catch level to the one observed in 1994 (133,000), the risk is close to 70% in both years (Figures 8.9a and b). Figure 8.10a-d shows the predicted total landings, fishing mortality, recruitment and stock size with confidence intervals in 1996 and 1997 at four different catch levels: 50, 75, 100 and 125 thousand tons.

### 8.14 Medium Term Projections

The same method was used to estimate total landings, fishing mortality, recruitment and stock size for the period starting in 1995 to the year 2000. Estimated catches, recruitment and stock size with their confidence intervals for F *status quo* are shown in Figure 8.11.a. The probability of SBB falling below MBAL is shown in Figure 8.11.b.

The trends of the median Spawning Stock Biomass and the risk of falling below MBAL in each year for various levels of fishing mortality, (F-multiplier from 0.25 to 2, step 0.25) are shown in Figures 8.12 a and b. After an initial decrease in median SSB all scenarios show a recovery from 1998. The probability of falling below MBAL for $F_{status\ quo}$ decreases from close to 50% to less than 20% at the end of the period considered. In Figure 8.13 the predicted median catches for all F levels are shown.

All these scenarios were carried out under the hypothesis of a recruitment independent of the SSB, recruitment varying around the geometric mean. At levels of SSB below the historical level, which are likely in most scenarios in 1996, there is no evidence to support this hypothesis. Thus, the prospect of recovery may be too optimistic.

### 8.15 Long-Term Yield

The input data for the Yield-per-Recruit is given in Table 8.20. The long-term trends in yield and spawning stock biomass against the average fishing mortality (ages 2-5) are given in Table 8. 22 and Figure 8.8-C.

### 8.16 Comments on the Assessment

The principal cause for concern in the assessment of this stock is the estimation of recruitment in 1995. The Portuguese part of the acoustic survey was carried out too early in the year fully to represent the strength of this year-class, which may have been underestimated. However, biomass appears to be declining in this stock, and recruitment appears to have been low for the last three years in succession. Calculating a catch projection on the basis of the estimated low but uncertain recruitment may be overly pessimistic, but in contrast an assumption of geometric mean recruitment, given the recent trends in the fishery, is not a cautions choice.

### 8.17 Management Considerations

The fishing mortality levels of $F_{high}$, $F_{med}$ and $F_{low}$ were estimated from the plot of recruitment against SSB (Figure 8.14).

For the assessment the spawning stock biomass shows a decline from 1985 to 1991, a slight increase in 1992 and 1993 and a decrease in 1994. The yield has declined continuously since 1986 and the fishing mortality shows a decreasing trend from 1990. After 1983 no very strong year classes occurred, those of 1987 and 1991 appears to be on a good level. The 1993 and 1994 year classes are the lowest of the reported series.

For this stock:

$F_{high} > 0.91$, $F_{status\ quo} = 0.4098$, $F_{med} = 0.287$ and $F_{low}$ is undefined.
The $F_{status\ quo}$ is below $F_{med.}$

Contraction in the area of distribution, the decline of the catches (mainly in Division VIIIc) and the decreasing trend in the recruitment since 1983 and the low recruitment in the last three years, could indicate that the stock is not in good health. Both, stochastic and deterministic methods, show, for short-term projections, a decrease in the SSB. Stochastic medium-term projections, assuming recruitment at the geometric mean, however indicate that the probability of falling below MBAL for $F_{status\ quo}$ could decreases from close to 50% to less than 20% at the year 2000.

**Table 8.1** Landings (t) of SARDINE by country. (Data provided by the Working Group members).

**SARDINE VII**

| Country | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | | |
|---|---|---|---|---|---|---|---|---|
| France | 1,124 | 907 | 803 | 809 | 2,089 | 2,570 | | |
| UK (England & Wales) | | | | | | | | |
| | **1987** | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** |
| Denmark | | | | | - | 17,843 | - | 17,327 |
| France | 965 | 2,586 | 1,141 | 1,107 | 1,957 | 1,769 | 585 | 272 |
| UK (England & Wales) | | | | | 3,011 | 4,494 | 4,917 | 2,061 |
| Netherlands | | | | - | - | 42 | - | |
| **Total** | | | | **1,107** | **4,968** | **24,148** | **5,502** | **19,660** |

**SARDINE VIII**

| Country | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | | |
|---|---|---|---|---|---|---|---|---|
| France | | | | | | | | |
| Spain | 50,260 | 51,901 | 36,149 | 43,522 | 18,271 | 35,787 | | |
| | **1981** | **1982** | **1983** | **1984** | **1985** | **1986** | | |
| France | 9,676 | 5,928 | 6,467 | 4,491 | 8,169 | 10,229 | | |
| Spain | 33,550 | 31,756 | 32,374 | 217,970 | 25,907 | 39,195 | | |
| **Total** | **43,226** | **37,684** | **38,841** | **32,461** | **34,076** | **49,424** | | |
| | **1987** | **1988** | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** |
| France | 7,708 | 7,808 | 8,976 | 8,485 | 9,637 | 8,713 | 5,329 | 7,283 |
| Spain | 36,377 | 40,944 | 29,856 | 27,500 | 20,735 | 26,160 | 24,486 | 22,181 |
| UK England & Wales | | | | | | 1 | - | |
| **Total** | **44,085** | **48,752** | **38,832** | **35,985** | **30,372** | **34,874** | **29,815** | **29,464** |

**SARDINE IX**

| Country | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | | 1981 |
|---|---|---|---|---|---|---|---|---|
| Portugal | 95,877 | 79,649 | 79,819 | 86,553 | 91,294 | 106,302 | | 113,253 |
| Spain | 12,236 | 10,140 | 9,782 | 12,915 | 43,876 | 49,593 | | 65,330 |
| **Total** | **108,113** | **89,789** | **89,601** | **96,468** | **135,170** | **155,895** | | **178,583** |
| | **1982** | **1983** | **1984** | **1985** | **1986** | **1987** | | **1988** |
| Portugal | 100,859 | 85,922 | 95,110 | 111,709 | 103,451 | 90,1214 | | 93,591 |
| Spain | 71,889 | 62,843 | 79,606 | 66,491 | 37,960 | 42,234 | | 24,005 |
| **Total** | **172,748** | **148,765** | **174,716** | **178,200** | **141,411** | **132,448** | | **117,596** |
| | **1989** | **1990** | **1991** | **1992** | **1993** | **1994** | | |
| Portugal | 91,091 | 92,404 | 92,638[1] | 83,315 | 90,404 | 94,468 | | |
| Spain | 16,179 | 19,253 | 14,383 | 16,579 | 23,905 | 16,151 | | |
| **Total** | **107,270** | **111,657** | **107,021** | **99,894** | **114,309** | **110,619** | | |

[1]Portuguese catches of 1991 included 5,492 t of discards.
(-)Unknown catches.

**Table 8.2** Annual landings (t) of SARDINE by Division and Sub-area. (Data provided by the Working Group members).

| Division | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|
| VIId | 172 | 59 | 211 | 147 | 465 | 512 |
| VIIe | 952 | 828 | 590 | 661 | 1,624 | 2,058 |
| VIIf | - | 20 | - | - | | |
| VIIg | | - | - | 1 | - | |
| VIIh | | | 2 | - | | |
| **Total VII** | **1,124** | **907** | **803** | **809** | **2,089** | **2,570** |
| VIIIa | 8,482 | 5,928 | 6,013 | 4,472 | 8,090 | 10,186 |
| VIIIb | 1,194 | | 454 | 19 | 79 | 77 |
| VIIIc | 35,550 | 31,756 | 32,374 | 27,970 | 25,907 | 39,195 |
| VIIId | | | | | | |
| **Total VIII** | **45,226** | **37,684** | **38,841** | **32,461** | **34,076** | **49,458** |
| **Total IXa** | **178,583** | **172,748** | **148,765** | **174,716** | **178,200** | **141,411** |
| TOTAL YEAR | 224,933 | 211,339 | 188,409 | 207,986 | 214,365 | 193,439 |

| Division | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|
| IVb | | | | | - | - | - | |
| IVc | | | | | - | 8 | 19 | |
| **Total IV** | | | | | | - | - | |
| VIa | | | | | - | 1 | | - |
| VIId | 67 | 29 | 93 | 64 | 170 | 153 | 127 | 2,086 |
| VIIe | 682 | 438 | 91 | 808 | 4,687 | 19,299[1] | 5,298 | 20,985 |
| VIIf | | | | | - | 335 | 6 | |
| VIIg | | | | | - | 0 | 0 | 0 |
| VIIh | 216 | 2,119 | 957 | 235 | 110 | 4 | 71 | |
| **Total VII** | **965** | **2,586** | **1,141** | **1,107** | **4,968** | **19,682** | **5,502** | **23,071** |
| VIIIa | 7,631 | 7,770 | 8,885 | 8,381 | 9,113 | 8,565 | 4,703 | 7,164 |
| VIIIb | 77 | 38 | 85 | 104 | 482 | 141 | 548 | 119 |
| VIIIc | 36,377 | 40,944 | 29,862 | 27,500 | 20,735 | 26,166 | 24,486 | 22,181 |
| VIIId | | | | | 42 | 2 | 78 | 0 |
| **Total VIII** | **44,085** | **48,752** | **38,832** | **35,985** | **30,372** | **34,874** | **29,815** | **29,464** |
| **Total IXa** | **132,448** | **117,596** | **107,270** | **111,657** | **107,021** | **99,894** | **114,309** | **110,619** |
| TOTAL YEAR | 177,498 | 168,934 | 147,243 | 148,749 | 142,361 | 154,569 | 149,645 | 163,154 |

Sub-area VII - 1981-1990 only French data were available.
[1]17,507 t from Divisions VIId + VIIe, caught by Denmark.
(-) Unknown catches.

**Table 8.3** Annual landings (t) of SARDINE in Divisions VIIIc and IXa by country.

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

| | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|
| Portugal | 100,859 | 85,922 | 95,110 | 111,709 | 103,451 | 90,214 |
| Spain | 103,645 | 95,217 | 107,576 | 92,398 | 77,155 | 78,611 |
| Total | 204,504 | 181,139 | 202,686 | 204,107 | 180,606 | 168,825 |

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995[2] |
|---|---|---|---|---|---|---|---|---|
| Portugal | 93,591 | 91,091 | 92,404 | 92,638[1] | 83,315 | 90,404 | 94,468 | 31,353 |
| Spain | 64,949 | 46,035 | 46,753 | 35,118 | 42,739 | 48,391 | 38,332 | 12,512 |
| Total | 158,540 | 137,126 | 139,157 | 127,756 | 126,054 | 138,795 | 132,800 | 43,865 |

[1]Discards included.

[2]Preliminary landings from 1 September.

**Table 8.4** SARDINE (VIIIc + IXa)
Quarterly catches (t) by gear by country and fleets in 1994 (Provided by the WG members)

| Country/Quarter | 1st | 2nd | 3rd | 4th | Year |
|---|---|---|---|---|---|
| **Total** | **19315** | **23696** | **44774** | **45015** | **132800** |
| **Spain (VIIIc + IXa):** | | | | | |
| Purse-seine | 8654 | 8190 | 10352 | 11136 | 38332 |
| **Portugal (IXa):** | 10661 | 15506 | 34422 | 33879 | 94468 |
| Purse-seine | 10122 | 14742 | 32604 | 32974 | 90443 |
| Artisanal | 331 | 626 | 1721 | 692 | 3370 |
| Trawl | 207 | 138 | 97 | 213 | 655 |

**Table 8.5** SARDINE (VIIIc +IXa)
Total nominal catches (t) by Quarter and Areas of Divisions VIIIc and IXa during 1994

| Area | 1st | 2nd | 3rd | 4th | Total 1994 |
|---|---|---|---|---|---|
| VIIIc East | 3366 | 367 | 1663 | 2306 | 7702 |
| VIIIc West | 2192 | 2800 | 5225 | 4262 | 14479 |
| IXa North | 3096 | 5024 | 3464 | 4567 | 16151 |
| IXa Central-North | 1667 | 7044 | 19524 | 20901 | 49136 |
| IXa Central-South | 6252 | 4753 | 9920 | 9465 | 30390 |
| IXa South (>7°24' W) | 2741 | 3709 | 4978 | 3514 | 14942 |
| Total | 19314 | 23697 | 44774 | 45015 | 132800 |

**Table 8.6** 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/fday |
| 1982 | | | | | 7,685 | 4.87 | | |
| 1983 | | | | | 7.863 | 4.01 | | |
| 1984 | | | | | 8,369 | 4.65 | | |
| 1985 | | | | | 5,731 | 4.86 | | |
| 1986 | | | | | 3,541 | 4.23 | | |
| 1987 | | | 4,455 | 2.07 | 4,099 | 4.71 | | |
| 1988 | | | 4,192 | 2.34 | 3,601 | 2.75 | 22,080 | 3.91 |
| 1989 | 314 | 4.10 | 4,008 | 1.95 | 3,059 | 2.45 | 21,432 | 3.93 |
| 1990 | 389 | 3.65 | 3,465 | 1.55 | 3,488 | 2.80 | 25,710 | 3.50 |
| 1991 | 394 | 3.13 | 2,891 | 0.93 | 3,279 | 2.44 | 21,798 | 3.56 |
| 1992 | 570 | 1.63 | 2,619 | 1.42 | 3.790 | 2.44 | 26,418 | 2.97 |
| 1993 | 498 | 1.70 | 2,054 | 2.07 | 4,758 | 2.66 | 21,659 | 3.61 |
| 1994 | 274 | 4.00 | 2,029 | 2.03 | 4,452 | 2.28 | 22,123 | 4.05 |

Table 8.7: Number of fish (millions), biomass (tonnes), mean length (cm), mean weight (g) and percentage in number and weight by age group and area during the 1995 acoustic survey

AREA: VIIIc East

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 0.1 | 0.1 | 20.25 | 3.8 | 0.1 | 63.3 |
| II | 0.2 | 0.2 | 20.75 | 12.3 | 0.2 | 68.3 |
| III | 18.0 | 24.8 | 21.53 | 1409.7 | 22.5 | 76.7 |
| IV | 30.5 | 42.0 | 21.76 | 2465.9 | 39.4 | 79.3 |
| V | 13.2 | 18.1 | 22.79 | 1218.9 | 19.5 | 91.7 |
| VI | 6.6 | 9.1 | 23.60 | 682.7 | 10.9 | 102.3 |
| VII | 4.1 | 5.6 | 24.23 | 460.8 | 7.4 | 111.1 |
| Total | 72.7 | | 22.20 | 6254.1 | | 84.4 |

AREA: VIIIc West

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 0.1 | 0.4 | 19.56 | 8.8 | 0.3 | 56.7 |
| II | 0.6 | 1.6 | 19.86 | 36.2 | 1.3 | 59.5 |
| III | 14.4 | 39.0 | 20.94 | 1035.7 | 37.9 | 70.3 |
| IV | 18.3 | 49.8 | 21.23 | 1375.2 | 50.4 | 73.4 |
| V | 2.4 | 6.4 | 21.77 | 190.9 | 7.0 | 79.4 |
| VI | 0.4 | 1.0 | 22.10 | 32.3 | 1.2 | 83.2 |
| VII | 0.7 | 1.8 | 21.38 | 51.0 | 1.9 | 75.0 |
| Total | 36.9 | | 21.13 | 2730.2 | | 72.3 |

AREA: IXa North

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 18.1 | 13.3 | 17.59 | 775.8 | 9.6 | 40.6 |
| II | 15.9 | 11.6 | 18.53 | 798.9 | 9.9 | 47.9 |
| III | 65.0 | 47.6 | 19.72 | 3929.2 | 48.5 | 58.2 |
| IV | 31.8 | 23.3 | 20.47 | 2151.5 | 26.6 | 65.4 |
| V | 3.5 | 2.6 | 22.10 | 298.2 | 3.7 | 83.2 |
| VI | 1.5 | 1.1 | 19.81 | 89.2 | 1.1 | 59.0 |
| VII | 0.7 | 0.5 | 21.14 | 52.4 | 0.6 | 72.4 |
| Total | 136.6 | | 19.54 | 8095.3 | | 56.5 |

AREA: IXa Central North

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 113.7 | 8.4 | 16.06 | 3735.2 | 0.0 | 32.5 |
| II | 143.0 | 10.6 | 16.99 | 5538.8 | 0.1 | 38.4 |
| III | 264.1 | 19.6 | 19.69 | 15880.0 | 0.2 | 59.6 |
| IV | 472.2 | 34.9 | 20.55 | 32239.0 | 0.4 | 67.7 |
| V | 354.4 | 26.2 | 21.47 | 27414.0 | 0.3 | 77.1 |
| VI | 3.6 | 0.3 | 22.75 | 334.0 | 0.0 | 91.6 |
| VII | | | | | | |
| Total | 1351.0 | | 19.87 | 85141.0 | | 61.3 |

Table 8.7 (continued)

AREA: IXa Central South

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 20.2 | 1.0 | 16.86 | 764.7 | 0.6 | 37.6 |
| II | 19.4 | 0.9 | 17.52 | 820.3 | 0.6 | 42.1 |
| III | 613.3 | 29.0 | 19.26 | 34419.6 | 26.3 | 55.8 |
| IV | 1211.5 | 57.4 | 19.97 | 75892.6 | 58.0 | 62.2 |
| V | 178.9 | 8.5 | 21.06 | 13118.8 | 10.0 | 72.8 |
| VI | 68.2 | 3.2 | 22.26 | 5876.0 | 4.5 | 85.9 |
| VII | | | | | | |
| Total | 2111.4 | | 19.88 | 130892.0 | | 61.4 |

AREA: IXa South

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 15.5 | 0.5 | 13.75 | 318.0 | 0.2 | 20.5 |
| II | 161.3 | 4.8 | 17.25 | 6505.5 | 3.9 | 40.2 |
| III | 1164.1 | 34.5 | 17.93 | 52826.4 | 31.8 | 45.1 |
| IV | 1723.2 | 51.1 | 18.56 | 87201.7 | 52.4 | 50.0 |
| V | 280.8 | 8.3 | 20.00 | 17624.0 | 10.6 | 62.5 |
| VI | 26.8 | 0.8 | 20.60 | 1838.4 | 1.1 | 68.2 |
| VII | | | | | | |
| Total | 3371.9 | | 18.39 | 166314.0 | | 48.7 |

AREA: IXa Cádiz

| AGE GROUPS | No | % | Mean Length | Biomass | % | Mean Weight |
|---|---|---|---|---|---|---|
| I | 535.2 | 10.2 | 13.01 | 9871.4 | 4.3 | 17.4 |
| II | 1817.2 | 34.7 | 17.56 | 77795.9 | 33.5 | 42.4 |
| III | 2436.4 | 46.5 | 18.31 | 117858.2 | 50.7 | 48.0 |
| IV | 441.6 | 8.4 | 19.54 | 25818.3 | 11.1 | 58.3 |
| V | 13.5 | 0.3 | 20.39 | 895.0 | 0.4 | 66.2 |
| VI | | | | | | |
| VII | | | | | | |
| Total | 5243.9 | | 17.62 | 232238.8 | | 42.8 |

**Table 8.8a** Sardine in Divisions VIIIc and IXa. Abundance estimates from acoustic survey 1995.

| Age | Spain Divs VIIIc and IXa | Portugal Div IXa | Spain IXa Cádiz | Total |
|---|---|---|---|---|
| 1 | 18 | 149 | 535 | 704 |
| 2 | 17 | 324 | 1817 | 2160 |
| 3 | 97 | 2042 | 2436 | 4578 |
| 4 | 81 | 3407 | 442 | 3933 |
| 5 | 19 | 814 | 14 | 852 |
| 6 | 9 | 99 | - | 113 |
| 7 | 6 | - | - | 13 |
| 6+ | 14 | 99 | - | 126 |
| Total biomass (B) | 17 | 382 | 232 | 632 |

Numbers in millions.
Biomass in thousands tonnes.

**Table 8.8b** Sardine in Divisions VIIIc and IXa. Abundance estimates from acoustic surveys 1986-1993.

| Age | 1986 | | | | 1987 | | | 1988 | | | 1990 | 1991 | 1992 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spain Divs. VIIIc and IXa | Portugal Division IXa | | | Spain Divs. IIIc and IXa | Portugal Division IXa | | Spain Divs. VIIIa and IXa | Portugal Division IXa | | Spain Divs. VIIIc and IXa(N) | Spain Divs. VIIIc and IXa(N) | Spain Divs. VIIIc & IXa(N) | Portugal Div. IXa | Spain Divs. VIIIc & IXa(N) |
| | Mar | Mar | Aug | Dec | Mar | Aug | Nov | Apr | Mar | Aug | Apr | Mar/Apr | Apr/May | Nov | Apr |
| 0 | - | - | 4,007 | 2,493 | - | 4,546 | 3,715 | - | - | 3,139 | - | - | - | 4,637 | - |
| 1 | 55 | 2,344 | 2,729 | 1,612 | 44 | 1,203 | 2,379 | 221 | 7,743 | 1,823 | 69 | 25 | 159 | 5,944 | 242 |
| 2 | 21 | 4,025 | 2,492 | 1,670 | 36 | 1,408 | 1,344 | 63 | 2,684 | 989 | 56 | 150 | 76 | 1,205 | 324 |
| 3 | 1,040 | 1,544 | 718 | 658 | 4 | 1,102 | 928 | 72 | 1,617 | 802 | 274 | 126 | 85 | 817 | 92 |
| 4 | 215 | 518 | 21 | 323 | 398 | 670 | 666 | 64 | 1,447 | 426 | 55 | 314 | 29 | 307 | 83 |
| 5 | 409 | 471 | 0 | 127 | 118 | 163 | 236 | 858 | 804 | 70 | 88 | 51 | 115 | 38 | 83 |
| 6 | 279 | 21 | 0 | 50 | 85 | 46 | 49 | 175 | 425 | 90 | 134 | 79 | 24 | 1 | 267 |
| 7 | 192 | - | - | 0 | 98 | 30 | 31 | 310 | 104 | - | 249 | 56 | 20 | 0 | 27 |
| 8 | 50 | - | - | - | 40 | - | - | 342 | - | - | 70 | 345 | 12 | - | 74 |
| 9 | 36 | - | - | - | 14 | - | - | 53 | - | - | 49 | 29 | 57 | - | 71 |
| 10 | 12 | - | - | - | 7 | - | - | 18 | - | - | 46 | 71 | 3 | - | 226 |
| 11 | 3 | - | - | - | 1 | - | - | - | - | - | 23 | 6 | 9 | - | 79 |
| 12 | - | - | - | - | - | - | - | - | - | - | 8 | 2 | - | - | - |
| 6+ | 572 | 21 | 0 | 50 | 245 | 76 | 80 | 898 | 529 | 90 | 445 | 588 | 125 | 1 | 744 |
| Total biomass(B) | 161 | 318 | 332 | 283 | 65 | 316 | 323 | 176 | 481 | 243 | 97 | 106 | 45 | 564 | 126 |
| Annual catch (Y) | 77 | | 103 | | 79 | | 90 | 65 | 94 | | 47 | 35 | 43 | 83 | 24 |
| Y/B | 0.479 | 0.325 | 0.312 | 0.366 | 1.209 | 0.285 | 0.279 | 0.369 | 0.195 | 0.385 | 0.482 | 0.331 | 0.950 | 0.147 | 0.190 |
| Year | 1986 | | | | 1987 | | | 1988 | | | 1990 | 1991 | 1992 | | 1993 |

Numbers in millions.
Biomass in thousand tonnes.

**Table 8.9** SARDINE in Divisions VIIIc and IXa. Purse seine catch length distribution ('000) by country and quarter in 1994

| | QUARTER 1 | | | | QUARTER 2 | | | | QUARTER 3 | | | | QUARTER 4 | | | | YEAR 1994 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | Portugal | Spain | Spain | | Portugal | Spain | Spain | | Portugal | Spain | Spain | | Portugal | Spain | Spain | | Portugal | Spain | Spain | |
| (cm) | IXa | IXa | VIIIc | TOTAL | IXa | IXa | VIIIc | TOTAL | IXa | IXa | VIIIc | TOTAL | IXa | IXa | VIIIc | TOTAL | IXa | IXa | VIIIc | TOTAL |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 8.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 37 | 49 | 0 | 0 | 70 | 70 | 0 | 11 | 2 | 13 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 83 | 141 | 0 | 0 | 1,090 | 1,090 | 0 | 57 | 8 | 66 |
| 9.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 126 | 72 | 199 | 0 | 0 | 3,200 | 3,200 | 0 | 126 | 108 | 234 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 609 | 11 | 619 | 133 | 0 | 3,340 | 3,473 | 133 | 609 | 1,173 | 1,915 |
| 10.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,619 | 1 | 1,620 | 133 | 0 | 2,321 | 2,454 | 133 | 1,619 | 3,272 | 5,024 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 117 | 1,642 | 0 | 1,759 | 2,024 | 0 | 1,512 | 3,536 | 2,141 | 1,642 | 3,351 | 7,134 |
| 11.5 | 261 | 0 | 0 | 261 | 0 | 0 | 0 | 0 | 903 | 1,344 | 0 | 2,247 | 2,975 | 48 | 387 | 3,410 | 4,140 | 1,391 | 2,321 | 7,853 |
| 12 | 477 | 0 | 0 | 477 | 251 | 0 | 0 | 251 | 3,471 | 758 | 0 | 4,229 | 4,867 | 0 | 352 | 5,218 | 9,066 | 758 | 1,512 | 11,335 |
| 12.5 | 518 | 0 | 0 | 518 | 2,009 | 0 | 0 | 2,009 | 2,742 | 551 | 541 | 3,834 | 7,229 | 48 | 70 | 7,347 | 12,498 | 599 | 387 | 13,483 |
| 13 | 481 | 7 | 0 | 488 | 5,315 | 0 | 0 | 5,315 | 899 | 287 | 2,108 | 3,294 | 15,421 | 97 | 0 | 15,518 | 22,117 | 391 | 352 | 22,859 |
| 13.5 | 722 | 0 | 0 | 722 | 3,525 | 0 | 0 | 3,525 | 2,198 | 115 | 609 | 2,921 | 14,343 | 171 | 211 | 14,725 | 20,787 | 286 | 611 | 21,685 |
| 14 | 289 | 7 | 0 | 295 | 3,540 | 0 | 0 | 3,540 | 2,727 | 20 | 189 | 2,936 | 11,946 | 404 | 35 | 12,385 | 18,501 | 430 | 2,108 | 21,039 |
| 14.5 | 190 | 46 | 36 | 272 | 1,279 | 9 | 0 | 1,288 | 851 | 0 | 125 | 976 | 10,722 | 347 | 0 | 11,069 | 13,042 | 402 | 820 | 14,263 |
| 15 | 327 | 55 | 23 | 405 | 754 | 35 | 60 | 848 | 1,211 | 20 | 72 | 1,303 | 7,901 | 847 | 0 | 8,748 | 10,194 | 956 | 225 | 11,374 |
| 15.5 | 350 | 238 | 139 | 727 | 914 | 127 | 0 | 1,041 | 504 | 20 | 195 | 719 | 3,839 | 933 | 35 | 4,807 | 5,607 | 1,318 | 160 | 7,085 |
| 16 | 2,212 | 591 | 164 | 2,966 | 1,726 | 560 | 65 | 2,351 | 1,121 | 0 | 314 | 1,435 | 3,208 | 1,781 | 9 | 4,997 | 8,267 | 2,932 | 155 | 11,354 |
| 16.5 | 4,012 | 758 | 198 | 4,969 | 3,136 | 657 | 41 | 3,834 | 1,723 | 17 | 308 | 2,049 | 3,113 | 801 | 35 | 3,949 | 11,984 | 2,234 | 370 | 14,588 |
| 17 | 9,172 | 2,123 | 413 | 11,708 | 15,665 | 1,654 | 10 | 17,329 | 8,682 | 297 | 81 | 9,061 | 5,441 | 1,678 | 4 | 7,123 | 38,960 | 5,752 | 551 | 45,263 |
| 17.5 | 15,605 | 2,410 | 900 | 18,915 | 36,737 | 3,245 | 163 | 40,145 | 34,586 | 444 | 60 | 35,090 | 21,015 | 2,095 | 0 | 23,110 | 107,944 | 8,193 | 582 | 116,720 |
| 18 | 35,813 | 6,323 | 1,161 | 43,296 | 62,421 | 9,418 | 378 | 72,217 | 88,434 | 2,816 | 239 | 91,490 | 59,953 | 3,785 | 2 | 63,741 | 246,621 | 22,343 | 508 | 269,472 |
| 18.5 | 34,551 | 10,168 | 2,096 | 46,816 | 61,381 | 15,748 | 1,043 | 78,172 | 130,832 | 6,230 | 224 | 137,286 | 79,257 | 3,706 | 122 | 83,085 | 306,021 | 35,852 | 1,123 | 342,996 |
| 19 | 28,549 | 10,109 | 4,697 | 43,355 | 42,931 | 16,628 | 3,422 | 62,980 | 105,363 | 9,895 | 1,836 | 117,095 | 83,887 | 6,116 | 1,397 | 91,400 | 260,729 | 42,749 | 1,780 | 305,258 |
| 19.5 | 20,134 | 6,682 | 6,695 | 33,511 | 26,755 | 9,093 | 7,715 | 43,563 | 68,494 | 6,856 | 8,043 | 83,393 | 74,545 | 6,026 | 5,938 | 86,508 | 189,928 | 28,657 | 3,486 | 222,071 |
| 20 | 20,411 | 11,873 | 9,214 | 41,498 | 14,105 | 15,010 | 8,771 | 37,886 | 41,223 | 11,217 | 17,203 | 69,643 | 55,990 | 14,651 | 14,100 | 84,742 | 131,730 | 52,751 | 11,353 | 195,834 |
| 20.5 | 14,576 | 2,923 | 9,821 | 27,320 | 6,744 | 3,590 | 7,126 | 17,460 | 21,979 | 3,771 | 20,155 | 45,904 | 39,286 | 8,307 | 15,025 | 62,617 | 82,586 | 18,590 | 28,391 | 129,566 |
| 21 | 8,043 | 1,828 | 7,344 | 17,216 | 3,436 | 2,398 | 4,897 | 10,731 | 12,012 | 3,250 | 14,760 | 30,022 | 21,588 | 6,762 | 13,155 | 41,504 | 45,079 | 14,239 | 49,287 | 108,605 |
| 21.5 | 3,308 | 585 | 6,679 | 10,572 | 2,123 | 842 | 3,363 | 6,329 | 3,693 | 880 | 8,763 | 13,336 | 10,389 | 2,549 | 10,052 | 22,990 | 19,514 | 4,856 | 52,127 | 76,497 |
| 22 | 2,596 | 1,942 | 6,869 | 11,407 | 476 | 888 | 2,436 | 3,799 | 1,354 | 1,613 | 4,087 | 7,053 | 2,995 | 3,905 | 6,305 | 13,205 | 7,421 | 8,348 | 40,156 | 55,924 |
| 22.5 | 350 | 264 | 6,538 | 7,151 | 55 | 80 | 1,619 | 1,753 | 394 | 339 | 2,482 | 3,215 | 1,852 | 655 | 3,755 | 6,263 | 2,650 | 1,338 | 28,856 | 32,844 |
| 23 | 250 | 165 | 4,941 | 5,357 | 0 | 69 | 968 | 1,037 | 245 | 235 | 1,898 | 2,378 | 312 | 405 | 3,131 | 3,848 | 807 | 874 | 19,697 | 21,378 |
| 23.5 | 54 | 57 | 4,289 | 4,400 | 0 | 0 | 584 | 584 | 0 | 71 | 1,073 | 1,145 | 0 | 5 | 1,892 | 1,897 | 54 | 134 | 14,394 | 14,582 |
| 24 | 0 | 35 | 2,802 | 2,837 | 32 | 0 | 272 | 304 | 0 | 92 | 421 | 514 | 0 | 203 | 1,037 | 1,240 | 32 | 331 | 10,938 | 11,301 |
| 24.5 | 160 | 0 | 1,826 | 1,986 | 0 | 0 | 87 | 87 | 0 | 0 | 111 | 111 | 0 | 0 | 197 | 197 | 160 | 0 | 7,837 | 7,997 |
| 25 | 0 | 0 | 1,130 | 1,130 | 0 | 20 | 101 | 121 | 0 | 8 | 9 | 17 | 0 | 0 | 254 | 254 | 0 | 28 | 4,531 | 4,559 |
| 25.5 | 0 | 0 | 258 | 258 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 23 | 0 | 0 | 2,221 | 2,221 |
| 26 | 0 | 0 | 123 | 123 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,493 | 1,493 |
| 26.5 | | | 35 | 35 | 0 | | 3 | 3 | 0 | | 0 | 0 | 0 | | 22 | 22 | | | 287 | 287 |
| 27 | | | 6 | 6 | 0 | | 1 | 1 | 0 | | 0 | 0 | 0 | | | 0 | | | 125 | 125 |
| 27.5 | | | 21 | 21 | | | 0 | | | | | | | | | | | | 60 | 60 |
| | | | | | | | | | | | | | | | | | | | 7 | 7 |
| | | | | | | | | | | | | | | | | | | | 21 | 21 |
| TOTAL | 203,412 | 59,189 | 78,416 | 341,018 | 295,311 | 80,070 | 43,130 | 418,510 | 535,759 | 55,210 | 86,123 | 677,093 | 544,363 | 66,323 | 89,078 | 699,763 | 1,578,845 | 260,792 | 296,535 | 2,136,172 |
| atch(t) | 10,122 | 3,096 | 5,558 | 18,776 | 14,742 | 5,024 | 3,167 | 22,933 | 32,604 | 3,464 | 6,888 | 42,956 | 32,974 | 4,567 | 6,569 | 44,110 | 90,443 | 16,151 | 22,181 | 128,775 |

**Table 8.10** Sardine in Division VIIe. Catch length composition ('000) by quarter and by gear during 1994.

England Trawl VIIe

| Length (cm) | Quarter 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| 15 | | | | | |
| 16 | | | | | |
| 17 | | | | | |
| 18 | 109 | | | | 109 |
| 19 | 589 | | | | 589 |
| 20 | 1564 | | | | 1564 |
| 21 | 1704 | | | | 1704 |
| 22 | 2352 | | | | 2352 |
| 23 | 3202 | | | | 3202 |
| 24 | 2881 | | | | 2881 |
| 25 | 2163 | | | | 2163 |
| 26 | 684 | | | | 684 |
| 27 | 218 | | | | 218 |
| 28 | 5 | | | | 5 |
| 29 | | | | | |
| 30 | | | | | |
| 31 | | | | | |
| 32 | | | | | |
| Total N | 15471 | | | | 15471 |
| Catch (t) | 1892 | | | | 1892 |
| Mean length | 23.3 | | | | 23.3 |

**Table 8.11** Catch in numbers ('000) at age by quarter and by Sub-division of SARDINE in 1994.

| 1994 Age | VIIIc East 1'st Q catch('000 | VIIIc West 1'st Q atch('000 | IXa North 1'st Q catch('000 | Xa Centr- 1'st Q atch('000 | Xa Centr- 1'st Q atch('000 | IXa South 1'st Q atch('000 | All areas 1'st Q catch ('000) |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 157 | 199 | 913 | 0 | 3,045 | 337 | 4,651 |
| 2 | 4,058 | 8,402 | 25,499 | 3,030 | 13,874 | 12,053 | 66,916 |
| 3 | 9,859 | 14,616 | 25,384 | 14,367 | 55,691 | 28,439 | 148,357 |
| 4 | 4,285 | 3,424 | 3,061 | 6,271 | 32,108 | 10,051 | 59,201 |
| 5 | 8,886 | 3,752 | 2,182 | 3,197 | 19,382 | 4,672 | 42,070 |
| 6 | 4,718 | 1,673 | 937 | 2,006 | 2,320 | 1,277 | 12,930 |
| 7 | 6,166 | 1,851 | 897 | 395 | 1,018 | 124 | 10,452 |
| 8 | 1,159 | 320 | 163 | 0 | 0 | 0 | 1,642 |
| 9 | 2,392 | 448 | 116 | 0 | 0 | 0 | 2,956 |
| 10 | 670 | 104 | 11 | 0 | 0 | 0 | 786 |
| 11 | 954 | 137 | 18 | 0 | 0 | 0 | 1,109 |
| 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 | 43,306 | 34,926 | 59,183 | 29,265 | 127,438 | 56,953 | 351,070 |
| onne | 3,366 | 2,191 | 3,096 | 1,667 | 6,252 | 2,742 | 19,314 |

| Age | VIIIc East 2'nd Q catch('000 | VIIIc West 2'nd Q atch('000 | IXa North 2'nd Q catch('000 | Xa Centr- 2'nd Q atch('000 | Xa Centr- 2'nd Q atch('000 | IXa South 2'nd Q atch('000 | All areas 2'nd Q catch ('000) |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 4 | 85 | 914 | 709 | 17,658 | 0 | 19,369 |
| 2 | 745 | 8,216 | 35,636 | 24,353 | 12,114 | 8,761 | 89,826 |
| 3 | 1,695 | 17,453 | 35,538 | 98,497 | 42,341 | 51,148 | 246,672 |
| 4 | 504 | 3,994 | 4,029 | 11,089 | 17,456 | 13,122 | 50,193 |
| 5 | 734 | 4,166 | 2,267 | 2,941 | 5,852 | 2,014 | 17,973 |
| 6 | 351 | 1,763 | 893 | 1,127 | 789 | 118 | 5,040 |
| 7 | 425 | 1,872 | 599 | 185 | 92 | 0 | 3,173 |
| 8 | 63 | 316 | 117 | 211 | 0 | 0 | 706 |
| 9 | 119 | 381 | 61 | 0 | 0 | 0 | 561 |
| 10 | 25 | 66 | 4 | 0 | 0 | 0 | 95 |
| 11 | 37 | 112 | 12 | 0 | 0 | 0 | 161 |
| 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 | 4,701 | 38,423 | 80,070 | 139,110 | 96,301 | 75,163 | 433,768 |
| onne | 366 | 2,800 | 5,023 | 7,044 | 4,753 | 3,709 | 23,695 |

**Table 8.11 (continued)**

| Age | VIIIc East 3'rd Q catch('000 | VIIIc West 3'rd Q atch('000 | IXa North 3'rd Q catch('000 | Xa Centr- 3'rd Q atch('000 | Xa Centr- 3'rd Q atch('000 | IXa South 3'rd Q atch('000 | All areas 3'rd Q catch ('000) |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 4,505 | 7,190 | 393 | 12,196 | 0 | 24,284 |
| 1 | 475 | 1,547 | 6,046 | 743 | 5,868 | 0 | 14,678 |
| 2 | 6,357 | 22,142 | 23,471 | 99,383 | 54,583 | 32,264 | 238,199 |
| 3 | 7,010 | 24,578 | 13,260 | 173,310 | 82,204 | 37,668 | 338,030 |
| 4 | 1,890 | 5,786 | 2,513 | 20,035 | 24,271 | 9,489 | 63,984 |
| 5 | 1,216 | 2,881 | 832 | 5,417 | 3,642 | 727 | 14,714 |
| 6 | 973 | 2,171 | 754 | 2,720 | 477 | 0 | 7,095 |
| 7 | 1,258 | 2,452 | 974 | 155 | 0 | 0 | 4,839 |
| 8 | 109 | 234 | 64 | 155 | 0 | 0 | 561 |
| 9 | 85 | 228 | 52 | 0 | 0 | 0 | 365 |
| 10 | 24 | 67 | 36 | 0 | 0 | 0 | 127 |
| 11 | 45 | 93 | 19 | 0 | 0 | 0 | 157 |
| 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 | 19,440 | 66,683 | 55,210 | 302,313 | 183,241 | 80,147 | 707,035 |
| onne | 1,663 | 5,224 | 3,464 | 19,524 | 9,920 | 4,978 | 44,773 |

| Age | VIIIc East 4'th Q catch('000 | VIIIc West 4'th Q atch('000 | IXa North 4'th Q catch('000 | Xa Centr- 4'th Q atch('000 | Xa Centr- 4'th Q atch('000 | IXa South 4'th Q atch('000 | All areas 4'th Q catch ('000) |
|---|---|---|---|---|---|---|---|
| 0 | 7 | 12,646 | 4,812 | 13,593 | 65,454 | 0 | 96,513 |
| 1 | 284 | 998 | 7,354 | 5,450 | 7,408 | 0 | 21,494 |
| 2 | 6,888 | 16,336 | 26,008 | 31,304 | 42,646 | 9,040 | 132,222 |
| 3 | 9,365 | 18,955 | 19,104 | 201,195 | 56,877 | 19,887 | 325,384 |
| 4 | 2,935 | 5,038 | 4,053 | 55,502 | 10,766 | 9,792 | 88,087 |
| 5 | 2,035 | 3,030 | 1,679 | 6,684 | 4,202 | 14,248 | 31,878 |
| 6 | 1,947 | 2,319 | 1,403 | 1,203 | 1,874 | 1,434 | 10,182 |
| 7 | 2,282 | 2,805 | 1,525 | 0 | 0 | 0 | 6,613 |
| 8 | 202 | 279 | 152 | 0 | 0 | 0 | 633 |
| 9 | 138 | 191 | 108 | 0 | 0 | 0 | 437 |
| 10 | 52 | 88 | 87 | 0 | 0 | 0 | 227 |
| 11 | 89 | 119 | 36 | 0 | 0 | 0 | 245 |
| 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 | 26,226 | 62,806 | 66,323 | 314,931 | 189,227 | 54,401 | 713,914 |
| onne | 2,306 | 4,263 | 4,567 | 20,901 | 9,465 | 3,513 | 45,015 |

| Age | VIIIc East 1-4 Q catch('000 | VIIIc West 1-4 Q atch('000 | IXa North 1-4 Q catch('000 | Xa Centr- 1-4 Q atch('000 | Xa Centr- 1-4 Q atch('000 | IXa South 1-4 Q atch('000 | All areas 1-4 Q catch ('000) |
|---|---|---|---|---|---|---|---|
| 0 | 7 | 17,151 | 12,003 | 13,987 | 77,650 | 0 | 120,797 |
| 1 | 920 | 2,829 | 15,228 | 6,901 | 33,979 | 337 | 60,194 |
| 2 | 18,048 | 55,096 | 110,614 | 158,070 | 123,217 | 62,118 | 527,163 |
| 3 | 27,929 | 75,603 | 93,287 | 487,368 | 237,114 | 137,142 | 1,058,442 |
| 4 | 9,614 | 18,243 | 13,656 | 92,897 | 84,601 | 42,454 | 261,466 |
| 5 | 12,870 | 13,828 | 6,960 | 18,239 | 33,077 | 21,660 | 106,635 |
| 6 | 7,989 | 7,926 | 3,988 | 7,057 | 5,459 | 2,828 | 35,247 |
| 7 | 10,132 | 8,980 | 3,995 | 735 | 1,110 | 124 | 25,076 |
| 8 | 1,533 | 1,148 | 495 | 366 | 0 | 0 | 3,543 |
| 9 | 2,734 | 1,248 | 337 | 0 | 0 | 0 | 4,319 |
| 10 | 771 | 325 | 138 | 0 | 0 | 0 | 1,235 |
| 11 | 1,125 | 461 | 85 | 0 | 0 | 0 | 1,672 |
| 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 | 93,673 | 202,839 | 260,786 | 785,620 | 596,207 | 266,664 | 2,205,787 |
| onne | 7,701 | 14,478 | 16,150 | 49,136 | 30,390 | 14,942 | 132,797 |

**Table 8.12** Sardine in Fishing Areas VIIIc and IXa. Catch in numbers (thousands).

Run title : Sardine South (run: VPARUN8/GP8)

At 13-Oct-95 14:28:20

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

| YEAR, | 1976, | 1977, | 1978, | 1979, | 1980, | 1981, | 1982, | 1983, | 1984, |
|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | |
| 0, | 420000, | 844000, | 854000, | 643000, | 842000, | 1021000, | 60000, | 1061000, | 109000, |
| 1, | 1870999, | 2420999, | 2145001, | 1479000, | 1997000, | 1919999, | 769000, | 553000, | 3289000, |
| 2, | 1425999, | 954000, | 913000, | 935000, | 1542000, | 1720000, | 1853999, | 838000, | 470000, |
| 3, | 252000, | 110000, | 281000, | 423000, | 372000, | 666000, | 701000, | 795000, | 488000, |
| 4, | 71000, | 22000, | 127000, | 187000, | 155000, | 192000, | 350000, | 322000, | 295000, |
| 5, | 12000, | 3000, | 40000, | 93000, | 47000, | 102000, | 130000, | 140000, | 176000, |
| +gp, | 3000, | 1000, | 16000, | 36000, | 30000, | 76000, | 129000, | 139000, | 116000, |
| TOTALNUM, | 4054998, | 4354998, | 4376002, | 3796002, | 4984999, | 5697001, | 3992999, | 3848000, | 4942999, |
| TONSLAND, | 141690, | 125750, | 139990, | 153441, | 191682, | 214133, | 204504, | 181139, | 202686, |
| SOPCOF %, | 85, | 81, | 85, | 97, | 95, | 90, | 98, | 106, | 97, |

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

| YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0, | 258000, | 238000, | 1401000, | 439000, | 244000, | 234000, | 1574000, | 490000, | 88000, | 121000, |
| 1, | 527000, | 702000, | 512000, | 979000, | 512000, | 562000, | 456000, | 985000, | 562000, | 61000, |
| 2, | 2343000, | 987000, | 615000, | 525000, | 895000, | 488000, | 404000, | 423000, | 1051000, | 527000, |
| 3, | 457000, | 903000, | 520000, | 428000, | 381000, | 680000, | 380000, | 317000, | 502000, | 1059000, |
| 4, | 290000, | 322000, | 521000, | 303000, | 215000, | 275000, | 256000, | 175000, | 245000, | 261000, |
| 5, | 197000, | 194000, | 147000, | 291000, | 198000, | 142000, | 72000, | 108000, | 111000, | 107000, |
| +gp, | 101000, | 166000, | 170000, | 189000, | 183000, | 104000, | 26000, | 19000, | 66000, | 35000, |
| TOTALNUM, | 4172999, | 3512000, | 3885999, | 3154000, | 2628000, | 2485000, | 3167999, | 2516999, | 2624999, | 2171000, |
| TONSLAND, | 204107, | 180606, | 168825, | 158540, | 137126, | 139157, | 127756, | 126054, | 138795, | 132800, |
| SOPCOF %, | 96, | 99, | 103, | 106, | 102, | 117, | 107, | 105, | 103, | 102, |

**Table 8.13** Length (cm) at age by quarter and by Sub-division of SARDINE in 1994.

| 1994 Age | VIIIc East 1'st Q length(cm) | VIIIc West 1'st Q length(cm) | IXa North 1'st Q length(cm) | Xa Centr- 1'st Q length(cm) | Xa Centr- 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 | 16.1 | 16.7 | 16.8 | 0.0 | 13.2 | 15.9 | 14.4 |
| 2 | 19.7 | 19.4 | 18.8 | 17.0 | 17.7 | 18.3 | 18.5 |
| 3 | 20.8 | 20.3 | 19.6 | 18.8 | 18.7 | 18.6 | 19.1 |
| 4 | 21.9 | 21.0 | 20.4 | 20.2 | 19.8 | 19.7 | 20.1 |
| 5 | 22.7 | 21.7 | 21.1 | 21.0 | 20.4 | 20.5 | 21.1 |
| 6 | 22.9 | 22.0 | 21.4 | 21.3 | 21.7 | 21.6 | 22.1 |
| 7 | 23.0 | 22.4 | 22.1 | 21.7 | 22.0 | 22.3 | 22.7 |
| 8 | 23.6 | 22.4 | 21.9 | 0.0 | 0.0 | 0.0 | 23.2 |
| 9 | 23.7 | 23.2 | 22.6 | 0.0 | 0.0 | 0.0 | 23.6 |
| 10 | 24.3 | 24.0 | 23.3 | 0.0 | 0.0 | 0.0 | 24.2 |
| 11 | 24.2 | 23.7 | 23.2 | 0.0 | 0.0 | 0.0 | 24.1 |
| 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 |
| -15 | 22.1 | 20.6 | 19.4 | 19.4 | 19.1 | 18.9 | 19.7 |

| Age | VIIIc East 2'nd Q length(cm) | VIIIc West 2'nd Q length(cm) | IXa North 2'nd Q length(cm) | Xa Centr- 2'nd Q length(cm) | Xa Centr- 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 | 17.8 | 16.2 | 17.3 | 15.5 | 13.8 | 0.0 | 14.0 |
| 2 | 19.8 | 19.8 | 18.8 | 18.1 | 17.7 | 17.6 | 18.4 |
| 3 | 20.5 | 20.3 | 19.6 | 18.5 | 19.1 | 18.4 | 18.9 |
| 4 | 21.3 | 20.9 | 20.2 | 19.8 | 19.3 | 19.2 | 19.6 |
| 5 | 22.1 | 21.6 | 20.8 | 21.0 | 20.2 | 20.2 | 20.8 |
| 6 | 22.4 | 21.9 | 21.0 | 21.2 | 21.5 | 20.5 | 21.5 |
| 7 | 22.6 | 22.2 | 21.8 | 21.6 | 22.3 | 0.0 | 22.1 |
| 8 | 22.6 | 22.1 | 21.7 | 22.3 | 0.0 | 0.0 | 22.1 |
| 9 | 23.2 | 23.0 | 22.5 | 0.0 | 0.0 | 0.0 | 23.0 |
| 10 | 23.7 | 23.6 | 23.8 | 0.0 | 0.0 | 0.0 | 23.6 |
| 11 | 23.6 | 23.8 | 24.3 | 0.0 | 0.0 | 0.0 | 23.8 |
| 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 |
| -15 | 21.2 | 20.6 | 19.3 | 18.6 | 18.1 | 18.5 | 18.8 |

