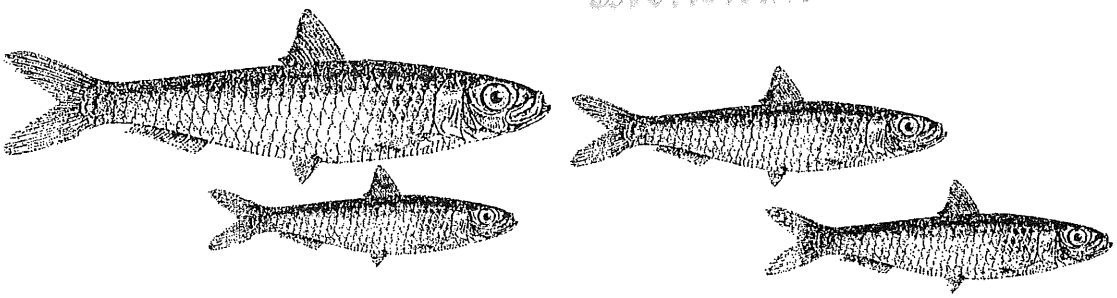
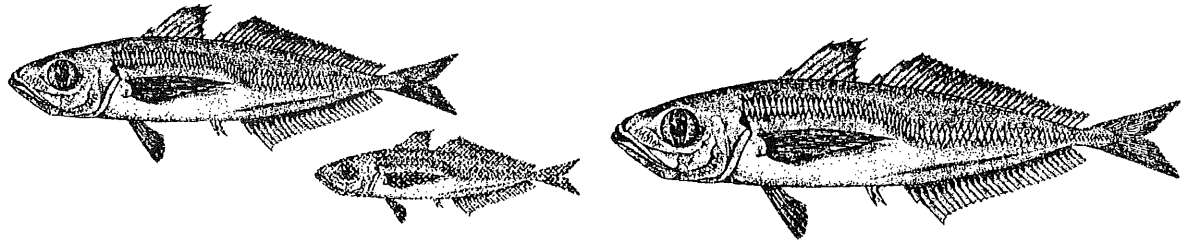
INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CONSEIL INTERNATIONAL POUR L´EXPLORATION DE LA MER

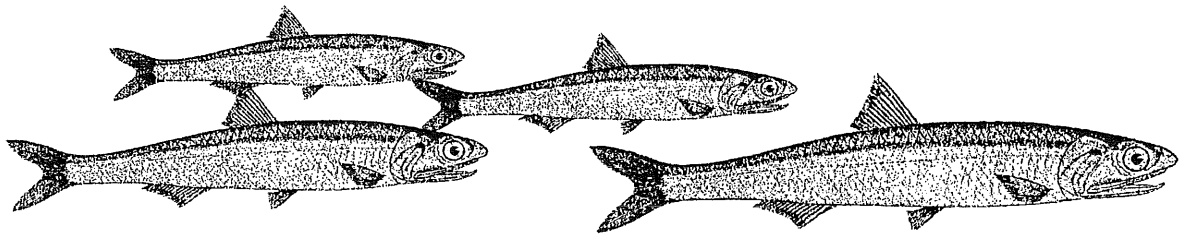
C.M. 1991/Assess :22



Working Group on the Assessment of the Stocks of Sardine, Horse Mackerel, Anchovy



Copenhagen 18-27 June 1991



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CONTENTS

ERRATA TO C.M.1991/Assess:22 - Sardine, Horse mackerel and Anchovy Working Group Report

ANNEX 1 (Replaced)

M CADIMA's formula (pers. comm., 1989)

Estimates of M are made using the population structure in number at age at the start (N_i) and at the end (N_{i+1}) of the year and the catch in number at age (C_i), caught during the year.

The relationship between the natural (M) and total (Z) mortality coefficient is equal to the relation between the number of fish deaths due to natural causes and the number of fish deaths due to total causes.

The total mortality coefficient during the year (i), Z_i, is:

$$Z_i = \ln N_i - \ln N_{i+1} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

During the year, i, the total number of deaths (D_i) will be:

$$N_i - N_{i+1}$$

and the number of deaths due to natural causes will be:

$$N_i - N_{i+1} - C_i$$

Since $M_i = Z_i - F_i$ ..... (2) and

$$C_i = \frac{F_i}{Z_i} * (N_i - N_{i+1}) \quad \ldots\ldots (3),$$

by substituting in (2), Z_i from equation (1) and F_i from equation (3), M_i will be expressed by the following equation:

$$M_i = (\ln N_i - \ln N_{i+1}) * \left(1 - \frac{C_i}{N_i - N_{i+1}} \right)$$

1. INTRODUCTION

1.1 Participants

P. Abaunza	Spain
M.F. Borges	Portugal
A. Eltink (Chairman)	Netherlands
S. Holzlöhner	Germany
S.A. Iversen	Norway
E. Kirkegaard (part-time)	Denmark
P. Lucio	Spain
J. Massé	France
G. Pestana	Portugal
C. Porteiro	Spain
P. Prouzet	France
B. Villamor	Spain
A. Uriarte	Spain

Dr R. Grainger, ICES Statistician, also participated in parts of the meeting.

1.2 Terms of Reference

At the 78th ICES Statutory Meeting in Copenhagen in 1990, it was decided (C.Res. 1990/2:5:17) that the Working Group on the Assessment of the Stocks of Sardine, Horse Mackerel and Anchovy (Chairman: Mr A. Eltink, the Netherlands) will meet at ICES Headquarters from 18-27 June 1991 to:

a) evaluate any new information available for defining stock units of horse mackerel;

b) assess the status of and provide catch options for 1992 within safe biological limits for the stocks of sardine in Divisions VIIIc and IXa, horse mackerel in Sub-areas IV, VII and VIII and Divisions IIa, IIIa, VIa, and IXa, and anchovy in Sub-area VIII.

In addition to the above terms of reference, the Chairman of the ACFM addressed a specific request to the Working Group based on a discussion on Anchovy in Sub-area VIII during the ACFM meeting in October-November 1990 (see Section 7.15 of ICES C.M.1990/Assess:24). The Working Group should:

c) evaluate the possibilities and biological implications of introducing a minimum landing size to protect O-group and 1-group anchovy and/or a limited or delayed fishing period to protect the anchovy spawning stock biomass at the beginning of the spawning season.

An ACFM proposal for re-arrangement of ICES Assessment Working Groups has been drafted in the form of a recommendation to be submitted to the Consultative Committee for consideration at the 1991 Statutory Meeting. The Working Group is requested to:

d) comment on this proposal as it relates to the Working Group and to consider and advise on the necessity and possibility to produce reliable annual updates of the assessments for all stocks incorporated within their terms of reference.

Following a resolution, proposed by ACFM at the ACFM Consultations in October 1990, and adopted by the Council at the 1990 Statutory Meeting (C. Res.1990/2:5:31):

> ACFM Consultations will take place for two full days before the 1991 Statutory Meeting and participation will be extended to include Chairmen of Assessment Working Groups or their designees to:

e) discuss proposals from ACFM for re-arrangement of Assessment Working Groups;

f) develop terms of reference for Assessment Working Groups for 1992.

2. SARDINE

2.1 Unit Stock

This year the Working Group again assumed for assessment purposes that the sardine in Divisions VIIIc and IXa represents a unit stock.

Schools of sardine are often detected and caught during acoustic and bottom trawl surveys in the Bay of Biscay, the English Channel and the North Sea. However, data from these fisheries are not available to the Working Group.

2.2 The Fishery

The officially reported total landings in 1990 were 139,157 t which are at the same level as the year before. Table 2.1 and Figure 2.1 show that the total catch decreased from 1986 to 1990 after near stable catches of about 200,000 t during 1980-1985.

Most of the Portuguese caches of sardine during the years (1927-1990) came from the western part of the coast (Division IXa), between 41°50'N and 39°N, in depths of less than 200 m depth (Pestana, 1989). The reported landings for 1990 were about 92,400 t. This has been the level of the Portuguese catches in the last three years. The purse seiner fleet caught about 94% of the total catches in the last three years. At the beginning of each year, the fishermen voluntarily closed their purse seine fishery for two months.

The Spanish catches in 1990 are at the same level as in 1989, having increased in Division IXa and decreased in Division VIIIc. In the central and eastern parts of Division VIIIc, catches remained at the same level as in previous years because the only market there is for fresh human consumption.

In the western part of Division VIIIc and the northern part of Division IXa (Galicia), catches have decreased. These catches are mainly for canning and the fresh market. Due to the crisis in this fishery, the Galician purse seiner fleet was temporarily stopped during the period 1 March to 15 April.

The seasonal pattern of catches by the two countries has been constant since 1979, with about 40% and 60% of the annual catches being landed in the first and second halves of the year, respectively (Tables 2.2 and 2.3).

Quarterly catches by ICES statistical division are presented in Figures 2.2a-d. The third quarter seems to be the most important and the largest catches occurred mainly in Division IXa.

Additional information on the French landings of sardine by division in Sub-areas VII and VIII were also provided (Table 2.4). This fishery in Divisions VIIIa and VIIIb is an artisanal one, generally close to the coast and mainly for fresh consumption.

2.3 Effort and Catch per Unit Effort

The available data on fishing effort and CPUE indices for Portuguese and Spanish purse seiner fleet are shown in Table 2.5.

The fishing effort, number of fishing days, and the CPUE indices of the Spanish purse seiners in the northern part of IXa Division (South of Galicia) in 1982-1990 have been revised (Otero and Porteiro, WD 1990). From 1984 the effort decreased until 1989 (8,369 fishing days in 1984 to 3,059 in 1989). The CPUE

was rather stable during the period 1982-1987, at approximately 4.55 t/fishing day. Following a decrease in 1988, it remained at a lower level.

The Portuguese effort, in numbers of purse seiners, remained at the same level during 1981-1987 (approximately 193 boats operating), but decreased in 1988 (180 boats) and increasing in 1989-1990 (222 boats).

The CPUE index from Portugal was lower in the last two years, at a level similar to that in the period 1982-1984 (about 350 t/purse seiner and by year). During 1985-1988 the CPUE was about 500 t/purse seiner.

2.4 Fishery-Independent Information

2.4.1 Acoustic surveys

In 1991 an acoustic survey was carried out in Spanish Atlantic waters (Divisions IXa-northern part and VIIc) to estimate abundance of sardine by age. The same area has been covered during these surveys each year since 1985 (1989 excluded) (Carrera and Meixide, WD 1991). A Simrad EK-500 split beam 38 Khz echo sounder and integrator system was used during the survey. The surveyed area was delimited by the 1000 m isobath and was covered by a zig-zag track (1790 nautical miles integrated). The methodology used was that adopted by the Planning Group for Acoustic Surveys in ICES Sub-areas VIII and IX (Anon., 1986b).

The total biomass estimated was at about 106,000 t. The distribution of echo intensity of sardine in the area is shown in Figure 2.3 and Table 2.6. Sardine seems to be only distributed near the coast in shallow waters.

The highest concentrations of sardine were detected in the Cantabrian Sea, mainly in the central part of Division VIIIc where it accounted for about 41% of the total biomass.

The lowest abundance was observed in the western area (northern part of Division IXa and the western part of Division VIIIc); this area accounted for about 13% of the total biomass.

The 1983 and 1987 year classes accounted for about 21% and 31% of the total biomass. These two strong year classes dominated in all zones except in the South of Galicia, where the 1989 year class was also important.

The biomass obtained on this survey was similar to that estimated in 1990 (95,000 t). However, the distribution area was different. In 1990 the sardine was found more oceanic and scattered than in 1991 (Figure 2.3). This change in the spatial distribution could be due to the predominant bad weather conditions or to changes in the pattern distribution.

In April 1991, during a French acoustic survey in Division VIIIa-c, small size sardine were observed close inshore all along the French coast between 20 and 60 m depth. The distribution of sardine was more abundant to the south of 45°00'N, where they were observed from the coast to a depth of 120 m. They were also observed north of 45°00'N between the 120 m isobath and the continental shelf break, but here they were in lower densities and mixed with horse mackerel and mackerel (Massé and Leroy, WD 1991).

2.4.2 Egg surveys

During 1990, a survey in Spanish waters (Divisions VIIIc, IXa) was carried out with the purpose of evaluating the spawning biomass of the sardine, using the daily egg production method.

The estimated spawning biomass of sardine was not available at this Working Group meeting, only the following parameters were available: relative female fecundity (394 eggs/g $\pm$ 0.239) and average gonad free weight of females (74 g $\pm$ 0.216) (Perez, N., pers. comm.).

2.5 Length Composition by Fleet and by Country

In 1990 the quarterly and annual catch length composition (million of fish in half-cm length groups) by fleet were provided by Portugal and Spain (Table 2.7). The largest fish (>24.5 cm) were caught in Division VIIIc and the smallest fish (5.0-8.5 cm) were caught in Division IXa.

2.6 Catch in numbers

Quarterly and annual catches in numbers and mean weights at age were compiled for each Division and for the total Atlantic Iberian waters, using data submitted by the two countries fishing sardine in this area in 1990 (Tables 2.8 and 2.9a).

The youngest age groups are present off Portugal and Galicia throughout the year, whereas oldest age groups are present in Spanish waters, mainly in Division VIIIc. The O-group fish (recruits) are found mainly on the west coast of the Iberian peninsula. The 1-group fish occur mainly in the southern part of the area occupied by the stock, in Portuguese waters. Fish of five years and older are found in the Cantabrian Sea (Porteiro *et al.*, 1986).

In the northern area of Portugal age-group 3 (1987 year class) is best represented in the catches in the 1st, 3rd and 4th quarters, in the central area in the 1st, 2nd and 4rd quarters, and in the southern area of Division IXa in the 1st and 2nd quarters (Pestana and Figueiredo, WD).

2.7 Mean Weight at Age

The mean weights and length at age (weighted by numbers caught) of fish in the catches in 1990 are presented by country and quarter in Table 2.9b. The same procedure was used in 1989. The 1989 and 1990 values have been used to update the VPA (Table 2.13). For the period 1976-1988 the mean weights at age in the catch were assumed the same (Anon., 1990a). The tables show that the oldest ages (above age 7) are not present in the Division IXa (Portuguese waters). It seems that the mean weights are similar for both countries in 1990. The small differences in the mean weight at age 0 could be caused by poor sampling. In the fourth quarter most fish will be at or approaching their peak weights just prior to spawning.

The mean weight at age in the stock in 1990 have been taken to be the same as reported last year (Anon., 1990a).

2.8 Maturity at Age

The maturity ogive at age and length was estimated using the data from the Portuguese market sampling (January-March and October-December in 1990, 524 aged), from the Portuguese bottom trawl survey (October-December in 1990, 221 aged) and from the Spanish market sampling (October-December in 1989 and January-March in 1990, 240 aged). For the selected period of the spawning season, the monthly development of each maturity stage percentage based on the Portuguese samples in 1990 (Oct-Dec, Jan-Mar) was used (Pestana and Figueiredo, WD 1991). The maturity ogive at age for the stock (females-maturity stage 3 and above) was as follows:

Age	0	1	2	3	4	5	6	7
%	36	66	86	100	100	100	100	100

The first maturation occurs at age 0. The 1990 maturity data have been used for the whole period 1976-1990.

2.9 Natural and Fishing Mortality and Tuning of the VPA

Natural mortality

The natural mortality was revised from the value of 0.4 assumed last year. The new adopted value of 0.33 was the mean value obtained by three different methods, assuming that the M value at age does not vary greatly for the period analysed (Pestana, 1989):

a) Beverton-Holt (1957)

$$N_i = R * e^{-M(ti-tr)}$$

With 5% of survivals of an unexploited cohort at age 10

Results M = 0.30

b) Pope (1972)

$$N_i \approx (N_{i+1} * e^{1/2M} + C_i)e^{1/2M}$$

with N_i, N_{i+1}y from Portuguese acoustic surveys carried out in the second half of year during 1984-1988 (Division IXa-Portugal) and the Portuguese catch in number at age caught in the period between surveys

Results:

Age	0	1	2	3	4	5	M_i=M
M_i (average)	0.395	0.287	0.198	0.483	0.502	0.249	0.352

c) M Cadima formula (see Annex 1)

$$M_i = (\ln N_i - \ln N_{i+1}) * (1 - \frac{C_i}{N_i - N_i + 1})$$

With the same data of b)

Results:

Age	0	1	2	3	4	5	M_i=M
M_i/ year	0.396	0.289	0.201	0.508	-	0.271	0.333

The Working Group assumed an M value of 0.33 for all age groups.

Fishing mortality and tuning of the VPA

Terminal fishing mortality coefficients were estimated by tuning, using the CPUE data from three sources:

- Spanish acoustic surveys carried out in Divisions VIIIc and IXa (off Galicia) during March 1986-1990
- Portuguese purse seiner fleet (Division IXa) (1981-1990)
- Spanish purse seiner fleet from Vigo and Riveira (1982-1990)

Table 2.10 shows the input file used to tune the VPA (Laurec-Shepherd method). A first trial was made using only the commercial CPUE data, for 1981-1990 and an F for oldest age equal to the average of 3 younger ages.

Although this trial seemed acceptable, another trial was run using the three fleets for a period from 1986-1990. March surveys from Spain were included because the area surveyed was the same as that worked by the purse seine fleets and the age range in the catches was similar to that in the commercial catches (mainly below age 3).

Table 2.11 shows the estimated fishing mortality and log catchability at age by fleet and year for the run using all three fleets. Results indicate consistency among estimates, except for age 0, which is not fully recruited. The log catchability plot against time for all age groups for each fleet are shown in Figures 2.4a-c. There does not appear to be any trend with time.

It was decided to use the fishing mortality at age 2 (F = 0.161) and the value of terminal S = 1 to run a SPVA. The results show a flat exploitation pattern (Table 2.12).

A final VPA was performed using the terminal populations of SPVA. Fishing mortalities, stock size and biomass estimates generated by the final VPA are given in Tables 2.14 and 2.15 and Figures 2.5A and B.

A linear regression analysis between the total biomass for 1984 to 1987 estimated from the final VPA and the total biomass estimated from the Portuguese August acoustic surveys, in the same period, showed a good agreement.

2.10 Recruitment

Analysis of sardine stock trends during the period 1976 to 1988 shows that in the short term predictions of yield depend to a great extent on the recruitment indices (Pestana, 1989).

In a recent paper (Robles *et al.*, 1991) concerning the sardine stock, an attempt was made to qualitatively relate the variability of certain environmental factors to the variations observed in recruitment, and thus the changes in sardine stock abundance generated by them.

No clear trends have been identified during the 1980s in environmental parameters (upwelling index, Lasker windows and sea level) which have remained within "normal" limits. Only during 1983 were significant climatic anomalies noted: the upwelling season was reduced to half (to 3 months) and the sea level was higher throughout the year than during the rest of the series.

Table 2.15 shows the stock sizes. The 1988, 1989 year classes were the poorest in the historical period of 1976-1989, and the 1982, 1985 and 1986 year classes were also relatively weak. The 1983 year class was the strongest on record, and the 1978 year class was also relatively strong. It was not possible to carry out the joint Portuguese/Spanish acoustic survey for recruitment in November-December 1990.

The RCRTINX2 program was used to regress the numbers at age 0 from final VPA for 1984-1990 against information of the acoustic surveys (Portuguese March/August and November surveys and Spanish March Surveys) and of the indices from Spanish purse seiners (juvenile catches in numbers in the second half of the year by number of fishing days from directed fishery) (Table 2.16).

Table 2.17 shows the predicted values for the 1989-1990 year classes. The predicted value for 1989 (11,873 million fish) corresponds reasonably well to the value of the VPA estimate of 8,433 million fish. The predicted value for 1990 (10,232 million fish) is higher than the estimated year class strength from the VPA (5,546 million fish).

The number at ages 1 and 2 for the predictions were obtained from the predicted recruitment 0-group in 1989 and 1990.

2.11 Yield per Recruit

The input data for the yield per recruit and catch forecast are given in Table 2.18. The exploitation pattern was taken from the SVPA and assuming that 2-year-old sardine are fully exploited. Plots are shown in Figures 2.5C and D. $F_{0.1}$ was estimated as 0.402.

2.12 Forecast

Stock size for age 3 and older in 1991 is taken from the final VPA and for ages 1 and 2 from the RCRTINX2 analysis. The level of the recruitment for later years was taken as 13 x 10^9 individuals at age 0 which is the geometric mean of the 1980-1989 year classes from VPA, excluding the very strong 1983 the very weak 1989 year class.

The catch mean weights at age used were averages for the period 1988-1990.

Catch predictions for 1991 and 1992 are given in Table 2.19 and Figure 2.5D. Fishing at the *status quo* level produces catches of 143,000 t and 141,000 t in 1991 and 1992, respectively. This will leave a spawning stock biomass at spawning time in 1992 of 764,000 t, which is similar to the predicted 1991 spawning stock biomass of 786,000 t. Detailed output of the prediction is shown in Table 2.20.

2.13 Biologically Safe Limits

The fishing mortality levels of F_{high}, F_{med}, and F_{low} were estimated from the plot of recruitment *versus* spawning stock biomass at spawning time for the period 1980-1990 (Figure 2.6).

The spawning stock biomass decreased after 1985 in spite of the occurrence of the strongest year class of 1983. Recruitment fluctuated widely during the period 1980-1990.

After the 1983 year class, only the 1987 year class achieved a medium level. The 1984, 1985, 1986, 1988, and 1989 year classes were at low levels. Due to high variability in recruitment and lack of a relationship between recruitment and SSB, it is for the time being impossible to define a stock size corresponding to the level of safe biological limits.

2.14 Management Measures and Considerations

The VPA indicates that the sardine stock has been stable since 1983 to 1987, with a decrease in the catch level. In spite of this poor recruitments occur and the SSB has decreased since 1985.

Fishing mortality has increased slightly since 1988, and the *status quo* F(0.161) is above the F_{med} (0.121).

Compared to the catch of 139,000 t in 1990, the forecast for 1992 indicates a catch of the same level (141,000 t) assuming the same fishing pattern in 1990, 1991, and 1992.

Low recruitment levels as in 1988-1990, combined with fishing mortality above F_{med} may, in the near future, lead to a continuous decrease in the spawning stock biomass.

The fishery in Division IXa is mainly catching fish of ages 0-3. Therefore, closures of the fishery should be recommended in the juvenile areas (total Division IXa) during the peak of juvenile abundance, which is usually in March.

The TACs recommended in previous years were not implemented and the only existing management measures for sardine is the minimum landing size of 11 cm (fish aged 0).

3. HORSE MACKEREL GENERAL

3.1 *Anisakis* Infestation in Horse Mackerel

The information on stock distribution and stock units is essential for assessment purposes, where catches are assumed to be taken from a certain stock. Parasites in fish can be used as biological tags and can provide important information on fish migrations, distributions and stock identity.

Figure 3.1 shows preliminary results of Dutch and Norwegian research on the *Anisakis* infestation of horse mackerel during the period August 1990 and March 1991. It indicates that horse mackerel from the southern North Sea have a low infestation compared to most of the samples west and southwest of Ireland. It also indicates that not all of the horse mackerel to the west and southwest of Ireland do migrate to the northern North Sea (this is confirmed by the distribution of the fishery during the third and fourth quarter (Section 3.5 and Figures 3.9c and 3.9d). The *Anisakis* infestation of the horse mackerel from the southern North Sea is different from the northern North Sea and, therefore, justifies the allocation of catches taken in the northern North Sea to the western horse mackerel stock (see Section 3.3).

Plans have been made to carry out research on the *Anisakis* infestation in horse mackerel during the period August 1991 to August 1992.

3.2 Horse Mackerel Distribution

3rd Quarter

The distribution of horse mackerel during the third quarter in the North Sea was analysed from data of the in the North Sea was analysed from data of the English Groundfish Surveys for the period 1985 - 1990. Figure 3.2 shows the distribution of horse mackerel smaller than 20 cm. Since the 1-group horse mackerel are absent in the North Sea area (Anon., 1987 Figure 3.3), this corresponds to the general distribution of the O-group horse mackerel in the North Sea, which is only present in the southern North Sea and the eastern part of the central North Sea. Figure 3.3 shows the distribution of horse mackerel larger than 19 cm, which corresponds to the distribution of the 2+-group representing the distribution of the adults in the North Sea. They are abundant not only in the southern North Sea and eastern part of the central North Sea, but also in the northern North Sea above the 59°N. They have a very low abundance in the western North Sea.

The distribution of juvenile and adult horse mackerel was similar in each year of the period 1985 - 1990.

4th Quarter

The distribution of horse mackerel during the fourth quarter in 1990 in Sub-areas IV (part), VI, VII, VIII and IX was based on research vessel bottom trawl data presented by Scotland, England, the Netherlands,

France, Spain and Portugal (Figures 3.4, 3.5 and 3.6). Details of the gears used and areas covered by each of the countries are given in Section 3.8 and Anon. (1991b).

The distribution of the O-group horse mackerel is shown in Figure 3.4 indicating that a high abundance of 0-group occurs in the southern and central North Sea (already leaving the eastern part of the central North Sea in October), a relatively low abundance in the English Channel, but a very high abundance off Cornwall. A very high abundance of O-group also occurs in the French coastal areas in Division VIIIa,b (but in this area the abundance estimated is too high due to improper use of the length interval of this age group). North of Spain the abundance is low, but another high abundance area occurred off the Portuguese coast.

The distribution of the 1-group horse mackerel is shown in Figure 3.5 indicating that 1-group is more or less absent from the southern and central North Sea. Abundance was relatively low in the English Channel, but was high off Cornwall. A high abundance of 1-group occurred in the French coastal areas in Division VIIIa,b (but in this area the abundance estimated is too low due to improper use of the length interval of this age group). Another high abundance area occurred off the Portuguese coast.

The distribution of the juveniles is mainly restricted to the inshore areas which need to be covered very well by trawl surveys if abundance indices are to be obtained for horse mackerel in future.

The distribution of the 2+ group horse mackerel is shown in Figure 3.6 indicating that a high abundance of 2+-group occurs in the southern and central North Sea (already leaving the eastern part of the central North Sea in October) and in the English Channel, and having a very high abundance off Cornwall. Also a high abundance of 2+-group occurs over the continental shelf off France in Division VIIIa,b. High abundances sometimes occur along the 200 m depth line due to the schooling behaviour of these fish.

3.3 Unit Stocks

For assessment purposes the Working Group considers the southern, northern and North Sea horse mackerel as three different stocks as was done last year (Anon., 1990a).

A possible migratory pattern for the three stocks based on information both from the fishery itself and from surveys is given in Anon. (1990a). The fishery in 1990 supports that suggested pattern. The study of *Anisakis* infestation rates was continued in 1990. This year, samples from the Norwegian fishery in Divisions IIa and IVa demonstrated a similar infestation rate as in the Western area (Figure 3.1) which is higher than the infestation rate in the North Sea.

This, therefore, supports the suggested migration of Western horse mackerel to Divisions IIa and IVa during the third and fourth quarters of the year. It seems that the bigger fish in particular undertake this rather extended migration since the weights in the Norwegian catches in Divisions IIa and IVa are on average about 55% higher than the weights in the same year classes further south, e.g., in the Dutch catches in Divisions VIIb,c at the same time.

Data from the English Groundfish Surveys demonstrate that there are horse mackerel in the northwestern part of Division IVa, at least in the third quarter (see Figure 3.3 and Section 3.2). This indicates that the horse mackerel both enters and leaves the North Sea this way. This is indicated in Figure 3.7 which is a revised version of the schematic outline of migration given in last year's report (Anon., 1990a).

The Working Group maintained the basic assumptions of the existence of three "stock units" (Anon., 1988, 1989, and 1990a). The Working Group allocated the catches in Divisions IIa, IVa, VIa, VIIa-c, e-k, and VIIIa,b,d,e to the Western "stock". The Norwegian catches in Divisions IVb and IIIa and the Danish catches in Division IIIa were so close to Division IVa that they were also allocated to the Western stock. The Norwegian fishing areas were similar in 1988 and 1989 and, therefore, all catches from Divisions IVb and IIIa were also allocated to this "stock".

The rest of the catches in Divisions IIIa, IVb,c and VIId was allocated to the North Sea stock, and the catches in Divisions VIIIc and IXa to the Southern stock (Table 3.9).

However, it has to be remembered that assigning catches to stocks on an area basis a highly arbitrary approach. There are no biological data at present which can be used for separating catches from the different stocks.

3.4 Species Mixing

In line with the 1990 Working Group recommendation (Anon., 1990a), special care was taken by Spain and Portugal in 1990 to ensure that "catch and length distributions, and numbers at age of *T. trachurus* provided to the Working Group did not include *T. mediterraneus* and *T. picturatus*" (Anon., 1990a).

In the Western horse mackerel stock, species mixing in 1990 is regarded as negligible: 298 t of *T. mediterraneus* have been reported from Divisions VIIIa-b and they have not been included in the *T. trachurus* fishery (Table 3.10).

In the Southern horse mackerel stock, the fishery of *T. mediterraneus* in 1990 occurred only in eastern and central parts of Divisions VIIIc, as in the past years (Lucio and Villamor, WD 1991). The catches amounted to 2,943 t (1,000 t less than in 1989) and were not included in the *T. trachurus* catches reported from Division VIIIc. Length distributions for *T. mediterraneus* were presented separately. The *T. trachurus* catch from Division VIIIc in 1989 has been revised by taking away the values related to *T. mediterraneus*.

The *T. picturatus* occurred only in the southern part of Division IXa, but the Portuguese catches and biological sample data do not include this species.

3.5 The Fisheries in 1990

The total international landings of horse mackerel in the northeastern North Atlantic in ICES Sub-areas II, IV, VI, VII, VIII, and IX are shown in Table 3.1. In the late 1970s and early 1980s, the catches declined, but since 1982 the catches have increased steadily each year from about 100,000 t to 441,000 t in 1990. The catch in 1990 is the highest recorded in the period 1974-1990. In Figure 3.8 the development of the northeast North Atlantic horse mackerel fishery is presented as total catches from 1965-1990 and catches as allocated to stocks (Table 3.9).

The catch tables (Tables 3.1- 3-7) are slightly different from last year (Anon., 1990a). The revisions of total catches (Table 3.1) represents a change of less than 0.2% and is related only to 1989 (Anon., 1989).

3.5.1 The fishery by Sub-areas or Divisions

Division IIa

The catches in Division IIa have been at a very low level except in the last four years (Table 3.2). From 1986 to 1988, the catches increased from about 200 t to 6,800, and in 1990, to 11,400 t, mainly due to the Norwegian catches.