**Table 8.13 (continued)**

| Age | VIIIc East 3'rd Q length (cm | VIIIc West 3'rd Q length (cm | IXa North 3'rd Q length (cm | Xa Centr- 3'rd Q ength (cm | Xa Centr- 3'rd Q ength (cm | IXa South 3'rd Q ength (cm | All areas 3'rd Q length(cm) |
|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 13.6 | 11.5 | 14.2 | 13.0 | 0.0 | 12.7 |
| 1 | 19.6 | 19.3 | 18.9 | 16.5 | 15.2 | 0.0 | 17.4 |
| 2 | 20.5 | 20.5 | 19.6 | 18.6 | 18.5 | 18.5 | 18.9 |
| 3 | 20.9 | 20.9 | 20.3 | 19.1 | 19.5 | 18.8 | 19.4 |
| 4 | 21.5 | 21.3 | 20.6 | 20.2 | 20.2 | 19.7 | 20.3 |
| 5 | 22.2 | 21.8 | 21.5 | 20.5 | 21.0 | 21.0 | 21.1 |
| 6 | 22.5 | 21.8 | 21.6 | 20.7 | 22.7 | 0.0 | 21.5 |
| 7 | 22.8 | 22.1 | 21.2 | 22.8 | 0.0 | 0.0 | 22.1 |
| 8 | 22.4 | 22.3 | 22.3 | 22.8 | 0.0 | 0.0 | 22.5 |
| 9 | 22.0 | 21.4 | 21.4 | 0.0 | 0.0 | 0.0 | 21.5 |
| 10 | 22.3 | 22.3 | 22.3 | 0.0 | 0.0 | 0.0 | 22.3 |
| 11 | 22.8 | 22.8 | 22.8 | 0.0 | 0.0 | 0.0 | 22.8 |
| 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 |
| -15 | 21.1 | 20.4 | 18.8 | 19.0 | 18.8 | 18.8 | 19.1 |

| Age | VIIIc East 4'th Q length(cm) | VIIIc West 4'th Q length(cm) | IXa North 4'th Q length(cm) | Xa Centr- 4'th Q length(cm) | Xa Centr- 4'th Q length(cm) | IXa South 4'th Q length(cm) | All areas 4'th Q length(cm) |
|---|---|---|---|---|---|---|---|
| 0 | 16.3 | 10.5 | 15.5 | 14.2 | 13.6 | 0.0 | 13.4 |
| 1 | 19.9 | 19.8 | 18.3 | 15.9 | 16.3 | 0.0 | 17.1 |
| 2 | 20.7 | 20.5 | 19.8 | 18.8 | 18.6 | 18.2 | 19.2 |
| 3 | 21.2 | 21.0 | 20.6 | 19.4 | 19.5 | 18.7 | 19.6 |
| 4 | 21.8 | 21.5 | 21.1 | 20.4 | 20.6 | 19.6 | 20.5 |
| 5 | 22.3 | 22.1 | 21.7 | 21.3 | 21.5 | 20.1 | 21.0 |
| 6 | 23.0 | 22.3 | 21.6 | 22.0 | 22.1 | 21.1 | 22.1 |
| 7 | 23.0 | 22.5 | 21.6 | 0.0 | 0.0 | 0.0 | 22.5 |
| 8 | 22.5 | 22.4 | 22.3 | 0.0 | 0.0 | 0.0 | 22.4 |
| 9 | 22.3 | 21.9 | 21.3 | 0.0 | 0.0 | 0.0 | 21.9 |
| 10 | 22.3 | 22.3 | 22.3 | 0.0 | 0.0 | 0.0 | 22.3 |
| 11 | 22.8 | 22.8 | 22.8 | 0.0 | 0.0 | 0.0 | 22.8 |
| 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 |
| -15 | 21.5 | 19.0 | 19.8 | 19.3 | 17.3 | 19.2 | 18.8 |

| Age | VIIIc East 1-4 Q length(cm) | VIIIc West 1-4 Q length(cm) | IXa North 1-4 Q length(cm) | Xa Centr- 1-4 Q length(cm) | Xa Centr- 1-4 Q length(cm) | IXa South 1-4 Q length(cm) | All areas 1-4 Q length(cm) |
|---|---|---|---|---|---|---|---|
| 0 | 16.3 | 11.3 | 13.1 | 14.2 | 13.5 | 0.0 | 13.2 |
| 1 | 19.1 | 19.2 | 18.4 | 15.9 | 14.5 | 15.9 | 16.0 |
| 2 | 20.4 | 20.2 | 19.2 | 18.5 | 18.4 | 18.3 | 18.8 |
| 3 | 20.9 | 20.7 | 19.9 | 19.1 | 19.2 | 18.6 | 19.3 |
| 4 | 21.8 | 21.2 | 20.6 | 20.3 | 19.9 | 19.5 | 20.2 |
| 5 | 22.6 | 21.8 | 21.2 | 21.0 | 20.6 | 20.2 | 21.0 |
| 6 | 22.9 | 22.0 | 21.4 | 21.2 | 21.9 | 21.3 | 21.9 |
| 7 | 23.0 | 22.3 | 21.6 | 21.9 | 22.0 | 22.3 | 22.4 |
| 8 | 23.3 | 22.3 | 22.0 | 22.5 | 0.0 | 0.0 | 22.7 |
| 9 | 23.6 | 22.6 | 22.0 | 0.0 | 0.0 | 0.0 | 23.2 |
| 10 | 24.1 | 23.1 | 22.4 | 0.0 | 0.0 | 0.0 | 23.6 |
| 11 | 24.0 | 23.3 | 23.1 | 0.0 | 0.0 | 0.0 | 23.8 |
| 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 |
| -15 | 21.7 | 20.0 | 19.3 | 19.1 | 18.2 | 18.8 | 19.0 |

**Table 8.14** Weight (g) at age at age by quarter and by Sub-division of SARDINE in 1994.

| 1994 Age | VIIIc East 1'st Q weight(g) | IIIc Wes 1'st Q weight(g) | IXa North 1'st Q weight(g) | a Centr- 1'st Q weight(g) | a Centr- 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 | 30 | 34 | 35 | 0 | 17 | 29 | 23 |
| 2 | 55 | 52 | 48 | 38 | 37 | 43 | 45 |
| 3 | 64 | 59 | 54 | 53 | 46 | 45 | 50 |
| 4 | 74 | 66 | 60 | 66 | 54 | 54 | 58 |
| 5 | 82 | 72 | 67 | 75 | 59 | 60 | 67 |
| 6 | 85 | 75 | 70 | 78 | 71 | 69 | 77 |
| 7 | 85 | 79 | 76 | 83 | 74 | 76 | 82 |
| 8 | 92 | 79 | 75 | 0 | 0 | 0 | 88 |
| 9 | 93 | 87 | 81 | 0 | 0 | 0 | 92 |
| 10 | 100 | 97 | 88 | 0 | 0 | 0 | 99 |
| 11 | 99 | 94 | 87 | 0 | 0 | 0 | 99 |
| 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 | 77 | 62 | 53 | 59 | 49 | 48 | 55 |

| Age | VIIIc East 2'nd Q weight(g) | IIIc Wes 2'nd Q weight(g) | IXa North 2'nd Q weight(g) | a Centr- 2'nd Q weight(g) | a Centr- 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 | 52 | 42 | 48 | 29 | 19 | 0 | 21 |
| 2 | 66 | 66 | 59 | 46 | 44 | 42 | 53 |
| 3 | 71 | 70 | 64 | 50 | 55 | 48 | 54 |
| 4 | 78 | 75 | 69 | 60 | 62 | 55 | 61 |
| 5 | 85 | 80 | 74 | 71 | 66 | 63 | 72 |
| 6 | 87 | 83 | 76 | 73 | 80 | 66 | 79 |
| 7 | 89 | 86 | 82 | 77 | 91 | 0 | 85 |
| 8 | 89 | 85 | 81 | 85 | 0 | 0 | 85 |
| 9 | 95 | 93 | 88 | 0 | 0 | 0 | 93 |
| 10 | 100 | 99 | 101 | 0 | 0 | 0 | 99 |
| 11 | 99 | 100 | 105 | 0 | 0 | 0 | 100 |
| 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 | 77 | 73 | 62 | 51 | 49 | 49 | 55 |

**Table 8.14 (continued)**

| Age | VIIIc East 3'rd Q weight (g | IIIc Wes 3'rd Q weight (g | IXa North 3'rd Q weight (g | a Centr- 3'rd Q weight (g | a Centr- 3'rd Q weight (g | IXa South 3'rd Q weight (g | All areas 3'rd Q weight(g) |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 20 | 12 | 28 | 17 | 0 | 16 |
| 1 | 66 | 63 | 59 | 43 | 27 | 0 | 46 |
| 2 | 77 | 77 | 66 | 60 | 50 | 60 | 60 |
| 3 | 82 | 82 | 75 | 65 | 59 | 62 | 65 |
| 4 | 90 | 87 | 78 | 76 | 66 | 71 | 73 |
| 5 | 100 | 94 | 90 | 80 | 75 | 85 | 84 |
| 6 | 105 | 94 | 91 | 82 | 95 | 0 | 91 |
| 7 | 108 | 98 | 85 | 107 | 0 | 0 | 98 |
| 8 | 103 | 101 | 102 | 107 | 0 | 0 | 103 |
| 9 | 97 | 89 | 88 | 0 | 0 | 0 | 91 |
| 10 | 100 | 100 | 100 | 0 | 0 | 0 | 100 |
| 11 | 108 | 108 | 108 | 0 | 0 | 0 | 108 |
| 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 | 85 | 78 | 62 | 65 | 54 | 62 | 63 |

| Age | VIIIc East 4'th Q weight(g) | IIIc Wes 4'th Q weight(g) | IXa North 4'th Q weight(g) | a Centr- 4'th Q weight(g) | a Centr- 4'th Q weight(g) | IXa South 4'th Q weight(g) | All areas 4'th Q weight(g) |
|---|---|---|---|---|---|---|---|
| 0 | 39 | 10 | 34 | 25 | 21 | 0 | 21 |
| 1 | 72 | 71 | 56 | 35 | 38 | 0 | 45 |
| 2 | 83 | 80 | 72 | 60 | 58 | 54 | 65 |
| 3 | 88 | 86 | 82 | 67 | 68 | 59 | 69 |
| 4 | 96 | 93 | 87 | 78 | 81 | 68 | 79 |
| 5 | 104 | 100 | 95 | 91 | 93 | 75 | 86 |
| 6 | 114 | 103 | 94 | 101 | 103 | 88 | 102 |
| 7 | 113 | 106 | 93 | 0 | 0 | 0 | 105 |
| 8 | 107 | 104 | 103 | 0 | 0 | 0 | 105 |
| 9 | 104 | 98 | 89 | 0 | 0 | 0 | 98 |
| 10 | 103 | 103 | 103 | 0 | 0 | 0 | 103 |
| 11 | 110 | 110 | 110 | 0 | 0 | 0 | 110 |
| 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 | 93 | 72 | 73 | 66 | 50 | 65 | 64 |

| Age | VIIIc East 1-4 Q weight(g) | IIIc Wes 1-4 Q weight(g) | IXa North 1-4 Q weight(g) | a Centr- 1-4 Q weight(g) | a Centr- 1-4 Q weight(g) | IXa South 1-4 Q weight(g) | All areas 1-4 Q weight(g) |
|---|---|---|---|---|---|---|---|
| 0 | 39 | 13 | 21 | 25 | 20 | 0 | 20 |
| 1 | 62 | 63 | 56 | 35 | 25 | 29 | 36 |
| 2 | 74 | 73 | 61 | 58 | 51 | 53 | 58 |
| 3 | 77 | 76 | 67 | 62 | 58 | 53 | 62 |
| 4 | 84 | 82 | 74 | 75 | 63 | 61 | 70 |
| 5 | 87 | 85 | 79 | 82 | 67 | 71 | 76 |
| 6 | 94 | 90 | 84 | 83 | 86 | 79 | 87 |
| 7 | 95 | 94 | 86 | 87 | 75 | 76 | 92 |
| 8 | 95 | 92 | 88 | 95 | 0 | 0 | 93 |
| 9 | 94 | 91 | 86 | 0 | 0 | 0 | 93 |
| 10 | 100 | 100 | 101 | 0 | 0 | 0 | 100 |
| 11 | 101 | 102 | 104 | 0 | 0 | 0 | 101 |
| 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 | 83 | 72 | 63 | 63 | 51 | 56 | 60 |

**Table 8.15** Sardine in Fishing Areas VIIIc and IXa. Mean weight of catch (kg).

Run title : Sardine South (run: VPARUN8/GP8)

At 13-Oct-95 14:28:20

| Table 2 | Catch weights at age (kg) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| YEAR, | 1976, | 1977, | 1978, | 1979, | 1980, | 1981, | 1982, | 1983, | 1984, |
| AGE | | | | | | | | | |
| 0, | .0170, | .0170, | .0170, | .0170, | .0170, | .0170, | .0170, | .0170, | .0170, |
| 1, | .0340, | .0340, | .0340, | .0340, | .0340, | .0340, | .0340, | .0340, | .0340, |
| 2, | .0520, | .0520, | .0520, | .0520, | .0520, | .0520, | .0520, | .0520, | .0520, |
| 3, | .0600, | .0600, | .0600, | .0600, | .0600, | .0600, | .0600, | .0600, | .0600, |
| 4, | .0680, | .0680, | .0680, | .0680, | .0680, | .0680, | .0680, | .0680, | .0680, |
| 5, | .0720, | .0720, | .0720, | .0720, | .0720, | .0720, | .0720, | .0720, | .0720, |
| +gp, | .0790, | .0790, | .0790, | .0790, | .0790, | .0790, | .0790, | .0790, | .0790, |
| SOPCOFAC, | .8538, | .8131, | .8507, | .9744, | .9536, | .8981, | .9786, | 1.0588, | .9684, |

| Table 2 | Catch weights at age (kg) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
| AGE | | | | | | | | | | |
| 0, | .0170, | .0170, | .0170, | .0170, | .0130, | .0240, | .0200, | .0180, | .0170, | .0200, |
| 1, | .0340, | .0340, | .0340, | .0340, | .0350, | .0320, | .0310, | .0450, | .0370, | .0360, |
| 2, | .0520, | .0520, | .0520, | .0520, | .0520, | .0470, | .0580, | .0550, | .0510, | .0580, |
| 3, | .0600, | .0600, | .0600, | .0600, | .0590, | .0570, | .0630, | .0660, | .0580, | .0620, |
| 4, | .0680, | .0680, | .0680, | .0680, | .0660, | .0610, | .0730, | .0700, | .0660, | .0700, |
| 5, | .0720, | .0720, | .0720, | .0720, | .0710, | .0670, | .0740, | .0790, | .0710, | .0760, |
| +gp, | .0790, | .0790, | .0790, | .0790, | .0870, | .0700, | .0870, | .0830, | .0810, | .0870, |
| SOPCOFAC, | .9563, | .9902, | 1.0304, | 1.0554, | 1.0212, | 1.1707, | 1.0712, | 1.0532, | 1.0327, | 1.0193, |

**Table 8.16** Sardine in Fishing Areas VIIIc and IXa. Stock mean weights at age (kg).

Run title : Sardine South (run: VPARUN8/GP8)

At 13-Oct-95 14:28:20

| Table 3 Stock weights at age (kg) YEAR, | 1976, | 1977, | 1978, | 1979, | 1980, | 1981, | 1982, | 1983, | 1984, |
|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | |
| 0, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, |
| 1, | .0150, | .0150, | .0150, | .0150, | .0150, | .0150, | .0150, | .0150, | .0150, |
| 2, | .0380, | .0380, | .0380, | .0380, | .0380, | .0380, | .0380, | .0380, | .0380, |
| 3, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, |
| 4, | .0640, | .0640, | .0640, | .0640, | .0640, | .0640, | .0640, | .0640, | .0640, |
| 5, | .0670, | .0670, | .0670, | .0670, | .0670, | .0670, | .0670, | .0670, | .0670, |
| +gp, | .0770, | .0770, | .0770, | .0770, | .0770, | .0770, | .0770, | .0770, | .0770, |

| Table 3 Stock weights at age (kg) YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, |
| 1, | .0150, | .0150, | .0150, | .0150, | .0150, | .0150, | .0190, | .0270, | .0220, | .0310, |
| 2, | .0380, | .0380, | .0380, | .0380, | .0380, | .0380, | .0420, | .0360, | .0450, | .0400, |
| 3, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, | .0500, | .0570, | .0490, |
| 4, | .0640, | .0640, | .0640, | .0640, | .0640, | .0640, | .0640, | .0620, | .0640, | .0600, |
| 5, | .0670, | .0670, | .0670, | .0670, | .0670, | .0670, | .0710, | .0690, | .0730, | .0670, |
| +gp, | .0770, | .0770, | .0770, | .0770, | .0770, | .0790, | .0750, | .0760, | .0760, | .0700, |

**Table 8.17** Sardine in Fishing Areas VIIIc and IXa. Proportion mature at year start.

Run title : Sardine South (run: VPARUN8/GP8)

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Table 5 Proportion mature at age

| YEAR, | 1976, | 1977, | 1978, | 1979, | 1980, | 1981, | 1982, | 1983, | 1984, |
|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | |
| 0, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, |
| 1, | .6500, | .6500, | .6500, | .6500, | .6500, | .6500, | .6500, | .6500, | .6500, |
| 2, | .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, |
| 4, | 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, |
| +gp, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | 1.0000, |

Table 5 Proportion mature at age

| YEAR, | 1985, | 1986, | 1987, | 1988, | 1989, | 1990, | 1991, | 1992, | 1993, | 1994, |
|---|---|---|---|---|---|---|---|---|---|---|
| AGE | | | | | | | | | | |
| 0, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, | .0000, |
| 1, | .6500, | .6500, | .6500, | .6500, | .2300, | .6000, | .7400, | .7900, | .4700, | .8000, |
| 2, | .9500, | .9500, | .9500, | .9500, | .8300, | .8100, | .9100, | .9100, | .9300, | .8900, |
| 3, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | .9100, | .8800, | .9600, | .9500, | .9400, | .9600, |
| 4, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | .9200, | .8900, | .9700, | .9800, | .9700, | .9600, |
| 5, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | .9400, | .9400, | 1.0000, | 1.0000, | .9900, | .9700, |
| +gp, | 1.0000, | 1.0000, | 1.0000, | 1.0000, | .9700, | .9700, | 1.0000, | 1.0000, | 1.0000, | 1.0000, |

**Table 8.18** Sardine in Fishing Areas VIIIc and IXa.

```
Sardine in Fishing Areas VIIIc and IXa
102
Fleet 1-Spanish Acoustic Survey - Spring (Catch: millions)
1988 1995
1 1 0.25 0.33
1 11
1 221000 63000 72000 64000 858000 175000 310000 342000 53000 18000 -1
1 73000 304000 66000 96000 76000 906000 156000 177000 97000 42000 11000
1 69000 56000 274000 55000 88000 134000 249000 70000 49000 46000 23000
1 25000 150000 126000 314000 51000 79000 56000 345000 29000 71000 6000
1 159000 78000 85000 29000 115000 24000 20000 12000 57000 3000 9000
1 242000 324000 92000 83000 83000 267000 27000 74000 71000 226000 79000
1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
1 18300 16700 97400 80600 19100 8500 5500 -1 -1 -1 -1
Fleet 6-Portugue acoustic survey-No (Catch:millions)
1984 1995
1 1 0.84 0.92
0 6
1 2957000 5733000 1152000 1037000 528000 76000 40000
1 2063000 2744000 4548000 1083000 839000 144000 61000
1 2493000 1612000 1670000 658000 323000 127000 50000
1 3715000 2379000 1344000 929000 666000 237000 49000
1 -1 -1 -1 -1 -1 -1 -1
1 -1 -1 -1 -1 -1 -1 -1
1 -1 -1 -1 -1 -1 -1 -1
1 -1 -1 -1 -1 -1 -1 -1
1 4638000 5944000 1205000 818000 307000 38000 1000
1 -1 -1 -1 -1 -1 -1 -1
1 -1 -1 -1 -1 -1 -1 -1
1 149400 323700 2041500 3407000 814100 98600 -1
```

Table 8.19 Sardine. Results from fitting the population model described in section 8.10. Catch at age and survey observations, fitted population parameters, residuals and diagnostics. `Results from ICA programme.`

CATCH NUMBERS AT AGE (Millions)

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 420. | 844. | 854. | 643. | 842. | 1021. | 60. | 1061. | 109. | 258. | 238. | 1401. | 439. | 244. | 234. | 1574. | 490. | 88. | 121. |
| 1 | 1871. | 2421. | 2145. | 1479. | 1997. | 1920. | 769. | 553. | 3289. | 527. | 702. | 512. | 979. | 512. | 562. | 456. | 985. | 562. | 61. |
| 2 | 1426. | 954. | 913. | 935. | 1542. | 1720. | 1854. | 838. | 470. | 2343. | 987. | 615. | 525. | 895. | 488. | 404. | 423. | 1051. | 527. |
| 3 | 252. | 110. | 281. | 423. | 372. | 666. | 701. | 795. | 488. | 457. | 903. | 520. | 428. | 381. | 680. | 380. | 317. | 502. | 1059. |
| 4 | 71. | 22. | 127. | 187. | 155. | 192. | 350. | 322. | 295. | 290. | 322. | 521. | 303. | 215. | 275. | 256. | 175. | 245. | 261. |
| 5 | 12. | 3. | 40. | 93. | 47. | 102. | 130. | 140. | 176. | 197. | 194. | 147. | 291. | 198. | 142. | 72. | 108. | 111. | 107. |
| 6 | 3. | 1. | 16. | 36. | 30. | 76. | 129. | 139. | 116. | 101. | 166. | 170. | 189. | 183. | 104. | 26. | 19. | 66. | 35. |
| 7 | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 61. | 142. | 79. | 61. | 52. | 36. |

AGE - STRUCTURED INDICES

INDEX : 1 from 1988 to 1995 (Spanish Acoustic Survey)

| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|
| 1 | .221E+06 | .730E+05 | .690E+05 | .250E+05 | .159E+06 | .242E+06 | | .183E+05 |
| 2 | .630E+05 | .304E+06 | .560E+05 | .150E+06 | .780E+05 | .324E+06 | | .167E+05 |
| 3 | .720E+05 | .660E+05 | .274E+06 | .126E+06 | .850E+05 | .920E+05 | | .974E+05 |
| 4 | .640E+05 | .960E+05 | .550E+05 | .314E+06 | .290E+05 | .830E+05 | | .806E+05 |
| 5 | .858E+06 | .760E+05 | .880E+05 | .510E+05 | .115E+06 | .830E+05 | | .191E+05 |
| 6 | .175E+06 | .906E+06 | .134E+06 | .790E+05 | .240E+05 | .267E+06 | | .850E+04 |
| 7 | .310E+06 | .156E+06 | .249E+06 | .560E+05 | .200E+05 | .270E+05 | | .550E+04 |
| 8 | .342E+06 | .177E+06 | .700E+05 | .345E+06 | .120E+05 | .740E+05 | | -.100E+01 |
| 9 | .530E+05 | .970E+05 | .490E+05 | .290E+05 | .570E+05 | .710E+05 | | -.100E+01 |
| 10 | .180E+05 | .420E+05 | .460E+05 | .710E+05 | .300E+04 | .226E+06 | | -.100E+01 |
| 11 | -.100E+01 | .110E+05 | .230E+05 | .600E+04 | .900E+04 | .790E+05 | | -.100E+01 |

INDEX : 2 from 1984 to 1995 (Portuguese Acoustic Survey)

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .296E+07 | .206E+07 | .249E+07 | .372E+07 | | | | | .464E+07 | | | .149E+06 |
| 1 | .573E+07 | .274E+07 | .161E+07 | .238E+07 | | | | | .594E+07 | | | .324E+06 |
| 2 | .115E+07 | .455E+07 | .167E+07 | .134E+07 | | | | | .121E+07 | | | .204E+07 |
| 3 | .104E+07 | .108E+07 | .658E+06 | .929E+06 | | | | | .818E+06 | | | .341E+07 |
| 4 | .528E+06 | .839E+06 | .323E+06 | .666E+06 | | | | | .307E+06 | | | .814E+06 |
| 5 | .760E+05 | .144E+06 | .127E+06 | .237E+06 | | | | | .380E+05 | | | .986E+05 |
| 6 | .400E+05 | .610E+05 | .500E+05 | .490E+05 | | | | | .100E+04 | | | |

**Table 8.19 (continued)**

FISHING MORTALITY

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .0426 | .0872 | .0797 | .0508 | .0629 | .1149 | .0096 | .0566 | .0145 | .0616 | .0737 | .0758 | .0777 | .0861 | .1085 | .0800 | .0654 | .0867 | .0808 |
| 1 | .3725 | .4237 | .3850 | .2220 | .2535 | .2293 | .1364 | .1309 | .2870 | .1179 | .1411 | .1452 | .1487 | .1648 | .2077 | .1532 | .1251 | .1660 | .1546 |
| 2 | .4995 | .3857 | .3250 | .3357 | .4438 | .4217 | .4221 | .2495 | .1805 | .2185 | .2613 | .2689 | .2755 | .3054 | .3849 | .2838 | .2318 | .3075 | .2865 |
| 3 | .1925 | .0729 | .2153 | .2847 | .2501 | .4093 | .3537 | .3763 | .2607 | .3096 | .3704 | .3811 | .3904 | .4328 | .5454 | .4021 | .3286 | .4358 | .4060 |
| 4 | .0926 | .0262 | .1293 | .2512 | .1844 | .2283 | .4607 | .3167 | .2699 | .3530 | .4222 | .4345 | .4451 | .4934 | .6218 | .4585 | .3746 | .4968 | .4629 |
| 5 | .0224 | .0057 | .0695 | .1514 | .1056 | .2048 | .2761 | .3948 | .3328 | .3688 | .4412 | .4540 | .4651 | .5155 | .6497 | .4790 | .3914 | .5191 | .4837 |
| 6 | .0066 | .0026 | .0435 | .0944 | .0764 | .2868 | .5052 | .6317 | .8028 | .3110 | .3720 | .3828 | .3922 | .4347 | .5479 | .4039 | .3300 | .4377 | .4079 |
| 7 | .0029 | .0031 | .0037 | .0039 | .0038 | .0037 | .0061 | .0072 | .0090 | .0923 | .1104 | .1136 | .1164 | .1291 | .1626 | .1199 | .0980 | .1299 | .1211 |

NUMBERS AT AGE (Millions)

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0. | 11808. | 11835. | 13057. | 15218. | 16193. | 11008. | 7403. | 22607. | 8878. | 6439. | 5249. | 10798. | 5915. | 5617. | 5786. | 15081. | 7610. | 1070. | 1606. | 377. |
| 1. | 6992. | 8135. | 7798. | 8668. | 10398. | 10932. | 7055. | 5272. | 15358. | 6291. | 4353. | 3505. | 7196. | 3935. | 3705. | 3732. | 10009. | 5125. | 705. | 1065. |
| 2. | 4201. | 3464. | 3829. | 3814. | 4991. | 5802. | 6249. | 4425. | 3325. | 8287. | 4020. | 2718. | 2180. | 4459. | 2399. | 2164. | 2302. | 6349. | 3121. | 434. |
| 3. | 1680. | 1833. | 1693. | 1989. | 1960. | 2302. | 2736. | 2946. | 2479. | 1996. | 4789. | 2225. | 1493. | 1190. | 2362. | 1174. | 1171. | 1313. | 3356. | 1685. |
| 4. | 940. | 997. | 1225. | 982. | 1075. | 1097. | 1099. | 1381. | 1454. | 1373. | 1053. | 2377. | 1093. | 726. | 555. | 984. | 564. | 606. | 610. | 1608. |
| 5. | 637. | 616. | 698. | 774. | 549. | 643. | 628. | 498. | 723. | 798. | 694. | 496. | 1107. | 503. | 319. | 214. | 447. | 279. | 265. | 276. |
| 6. | 532. | 448. | 440. | 468. | 478. | 355. | 377. | 343. | 241. | 373. | 397. | 321. | 227. | 500. | 216. | 120. | 95. | 217. | 119. | 118. |
| 7. | 401. | 380. | 321. | 303. | 306. | 318. | 192. | 163. | 131. | 78. | 196. | 197. | 157. | 110. | 233. | 90. | 57. | 49. | 101. | 57. |
| 8. | 275. | 287. | 272. | 230. | 217. | 219. | 228. | 137. | 117. | 93. | 51. | 126. | 126. | 101. | 70. | 142. | 57. | 37. | 31. | 64. |
| 9. | 211. | 197. | 206. | 195. | 164. | 155. | 157. | 163. | 98. | 83. | 66. | 36. | 89. | 89. | 71. | 49. | 100. | 41. | 26. | 22. |
| 10. | 136. | 151. | 141. | 147. | 139. | 117. | 111. | 112. | 116. | 69. | 59. | 47. | 25. | 63. | 63. | 50. | 34. | 71. | 29. | 19. |
| 11+. | 0. | 97. | 177. | 227. | 266. | 289. | 289. | 285. | 282. | 283. | 251. | 219. | 189. | 152. | 152. | 152. | 143. | 126. | 139. | 119. |

Table 8.19 (continued)

STOCK SUMMARY

| Year | Recruits x10^6 | Total B tonnes | Spawn B tonnes | Landings tonnes | Yld/SSB | Ref. F Fbar 2- 5 |
|---|---|---|---|---|---|---|
| 1976 | 11808. | 589058. | 473996. | 141690. | .2989 | .2017 |
| 1977 | 11835. | 590715. | 478522. | 125750. | .2628 | .1226 |
| 1978 | 13057. | 613356. | 496433. | 139990. | .2820 | .1848 |
| 1979 | 15218. | 631011. | 505550. | 153441. | .3035 | .2558 |
| 1980 | 16193. | 691114. | 544227. | 191682. | .3522 | .2460 |
| 1981 | 11008. | 745709. | 581101. | 214133. | .3685 | .3160 |
| 1982 | 7403. | 716476. | 568138. | 204504. | .3600 | .3782 |
| 1983 | 22607. | 626363. | 508132. | 181139. | .3565 | .3343 |
| 1984 | 8878. | 713270. | 542647. | 202686. | .3735 | .2610 |
| 1985 | 6439. | 738640. | 598677. | 204107. | .3409 | .3125 |
| 1986 | 5249. | 661378. | 537884. | 180606. | .3358 | .3738 |
| 1987 | 10798. | 536949. | 436063. | 168825. | .3872 | .3847 |
| 1988 | 5915. | 483455. | 376708. | 158540. | .4209 | .3940 |
| 1989 | 5617. | 456576. | 313560. | 137126. | .4373 | .4368 |
| 1990 | 5786. | 394342. | 278585. | 139157. | .4995 | .5505 |
| 1991 | 15081. | 354799. | 277476. | 127756. | .4604 | .4059 |
| 1992 | 7610. | 523515. | 399368. | 126054. | .3156 | .3316 |
| 1993 | 1070. | 580965. | 421234. | 138795. | .3295 | .4398 |
| 1994 | 1606. | 405048. | 320281. | 132800. | .4146 | .4098 |

PARAMETER ESTIMATES +/- SD

| | | | | |
|---|---|---|---|---|
| Separable Model: Reference F by year | | | | |
| 1 | 1985 | .2185 | .1880 | .2539 |
| 2 | 1986 | .2613 | .2263 | .3018 |
| 3 | 1987 | .2689 | .2332 | .3101 |
| 4 | 1988 | .2755 | .2391 | .3175 |
| 5 | 1989 | .3054 | .2671 | .3491 |
| 6 | 1990 | .3849 | .3356 | .4413 |
| 7 | 1991 | .2838 | .2441 | .3298 |
| 8 | 1992 | .2318 | .1978 | .2717 |
| 9 | 1993 | .3075 | .2579 | .3666 |
| 10 | 1994 | .2865 | .2332 | .3520 |
| Separable Model: Selection (S) by age | | | | |
| 11 | 0 | .2819 | .2443 | .3254 |
| 12 | 1 | .5397 | .4809 | .6057 |
| | 2 | 1.0000 | Fixed : Reference age | |
| 13 | 3 | 1.4172 | 1.2648 | 1.5881 |
| 14 | 4 | 1.6157 | 1.4110 | 1.8501 |
| 15 | 5 | 1.6882 | 1.3789 | 2.0669 |
| 16 | 6 | 1.4236 | 1.0119 | 2.0027 |
| 17 | 7 | .4226 | .1727 | 1.0342 |
| 18 | 8 | .0581 | .0232 | .1453 |
| 19 | 9 | .0710 | .0280 | .1801 |
| | 10 | .0500 | Fixed : last true age | |
| Separable Model: Populations in year 1994 | | | | |
| 20 | 0 | 1606166. | 1147484. | 2248196. |
| 21 | 1 | 705440. | 552534. | 900661. |
| 22 | 2 | 3120924. | 2554727. | 3812605. |
| 23 | 3 | 3356337. | 2768230. | 4069388. |
| 24 | 4 | 610300. | 495482. | 751726. |
| 25 | 5 | 265252. | 205029. | 343163. |
| 26 | 6 | 119353. | 83908. | 169769. |
| 27 | 7 | 100910. | 61417. | 165798. |
| 28 | 8 | 31118. | 18149. | 53352. |
| 29 | 9 | 26448. | 14942. | 46812. |
| 30 | 10 | 28579. | 15611. | 52321. |
| Separable Model: Populations at age 10 | | | | |
| 31 | 1985 | 69308.7433 | 6099.4940 | 787557.4400 |
| 32 | 1986 | 58746.1343 | 9685.4217 | 356319.8780 |
| 33 | 1987 | 46729.5000 | 10232.7362 | 213398.0725 |
| 34 | 1988 | 25465.0968 | 10422.8963 | 62216.0228 |
| 35 | 1989 | 63074.8000 | 32944.3439 | 120762.1682 |
| 36 | 1990 | 62780.3179 | 36153.1110 | 109018.7870 |
| 37 | 1991 | 49715.0469 | 28815.6186 | 85772.4390 |
| 38 | 1992 | 34434.2490 | 19850.0153 | 59733.8334 |
| 39 | 1993 | 71071.2761 | 39883.5442 | 126646.8762 |
| Recruitment in Year 1995 | | | | |
| 40 | 0 | 376830.4491 | 184083.9660 | 771393.5680 |

**Table 8.19 (continued)**

```
 Age-structured index catchabilities
     Age-Structured Index    1 (Spanish Acoustic Survey)

 Linear model fitted. Slopes at age:
41   1 Q       .21978E-01      .15870E-01      .30437E-01
42   2 Q       .49764E-01      .35957E-01      .68873E-01
43   3 Q       .89196E-01      .64111E-01      .12410E+00
44   4 Q       .12381E+00      .87508E-01      .17518E+00
45   5 Q       .30018E+00      .20338E+00      .44306E+00
46   6 Q       .66734E+00      .41406E+00      .10756E+01
47   7 Q       .70481E+00      .39489E+00      .12580E+01
48   8 Q       .14377E+01      .76575E+00      .26993E+01
49   9 Q       .88516E+00      .47156E+00      .16615E+01
50  10 Q       .79297E+00      .41883E+00      .15013E+01
51  11 Q       .12302E+00      .70151E-01      .21574E+00


     Age-Structured Index    2  (Portuguese Acoustic Survey)

 Linear model fitted. Slopes at age:
52   0 Q       .56911E+00      .42222E+00      .76709E+00
53   1 Q       .68280E+00      .51534E+00      .90468E+00
54   2 Q       .11247E+01      .84812E+00      .14916E+01
55   3 Q       .93595E+00      .69981E+00      .12518E+01
56   4 Q       .79226E+00      .57934E+00      .10834E+01
57   5 Q       .37575E+00      .26109E+00      .54074E+00
58   6 Q       .17909E+00      .11367E+00      .28216E+00
```

**Table 8.19 (continued)**

RESIDUALS ABOUT THE MODEL FIT

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

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -.24058E+00 | -.29040E+00 | .73325E+00 | .15143E+00 | -.48329E+00 | -.77567E+00 | .46389E+00 | .17621E+00 | .14838E+00 | .12864E+00 | .50000E+00 |
| 1 | -.12626E+00 | .36033E+00 | .23443E+00 | .14091E+00 | .87969E-03 | -.57596E-01 | .59852E-02 | -.21192E-01 | -.17655E+00 | -.34870E+00 | .10000E+01 |
| 2 | .51953E+00 | .21881E+00 | .11200E+00 | .15317E+00 | -.11866E+00 | -.30135E+00 | -.12752E+00 | .35346E-01 | -.31738E+00 | -.23622E+00 | .10000E+01 |
| 3 | .11755E-02 | -.34521E+00 | -.15459E+00 | .29741E-01 | .56157E-01 | -.23299E+00 | .12704E+00 | .11717E+00 | .22809E+00 | .93318E-01 | .10000E+01 |
| 4 | -.19150E+00 | .30302E-01 | -.32630E+00 | -.11065E+00 | -.12740E+00 | .21170E+00 | -.19829E+00 | .14269E+00 | .17844E+00 | .29120E+00 | .10000E+01 |
| 5 | -.72097E-01 | -.94794E-01 | -.60255E-01 | -.19893E+00 | .12263E+00 | .72507E-01 | .23203E-01 | -.14405E+00 | .12870E+00 | .19787E+00 | .10000E+01 |
| 6 | .16551E+00 | .44830E+00 | .66062E+00 | .10944E+01 | .18665E+00 | .27734E+00 | -.27578E+00 | -.19284E+00 | -.67058E-02 | .16437E-01 | .10000E-01 |
| Wts | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | |

( Weights for ages >= 7 set 0.01. Weights for age 6 set to 1 after 1989)

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

Aged Index 1 Spanish Acoustic Survey

| Age | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|
| 1 | .47337E+00 | -.25923E-01 | -.97640E-02 | -.10480E+01 | -.19262E+00 | .90863E+00 | | -.10568E+00 |
| 2 | -.36773E+00 | .49912E+00 | -.54965E+00 | .50928E+00 | -.22146E+00 | .20998E+00 | | -.79540E-01 |
| 3 | -.40603E+00 | -.25364E+00 | .51668E+00 | .39762E+00 | -.15487E-01 | -.18947E-01 | | -.22019E+00 |
| 4 | -.52380E+00 | .30402E+00 | .53713E-01 | .11752E+01 | -.67515E+00 | .34012E+00 | | -.67414E+00 |
| 5 | .11795E+01 | -.44201E+00 | .20013E+00 | .30053E-02 | .54164E-01 | .23727E+00 | | -.12320E+01 |
| 6 | .35586E+00 | .12213E+01 | .18109E+00 | .20177E+00 | -.78386E+00 | .83238E+00 | | -.20085E+01 |
| 7 | .11581E+01 | .83219E+00 | .56088E+00 | .77435E-02 | -.58135E+00 | -.11869E+00 | | -.18588E+01 |
| 8 | .73477E+00 | .30256E+00 | -.25395E+00 | .62434E+00 | -.18265E+01 | .41883E+00 | | -.10000E+01 |
| 9 | -.30024E+00 | .30735E+00 | -.14622E+00 | -.29840E+00 | -.34464E+00 | .78215E+00 | | -.10000E+01 |
| 10 | -.15315E-01 | -.74573E-01 | .22231E-01 | .68813E+00 | -.21094E+01 | .14890E+01 | | -.10000E+01 |
| 11 | -.10000E+01 | -.43013E+00 | .30668E+00 | -.10345E+01 | -.56921E+00 | .17296E+01 | | -.10000E+01 |

**Table 8.19 (continued)**

Aged Index 2 Portuguese Acoustic Survey

| Age | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -.23257E+00 | -.22992E+00 | .17442E+00 | -.14619E+00 | | | | | .41644E+00 | | | -.64900E-09 |
| 1 | -.60956E-01 | -.53961E-01 | -.19722E+00 | .41205E+00 | | | | | .26098E+00 | | | -.38299E+00 |
| 2 | -.72827E+00 | -.23492E+00 | -.47553E+00 | -.29457E+00 | | | | | -.27047E+00 | | | .19722E+01 |
| 3 | -.28544E+00 | .17848E-01 | -.13023E+01 | -.18149E+00 | | | | | .28655E+00 | | | .14181E+01 |
| 4 | -.25188E+00 | .34127E+00 | -.28658E+00 | -.36668E+00 | | | | | .24398E+00 | | | .25014E+00 |
| 5 | -.69093E+00 | -.11822E+00 | -.40159E-01 | .93001E+00 | | | | | -.85210E+00 | | | .66491E+00 |
| 6 | .91888E+00 | .47387E+00 | .26667E+00 | .46835E+00 | | | | | -.22571E+01 | | | -.10000E+01 |

****

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1985 to 1994

| | | |
|---|---|---|
| Variance | : | .9192 |
| Skewness test statistic | : | -1.1990 |
| Kurtosis test statistic | : | 11.0271 |
| Partial chi-square | : | 7.4680 |
| Probability of chi-square | : | 1.0000 |
| Degrees of freedom | : | 71 |

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1 (Spanish Acoustic Survey)

Linear catchability relationship assumed.

| Age | : | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variance | : | .3662 | .1742 | .1172 | .4628 | .5339 | 1.1722 | 1.0259 | .9195 | .2051 | 1.4293 | 1.1662 |
| Skewness test stat. | : | -.2660 | .1031 | .5177 | .5762 | -.1466 | -.9387 | -.8074 | -1.3341 | .9666 | -.7385 | .7763 |
| Kurtosis test stat. | : | -.1011 | -.7785 | -.6272 | -.4341 | -.0429 | -.1394 | -.1805 | .1489 | -.3197 | -.0351 | -.2951 |
| Partial chi-square | : | .1933 | .0899 | .0603 | .2426 | .2740 | .6175 | .5691 | .4042 | .0963 | .6902 | .4854 |
| Prob. of chi-square | : | .9999 | 1.0000 | 1.0000 | .9997 | .9996 | .9961 | .9969 | .9952 | .9999 | .9835 | .9749 |
| Number of data | : | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 5 |
| Degrees of freedom | : | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 5 | 5 | 4 |
| Weight in analysis | : | .0909 | .0909 | .0909 | .0909 | .0909 | .0909 | .0909 | .0909 | .0909 | .0909 | .0909 |

**Table 8.19 (continued)**

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2 (Portuguese Acoustic Survey)

Linear catchability relationship assumed. (Portuguese Acoustic Survey)

| Age | : | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| Variance | : | .0664 | .0860 | .9722 | .7807 | .1036 | .5048 | 1.6126 |
| Skewness test stat. | : | .6355 | .2041 | 1.6270 | .2025 | -.1240 | .0904 | -1.3066 |
| Kurtosis test stat. | : | -.4891 | -.5835 | .4648 | -.1348 | -.9437 | -.7013 | .0975 |
| Partial chi-square | : | .0223 | .0307 | .3758 | .2773 | .0391 | .2214 | .6924 |
| Prob. of chi-square | : | 1.0000 | 1.0000 | .9960 | .9980 | 1.0000 | .9989 | .9523 |
| Number of data | : | 6 | 6 | 6 | 6 | 6 | 6 | 5 |
| Degrees of freedom | : | 5 | 5 | 5 | 5 | 5 | 5 | 4 |
| Weight in analysis | : | .1429 | .1429 | .1429 | .1429 | .1429 | .1429 | .1429 |

**Table 8.20**

10:08 Wednesday, October 18, 1995

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

Prediction with management option table: Input data

| Year: 1995 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Stock size | Natural mortality | Maturity ogive | Prop.of F bef.spaw. | Prop.of M bef.spaw. | Weight in stock | Exploit. pattern | Weight in catch |
| 0 | 377.000 | 0.3300 | 0.0000 | 0.2500 | 0.2500 | 0.000 | 0.0808 | 0.019 |
| 1 | 1065.000 | 0.3300 | 0.7000 | 0.2500 | 0.2500 | 0.025 | 0.1546 | 0.037 |
| 2 | 434.000 | 0.3300 | 0.9100 | 0.2500 | 0.2500 | 0.041 | 0.2865 | 0.056 |
| 3 | 1685.000 | 0.3300 | 0.9500 | 0.2500 | 0.2500 | 0.052 | 0.4060 | 0.062 |
| 4 | 1608.000 | 0.3300 | 0.9700 | 0.2500 | 0.2500 | 0.063 | 0.4629 | 0.070 |
| 5 | 276.000 | 0.3300 | 0.9900 | 0.2500 | 0.2500 | 0.070 | 0.4837 | 0.075 |
| 6+ | 399.000 | 0.3300 | 1.0000 | 0.2500 | 0.2500 | 0.074 | 0.4079 | 0.090 |
| Unit | Millions | - | - | - | - | Kilograms | - | Kilograms |

| Year: 1996 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Recruit-ment | Natural mortality | Maturity ogive | Prop.of F bef.spaw. | Prop.of M bef.spaw. | Weight in stock | Exploit. pattern | Weight in catch |
| 0 | 7679.000 | 0.3300 | 0.0000 | 0.2500 | 0.2500 | 0.000 | 0.0808 | 0.019 |
| 1 | . | 0.3300 | 0.7000 | 0.2500 | 0.2500 | 0.025 | 0.1546 | 0.037 |
| 2 | . | 0.3300 | 0.9100 | 0.2500 | 0.2500 | 0.041 | 0.2865 | 0.056 |
| 3 | . | 0.3300 | 0.9500 | 0.2500 | 0.2500 | 0.052 | 0.4060 | 0.062 |
| 4 | . | 0.3300 | 0.9700 | 0.2500 | 0.2500 | 0.063 | 0.4629 | 0.070 |
| 5 | . | 0.3300 | 0.9900 | 0.2500 | 0.2500 | 0.070 | 0.4837 | 0.075 |
| 6+ | . | 0.3300 | 1.0000 | 0.2500 | 0.2500 | 0.074 | 0.4079 | 0.085 |
| Unit | Millions | - | - | - | - | Kilograms | - | Kilograms |

| Year: 1997 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Recruit-ment | Natural mortality | Maturity ogive | Prop.of F bef.spaw. | Prop.of M bef.spaw. | Weight in stock | Exploit. pattern | Weight in catch |
| 0 | 7679.000 | 0.3300 | 0.0000 | 0.2500 | 0.2500 | 0.000 | 0.0808 | 0.019 |
| 1 | . | 0.3300 | 0.7000 | 0.2500 | 0.2500 | 0.025 | 0.1546 | 0.037 |
| 2 | . | 0.3300 | 0.9100 | 0.2500 | 0.2500 | 0.041 | 0.2865 | 0.056 |
| 3 | . | 0.3300 | 0.9500 | 0.2500 | 0.2500 | 0.052 | 0.4060 | 0.062 |
| 4 | . | 0.3300 | 0.9700 | 0.2500 | 0.2500 | 0.063 | 0.4629 | 0.070 |
| 5 | . | 0.3300 | 0.9900 | 0.2500 | 0.2500 | 0.070 | 0.4837 | 0.075 |
| 6+ | . | 0.3300 | 1.0000 | 0.2500 | 0.2500 | 0.074 | 0.4079 | 0.085 |
| Unit | Millions | - | - | - | - | Kilograms | - | Kilograms |

Notes: Run name : HS2
Date and time: 18OCT95:10:53

**Table 8.21**

10:08 Wednesday, October 18, 1995

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

Prediction with management option table

| Year: 1995 | | | | | Year: 1996 | | | | | Year: 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F Factor | Reference F | Stock biomass | Sp.stock biomass | Catch in weight | F Factor | Reference F | Stock biomass | Sp.stock biomass | Catch in weight | Stock biomass | Sp.stock biomass |
| 1.0000 | 0.4098 | 282189 | 220394 | 93710 | 0.0000 | 0.0000 | 170285 | 150410 | 0 | 276508 | 214079 |
| . | . | . | . | . | 0.1000 | 0.0410 | . | 148829 | 7783 | 269838 | 206696 |
| . | . | . | . | . | 0.2000 | 0.0820 | . | 147265 | 15289 | 263412 | 199657 |
| . | . | . | . | . | 0.3000 | 0.1229 | . | 145718 | 22529 | 257218 | 192943 |
| . | . | . | . | . | 0.4000 | 0.1639 | . | 144188 | 29515 | 251247 | 186538 |
| . | . | . | . | . | 0.5000 | 0.2049 | . | 142675 | 36256 | 245490 | 180426 |
| . | . | . | . | . | 0.6000 | 0.2459 | . | 141178 | 42763 | 239938 | 174592 |
| . | . | . | . | . | 0.7000 | 0.2868 | . | 139697 | 49044 | 234582 | 169021 |
| . | . | . | . | . | 0.8000 | 0.3278 | . | 138232 | 55111 | 229414 | 163700 |
| . | . | . | . | . | 0.9000 | 0.3688 | . | 136784 | 60970 | 224427 | 158617 |
| . | . | . | . | . | 1.0000 | 0.4098 | . | 135351 | 66631 | 219612 | 153758 |
| . | . | . | . | . | 1.1000 | 0.4508 | . | 133933 | 72101 | 214963 | 149112 |
| . | . | . | . | . | 1.2000 | 0.4917 | . | 132531 | 77388 | 210473 | 144669 |
| . | . | . | . | . | 1.3000 | 0.5327 | . | 131144 | 82499 | 206135 | 140419 |
| . | . | . | . | . | 1.4000 | 0.5737 | . | 129773 | 87442 | 201944 | 136351 |
| . | . | . | . | . | 1.5000 | 0.6147 | . | 128416 | 92224 | 197892 | 132457 |
| . | . | . | . | . | 1.6000 | 0.6556 | . | 127074 | 96850 | 193975 | 128727 |
| . | . | . | . | . | 1.7000 | 0.6966 | . | 125746 | 101326 | 190186 | 125153 |
| . | . | . | . | . | 1.8000 | 0.7376 | . | 124433 | 105660 | 186521 | 121728 |
| . | . | . | . | . | 1.9000 | 0.7786 | . | 123134 | 109855 | 182975 | 118445 |
| . | . | . | . | . | 2.0000 | 0.8196 | . | 121849 | 113919 | 179543 | 115295 |
| - | - | Tonnes | Tonnes | Tonnes | - | - | Tonnes | Tonnes | Tonnes | Tonnes | Tonnes |

Notes: Run name : HS2
Date and time : 18OCT95:10:53
Computation of ref. F: Simple mean, age 2 - 5
Basis for 1995 : F factors

**Table 8.22**

15:14 Wednesday, October 18, 199

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 | 27319987 | 960712 | 17408647 | 892334 | 16030081 | 821672 |
| 0.0500 | 0.0205 | 279980 | 17281 | 26479610 | 904183 | 16586583 | 836580 | 15209267 | 766743 |
| 0.1000 | 0.0410 | 529943 | 32199 | 25730054 | 854239 | 15854975 | 787390 | 14478939 | 718346 |
| 0.1500 | 0.0615 | 754656 | 45163 | 25056868 | 809813 | 15199388 | 743699 | 13824662 | 675420 |
| 0.2000 | 0.0820 | 957936 | 56494 | 24448491 | 770057 | 14608273 | 704659 | 13234895 | 637117 |
| 0.2500 | 0.1024 | 1142869 | 66453 | 23895572 | 734283 | 14072289 | 669583 | 12700299 | 602752 |
| 0.3000 | 0.1229 | 1311979 | 75248 | 23390463 | 701929 | 13583803 | 637910 | 12213244 | 571765 |
| 0.3500 | 0.1434 | 1467349 | 83052 | 22926857 | 672533 | 13136515 | 609179 | 11767432 | 543697 |
| 0.4000 | 0.1639 | 1610712 | 90004 | 22499502 | 645710 | 12725187 | 583005 | 11357626 | 518166 |
| 0.4500 | 0.1844 | 1743523 | 96223 | 22103996 | 621138 | 12345426 | 559067 | 10979433 | 494850 |
| 0.5000 | 0.2049 | 1867008 | 101805 | 21736621 | 598547 | 11993522 | 537095 | 10629147 | 473481 |
| 0.5500 | 0.2254 | 1982213 | 106833 | 21394216 | 577705 | 11666324 | 516858 | 10303616 | 453830 |
| 0.6000 | 0.2459 | 2090030 | 111376 | 21074075 | 558416 | 11361137 | 498161 | 10000143 | 435701 |
| 0.6500 | 0.2664 | 2191228 | 115493 | 20773875 | 540512 | 11075643 | 480835 | 9716413 | 418927 |
| 0.7000 | 0.2868 | 2286471 | 119234 | 20491604 | 523845 | 10807840 | 464734 | 9450422 | 403364 |
| 0.7500 | 0.3073 | 2376337 | 122643 | 20225516 | 508291 | 10555988 | 449734 | 9200430 | 388887 |
| 0.8000 | 0.3278 | 2461331 | 125756 | 19974086 | 493739 | 10318571 | 435724 | 8964920 | 375387 |
| 0.8500 | 0.3483 | 2541893 | 128605 | 19735977 | 480093 | 10094258 | 422609 | 8742561 | 362769 |
| 0.9000 | 0.3688 | 2618413 | 131218 | 19510014 | 467269 | 9881880 | 410304 | 8532182 | 350949 |
| 0.9500 | 0.3893 | 2691236 | 133620 | 19295156 | 455192 | 9680404 | 398736 | 8332751 | 339854 |
| 1.0000 | 0.4098 | 2760665 | 135831 | 19090483 | 443795 | 9488915 | 387839 | 8143350 | 329420 |
| 1.0500 | 0.4303 | 2826973 | 137871 | 18895174 | 433022 | 9306599 | 377556 | 7963165 | 319588 |
| 1.1000 | 0.4508 | 2890403 | 139755 | 18708499 | 422820 | 9132730 | 367833 | 7791469 | 310308 |
| 1.1500 | 0.4712 | 2951170 | 141498 | 18529802 | 413142 | 8966658 | 358627 | 7627610 | 301534 |
| 1.2000 | 0.4917 | 3009470 | 143113 | 18358495 | 403948 | 8807801 | 349894 | 7471004 | 293225 |
| 1.2500 | 0.5122 | 3065479 | 144611 | 18194048 | 395199 | 8655632 | 341599 | 7321126 | 285344 |
| 1.3000 | 0.5327 | 3119355 | 146003 | 18035983 | 386862 | 8509680 | 333708 | 7177501 | 277860 |
| 1.3500 | 0.5532 | 3171243 | 147297 | 17883867 | 378908 | 8369515 | 326191 | 7039699 | 270741 |
| 1.4000 | 0.5737 | 3221271 | 148501 | 17737306 | 371308 | 8234749 | 319020 | 6907330 | 263962 |
| 1.4500 | 0.5942 | 3269560 | 149622 | 17595945 | 364037 | 8105029 | 312172 | 6780040 | 257497 |
| 1.5000 | 0.6147 | 3316218 | 150668 | 17459456 | 357074 | 7980034 | 305624 | 6657507 | 251326 |
| 1.5500 | 0.6352 | 3361343 | 151644 | 17327543 | 350398 | 7859468 | 299356 | 6539434 | 245428 |
| 1.6000 | 0.6556 | 3405025 | 152555 | 17199933 | 343990 | 7743065 | 293349 | 6425554 | 239784 |
| 1.6500 | 0.6761 | 3447349 | 153406 | 17076376 | 337833 | 7630577 | 287586 | 6315617 | 234379 |
| 1.7000 | 0.6966 | 3488390 | 154201 | 16956642 | 331911 | 7521778 | 282053 | 6209397 | 229197 |
| 1.7500 | 0.7171 | 3528219 | 154945 | 16840520 | 326210 | 7416460 | 276734 | 6106685 | 224223 |
| 1.8000 | 0.7376 | 3566901 | 155640 | 16727815 | 320717 | 7314431 | 271616 | 6007286 | 219446 |
| 1.8500 | 0.7581 | 3604497 | 156291 | 16618346 | 315419 | 7215514 | 266689 | 5911024 | 214853 |
| 1.9000 | 0.7786 | 3641061 | 156900 | 16511946 | 310306 | 7119545 | 261940 | 5817733 | 210434 |
| 1.9500 | 0.7991 | 3676645 | 157470 | 16408461 | 305367 | 7026372 | 257359 | 5727260 | 206178 |
| 2.0000 | 0.8196 | 3711297 | 158004 | 16307747 | 300593 | 6935854 | 252938 | 5639464 | 202076 |
| - | - | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes | Thousands | Tonnes |

Notes: Run name : PP1
Date and time : 18OCT95:15:26
Computation of ref. F: Simple mean, age 2 - 5
F-0.1 factor : 1.0822
F-max factor : Not found
F-0.1 reference F : 0.4435
F-max reference F : Not found
Recruitment : 7679 (Millions)

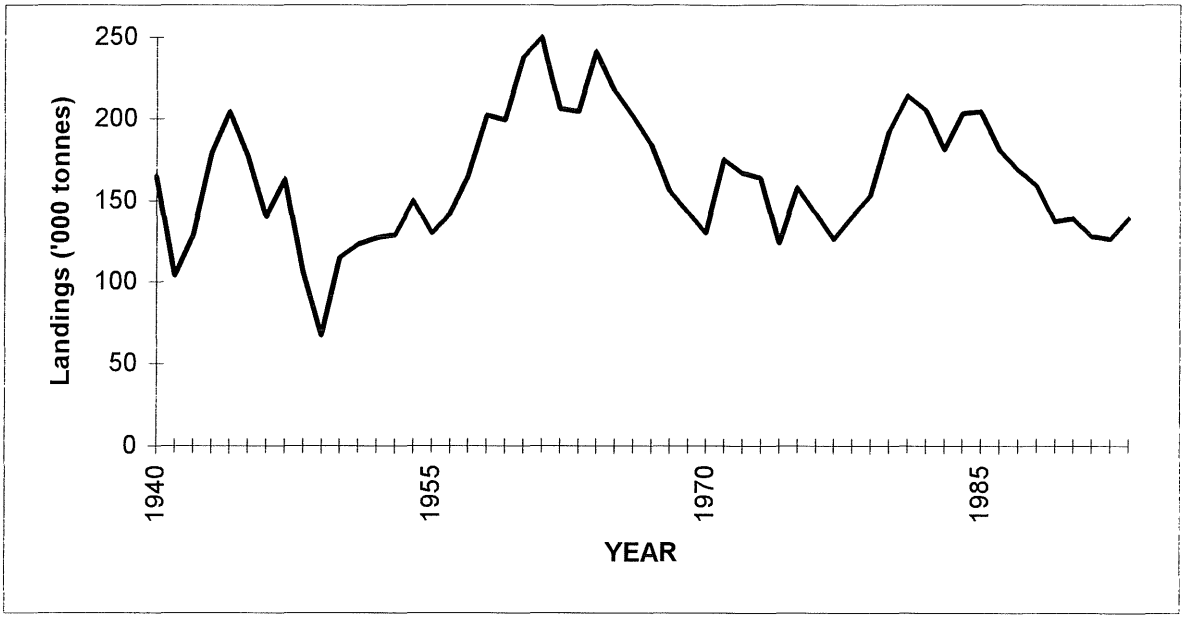



Figure 8.1 Total landings of sardine in Divisions VIIIc and IXa from 1940-1994.