Sub-area IV

The catches in Sub-area IV (Table 3.3) have increased enormously in the last 12 years from a mean level of about 3,600 t in the period 1979-1983, to about 20,000 t in 1984-1987, and to 62,000 and 112,000 in 1988 and 1989, respectively. In 1990, the catch was even greater (145,000 t) and mainly taken in Division IVa and in more northern part of Division IVb. The increases in later years are mainly caused by the increased Norwegian catches.

Division VIa

The catches in Sub-area VI are shown in Table 3.4. Catches increased from about 10,000 t in 1979 to about 45,000 t in 1988. Catches subsequently decreased to 20,900 t, in 1990.

Sub-area VII

The catches in Sub-area VII (Table 3.5) fluctuated between 30,000 t and 45,000 t in the period 1980-1985. The catches then increased to 192,000 t in 1990, which is the highest level in the period 1974-1990. This was principally due to increased Dutch catches.

Sub-area VIII

The catches in Sub-area VIII (Table 3.6) declined from about 125,000 t in 1976-1977 to 22,000 t in 1982. Since then, the catches have increased, reaching about twice the 1982 level in 1989. In 1990, the catch increased further by 5,000 t to 47,800 t.

Division IXa

The catches in Sub-area IX (Table 3.7) have fluctuated since 1974. They decreased from an average level of 53,000 t in the period 1974-1978, to about 39,000 t in 1979-1983 and to about 20,000 t in 1984-1985. The catches then increased to 38,000 t in 1989, but in 1990 decreased to 24,000 t.

3.5.2 Quarterly distribution of the fishery

Based on data submitted by members, the Working Group was able to distribute more than 95% of the total 1990 'catch by quarters and area (Table 3.8).

In the western areas the fishery started in the south and west of Ireland in the first quarter with rather high catches. In 1990 the catch in this area was almost constant throughout the year whereas in 1989 the catch declined in the last three quarters. In the 3rd quarter, the fishery also appeared further north in Division VIa and in Sub-area IV. In the fourth quarter, the main catches were taken in Sub-area IV, but Division VII e-h was also an important fishing area. In the Bay of Biscay, the main catches were taken in the 1st and 4th quarters. The fishery in the North Sea (Divisions IVa,b and IIIa) was negligible in the first half of the year, but large catches were taken in the 3rd and 4th quarters.

In the southern areas (Divisions VIIIc and IXa), the fishery in 1990 was stable throughout the year.

Based on catch data by rectangle submitted by Denmark, Germany (ex GDR), Ireland, the Netherlands, Norway, Portugal and Spain, the distribution of the fishery by quarter is given in Figure 3.9a-d. These data represent 89% of the catches.

3.5.3 The fishery by stock

As mentioned earlier, the basis for both the definition of the stock units and the allocations of catches to these stocks is rather arbitrary. However, the total fishery of horse mackerel has increased considerably from about 105,000 t in 1982 to 442,000 t in 1990 (Table 3.9). This is mainly due to an increase in the catches of western horse mackerel from about 42,000 t to 373,000 t in the same period.

The catches of southern horse mackerel have fluctuated in this period between 45,000 t and 75,000 t. Except for an increase in the catches in 1989, there has been a downward trend in the catches over the last four years (Figure 3.8).

3.6 Review of the Report of the Horse Mackerel Age Determination Workshop

The Horse Mackerel Age Determination Workshop met in Lisbon, Portugal from 21-27 November 1990, in accordance with the terms of a contract with the Commission of the European Communities (Studies Contract 1990.11) and INIP (the contractor):

1) to evaluate the results of the otolith exchange programme carried out during 1988-1990;

2) to evaluate the different methods of otolith preparation;

3) to advise on for which age groups valid age readings can be achieved.

The Report of this Workshop was presented to the Working Group (Anon., 1991c).

The results of the North Sea and Western otolith exchange samples were evaluated at the Workshop. The exchange samples of Bay of Biscay and southern area were not completely read at the time of the Workshop; therefore, these results will be presented at the Statutory Meeting in 1991.

Only the North Sea otolith exchange sample has been completed by all the readers before the Workshop; therefore, a replication of this sample has been read to check the variability of the interpretation of each otolith reader.

There was a fairly good degree of agreement between the two sets of age determinations for most readers. The improvement in the age determinations was demonstrated by comparing the standard deviation frequency distributions by age ranges.

This methodology has been repeated with a third fresh otolith sample which was read after discussion among the readers. This helped to resolve some of the differences in interpretation and was found very beneficial.

For the age groups 0-3, the standard deviations were similar in sample 3 compared to sample 1. However, when discussing the results it became clear that two otolith readers did not assume the birth date to be the 1st of January. If the ages were revised, it would indeed show an improvement for ages 0-3 would be demonstrated.

For ages 4-7 and 8-11, the standard deviations decreased remarkably in sample 3 compared to sample 1. For ages 12-15, there was some improvement. However, the number of otoliths is low for these age groups. For the 16+ age group, there was a great improvement. For this group 64% of the standard deviations were below 0.5.

Considering that most otolith readers were inexperienced with horse mackerel age determinations, it is likely that the ageing agreement will improve in the future.

During the Workshop it became clear that two subjects were important for the interpretation of the otoliths. These were: the interpretation of the rings and the interpretation of the edge of the otoliths. This is discussed in the Report of the Workshop.

The Workshop recommended that:

1) all the readers should use the broken burnt technique for horse mackerel otoliths when age reading;

2) all the readers collect information on the number of otoliths having a hyaline or opaque edge by month and by area using the method described in Appendix A of Anon. 1991c;

3) further research should be carried on the sectioning technique used to obtain thin slices of otoliths in order to improve the readability by increasing the contrast between the hyaline and opaque zones.

This Working Group endorses the recommendations made by the Workshop.

3.7 Review of the Report of the Mackerel/Horse Mackerel Egg Production Workshop

The Mackerel/Horse Mackerel Egg Production Workshop met in IJmuiden, the Netherlands from 15-18 January 1991 to;

1) to coordinate the timing and planning of the 1992 Mackerel/Horse Mackerel Egg Surveys in ICES Sub-areas IV, VI-IX;

2) to coordinate the implementation in 1992 of the batch fecundity method for stock size estimation for mackerel and horse mackerel;

3) to make arrangements for processing the data from future egg survey results;

4) to evaluate problems in mackerel and horse mackerel fecundity estimation; and

5) to review the basis for estimating spawning stock biomass from these surveys (Anon., 1991a).

The terms "total fecundity egg production method" and "batch fecundity egg production method" are used to describe the two approaches to estimating spawning stock biomass from the western mackerel and horse mackerel egg surveys. These terms are not commonly used by other workers in this field and their use by the present Workshop could lead to some misunderstanding. The Workshop, therefore, recommended that in future these terms be replaced by "Annual Egg Production Method" and "Daily Egg Production Method", respectively.

Both methods of estimating spawning stock biomass were discussed and reviewed. In addition, the problems concerning mackerel and horse mackerel fecundity were evaluated for both the annual and the daily egg production method. Detailed information on this is reported in Anon. (1991a).

In the North Sea area the Netherlands is carrying out a sole/horse mackerel egg survey together with Germany and England from March - July 1991. But there will be no horse mackerel egg survey in 1992.

In the western area, the surveys were arranged so that the daily and total egg production method could be carried out at the same time for both mackerel and horse mackerel. The planned research vessel deployment of the 1992 Mackerel/Horse Mackerel Egg Surveys is listed in Table 3.11.

In the southern area, plans were made for carrying out the daily egg production method for horse mackerel in 1992 (Table 3.11).

The data base of the egg survey data of the western mackerel and horse mackerel will be transferred from the Fisheries Laboratory, Lowestoft, UK to the Marine Laboratory, Aberdeen, UK.

The main potential source of systematic error in the biomass estimate of the daily egg production method is the lack of information on durations of oocyte or post-ovulatory follicle stages for horse mackerel. The Workshop recommended that studies on the durations of oocyte or post-ovulatory follicle stages be pursued as soon as possible.

This Working Group endorses the recommendations made by the Workshop.

3.8 Review of the Report of the Study Group on the Coordination of Bottom Trawl Surveys in Sub-areas VI, VII, VIII and Division IXa

The Study Group on the Coordination of Bottom Trawl Surveys in Sub-areas VI, VII, VIII, and Division IXa met in Nantes, France from 11-16 April 1991 to 1) collate information on the existing surveys conducted in Sub-areas VI, VII, VIII and IX, 2) to consider whether and how these surveys might evolve into a coordinated international programme and 3) to consider the feasibility of making the data available in an agreed common format (Anon., 1991b).

In recent years an almost complete coverage of all shelf areas in ICES Sub-areas VI-IX was achieved during the fourth quarter of the year. Most of Division VIIa and the inshore areas of Division VIa were not covered. In recent years the English Channel and the continental shelf between 44° and 61°N was covered primarily by GOV-trawl. A Baka and a Campell trawl were used on the Spanish and Portuguese continental shelf, respectively.

Results on the distribution and abundance from these bottom trawl surveys are requested by the present Working Group. Distribution charts of 0-group, 1-group and 2+-group horse mackerel obtained from these surveys are shown in Figure 3.4-3.6 (see also Section 3.2).

This Working Group endorses the recommendations made by this Study Group.

3.9 Length Compositions by Fleet and by Country

The 1990 annual length compositions by fleet were provided by Ireland, the Netherlands, Norway, Portugal, Spain and Germany. These length distributions were available for all the major fishing fleets accounting for about 81% of the total landings in 1990. The length distributions by country for each fleet (in millions) of fish per cm-length group are shown in Table 3.12 for 1990.

The Working Group examined the level of sampling carried out in 1990 for the different areas. The data, which are summarized in Table 8.2, are based on the details submitted by Working Group members and the Administrative Report of the Pelagic Fish Committee (Anon., 1991e).

3.10 Discards

The Working Group still believes that considerable amounts of horse mackerel might be discarded or slipped. Discarding seems to be rather variable, depending on such factors as the fleet, time period, catch size, freezing capacity, area, country and the vessels' home ports involved. Often the horse mackerel is caught as by-catch in fisheries for other species and is, therefore, discarded.

The estimate of discards given in Table 3.9 are based on few data and is, therefore, probably far too small. However, in Divisions VIIIc and IXa the amount of horse mackerel discarded is probably low. The fleets fishing horse mackerel for fish meal production are not known to discard.

The Working Group, therefore, once more recommends that the different nations fishing horse mackerel collect data to evaluate the magnitude of discards.

3.11 Natural Mortality

Until 1988 the natural mortality used in the assessments for Western horse mackerel was M = 0.2. ACFM considered that this factor was probably too high and the Working Group (Anon., 1989) adopted a new M of 0.15 for the Western horse mackerel, considering the known longevity of horse mackerel which is up to 30 years.

About the stock assessment which has been done in 1990 for the Southern horse mackerel, ACFM (ACFM meeting - November 1990) pointed out that the value of M assumed for the Southern stock (0.2) was different from the one assumed for the Western horse mackerel (0.15) and that there was little evidence for this.

The Working Group decided this year to maintain the M at 0.15 for the Western horse mackerel assessment for the following reasons:

- On the assumption that the life span of horse mackerel seems to surpass that of the mackerel, the real value may be even lower than the assumed value.

- This value corresponds to the natural mortality assumed for mackerel which has similar migration patterns and areas of distribution.

As no analytical assessment for the Southern horse mackerel has been done, the Working Group members agreed to delay the decision of which M to use for that assessment to the 1992 Working Group meeting, when revised age compositions will be available for a new assessment of this stock.

4. NORTH SEA HORSE MACKEREL (DIVISIONS IIIa, IVb,c and VIId)

The horse mackerel fishery by sub-area is described in Section 3.5. The total landings of the North Sea stock is shown by year in Table 3.9. In 1990 the catches were lower than in 1989. However, it should be remembered that catches are allocated on an area basis to the different stocks. Therefore, some catches of North Sea horse mackerel are included in the catches of Western horse mackerel.

4.1 Fishery-Independent Information

4.1.1 Egg surveys

During the period 12 March to 20 July 1990 the spawning area of the North Sea horse mackerel was investigated by research vessels from the Netherlands (Eltink, Working Document 1991). Based on the plankton samples and temperature observations obtained during this period, the egg production and spawning stock size were estimated. The total horse mackerel egg production in 1990 of 201 x 10^{12} stage 1 eggs represents a spawning stock biomass of 255,000 t. In 1988 and 1989, the spawning stock biomass was estimated to be 120,000 and 217,000 t, respectively. Spawning appeared to occur further north in 1989 and 1990 compared to 1988 and, therefore, the areal average of the last two years was assumed to be more appropriate.

4.1.2 Acoustic surveys

Since 1985 an acoustic survey aimed at herring has been carried out in the eastern central North Sea by the Danish Institute for Fisheries and Marine Research. The estimated biomass in 1990 of horse mackerel was 12,000 t. As in 1989 (Anon., 1990a), the survey in 1990 does not give a representative picture of the abundance of North Sea horse mackerel.

4.2 Assessment

The egg surveys in 1989 and 1990 are considered to give reliable estimates of the spawning stock biomass.

Samples taken from the Dutch commercial catches and research vessel catches indicate a fairly strong 1982 year class (Table 4.1). The relatively strong 1985 and 1986 year classes which were observed in the samples taken in 1989 did not show up in the 1990 samples. The age compositions given in Table 4.1 are based on

a limited number of samples, and may only be taken as a rough indication of the age composition in the stock.

Samples from the commercial catches are only available for the last four years, and only for a small proportion of the catches. For this reason it was not possible for the Working Group to do an analytical assessment of North Sea horse mackerel.

As there is little directed fishing for horse mackerel in Divisions IVb,c and VIId, the Working Group believes that effort has been relatively constant, and that the high catches since 1984 are due to the strong 1982 year class.

4.3 Biologically Safe Limits

There is no evidence that low recruitment occurs at low SSB levels.

There is no indication that an historically low level of SSB will be reached in 1991 or 1992 with the present level of fishing.

5. WESTERN HORSE MACKEREL (DIVISIONS IIa, VIIa-c,e-k AND VIIIa,b,d,e)

5.1 Fishery-Independent Information

5.1.1 Egg surveys

The last egg survey was carried out in 1989 and the next is planned to take place in 1992 (Anon., 1991a).

Table 5.1 gives the estimated total egg productions and the corresponding spawning stock sizes for the years 1977, 1980, 1983, 1986 and 1989 (Anon., 1990a).

5.1.2 Trawl surveys

As pointed out in recent years' Working Group reports (Anon., 1989, 1990a), trawl surveys in the fourth quarter in the Western and the North Sea areas do not indicate the strength of O- and 1-group horse mackerel with any accuracy. As shown in Section 3.2, the O- and 1-group fish are mainly distributed very close to the shore (Figures 3.4, 3.5). These areas are difficult to sample properly and so recruitment indices are not so reliable.

5.2 Catch in Numbers

The landings and discards for Western horse mackerel in different divisions are given in Table 3.9. However, as mentioned in Section 3.10, the estimate of discards is only based on few data.