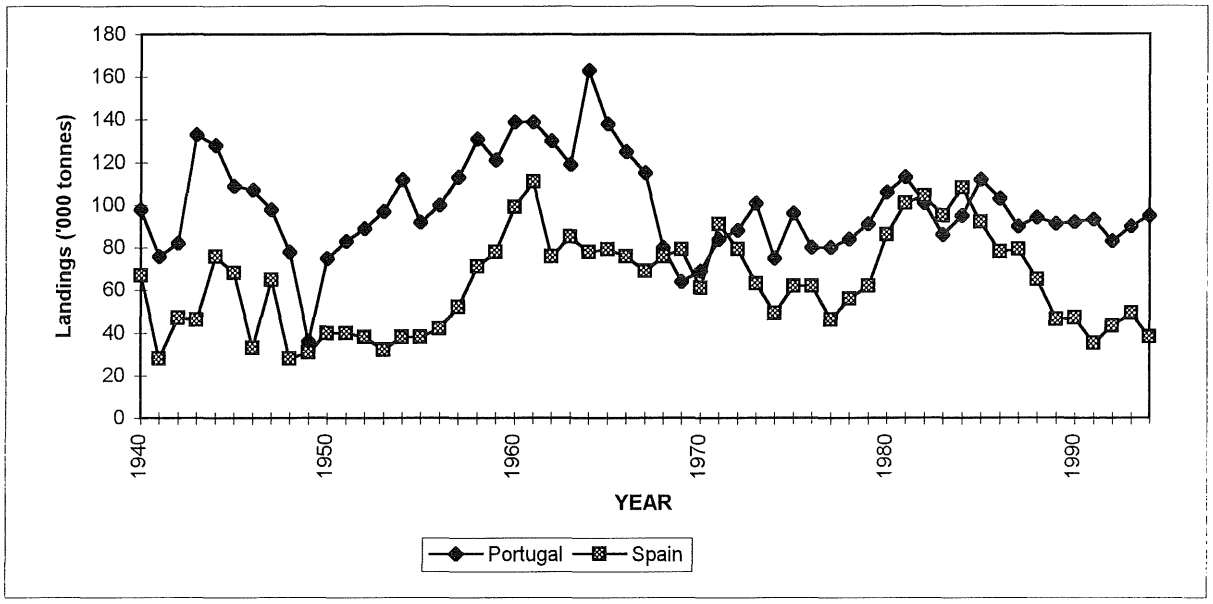



Figure 8.2 Landings of Sardine in Divisions VIIIc and IXa by country during 1940-1994

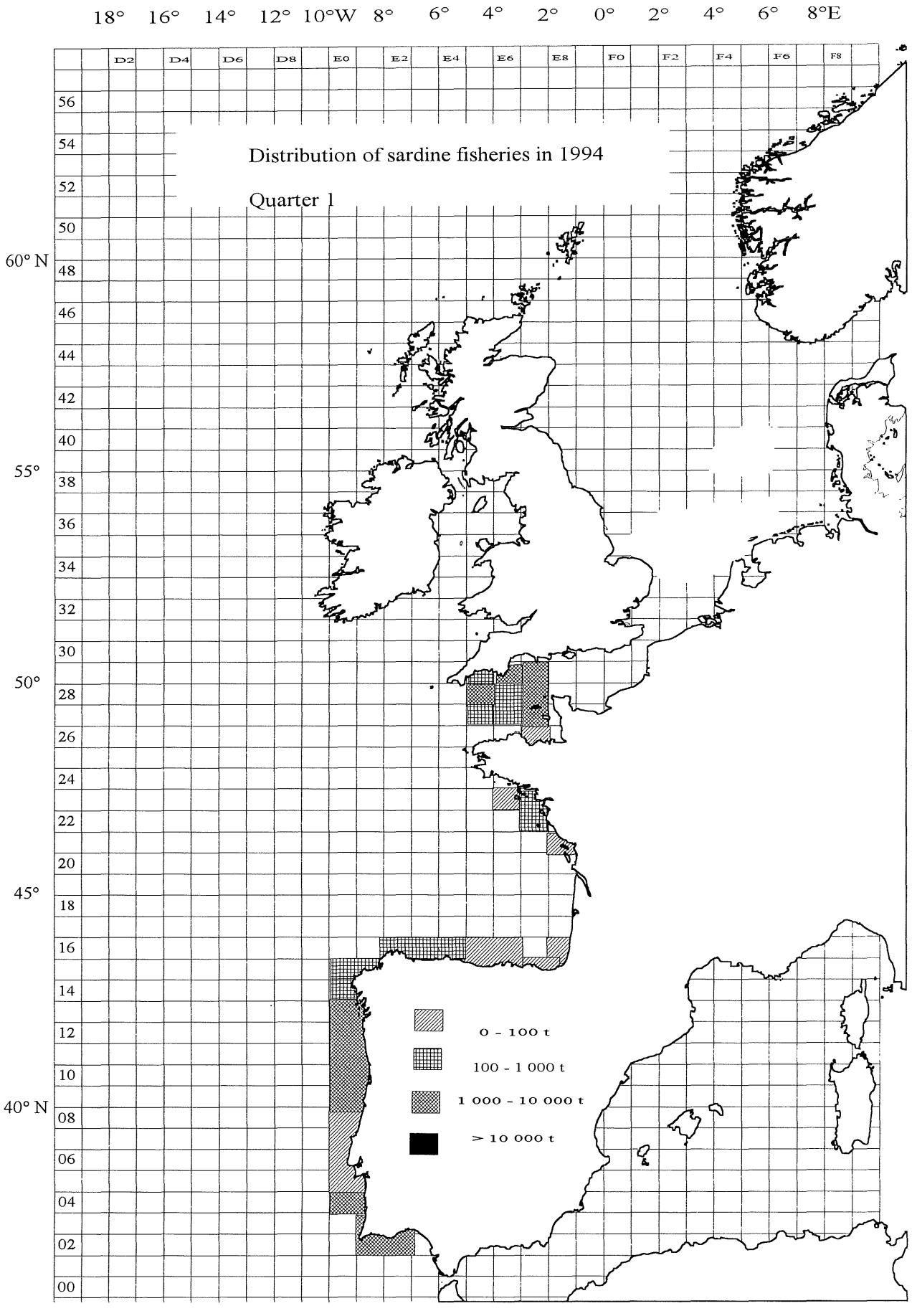

18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Distribution of sardine fisheries in 1994
Quarter 1
0 - 100 t
100 - 1 000 t
1 000 - 10 000 t
> 10 000 t

**Figure 8.3.a**

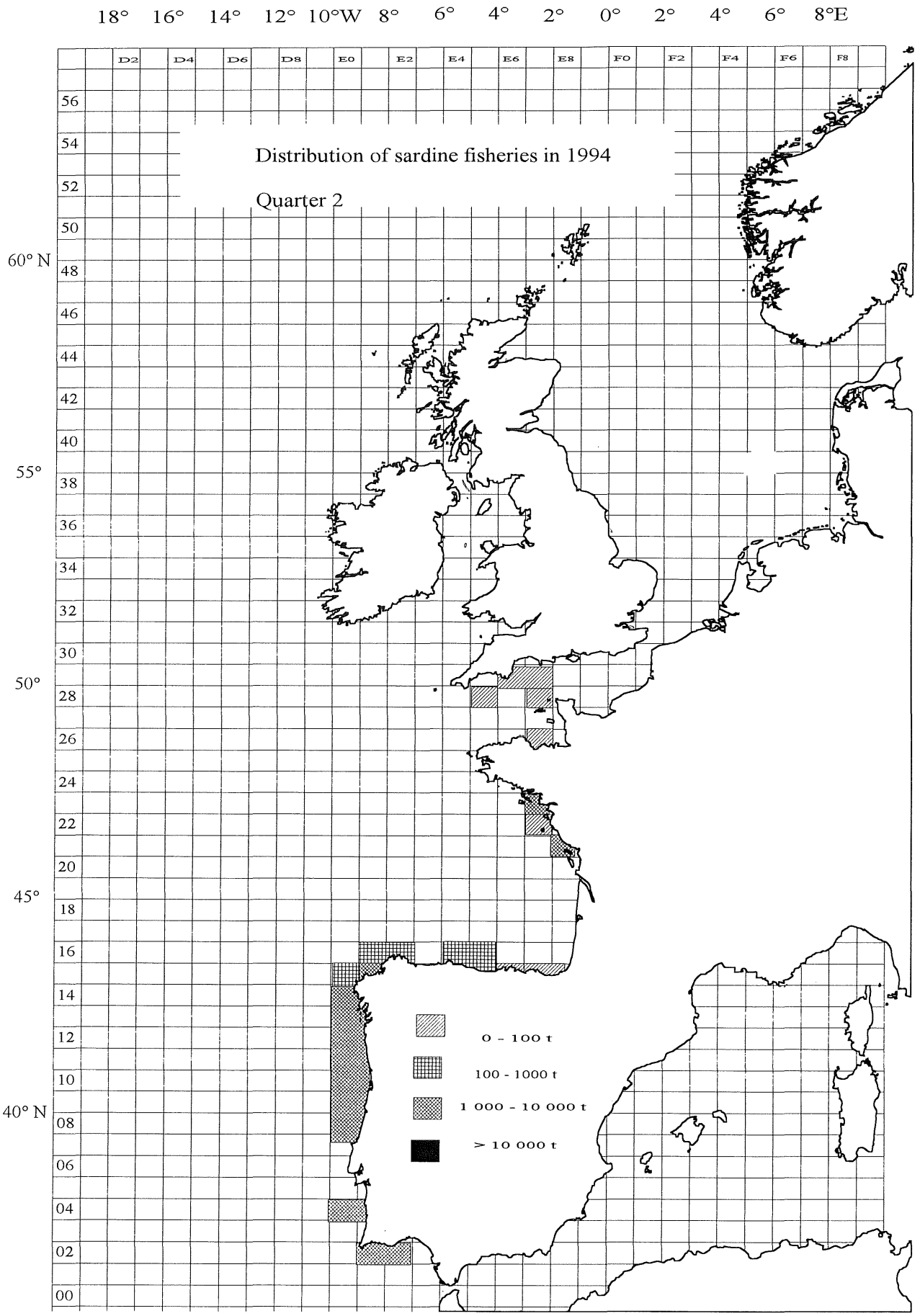

18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Distribution of sardine fisheries in 1994
Quarter 2
0 - 100 t
100 - 1000 t
1 000 - 10 000 t
> 10 000 t

**Figure 8.3.b**

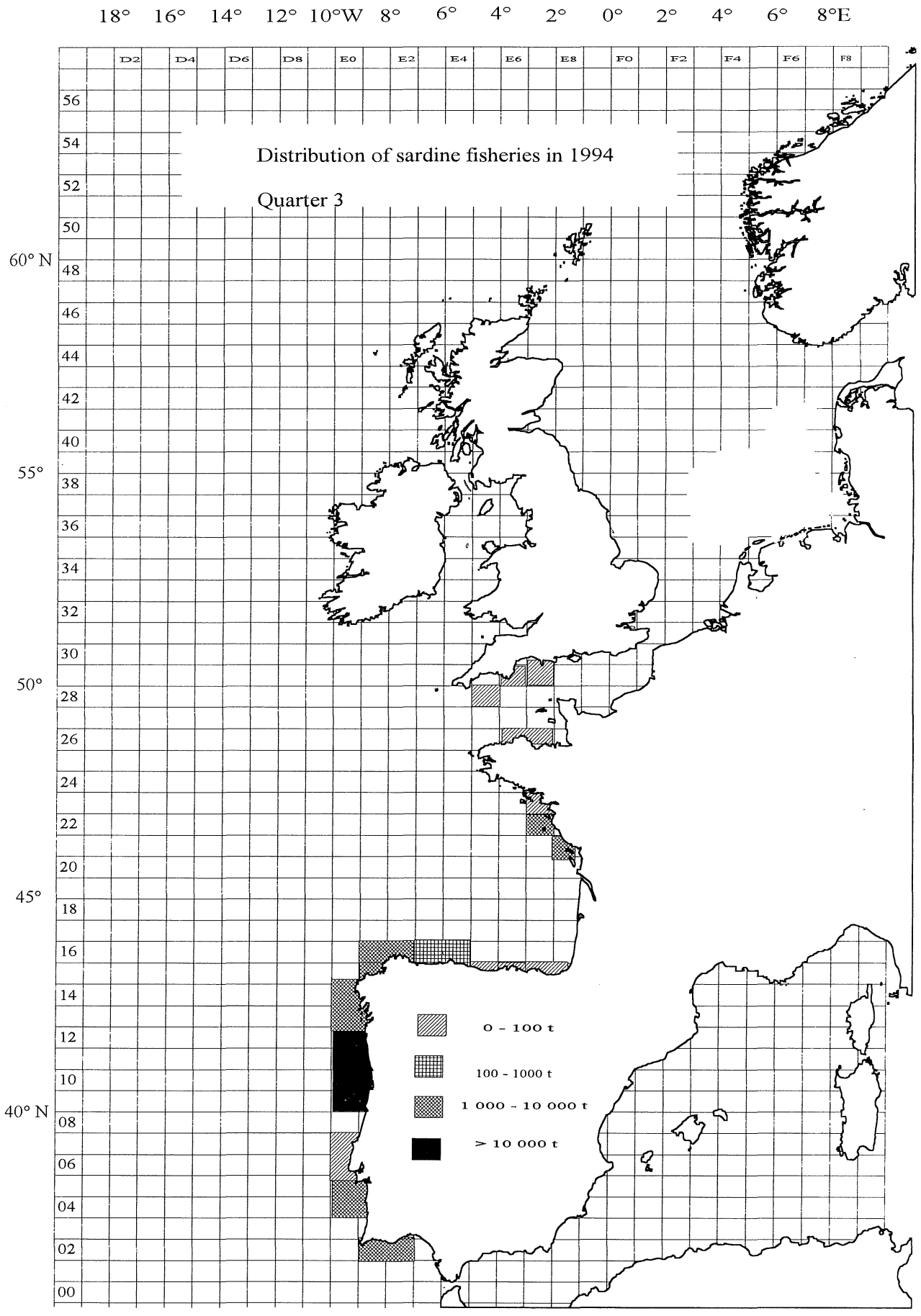

18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Distribution of sardine fisheries in 1994
Quarter 3
0 - 100 t
100 - 1000 t
1 000 - 10 000 t
> 10 000 t

**Figure 8.3.c**

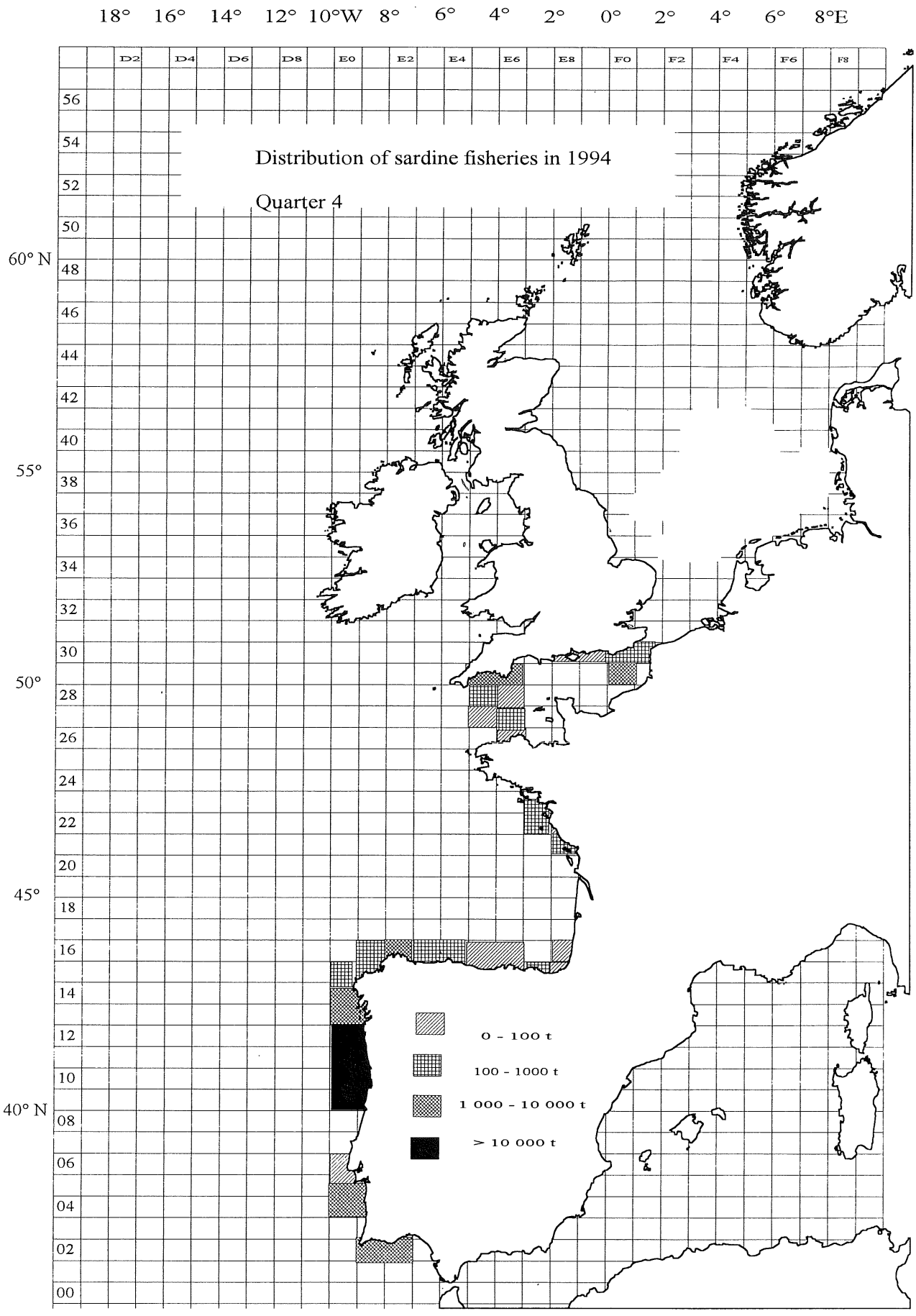

18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Distribution of sardine fisheries in 1994
Quarter 4
0 - 100 t
100 - 1000 t
1 000 - 10 000 t
> 10 000 t

**Figure 8.3.d**

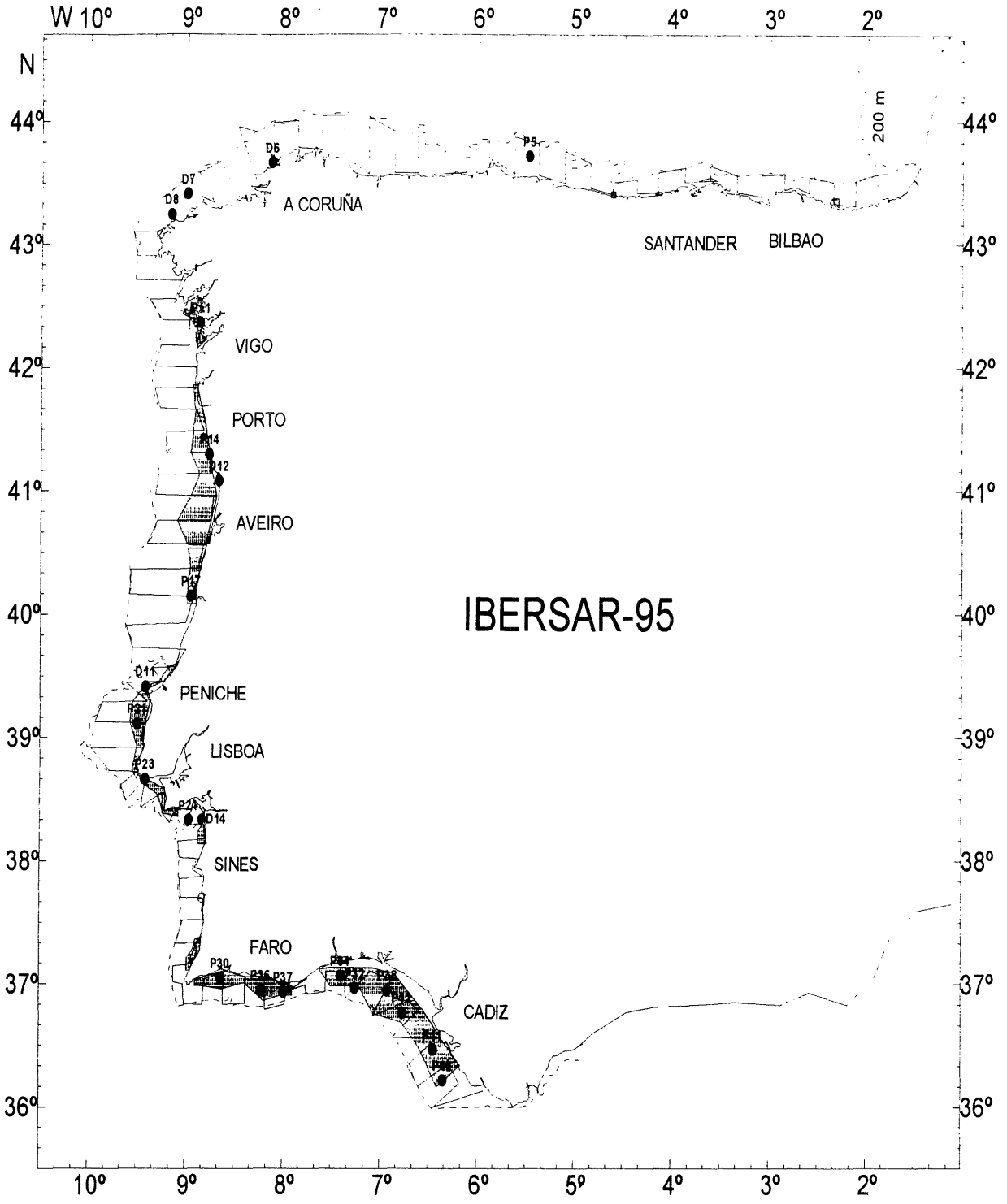



**Figure 8.4** Sardine distribution during the 1995 acoustic survey (Marques *et al.* WD 1995).

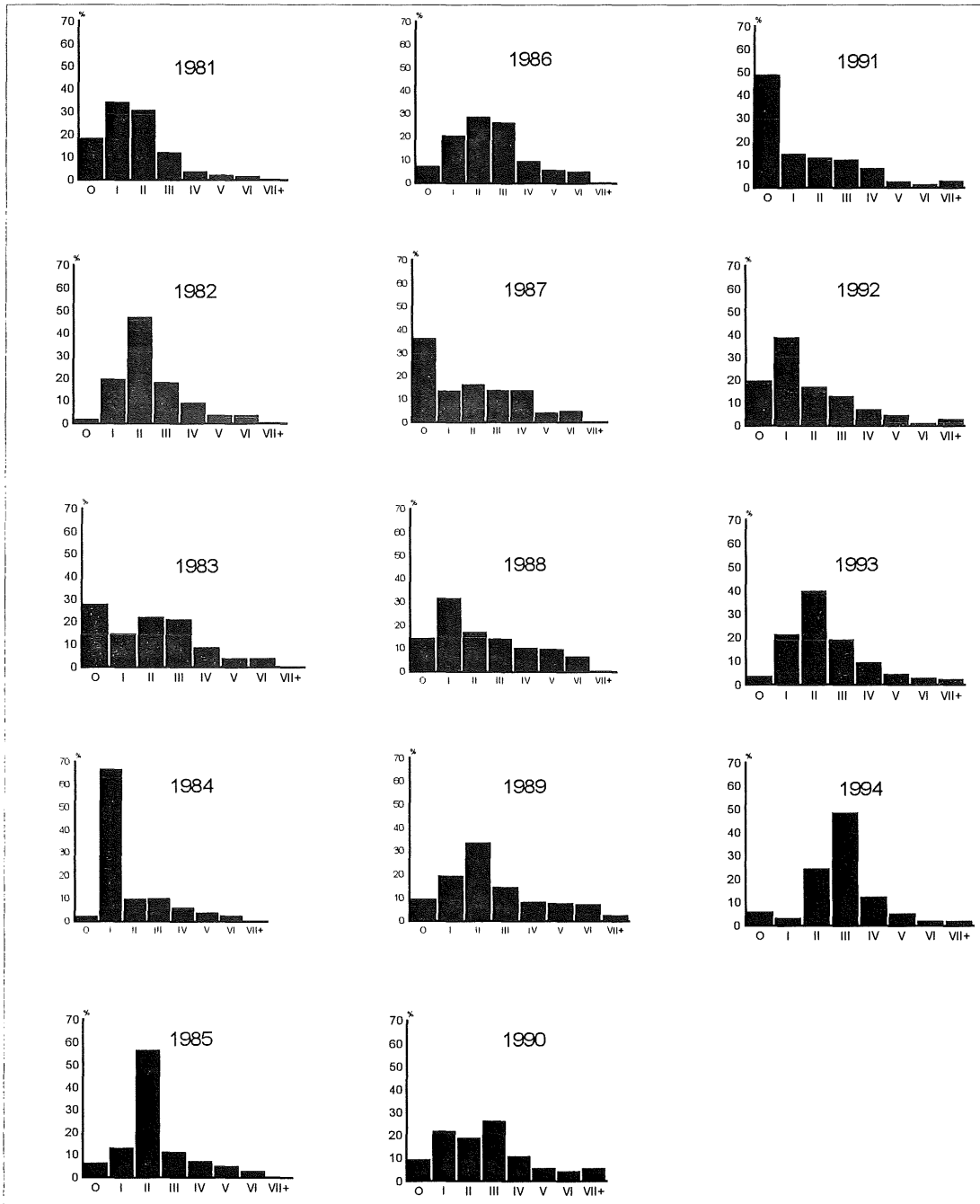



**Figure 8.5 Relative annual catch in number at age from 1981 to 1994**

**Figure 8.6a** Stock summary and separable model diagnostics.

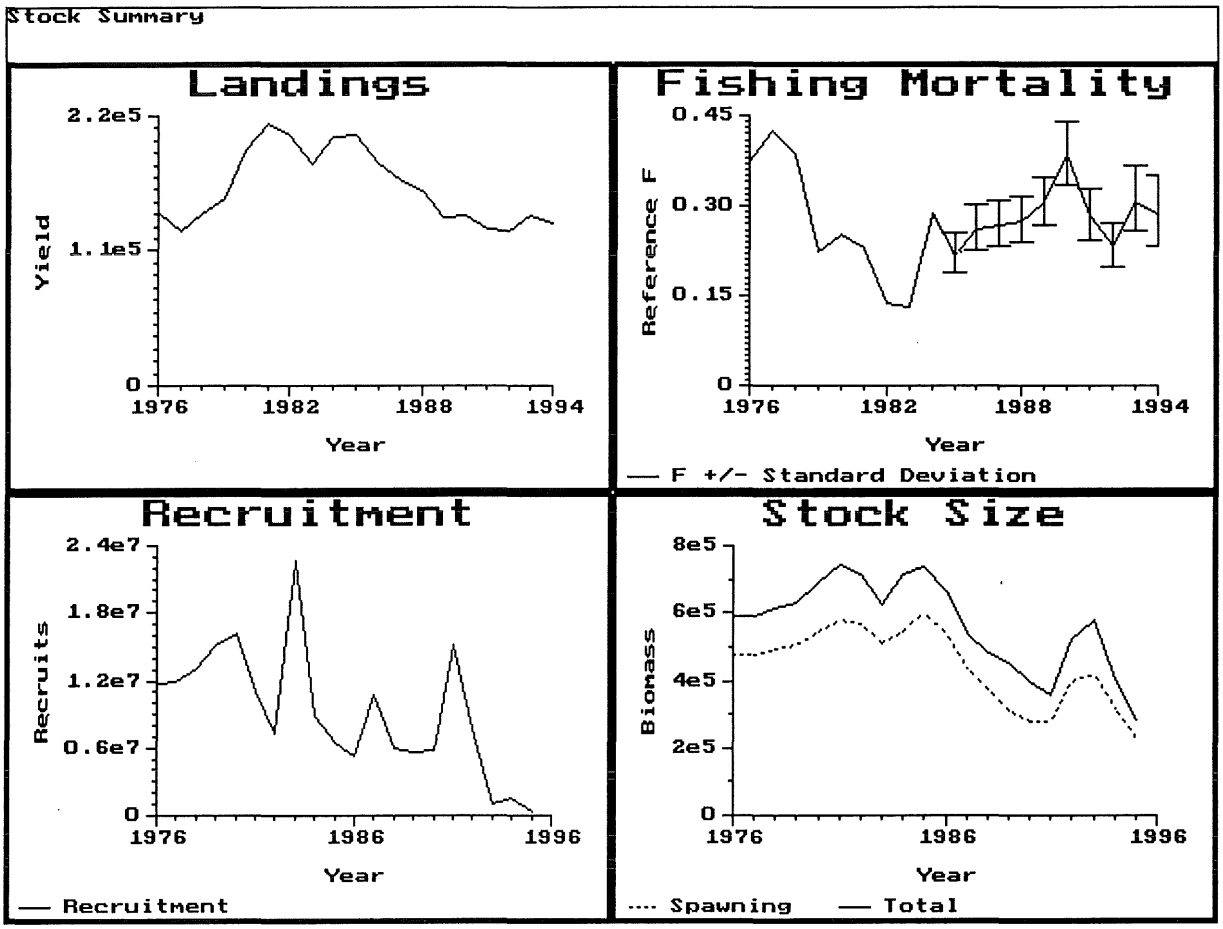


Figure 8.6a (continued)

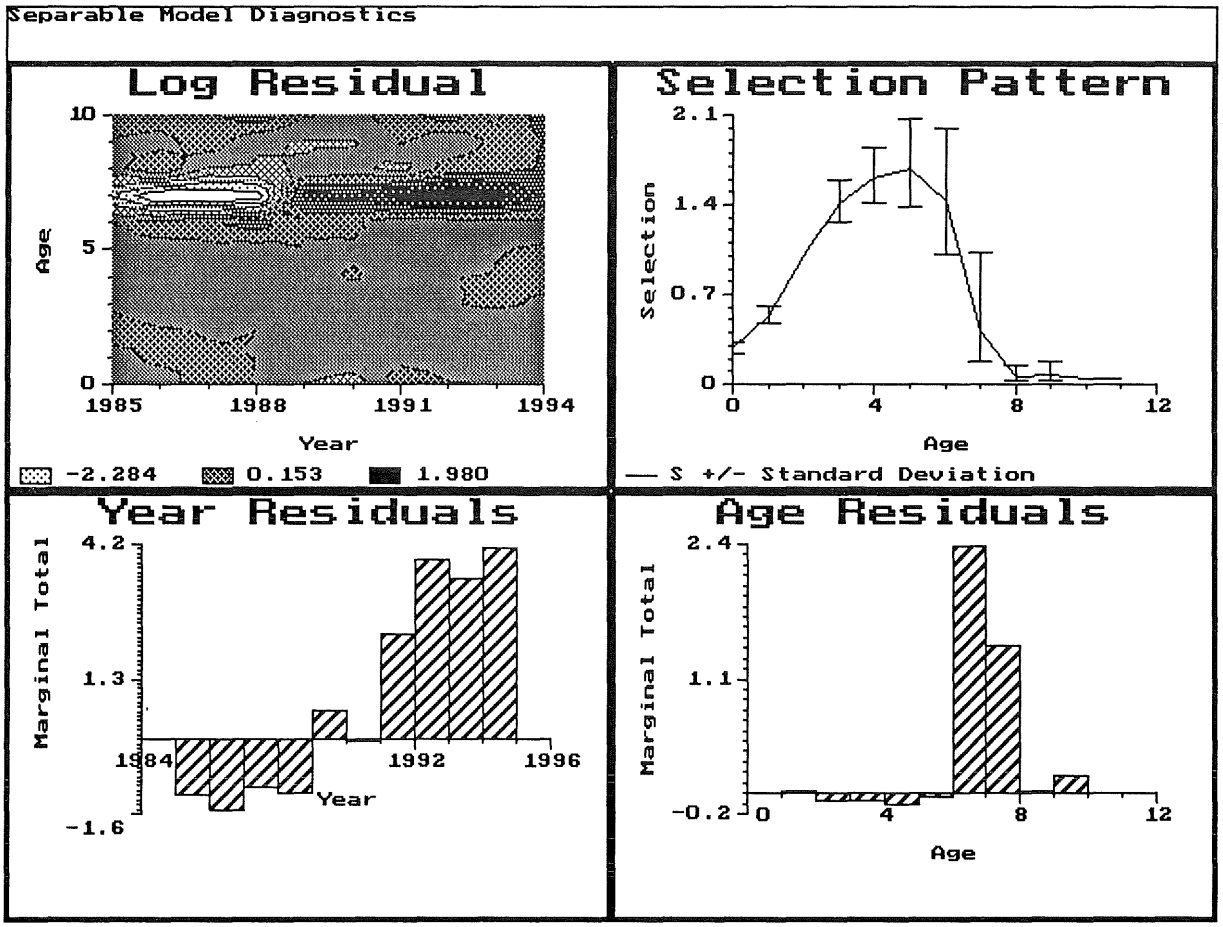


**Figure 8.6b** Tuning diagnostics: Aged Index 1 at ages 1, 2, 3 and 4.

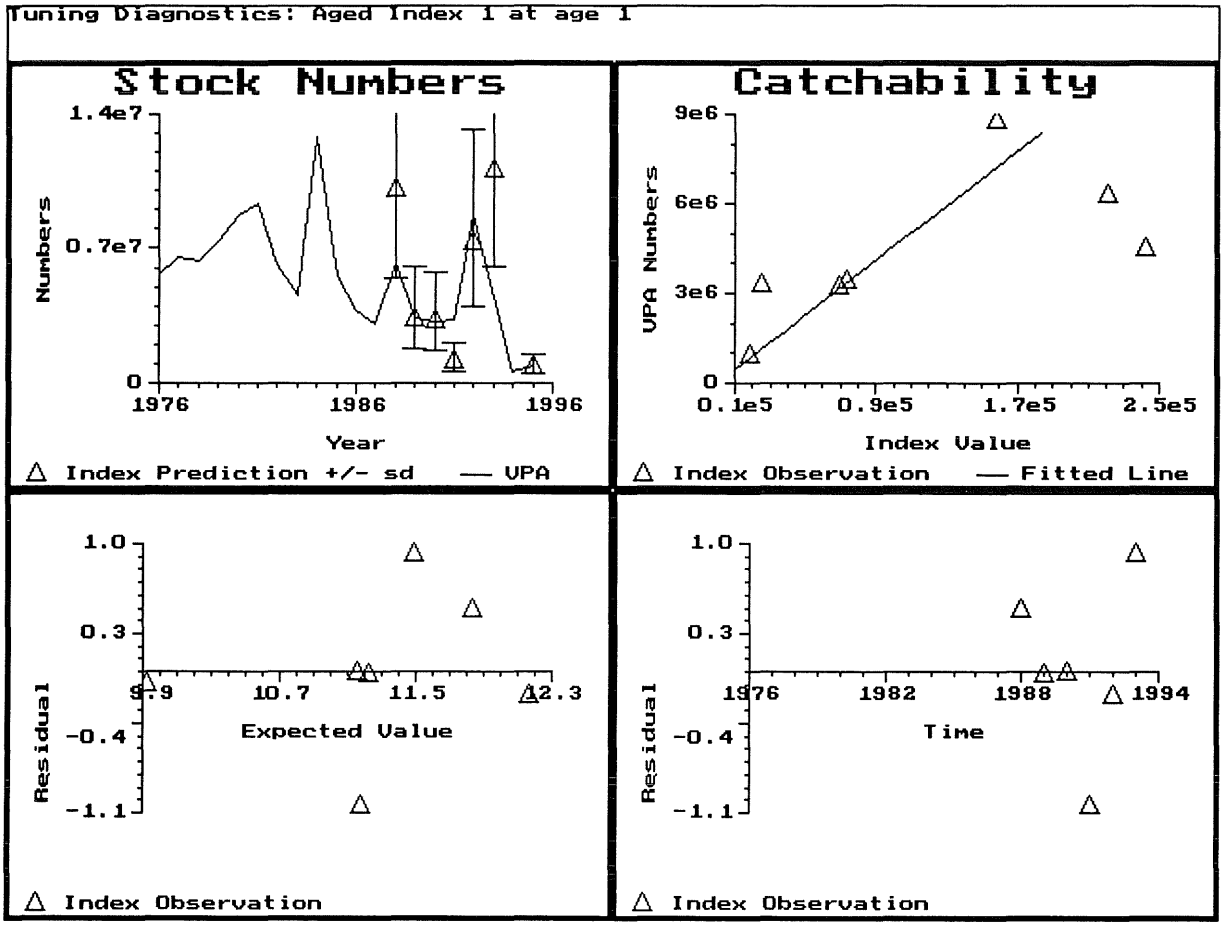


Figure 8.6b (continued)

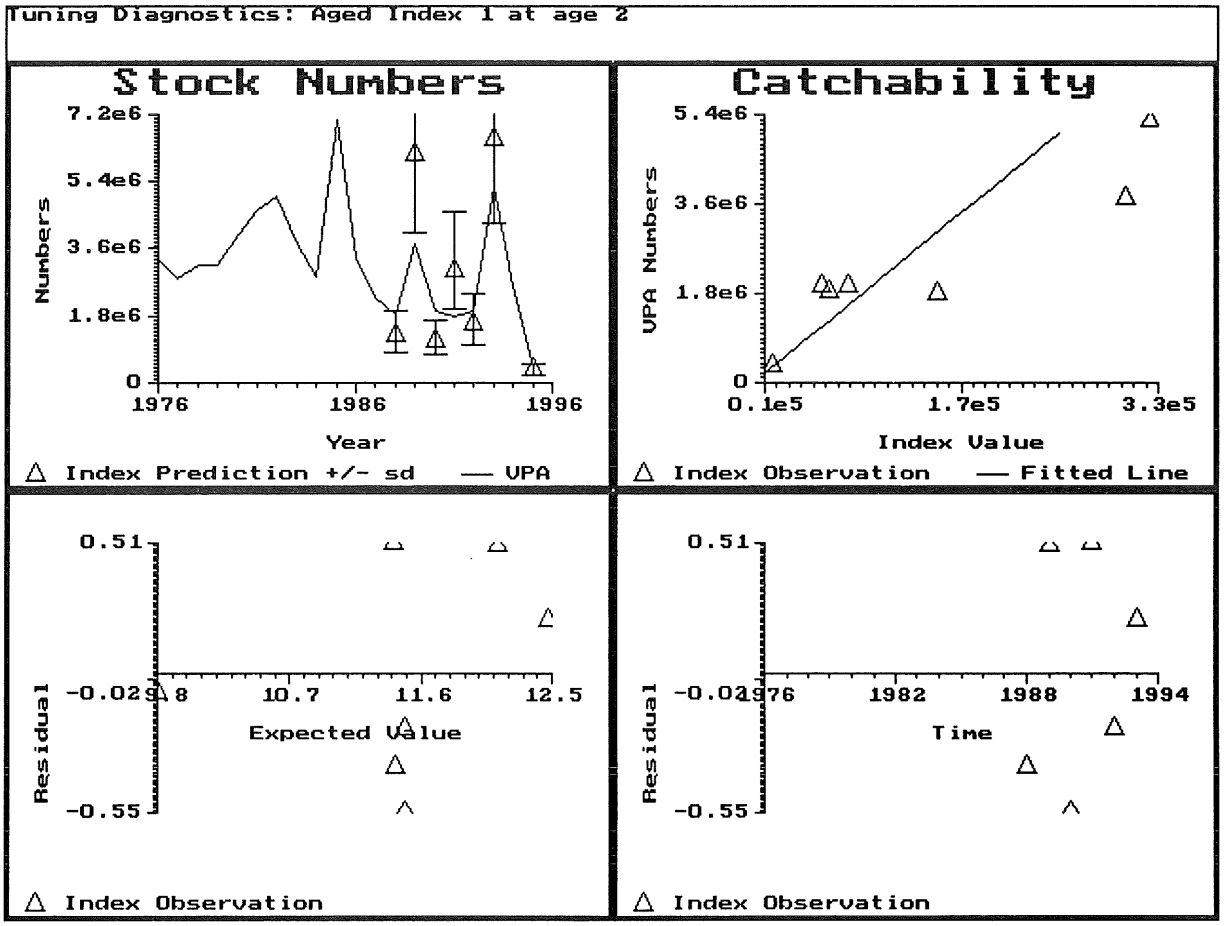


Figure 8.6b (continued)

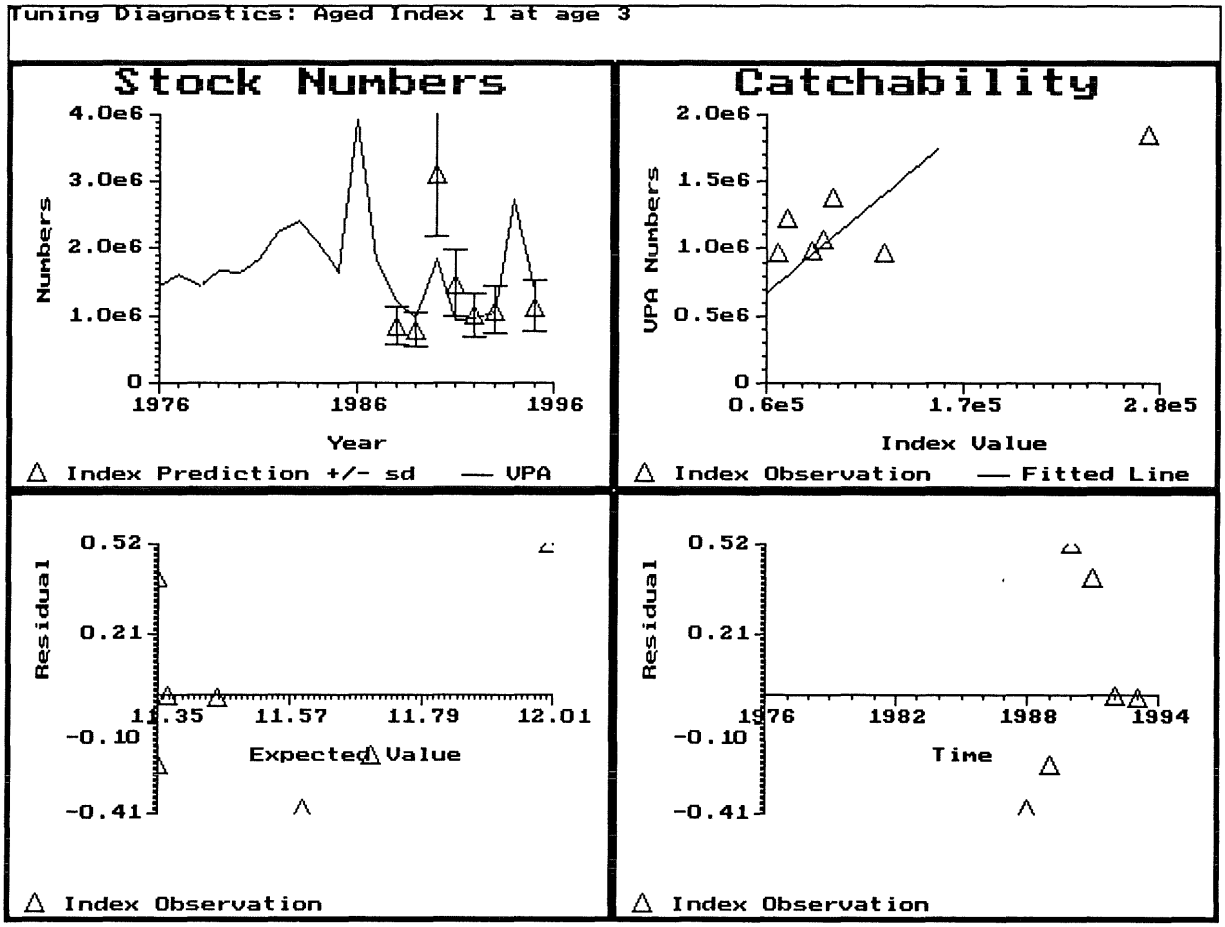


Figure 8.6b (continued)

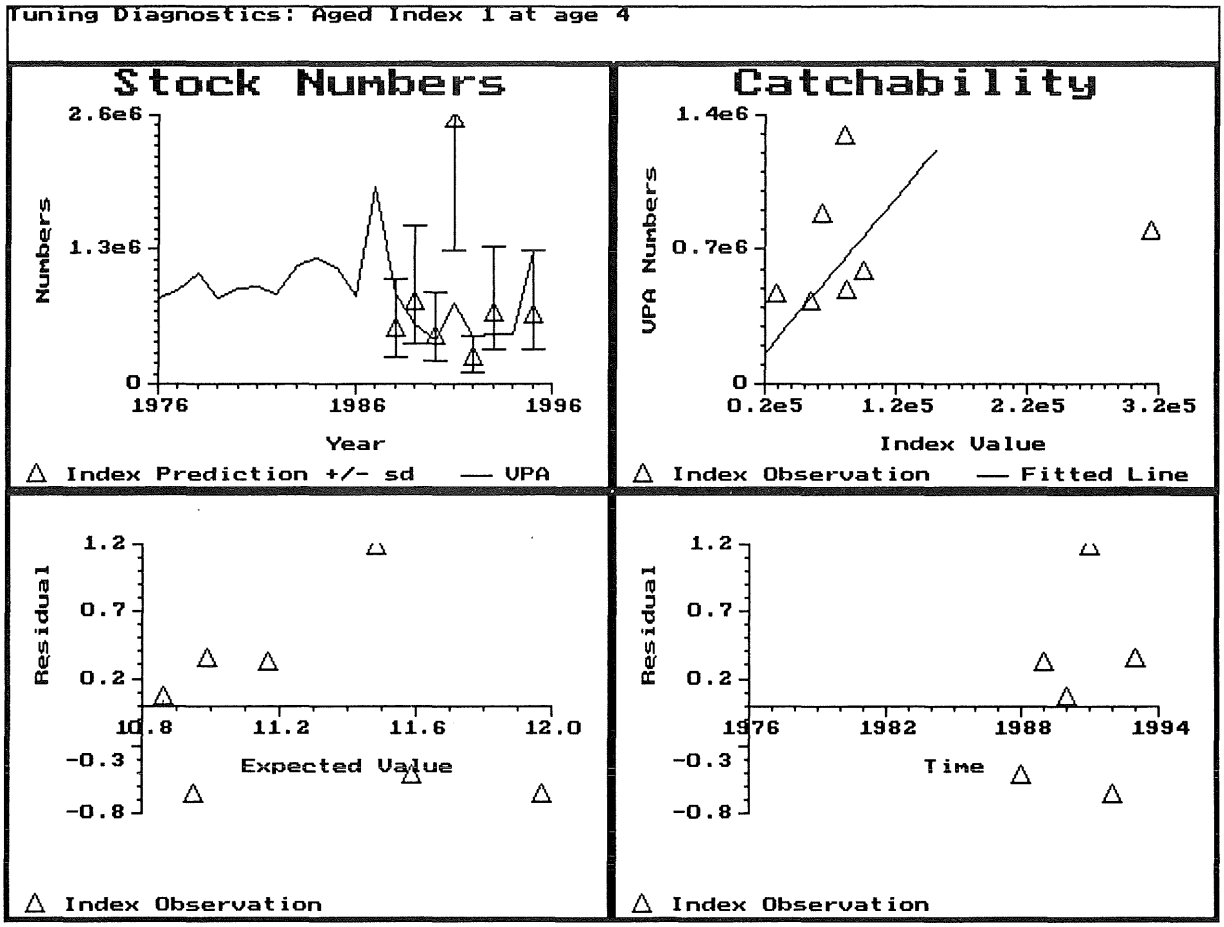


**Figure 8.6c** Tuning diagnostics: Aged Index 1 at ages 5, 6, 7 and 8.

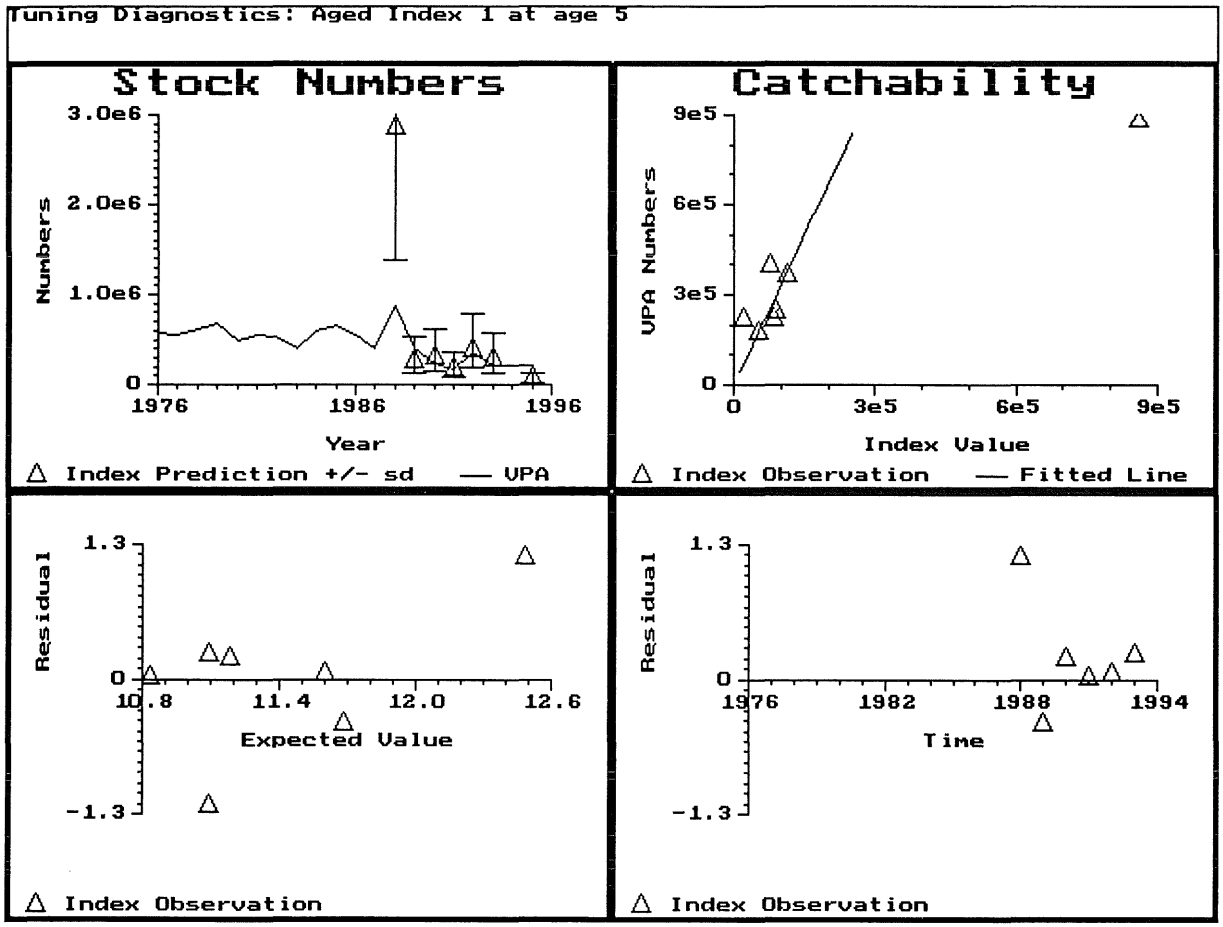


Figure 8.6c (continued)

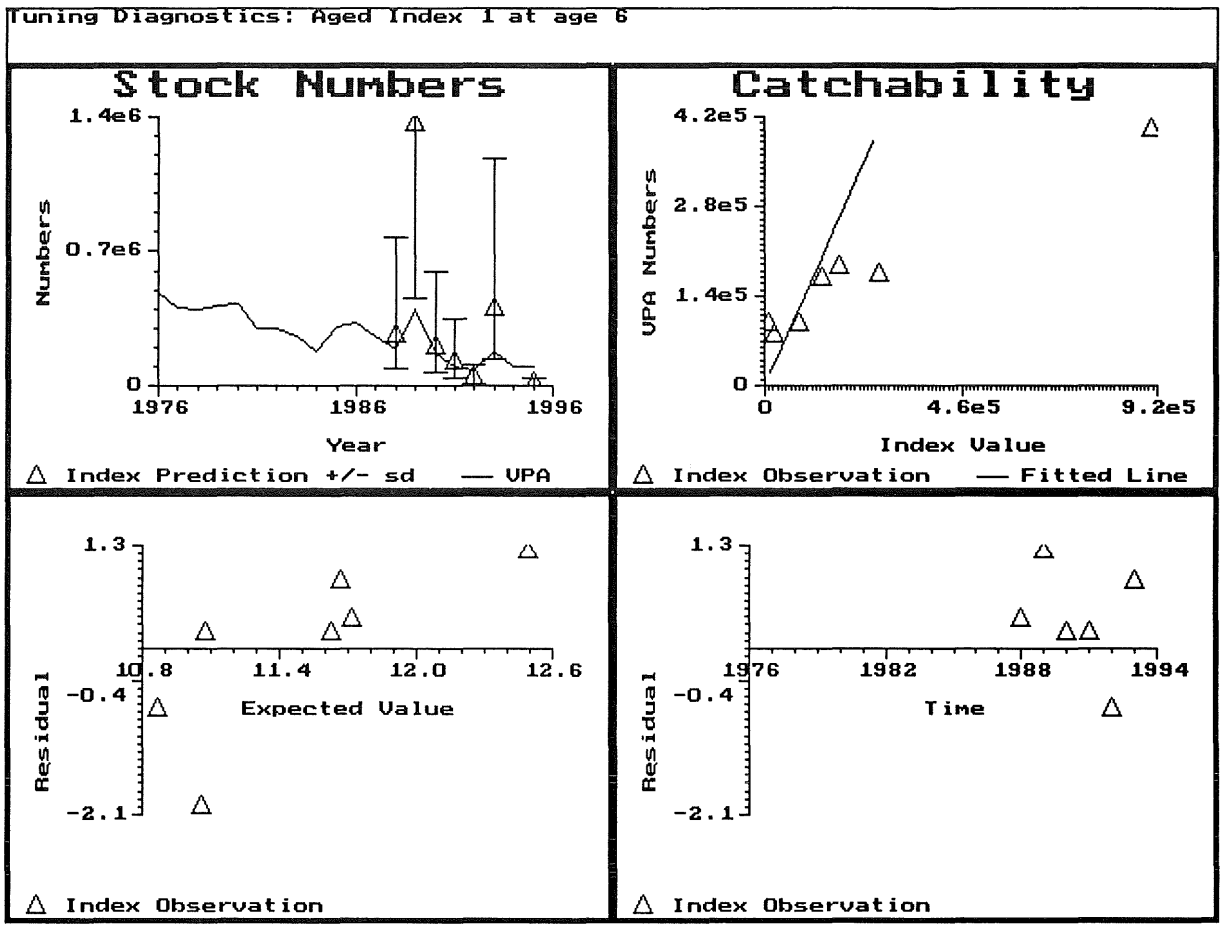


Figure 8.6c (continued)

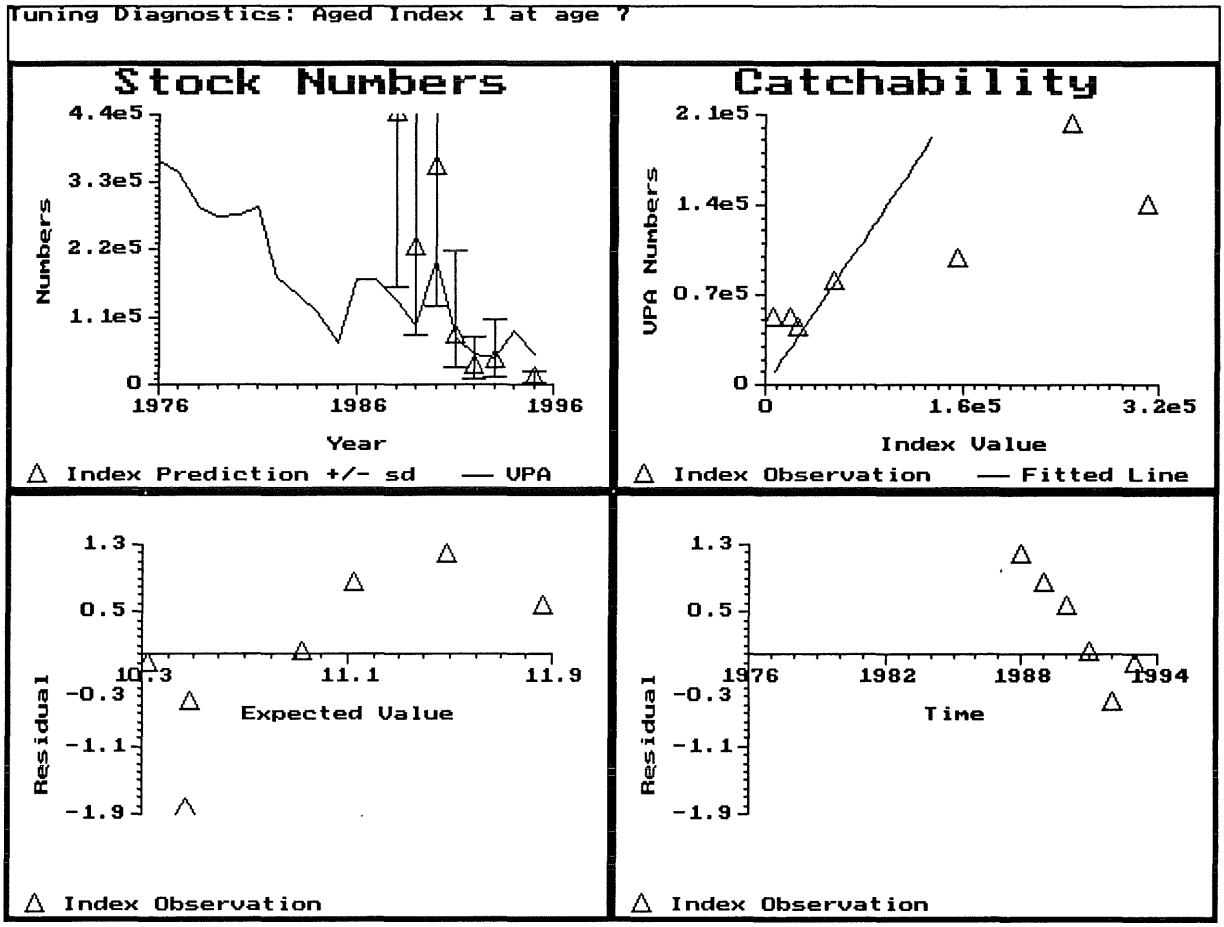


Figure 8.6c (continued)

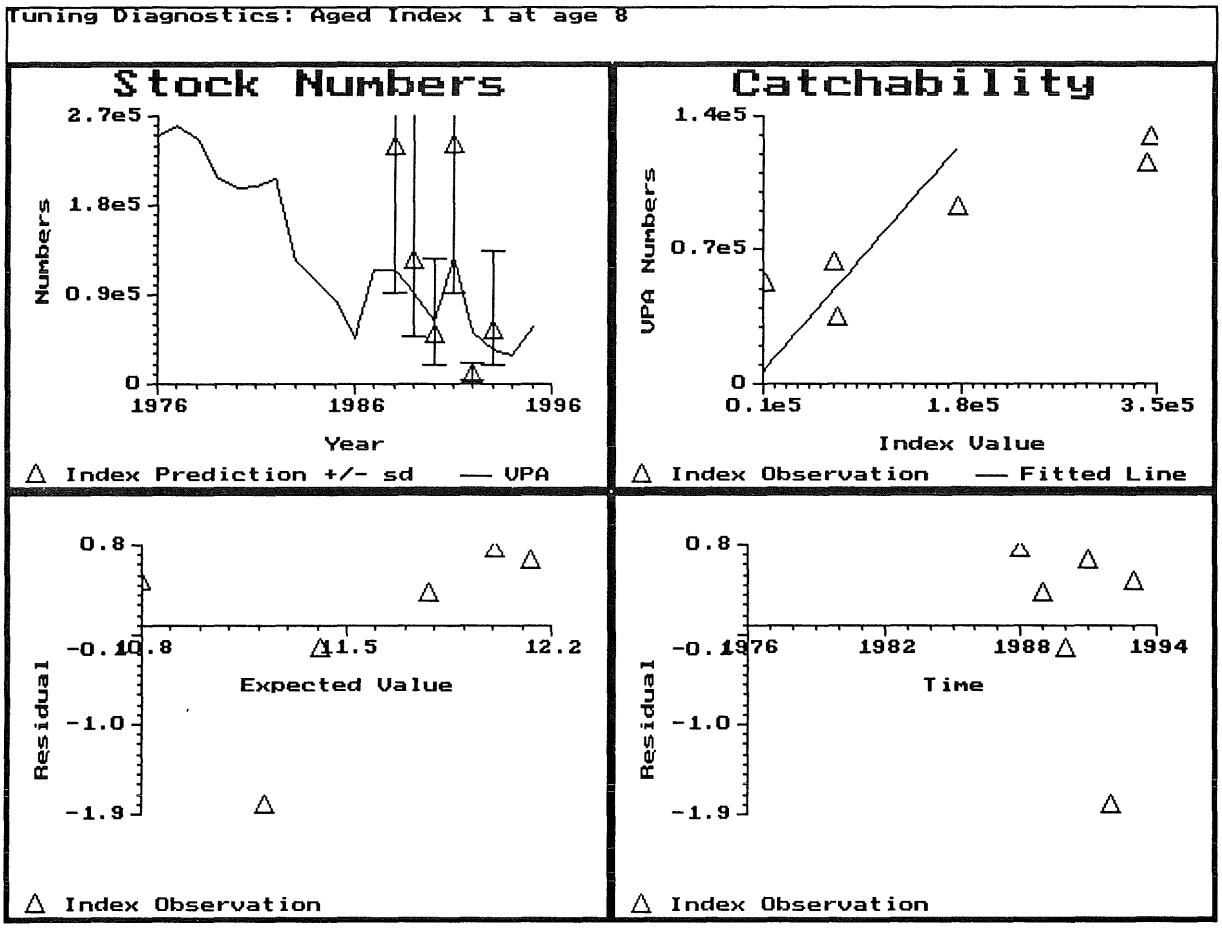


**Figure 8.6d** Tuning diagnostics: Aged Index 1 at ages 9, 10 and 11.

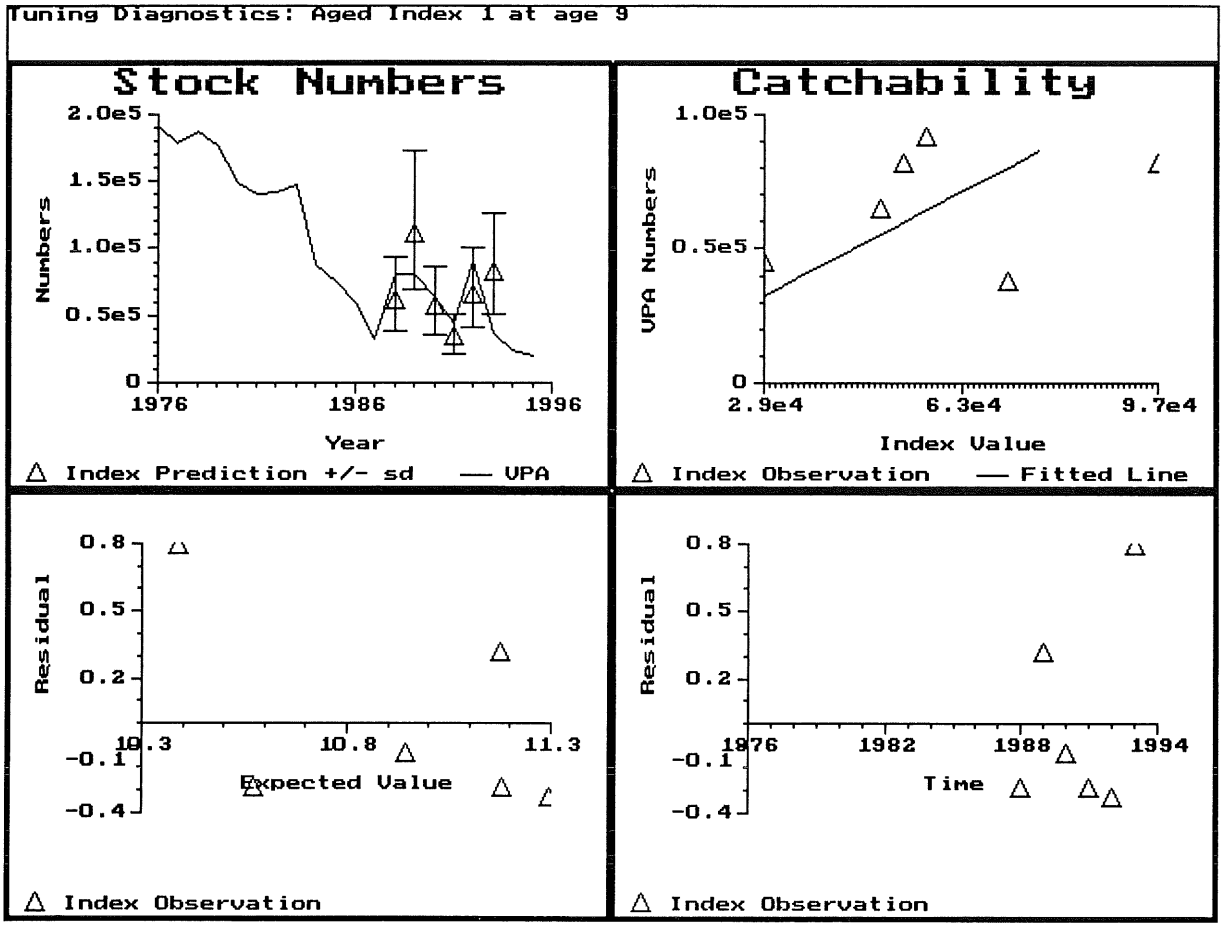


Figure 8.6d (continued)

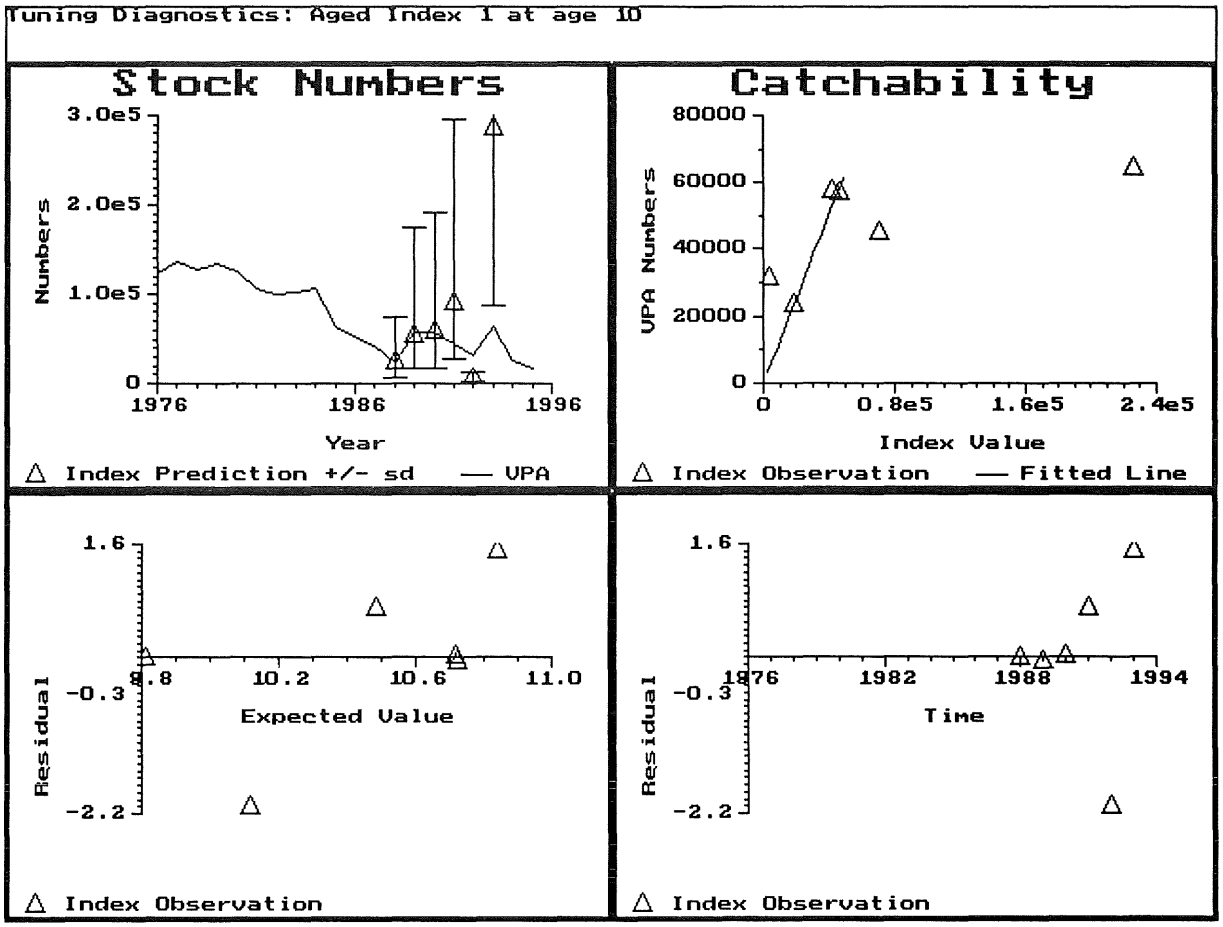


Figure 8.6d (continued)

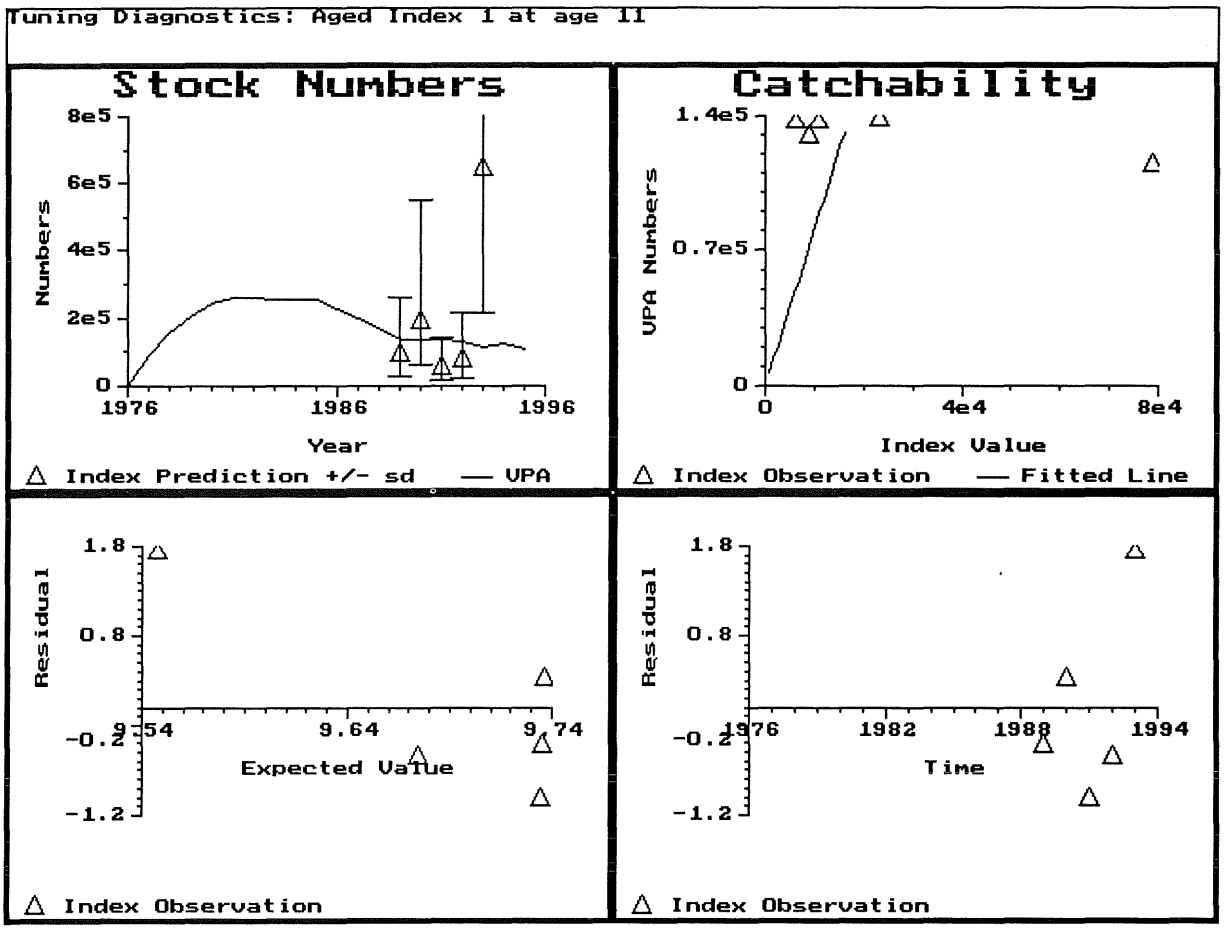


**Figure 8.6e** Tuning diagnostics: Aged Index 2 at ages 0, 1, 2 and 3.

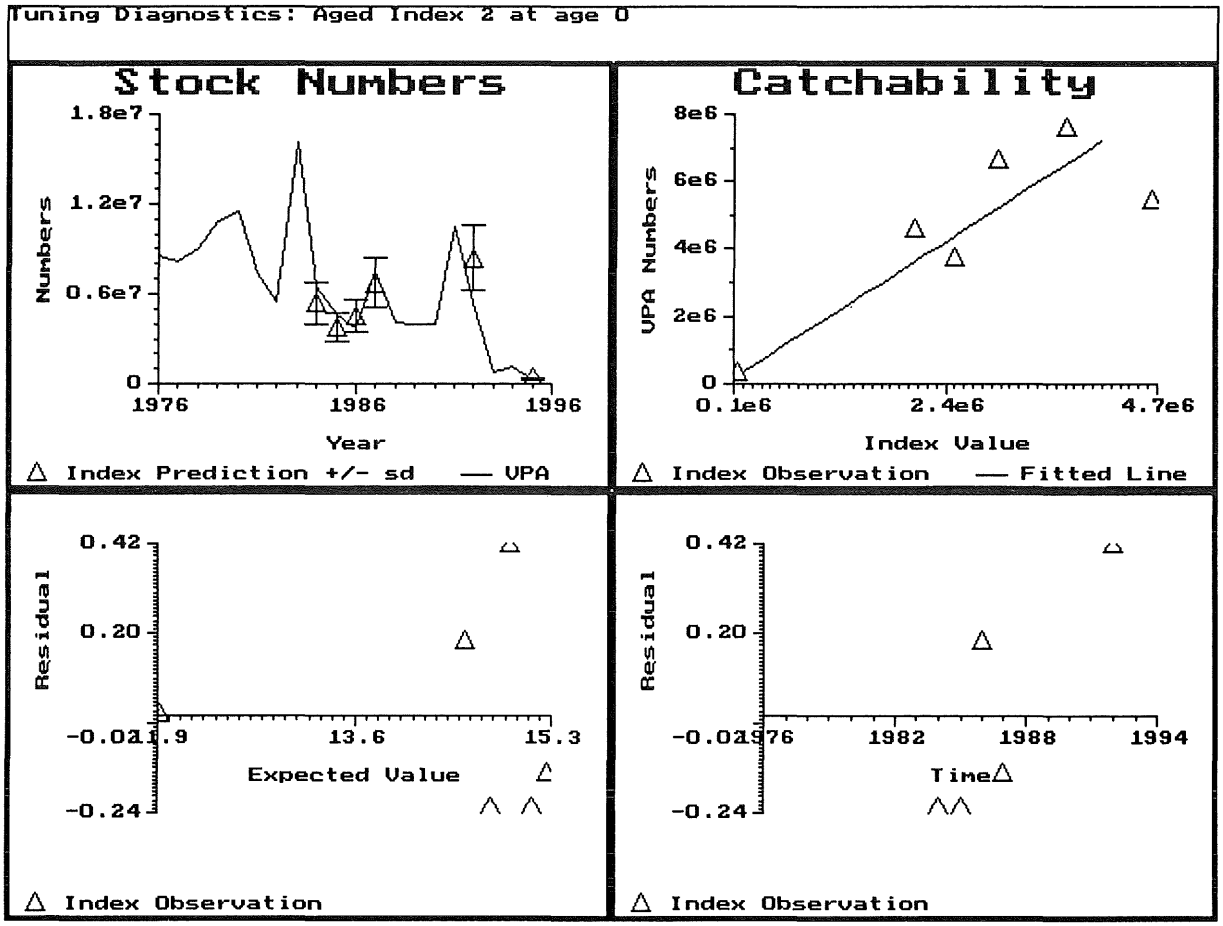


Figure 8.6e (continued)

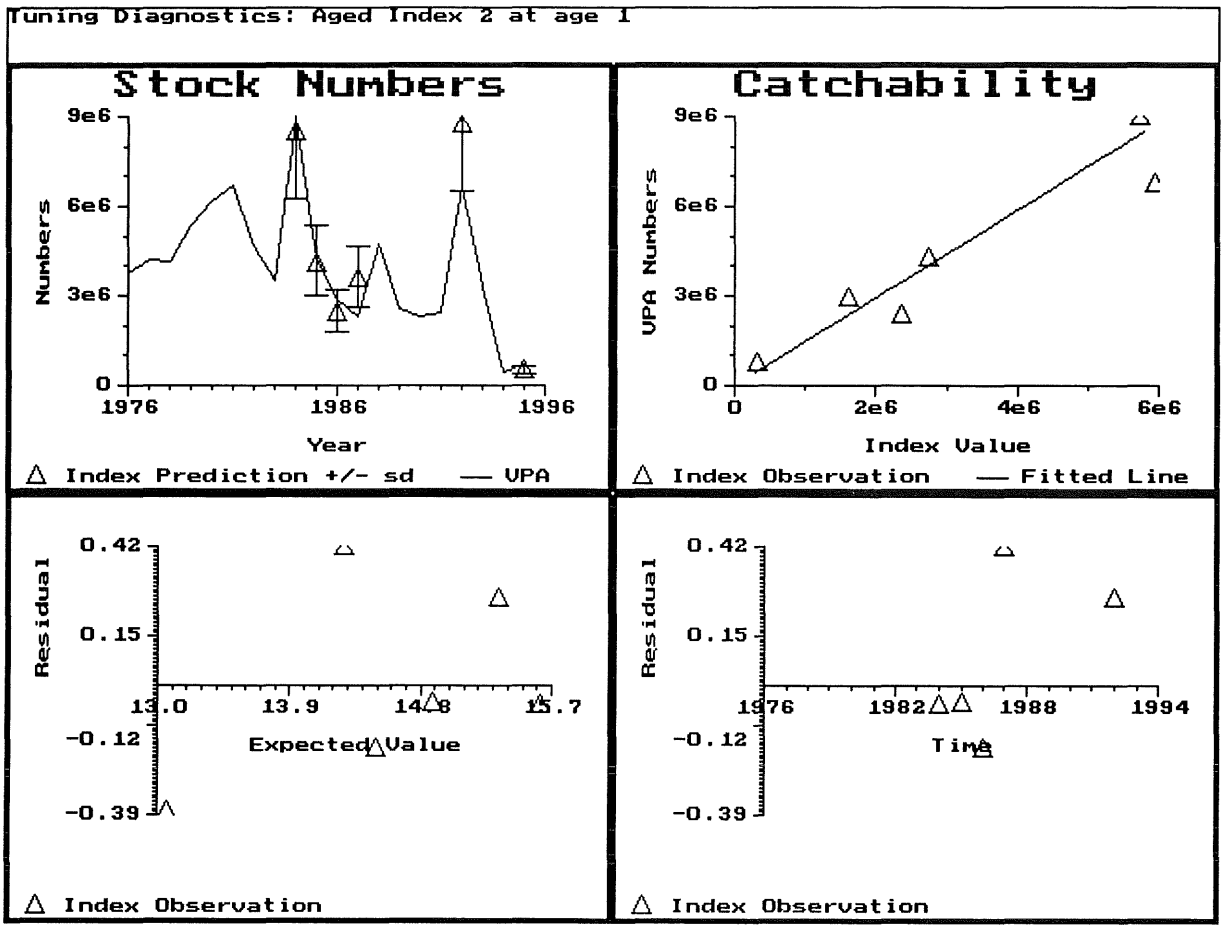


Figure 8.6e (continued)

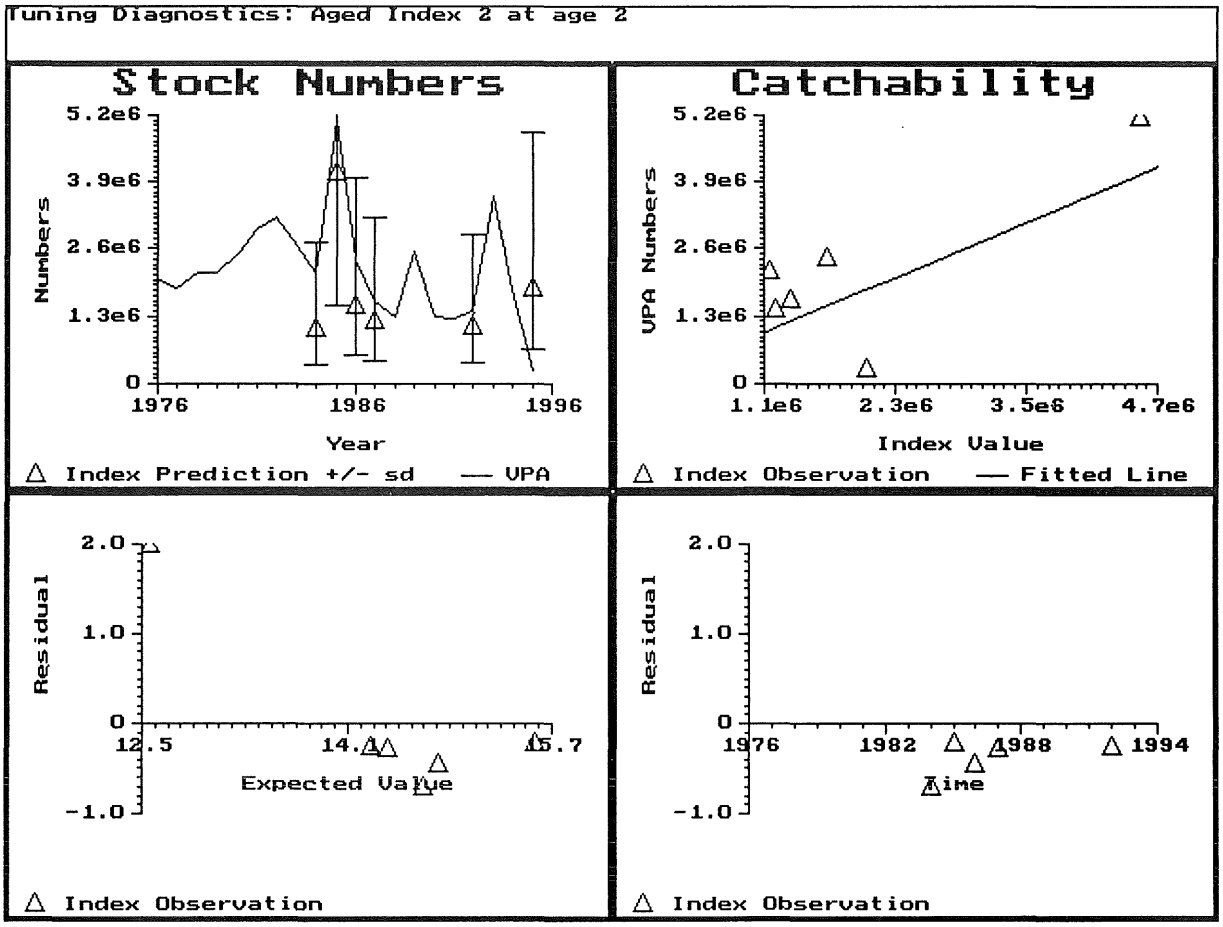


Figure 8.6e (continued)

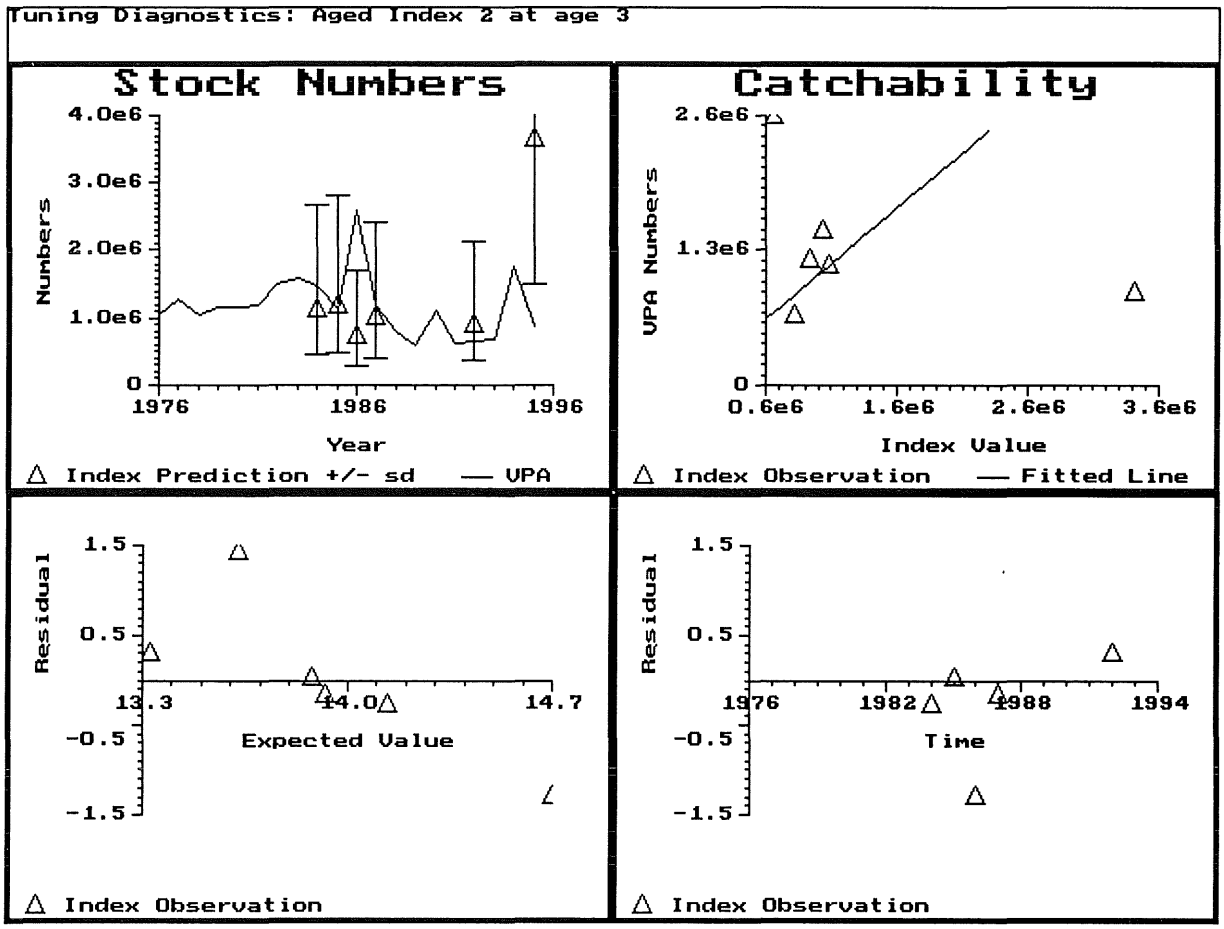


**Figure 8.6f** Tuning diagnostics: Aged Index 2 at ages 4, 5 and 6.

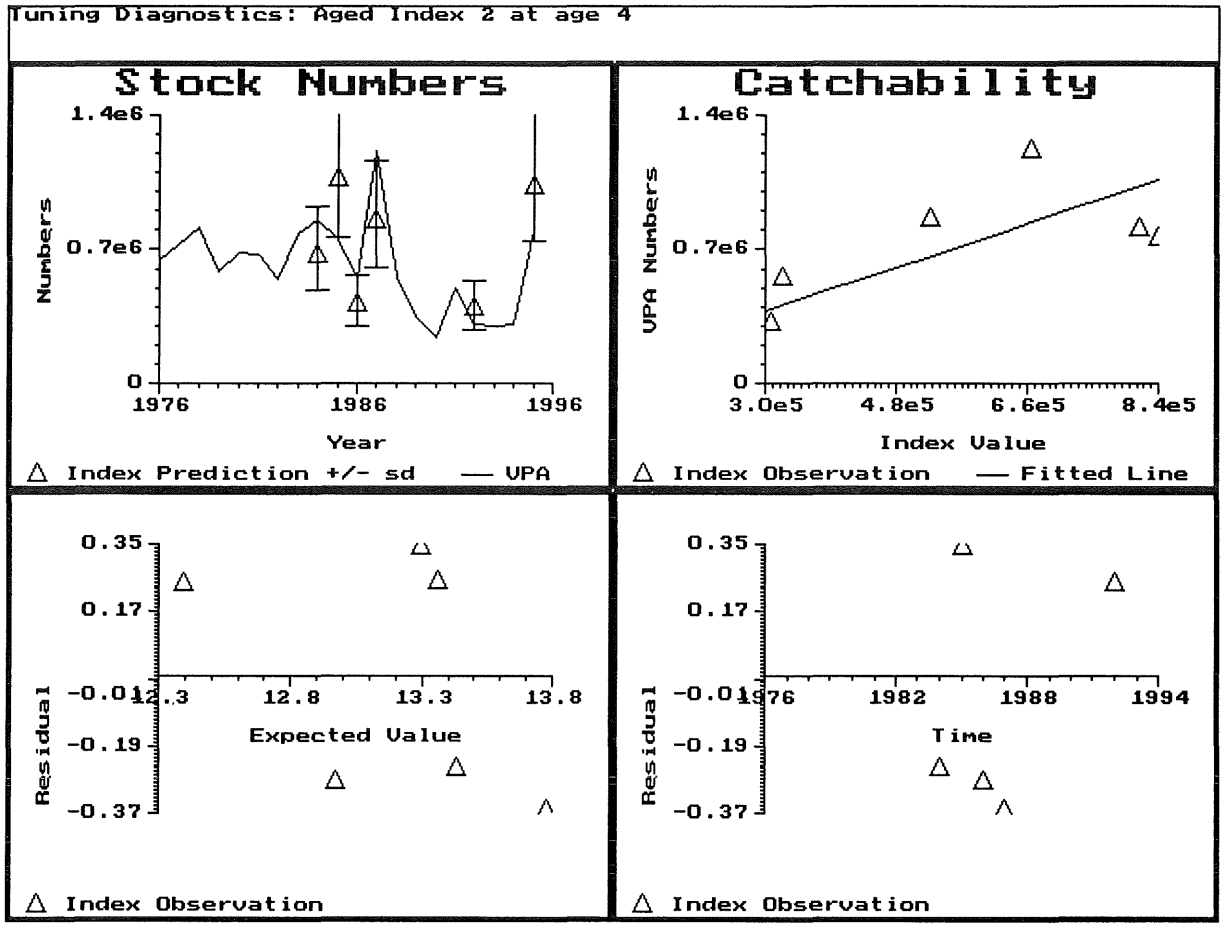


Figure 8.6f (continued)

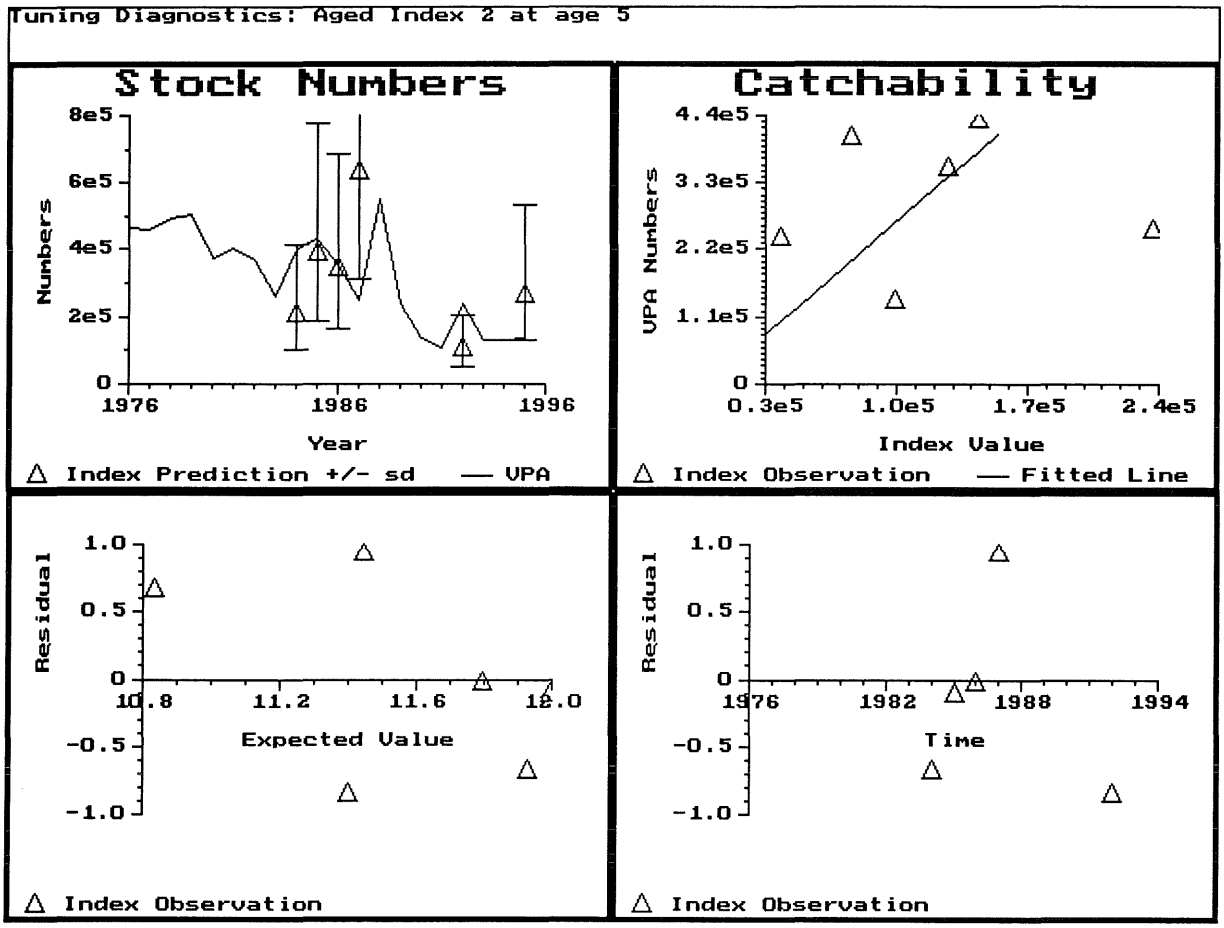
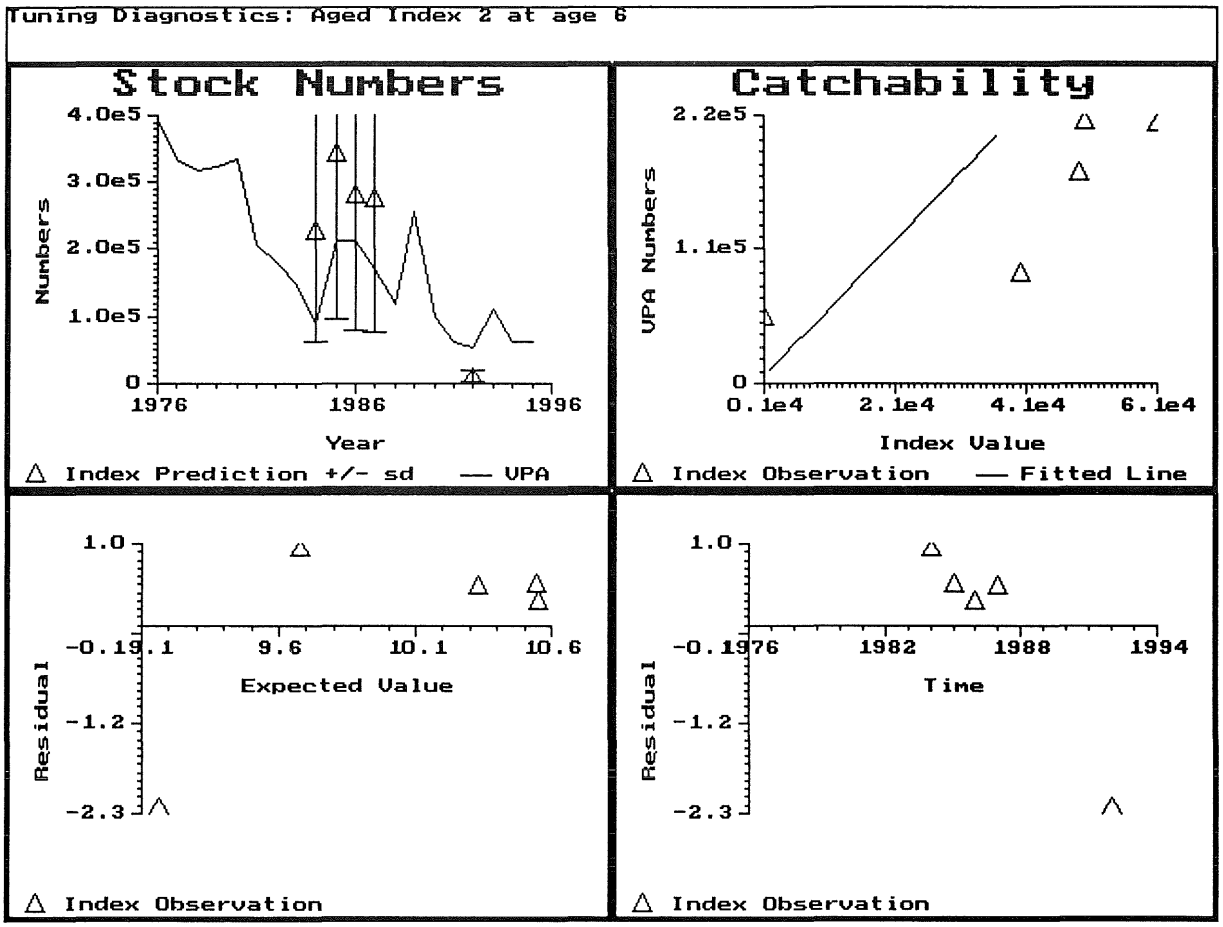