For the years 1982-1989 the catches were raised to catch in numbers according to the Dutch catch in numbers by age groups. For 1990 Norway also provided catch-at-age data based on age readings. The average weights in the Norwegian catches per year class were higher than in Dutch catches. For 1988 and 1989, Norwegian data also demonstrated higher overall mean weights in their catches. Raising the Norwegian catches in 1988 and 1989 to numbers by age group using Dutch data would overestimate the catch in numbers by age groups. The catch in numbers for 1988 and 1989 were, therefore, adjusted. The mean weights in the Norwegian catches in 1990 were used to calculate the total numbers of fish caught by the Norwegian fleet in 1988 and 1989. Since no age readings were available the relative distribution of the different year classes in the catches in 1990 were also applied for the catches in 1988 and 1989.
The Norwegian catches in Divisions IVb and IIIa in 1988, 1989 and 1990 were taken close to Division IVa and these have now been included in the Western stock. The catch in numbers by age group in 1988 and 1989 has been revised accordingly (Table 5.5).

For 1990 catches as numbers at age were provided by the Netherlands (Divisions VIa, VIIb,c,e,f,j and VIIIa), Norway (Divisions IIa, and IVa) and Spain (Divisions VIIj and VIIIa,b). The catch in numbers were worked out quarterly by Divisions (Tables 5.2 and 5.5).

5.3 Mean Weight at Age

Mean weight at age in the catch in 1990

The mean weights at age in the catch from 1982 - 1990 are shown in Table 5.6. The mean weights for 1982 - 1987 were based only on Dutch biological sampling.

For 1990, mean weights at age in the catches by quarter were provided by the Netherlands (Divisions VIa, VIIb,c,e,f,j and VIIIa), Norway (Divisions IIa and IVa) and Spain (Divisions VIIj and VIIIa,b). Mean catch weights at age (weighted by number) were estimated by division(s), by quarter and by year. These are shown in Table 5.3 by division, but Divisions VIIb,c,j,k and Divisions VIIa,e-h and also Divisions VIIIa,b,d,e were combined. The mean weights at age by quarter and division(s) are shown in Table 5.3 and for all divisions in 1990 in Table 5.6.

Revision of mean weights in the catch in 1988 and 1989

As mentioned in Section 5.2, the average weights at age in the Norwegian catches were higher than in the Dutch catches. Therefore, the mean weights at age in the catch for 1988 and 1989 were revised in line with the revisions of the catch data. The Norwegian fishery exploited the 1985 year class and the older ones. The average weight at age for those year classes in the Norwegian catches in 1988 and 1989 were 70% higher than in the Dutch catches (Anon., 1990a). The Norwegian mean weights at age were estimated by increasing the Dutch weights by 70%. It was then possible to calculate the revised mean weights at age for 1988 and 1989 as given in Table 5.6.

Mean weight at age in the stock in 1990

The mean weights at age of the spawning stock at spawning time for 1982 - 1990 are shown in Table 5.7. They are the weighted means of the mean weight at age from the first and second quarters in Division VIIj and were based on fish in all maturity stages from the spawning area caught by Dutch freezer trawlers. The mean weights at age in the stock decreased markedly for each age group during this period of years.

5.4 Mean Length at Age

The mean lengths at age in the catch from 1982-1989 are shown in Table 5.4 and were based only on Dutch biological sampling. The mean length at age decreased markedly for each age group during this period.

5.5 Maturity at Age

The maturity ogive used in last year's assessment (Anon., 1990a) was based on maturity-at-length data. The length at which 50% is mature was expected to be about 23 cm (Anon., 1986). The mean length of the 1982 year class in 1986 was 23.7 cm (Table 5.4). Therefore, the proportion mature was assumed to be 0.6 for this year class. Since there has effectively only been one year class (1982) spawning, the increase in the total egg production from 0.5×10^{15} eggs in 1986 to 1.7×10^{15} eggs in 1989 should be ascribed to an increase in the proportion mature of the 1982 year class.

If the spawning stock biomass is to correspond with the estimates from the egg surveys, the proportion mature of the 1982 year class in 1986 should be reduced from 0.6 to 0.1. At its 1990 meeting, the Working Group decided not to change the maturity ogive at age and recommended that further investigations should be undertaken to revise the maturity at age for the period 1982 - 1990 (Anon., 1990a). This year the Working Group again decided not to change the maturity ogive, but to wait until it is possible to make an

assessment including the biomass estimate from the 1992 egg survey. The Working Group recommends that further investigations should be carried out on the maturity at age of horse mackerel.

5.6 Fishing Mortality and Tuning of the VPA

Due to the increased Norwegian fishery exploiting the 1985 year class and older fish, the fishing pattern has changed considerably over the last three years. Therefore, it was not possible to establish the fishing pattern by the separable VPA method. The fishing pattern was, therefore, established in the following way. Due to an increase in the catches of younger fish, particularly in Division VIIe in the fourth quarter, the fishing mortality was increased on the 2-4 groups. The Norwegian fishery exploited five-year-olds and older fish. Therefore, the 5-7 age groups were assumed to have the same fishing mortality as the 1982 year class. The fishing mortality on this year class was assumed to be a little higher than estimated last year for 1989 (Anon., 1990a). Since the older age groups in particular were fished more heavily than in earlier years, the fishing mortality was set relatively high for these age groups.

The VPA was then tuned to match the spawning stock estimates from the egg surveys in 1989 and 1983 to be consistent with the VPA run last year (Anon., 1990a). Since this was a rather arbitrary method of tuning the VPA, it was run with rounded values of terminal fishing mortalities. The outputs are given in Tables 5.5 - 5.10 and Figures 5.1A and B.

The final VPA matches rather well with the spawning stock estimates based on the egg surveys in 1983 and 1989. For 1986, the VPA estimates were far too high compared with the estimate from the egg surveys. The VPA run last year gave a difference of the same magnitude and the explanation for that was thought to be due to using the wrong maturity ogive. A maturity of 60% of the 1982 year class in 1986 seems to be far too high (see Section 5.5).

5.7 Recruitment

Over the last 50 years there have only been seven strong year classes of horse mackerel (Eltink and Kuiter, 1989). The last strong one was the 1982 year class.

In last year's Working Group report (Anon., 1990a) the recruitment of 1-year-olds was calculated as the arithmetic mean of the weak year classes 1981, 1983, 1984, 1985 and 1986. These year classes were estimated to be even weaker this year (Table 5.10). Therefore, to be cautious and consistent with other working groups it was decided to use the geometric mean of the same year classes as an input for recruitment at age 1 in 1991, 1992 and 1993. This was estimated at 500 millions which is 1.4% of the strong 1982 year class

5.8 Yield per Recruit

The long-term yield per recruit and spawning stock biomass per recruit curves against F were calculated using input data shown in Table 5.11. For the exploitation pattern, the fishing mortality assumed for the 1982 year class in 1990 was applied to age groups 5-11. The output of the analysis is shown in Figure 5.1C. The $F_{0.1}$ was estimated to be 0.077 for M = 0.15. Weight in the catch per age group for the yield-per-recruit analysis was obtained by smoothing the 1990 data and estimating the weights of the 1982 and 1979 year classes as (see Section 5.9). However, it has to be remembered that the estimate of $F_{0.1}$ is rather imprecise due to the recent shift in exploitation pattern and the consequential problems of selecting an exploitation pattern and weights at age in the catches for this analysis.

5.9 Forecast

The assumptions as given below and the parameters given in Table 5.11 were used in the predictions:

1. The stock sizes in numbers at ages 5-12+ at 1 January 1991 were taken from the VPA.

2. The number of 1-groups in 1991, 1992, and 1993 was set at 500 million (Section 5.7).

3. The numbers of 2-, and 3-, and 4-groups in 1991 were calculated at 426 million, and 379 million and 286 million, respectively, which is 500 million reduced by M and low F values (age 1: F = 0.01, age 2: F = 0.054, age 3: = 0.05).

4. The proportions of mature at age were assumed to be the same as in 1990

5. The weights at age in the catch and in the stock were assumed to be the smoothed weights in 1990 for all ages except for the 1982 and 1979 year classes, since these two strong year classes have been observed to have a different growth pattern than the other year classes. For these two year classes the weights were estimated from the following regressions based on the weight in the catch and the stock for the last five years from Dutch data (Eltink, pers. comm.):

   1979 year class: weight in catch = 191.6 + 6.2 x age (r^2 = 0.251)
   1979 " " weight in stock = 73.0 + 18.8 x age (r^2 = 0.735)
   1982 year class: weight in catch = 73.0 + 11.5 x age (r^2 = 0.785)
   1982 " " weight in stock = 58.4 + 13.1 x age (r^2 = 0.887)

   Since the Norwegian fishery exploits bigger fish than the Dutch fleet, the Dutch data for the actual two year classes have to be increased by about 20% as in 1990 to match the average weight in the total catch of these two year classes (Table 5.6).

6. The same fishing pattern and fishing mortality as used in the VPA was also used in the prediction except for the 1982 year class in 1991, 1992 and 1993 which was kept at the 1990 level.

7. The catch in 1991 was assumed to be 400,000 t. The EC quota for 1991 is 230,000 t. Norway and the Netherlands are likely to have catches similar to those in 1990.

The predictions for stock and catch in 1992 and 1993 were calculated for different options for fishing mortalities (Table 5.12 and Figure 5.1D). As shown in Figure 5.3, the F_{med} is undefined and it is not possible to give a precise estimate of F_{high} The line drawn in Figure 5.3 corresponds with F_{high} = 1.

The results of the prediction shows that even with no fishing in 1992 the spawning stock will decrease. If the catch level of 400,000 t is maintained in 1992, the spawning stock in 1992 is predicted to be just below 1 million t, which is a reduction of about 50% since the egg survey in 1989.

The prediction was also run with the average weights in the catch from 1990 data for year classes up to the 1982 year class and then the same weights for the older age groups as given in Table 5.11. This gave results very similar to those given in Table 5.12.

5.10 Biologically Safe Limits

Since no other strong year classes have been observed in the 1980s, the fishery in the coming years will be rather dependent on the 1982 year class. In 1990, this year class accounted for 88% of the spawning stock and for 63% of the catches (235,000 t). Figure 5.2 shows the development of this year class under different catch options. If the same fishing mortality is applied in the coming years as in 1990, the cohort will last beyond this century. However, it will account for less than 500,000 t as soon as 1995. The cohort has a similar development with a yearly fishery of 100,000 t, but it will not last beyond this century. If the yearly catches are 200,000 t or 300,000 t, the cohort will last until 1996 and 1995, respectively.

5.11 Management Measures and Considerations

The TAC set for 1992 should apply to all areas in which Western mackerel are caught, i.e., Divisions IIa, IVa, VIa, VIIa-c, e-k, VIIIa,b,d,e and in the most northerly part of Division IVb and the most westerly part of Division IIIa.

Since there are no signs of incoming strong year classes, it seems that both the fishery and the spawning stock size will depend on the 1982 year class in the coming years.

Based on the VPA, it seems that a spawning stock size in the order of 500,000-600,000 t is able to produce a strong year class as was the case in 1982. It is, therefore, at present thought to be the minimum acceptable level for the spawning stock. With yearly catches at the level of 400,000 t, the spawning stock will be reduced by 28% from 1991 to 1992.

6. SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

6.1 Revision of Data Base for Assessment

According to the Minutes of the November 1990 ACFM meeting, ACFM commented in relation to last year's assessment (Anon., 1990a) that "There are basic data problems for this stock. The stock definition is not clear and the Working Group has identified the need for further research into it".

Considering the results of the Horse Mackerel Age Determination Workshop, the Working Group recommends that the catch-in-numbers at age be revised accordingly to the one-year-ring interpretation. For 1990 this method has already been applied, but it is necessary to revise the age readings backwards, and it was not possible to do this in time for this meeting. For this reason the Working Group did not perform an analytical assessment at this meeting.

The following sections deal with the 1990 data and special comments are made as guidance for the revision of the mean weight-at-age and maturity-at-age data to be used in next year's analytical assessment.

At this meeting the Working Group considered it appropriate to apply a simple method for short-term forecasting of catch and biomass (Shepherd, 1984, 1991).

6.2 Effort and Catch per Unit Effort

Table 6.1. shows the annual catches of Southern horse mackerel by countries by gear in Divisions VIIIc and IXa.

Table 6.2 shows the commercial CPUE series from 1979 to 1990 for the Portuguese and Spanish trawl and purse-seine fleets. The CPUE of the Portuguese purse seiners in 1989 has been revised from 50.9 to 37.1 due to improved data becoming available on effort. In 1990, the CPUE of the Portuguese purse-seine fleet shows a decrease of 28% while the Portuguese trawl indicates an increase of 42%. The Spanish purse-seine CPUE indicates the same level as in 1989.

Two new Spanish trawl series have been presented at the meeting from two ports in Division VIIIc (Pereda and Villamor, Working Document 1991).

The CPUE of the Spanish trawl from Aviles (Cantabrian Sea) shows a large increase (around 252%) as compared to 1989, while the north Galicia trawl (from La Coruña) indicates a decrease of about 15%.

Figure 6.1 and Table 6.3 show the effort trends from different fleets and areas. In 1990, the effort decreased by 43 % in the Portuguese trawl fishery and slightly decreased in the Portuguese purse-seine fishery relative

to 1989. In Division VIIIc the Spanish trawl fishery in the Cantabrian Sea (Aviles) indicates a decrease of 12% from 1988 to 1989 and a slight increase (5%) from 1989 to 1990. In North Galicia (La Coruña), effort seems to have been stable during 1989-1990.

6.3 Fishery-Independent Information

6.3.1 Trawl surveys

Table 6.4 shows biomass and abundance indices estimated from the Portuguese bottom trawl October surveys carried out in Division IXa (Portuguese area) and from the Spanish Bottom Trawl September Survey, which cover the rest of Division IXa (south Galicia) and the west of Division VIIIc (north Galicia). The latter was carried out in 1989 with a different research vessel due to the unavailability of the R/V "CORNIDE SAAVEDRA". The biomass index from the Portuguese October survey shows an increase from 11.7 kg/h in 1989 to 21.5 kg/h in 1990.

Due to the need for revision of the number-per-hour-at age from surveys, Table 6.5 presents only the estimates for age group-0 and age-group-1 from the Portuguese October survey and Spanish September survey.

6.3.2 Egg surveys

In 1990, three eggs surveys for different species were carried out by Spain (Figure 6.2).

From the review presented by Franco *et al.* (Working Document 1991), it seems that horse mackerel eggs are in fact distributed over the whole surveyed area in all years analyzed (1987-1990). The low egg production values in some parts of the Cantabrian Sea might be partly explained by the fact that certain surveys did not coincide with the peak of the spawning season.

The abundance of eggs decreases from north to south in the investigated area. The egg abundances were always higher east of 5°W. The high abundances of eggs were observed far from the coast at higher latitudes (French waters) and closer to the coast in the southern areas (Spanish waters), following the continental shelf. West of 5°W the egg concentrations were lower and were only observed in small patches. In the years analyzed, the surface temperature ranged between 13°C-18°C.

No new information about distribution of horse mackerel eggs and larvae in Division IXa (central and southern parts) was available for this meeting.

No new fishery-independent information on spawning stock biomass based on egg surveys will be available to the Working Group until the 1992 egg surveys have been carried out (Table 3.11 and Anon. 1991a).

6.4 Catch in Numbers

Catch in numbers at age

Catch in numbers at age (Table 6.6 and Figure 6.3a-d) for 1990 have been obtained using the one-year-ring age determination (see Section 3.6).

Quarterly age-length keys were obtained by the Portuguese reader and raised to the Portuguese quarterly catch length distribution in Division IXa with the corresponding mean-length-at-age and mean-weight-at-age in the catch.