Figure 8.6f (continued)



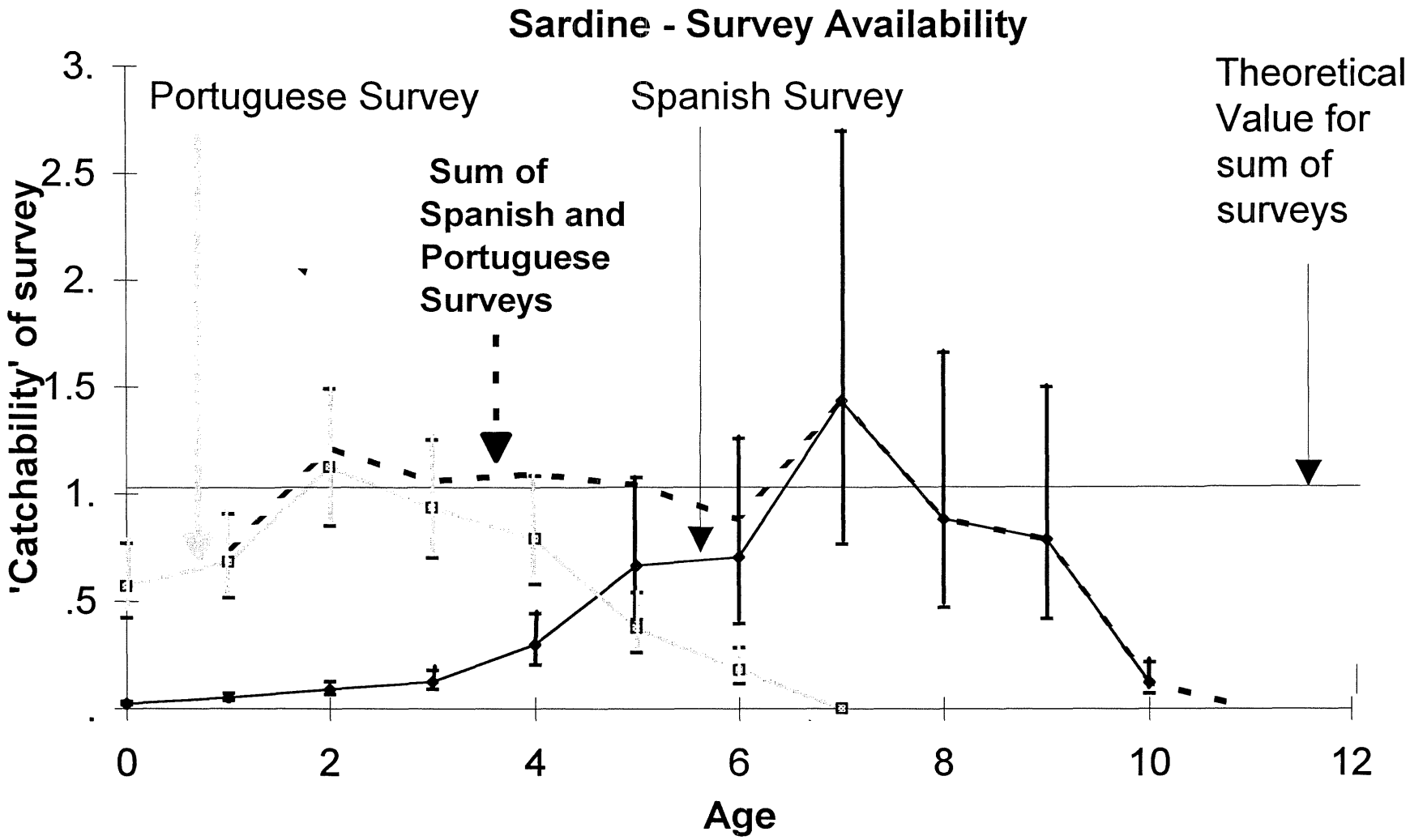
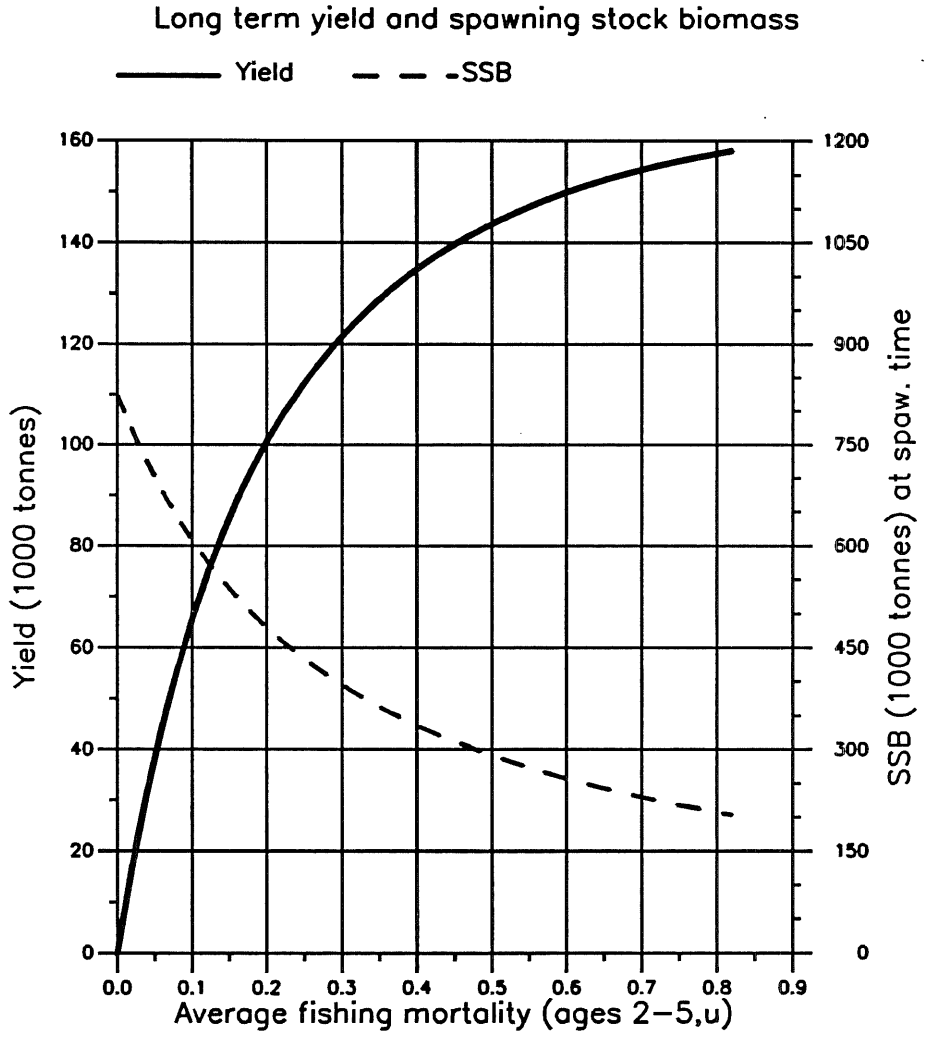


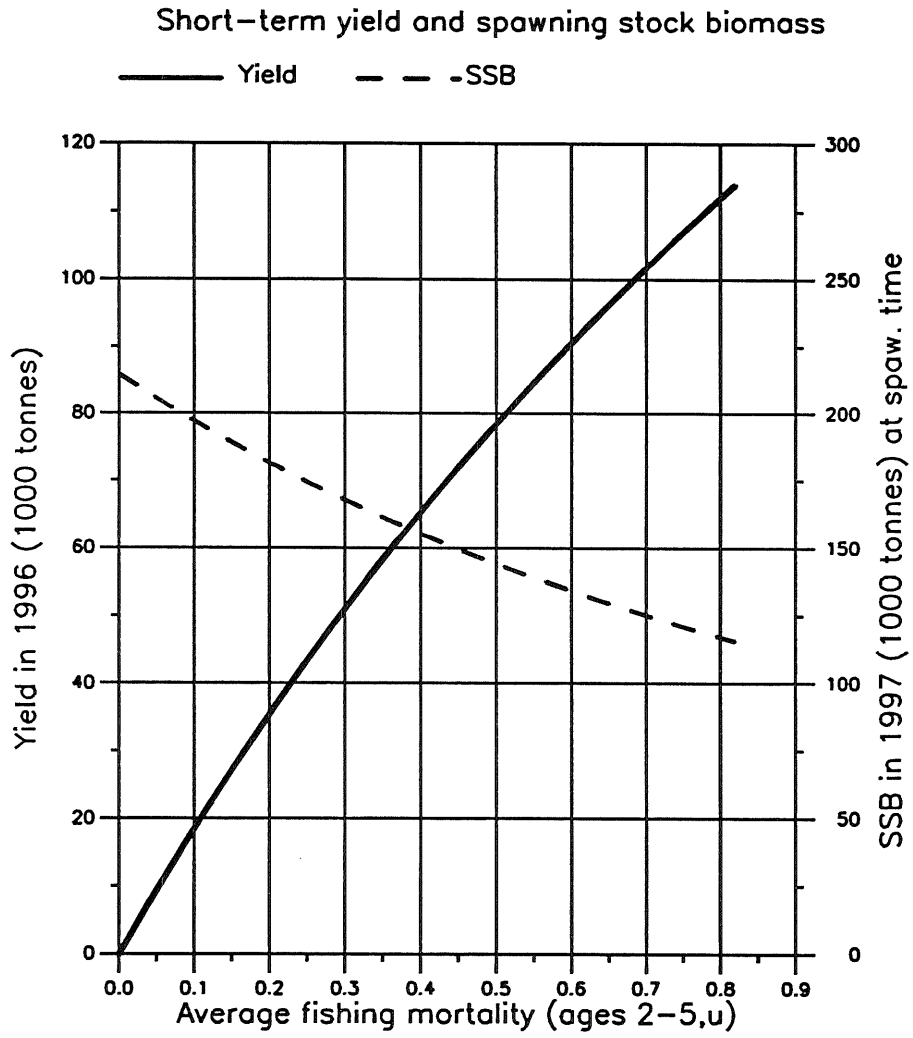

**Figure 8.7** Sardine survey availability.

Figure 8.8

# FISH STOCK SUMMARY
## STOCK: Sardine in the Southern Area (Fishing Areas VIIIc and IXa)
## 18–10–1995




(run: PP1) **C**




(run: HS2) **D**

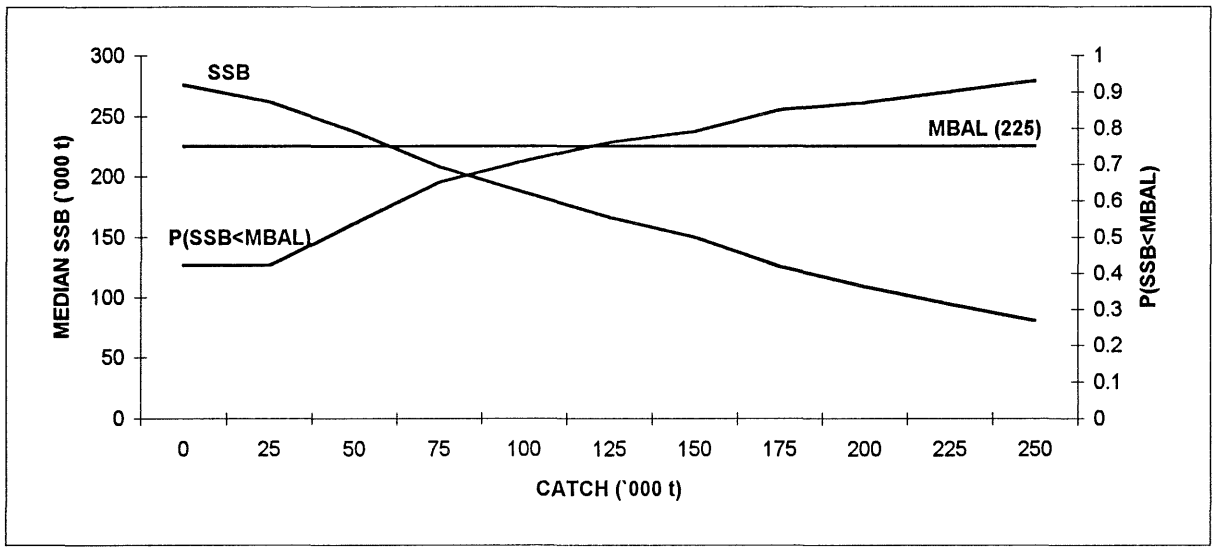



**Figure 8.9a:** Risk of falling below MBAL (SSB in 1995) for increasing catch level in 1996

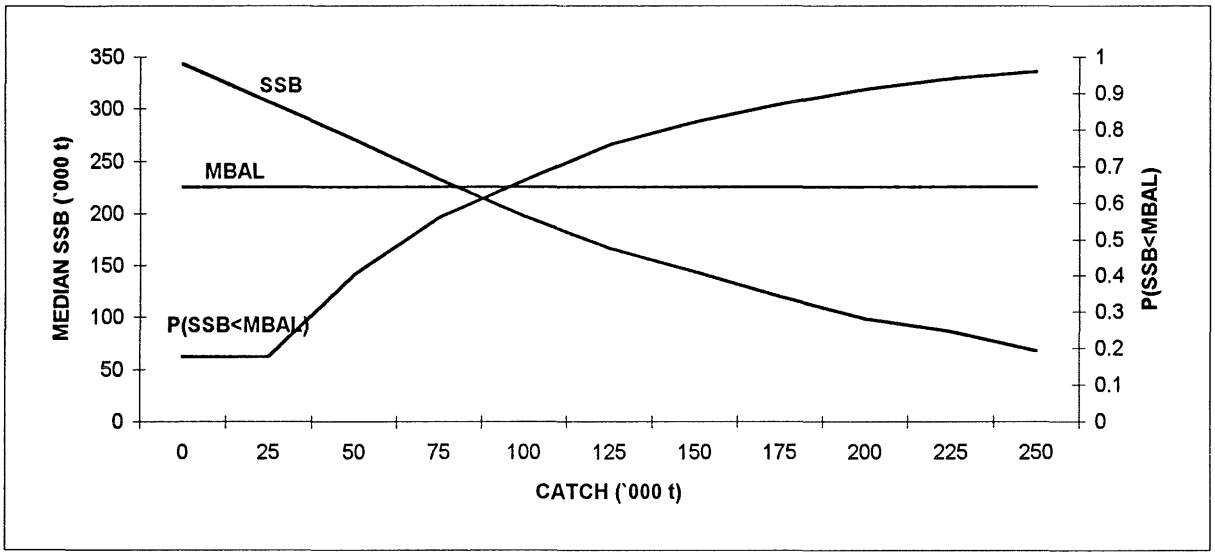
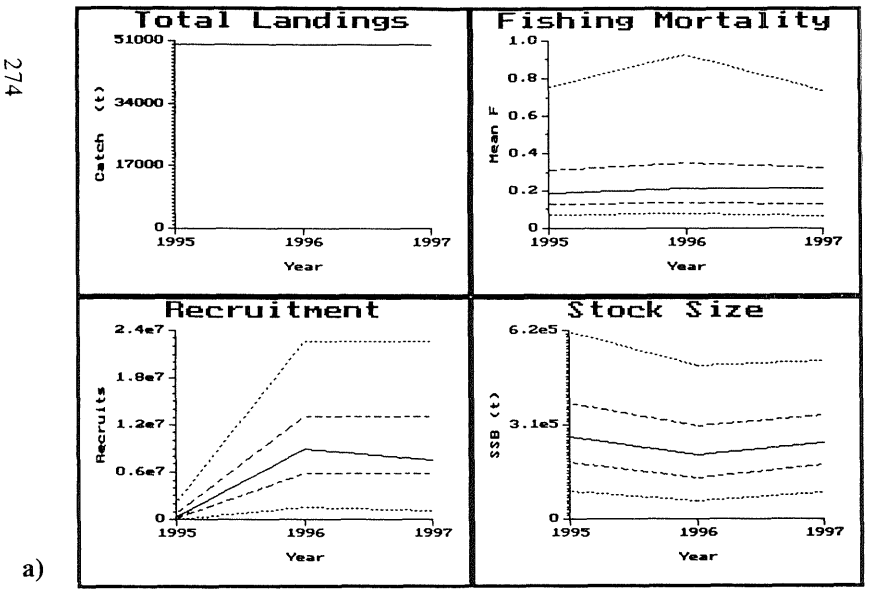
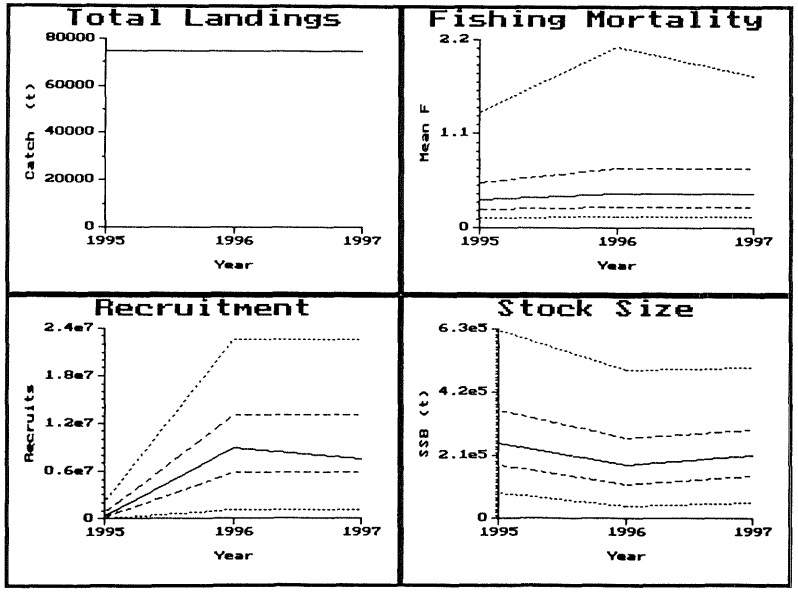


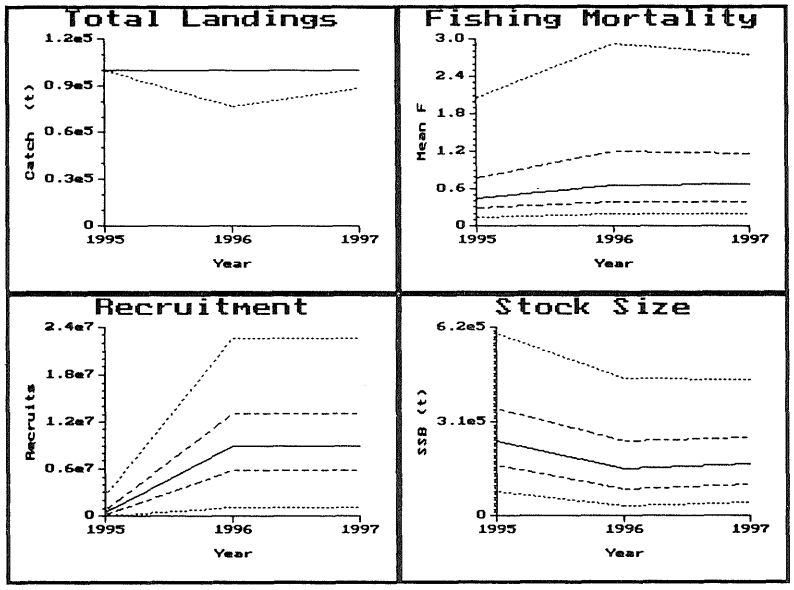

**Figure 8.9b** Risk of falling below MBAL (SSB in 1995) for increasing catch level in 1997



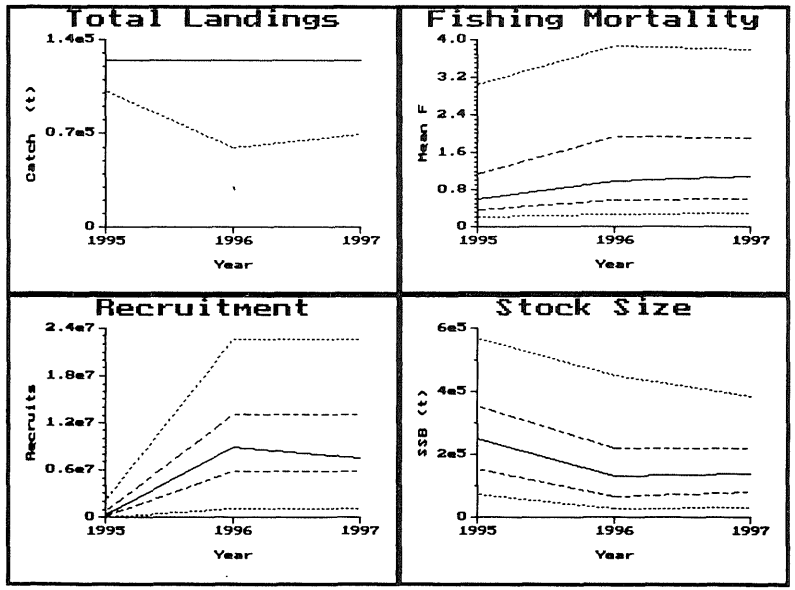

a)




b)




c)




d)

**Figure 8.10** Total landings, fishing mortality, recruitment and stock size predicted for fixed catches.
a) 50,000 t, b) 75,000 t, c) 100,000 t and d) 150,000 t.

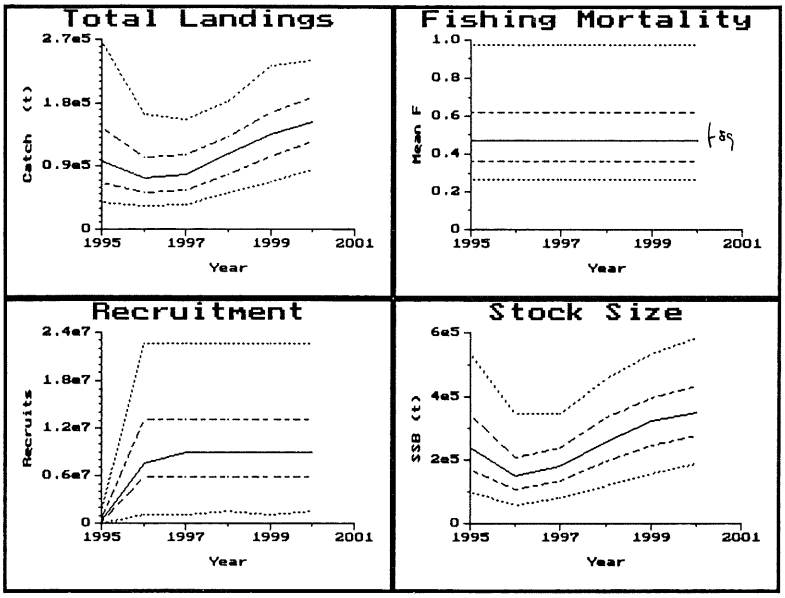



**Figure 8.11a** Total landings, fishing mortality and stock size for $F_{status\ quo.}$

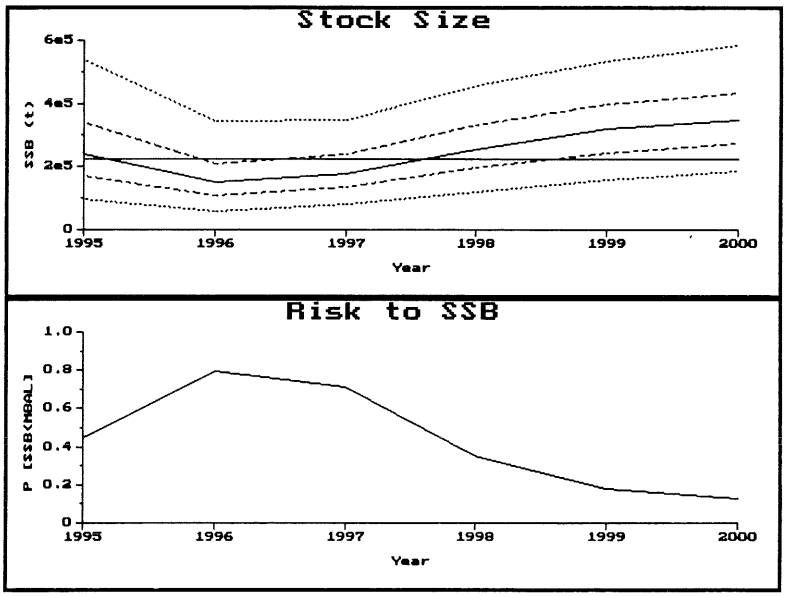



**Figure 8.11b** Predicted stock size and risk of SSB falling below MBAL.

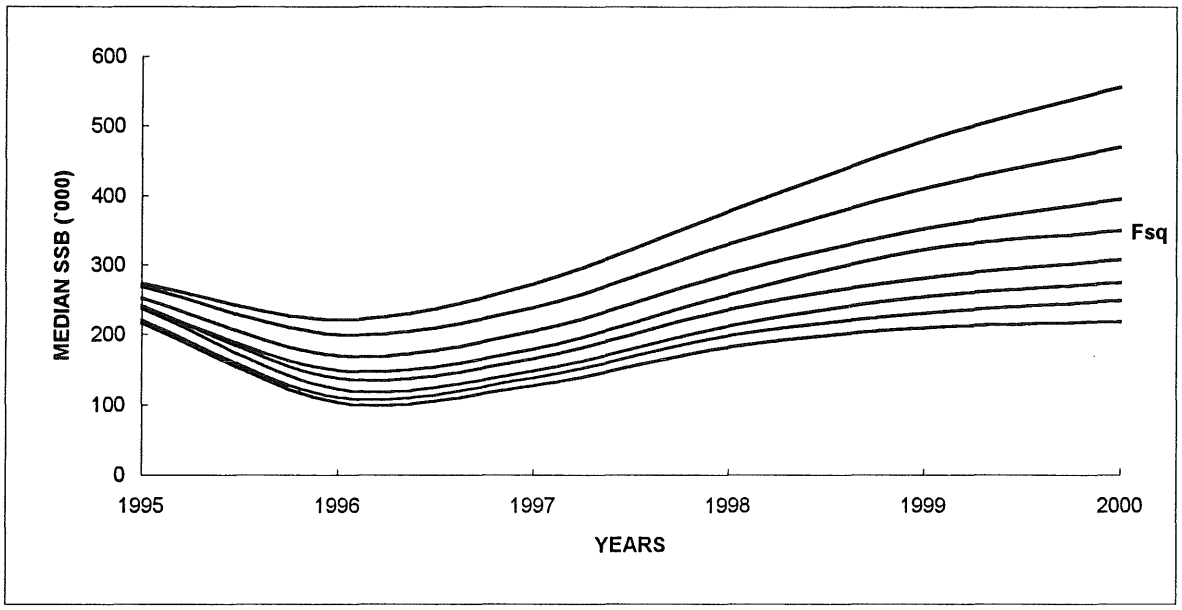



**Figure 8.12a** Median Spawning Stock Biomass with increasing exploitation level (F-mult from 0.25 to 2.0, step 0.25)

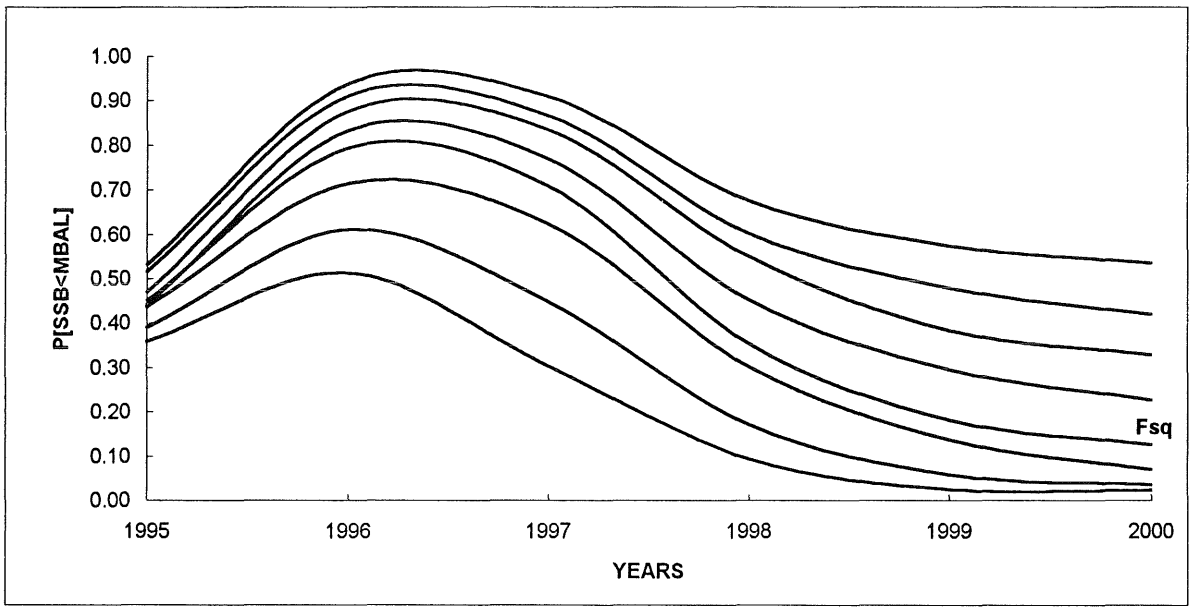



**Figure 8.12b** Probability of SSB falling below SSB in 1995 with increasing exploitation level (F-mult from 0.25 to 2.0, step 0.25)

FIG8_12.XLS

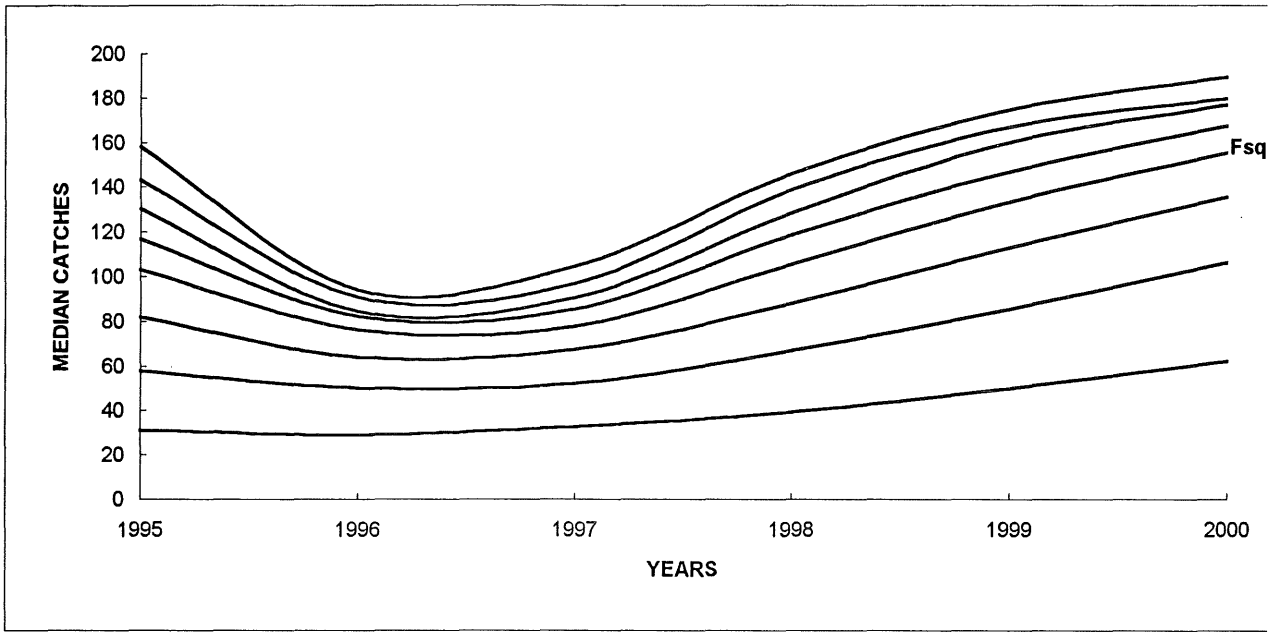



**Figure 8.13** Annual median catches with increasing exploitation level (F-mult from 0.25 to 2.0, step 0.

FIG8_13.XLS

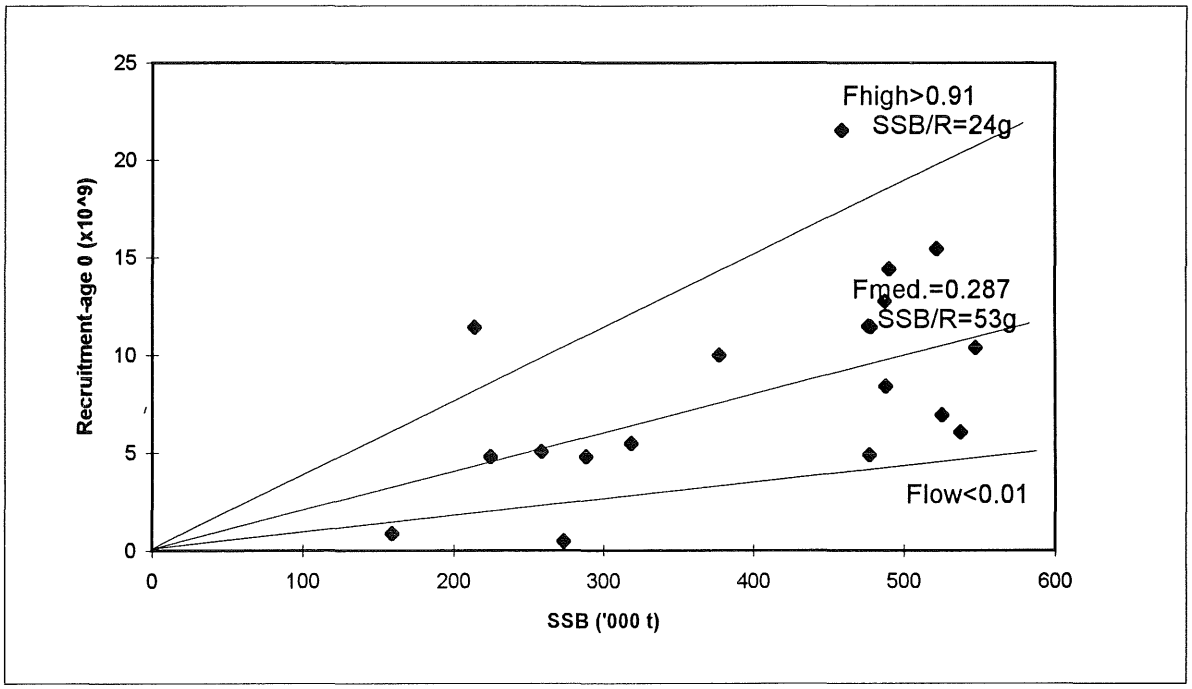



**Figure 8.14** Sardine recruitment ploited against spawning stock biomass at spawning time.

# 9 ANCHOVY - GENERAL

## 9.1 Unit Stocks

Considering the phenotypic and genetic studies made and mainly the migration pattern of the anchovy in the Bay of Biscay (Junquera 1993, Prouzet & Metuzals 1994), the Working Group continued to consider the Bay of Biscay anchovy population as a single management unit in Sub-area VIII and assumed that anchovy off Portugal in the Division IXa is another stock.

## 9.2 Distribution of the Anchovy Fisheries

Figures 9.1a-d sum up all the information on the fisheries directed towards anchovy in Sub-area VIII for 1994. During the first quarter, the main fishery (predominantly 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 semester, the main fisheries (French fleet) were located in the north of the Bay of Biscay whereas small landings appeared along the Spanish coast (Spanish fleet).

Concerning Division IXa, the main fishery is the Spanish one which takes place in the Bay of Cadiz, in the south of this Division during the first semester. In 1994, an increase of catches were observed in the North of Division IXa. This increase was even higher on the first half of 1995.

## 9.3 Length Compositions by Fleet and by Country

1994 annual length compositions of landings of the Bay of Biscay anchovy (Sub-area VIII) by fleet were provided by France and Spain (Table 9.1 and Figures 9.2a, b, c and d). In the second quarter, the anchovies caught by France are smaller than those caught during the first semester. This was due to the fact that pelagic trawlers retired from the fishery and the French catches only corresponded to the purse seiners which fish small anchovy close to the shore. On the other hand, the Spanish catches of the second quarter are characterised by bigger anchovies similar to those landed, in the first quarter, by the French pelagic trawlers. This is due to the normal pattern of availability of anchovy to the purse seine fishery according to size over the spring fishing season (Uriarte & Motos, 1993). For the second semester, (Figures 9.2c and d), the fleets continued to catch medium size or big anchovies found in spring, except for the fourth quarter when the Spanish purse seiners caught very small anchovy (0-groups).

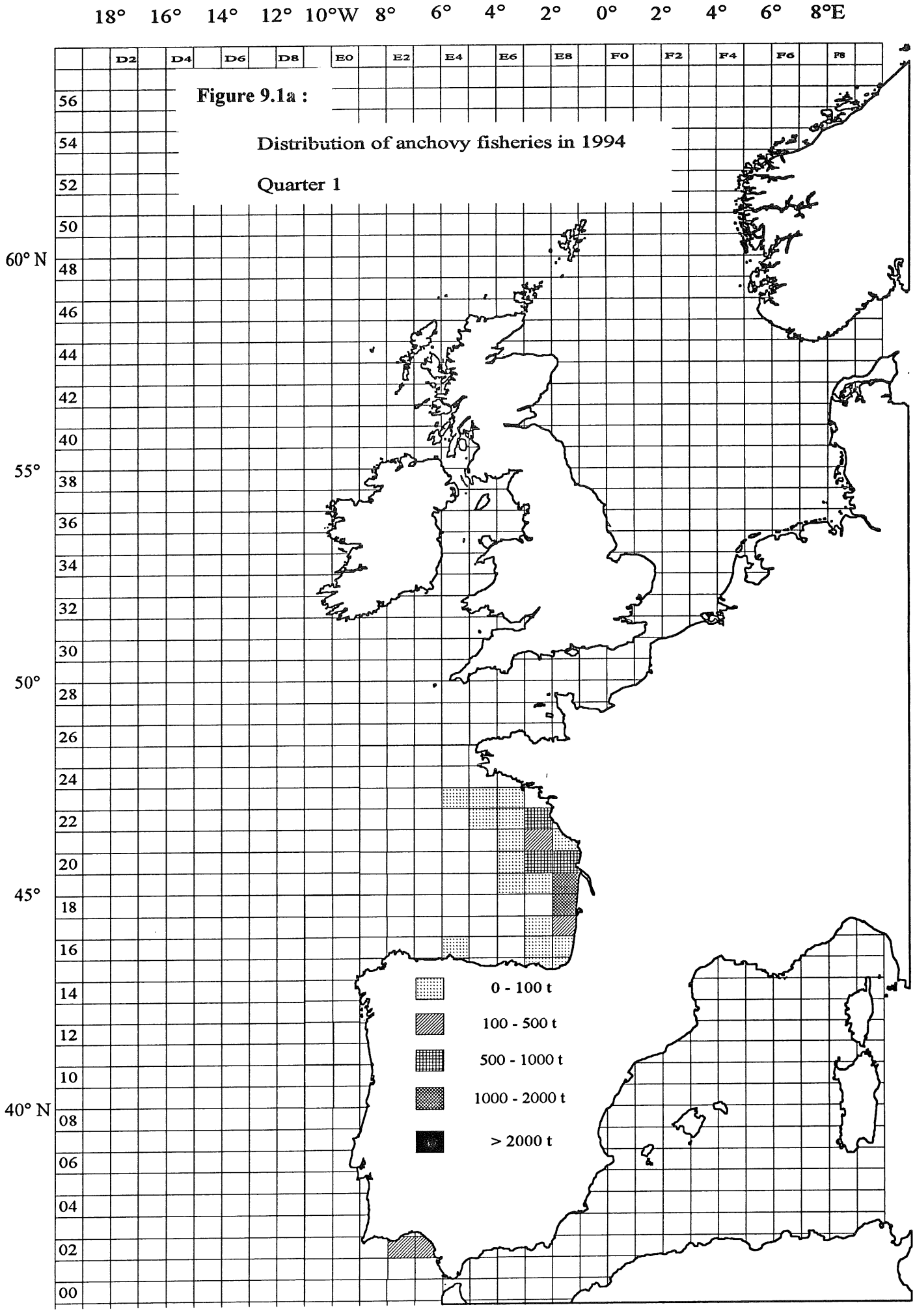
1994 Spanish length compositions of the catches of anchovy in Sub-Division IXa South are shown in Table 9.2 and Figure 9.3. The mean length and weight in the catch are lower than those recorded for the Bay of Biscay anchovy throughout the year. This year, a large number of juveniles is captured (individuals with a length of less than 10cm), their proportion in the total landings was 36% (mainly caught in the first semester).

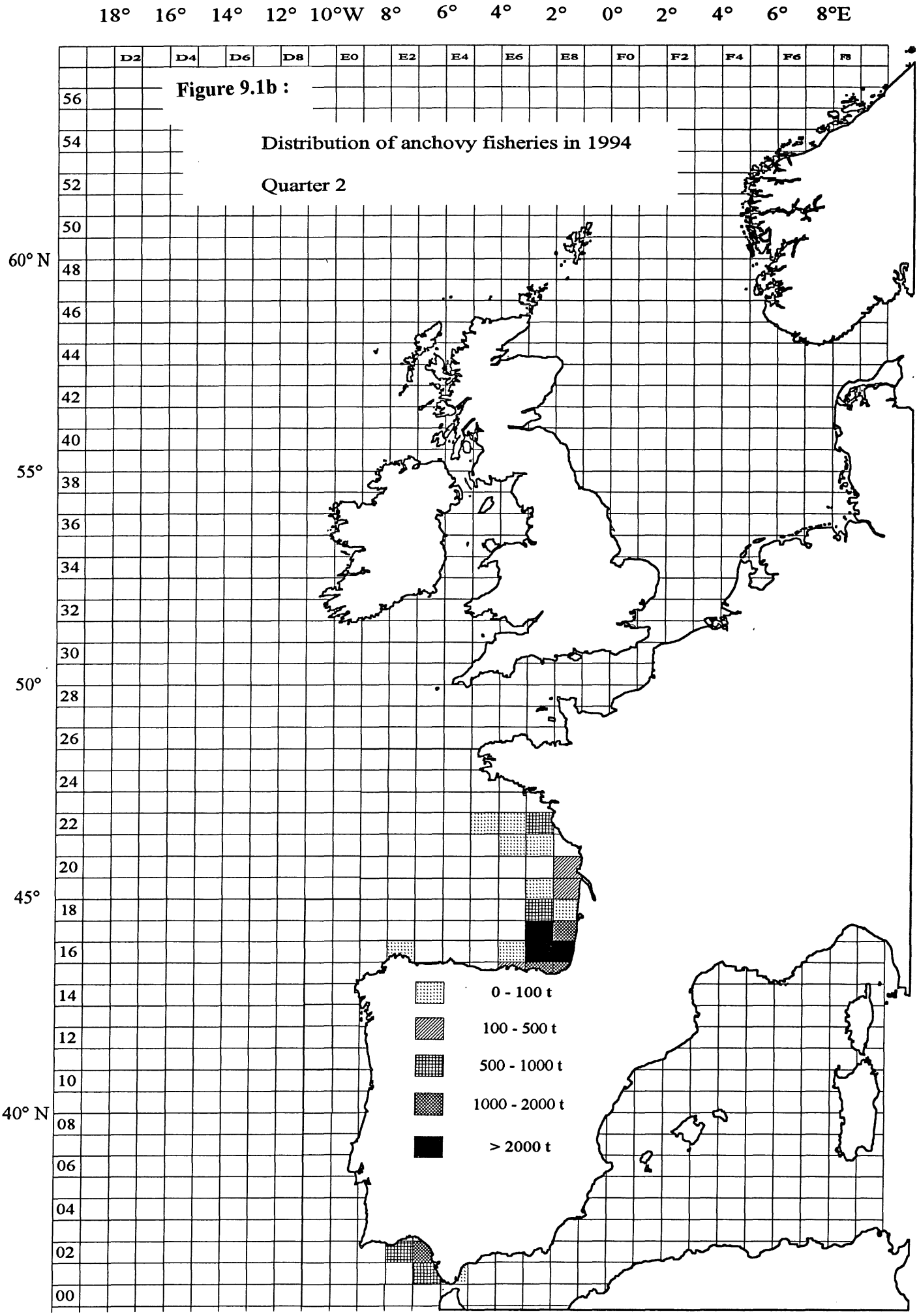
Table 9.1 Length distribution ('000) of Bay of Biscay ANCHOVY by country, gear and divisions in 1994.

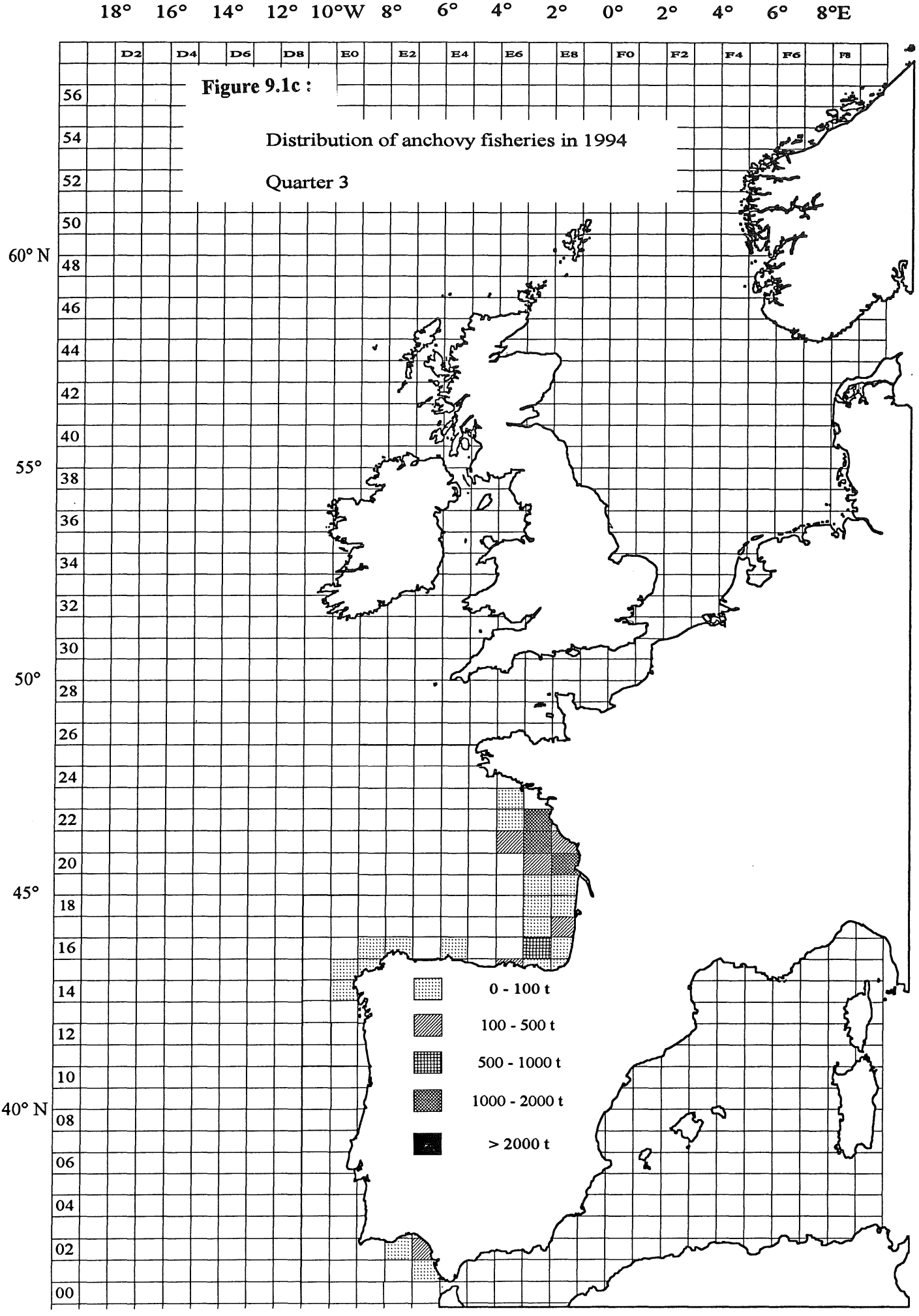
| | QUARTER 1 | | | | QUARTER 2 | | | | QUARTER 3 | | | | QUARTER 4 | | | | TOTAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length (cm) | FRANCE Total VIIIab | SPAIN Seine VIIIb | SPAIN Seine VIIIc | Total | FRANCE Total VIIIab | SPAIN Seine VIIIb | SPAIN Seine VIIIc | Total | FRANCE Total VIIIab | SPAIN Seine VIIIb | SPAIN Seine VIIIc | Total | FRANCE Total VIIIab | SPAIN Seine VIIIb | SPAIN Seine VIIIc | Total | FRANCE Total VIIIab | SPAIN Seine VIIIb | SPAIN Seine VIIIc | Total |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.5 | 1686 | 0 | 0 | 1686 | 611 | 0 | 0 | 611 | 260 | 0 | 24 | 284 | 0 | 0 | 61 | 61 | 2557 | 0 | 61 | 2618 |
| 10 | 16 | 67 | 0 | 83 | 200 | 330 | 0 | 530 | 292 | 0 | 552 | 844 | 0 | 0 | 1419 | 1419 | 508 | 397 | 1486 | 2391 |
| 10.5 | 6808 | 83 | 0 | 6891 | 4339 | 0 | 0 | 4339 | 1196 | 0 | 895 | 2091 | 0 | 0 | 2301 | 2301 | 12343 | 83 | 2384 | 14810 |
| 11 | 6400 | 126 | 103 | 6630 | 19407 | 1982 | 0 | 21389 | 1535 | 0 | 778 | 2313 | 0 | 0 | 2077 | 2077 | 27342 | 2108 | 2306 | 31757 |
| 11.5 | 6447 | 108 | 52 | 6606 | 17663 | 2643 | 0 | 20306 | 2802 | 0 | 157 | 2959 | 0 | 0 | 606 | 606 | 26912 | 2750 | 766 | 30428 |
| 12 | 14785 | 150 | 84 | 15019 | 19399 | 3053 | 856 | 23308 | 3356 | 0 | 627 | 3983 | 0 | 0 | 2817 | 2817 | 37540 | 3203 | 3907 | 44649 |
| 12.5 | 4396 | 144 | 39 | 4578 | 15599 | 8268 | 3230 | 27097 | 685 | 0 | 922 | 1607 | 23 | 0 | 5570 | 5593 | 20703 | 8412 | 8983 | 38097 |
| 13 | 18874 | 131 | 137 | 19142 | 12968 | 21396 | 16258 | 50621 | 2121 | 0 | 1396 | 3517 | 275 | 0 | 7359 | 7634 | 34238 | 21527 | 23884 | 79649 |
| 13.5 | 18477 | 91 | 80 | 18648 | 6921 | 22864 | 30023 | 59807 | 5086 | 0 | 3878 | 8964 | 444 | 0 | 8680 | 9124 | 30928 | 22954 | 38873 | 92755 |
| 14 | 34517 | 312 | 227 | 35056 | 11720 | 22883 | 48013 | 82616 | 10572 | 0 | 8947 | 19519 | 2160 | 0 | 8732 | 10892 | 58969 | 23195 | 57284 | 139448 |
| 14.5 | 33637 | 453 | 273 | 34363 | 10972 | 16593 | 45575 | 73140 | 24355 | 0 | 10444 | 34799 | 10836 | 0 | 4649 | 15485 | 79800 | 17046 | 50949 | 147795 |
| 15 | 47023 | 861 | 532 | 48415 | 17093 | 16645 | 61181 | 94919 | 30829 | 0 | 10696 | 41525 | 14034 | 0 | 3339 | 17373 | 108979 | 17506 | 65912 | 192397 |
| 15.5 | 31633 | 755 | 439 | 32827 | 12699 | 15468 | 54360 | 82526 | 40055 | 0 | 7803 | 47858 | 18780 | 0 | 3287 | 22067 | 103167 | 16223 | 58841 | 178231 |
| 16 | 25467 | 652 | 163 | 26282 | 6067 | 12170 | 54591 | 72828 | 47342 | 0 | 8215 | 55557 | 22566 | 0 | 2077 | 24643 | 101442 | 12823 | 57483 | 171748 |
| 16.5 | 11147 | 643 | 81 | 11871 | 3344 | 9341 | 45270 | 57955 | 36412 | 0 | 4187 | 40599 | 16900 | 0 | 776 | 17676 | 67803 | 9985 | 46770 | 124558 |
| 17 | 3597 | 161 | 74 | 3832 | 1830 | 6067 | 36194 | 44091 | 20459 | 0 | 3285 | 23744 | 12686 | 0 | 610 | 13296 | 38572 | 6228 | 37040 | 81840 |
| 17.5 | 2527 | 0 | 25 | 2552 | 1346 | 2921 | 20932 | 25199 | 6863 | 0 | 584 | 7447 | 3339 | 0 | 274 | 3613 | 14075 | 2921 | 21231 | 38227 |
| 18 | 1218 | 0 | 31 | 1249 | 936 | 2062 | 11697 | 14696 | 622 | 0 | 30 | 652 | 835 | 0 | 203 | 1038 | 3611 | 2062 | 11932 | 17605 |
| 18.5 | 530 | 0 | 5 | 535 | 402 | 1010 | 8335 | 9747 | 444 | 0 | 0 | 444 | 62 | 0 | 23 | 85 | 1438 | 1010 | 8362 | 10810 |
| 19 | 277 | 0 | 5 | 282 | 42 | 241 | 4578 | 4861 | 533 | 0 | 0 | 533 | 37 | 0 | 0 | 37 | 889 | 241 | 4583 | 5713 |
| 19.5 | 0 | 0 | 0 | 0 | 0 | 125 | 1879 | 2005 | 267 | 0 | 0 | 267 | 163 | 0 | 0 | 163 | 430 | 125 | 1879 | 2435 |
| 20 | 0 | 0 | 0 | 0 | 0 | 69 | 411 | 481 | 89 | 0 | 0 | 89 | 54 | 0 | 0 | 54 | 143 | 69 | 411 | 624 |
| 20.5 | 0 | 0 | 0 | 0 | 0 | 0 | 52 | 52 | 89 | 0 | 0 | 89 | 12 | 0 | 0 | 12 | 101 | 0 | 52 | 153 |
| 21 | 0 | 0 | 0 | 0 | 0 | 0 | 41 | 41 | 89 | 0 | 0 | 89 | 12 | 0 | 0 | 12 | 101 | 0 | 41 | 142 |
| 21.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total N | 269462 | 4736 | 2350 | 276548 | 163558 | 166132 | 443475 | 773166 | 236353 | 0 | 63421 | 299774 | 103218 | 0 | 54860 | 158078 | 772591 | 170869 | 505422 | 1448881 |
| Catch (T) | 5347 | 107 | 51 | 5505 | 2540 | 3672 | 11389 | 17601 | 6019 | 0 | 1420 | 7439 | 2814 | 0 | 914 | 3728 | 16720 | 3779 | 12461 | 32961 |
| Lmoy (cm) | 14.6 | 15.0 | 14.9 | 14.6 | 13.5 | 14.7 | 15.7 | 15.0 | 15.7 | 0.0 | 15.1 | 15.6 | 16.1 | 0.0 | 13.8 | 15.3 | 14.9 | 14.7 | 15.5 | 15.1 |
| Wmoy (g) | 19.8 | 22.6 | 21.6 | 19.9 | 15.5 | 22.1 | 25.7 | 22.8 | 25.5 | 0.0 | 22.4 | 24.8 | 27.3 | 0.0 | 16.7 | 23.6 | 21.6 | 22.1 | 24.7 | 22.7 |

**Table 9.2** Spanish length distribution ('000) of Bay of Cadiz anchovy from the purse seiner in Sub-Division IXa South in 1994.

| Length (cm) | 1st quarter | 2nd quarter | 3rd quarter | 4th quarter | Total |
|---|---|---|---|---|---|
| **4** | 0 | 0 | 0 | 0 | 0 |
| **4.5** | 0 | 0 | 0 | 0 | 0 |
| **5** | 0 | 0 | 0 | 0 | 0 |
| **5.5** | 0 | 0 | 0 | 0 | 0 |
| **6** | 0 | 0 | 0 | 0 | 0 |
| **6.5** | 4803 | 315 | 0 | 0 | 5119 |
| **7** | 10567 | 631 | 0 | 0 | 11198 |
| **7.5** | 14090 | 3130 | 10 | 3 | 17233 |
| **8** | 11208 | 10987 | 93 | 28 | 22316 |
| **8.5** | 7045 | 13593 | 275 | 81 | 20994 |
| **9** | 5124 | 13499 | 530 | 159 | 19312 |
| **9.5** | 3757 | 9939 | 359 | 94 | 14149 |
| **10** | 12092 | 9941 | 308 | 84 | 22426 |
| **10.5** | 13737 | 12128 | 195 | 22 | 26082 |
| **11** | 10143 | 16743 | 191 | 9 | 27087 |
| **11.5** | 8514 | 23551 | 135 | 3 | 32203 |
| **12** | 3021 | 22279 | 195 | 0 | 25494 |
| **12.5** | 3772 | 24792 | 497 | 24 | 29085 |
| **13** | 959 | 13457 | 557 | 133 | 15107 |
| **13.5** | 144 | 6773 | 727 | 342 | 7987 |
| **14** | 0 | 4211 | 784 | 312 | 5307 |
| **14.5** | 0 | 2649 | 1242 | 415 | 4306 |
| **15** | 0 | 1349 | 1704 | 265 | 3318 |
| **15.5** | 0 | 0 | 642 | 121 | 763 |
| **16** | 0 | 0 | 646 | 85 | 731 |
| **16.5** | 0 | 0 | 274 | 49 | 323 |
| **17** | 0 | 0 | 179 | 0 | 179 |
| **Total N** | 108976 | 189967 | 9543 | 2231 | 310717 |
| **Catch (T)** | 642 | 1991 | 207 | 43 | 2883 |
| **Lmoy (cm)** | 9.6 | 11.3 | 13.7 | 13.5 | 10.8 |
| **Wmoy (g)** | 5.9 | 10.5 | 21.7 | 19.5 | 9.3 |


18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Figure 9.1a :
Distribution of anchovy fisheries in 1994
Quarter 1
0 - 100 t
100 - 500 t
500 - 1000 t
1000 - 2000 t
> 2000 t


18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
Figure 9.1b :
Distribution of anchovy fisheries in 1994
Quarter 2
60° N
55°
50°
45°
40° N
0 - 100 t
100 - 500 t
500 - 1000 t
1000 - 2000 t
> 2000 t


18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Figure 9.1c :
Distribution of anchovy fisheries in 1994
Quarter 3
0 - 100 t
100 - 500 t
500 - 1000 t
1000 - 2000 t
> 2000 t

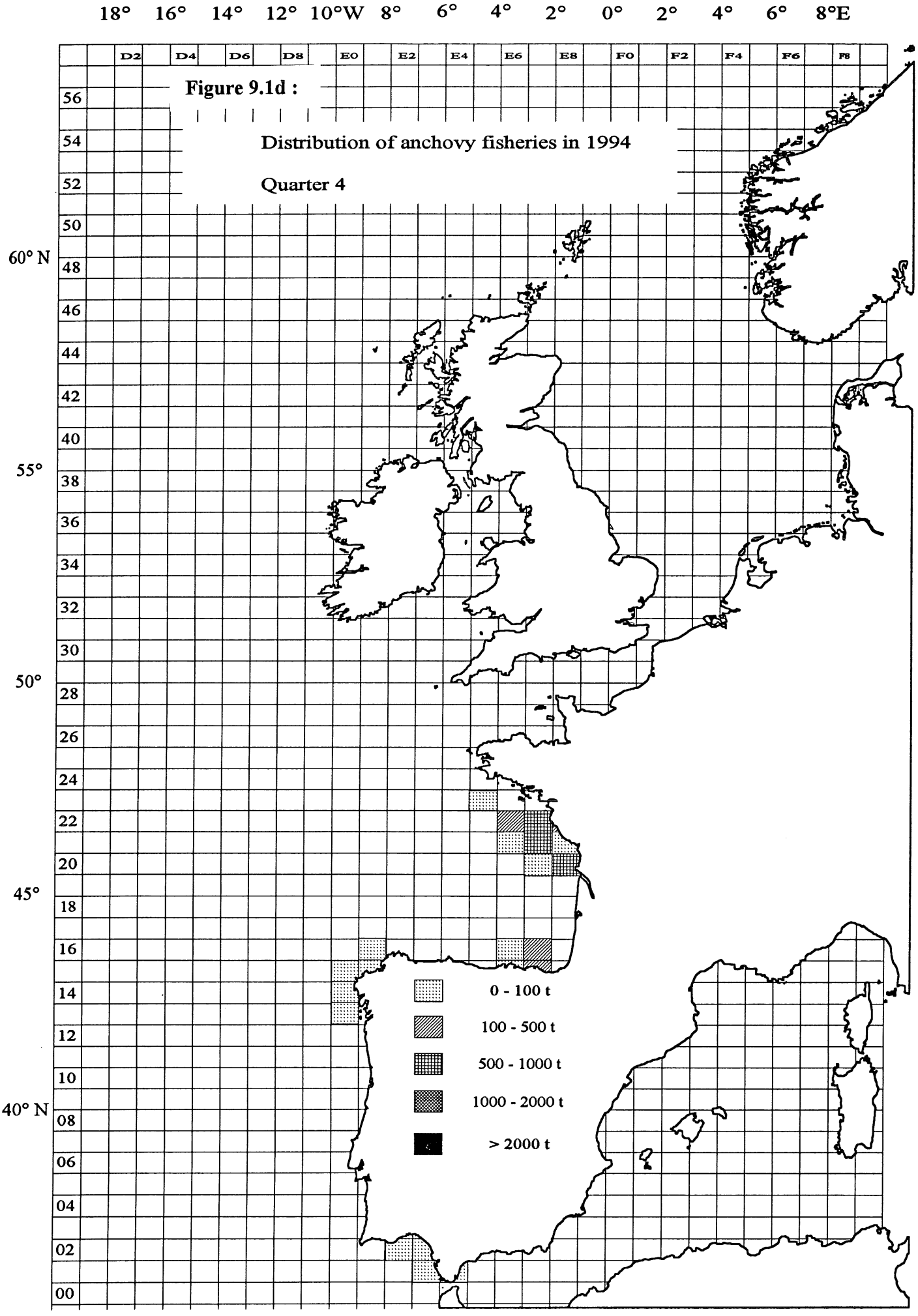
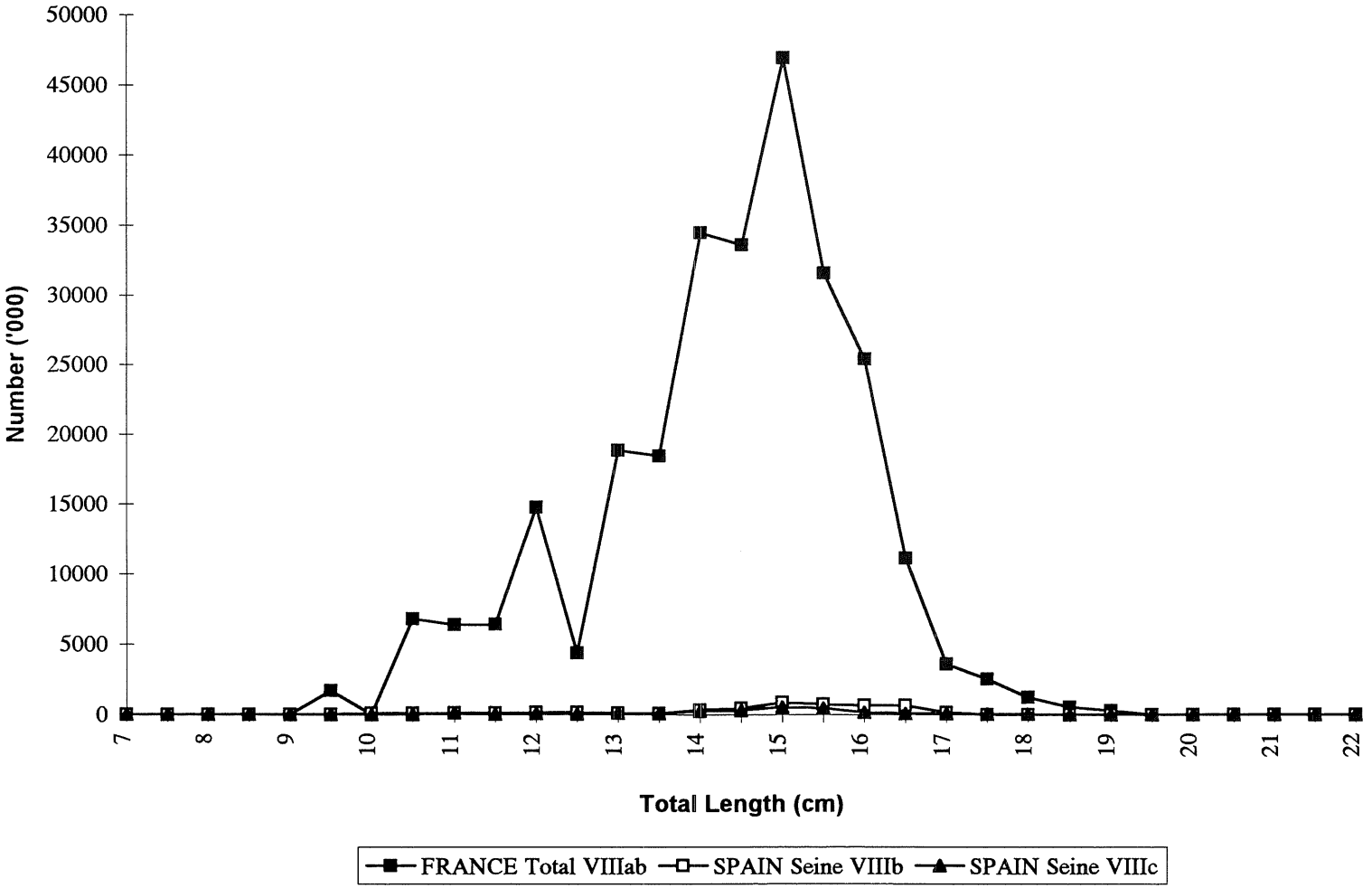
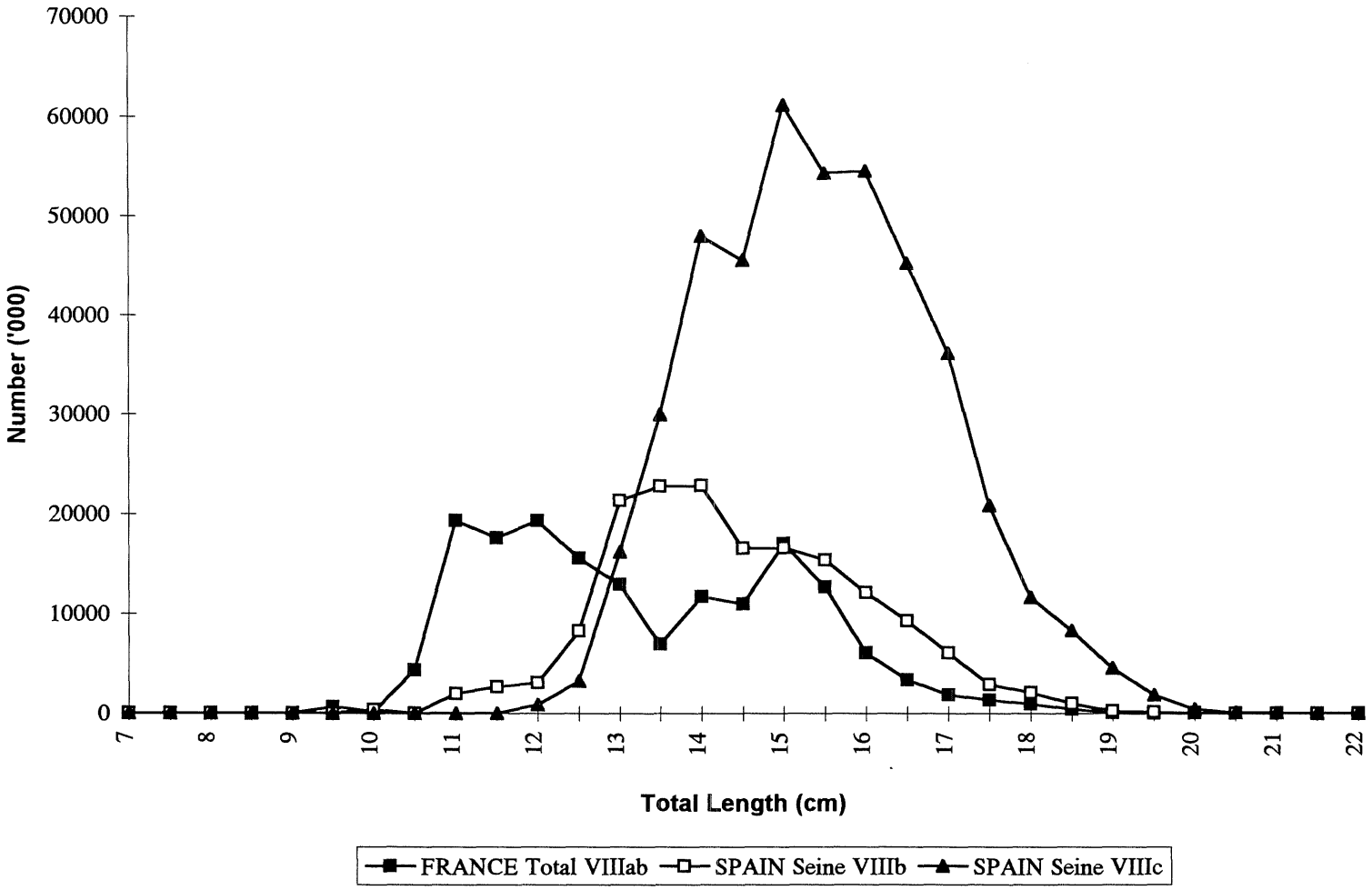

18° 16° 14° 12° 10°W 8° 6° 4° 2° 0° 2° 4° 6° 8°E
D2 D4 D6 D8 E0 E2 E4 E6 E8 F0 F2 F4 F6 F8
56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 08 06 04 02 00
60° N
55°
50°
45°
40° N
Figure 9.1d :
Distribution of anchovy fisheries in 1994
Quarter 4
0 - 100 t
100 - 500 t
500 - 1000 t
1000 - 2000 t
> 2000 t

**Figure 9.2.a Length distributions of landings of Bay of Biscay anchovy in Divisions VIIIa,b and c for the first quarter in 1994**




G\ACFM\WGMHSA96\ANCHOA\TAB91.XLS-CHART1

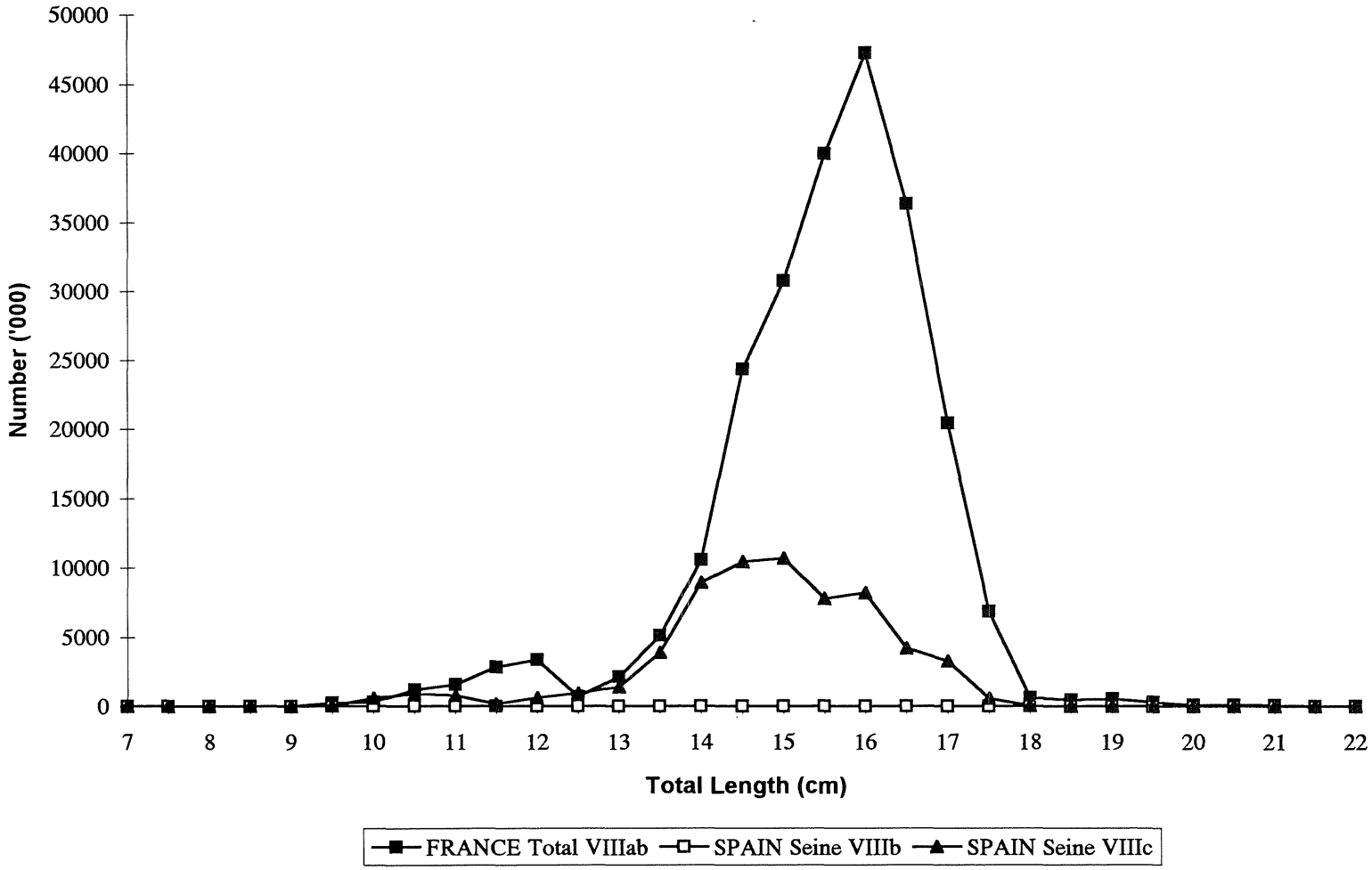
**Figure 9.2b Length distributions of landings of Bay of Biscay anchovy in Divisions VIIIa,b and c for the second quarter in 1994**





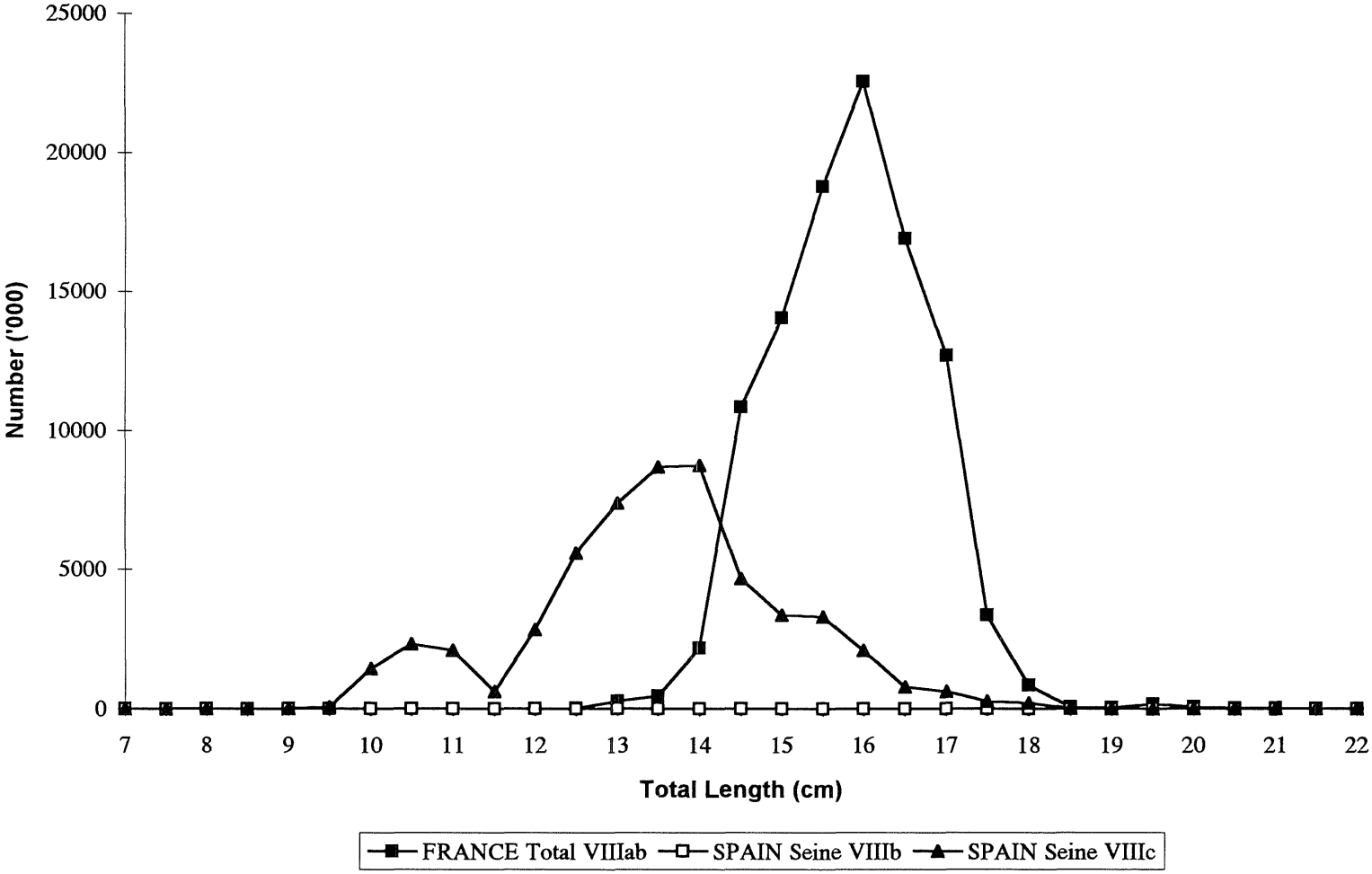

G\ACFM\WGMHSA96\ANCHOA\TAB91.XLS-CHART2

**Figure 9.2c Length distributions of landings of Bay of Biscay anchovy in Divisions VIIIa,b and c for the third quarter in 1994**



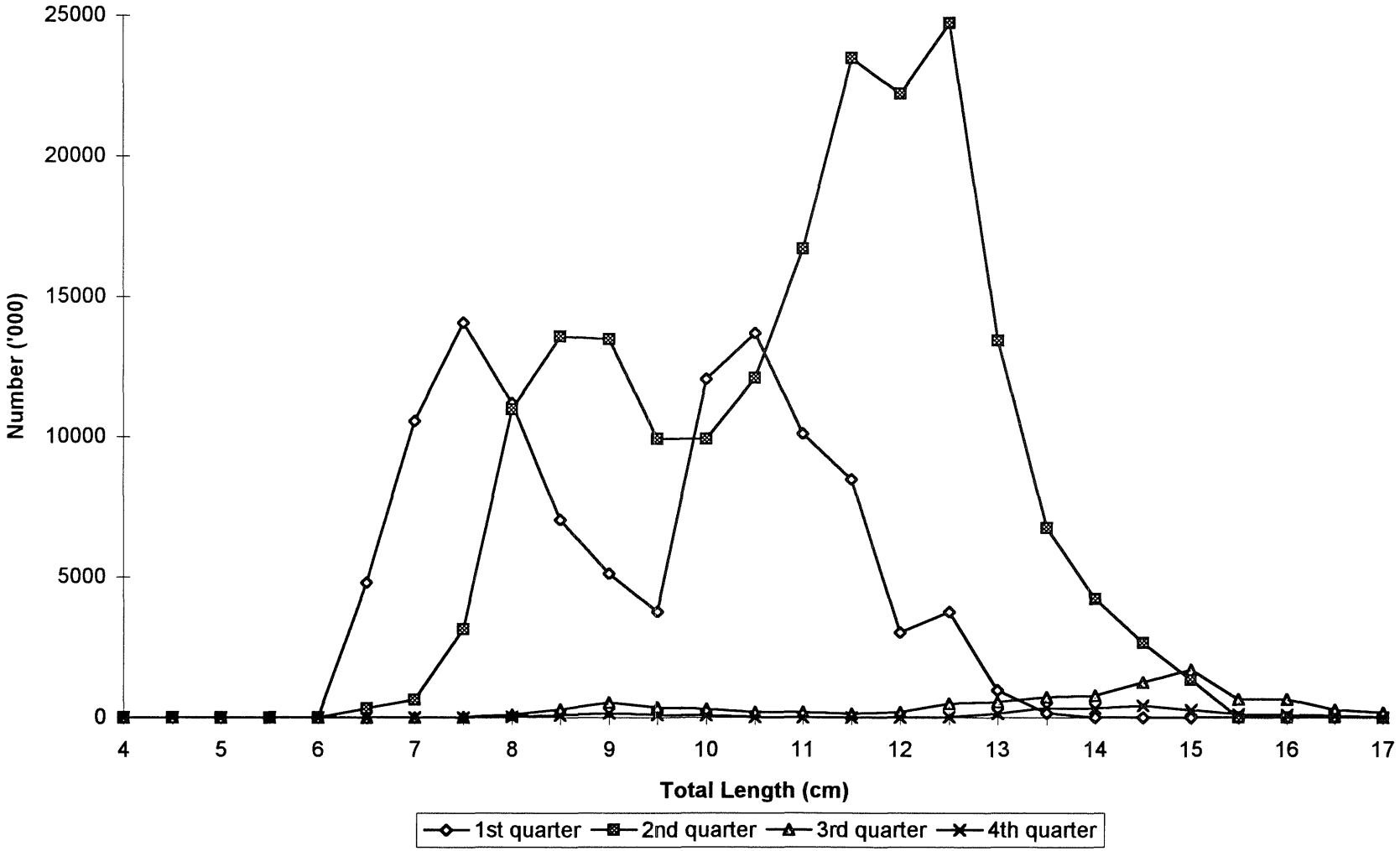

G\ACFM\WGMHSA96\ANCHOA\TAB91.XLS-CHART3

**Figure 9.2d Length distributions of landings of Bay of Biscay anchovy in Divisions VIIIa,b and c for the fourth quarter in 1994**




G\ACFM\WGMHSA96\ANCHOA\TAB91.XLS-CHART4

**Figure 9.3 Length distributions of landings of Bay of Cadiz anchovy by quarter in Sub-Division IXa South in 1994**




G\ACFM\WGMHSA96\ANCHOA\TAB92.XLS-CHART1

## ANCHOVY - SUB-AREA VIII

### 10.1 The Anchovy Fishery in 1994

#### 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. Spanish purse seiners are allowed to fish anchovy in Sub-division VIIIb only during the spring season and under a system of fishing licences (see more details in Anon. 1987), while Division VIIIa is closed to them for the whole year.

French Pelagic Trawlers: Operative in summer, autumn and winter. Until 1992, it 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 semester and VIIIa, mainly, during the second one. The VIIIc area is prohibited to the French pelagic fleet.

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

Since the eighties, the TAC of 30,000 t (33,000t in 1995) has been agreed but often exceeded. 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 midwater pelagic activity for anchovy stop during the main Spanish fishery in spring (from 20 March to 1 June). In addition since 1995, 8,000 t from the Portuguese quota in the Sub-area IXa are allocated to the French fleet. This amount of landings is in addition to the agreed TAC.

#### 10.1.2 Landings in Sub-area VIII

Under these circumstances, total international landings in Sub-area VIII amounted to 34,547 t in 1994 (Table 10.1 and Figure 10.1), slightly inferior to the catch level of 1993 and similar to those observed in 1990 and 1992. The French and the Spanish fisheries have achieved, as in 1993, roughly the same landings : 17,554 t for the Spanish fishery (85.8% in the spring fishery) and 16,993 t for the French fishery (52.8% in the second half of the year) (Table 10.2). Since 1992, after the bilateral agreement between France and Spain concerning the anchovy fishery in the Bay of Biscay, French landings decreased during April and May and increased in autumn at the end of the fishing season (Figure 10.2).

No discards were observed in the Spanish fishery and the discards have not been recorded in the French fishery, although in the reported total French landings the catches withdrawn are included.

During the first half of 1995, total international catches reached 21,816 t (preliminary data).

#### 10.1.3 Landings by divisions

In 1994, the Spanish and French fisheries were well separated geographically and in time as in previous year. More than 75% of the Spanish landings were caught in Division VIIIc, mainly in spring, while more than 55% of the French landings were caught in Division VIIIa, mainly in summer and autumn and in Division VIIIb mainly in winter and summer (Table 10.3).

#### 10.1.4 Landings by EU categories

The distribution of Spanish and French landings by EU market category in Sub-area VIII by quarter are given in Table 10.4. For the whole year combined the distributions by EU market category are rather similar for the two countries. Since 1989, the main EU market category for the two countries is T2 (30-50 fish per kg).

### 10.2 Effort and Catch per Unit Effort

The evolution of the fishing fleets during recent years is shown in Table 10.5 and Figure 10.3. The French fleet of midwater trawlers involved in the anchovy fishery has increased continuously over these years. In 1994, the number of pelagic trawlers is more than the half of the number of Spanish purse seiners. Table 10.5 shows that, during the last 5 years, the number of vessels in the French pelagic fleet for anchovy has doubled and at the same time their catches have reached the same level as the Spanish ones. These general observations indicate a sharp increase of fishing effort on anchovy in the Bay of Biscay since 1987, despite some decrease in the number of Spanish purse seiners. Although the pelagic trawlers are not allowed to fish anchovy in Division VIIIc, they have opened new fishing periods (autumn and winter mainly) and a new fishing ground in Division VIIIa, especially since 1990 (Prouzet *et al.*, 1994).

A rough evaluation of the Spanish and French efforts in terms of number of gears multiplied by the number of months of activity showed in 1993 a comparable fishing power : around 430 vessel*months for the French fleet and around 500 vessel*months for the Spanish fleet. This observation further indicates that effort developed by the two countries is, at present, similar although the fishing pattern is different. Nowadays, twice the number of Spanish purse seiners would be about the level of effort that existed in this fishery at the beginning of the seventies.

The CPUE of the purse seiners in the Spanish spring fishery on anchovy is linked to the anchovy abundance in the southern area of the Bay of Biscay and, 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 1995 shows an increase in the CPUE of the total catch (the highest of the series observed) as well as that of the 1-year-old anchovy compared to the ones estimated in 1993 and 1994 (Table 10.6, Figure 10.4). For the French fishery, the CPUE is given for the purse seiners and pelagic trawlers only for 1994 (Table 10.7). A rough comparison between CPUE of French pelagic trawlers and Spanish purse seiners could be done in dividing the French CPUE by a number ranged between 20 and 40[1] . The highest CPUE of the pelagic trawlers is observed during the second half of the year when this fishery is concentrated mainly in the Division VIIIa.

## 10.3 Fishery Independent Information

### 10.3.1 Egg surveys

Egg surveys to estimate the spawning stock biomass (SSB) of the Bay of Biscay anchovy through the Daily Egg Production Method (DEPM) were undertaken without interruption from 1987 to 1992. In 1994 and 1995, DEPM surveys were performed in the Bay of Biscay but only the results for 1994 are presently available (Table 10.8).This was due to financial problems in 1995. In the future more effort would be made to purchase the whole budget to have the data available just after a survey. The highest SSB was observed in 1990 and 1992, due to strong recruitment of 1-year-old anchovies. In 1994, a medium recruitment from the 1993 spawning was recorded.

The surveys are considered to be unbiased and to produce absolute figures of biomass. The composition of the stock was derived for all these surveys, based on the adult sampling performed during the 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 had to be made. Because of this the age compositions for the DEPM surveys in 1987 and 1988 are less reliable than those of the following years.

### 10.3.2 Acoustic surveys

The French acoustic surveys aimed at estimating the abundance of the Bay of Biscay anchovy were also stopped in 1993. The results of the surveys between 1983 and 1992 appear in Table 10.9. The figures for 1991 and 1992 were revised and updated for a FAR programme on anchovy. In 1993 and 1994, only observations concerning the ecology of anchovy, especially located close to the Gironde estuary (one of the major spawning area of the Bay of Biscay for anchovy), were made.

According to the discussion made in 1993 (Anon. 1993b) the acoustic values are considered to be relative index of abundance and the values of 1983 and 1984 seems to be an underestimate.

### 10.3.3 Comparison of abundance indices

The general trend in the estimates of anchovy biomass from the acoustic and DEPM methods is comparable between 1989 and 1992 but there was an anomaly in 1991. Both methods, however, indicate a similar trend in the population particularly for the 1 year old recruits (Table 10.10 and Figure 10.4).

## 10.4 Recruitment

The results gathered in 1994 suggest a medium recruitment of 1 year old from the 1993 spawning period. Figure 10.4 shows the co-variation of different recruitment indices. Their fluctuations are rather concordant on the period 1987-1995 and confirm the high level of recruitment observed in 1990 and 1992 when the level of spawning biomass was low.

Figure 10.5 shows the variations of recruitment level per unit of biomass expressed with two different indices. The biomass for 1993 was estimated by the division of 1993 catches by the mean ratio of the catch and SSB estimates on the period 1987-1994[2]. The number of 1 year old recruits in 1993 was estimated by the means of a linear relationship between the number of 1-year-olds estimated by the SSB method and the CPUE of 1-year-olds on the period 1987-1994[3]. So, we observed from 1992 to 1994 a recruitment level per unit of biomass much lower than those observed in 1989 and in 1991 but higher than those of 1988 and 1990.

## 10.5 Catch in Numbers at Age

In 1994, the age distribution of the international catches of anchovy (in number) in the first semester differed from those of the previous year. In 1993, these catches consisted mainly of 1-year-old anchovies, making up 64% (Anon. 1995b) whereas, in 1994, only 47.2% of the anchovies caught during the first semester were 1-year old anchovies. The contribution of the 1-group to the French landings is higher (70.6%) than the Spanish one (40.6%). This is mainly due to the different seasonality of these two fisheries. A rough calculation indicates that 23% of the total catches were taken from the immature prior to their first spawning of May (Table 10.11).

[1] 2 boats (pairs of trawler) fishing approximately 20 days for the best month in late summer and early autumn and 10 to 15 days during winter, late spring and early winter.

[2] mean ratio = 0.54.

[3] SSB1 = 72.99*CPUE1 - 121.78 ; R= 0.897 ; N= 7.

The catches of anchovy in the live bait fishery for the period 1987-1994 are given in Table 10.12. Live bait catches of anchovy are rather variable depending on the availability of several small pelagic species in general and not only on anchovy. Catches of immature for tuna fishing in recent years seems to be low compared to the period 1987-1990.

Table 10.13 records the age composition of the international catches since 1989, on a half-yearly basis. In 1994, the proportion of 1 and 2-years-old anchovies are rather similar and the 2 years-old anchovies contributed largely to the landings in 1994, particularly during the first half of the year. In the second half of the year, there are catches of immature belonging to the age 0 group but the main catches are composed of 1-year-old anchovy.

Table 10.14 contains the available historical catches by age on an annual basis for the Bay of Biscay anchovy. The changes in age composition between the 1984 - 1994 period and the earlier years could be related to a higher dependence of catches on recruitment in recent years and a change in the seasonality of this fishery. However, there also appears to have been some differences in the age - reading procedure, because age group 1 is rarely dominant in the landings prior to 1983. A revision of the age composition of the anchovy catches prior to 1983 has been done in the framework of a FAR program and the conclusions suggest that, effectively, in some of those past years, there were used different ageing criteria than the ones presently defined (Cendrero, 1994).

## 10.6 Mean Weight at Age and Mean Length at Age

Mean weight data are shown in Table 10.15. The French mean weights at age in the catches were based on biological sampling of scientific survey and commercial catches. Spanish mean weights at age were calculated from routine biological sampling of commercial catches.

Large differences were observed between the mean weight of age groups caught by the Spanish and the French fleets over the past year 1994. These differences can be explained by the different seasons and fishing grounds of the two fleets. For instance, during the first semester 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. In the second half of the year, the French landings were caught off the VIIIa and b, whereas the Spanish ones were mainly caught in the VIIIc.

Annual mean weight at age in the fishery and in the stock are shown in Table 10.16 and Table 10.17 respectively. The values for the fishery represent the weighted averages of the half year values per country, according to their respective landings. The values for the stock are the ones estimated for the spawners during the DEPM surveys of 1990-1994.

## 10.7 Maturity at Age

As reported in previous years' reports, ages 1 and older are fully mature in spring. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age (Anon., 1992).

## 10.8 Stock Assessment

The Integrated Catch at Age analysis, which assumes a separable model of fishing mortality, has been applied for the assessment of the anchovy. The assessment inputs are summarised in Table 10.18. CPUE data from the Spanish purse seine fishery was finally excluded from the tuning data because it did not reduce significantly the variance of the residuals from the separable model, and because it is presumed that purse seiners can increase the catchability at low levels of abundance (Csirke, 1988). The analysis uses as tuning data the DEPM and the acoustic figures (as biomass and as population numbers at age estimates). These 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 by this Working Group (Anon., 1985). The assessment starts in 1987 when the DEPM began to be applied. However, the catch data from 1987 and 1988 are down weighted in the analysis because in those years French catch at age were estimated from the Spanish ones. Results are presented in Tables 10.19, 10.20, 10.21 and 10.22 and Figures 10.6a, b, c.

The results shows that the minimisation of residuals is not well defined for a wide range of fishing mortalities between 0.6 and 1.1 (+- s.d.) (Table 10.20). Residuals about the separable model are large, both across ages and years and the fitting to the direct estimates of abundance seems to be poor. Thus the Working Group. considered that the assessment is not reliable, but that it could be useful to show the recent tendencies in population abundance and fishing mortalities. 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 it includes the biomass of the age 0 group at the beginning of every year (when it does not exist).

## 10.9 Trends in Biomass and Recruitment

The 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 overfishing, but it cannot be proved. The possibility that environmental factors have caused the reduction of the stock is also considered (Junquera, 1986). In this sense, Borja *et al.* (pers. com.) showed a significant relationship between two environmental variables, upwelling and turbulence indices, and an index of annual recruitment of anchovy (calculated as the cumulative CPUE per cohort).

A relationship between the temperatures and the catches has also been presented by Brander (WD., 1996).

Relationships between the biomass level and the number of recruits (1-year-olds) estimated with the DEPM (Figure 10.7a) and the CPUE in number for a given cohort (Figure 10.7b) show a large variation of recruitment by year with no clear relationships with the levels of biomass. Since 1991 (Figures 10.7a and b) significant recruitments occurred in the stock of the Bay of Biscay.

For the time being, the Working Group noted that the large fluctuations in SSB observed during the last six years are mainly due to the variations in 1-year-old recruitment calculated by the DEPM estimates.

### 10.10 Catch Forecast

No forecast will be available since there is no direct estimation of the stock in 1995 and because, as mentioned last year, a proper catch forecast has to be based on the results of a survey performed at the beginning of the management year in question.

### 10.11 Biologically Safe Limits

The data available show that an SSB of 15,000- 20,000 t produced the highest recruitment in the period 1987-1992. This gives a reference for a minimum precautionary biomass level. However, no information is available on the size of year classes produced in the 1960s when the spawning stock size is likely to have been much larger than at present.

### 10.12 Comments on Assessment

Estimates of F and M are highly dependent on the direct estimates of biomass from the DEPM surveys. Improvement of the mortality estimates has to be made by taking into account the errors associated with the SSB estimates.

### 10.13 Management Measures and Considerations

The anchovy occurring in the Bay of Biscay is a short-lived species which is 100% mature at 1 year old. The Bay of Biscay anchovy is a small stock and the value of the catch can reach a very high level. The landings are used for canning and fresh consumption. The fleets are purse seiners and mid-water trawlers and these are very dependent on this resource for their survival.

The analysis of catch data at age shows since 1987 a decrease of the mean age of the catch. This fact associated with an increasing fishing effort seems to show an increase of the fishing mortality in the recent years. The catches are currently exceeding the average catches since 1960. The past history of this fishery shows that a large fleet or high levels of effort cannot be sustained for a long period. Therefore, the necessity of managing the fishery is clear.

Provisionally, the Working Group indicated procedures for managing the stock (Anon., 1993b), which can be summarised as follows:

- Quantitative management of the fishery: regulation of catch via an analytical TAC;
- Qualitative management of the fishery: fishing effort regulations (licences), including close seasons, close areas.

Some additional comments can be added:

Quantitative management of the fishery seems to be possible for short-lived pelagic species present in other areas ; examples are the South African Anchovy (Butterworth *et al.,* 1993) and the Icelandic Capelin (Anon., 1993c). The management of the Bay of Biscay anchovy could be optimized if a reliable estimate of the coming recruitment (by means of acoustics) was available as soon as possible, either prior or at the start of the fishing season. Further acoustic and DEPM surveys would be required to evaluate fully the performance of the surveys and the management procedure.

In the case of qualitative management of the fishery, some of the measures outlined can already be applied, i.e. size limits, closed periods and areas. However, precise definition of the allowable level of effort has to be further investigated. The number of fishing licences would have to be related to the expected average yield of the stock within safe biological limits. In order to estimate this level and to check performance of this management procedure, regular direct DEPM estimates for the stock will be necessary. If effort is set at medium or low levels the performance of qualitative management could be as good as that using quantitative methods. The DEPM monitoring could also be used to strengthen effort regulation and technical measures at low levels of SSB.

The Working Group stresses that if the exploitation of this stock is to be managed, a management system needs to be designed wherein an in-season TAC can be calculated on the basis of recent survey information.