Quarterly age-length keys from the eastern part of Division VIIIc were obtained and raised to the corresponding catch. In the central and western parts of Division VIIIc and north of Division IXa, the age-

length keys were obtained on a half-yearly basis and raised to the corresponding catch length distribution by quarter. The otoliths were read by two Spanish readers.

Nevertheless, by inspecting the results by quarter it is observed that one otolith reader is reading age-group 8 as age-group 7 in the first and second quarters, probably because the edge was not counted (see Section 3.6). This implies that the 1990 catch-in-numbers need to be revised again.

Catch in numbers at length

The quarterly length distribution in 1990 by geographical areas of Division VIIIc and IXa are shown in Figures 6.4 a-d.

The catch in general consists of juveniles (less than 20 cm) and adults throughout the year.

The length distributions of the catch are quite variable by quarter and geographical area. However, the catch in tonnes seems to be stable between quarters within the same geographical area, except in the eastern part of Division VIIIc and the northern part of Division IXa.

Large catches are obtained in the western part of Division VIIIc and in the central and southern parts of Division IXa, together constituting 76% of the total catch in Divisions VIIIc and IXa.

During 1990, recruitment to the fishery started in the third quarter in the north of Division IXa but it showed a peak in the fourth quarter.

In 1990, adults are mainly present in catches of the western part of Division VIIIc and these had a modal length of less than 30 cm.

6.5 Mean Weight at Age

Data on the quarterly mean weights at age in the catch in 1990 for Divisions VIIIc and IXa, were provided by Spain and Portugal (Table 6.7).

However due to the discrepancies in the otolith reading in the past, the Working Group considered that the mean weight at age in the catch and in the stock for 1990 and former years should be revised and presented to the next Working Group meeting.

6.6 Maturity at Age

Maturity at age and at length data obtained during the spawning season in 1990 have been presented by Spain for Division VIIIc. No maturity at age data have been revised since a major revision of these data is going to be carried out before next Working Group meeting (see Section 6.10).

6.7 Recruitment

Estimates of 0- and 1-groups were available for the Portuguese October survey in Division IXa and from the Spanish September survey in Divisions IXa (north) and VIIIc (Table 6.5). The latter series does not seem to be suitable for estimating recruitment for horse mackerel since these surveys are directed to hake (Figure 6.5 and Section 3.2). The Portuguese October survey in 1990 indicted a year class of medium strength. This year class seems to be of similar strength to the 1989 year class which was confirmed during 1990 to be of medium strength (around 50% of the 1982 year class).

6.8 Short-term Forecast-SHOT Method

The basic idea of the SHOT method is that the future catch and biomass from a stock are determined partly by the size of the surviving stock, together with the contribution due to recruits and, thus it may not be necessary to consider the full age structure to achieve a useful approximation for a short-term forecast (Shepherd 1984, 1991; Anon., 1984, 1986a).

Table 6.8 presents the results using the 0-group recruit indices from the Portuguese October survey. A running weighted average over the recruitment series has been used, of 0.25, 0.50 and 0.25 on ages 0, 1 and 2, respectively, to smooth the recruit indices accordingly to the selection at age shown by the catch in numbers.

The yield/biomass ratio was set to a level of 0.3, considering an average yield of 60,000 t and an average biomass of 200,000 t as an approximation (Anon., 1990). The difference between G, the weight growth rate and M, the natural mortality rate, was assumed to be zero.

At *status quo* conditions, the catch forecast for 1992 is indicated to be 52,000 t.

Four other runs were made with the following differences from the former one (SHOT 1):

-SHOT 2 - assuming G-M to be 0.10;
-SHOT 3 - using the 1-group recruit index from the Portuguese October survey;
-SHOT 4 - Catch data only (not using any recruitment indices).

Figure 6.4 shows the results of the estimated *status quo* catch and the predicted catch levels for 1991 and 1992. All the assumptions indicate the same level of *status quo* catch for 1992 of the order of 49,000-52,000 t.

The actual catches were much higher than the estimated *status quo* catches in 1986 and much lower in 1990, probably due to changes in the fishing effort. Available effort data presented in Figure 6.1 suggest a decline in 1990 for at least one fleet.

6.9 Management Measures and Considerations

The Working Group recommends that the catch in 1992 should be kept below the level of about 50,000 t.

6.10 Recommendation for a Workshop

The Working Group recommends that before its next meeting a Workshop should be held on Horse Mackerel in Divisions VIIIc and IXa with the following terms of reference:

a) to revise the catch-in-numbers-at-age according to the one-year-ring interpretation from 1990, back to 1984, if possible;

b) to analyse the length-weigth relationships by quarter and by area;

c) to revise the mean-weights-at-age in the catch and in the stock;

d) to revise the maturity-at-age data by area and to adopt a combined for assessment purposes;

e) to revise the CPUE-at-age from the fleets and surveys for use in VPA tuning.

7. ANCHOVY (SUB-AREA VIII)

7.1 Unit Stocks

Further studies concerning morphometric characteristics of the Bay of Biscay anchovy were carried out in 1990 during the French acoustic survey . The main results obtained confirmed the previous observations made in 1989 which were of three geographic groups well discriminated by linear discriminant function analysis (79% well classified). In 1991, the study is being conducted again and, in addition, samples for genetic characteristics have been collected to study the possible presence of several subpopulations of anchovy in the Bay of Biscay.

For the time being, the Working Group decided to consider the Bay of Biscay anchovy population as a single management unit in Sub-area VIII as before and assumed that the landings of anchovy off Portugal and the west Galician coasts were from a different stock (Table 7.1).

7.2 The Fishery

Landings in Sub-area VIII

Total international landings in Sub-area VIII amounted to 33,856 t in 1990 (Table 7.2). In spite of the closure of the French fishery by the EC in November 1990, the agreed TAC (30,000 t) was exceeded. Spanish landings in 1990 reached 23,258 t (3 times the 1989 level) (Figure 7.1). Estimated French landings were the highest on record since 1960 (10,598 t). These French catches take into account the discards at the fishing harbour. As in previous years, a correcting factor for salted weight to fresh weight was applied to French catches.The temporal and spatial distributions of Spanish and French catches were different in 1990 (Table 7.3). The main season for Spain was the spring season in Division VIIIc while autumn was the principal one for the French fishery in Division VIIIa.

Landings by Divisions (Table 7.4)

The distribution of Spanish catches were similar in 1990 and in 1989. Nearly all anchovy landings came from Division VIIIc both in autumn and spring. The French spring fishery was located in Division VIIIb as in the previous year. However, the main French fishery in 1990 took place in Division VIIIa in the summer and autumn. At the same time, the Spanish summer fishery was located in the western part of Division VIIIc. Thus, the principal fisheries for the two countries were completely separated in space (southern part for Spain and northern part for France) and in time (spring fishery for Spain; summer and autumn fisheries for France). Spanish catches in western Division VIIIc in the summer were considered to be higher than the summer catches of recent years.

Landing by EC categories

Table 7.5 gives the distributions of Spanish and French landings by EC market categories in Sub area VIII by half year. The distributions are rather similar for the two countries..

7.3 Effort and Catch per Unit Effort

Figure 7.2 shows an increase in 1990 of the size of the French fleet fishing for anchovy (both purse seiners and pelagic trawlers). Some accidental catches were also made by bottom trawlers in the north of the Bay of Biscay during the autumn (2.8% of the total French landings, Prouzet et Luro, 1991). The number of purse seiners recorded in 1990 is the number of units that have effectively fished. The number of pelagic trawl units is less because some fishing boats fish by pair trawling (2 or 3). Since 1987, there has been an increase in the number of pelagic trawlers involved in that fishery. In the same period, the Spanish purse seine fleet has remained more or less constant with a slight decrease in 1990 and 1991 resulting from a strike in 1989 in Bermeo harbour. Presently, catch-per-unit effort data are not available.

7.4 Fishery-independent Information

7.4.1 Egg surveys

Table 7.6 summarizes the results of SSB estimates from the daily egg production method (DEPM) of the 1987-1991 period. Data concerning numbers at age in 1989 were modified from the results of Uriarte and Santiago (1990) according to new estimates of catches at age for Spanish purse seiners. The 1989 SSB estimate is considered to be underestimated by at least 10-12% (Motos and Santiago, 1990).

The 1990 spawning biomass was estimated by the daily egg production method (Motos and Uriarte, WD 1991) at 98,000 t, much higher than the biomass estimated in 1989 using the same technique (Motos and Santiago, 1990). The stock was mainly composed (96%) of the 1989 year class. This result explains the high catches of 1-year-old anchovies landed in 1990 (see Section 7.7) and the huge increase in biomass from 1989 to 1990 due to a strong recruitment of the 1989 year class.

The only result available at present from th 1991 egg survey is the total positive spawning area. For the four previous years, the variation of the positive spawning area and of the final SSB estimate were closely related (Figure 7.3, from Motos, Franco and Garcia, pers, comm.). Thus, the positive spawning area can be taken as a SSB index and it suggests a decrease of biomass in 1991. This survey, conducted as an EC project by Spanish and French scientific organisations, will continue in 1992.

7.4.2 Acoustic surveys

The preliminary results given in the 1990 Working Group report from the French acoustic survey seemed to be doubtful (Massé and Leroy, WD 1991). Further investigations on these acoustic data showed that the echo-sounder was not working properly because of problems with the TVG function.

For the time being, only a rough estimate of 60,000 to 110,000 t can be provided as a relative abundance index. Probably this estimate can be improved by further investigations and it should be possible to provide an acceptable index for 1990.

The IFREMER acoustic data acquisition system (Diner, 1989) was used during the 1991 egg survey and the methodology was according to Massé (1988).

Due to several tests during the survey in 1991, it was possible to correct for the TVG function failure this year.

The anchovy distribution in April 1991 (Massé and Leroy, WD 1991) can be summarized as follows (Figure 7.4 and Table 7.7):

- from the Spanish coast to 43°40'N, no anchovy was observed;
- from the French coast to the continental shelf break and from 43°40'N to 44°55'N, anchovies belonging mainly to the 2 group were recorded with an abundance index estimated to 58,000 t;
- from the French coast to the continental shelf break and from 45°05'N to 46°25'N, an abundance index of 22,000 t of anchovies belonging mainly to the 1 group were recorded.

This confirms the good recruitment of 1989 year class which was well represented in the samples, and shows a lower recruitment of the 1990 year class.

Many hydrographic data have been collected during this survey which is part of an EC project undertaken by Spanish and French scientific organisations. These data have yet to be fully analysed but first results show a break in anchovy distribution between 44°50'N and 45°10'N. This area corresponds to surface water

with high salinity between the influences of the Gironde and the Adour fluvial systems (Massé and Leroy, WD 1991).

7.4.3 Comparison of abundance indices of anchovy

The positive area provided by the egg survey in May 1991 suggests a large decrease of the SSB. The preliminary results of the April 1991 acoustic survey also suggest a lower biomass than the one observed in 1990 with the same method, but this decrease is not so large (Table 7.8). Unfortunately, as the 1990 acoustic index is not actually available it is impossible to state a precise level.

It is difficult to understand the meaning of this preliminary disagreement because no series of egg production and acoustic abundance index is available . A strong research effort is in progress as part of the EC project to improve both types of assessment, and a series of three years (1990-1992) will probably available next year.

For the time being, the Working Group members agreed to accept the 1990 egg production index and the 1991 acoustic index as two independent indices of anchovy abundance for these respective years.

7.5 Recruitment

Table 7.8 summarizes the recruitment indices obtained from direct estimation methods (acoustic and egg survey). A strong recruitment in 1990 from the low 1989 spawning stock biomass is recorded. In 1991, the French acoustic survey showed a lesser recruitment (1990 year class) at high spawning stock biomass than the previous year. Compared to the 1989 year class, it only has 33 % of its strength, and it is in the range of the low recruitments of the last decade. The size of the positive spawning area also suggests a lower recruitment than from the 1989 year class.

The very strong variability of recruitment (expressed by the number of recruits of 1 year old per unit of SSB the year before) is shown in Figure 7.5.

7.6 Length Compositions by Fleet and by Country

Spanish data on catch at length and age for 1989 have been revised, resulting in minor modifications. In addition to this, catches at age for the Spanish live bait tuna fishery have been reported. For that reason, 1989 data on length and age are updated and presented in this report (Tables 7.9a and 7.10b).

The 1990 annual length composition of landings by fleet were provided by France and Spain. Half yearly distributions for the two countries are very similar (Tables 7.9b and Figures 7.6a and b) and almost identical in the second half of the year. The increase in size of landed anchovy between the first and second semester reflects mainly the increase in size of one year old anchovies (more than 90% of the total catches in 1990). This 1989 cohort was also fished in 1989 (0 group) as it can be seen in Table 7.9a.

7.7 Catch in Numbers

Following a recommendation made by the Working Group last year, some work has been done on otolith reading between French and Spanish scientists. This otolith exchange showed an improved agreement on otolith reading. However, further work on this subject should be undertaken in the future.

Following a recommendation in last year's Working Group report, monthly catches of small pelagic fishes used as live bait by Spanish tuna fishing boats have been reported (Santiago, WD 1991) and these were converted into numbers at age. The catches from 1989 were not recorded by age due to insufficient sampling.

Landings of anchovy by country and half year in numbers at age are given in Tables 7.10b and c for the years 1989 (revised) and 1990. Live bait catches are not included since they are not landed. Total catches-in-number since 1974 are presented in Table 7.11, including catches for live bait for the 1987-1990 period and previously non reported catches of 0-groups (Uriarte and Motos, 1991). Catches discarded in 1990 at French harbours were included and these amounted to about 500 t. Discards at sea were not available but were thought to be low in 1990.

1-year old anchovies accounted for more than 90% of the total catches in number in 1990.

7.8 Mean Weight at Age

The French mean weights at age for the catches were based on biological sampling of scientific survey catches and commercial catches. Spanish mean weights at age in the catch were calculated from routine biological sampling of commercial catches for length distributions by applying length-weight relationships (Tables 7.12a and 7.12b).

7.9 Maturity at Age

As reported in previous years, all age groups are mature in spring. Lucio and Uriarte (1990) confirmed these observations for the years 1987 and 1988 from macroscopical examinations of ovaries and Motos *et al.* (in press) from histological examinations of gonads of females for the 1987-1990 period. No differences in specific fecundity (number of eggs per gram of body weight) have been found according to age.

7.10 Natural Mortality and Assessment

Analysis of the direct estimations from 1987 to 1991 from DEPM and acoustic surveys shows that M fluctuates among years and is high with values between 0.7 and 1.77. Again this year, the natural mortality on 1-group was estimated to be higher than the fishing mortality (Figure 7.7). (See Annex 2 for methodological explanations.)

The fishing mortality obtained for all age groups was in the range of 0.39 to 0.44 for the years 1987 to 1989, whereas between 1990 and 1991 it was estimated at $F = 0.32$. This last estimate corresponds to the 1-year old anchovies and is probably biassed as it does not represent a complete year.

In the Minutes of the November 1990 ACFM meeting, mention is made of the possibility of a change in the fishing pattern around 1983 towards a more heavy fishery on age 1. The Working Group had indicated that there might be a shift in fishing pattern. Possible causes for such a shift are:

- a general increase of effort
- new fishing periods
- differences in age reading
- sampling strategies in the eighties in comparison to the 1970s.

7.11 Trends in Biomass and Recruitment

From Figure 7.1 it is clear that the stock size is greatly reduced compared to the 1950s and 1960s. In those years there was a much bigger fleet than the current one and since there has been a continuous improvement of facilities (Figures 7.1 and 7.2). It is the possibility that there was overfishing in the earlier period but that cannot be proven. Alternatively, a change in environmental factors might have caused a reduction of the spatial distribution of this stock in the Bay of Biscay (Junquera, 1986 and 1991).

The current situation is characterized by a low or medium level of biomass. Whether this level is caused mainly by persistent adverse environmental conditions or by a poor recruitment associated with a low biomass is not known. For the four last years for which direct estimations of the SSB are available , no relationship between the number of recruits and the size of the spawning stock biomass can be defined. The stock has increased since 1989. Figure 7.8 shows that the two highest recruitments have been obtained from the two lowest spawning stock biomasses. The large fluctuations of SSB observed during the last four years are mainly due to the variations of the 1-year old recruitment (by a factor from 1 to 150, see Figure 7.6). The development of the 1991 biomass was simulated using the Ricker's exponential growth model. Different values for M and F were taken according to the results obtained in those years from direct estimations of the biomass.

Figures 7.9 and 7.10 show that the abundance of 2- and 3-year-old anchovies will be in the range between 17,000 and 39,000 t at the beginning of 1992.

However, the abundance of the 1991 year class (abundance of the 1-group in 1992) is unknown and, as indicated in Section 7.5, the prediction of the recruitment one year ahead is presently impossible. Due to the large variations of recruitment observed the four last years (see Sections 7.5 and 7.10) only a rough prediction can be made, giving a total biomass between 21,000 and 145,000 t.

7.12 Forecast

Assuming the same level of exploitation in 1991 as in 1990, a catch forecast can be made for the 1989 and 1990 year classes although a problem remains concerning the 1991 year class, which cannot be estimated before mid-May 1992. Only a rough estimation of the range of the probable catches can be proposed:

- at F=0.32 (1990 value), catches would be between 4,140 and 32,950 t;
- at F=0.39 (average value of the 1987-1990 period), catches would be between 4,900 and 39,000 t);
- at F=1.0 (F=M), catches would be between 9,940 and 77,750 t.

However, Table 7.13 suggests that the real situation is more complex. In one case, at the lower biomass the total stock at the end of the year is too low even with F equal to 0, and in the other case (maximum biomass), an increase of F up to 1.0 still results in a substantial biomass (35,880 t) at the end of the year with a high level of landings. In fact, this example represents the actual situation in 1989 and 1990.

7.13 Biologically Safe Limits

Biologically safe limits are presently difficult to define. From the data obtained from acoustic or eggs surveys, it is evident that environmental factors mainly affect recruitment and thereby cause fluctuations in the stock. Similar patterns have been observed in other anchovy stocks for which a minimum spawning stock biomass has been chosen as a management objective in order to protect the stock from depletion and recruitment failure.

The limited data available show that SSB in the range of 15,000 to 30,000 t can produce significant recruitments. Therefore, for the time being, the Working Group suggests that a SSB of this level be taken as a biologically safe limit.

7.14 Management Measures and Considerations

Figure 7.11 describes the different options that could be defined to manage this fishery (see Annex 3). The choice of the two opposite solutions : " Opportunistic solution" and "Smoothing solution" will depend on the final objective of the managers.

If the main objective is to conserve a minimum biomass to prevent the collapse of the fishery and to catch the maximum of biomass over this level[1], the "Opportunistic solution" will be the best, but with rather variable catches. If the main objective is to increase the biomass up to the 1960s level, which seems to be more appropriate for the management of the fishery[2], then the "Smoothing solution" or even a fishery closure for a certain period would be the best solution.

Different options for technical management measures include:

1. Use of precautionary TAC

The precautionary TAC recommended for 1991 by ACFM cannot be accepted as an operative management measure:

a) being defined for a calendar year, it would not, theoretically, prevent a drastic decrease of the stock in case of low recruitment for two consecutive years;

b) it does not take into account the wide natural variations of the population so that in some years the level of final TAC could be far above or far below the spawning biomass.

2. Catch forecast based on analytical basis

For the first half of the year, a provisional rough catch forecast could be carried out, based on average recruitment of recent years. After the spring biomass estimates, a total annual catch forecast can be given for the second half of the year, which accounts for half of the fishing mortality.

This possibility to manage the stock on an analytical basis, requires a close annual monitoring of the biomass.

3. Use of alternative or additional measures

The following measures given by Prouzet (WD, 1991), could be proposed to prevent a cohort from disappearing too quickly:

1) Minimum landing size or maximum grade: To reduce the fishing mortality on small anchovies.

2) Fishing in specific areas or depths: In order to prevent problems with discards, specific areas and depths are given in Figure 7.12 for the different seasonal fisheries.

3) Fishing seasons: This measure can be used to strengthen the two previous measures.

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[1] In the absence of relationship between stock and recruitment and strong impact of environmental factors.

[2] Particularly if the level of the actual biomass is the main factor which conditions the recruitment level whatever the environmental conditions are.

These kinds of alternative or additional measures have the advantages of better taking into account the natural fluctuations and biological characteristics of this species. The main disadvantage is that as supplements to precautionary TACs, these measures are probably not sufficient to prevent stock collapse.

8. DEFICIENCIES IN DATA

8.1 Sardine

Coverage of age and length sampling

The countries with catches of sardine ranked in order of importance are Portugal, Spain and France. These countries provide length- an age-composition data corresponding to their catches. Table 8.1 shows the summary of sampling by quarter and by division. A deficiency of length and age sampling exists in Divisions VIIIa,b.

Data on sardine

Data on sardine outside Divisions VIIIc and IXa have not yet been made available to the Working Group.

Acoustic surveys

No acoustic surveys have been carried out in the stock area since 1988. It should be stressed that the analysis of this stock must be based on acoustic surveys carried out mainly in the recruitment season.

8.2 Horse Mackerel

Coverage of age and length sampling

The countries with catches of horse mackerel ranked by importance are the Netherlands, Norway, Ireland, Spain, Portugal, Germany and France. The ranking by quantity of age data provided is Portugal, Spain, the Netherlands, Germany, France and Norway. The ranking by quantity of length data provided is Portugal, Spain, Ireland, the Netherlands, Germany, Norway and France. Table 8.2 shows the summary of sampling by quarter and by division. A deficiency of age and length sampling exists in Division IVa and to a lesser extent in Sub-area VII.

Ageing

For the Western and Southern horse mackerel, 70% and 100%, respectively, of the catches were covered by age sampling. The catches of the Western horse mackerel in the North Sea area were covered by only 150 aged fish.

Stock separation

Still more information on stock separation is required.

Catches

Official catches by countries are reported annually, whereas catches on quarterly basis are required. Catches by some countries are reported by Sub-area, whereas catches on division and even on a rectangle basis are needed.

Maturity

Proportions mature for Western horse mackerel appear to be unreliable, because fist maturing fish seem to produce much fewer eggs than expected.

Discards

Information on discarding is scarce. Only data from two countries were available.

Length distributions

Annual and quarterly length distributions were not presented by all countries.

Egg surveys

Horse mackerel egg production in the English Channel and around the Iberian peninsula is still not well enough known.

Recruitment

Data on recruitment are lacking for the Western horse mackerel.

8.3 Anchovy

Coverage of age and length sampling

The countries with catches of anchovies ranked by importance are Spain, France and Portugal. Length and age data were made available by Spain and France. Table 8.3 shows the summary of sampling by quarter and by division. There is no deficiency of length and age sampling.

Discards

Data on discarding at sea by the French fleet are lacking.

Recruitment and natural mortality

The time series on recruitment and natural mortality are too short for their reliability to be evaluated.

9. RE-ARRANGEMENT OF ICES WORKING GROUPS

9.1 Comments on the Re-arrangement Proposal

In the proposal for re-arrangement ACFM suggests that the Working Group on the Assessment of Sardine, Horse Mackerel and Anchovy and the Mackerel Working Group should be merged into one working group. ACFM further suggests that, as a long-term objective, the Blue Whiting Assessment Working Group should be integrated into the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group.

The Working Group discussed the proposal taking the biology, the fisheries and the logistical problems of the different stocks into consideration.

The Working Group considers it important that the size of working groups both with regard to the number of participants and number of stocks be kept at a level which allows full plenary discussions for all stocks and ensures that all members of the group feel responsibility for all of the assessments.

Merging all three working groups will make a total of 10 stocks to be assessed. The Working Group feels that this number of stocks is at the upper limit of what can reasonably be managed and agrees with the North Sea Flatfish Working Group (Anon., 1991) that the maximum number of stocks should be about 8.

The Working Group feels that the assessments for horse mackerel and mackerel would benefit if carried out by the same working group. There is a high degree of similarity in the distribution and migration of the two species and they are in general caught by the same fleets. In most institutes the same people are responsible for the work on both species.

The similarities between sardine and anchovy on the one hand and horse mackerel and mackerel on the other is less obvious. Sardine and anchovy are mainly found in the southern areas where the abundance of mackerel and horse mackerel is relatively low. Some of the methods used in the assessment of sardine, anchovy and horse mackerel and mackerel are different and there is relatively little overlap in the fisheries. For these reasons the Working Group feels that the advantage of having the sardine and anchovy stocks assessed by the same group as the mackerel and horse mackerel stocks is relatively small. The Working Group, however, felt that the assessments of sardine and anchovy should be integrated into a larger group and that the Mackerel and Horse Mackerel Working Group may be an appropriate group. Another possibility could be to establish a new working group dealing with short living species, e.g. sardine, anchovy, sprat, sandeel and Norway pout.

The Working Group does not find any important assessment relationships between blue whiting and sardine, anchovy and horse mackerel and can not see any major benefit of integrating the Blue Whiting Assessment Working Group into a Mackerel, Horse Mackerel, Sardine and Anchovy Working Group.

9.2 Consideration and Advice on the Necessity of Producing Reliable Annual Updates of the Assessments

Sardine:

It is important to follow the sardine abundance in the fisheries in Divisions VIIIc and IXa, which are mainly catching 0-3 group fish. To perform the forecast it is, therefore, necessary to have an index of recruitment estimated each year by the acoustic surveys carried out during the recruitment season (August - December). For these reasons the Working Group suggests that the assessment of this stock should be carried out on an annual basis.

North Sea Horse Mackerel:

Very little information is available for this stock and it is not possible to carry out an analytical assessment at present. The evaluation of the state of the stock is based on the results of egg surveys. At present there are no plans to continue these surveys after 1991. The number of biological samples from this stock is very low. In 1990 and 1989 only 275 fish were aged. The Working Group has no reason to believe that the data will improve in the near future.

Western Horse Mackerel:

The stock is dominated by the 1982 year class (88% of SSB and 63% of the catch in 1990) and the precision of the current forecast depends to a large extend on the estimate of the strength of this year class. The VPA is tuned using the SSB estimates from the egg surveys. Major revisions or changes in the assessment are only likely to take place in years where results from a new egg survey are included in the assessment or if a new strong year class shows up. At present, the egg survey takes place every third year. The fishing mortality on the juveniles is very low and the forecast is not very dependent on the youngest year classes.

It is, therefore, suggested, that the assessment should be updated every year but new predictions may only be necessary every second year and when results of new egg surveys are available.

Southern Horse Mackerel:

For this stock fishing mortality is very high on the juveniles and the catch forecast is dependent on a reliable estimate of the recruitment. The estimate of recruitment is based on the result of the Portuguese October bottom trawl survey and the Spanish September survey. This means that the forecast for this stock will not be available before October, and that it is not possible to make two year predictions without significant loss of precision.

Anchovy:

For such a short-lived species, a close monitoring is necessary. Therefore, this stock should be assessed every year. If advice on the catch for the current year is required to be updated for the second half each year, the best time to make the assessment is May because acoustic stock estimations are then available. If management is only going to be based on technical measures such as those described in Section 7.14, then an October meeting would be best, because most of the data for the current year will be available (i.e., acoustic biomass and DEPM SSB estimations, and data of catch at age from the fishery).

10. RECOMMENDATIONS

10.1 Research Recommendations

Horse Mackerel

This Working Group endorses the recommendations made by the Mackerel/Horse Mackerel Egg Production Workshop (Anon., 1991a).

This Working Group endorses the recommendations made by the Study Group on Coordination of Bottom Trawl Surveys in Sub-areas VI, VII, VIII and Division IXa (Anon., 1991b) and stresses the need for good distribution charts of juvenile and adult horse mackerel in the whole of the area of distribution.

This Working Group endorses the recommendations made by the Horse Mackerel Age Determination Workshop (Anon., 1991c).

This Working Group further recommends that:

a) further studies should be undertaken on the stock identity of horse mackerel;

b) more countries should provide age data;

c) further studies should be undertaken on the maturity ogive of Western horse mackerel;

d) data on discarding should be made available to the Working Group.

Anchovy

Age reading

Improvement of age reading should be continued by means of otolith exchanges and direct validation techniques.

Natural mortality

Considering the importance of the natural mortality on the choice of the different management options, the Working Group recommends that studies on the ecological and dynamic characteristics of the stock be increased and that they should continue for a sufficiently long period to provide accurate advice for management purposes.

Discarding

More information on discarding should be made available to the Working Group.

Gear comparison

Relative efficiency of gears should be measured in order to quantify the impact on fishing mortality resulting from the increasing fleet during recent years.

10.2 Management Recommendations

Sardine

1) Closures of the fishery in the juvenile areas (total Division IXa) during the peak of the juvenile abundance, which is usually in March.

Horse Mackerel

1) If a TAC is set for the Western horse mackerel, it should apply to all areas where it is caught (Divisions IIa, IVa, VIa, VIIa-c,e-k, VIIIa,b,d,e and the most northerly part of Division IVb and the most westerly part of Division IIIa).

2) If a TAC is set for the North Sea horse mackerel, it should apply to all areas where it is caught (Divisions IIIa, IVb,c and VIId).

3) The catch of Southern horse mackerel should be kept below the level of about 50,000 t.

Anchovy

1) A precautionary TAC is not suitable for the management of this stock. Other possible measures exist and are defined in Figure 7.11 of this Working Group report. Annex 3 of this report discusses advantages and disadvantages of the different options.

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Table 2.1 Total nominal catch (tonnes) of SARDINE by countries in Divisions VIIIc and IXa (as estimated by the Working Group).