**Table 10.1** Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII) As estimated by the Working Group.

| | COUNTRY | | |
|---|---|---|---|
| | **FRANCE** | **SPAIN** | **TOTAL** |
| **YEAR** | VIIIab | VIIIbc | VIII |
| 1960 | 1085 | 57000 | 58085 |
| 1961 | 1494 | 74000 | 75494 |
| 1962 | 1123 | 58000 | 59123 |
| 1963 | 652 | 48000 | 48652 |
| 1964 | 1973 | 75000 | 76973 |
| 1965 | 2615 | 81000 | 83615 |
| 1966 | 839 | 47519 | 48358 |
| 1967 | 1812 | 39363 | 41175 |
| 1968 | 1190 | 38429 | 39619 |
| 1969 | 2991 | 33092 | 36083 |
| 1970 | 3665 | 19820 | 23485 |
| 1971 | 4825 | 23787 | 28612 |
| 1972 | 6150 | 26917 | 33067 |
| 1973 | 4395 | 23614 | 28009 |
| 1974 | 3835 | 27282 | 31117 |
| 1975 | 2913 | 23389 | 26302 |
| 1976 | 1095 | 36166 | 37261 |
| 1977 | 3807 | 44384 | 48191 |
| 1978 | 3683 | 41536 | 45219 |
| 1979 | 1349 | 25000 | 26349 |
| 1980 | 1564 | 20538 | 22102 |
| 1981 | 1021 | 9794 | 10815 |
| 1982 | 381 | 4610 | 4991 |
| 1983 | 1911 | 12242 | 14153 |
| 1984 | 1711 | 33468 | 35179 |
| 1985 | 3005 | 8481 | 11486 |
| 1986 | 2311 | 5612 | 7923 |
| 1987 | 5061 | 9863 | 14924 |
| 1988 | 6743 | 8266 | 15009 |
| 1989 | 2200 | 8174 | 10374 |
| 1990 | 10598 | 23258 | 33856 |
| 1991 | 9708 | 9573 | 19281 |
| 1992 | 15207 | 22468 | 37675 |
| 1993 | 20914 | 19173 | 40087 |
| 1994 | 16993 | 17554 | 34547 |
| 1995 | 3700 | 18116 | 21816 (*) |
| AVERAGE (1960-94) | 4309 | 30182 | 34491 |

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

**Table 10.2** **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 | O | S | O | N | D | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1987** | 0.0 | 0.0 | 0.0 | 1225.0 | 1716.0 | 283.0 | 162.0 | 643.0 | 749.0 | 273.0 | 15.0 | 1.0 | 5067.0 |
| **1988** | 0.0 | 0.4 | 14.0 | 784.0 | 1388.0 | 781.0 | 296.0 | 1154.0 | 2000.0 | 324.0 | 0.2 | 0.0 | 6741.6 |
| **1989** | 699.6 | 81.4 | 11.0 | 378.4 | 763.4 | 11.0 | 59.4 | 8.8 | 30.8 | 151.8 | 4.4 | 0.0 | 2200.0 |
| **1990** | 0.4 | 0.0 | 15.9 | 1330.0 | 1511.3 | 127.2 | 269.2 | 1904.5 | 3274.8 | 1446.3 | 635.9 | 82.7 | 10598.1 |
| **1991** | 1318.0 | 2135.4 | 603.1 | 808.0 | 1622.0 | 195.2 | 124.2 | 419.1 | 1587.3 | 556.7 | 53.7 | 285.5 | 9708.2 |
| **1992** | 2062.0 | 1480.0 | 941.0 | 783.0 | 48.0 | 10.0 | 335.0 | 1202.0 | 2786.0 | 3165.0 | 2395.0 | 0.4 | 15207.4 |
| **1993** | 1636.4 | 1805.3 | 1536.7 | 91.2 | 342.5 | 1439.2 | 1314.6 | 2639.7 | 4056.6 | 3277.3 | 2726.7 | 47.2 | 20913.4 |
| **1994** | 1972.4 | 1907.6 | 1442.2 | 171.9 | 770.1 | 1730.2 | 662.7 | 2125.0 | 3276.4 | 2652.3 | 222.9 | 0.0 | 16933.7 |
| Average 87-94 | 961.1 | 926.3 | 570.5 | 696.4 | 1020.2 | 572.1 | 402.9 | 1262.0 | 2220.1 | 1480.8 | 756.7 | 52.1 | 10921.2 |
| in percentage | 8.8% | 8.5% | 5.2% | 6.4% | 9.3% | 5.2% | 3.7% | 11.6% | 20.3% | 13.6% | 6.9% | 0.5% | 100% |
| Average 92-94 | 1890.3 | 1731.0 | 1306.6 | 348.7 | 386.9 | 1059.8 | 770.8 | 1988.9 | 3373.0 | 3031.5 | 1781.5 | 15.9 | 17684.8 |
| in percentage | 10.7% | 9.8% | 7.4% | 2.0% | 2.2% | 6.0% | 4.4% | 11.2% | 19.1% | 17.1% | 10.1% | 0.1% | 100% |

**COUNTRY:** **SPAIN**

| YEAR\MONTH | J | F | M | A | M | J | J | O | S | O | N | D | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1987** | 0.0 | 0.0 | 453.5 | 4133.0 | 3677.0 | 514.0 | 80.6 | 53.5 | 27.9 | 456.9 | 202.1 | 265.1 | 9863.6 |
| **1988** | 6.0 | 0.0 | 27.9 | 785.7 | 2931.4 | 3203.8 | 292.1 | 97.6 | 421.1 | 118.3 | 136.2 | 245.9 | 8265.9 |
| **1989** | 1.9 | 2.3 | 25.1 | 257.8 | 4295.5 | 794.9 | 90.0 | 509.7 | 115.6 | 198.4 | 1609.6 | 272.7 | 8173.5 |
| **1990** | 79.2 | 5.6 | 2084.7 | 1327.8 | 9947.4 | 2956.7 | 1202.4 | 3226.9 | 2278.3 | 123.2 | 16.4 | 9.5 | 23258.2 |
| **1991** | 99.6 | 39.7 | 23.0 | 1227.6 | 5290.8 | 1662.7 | 90.5 | 59.5 | 34.1 | 265.3 | 184.4 | 596.2 | 9573.3 |
| **1992** | 360.0 | 384.0 | 340.0 | 3458.0 | 13068.0 | 3437.0 | 384.0 | 286.0 | 505.0 | 63.0 | 94.0 | 89.0 | 22468.0 |
| **1993** | 101.7 | 59.1 | 1825.0 | 3169.0 | 7563.5 | 4488.2 | 794.9 | 339.7 | 197.5 | 64.9 | 546.3 | 23.0 | 19172.8 |
| **1994** | 0.0 | 9.3 | 148.7 | 5569.1 | 3991.1 | 5501.2 | 1133.2 | 181.4 | 105.6 | 642.5 | 198.0 | 73.8 | 17553.9 |
| Average 87-94 | 81.0 | 62.5 | 616.0 | 2491.0 | 6345.6 | 2819.8 | 508.5 | 594.3 | 460.6 | 241.6 | 373.4 | 196.9 | 14791.2 |
| in percentage | 0.5% | 0.4% | 4.2% | 16.8% | 42.9% | 19.1% | 3.4% | 4.0% | 3.1% | 1.6% | 2.5% | 1.3% | 100% |
| Average 92-94 | 153.9 | 150.8 | 771.2 | 4065.4 | 8207.5 | 4475.5 | 770.7 | 269.0 | 269.4 | 256.8 | 279.4 | 61.9 | 19731.6 |
| in percentage | 0.8% | 0.8% | 3.9% | 20.6% | 41.6% | 22.7% | 3.9% | 1.4% | 1.4% | 1.3% | 1.4% | 0.3% | 100% |

Table 10.3 **ANCHOVY catches in the Bay of Biscay by country and divisions in 1994**

| | DIVISIONS | QUARTERS | | | | CATCH ( t ) | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | ANNUAL | % |
| SPAIN | VIIIb | 107.2 | 3672.2 | 0.0 | 0.0 | 3779.4 | 21.5% |
| | VIIIC | 50.8 | 11389.2 | 1420.2 | 914.3 | 13774.5 | 78.5% |
| | TOTAL | 158.0 | 15061.4 | 1420.2 | 914.3 | 17553.9 | |
| | % | 0.9% | 85.8% | 8.1% | 5.2% | 100.0% | 100.0% |
| FRANCE | VIIIa | 785.5 | 163.0 | 3703.3 | 2520.2 | 7172.0 | 42.4% |
| | VIIIb | 4493.9 | 2418.2 | 2340.7 | 341.0 | 9593.7 | 56.7% |
| | VIIIc | 16.0 | 16.0 | 5.5 | 0.0 | 37.5 | 0.2% |
| | VIIId | 26.6 | 74.8 | 14.6 | 13.8 | 129.8 | 0.8% |
| | TOTAL | 5322.0 | 2672.0 | 6064.0 | 2875.0 | 16933.0 | |
| | % | 31.4% | 15.8% | 35.8% | 17.0% | 100.0% | 100.0% |
| TOTAL | VIIIa | 785.5 | 163.0 | 3703.3 | 2520.2 | 7172.0 | 20.8% |
| | VIIIb | 4601.1 | 6090.4 | 2340.7 | 341.0 | 13373.1 | 38.8% |
| | VIIIC | 66.8 | 11405.2 | 1425.6 | 914.3 | 13812.0 | 40.1% |
| | VIIId | 26.6 | 74.82 | 14.55 | 13.8 | 129.8 | 0.4% |
| | TOTAL | 5480.0 | 17733.4 | 7484.2 | 3789.3 | 34486.9 | |
| | % | 15.9% | 51.4% | 21.7% | 11.0% | 100.0% | 100.0% |



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Table 10.4 Bay of Biscay ANCHOVY catches by country and EC categories in 1994

| | | QUARTERS | | | | | |
|---|---|---|---|---|---|---|---|
| COUNTRY | EEC CAT. | 1 | 2 | 3 | 4 | ANNUAL | % |
| SPAIN | T1 | 5413 | 2394726 | 0 | 402 | 2400541 | 13.7% |
| | T2 | 107731 | 10943588 | 1292066 | 297612 | 12640997 | 72.0% |
| | T3 | 38594 | 1722389 | 100620 | 561068 | 2422671 | 13.8% |
| | T4 | 6223 | 705 | 27495 | 55268 | 89691 | 0.5% |
| | TOTAL | 157961 | 15061408 | 1420181 | 914350 | 17553900 | 100.0% |
| FRANCE | T1 | 120219 | 17580 | 296236 | 41188 | 475223 | 2.8% |
| | T2 | 2839458 | 1010633 | 5436751 | 2807563 | 12094405 | 71.4% |
| | T3 | 2298192 | 1010901 | 266314 | 26405 | 3601812 | 21.3% |
| | T4 | 64260 | 633077 | 64761 | 0 | 762098 | 4.5% |
| | TOTAL | 5322129 | 2672191 | 6064062 | 2875156 | 16933538 | 100.0% |
| TOTAL | T1 | 125632 | 2412306 | 296236 | 41590 | 2875764 | 8.3% |
| | T2 | 2947189 | 11954221 | 6728817 | 3105175 | 24735402 | 71.7% |
| | T3 | 2336786 | 2733290 | 366934 | 587473 | 6024483 | 17.5% |
| | T4 | 70483 | 633782 | 92256 | 55268 | 851789 | 2.5% |
| | TOTAL | 5480090 | 17733599 | 7484243 | 3789506 | 34487438 | 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.

G\ACFM\WGMHSA96\ANE_BISC\TABLE104.XLS

**Table 10.5** Evolution of the French and Spanish fleet for ANCHOVY (from Working Group members).Numbers of boats.

| | France | | | Spain | |
|---|---|---|---|---|---|
| Year | P. seiner | P. trawl | Total | P. seiner | total |
| 1960 (1) | 52 | 0 | 52 | 571 | 623 |
| 1972 (1) | 35 | 0 | 35 | 492 | 527 |
| 1976 (1) | 24 | 0 | 24 | 354 | 378 |
| 1980 (1) | 14 | n/a | 14 | 293 | 307 |
| 1984 (1) | n/a | 4 | 4 | 306 | 310 |
| 1987 (1) | 9 | 36 | 45 | 282 | 327 |
| 1988 | 10 | 61 | 71 | 278 | 349 |
| 1989 | 2 | 51 | 53 | 215 | 268 |
| 1990 | 30 | 80 (1) | 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 | 255 | 431 |
| 1995 (3) | 26 | 150 (2) | 176 | 262 | 438 |

(1) Only St. Jean de Luz and Hendaya.
(2) Maximun number of potential boats; the numberof mid-water trawls is roughly half of this number due to the fishing in pairs of mid-water trawlers.
(3) Provisional figures for 1995
n/a = Not available.

TABLE 10.6 Catch per unit effort of anchovy from the Spanish Spring fishery in the Bay of Biscay

| YEAR | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
|---|---|---|---|---|---|---|---|---|---|
| CPUE/PERIOD | 03-0 | 03-0 | 04-0 | 04-0 | 04-0 | 04-06 | 04-06 | 04-06 | 04-06 |
| CPUE (t/boat/day) | 0.9 | 0.6 | 0.8 | 1.5 | 1.2 | 2.5 | 1.7 | 1.6 | 2.8 |
| CPUE 1 (#) | 13.8 | 16.7 | 16.1 | 63.4 | 29.3 | 86.3 | 46.7 | 26.7 | 53.6 |
| CPUE 2 (#) | 12.2 | 7.0 | 13.7 | 4.4 | 20.2 | 16.6 | 29.7 | 32.8 | 33.8 |
| CPUE 3+ (#) | 5.3 | 2.0 | 1.2 | 0.8 | 0.4 | 1.3 | 0.1 | 4.7 | 7.9 |

# in thousands

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Table 10.7 Catch per unit of effort for the french anchovy fishery in 1994 in tonnes per purse seiner or per pair of trawlers (per month)

| gear | january | february | march | april | may | june | july | august | september | october | november |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Purse seiner | | | | 5.2 | | 7.8 | 7.8 | 0.4 | | | |
| Pelagic trawlers | 27.8 | 19.4 | 24.8 | | | 30.4 | 11.6 | 68.7 | 65.4 | 40.3 | 1.2 |



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TABLE 10.8 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.

| YEAR | | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|
| Period of year | | 2 - 7 June | 21 - 28 May | 10 - 21 May | 4 - 15 May | 16May-07Jun | 16May-13Jun | No survey | 17 May-3June. |
| Positive area (km2) | | 23850 | 45384 | 17546 | 59757 | 24264 | 67796 | | 48735 |
| Surveyed area (km2) | | 34934 | 59840 | 37930 | 79759 | 84032 | 92782 | | 60330 |
| Daily egg production | | 2.198 | 5.015 | 0.73 | 5.02 | 1.24 | 5.81 | | 4.48 |
| Exp(-12) | C.V. | 0.39 | 0.24 | 0.4 | 0.15 | 0.06 | 0.14 | | 0.14 |
| SSB (t) | | 29365 | 63500 | 11861 | 97239 | 19276 | 90720 | -- | 70940 |
| | C.V. | 0.48 | 0.31 | 0.41 | 0.17 | 0.14 | 0.2 | | 0.16 |
| Coastal egg Production Exp(-12) | | 2.319 | 5.312 | 0.328 | 3.35 | 0.524 | 2.97 | -- | 2.74 |
| 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 |
| REGIONAL ESTIMATES | | OCEANIC | OCEANIC | REMAINDER | OCEANIC | REMAINDER | REMAINDER | | REMAINDER |
| SSB (t) | | 21000 | 23400 | 9200 | 32315 | 12250 | 41464 | -- | 25318 |
| No/age: | 1 | 181 | 592 | 172 | 1230 | 282.6 | 1784 | | 344.6 |
| | 2 | 331 | 258 | 166 | 155 | 221.2 | 187 | | 609.5 |
| (millions) | 3+ | 142 | 68 | 16 | 35 | 4.1 | 16.7 | | 54 |
| | | COASTAL+GAR. | COASTAL+GAR. | GARONNE | COASTAL+GAR. | GARONNE | GARONNE | | COASTAL+GAR. |
| SSB (t) | | 9500 | 39600 | 2800 | 64924 | 7026 | 49256 | -- | 45622 |
| No/age: | 1 | 475 | 1757 | 74 | 4383 | 387.9 | 3787 | | 2112 |
| | 2 | 0 | 0 | 40 | 35 | 69.1 | 22.1 | | 395.8 |
| (millions) | 3+ | 0 | 0 | 2 | 5 | 0.7 | 0 | | 0 |

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Table 10.9 Evaluation of abundance index from French acoustic surveys

| | 1983<br>20/4-25/4 | 1984<br>30/4-13/5 | 1989 (2)<br>23/4-2/5 | 1990<br>12/4-25/4 | 1991<br>6/4-29/4 | 1992<br>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 10.10 Summary of egg and acoustic surveys of Bay of Biscay anchovy

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SSB (tonnes) | | | | | 29,365 | 63,500 | 11,860 | 97,239 | 19,276 | 90,720 | | 70,940 |
| Acoustic index (tonnes) | 50,000 | 38,500 | | | | | 15,500 | n.a. | 64,000 | 89,000 | | |
| Egg survey (million) (1-year-old) | | | | | 656 | 2,349 | 246 | 5,613 | 647 | 5,571 | | 2,457 |
| Acoustic survey (1-year-old) millions | 1,800 | 600 | | | | | 440 | n.a. | 1,373 | 9,072 | | |
| Y.C.C.(1) | 1,444 | 352 | 177 | 267 | 340 | 542 | 302 | 1,738 | 667 | 2,040 | 1,957 | 850 |
| catch | 14,153 | 35,179 | 11,846 | 7,923 | 14,924 | 15,009 | 10,374 | 33,856 | 19,281 | 37,676 | 40,087 | 34,547 |

(1) Year class cumulative in numbers $\sum_{i=1}^{N} C_{ij}$ with

N = number of catch years for the year class j

Cij = Catch from year class j in year i

Table 10.11 ANCHOVY catch at age in thousands for 1994 by country, division and quarter.

QUARTERS AND MAIN DIVISIONS

| | | 1 | 2 | 3 | 4 | Annual total |
|---|---|---|---|---|---|---|
| | AGE | VIIIbc | VIIIbc | VIIIbc | VIIIbc | VIIIbc |
| SPAIN | 0 | 0 | 0 | 2569 | 48581 | 51150 |
| | 1 | 3564 | 253486 | 38286 | 3026 | 298362 |
| | 2 | 3301 | 311720 | 21241 | 3253 | 339515 |
| | 3 | 221 | 44400 | 1325 | 0 | 45946 |
| | 4 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 7086 | 609606 | 63421 | 54860 | 734973 |
| | W MED. | 21.41 | 25.06 | 21.60 | 17.39 | 24.15 |
| | SOP | 151.67 | 15272.38 | 1370.73 | 953.02 | 17747.79 |
| | CATCH (Tn) | 157.96 | 15061.27 | 1420.18 | 914.35 | 17553.76 |
| | VAR % | -3.98% | 1.40% | -3.48% | 4.23% | 1.11% |

| | | | | | | Annual total |
|---|---|---|---|---|---|---|
| | AGE | VIIIab | VIIIab | VIIIab | VIIIab | VIIIab |
| FRANCE | 0 | 0 | 0 | 604 | 308 | 912 |
| | 1 | 90969 | 146590 | 214863 | 93735 | 546157 |
| | 2 | 161726 | 16689 | 20886 | 9011 | 208312 |
| | 3 | 16766 | 279 | 0 | 0 | 17045 |
| | 4 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 269461 | 163558 | 236353 | 103054 | 772426 |
| | W MED. | 19.74 | 16.41 | 25.88 | 27.01 | 21.88 |
| | SOP | 5320.00 | 2683.00 | 6116.00 | 2783.00 | 16902.00 |
| | CATCH (Tn) | 5322.00 | 2672.00 | 6064.00 | 2875.00 | 16933.00 |
| | VAR % | -0.04% | 0.41% | 0.86% | -3.20% | -0.18% |

| | Quarters | 1 | 2 | 3 | 4 | Annual total |
|---|---|---|---|---|---|---|
| | AGE | VIII | VIII | VIII | VIII | VIII |
| TOTAL | 0 | 0 | 0 | 3173 | 48889 | 52062 |
| | 1 | 94533 | 400076 | 253149 | 96761 | 844519 |
| Sub-area VIII | 2 | 165027 | 328409 | 42127 | 12264 | 547827 |
| | 3 | 16987 | 44679 | 1325 | 0 | 62991 |
| | 4 | 0 | 0 | 0 | 0 | 0 |
| | TOTAL | 276547 | 773164 | 299774 | 157914 | 1507399 |
| | W MED. | 19.78 | 23.23 | 24.97 | 23.67 | 22.99 |
| | SOP | 5471.67 | 17955.38 | 7486.73 | 3736.02 | 34649.79 |
| | CATCH (Tn) | 5479.96 | 17733.27 | 7484.18 | 3789.35 | 34486.76 |
| | VAR % | -0.15% | 1.25% | 0.03% | -1.41% | 0.47% |

Table 10.12 Spanish half - yearly catches of anchovy ( 2nd semester) by age in ('000) of Bay of Biscay anchovy from the live bait tuna boats.

| Age | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|
| 0 | 10020 | 97581 | N/A | 27993 | 6098 | 2167 | 3557 | 7872 |
| 1 | 24975 | 17353 | N/A | 22238 | 13736 | 14268 | 20160 | 5753 |
| 2 | 1461 | 203 | N/A | 109 | 0 | 0 | | 477 |
| 3 | 912 | 3 | N/A | 0 | 0 | 0 | | 0 |
| Total | 37368 | 115140 | N/A | 50340 | 19834 | 16435 | 23717 | 14102 |
| Catch (t) | 546 | 493 | | 416 | 353 | 200 | 306 | 143.2 |
| meanW (g) | 14.6 | 4.3 | | 8.3 | 17.8 | 12.1 | 12.9 | 10.2 |

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Table 10.13 Total catches of anchovy ( in millions) by age from 1989 to 1994 on a half-year basis including catches of live bait anchovies for tuna fishing.

| Year | 1989 | | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Semester | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Age | | | | | | | | | | | | |
| 0 | 0 | 175 | 0 | 33 | 0 | 79 | 0 | 36 | 0 | 64 | 0 | 60 |
| 1 | 157 | 8 | 842 | 541 | 328 | 113 | 998 | 452 | 796 | 613 | 495 | 356 |
| 2 | 130 | 12 | 62 | 58 | 322 | 16 | 197 | 23 | 437 | 90 | 493 | 55 |
| 3 | 14 | 3 | 10 | 5 | 16 | 1 | 17 | 1 | 7 | 0 | 62 | 1.3 |
| Total | 301 | 198 | 914 | 637 | 666 | 209 | 1212 | 512 | 1240 | 767 | 1050 | 472 |
| Catch (t) | 7321 | 3052 | 19385 | 14887 | 15025 | 4610 | 26381 | 11504 | 24057 | 16334 | 23213 | 11416 |

Table 10.14 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 |

| Age | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 31 | 128 | 175 | 33 | 79 | 36 | 64 | 60 |
| 1 | 53 | 52 | 220 | 385 | 164 | 1383 | 441 | 1450 | 1409 | 850 |
| 2 | 105 | 80 | 187 | 128 | 142 | 120 | 338 | 220 | 527 | 548 |
| 3 | 177 | 63 | 42 | 29 | 18 | 15 | 18 | 18 | 7 | 63 |
| 4 | 4 | 54 | 22 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5+ | 0 | 0 | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 339 | 249 | 514 | 674 | 499 | 1551 | 876 | 1724 | 2007 | 1521 |

(1) before 1983 some ageing errors could have occurred

Table 10.15 Half-year mean weight at age in the catches of the Bay of Biscay anchovy in 1994

| Country | Spain | France | Spain | France | | TOTAL | |
|---|---|---|---|---|---|---|---|
| Semester | 1 | 1 | 2 | 2 | 1 | 2 | Annual |
| Area | VIII CB | VIII AB | VIII CB | VIII AB | VIII | VIII | VIII |
| Age | | | | | | | |
| 0 | 0.00 | 0.00 | 15.91 | 10.87 | 0.00 | 15.82 | 15.82 |
| 1 | 18.65 | 16.63 | 20.34 | 26.14 | 17.68 | 25.46 | 20.90 |
| 2 | 29.21 | 20.61 | 25.71 | 27.52 | 26.10 | 26.70 | 26.16 |
| 3 | 32.01 | 22.06 | 30.02 | 0.00 | 29.26 | 30.02 | 29.28 |
| Total | 25.01 | 18.48 | 19.64 | 26.22 | 22.32 | 24.52 | 22.99 |



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Table 10.16 Weight at age (in grams) in the Total Catch of Anchovy in the Bay of Biscay.

| years | 0-group | 1-group | 2-group | 3-group |
|---|---|---|---|---|
| 1987 | 13 | 21 | 33 | 38 |
| 1988 | 13 | 21 | 31 | 35 |
| 1989 | 13 | 20 | 29 | 30 |
| 1990 | 10 | 22 | 28 | 42 |
| 1991 | 15 | 19 | 26 | 32 |
| 1992 | 12 | 21 | 31 | 38 |
| 1993 | 12 | 18 | 27 | 30 |
| 1994 | 15 | 21 | 26 | 29 |

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Table 10.17 Weight at age (in grams) in the stock of Anchovy in the Bay of Biscay.

| years | 0-group | 1-group | 2-group | 3-group |
|---|---|---|---|---|
| 1987 | 13 | 16 | 29 | 33 |
| 1988 | 13 | 16 | 29 | 33 |
| 1989 | 13 | 16 | 29 | 33 |
| 1990 | 10 | 16 | 29 | 35 |
| 1991 | 15 | 17 | 28 | 34 |
| 1992 | 12 | 15 | 32 | 32 |
| 1994 | 15 | 17 | 26 | 32 |

from Cendrero 1994



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Table 10.18 Input data and constraints for the assessment of the Bay of Biscay anchovy (Division VIII) with the ICA package (Patterson, 1994).

Index file: ANTDIR95.NDX  Biomass index file: ANT895SB.DAT
Desagregated index file: ANT895FL.DAT

Range of years for the analysis: 1987-1994:
Relative weight for each year in the analysis: 0.5 / 05 / 1 / 1 / 1 / 1 / 1 / 1

Catch Data: Matrix of annual catches at age from the International fishery in Division VIII.
Range of ages: 0-5. Significant range of ages: 1-3 years old.
Relative weights for the reliability of the catches at age: 0.1 / 1 / 1 / 1 / 0.1 / 0.1

Tuning data: Biomass indices:
In.1: DEPM: 7 Observations., 1987-1994 (missing value in 1993), Taken as absolute values.
In.2: Acoustic, 3 values, 1989,1991,1992. Used as relative index

Tuning data: Aged desagregated indices:
In. 1: DEPM Pop. estimates (1987-1994, except for 1993), used as absolute values. Ages: 1-3
In. 2: Acoustic Population estimates in 1989, 91 & 92. Used as relative figures. Ages: 1,2+

Equal confidence has been set to all the tuning indices. Relative weight for all = 1

Reference age for the separated constraint: 2 y.o.
Selection pattern: Flat. S on last age fixed at 1
Ages used to calculate the reference F : 1-3 y.o.

Number of observations: 77
Parameters to be estimated: 26

Table 10.19 ICA.AV file: Analysis of Variance for the assessment of the Bay of Biscay anchovy (Division VIII).

Total weighted SSQ is : 8.179836479644848

Unweighted Residuals About the Model fit

| | Start SSQ | End SSQ | df | Variance | IV Wt |
|---|---|---|---|---|---|
| Separable model: | 107.7835 | 9.9032 | 17 | .5825 | 1.71663 |
| Biomass idx 1 | 2.6170389 | 1.0361816 | 7 | .1480 | 3.93538 |
| Biomass idx 2 | 1.6306476 | .3692373 | 2 | .1846 | 3.15536 |
| Aged index 1 | 13.6966122 | 3.9773220 | 21 | .1894 | 3.07576 |
| Aged index 2 | 4.7439808 | 8325556 | 4 | .2081 | 2.79880 |

Partition of the weighted residuals
Catch at Age Matrix : .3498E+01 for 40 observations.
SSB Index 2 1.036182 7
SSB Index 2 3.692372E-01 3

Aged Index 1

| Age: | 1 | 2 | 3 |
|---|---|---|---|
| Wted SSQ: | .1059E+01 | .1116E+01 | .4766E+00 |
| No data: | 7 | 7 | 7 |

Aged Index 2

| Age: | 1 | 2 |
|---|---|---|
| Wted SSQ: | .4565E+00 | .1679E+00 |
| No data: | 3 | 3 |

Table 10. 20 ICA Outputs results for the asssessment of the Bay of Biscay anchovy (Division VIII).

FISHING MORTALITY

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|
| 0 | .0044 | .0063 | .0063 | .0065 | .0133 | .0088 | .0059 | .0055 |
| 1 | .2172 | .3157 | .3150 | .3242 | .6632 | .4364 | .2963 | .2726 |
| 2 | .6468 | .9401 | .9379 | .9654 | 1.9748 | 1.2994 | .8823 | .8117 |
| 3 | .5315 | .7725 | .7707 | .7933 | 1.6227 | 1.0677 | .7250 | .6670 |
| 4 | .6468 | .9401 | .9379 | .9654 | 1.9748 | 1.2994 | .8823 | .8117 |
| 5 | .6468 | .9401 | .9379 | .9654 | 1.9748 | 1.2994 | .8823 | .8117 |

NUMBERS AT AGE (Millions)

| | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 8. | 3. | 21. | 7. | 28. | 28. | 18. | 19. | 13. |
| 1 | 2. | 2. | 1. | 6. | 2. | 8. | 8. | 5. | 6. |
| 2 | 1. | 0. | 1. | 0. | 1. | 0. | 2. | 2. | 1. |
| 3 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 4 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 5 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

STOCK SUMMARY

| Year | Recruits x10^6 | Total B tonnes | Spawn B tonnes | Landings tonnes | Yld/SSB | Ref. F Fbar 1-3 |
|---|---|---|---|---|---|---|
| 1987 | 8. | 165456. | 31013. | 14924. | .4812 | .4652 |
| 1988 | 3. | 100808. | 30277. | 15009. | .4957 | .6761 |
| 1989 | 21. | 311707. | 16929. | 10374. | .6128 | .6745 |
| 1990 | 7. | 184753. | 61258. | 33856. | .5527 | .6943 |
| 1991 | 28. | 497315. | 29936. | 19281. | .6441 | 1.4202 |
| 1992 | 28. | 470537. | 71753. | 37675. | .5251 | .9345 |
| 1993 | 18. | 395010. | 96624. | 40087. | .4149 | .6346 |
| 1994 | 19. | 428779. | 77444. | 34547. | .4461 | .5838 |

PARAMETER ESTIMATES +/- SD

| | | | | |
|---|---|---|---|---|
| Separable Model: Reference F by year | | | | |
| 1 | 1987 | .6468 | .4692 | .8917 |
| 2 | 1988 | .9401 | .7195 | 1.2284 |
| 3 | 1989 | .9379 | .7510 | 1.1714 |
| 4 | 1990 | .9654 | .7735 | 1.2050 |
| 5 | 1991 | 1.9747 | 1.6917 | 2.3051 |
| 6 | 1992 | 1.2994 | 1.0415 | 1.6210 |
| 7 | 1993 | .8823 | .6844 | 1.1376 |
| 8 | 1994 | .8117 | .5863 | 1.1237 |
| Separable Model: Selection (S) by age | | | | |
| 9 | 0 | .0067 | .0039 | .0115 |
| 10 | 1 | .3358 | .2746 | .4108 |
| | 2 | 1.0000 | Fixed : Reference age | |
| 11 | 3 | .8217 | .6746 | 1.0010 |
| | 4 | 1.0000 | Fixed : last true age | |
| Separable Model: Populations in year | | 1994 | | |
| 12 | 0 | 18866. | 4609. | 77231. |
| 13 | 1 | 5349. | 4005. | 7142. |
| 14 | 2 | 1854. | 1419. | 2422. |
| 15 | 3 | 201. | 154. | 262. |
| 16 | 4 | 3. | 2. | 5. |
| Separable Model: Populations at age 4 | | | | |
| 17 | 1987 | 75.6946 | 12.6419 | 453.2270 |
| 18 | 1988 | 27.5916 | 17.5677 | 43.3352 |
| 19 | 1989 | 14.5412 | 9.8238 | 21.5239 |
| 20 | 1990 | 6.0109 | 4.0592 | 8.9011 |
| 21 | 1991 | 7.7900 | 5.4530 | 11.1286 |
| 22 | 1992 | .4910 | .1432 | 1.6839 |
| 23 | 1993 | 5.0271 | 3.1094 | 8.1275 |

# Table 10.21 Outputs from the ICA assessment of Bay of Biscay anchovy (Division VIII)

SSB Index catchabilities
SSB Index 1 was used as absolute estimator.
No fitted catchability for this index.
24 2 Linear Model : Q .13440E+01 .10513E+01 .17182E+01

Age-structured index catchabilities
Age-Structured Index 1
Absolute estimator: No fitted catchability.

Age-Structured Index 2
Linear model fitted. Slopes at age:
25 1 Q .11695E+01 .87791E+00 .15579E+01
26 2 Q .15618E+01 .11733E+01 .20789E+01

RESIDUALS ABOUT THE MODEL FIT

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

| Age | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | .38645E+00 | .23474E+01 | .80210E+00 | .17232E+00 | -.10051E+01 | -.13656E+01 | .35733E-01 | -.56425E-11 | .10000E+00 |
| 1 | .71128E-01 | -.50564E-01 | .16124E-01 | .26248E+00 | -.40486E+00 | -.20857E+00 | .10151E+00 | .10772E+00 | .10000E+01 |
| 2 | -.11097E+00 | -.25852E+00 | -.39965E+00 | .32957E+00 | -.89822E+00 | .30120E+00 | -.13075E+00 | -.16819E+00 | .10000E+01 |
| 3 | .28822E-01 | -.26156E+00 | .61060E-01 | -.39108E+00 | .28306E+00 | -.31110E+00 | -.25288E+00 | .32925E-01 | .10000E+01 |
| 4 | -.27995E-01 | -.13067E+01 | -.17941E+01 | -.10178E+01 | -.16561E+01 | .34043E+00 | -.80446E+00 | -.35668E+00 | .10000E+00 |
| Wts | .50000E+00 | .50000E+00 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | .10000E+01 | |

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

| Idx | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -.10000E+01 | -.10000E+01 | -.10000E+01 | -.10000E+01 | -.54589E-01 | .74064E+00 | -.12100E+00 | .46208E+00 | -.44021E+00 | .23454E+00 | -.10000E+01 | -.87720E-01 |
| 2 | -.10000E+01 | -.10000E+01 | -.10000E+01 | -.10000E+01 | -.10000E+01 | -.10000E+01 | -.38388E+00 | -.10000E+01 | .46414E+00 | -.80264E-01 | -.10000E+01 | -.10000E+01 |

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

Aged Index 1

| Age | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|
| 1 | -.31621E+00 | .66114E+00 | -.67762E+00 | .59387E+00 | -.30245E+00 | .37648E+00 | -.10000E+01 | -.78599E-01 |
| 2 | .11650E+00 | .51120E+00 | .38540E-01 | .88801E+00 | -.59838E-01 | .69867E+00 | -.10000E+01 | .34263E+00 |
| 3 | .68562E-01 | .41058E+00 | -.91733E-01 | .46877E+00 | -.31276E+00 | -.17142E+00 | -.10000E+01 | -.43162E+00 |

Aged Index 2

| Age | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|
| 1 | -.62834E+00 | -.10000E+01 | .22355E+00 | .40479E+00 |
| 2 | -.25237E+00 | -.10000E+01 | .37955E+00 | -.12718E+00 |

Table 10.22 Outputs from the ICA assessment of Bay of Biscay anchovy (Division VIII)

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1987 to 1994

| | |
|---|---|
| Variance | : 1.1449 |
| Skewness test statistic | : -.8709 |
| Kurtosis test statistic | : 3.0517 |
| Partial chi-square | : 10.0704 |
| Probability of chi-square | : .9006 |
| Degrees of freedom | : 17 |

PARAMETERS OF THE DISTRIBUTION OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR ln SSB INDEX 1

Index used as absolute measure of abundance.

| | |
|---|---|
| Variance | : .1370 |
| Skewness test statistic | : 1.1648 |
| Kurtosis test statistic | : -.2563 |
| Partial chi-square | : .0987 |
| Probability of chi-square | : 1.0000 |
| Number of observations | : 7 |
| Degrees of freedom | : 7 |
| Weight in the analysis | : 1.0000 |

DISTRIBUTION STATISTICS FOR ln SSB INDEX 2

Linear catchability relationship assumed.

Last age is a plus-group.

| | |
|---|---|
| Variance | : .1846 |
| Skewness test statistic | : .2342 |
| Kurtosis test statistic | : -.5303 |
| Partial chi-square | : .0356 |
| Probability of chi-square | : 1.0000 |
| 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 ln AGED INDEX 1

Index used as absolute measure of abundance.

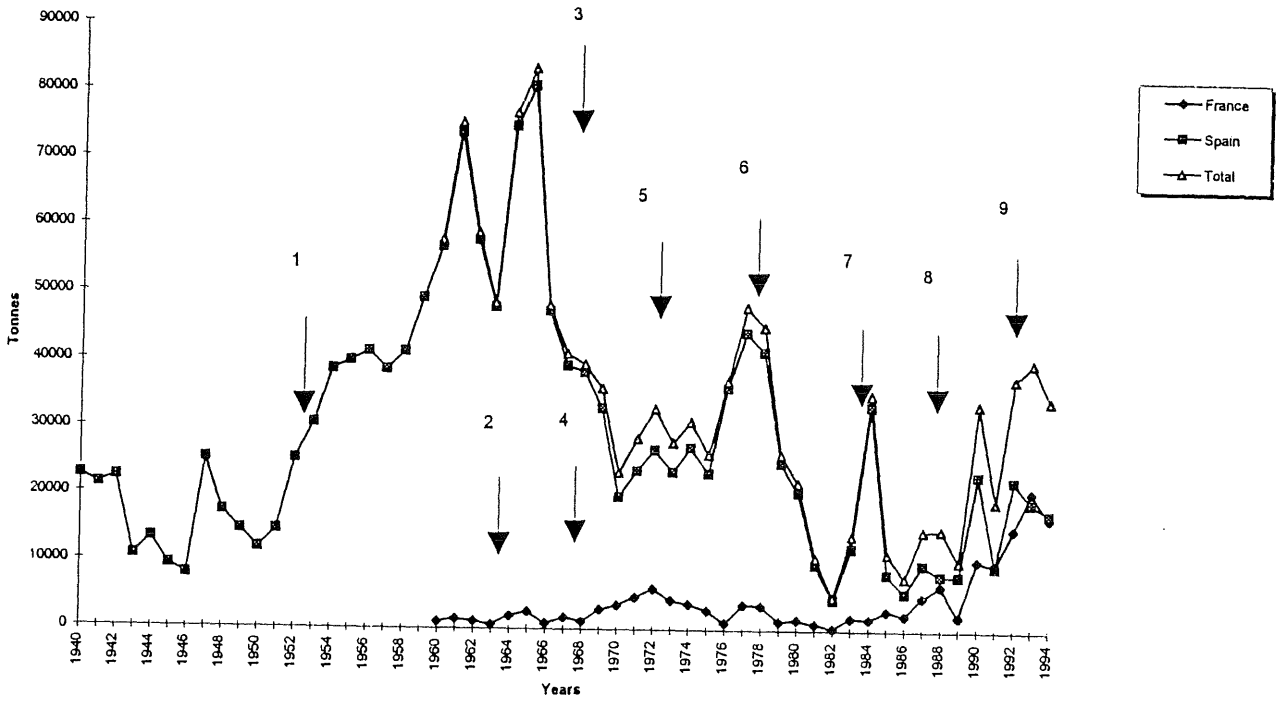
| Age | : | 1 | 2 | 3 |
|---|---|---|---|---|
| Variance | : | .2256 | .1079 | .1021 |
| Skewness test stat. | : | .2582 | 1.6051 | .2635 |
| Kurtosis test stat. | : | -.7739 | -.3489 | -.7183 |
| Partial chi-square | : | .2258 | .3590 | .2208 |
| Prob. of chi-square | : | 1.0000 | .9998 | 1.0000 |
| Number of data | : | 7 | 7 | 7 |
| Degrees of freedom | : | 7 | 7 | 7 |
| Weight in analysis | : | .6667 | .6667 | .6667 |

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed.

| Age | : | 1 | 2 |
|---|---|---|---|
| Variance | : | .3043 | .1120 |
| Skewness test stat. | : | -.4400 | .4224 |
| Kurtosis test stat. | : | -.5303 | -.5303 |
| Partial chi-square | : | .0853 | .0342 |
| Prob. of chi-square | : | .9583 | .9830 |
| Number of data | : | 3 | 3 |
| Degrees of freedom | : | 2 | 2 |
| Weight in analysis | : | .7500 | .7500 |

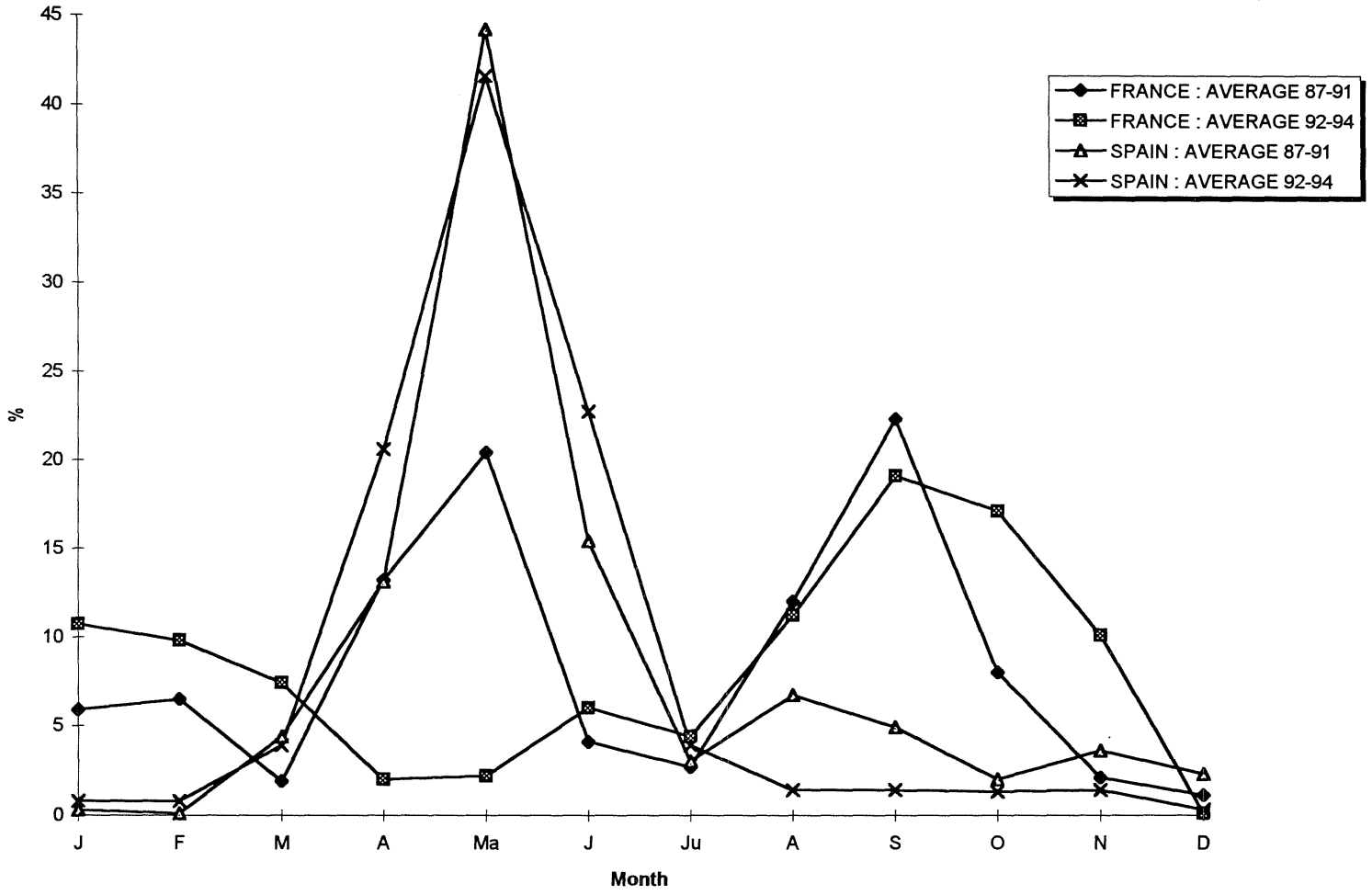
**Figure 10.1 Bay of Biscay anchovy ; historical evolution of the fishery since 1940**




G\ACFM\WGMHSA96\ANE_BISC\FIG101.XLC

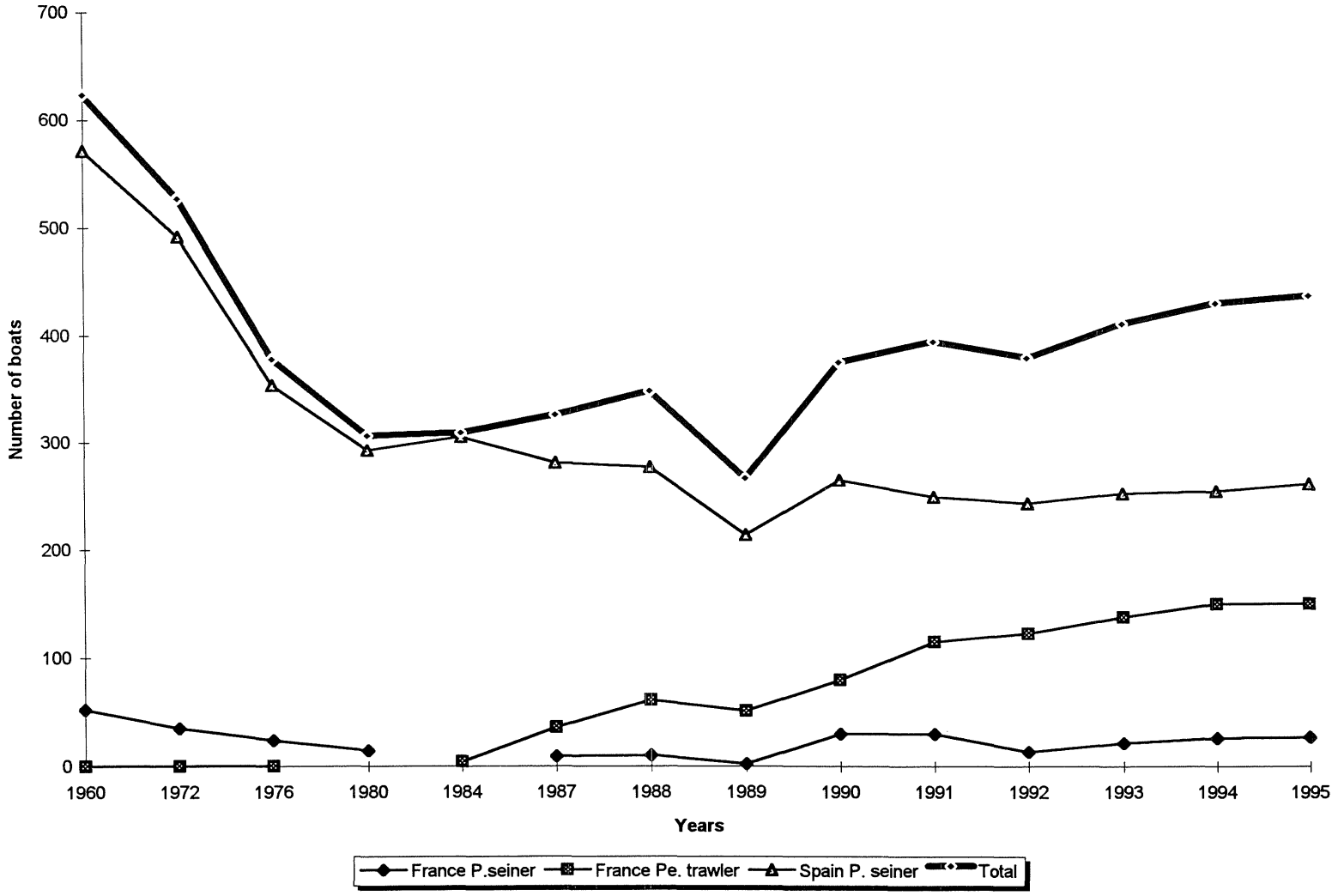
(1) Goniometer
(2) Echosounder ; anchovy dissapear from the coast of Galicia
(3) minimum length size : 9cm
(4) Power block
(5) 8 tonnes per boat and 5 days per week for the spanish fleet ;
the spanish fleet is not allowed to come into the french 6 nautical miles
(6) Radar and sonar
(7) 6 tonnes per boat for the spanish fleet
(8) Minimum 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 10.2 Mean monthly variations before and after 1992 for the French and Spanish anchovy fisheries in Sub-area VIII**



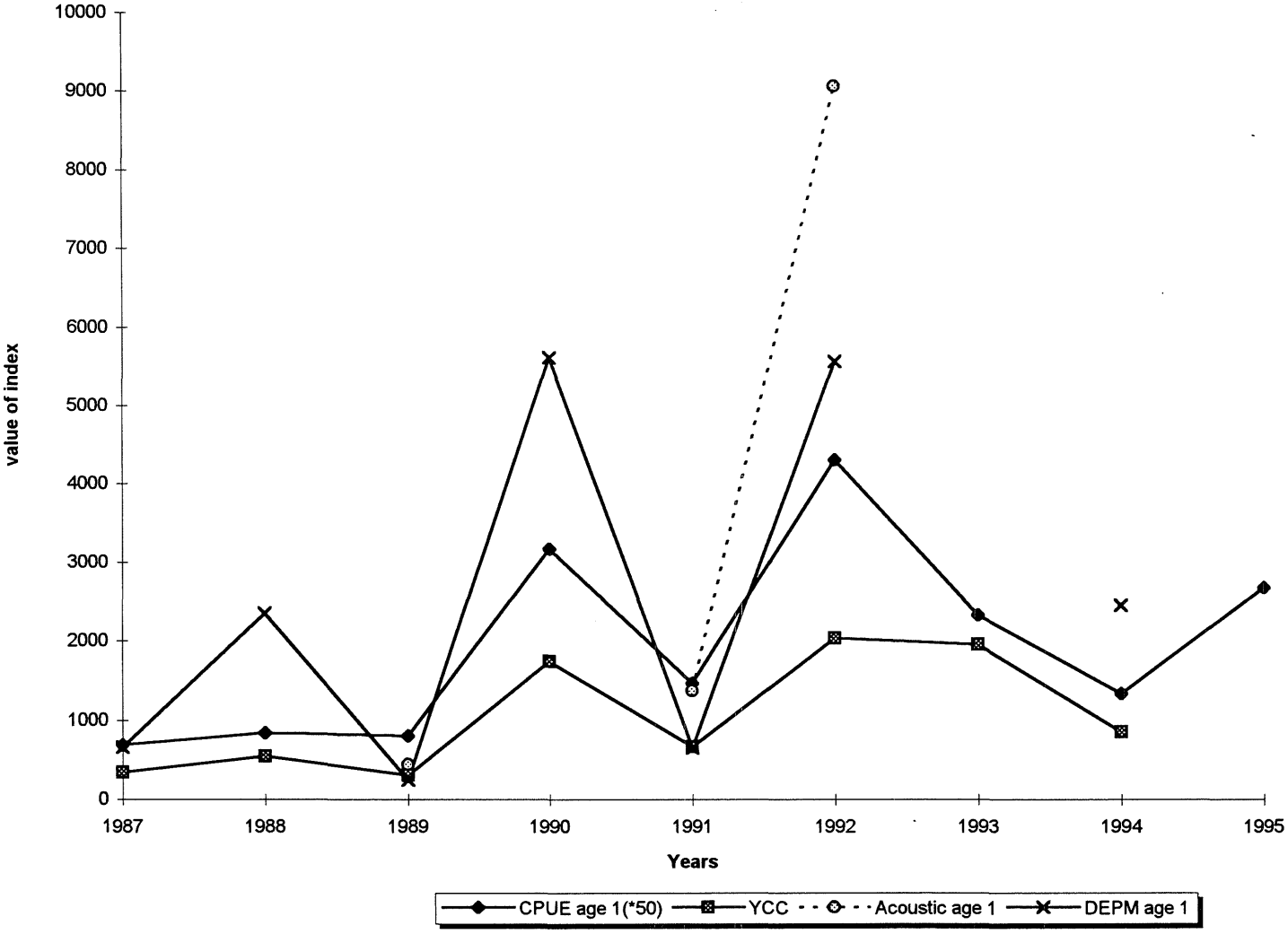

G\ACFM\WGMHSA96\ANE-BISC\FIG102.XLS

**Figure 10.3 Evolution of the fleets fishing for anchovy in the Bay of Biscay**



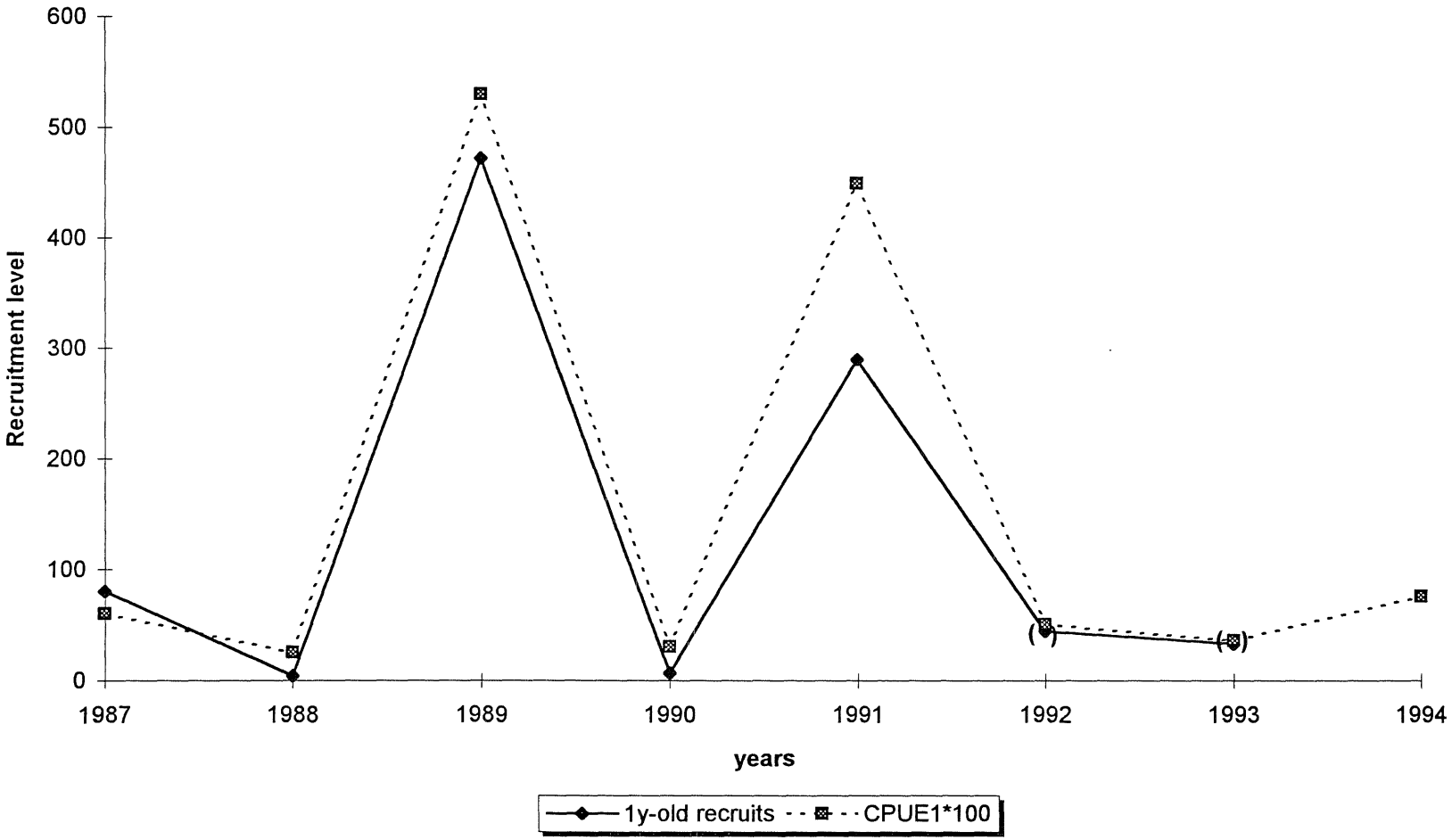

G\ACFM\WGMHSA96\ANE_BISC\FIG103.XLS

**Figure 10.4 Recruitment indices and variation of CPUE for age 1**



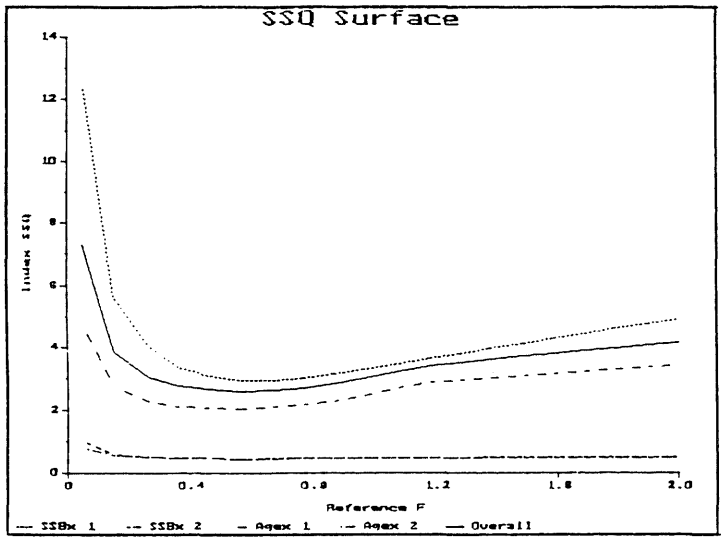

G\ACFM\WGMHSA96\ANE_BISC\FIG104.XLS

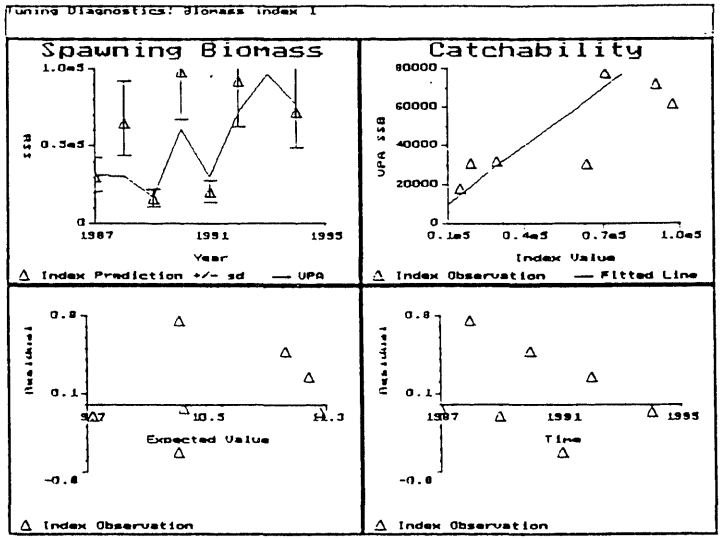
**Figure 10.5 variation of recruitment level (expressed as millions of one year old recruits or as thousands of catcth of 1-year-old per unit of effort per thousand tonnes of SSB the year before) during the 1987-1994 period**