Year	Portugal	Spain			Total
	IXa	VIIIc	IXa	Total	VIIIc+IXa
1940	98,212	66,816	-	66,816	165,028
1941	76,486	27,801	-	27,801	104,287
1942	81,667	47,208	-	47,208	128,875
1943	132,924	46,348	-	46,348	179,272
1944	128,221	76,147	-	76,147	204,368
1945	109,030	67,998	-	67,998	177,028
1946	107,454	32,280	-	32,280	139,734
1947	97,967	43,459	21,855	65,314	163,281
1948	78,001	10,945	17,320	28,265	106,266
1949	35,986	11,519	19,504	31,023	67,009
1950	74,618	13,201	27,121	40,322	114,940
1951	82,527	12,713	27,959	40,672	123,199
1952	88,948	7,765	30,485	38,250	127,198
1953	96,848	4,969	27,569	32,538	129,386
1954	112,474	8,836	28,816	37,652	150,126
1955	92,330	6,851	30,804	37,655	129,985
1956	99,827	12,074	29,614	41,688	141,515
1957	112,554	15,624	37,170	52,794	165,348
1958	131,088	29,743	41,143	70,886	201,974
1959	121,025	42,005	36,055	78,060	199,085
1960	138,846	38,244	60,713	98,957	237,703
1961	139,067	51,212	59,570	110,782	249,849
1962	130,236	28,891	46,381	75,272	205,508
1963	118,567	33,796	51,979	85,775	204,342
1964	163,294	36,390	40,897	77,287	240,581
1965	137,762	31,732	47,036	78,768	216,530
1966	124,831	32,196	44,154	76,350	201,181
1967	114,696	23,480	45,595	69,075	183,771
1968	79,526	24,690	51,828	76,518	156,044
1969	64,103	38,254	40,732	78,986	143,089
1970	69,158	28,934	32,306	61,240	130,398
1971	84,408	41,691	48,637	90,328	174,736
1972	87,528	33,800	45,275	79,075	166,603
1973	100,825	44,768	18,523	63,291	164,116
1974	75,071	34,536	13,894	48,430	123,501
1975	95,877	50,260	12,236	62,496	158,373
1976	79,649	51,901	10,140	62,041	141,690
1977	79,819	36,149	9,782	45,931	125,750
1978	83,553	43,522	12,915	56,437	139,990
1979	91,294	18,271	43,876	62,147	153,441
1980	106,302	35,787	49,593	85,380	191,682
1981	113,253	35,550	65,330	100,880	214,133
1982	100,859	31,756	71,889	103,645	204,504
1983	85,922	32,374	62,843	95,217	181,149
1984	95,110	27,970	79,606	107,576	202,686
1985	111,709	25,907	66,491	92,398	204,107
1986	103,451	39,195	37,960	77,155	180,606
1987	90,214	36,377	42,234	78,611	168,735
1988	93,591	40,944	24,005	64,949	158,540
1989	91,091	29,856	16,179	46,035	137,126
1990	92,404	27,500	19,253	46,753	139,157

Table 2.2 Catch (tonnes) of SARDINE (purse seiners) by 6-month period and by country.

Year	Portugal		Spain	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1960	20,504	111,570	-	-
1961	21,006	114,499	-	-
1962	23,000	106,978	-	-
1963	20,665	96,134	-	-
1964	31,725	125,711	-	-
1965	24,229	111,925	-	-
1966	24,119	97,826	-	-
1967	21,368	91,855	-	-
1968	14,160	63,719	-	-
1969	15,018	45,966	-	-
1970	12,842	52,072	-	-
1971	19,925	50,260	-	-
1972	15,802	58,663	-	-
1973	20,255	74,004	-	-
1974	14,382	54,900	-	-
1975	23,031	67,815	-	-
1976	23,934	48,951	-	-
1977	19,592	55,215	-	-
1978	24,545	53,953	-	-
1979	29,411	60,573	22,373	39,774
1980	32,989	72,012	34,152	51,228
1981	34,198	77,908	33,115	67,765
1982	34,320	61,591	45,708	57,937
1983	25,598[1]	60,324[1]	27,613	67,604
1984	30,076[1]	65,034[1]	47,484	60,092
1985	34,770[1]	76,939[1]	41,198	51,200
1986	28,910[1]	74,541[1]	31,064	46,091
1987	29,111[1]	61,103[1]	30,892	47,719
1988	29,910[1]	63,680[1]	30,667	34,282
1989	34,537[1]	56,554[1]	19,506	26,529
1990	32,669[1]	59,736[1]	22,025	24,728

(-)Data not available.
[1]Portugal - all gear catches.

Table 2.3 SARDINE. Divisions VIIIc + IXa.
Monthly catches (t) by gear by country and fleets in 1990.

Country	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Total	139,157	10,527	6,264	6,210	6,557	11,902	13,234	13,105	16,072
SPAIN - P. seiner (Div. VIIIc+IXa)	46,753	3,692	2,265	3,271	1,921	5,093	5,783	4,694	5,521
PORTUGAL (Div. IXa)	92,404	6,835	3,999	2,939	4,636	6,809	7,451	8,411	10,551
P. seiner	87,071	6,303	3,756	2,702	4,434	6,558	7,144	7,985	9,939
Artisanal	4,742	338	156	196	166	233	300	414	596
Trawl	591	194	87	41	36	19	7	12	15

Country	Sep	Oct	Nov	Dec
Total	13,412	14,537	18,699	8,639
SPAIN - P. seiner (Div. VIIIc+IXa)	4,187	3,172	3,777	3,377
PORTUGAL (Div. IXa)	9,225	11,365	14,922	5,262
P. seiner	8,611	10,717	14,064	4,858
Artisanal	610	636	812	284
Trawl	3	11	66	121

Table 2.4 SARDINE. French landings (tonnes) by division and total during 1981-1990.

Year	Total	Division							
		VIId	VIIe	VIIf	VIIg	VIIh	VIIIa	VIIIb	VIIIc	VIIId
1981	10,800	172	952	0	0	0	8,482	1,194	0	0
1982	6,835	59	828	20	0	0	5,928	0	0	0
1983	7,269	211	590	0	0	2	6,013	454	0	0
1984	5,300	147	661	0	1	0	4,472	19	0	0
1985	10,258	465	1,624	0	0	0	8,090	79	0	0
1986	12,799	512	2,058	0	0	0	10,186	43	0	0
1987	8,673	67	682	0	0	216	7,631	77	0	0
1988	10,394	29	438	0	0	2,119	7,770	38	0	0
1989	10,117	93	91	0	0	957	8,885	85	6	0
1990	9,538	64	808	0	0	235	8,381	50	0	0

[1] Preliminary.

Table 2.5 Number of Portuguese purse seiners and Portuguese catch per purse seiner and number of Spanish fishing days and catch per fishing days in 1981-1990.

Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
				Portugal (Division IXa)						
No. of purse s.	193	184	196	192	192	198	196	180	223	221
Tonnes/purse s.	457	340	312	329	527	517	437	495	383	394
				Spain[1] (Divs. VIIIc, IXa)						
No. of fishing days	-	7,685	7,867	8,369	5,731	3,541	4,099	3,601	3,059	3,488
Tonnes/Fishing day	-	4.87	4.01	4.65	4.86	4.23	4.71	2.75	2.45	2.80

[1] Only the two ports in Spain (Vigo and Riveira) in Division IXa.

Table 2.6 Sardine in Divisions VIIIc and IXa. Abundance estimates from acoustic surveys 1986-1991.

	1986				1987			1988			1990	1991
	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 VIIIc and IXa	Spain VIIIc and IXa
Age	Mar	Mar	Aug	Dec	Mar	Aug	Nov	Apr	Mar	Aug	Apr	Mar/Apr
0	-	-	3,949	3,545	-	4,185	3,690	-	-	3,139	-	-
1	55	2,326	2,772	1,535	632	753	2,413	221	7,743	1,823	69	25
2	21	4,124	2,504	1,503	257	1,482	1,355	63	2,684	987	56	150
3	1,040	1,496	615	610	27	1,230	932	72	1,617	801	274	126
4	215	467	41	309	2,390	802	643	64	1,447	426	55	314
5	409	486	3	123	586	249	245	858	804	70	88	51
6	279	21	3	48	481	104	78	175	425	9	134	79
7	192	-	-	-	528	-	-	310	104	-	249	56
8	50	-	-	-	159	-	-	342	-	-	70	345
9	36	-	-	-	61	-	-	53	-	-	49	29
10	12	-	-	-	25	-	-	18	-	-	46	71
11	3	-	-	-	4	-	-	-	-	-	23	6
12	-	-	-	-	-	-	-	-	-	-	8	2
Total biom.	161	318	331	258	363	325	331	176	481	243	97	106

Numbers in millions.
Biomass in thousands tonnes.

Table 2.7. Sardine in Divisions VIIIc and IXa. Catch length composition ('000) by quarter during 1990

L(cm)	1 st	2 nd	3 rd	4 th	TOTAL
5	0	0	0	0	0
5.5	0	0	0	0	0
6	0	1	435	5	441
6.5	0	0	123	0	123
7	0	2	131	0	132
7.5	0	25	228	0	253
8	0	40	1293	0	1332
8.5	4	146	3757	964	4871
9	22	239	9535	2572	12368
9.5	34	256	12937	2443	15670
10	134	205	15883	5173	21395
10.5	218	138	13434	3481	17271
11	925	180	15038	2185	18329
11.5	1057	72	15714	1911	18755
12	1941	435	17917	2885	23178
12.5	1296	2119	10821	3933	18169
13	919	8310	10565	6439	26233
13.5	619	15547	12496	6822	35484
14	1018	25374	14549	9936	50877
14.5	736	24896	13474	7140	46245
15	1645	15451	13610	6514	37220
15.5	1556	12968	32448	6041	53013
16	2291	12859	40671	9069	64890
16.5	4113	16449	36449	17935	74946
17	8717	22812	56530	32953	121012
17.5	27283	40249	55120	49294	171946
18	33911	55182	53588	55995	198676
18.5	50945	71488	67105	61827	251364
19	57961	72050	71118	72578	273708
19.5	48410	83506	75557	82239	289713
20	39431	63771	70883	74120	248205
20.5	26792	40816	47508	61589	176704
21	20774	19533	36380	44474	121160
21.5	17339	8745	19162	31593	76840
22	16290	5861	15000	22795	59946
22.5	13024	3553	10995	12730	40303
23	10397	2262	8120	8403	29183
23.5	5515	865	4617	3063	14061
24	3392	374	1955	905	6626
24.5	1505	55	871	475	2906
25	480	32	81	61	654
25.5	111	12	66	0	189
26	29	3	52	15	99
26.5	3	0	0	0	3
27	0	0	0	0	0
27.5	0	0	0	0	0
28	0	0	0	0	0
Total	400836	626883	886213	710558	2624491
Catch(t)	23000	31693	42589	41875	139157

Table 2.8 Sum of products check.

Sardine in Fishing Areas VIIIc and IXa
ATEGORY: TOTAL

ATCH IN NUMBERS UNIT: millions

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	420	844	854	643	842	1021	60	1061	109	258	238	1401
1	1871	2421	2145	1479	1997	1920	769	553	3289	527	702	512
2	1426	954	913	935	1542	1720	1854	838	470	2343	987	615
3	252	110	281	423	372	666	701	795	488	457	903	520
4	71	22	127	187	155	192	350	322	295	290	322	521
5	12	3	40	93	47	102	130	140	176	197	194	147
6	3	1	16	36	30	76	129	139	116	101	166	170
7+	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4055	4355	4376	3796	4985	5697	3993	3848	4943	4173	3512	3886

	1988	1989	1990
0	439	244	234
1	979	512	562
2	525	895	488
3	428	381	680
4	303	215	275
5	291	198	142
6	189	183	104
7+	0	61	142
TOTAL	3154	2689	2627

Table 2.9a SARDINE - Spain. (Divisions VIIIc + IXa).
CATCH IN NUMBER BY AGE GROUP (+SOP) country and quarter in 1990.

1990 MONTH: 1 3		MONTH: 4 6		MONTH: 7 9		MONTH: 10 12	
AGE	Ci ('000)	AGE	Ci ('000)	AGE	Ci ('000)	AGE	Ci ('000)
0	0	0	0	0	108463	0	20131
1	13633	1	34325	1	51242	1	19964
2	10885	2	27711	2	28912	2	10712
3	39009	3	87205	3	41343	3	28487
4	8666	4	17446	4	17357	4	12542
5	8313	5	11555	5	11911	5	10514
6	11954	6	6390	6	8840	6	7883
7	21228	7	9763	7	22825	7	21938
8	6112	8	1852	8	4357	8	4809
9	3695	9	1193	9	3076	9	2851
10	3816	10	1128	10	2901	10	2726
11	1137	11	202	11	2078	11	1795
12	602	12	120	12	541	12	956
TOTAL	129050	TOTAL	198890	TOTAL	303846	TOTAL	145308

PORTUGAL (Division IXa)
CATCH IN NUMBER BY AGE (+SOP)

1990 MONTH: 1 3		MONTH: 4 6		MONTH: 7 9		MONTH: 10 12	
AGE	Ci ('000)	AGE	Ci ('000)	AGE	Ci ('000)	AGE	Ci ('000)
0	0	0	0	0	68286	0	37255
1	7075	1	149148	1	158352	1	127571
2	35785	2	88382	2	143311	2	141545
3	106765	3	106360	3	114658	3	155148
4	75803	4	38459	4	46266	4	58401
5	28588	5	22988	5	24278	5	24014
6	14100	6	17382	6	20988	6	16578
7	3670	7	5274	7	6229	7	5239
TOTAL	271786		427993		582368		565751

SARDINE - DIVISIONS VIIIc + IXa

CATCH IN NUMBER AT AGE

1990 MONTH: 1 3		MONTH: 4 6		MONTH: 7 9		MONTH: 10 12	
AGE	Ci ('000)	AGE	Ci ('000)	AGE	Ci ('000)	AGE	Ci ('000)
0	0	0	0	0	176749	0	57386
1	20708	1	183473	1	209594	1	147535
2	46670	2	116093	2	172223	2	152257
3	145774	3	193565	3	156001	3	183635
4	84469	4	55905	4	63623	4	70943
5	36901	5	34543	5	36189	5	34528
6	26054	6	23772	6	29828	6	24461
7	24898	7	15037	7	29054	7	27177
8	6112	8	1852	8	4357	8	4809
9	3695	9	1193	9	3076	9	2851
10	3816	10	1128	10	2901	10	2726
11	1137	11	202	11	2078	11	1795
12	602	12	120	12	541	12	956
7+	40260	7+	19532	7+	42007	7+	40314
TOTAL	400836	TOTAL	626883	TOTAL	886214	TOTAL	711059

Table 2.9b SARDINE. Spain (Divisions VIIIc + IXA) Catch mean length and weight by age group, country and quarter in 1990.