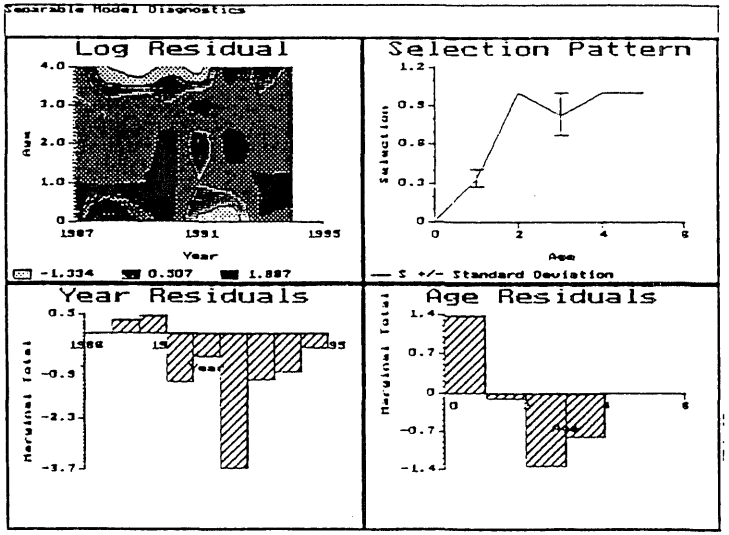



G:\ACFM\WGMHSA96\ANE_BISC\FIG105.XLS-CHART1

Figure 10.6 a, b and c : Results of the anchovy assessment in Division VIII with the ICA method



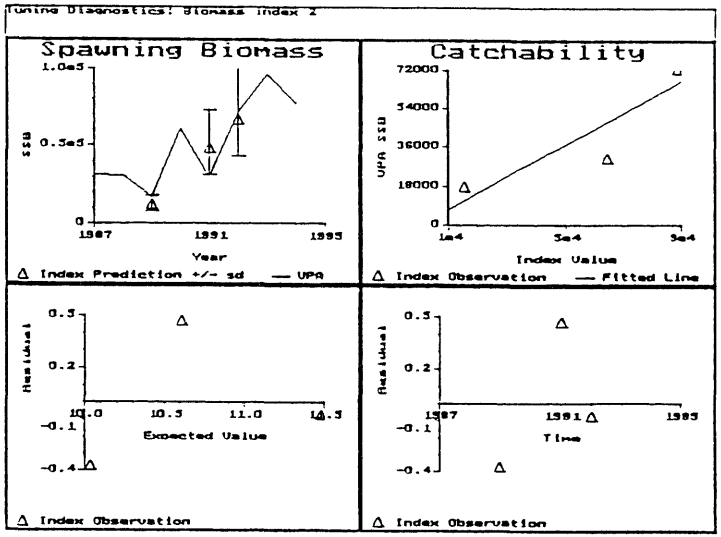
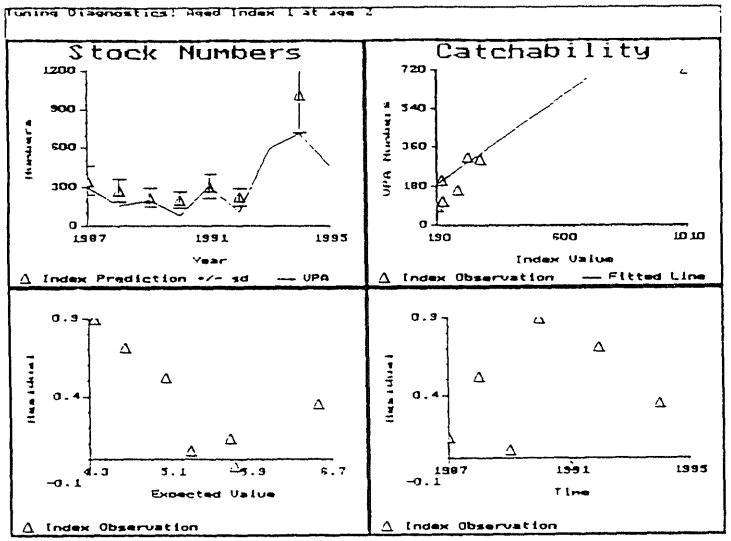
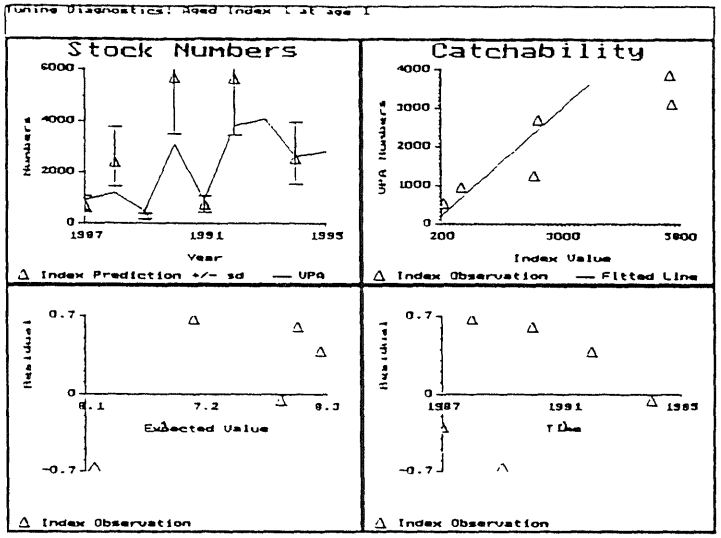
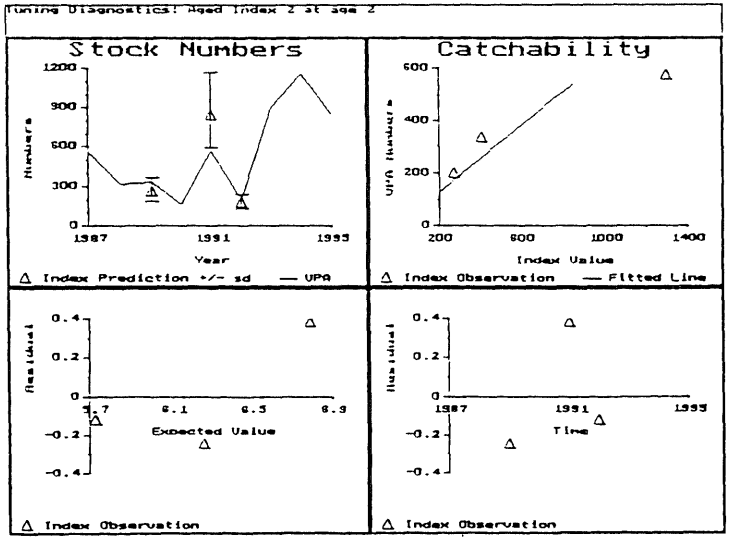




Figure 10.6 a


Tuning Diagnostics: Aged Index 1 at age 2
Stock Numbers
Catchability
Numbers
Year
Index Prediction +/- sd
VPA
UPA Numbers
Index Value
Index Observation
Fitted Line
Residual
Expected Value
Time


Tuning Diagnostics: Aged Index 1 at age 1
Stock Numbers
Catchability
Numbers
Year
Index Prediction +/- sd
VPA
UPA Numbers
Index Value
Index Observation
Fitted Line
Residual
Expected Value
Time


Tuning Diagnostics: Aged Index 2 at age 2
Stock Numbers
Catchability
Numbers
Year
Index Prediction +/- sd
VPA
UPA Numbers
Index Value
Index Observation
Fitted Line
Residual
Expected Value
Time

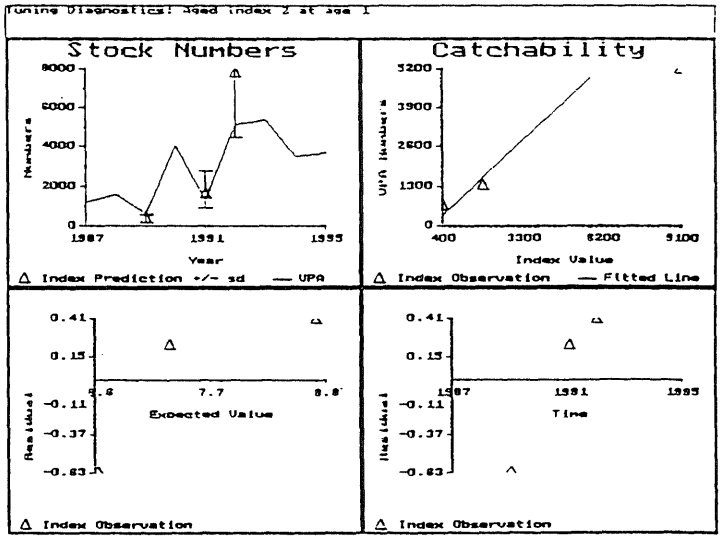
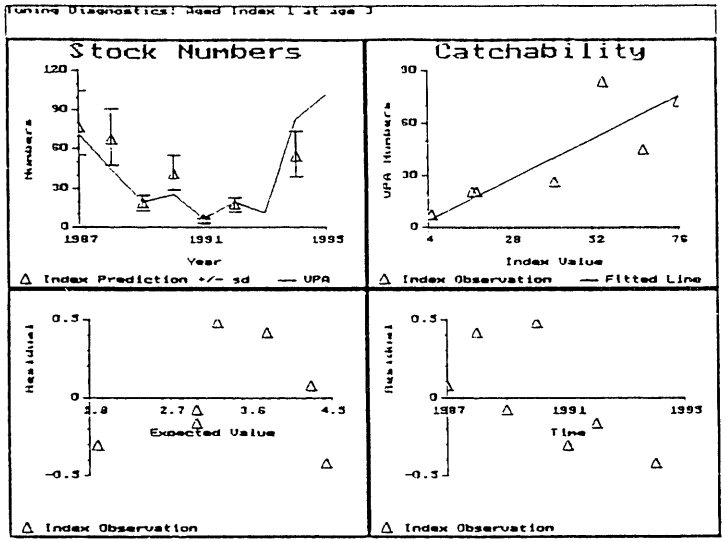

Tuning Diagnostics: Aged Index 2 at age 1
Stock Numbers
Catchability
Numbers
Year
Index Prediction +/- sd
VPA
UPA Numbers
Index Value
Index Observation
Fitted Line
Residual
Expected Value
Time

Figure 10.6 b


Tuning Diagnostics: Dead Index 1 at age 3
Stock Numbers
Numbers
Year
Δ Index Prediction +/- sd
— VPA
Catchability
VPA Numbers
Index Value
Δ Index Observation
— Fitted Line
Residual
Expected Value
Δ Index Observation
Time
Δ Index Observation

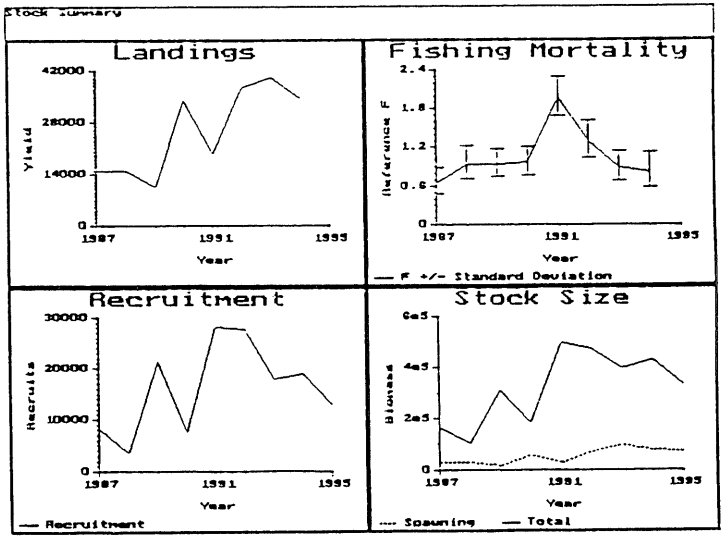
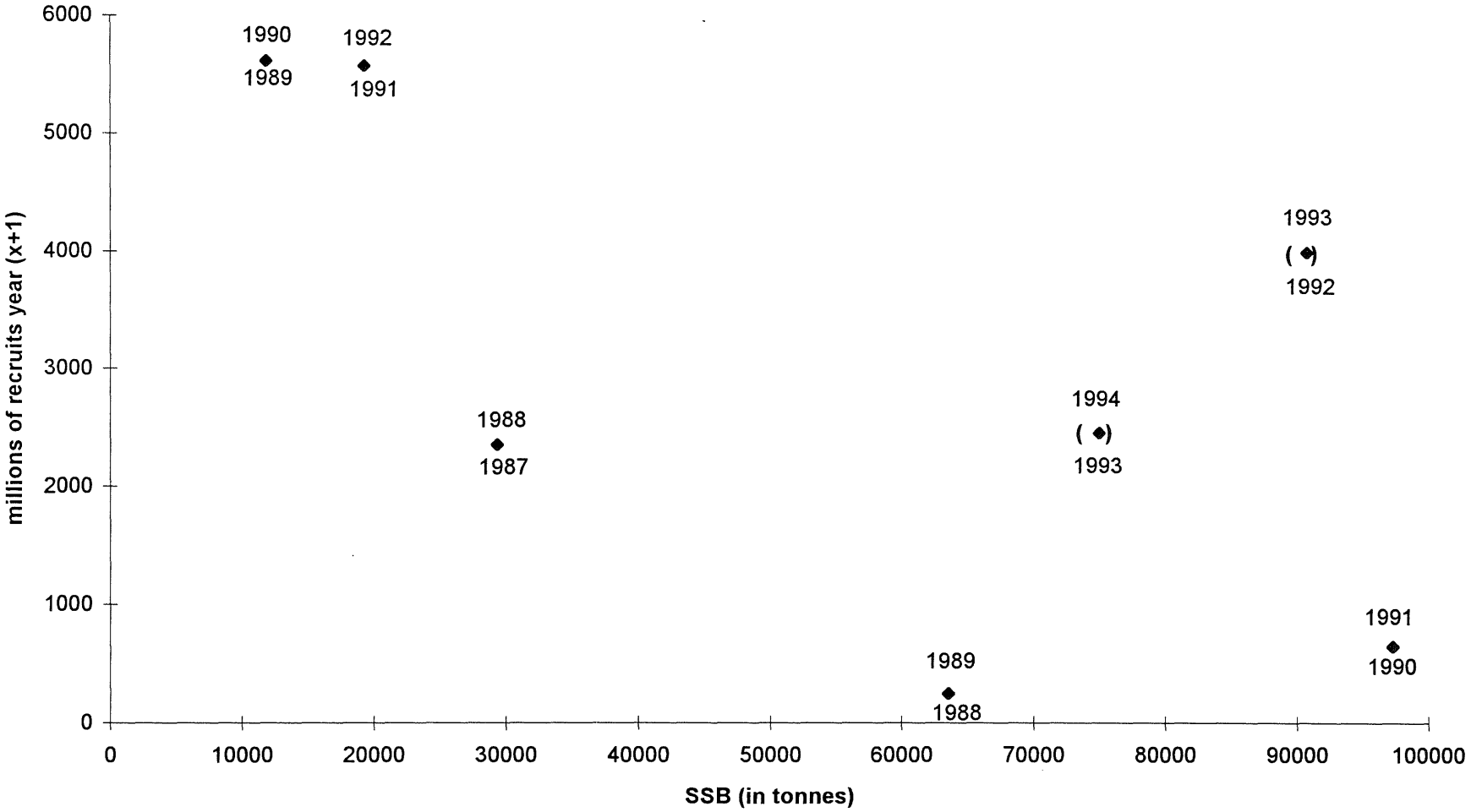

Stock Summary
Landings
Yield
Year
Fishing Mortality
Geometric F
Year
— F +/- Standard Deviation
Recruitment
Recruits
Year
— Recruitment
Stock Size
Biomass
Year
---- Spawning
— Total

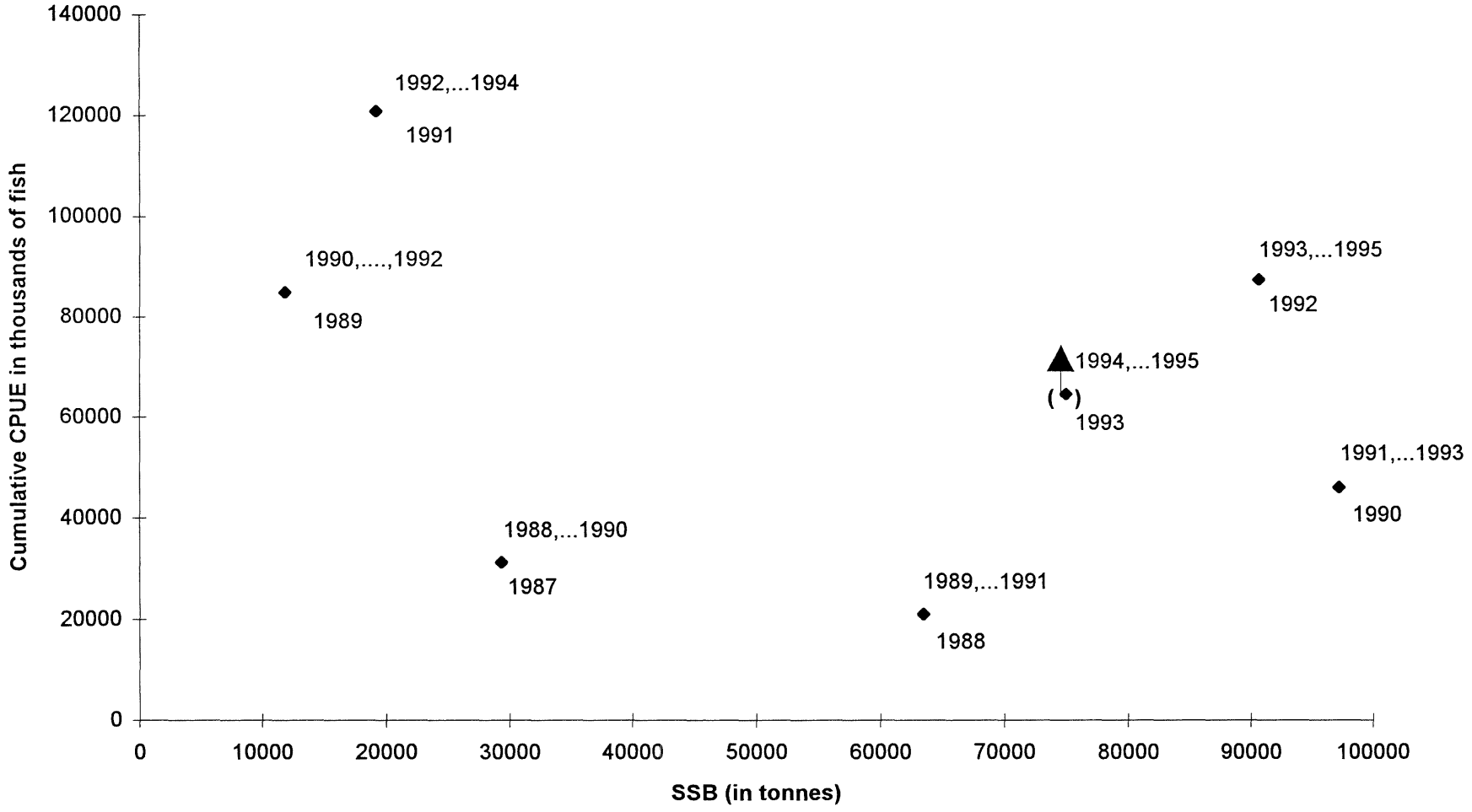
Figure 10.6 c

**Figure 10.7a Relationship between the number of recruits (1 year old anchovies) and the SSB estimated from direct estimation method**




G:\ACFM\WGMHSA96\ANE_BISC\FIG107.XLS-CHART3

**Figure 10.7b Relationship between the number of CPUE of anchovy (cumulated on 3 consecutive years) and the SSB estimated from direct estimation method.**




G:\ACFM\WGMHSA96\ANE-BISC\FIG107.XLS-CHART2

# 11 ANCHOVY IN DIVISION IXa

## 11.1 The Fishery in 1994

As in previous years the fishery is situated in the Bay of Cadiz (Sub-division IXa South), and the anchovy is a target species of the Spanish fleet in this area. The anchovy is not a target species in Sub-divisions IXa North, IXa Central - North, IXa Central-South and IXa South (Portugal).

The Spanish fleet in the Bay of Cadiz is mainly composed of purse-seiners (Anon., 1992) though currently there is another kind of fleet in the form of trawlers, prepared for pelagic species, mainly anchovies. (Table 11.2).

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 (Table 11.2).

### 11.1.1 Landings in Division IXa

The total catch in 1994 was 3,389 t (Table 11.1) having increased with respect to 1993 (1,984). It should be emphasized that catches in 1995 (preliminary data for the first half of the year) have increased substantially in Sub-division IXa north (Galician waters) and in Sub-division IXa central North (Portuguese waters) compared to previous years (Table 11.1). Portuguese catches in 1995 are at the level observed during the 1960s.

The catch in 1994 has increased in both countries. The Spanish catch in 1994 was 3,153 t and the Portuguese catch was 236 t. As in previous years the Spanish catch made up 99% of the total catch in Division IXa.

The catch of the Spanish purse-seine fleet in the Bay of Cadiz has increased by around 75% with respect to 1993, reaching 2,883 t. Nevertheless, the catches corresponding to the trawl fleet decreased by 54%, making up just 5% of the total catch. The decrease in the catch of the trawl fleet may be explained by a reduction in the fishing effort devoted to the anchovy, owing to the greater abundance of other species of interest to the fleet (e.g. prawn, squid, etc.).

As in previous years, the main season for the Spanish fishery was spring (March to June) with 87% of the total annual catch. Autumn was the main season for the Portuguese fishery, 99% of its total annual catch coming in this period (Table 11.3).

From 1943 to 1987 data of catches are only provided by Portugal and during this period the catches varied between 88 t and 12,510 t (Table 11.1). Data of the Spanish catches for this period cannot be given since they have been combined with anchovy catches in the area of Morocco.

### 11.1.2 Landings by sub-division

The distribution of Spanish catches in 1994 was similar to those of previous years, with 96% of catches located in Sub-division IXa South (Bay of Cadiz) and the rest (4%) in Sub-division IXa North (west of Galicia) Catches in the bay of Cadiz occurred mainly in spring (from March to June) and in Sub-division IXa North in autumn (Table 11.4).

The Portuguese catches were taken from Subdivision IXa Central North (96%) in Autumn.

As in previous years the main fisheries of the two countries are totally separated in both season and area (Table 11.4).

## 11.2 Effort and Catch per Unit Effort

The data provided for fishing effort and CPUE indices of anchovy in Division IXa refers to the Spanish purse-seine fleet in the Bay of Cadiz. No Portuguese data are available.

Effort measured as the number of effective fishing trips made by the three fleets of the Bay of Cadiz shows a decrease in 1994 in the single purpose fleet of Barbate. Nevertheless an increase in the multipurpose fleets of Barbate and San Lucar with respect to 1993 has been recorded (Table 11.5).

CPUEs in the whole fleets reflects a declining trend (Table 11.6).

## 11.3 Acoustic Surveys

An acoustic survey was carried out in the Bay of Cadiz (Subdivision IX a South) in 1993, to estimate anchovy abundance and the total biomass estimated was 6,569 t (Anon. 1995a). No new survey has been conducted since.

## 11.4 Management Measures and Considerations

The measures of regulation are the same as in the previous year and are summarised by Millan and Villlamor (WD 1992). As in previous years the purse-seine fleet in the Bay of Cadiz stopped operating voluntarily from October to February.

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

The distribution of Spanish catches in 1994 was similar to those of previous years, with 96% of catches located in Sub-division IXa South (Bay of Cadiz) and the rest (4%) in Sub-division IXa North (west of Galicia) Catches in the bay of Cadiz occurred mainly in spring

(from March to June) and in Sub-division IXa North in autumn (Table 11.4).

The Portuguese catches were taken from Sub-division IXa Central North (96%) in Autumn.

As in previous years the main fisheries of the two countries are totally separated in both season and area (Table 11.4).

**Table 11.1** Portuguese and Spanish annual landings of anchovy in Division IXa (From Pestana, 1989 and Working Group members).

| | Portugal | Spain | | |
|---|---|---|---|---|
| Year | IXa CN,C & S | IXa North | IXa South | TOTAL |
| 1943 | 9975 | - | - | |
| 1944 | 6651 | - | - | |
| 1945 | 992 | - | - | |
| 1946 | 6520 | - | - | |
| 1947 | 3392 | - | - | |
| 1948 | 4938 | - | - | |
| 1949 | 2684 | - | - | |
| 1950 | 3377 | - | - | |
| 1951 | 3594 | - | - | |
| 1952 | 4415 | - | - | |
| 1953 | 1033 | - | - | |
| 1954 | 3919 | - | - | |
| 1955 | 4523 | - | - | |
| 1956 | 7898 | - | - | |
| 1957 | 12610 | - | - | |
| 1958 | 3030 | - | - | |
| 1959 | 3788 | - | - | |
| 1960 | 9503 | - | - | |
| 1961 | 2492 | - | - | |
| 1962 | 4446 | - | - | |
| 1963 | 5714 | - | - | |
| 1964 | 4118 | - | - | |
| 1965 | 4460 | - | - | |
| 1966 | 4460 | - | - | |
| 1967 | 3818 | - | - | |
| 1968 | 970 | - | - | |
| 1969 | 1243 | - | - | |
| 1970 | 1172 | - | - | |
| 1971 | 326 | - | - | |
| 1972 | 207 | - | - | |
| 1973 | 126 | - | - | |
| 1974 | 238 | - | - | |
| 1975 | 372 | - | - | |
| 1976 | 88 | - | - | |
| 1977 | 3261 | - | - | |
| 1978 | 1011 | - | - | |
| 1979 | 655 | - | - | |
| 1980 | 980 | - | - | |
| 1981 | 978 | - | - | |
| 1982 | 656 | - | - | |
| 1983 | 673 | - | - | |
| 1984 | 392 | - | - | |
| 1985 | 2122 | - | - | |
| 1986 | 2153 | - | - | |
| 1987 | 1622 | - | - | |
| 1988 | 442 | - | 4263 | 4705 |
| 1989 | 823 | - | 5336 | 6159 |
| 1990 | 541 | - | 5911 | 6452 |
| 1991 | 210 | 15 | 5696 | 5921 |
| 1992 | 138 | 33 | 2995 | 3166 |
| 1993 | 23 | 1 | 1960 | 1984 |
| 1994 | 236 | 117 | 3036 | 3389 |
| 1995 | 2660* | 968 * | - | |

- Not available

* Preliminary data for the first half of the year

**Table 11.2** ANCHOVY IXa. Quartely catches (t) by gear and by country in 1994.

| Country/Quarter | 1st | 2nd | 3rd | 4th | Anual |
|---|---|---|---|---|---|
| **SPAIN** | 690 | 2055 | 211 | 197 | 3153 |
| **Purse seine** | 642 | 1991 | 208 | 160 | 3000 |
| **trawl** | 48 | 64 | 3 | 37 | 152 |
| **PORTUGAL** | 0 | 0 | 37 | 198 | 236 |
| **Trawl** | 0 | 0 | 0 | 0 | 1 |
| **Purse seine** | 0 | 0 | 35 | 198 | 233 |
| **Artisanal** | 0 | 0 | 3 | 0 | 3 |
| **Total** | 690 | 2056 | 248 | 395 | 3389 |

**Table 11.3** Anchovy cath distribution (t) and porcentage according to half of the year for the period 1988-1994, in Division IXa.

| | | 1st half year (1) | | 2nd half year (2) | | Anual |
|---|---|---|---|---|---|---|
| **Year** | **Country** | **Catch (t)** | **%** | **Catch (t)** | **%** | **Catch (t)** |
| **1988** | Spain | 2534 | 59.7 | 1708 | 40.3 | 4242 |
| **1989** | Spain | 3876 | 73.5 | 1394 | 26.5 | 5270 |
| **1990** | Spain | 3806 | 67.2 | 1860 | 32.8 | 5666 |
| **1991** | Spain | 4736 | 82.9 | 975 | 17.1 | 5711 |
| **1992** | Spain | 2492 | 82.3 | 536 | 17.7 | 3028 |
| **1993** | Spain | 1689 | 86.1 | 272 | 13.9 | 1961 |
| **1994** | Spain | 2745 | 87.1 | 408 | 12.9 | 3153 |
| **1991** | Portugal | 39 | 18.5 | 172 | 81.5 | 211 |
| **1992** | Portugal | 38 | 27.5 | 100 | 72.5 | 138 |
| **1993** | Portugal | 9 | 40.9 | 13 | 59.1 | 22 |
| **1994** | Portugal | 1 | 0.3 | 235 | 99.7 | 236 |

(1): Corresponds to the spring fishery in Division IXa
(2): Corresponds to the summer and autumn Spanish Fisheries and autumn Portuguese fisheries in Division IXa

**Table 11.4** Anchovy catches (t) in Division IXa by country and Subdivision in 1994.

| COUNTRY | SUBDIVISIONS | QUARTERS | | | | ANNUAL | |
|---|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | C (t) | % |
| SPAIN | IXa North | 0 | 0 | 1 | 116 | 117 | 3.7 |
| | IXa South | 690 | 2055 | 210 | 80 | 3035 | 96.3 |
| | TOTAL | 690 | 2055 | 211 | 196 | 3153 | |
| | % | 21.9 | 65.2 | 6.7 | 6.2 | | |
| PORTUGAL | IXa Central North | 0 | 0 | 29 | 198 | 227 | 96.3 |
| | IXa Central South | 0 | 0 | 8 | 0 | 8 | 3.6 |
| | IXa South | 0 | 0 | 0 | 0 | 0 | 0.2 |
| | TOTAL | 0 | 0 | 37 | 198 | 236 | |
| | % | 0.1 | 0.2 | 15.8 | 83.9 | | |
| TOTAL | IXa North | 0 | 0 | 1 | 116 | 117 | 3.5 |
| | IXa Central North | 0 | 0 | 29 | 198 | 227 | 6.7 |
| | IXa Central South | 0 | 0 | 8 | 0 | 8 | 0.2 |
| | IXa South | 690 | 2055 | 210 | 80 | 3035 | 89.6 |
| | TOTAL | 690 | 2055 | 248 | 394 | 3388 | |
| | % | 20.4 | 60.7 | 7.3 | 11.6 | | |

**Table 11. 5** ANCHOVY in Division IXa. Effort data : Spain IXa (Bay of Cadiz) number of fishing trips.

| | PURSE SEINE | | | | |
|---|---|---|---|---|---|
| Year | BARBATE Single purpose | BARBATE Multi purpose | SAN LUCAR Multi purpose | I. CRISTINA Single purpose | I.CRISTINA Multi purpose |
| | | | 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 |

**Table 11. 6** ANCHOVY in Division IXa. Spain IXa (Bay of Cadiz) CPUE series in commercial fisheries

| | PURSE SEINE | | | | |
|---|---|---|---|---|---|
| Year | BARBATE Single purpose | BARBATE Multi purpose | SAN LUCAR Multi purpose | I. CRISTINA Single purpose | I.CRISTINA Multi purpose |
| | | | 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 |

# 12 DATA REQUESTED BY THE MULTI-SPECIES WORKING GROUP

## 12.1 Mackerel

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

The catch of mackerel belonging to the North Sea stock has been included in the catches of the western stock in Sub-area IV since 1987 and in Division IIIa since 1993.

No notable changes have taken place in the fisheries in Sub-area IV or Division IIIa in 1994 compared with 1993. There have been no more egg surveys since the one in 1992 (Anon. 1993a) which confirmed the results of surveys in 1990 and 1991 indicating a very low but stable SSB. Therefore the total catch of North Sea stock mackerel was again assumed to 10,000 tonnes.

There was no data available on the age structure of North Sea stock mackerel in the catch in 1994. The age structure was therefore based on the 1992 data with some additional information from 1993 and the same mean weight in the catches as used in 1993 (Anon. 1995b).

The catch in numbers of North Sea mackerel for each quarter of 1994 was calculated using the proportion derived from the total weight of mackerel in Sub-area IV and Division IIIa and the assumed weight of the North Sea stock component, 10,000t. The North Sea stock component formed 2.1% of the total catch. The total number of North Sea stock mackerel in each quarter was then distributed across the ages using the same percentage distribution as for 1993 (Table 12.1).

It should be noted that a further egg survey is planned for 1996 but that the results will not be available to the 1996 Working Group.

### 12.1.2 Weight at age for the North Sea mackerel stock

There were no new observations on weight at age in the stock for any period in 1994. Therefore the data presented (Table 12.2) are the same as those given in 1994 (Anon., 1995b).

### 12.1.3 Stock distribution by quarter

There is no evidence of changes in the distribution in the North Sea therefore the Working Group have assumed the same quarterly distribution of the stocks in 1994 (Table 12.3) as described in the previous report (Anon., 1995b).

Some information on the distribution of the earliest age groups, 0 to 2+, may come from the quarterly distributions from the North Sea IBTS once these data become available to the Working Group.

## 12.2 Horse Mackerel

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

As explained in the last report of this Working Group (Anon., 1995b) the available samples from the commercial fishery are not representative of the majority of the catch. Therefore it is still not possible to provide a reliable estimate of the catch in numbers at age.

### 12.2.2 Weight at age for the North Sea horse mackerel

Weights at age given in Table 12.4 are based on only a few research vessel samples and commercial catches in Division IVb and IVc. The weight at age in the stock should be taken as the estimated weight at age in the catch in the second quarter.

### 12.2.3 Stock distribution by quarter

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 indicating very little migration. However, since then catches have increased to a maximum of 113,000t in 1990, which is about 30% of the total western stock catch. In 1994 the provisional catch in Division IVa was about 107,000t. (see section 6). This increase in the catch in Division IVa has been attributed to the influence of the large 1982 year class.
With a continued high catch in this area there is no change in the advice about horse mackerel stock distribution by quarter. The Working Group considers that 5% and 65% of the western stock horse mackerel were in the North Sea in the second and third quarters of the year, respectively. (Table 12.5).

Some information on the distribution of the earliest age groups, 0 to 2+, may come from the quarterly distributions from the North Sea IBTS once these data become available to the Working Group.

Table 12.1 Estimated catch in numbers ('000) of North Sea mackerel stock in 1988-1994 by quarter.

| Year | 1988 | | | | Sum | 1989 | | | | Sum | 1990 | | | | Sum | 1991 | | | | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarter | | | | | | | | | | | | | | | | | | | | |
| Age % | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 | |
| | 2.8 | 0.4 | 25.5 | 71.3 | | 5.5 | 0.6 | 36.4 | 57.5 | | 13.2 | 0.6 | 22.8 | 63.4 | | 31.2 | 0.3 | 25.2 | 45.3 | |
| 1 | 81 | 12 | 741 | 2,072 | 2,906 | 115 | 13 | 746 | 1,206 | 2,098 | 172 | 8 | 297 | 825 | 1,302 | 153 | 1 | 114 | 222 | 489 |
| 2 | 87 | 12 | 795 | 2,224 | 3,118 | 449 | 49 | 2,969 | 4,689 | 8,156 | 571 | 26 | 986 | 2,740 | 4,323 | 3,841 | 37 | 2,856 | 5,077 | 12,311 |
| 3 | 94 | 13 | 859 | 2,402 | 3,368 | 445 | 49 | 2,947 | 4,654 | 8,095 | 2,795 | 127 | 4,829 | 13,429 | 21,180 | 4,112 | 40 | 3,058 | 5,871 | 13,180 |
| 4 | 53 | 8 | 486 | 1,358 | 1,905 | 129 | 14 | 854 | 1,349 | 2,346 | 744 | 34 | 1,286 | 3,576 | 5,640 | 1,995 | 19 | 1,485 | 2,896 | 6,393 |
| 5 | 11 | 2 | 99 | 276 | 388 | 73 | 8 | 482 | 760 | 1,323 | 216 | 10 | 374 | 1,040 | 1,640 | 443 | 4 | 330 | 644 | 1,421 |
| 6 | 45 | 6 | 414 | 1,158 | 1,623 | 16 | 1 | 103 | 162 | 282 | 121 | 6 | 209 | 581 | 917 | 172 | 2 | 128 | 250 | 552 |
| 7 | 27 | 4 | 243 | 678 | 952 | 62 | 7 | 411 | 649 | 1,129 | 26 | 1 | 44 | 123 | 194 | 394 | 4 | 293 | 572 | 1,263 |
| 8 | 30 | 4 | 274 | 768 | 1,076 | 37 | 4 | 245 | 387 | 673 | 105 | 5 | 181 | 503 | 794 | + | + | + | + | + |
| 9 | 1 | + | 9 | 25 | 35 | 41 | 4 | 270 | 426 | 741 | 60 | 3 | 104 | 291 | 458 | 148 | 1 | 110 | 215 | 494 |
| 10 | 15 | 2 | 139 | 391 | 547 | 2 | + | 13 | 20 | 35 | 70 | 3 | 121 | 335 | 529 | 172 | 2 | 128 | 250 | 552 |
| 11 | 3 | + | 31 | 88 | 123 | 21 | 2 | 142 | 223 | 388 | 2 | + | 4 | 12 | 18 | 123 | 1 | 92 | 179 | 395 |
| 12 | 1 | + | 5 | 12 | 18 | 5 | 1 | 32 | 51 | 88 | 35 | 2 | 60 | 168 | 265 | 49 | + | 37 | 72 | 158 |
| 13 | 4 | 1 | 36 | 101 | 142 | 1 | + | 7 | 10 | 18 | 7 | + | 12 | 34 | 53 | 49 | + | 37 | 72 | 158 |
| 14 | 2 | + | 22 | 61 | 85 | 3 | + | 21 | 36 | 59 | + | + | + | 1 | 1 | 25 | + | 18 | 36 | 79 |
| 15 | 16 | 2 | 146 | 403 | 567 | 27 | 3 | 178 | 280 | 488 | 51 | 2 | 89 | 246 | 388 | 98 | 1 | 93 | 143 | 316 |

| Year | 1992 | | | | Sum | 1993 | | | | Sum | 1994 | | | | Sum | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quarter | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 | | 1 | 2 | 3 | 4 | | |
| Age % | 19.8 | 0.4 | 16.1 | 63.7 | | 17.5 | 0.3 | 16.5 | 65.7 | | 21 | 1 | 27 | 51 | | |
| 1 | 747 | 15 | 608 | 2,404 | 3,775 | 331 | 6 | 312 | 1,242 | 1,870 | 217 | 6 | 276 | 525 | 1,024 | 5 |
| 2 | 3,005 | 61 | 3,443 | 9,667 | 15,176 | 1,323 | 23 | 1,247 | 4,960 | 7,554 | 870 | 23 | 1,103 | 2,099 | 4,095 | 20 |
| 3 | 2,444 | 49 | 1,987 | 7,863 | 12,344 | 2,315 | 40 | 2,183 | 8,681 | 13,219 | 1522 | 39 | 1,931 | 3,674 | 7,166 | 35 |
| 4 | 573 | 12 | 480 | 1,890 | 2,982 | 1,693 | 29 | 1,596 | 6,149 | 9,669 | 1092 | 28 | 1,384 | 2,635 | 5,139 | 25 |
| 5 | 359 | 7 | 292 | 1,154 | 1,812 | 562 | 10 | 530 | 2,108 | 3,210 | 370 | 10 | 469 | 892 | 1,741 | 8.5 |
| 6 | 112 | 2 | 91 | 361 | 566 | 132 | 2 | 125 | 496 | 755 | 87 | 2 | 110 | 210 | 409 | 2.0 |
| 7 | 45 | 1 | 37 | 145 | 227 | 40 | 1 | 37 | 149 | 227 | 26 | 1 | 33 | 63 | 123 | 0.6 |
| 8 | 22 | + | 18 | 72 | 113 | 26 | + | 25 | 99 | 151 | 17 | * | 22 | 42 | 81 | 0.4 |
| 9 | + | + | + | + | + | 20 | + | 19 | 74 | 113 | 13 | * | 17 | 31 | 61 | 0.3 |
| 10 | + | + | + | + | + | + | + | + | + | + | * | * | * | * | 0 | + |
| 11 | 15 | + | 12 | 48 | 76 | + | + | + | + | + | 4 | * | 6 | 10 | 20 | 0.1 |
| 12 | 37 | 1 | 30 | 120 | 189 | 7 | + | 6 | 25 | 38 | 9 | * | 11 | 21 | 41 | 0.2 |
| 13 | 15 | + | 12 | 48 | 76 | 26 | + | 25 | 99 | 151 | 22 | 1 | 28 | 52 | 103 | 0.5 |
| 14 | + | + | + | + | + | 13 | + | 12 | 50 | 96 | 13 | * | 17 | 31 | 61 | 0.3 |
| 15+ | 82 | 2 | 67 | 264 | 415 | 126 | 2 | 119 | 471 | 718 | 87 | 2 | 110 | 210 | 409 | 2.0 |

**Table 12.2** Mean weight at age (g) by quarter in the North Sea mackerel stock and mean weight in the catch.

| Age | Quarter | | | | Mean weight in catch |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| .1 | 180 | 140 | 180 | 180 | 180 |
| 2 | 210 | 255 | 240 | 210 | 215 |
| 3 | 240 | 330 | 280 | 240 | 250 |
| 4 | 260 | 395 | 330 | 260 | 275 |
| 5 | 300 | 450 | 375 | 300 | 320 |
| 6 | 325 | 500 | 420 | 325 | 350 |
| 7 | 355 | 540 | 465 | 355 | 380 |
| 8 | 380 | 570 | 510 | 380 | 410 |
| 9 | 410 | 605 | 550 | 410 | 445 |
| 10 | 435 | 635 | 585 | 435 | 470 |
| 11 | 465 | 670 | 620 | 465 | 500 |
| 12 | 500 | 700 | 650 | 500 | 535 |
| 13 | 530 | 730 | 680 | 530 | 565 |
| 14 | 560 | 765 | 705 | 560 | 595 |
| 15+ | 590 | 790 | 720 | 590 | 620 |

**Table 12.3** Percentage of mackerel present in the North Sea by age, quarter and stock.

| Age | North Sea stock | | | | Western stock | | | |
|---|---|---|---|---|---|---|---|---|
| | 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** Mean weight at age (g) by quarter in the catches of North Sea horse mackerel in 1994. The numbers of fish analysed per age group are given in ( ).

| Age | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|---|
| 1 | no data | no data | no data | no data |
| 2 | no data | 76 (1) | 113 (34) | 107 (3) |
| 3 | no data | 119 (7) | 135 (63) | 143 (9) |
| 4 | no data | 143 (3) | 163 (19) | 179 (9) |
| 5 | no data | 188 (3) | 180 (22) | 196 (12) |
| 6 | no data | no data | 198 (3) | 199 (4) |
| 7 | no data | 175 (2) | 215 (5) | 235 (4) |
| 8 | no data | 229 (8) | 246 (19) | 235 (10) |
| 9 | no data | no data | 268 (4) | 224 (3) |
| 10 | no data | no data | no data | 240 (1) |
| 11 | no data | 263 (2) | 247 (2) | 235 (4) |
| 12 | no data | 298 (7) | 279 (19) | 298 (18) |
| 13 | no data | 246 (1) | 330 (1) | 321 (5) |
| 14 | no data | 284 (1) | 278 (8) | 249 (11) |
| 15+ | no data | 391 (15) | 310 (22) | 343 (22) |

**Table 12.5** Percentage of each horse mackerel stock assumed to be present in the North Sea by quarter in 1994.

| | North Sea Stock | | | | Western Stock | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Age 1 - 4 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 0 |
| Age 5+ | 100 | 100 | 100 | 100 | 0 | 0 | 5 | 65 |

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## 13 RECOMMENDATIONS

### 13.1 Mackerel

The Working Group recommends that all the countries fishing for mackerel should provide quarterly data on age distribution as well as geographical distribution of the catches. It is also recommended to provide information and data on discards and slipping of catches.

The basis for the maturity at age should be examined by the next meeting of the Egg Production Work Shop.

### 13.2 Horse Mackerel

The Working Group recommends all countries fishing for horse mackerel provide data on age distribution as well as geographical distribution of the catches.

Investigations on the maturity at age of horse mackerel should be carried out.

The Working Group recommends an otolith exchange to be carried out for horse mackerel in 1996 organized by A. Eltink.

The ICES Acoustic Survey Planning Group should be requested to include in their terms of reference to provide estimates of the abundance, distribution and age structure of horse mackerel in the North Sea during the ICES coordinated international acoustic surveys.

### 13.3 Sardine

The Working Group recommends to carry out a joint acoustic survey covering the entire distribution area of the sardine stock during the Spring (March-April) in 1996. In order to plan the survey and standardize the methodology, it is recommended that a 3 days meeting should take place in Vigo 23-25 January 1996 with Pablo Carrera as chairman.

The Working Group recommends to continue the program for exchanging otoliths between Spanish and Portuguese readers to improve age readings of sardine.

The Working Group recommends to collate sardine landings and fishing effort data from the South of Spain (Div. IXa) for as many years as possible.

### 13.4 Anchovy

The Working Group recommends that a choice should be made between the different management procedures proposed and draws attention to the fact that scientific advice on this stock requires the adoption of routine surveys for monitoring the stock.

The Working Group recommends that an estimate of F and M should be made during its next meeting taking into account the precision of the SSB estimates from the direct survey methods.

The Working Group recommends that an anchovy otoliths reading workshop takes place in 1996 in order to compare the otolith age reading made by the scientists of the different countries fishing anchovy. The Workshop should be held in San Sebastian three days in the first half of October 1996 and chaired by A. Uriarte.

### 13.5 General

The Working Group recommends that if a TAC is set for a stock it should apply to all those areas where the stock is fished.

The Working Group recommends that quantitative information on discarding and slipping of catches are sought for all species and stocks and reported to the next Working Group meeting.

### 13.6 ICES

The ICES secretariat is requested to restore the files used at the previous meeting of the Working Group to the ICES Network prior to the next meeting of the Working Group.

ICES is requested to consider moving the next Working Group meeting from May-June to October. This request was made by Anon. (1994) because of the mackerel egg-surveys in the North Sea in June-July 1996.

The Working Group strongly recommends that the ICES secretariat reopens the Sauna, not later than next Working Group meeting in 1996. The shock the sauna sub-group experienced when finding the sauna out of action has severely affected the work and efficiency of the whole Working Group.

## 14 WORKING DOCUMENTS

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