CATCH MEAN LENGTH AND WEIGHT BY AGE GROUP

1990 MONTH:	1	3	MONTH:	4	6	MONTH:	7	9	MONTH:	10	12
AGE	L (cm)	W (g)	AGE	L (cm)	W (g)	AGE	L (cm)	W (g)	AGE	L (cm)	W (g)
0	.0	.0	0	.0	.0	0	10.8	8.8	0	10.5	8.8
1	16.4	34.0	1	17.3	46.2	1	15.9	31.7	1	15.5	37.3
2	19.1	53.2	2	19.0	58.4	2	19.2	59.2	2	19.8	56.9
3	20.4	64.6	3	19.8	66.0	3	20.5	73.7	3	21.0	68.1
4	20.7	67.9	4	20.0	67.2	4	20.6	75.0	4	21.0	70.0
5	21.6	76.7	5	20.5	71.5	5	21.4	84.6	5	21.7	77.6
6	22.5	86.5	6	21.4	80.4	6	21.2	81.8	6	21.5	82.9
7	22.6	87.9	7	21.6	82.3	7	22.6	102.6	7	22.5	90.9
8	22.9	91.4	8	22.4	90.9	8	22.6	101.9	8	22.5	94.7
9	23.1	93.3	9	22.2	89.2	9	23.0	107.6	9	22.9	96.7
10	23.1	92.9	10	22.5	91.8	10	23.1	108.8	10	22.8	97.8
11	23.7	100.7	11	23.5	103.2	11	23.3	112.0	11	23.2	105.3
12	23.5	98.6	12	23.4	102.4	12	23.3	112.0	12	23.3	104.3

SARDINE - PORTUGAL (DIV. IXa)

CATCH MEAN LENGTH AND WEIGHT BY AGE GROUP

1990 MONTH:	1	3	MONTH:	4	6	MONTH:	7	9	MONTH:	10	12
AGE	L (cm)	W (g)	AGE	L (cm)	W (g)	AGE	L (cm)	W (g)	AGE	L (cm)	W (g)
0	.0	.0	0	.0	.0	0	13.1	23.6	0	14.3	23.6
1	14.9	19.0	1	16.0	26.1	1	17.2	38.1	1	17.5	42.2
2	17.9	40.5	2	18.3	45.7	2	18.3	49.7	2	18.9	53.3
3	19.0	48.6	3	19.4	54.6	3	19.4	58.7	3	19.7	66.0
4	19.9	54.6	4	19.8	57.5	4	20.2	64.9	4	20.2	67.9
5	20.3	58.0	5	20.4	63.6	5	20.8	71.2	5	20.8	75.4
6	20.6	63.8	6	20.5	64.1	6	20.7	70.1	6	20.9	74.8
7	22.1	74.0	7	21.2	65.1	7	14.4	76.5	7	21.9	88.5

SARDINE - DIVISIONS VIIIc + IXa

CATCH MEAN LENGTH AND WEIGHT BY AGE GROUP

1990 MONTH:	1	3	MONTH:	4	6	MONTH:	7	9	MONTH:	10	12
AGE	L (cm)	W (g)	AGE	L (cm)	W (g)	AGE	L (cm)	W (g)	AGE	L (cm)	W (g)
0	.0	.0	0	.0	.0	0	12.0	14.5	0	12.4	18.4
1	15.7	28.9	1	16.6	29.9	1	16.6	36.6	1	16.5	41.5
2	18.5	43.5	2	18.6	48.7	2	18.8	51.3	2	19.4	53.6
3	19.7	52.9	3	19.6	59.8	3	19.9	62.7	3	20.4	66.3
4	20.3	55.9	4	19.9	60.6	4	20.4	67.7	4	20.6	68.3
5	20.9	62.2	5	20.5	66.3	5	21.1	75.6	5	21.2	76.0
6	21.5	74.2	6	20.9	68.5	6	20.9	73.6	6	21.2	77.4
7	22.3	85.9	7	21.4	76.3	7	18.5	97.0	7	22.2	90.5
8	22.9	91.4	8	22.4	90.9	8	22.6	101.9	8	22.5	94.7
9	23.1	93.3	9	22.2	89.2	9	23.0	107.6	9	22.9	96.7
10	23.1	92.9	10	22.5	91.8	10	23.1	108.8	10	22.8	97.8
11	23.7	100.7	11	23.5	103.2	11	23.3	112.0	11	23.2	105.3
12	23.5	98.6	12	23.4	102.4	12	23.3	112.0	12	23.3	104.3

Table 2.10 VPA tuning data.

```
SARDINE IN DIVISIONS VIIIc AND IXa
103
PORTUGAL-P.SEINER FLEET
81,90
1,1
0,5
193,449,1165,772,293,63,31
184,12,369,960,222,64,13
196,284,365,420,340,96,33
192,72,476,198,161,69,27
192,201,437,1273,274,92,35
198,158,477,726,422,183,51
196,397,436,475,409,214,72
180,375,671,425,280,198,63
223,50,446,655,290,155,130
221,100,416,385,455,206,94
SP-P.SEINER F.(VIGO+RIVEIRA)
82,90
1,1
0,5
7685,22,137,254,159,98,23
7867,580,107,133,146,58,18
8369,134,657,91,107,81,24
5731,16,39,444,71,75,60
3541,8,26,31,100,20,27
4099,489,22,29,20,49,8
3601,19,89,22,17,13,32
3059,55,25,72,18,11,7
3488,70,56,28,50,12,7
SP.-MARCH ACOUST.SURVEY
86,90
1,1
1,5
1.0,55,21,1040,215,409
1.0,632,257,27,2390,586
1.0,221,65,72,64,858
1.0,-11,-11,-11,-11,-11
1.0,69,56,274,55,88
```

Table 2.11 SARDINE. Tuning analysis.

```
Module run at 17.51.57  23 JUNE 1991
DISAGGREGATED Qs
LOG TRANSFORMATION
NO exolanatory variate (Mean used)
Fleet  1 ,PORTUGAL-P.SEINER FL, has terminal q estimated as the mean
Fleet  2 ,SP-P.SEINER F.(VIGO+, has terminal q estimated as the mean
Fleet  3 ,SP.-MARCH ACOUST.SUR, has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
      , 1.000, 1.000, 1.000, 1.000, 1.000,
Oldest age F = 1.000*average of 3 younger ages. Fleets combined by variance of predictions
Fishing mortalities

   Age,    86,    87,    88,    89,    90,

     0,  .025,  .092,  .061,  .034,  .040,
     1,  .116,  .079,  .098,  .107,  .117,
     2,  .173,  .162,  .125,  .140,  .161,
     3,  .174,  .149,  .187,  .144,  .173,
     4,  .208,  .165,  .140,  .155,  .168,
     5,  .185,  .159,  .150,  .146,  .168,

Log catchability estimates

 Age  0
 Fleet,    86,    87,    88,    89,    90
-------,------,------,------,------,------
     1 , -9.38, -8.93, -8.15,-10.37, -9.47
     2 ,-15.25,-11.76,-14.13,-12.90,-12.59
     3 , No data for this fleet at this age

                                SUMMARY STATISTICS
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,    SE     ,INTRCPT,  SE
       ,   q    ,      ,   F   ,   F   ,          ,   Slope  ,       ,Intrcpt
-------,--------,------,-------,-------,----------,----------,-------,-------
     1 , -9.26  ,  .888, .0210 , .0491,   .000E+00,   .000E+00, -9.262,   .363
     2 ,-13.33  , 1.504, .0057 , .0190,   .000E+00,   .000E+00,-13.325,   .614
     3 , No data for this fleet at this age
      Fhar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
      .038         .765            .415            .765             .294

 Age  1
 Fleet,    86,    87,    88,    89,    90
-------,------,------,------,------,------
     1 , -7.83, -7.98, -7.89, -7.78, -7.84
     2 ,-13.62,-14.09,-12.91,-13.28,-12.61
     3 , -4.70, -2.33, -3.81, -7.04, -4.24

                                SUMMARY STATISTICS
 Fleet , Pred.  , SE(q),Partial,Raised,   SLOPE   ,    SE     ,INTRCPT,  SE
       ,   q    ,      ,   F   ,   F   ,          ,   Slope  ,       ,Intrcpt
-------,--------,------,-------,-------,----------,----------,-------,-------
     1 , -7.87  ,  .081, .0849 , .1144,   .000E+00,   .000E+00, -7.865,   .033
     2 ,-13.29  ,  .608, .0059 , .0595,   .000E+00,   .000E+00,-13.285,   .248
     3 , -4.42  , 1.876, .0120 , .0976,   .000E+00,   .000E+00, -4.424,   .766
      Fhar      SIGMA(int.)     SIGMA(ext.)     SIGMA(overall)  Variance ratio
      .113        .803E-01        .609E-01        .803E-01         .576
```

cont'd.

Table 2.11 cont'd.

Age 2

Fleet	86	87	88	89	90
1	-7.35	-7.35	-7.49	-7.68	-7.46
2	-13.39	-13.19	-13.44	-12.51	-12.84
3	-5.60	-2.69	-4.20	-7.33	-3.99

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-7.47	.149	.1263	.1601	.000E+00	.000E+00	-7.467	.061
2	-13.07	.432	.0073	.1275	.000E+00	.000E+00	-13.075	.176
3	-4.76	1.936	.0085	.0744	.000E+00	.000E+00	-4.765	.790

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.156	.141	.625E-01	.141	.197

Age 3

Fleet	86	87	88	89	90
1	-7.80	-7.42	-7.29	-7.62	-7.55
2	-12.12	-13.48	-13.09	-13.02	-12.52
3	-1.61	-4.96	-3.46	-6.45	-2.66

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-7.54	.211	.1177	.1759	.000E+00	.000E+00	-7.538	.086
2	-12.85	.580	.0092	.1249	.000E+00	.000E+00	-12.847	.237
3	-3.81	2.075	.0222	.0551	.000E+00	.000E+00	-3.808	.847

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.167	.197	.108	.197	.298

Age 4

Fleet	86	87	88	89	90
1	-7.42	-7.97	-7.59	-7.60	-7.47
2	-12.52	-12.48	-13.31	-12.86	-13.07
3	-1.97	-.28	-3.52	-5.80	-3.39

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-7.61	.235	.1096	.1463	.000E+00	.000E+00	-7.609	.096
2	-12.85	.387	.0092	.2102	.000E+00	.000E+00	-12.849	.158
3	-2.99	2.240	.0501	.2507	.000E+00	.000E+00	-2.993	.914

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.162	.200	.116	.200	.339

Table 2.12 Separable exploitation pattern and log catch residuals.

Title : Sardine in Fishing Areas VIIIc and IXa
At 11.19.56 25 JUNE 1991
from 80 to 90 on ages 0 to 5
with Terminal F of .161 on age 2 and Terminal S of 1.000

Initial sum of squared residuals was 26.585 and
final sum of squared residuals is 9.798 after 126 iterations

Matrix of Residuals

Years / Ages	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90		WTS
0/ 1	-.520	.555	-1.994	-.976	-1.133	-.469	-.502	.679	.157	-.330	.000	.125
1/ 2	.028	-.116	-.276	-.092	.377	-.506	-.018	-.115	-.008	.142	.000	.428
2/ 3	.369	.399	.312	-.053	-.269	.737	.149	-.066	-.115	.031	.000	.331
3/ 4	.063	.017	.116	.271	.098	.008	-.069	-.015	.127	-.043	.000	1.000
4/ 5	-.203	-.260	.230	-.142	-.044	.035	.140	.002	-.162	.021	.000	.648
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	-3.437	
WTS	.001	.001	.001	.001	.001	.001	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	80
F-values	.1949

	81	82	83	84	85	86	87	88	89	90
F-values	.1889	.1763	.1560	.1269	.1375	.1645	.1506	.1453	.1384	.1610

Selection-at-age (S)

	0	1	2	3	4	5
S-values	.3152	.6722	1.0000	1.0955	1.0637	1.0000

Table 2.13 SOP check.

ardine in Fishing Areas VIIIc and IXa
ATEGORY: TOTAL

EAN WEIGHT AT AGE IN THE CATCH UNIT: kilogram

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017
1	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034
2	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052	.052
3	.060	.060	.060	.060	.060	.060	.060	.060	.060	.060	.060	.060
4	.068	.068	.068	.068	.068	.068	.068	.068	.068	.068	.068	.068
5	.072	.072	.072	.072	.072	.072	.072	.072	.072	.072	.072	.072
6	.079	.079	.079	.079	.079	.079	.079	.079	.079	.079	.079	.079
7+	.093	.093	.093	.093	.093	.093	.093	.093	.093	.093	.093	.093

	1988	1989	1990
0	.017	.013	.024
1	.034	.035	.032
2	.052	.052	.047
3	.060	.059	.057
4	.068	.066	.061
5	.072	.071	.067
6	.079	.087	.070
7+	.093	.093	.096

Table 2.14 VPA

Sardine in Fishing Areas VIIIc and IXa

ISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .33

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.044	.083	.006	.042	.009	.027	.027	.089	.056	.035	.051
1	.176	.155	.096	.081	.206	.061	.110	.085	.094	.098	.119
2	.278	.262	.255	.164	.106	.256	.178	.153	.134	.134	.147
3	.205	.214	.186	.190	.156	.163	.171	.154	.175	.157	.165
4	.187	.179	.192	.141	.115	.151	.190	.162	.145	.143	.187
5	.194	.209	.204	.126	.122	.120	.164	.143	.147	.153	.152
6+	.194	.209	.204	.126	.122	.120	.164	.143	.147	.153	.152
2- 6)U	.212	.215	.208	.149	.124	.162	.173	.151	.149	.148	.161

Table 2.15 VPA

Sardine in Fishing Areas VIIIc and IXa

TOCK SIZE IN NUMBERS UNIT: millions

TOMASS TOTALS UNIT: thousand tonnes

AL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING TOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE SED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .250
PROPORTION OF ANNUAL M BEFORE SPAWNING: .250

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	22705	14944	11598	29979	14670	11240	10563	19348	9431	8433	5546	0
1	14437	15613	9884	8287	20658	10455	7863	7393	12730	6410	5857	3790
2	7406	8702	9611	6458	5492	12091	7072	5062	4884	8328	4178	3738
3	2340	4033	4815	5356	3939	3553	6729	4255	3122	3070	5235	2593
4	1060	1370	2340	2873	3183	2422	2170	4079	2622	1885	1887	3192
5	311	632	824	1389	1794	2040	1497	1290	2495	1630	1175	1126
6+	198	471	817	1379	1183	1046	1281	1492	1620	2009	2035	1981
TAL NO	48457	45764	39889	55721	50920	42846	37176	42920	36905	31766	25911	
S NO	24735	26123	24567	29402	30009	26985	23782	24379	23112	20568	17588	
T.BIOM	1037	1143	1186	1443	1338	1326	1211	1252	1128	1073	946	
S BIOM	632	773	861	977	955	977	919	901	847	819	748	

Table 2.16 Input data for RCRTINX2 analysis.

```
SARDINE DIV VIIIC IXA : RECRUITS AGE 0
4,7,2          (no. surveys, no. of years, no. of vpa column)
1984, 14670,   -11,   -11, 2971, 227
1985, 11240,   292,    55, 2061, 162
1986, 10565,  5949,   632, 3545,  85
1987, 19348,  4195,   221, 3690, 259
1988,  9431,  3139,   -11,   -11, 210
1989,  8433,   -11,    69,   -11, 139
1990,  5546,   -11,    25,   -11, 109
PAUGS
SMARS
PNOVS
GAL2ndS.
```

Table 2.17

Analysis by RCRTINX2 of data from file sarrecruit91a
SARDINE DIV VIIIC IXA : RECRUITS AGE 0

Data for 4 surveys over 7 years
REGRESSION TYPE = C
TAPERED TIME WEIGHTING APPLIED
POWER = 3 OVER 7 YEARS
PRIOR WEIGHTING NOT APPLIED
FINAL ESTIMATES SHRUNK TOWARDS MEAN
ESTIMATES WITH S.E.'S GREATER THAN THAT OF MEAN INCLUDED
MINIMUM S.E. FOR ANY SURVEY TAKEN AS .20
MINIMUM OF 5 POINTS USED FOR REGRESSION

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
PAUGS									
SMARS	4.2485	.000	.000	.0000	0	.0000	.00000	.00000	.00000
PNOVS									
GAL2nd	4.9416	1.227	3.096	.3005	5	9.1580	.57401	.65630	.18521
MEAN						9.4330	.31291	.31291	.81479

Yearclass = 1990

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
PAUGS									
SMARS	3.2581	.000	.000	.0000	0	.0000	.00000	.00000	.00000
PNOVS									
GAL2nd	4.7005	1.421	2.065	.3172	6	8.7435	.59283	.72614	.18111
MEAN						9.3417	.34149	.34149	.81889

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1988	.00	1.00	.00	.00	9.15 9432.00	.00
1989	9.38	11873.28	.28	.11	9.04 8433.99	.38
1990	9.23	10232.54	.31	.23	8.62 5547.00	.75

Table 2.18

List of input variables for the ICES prediction program.

SARDINE IN FISHING AREAS VIIIC AND IXA
The reference F is the mean F (non-weighted) for the age group range from 2 to 6

The number of recruits per year is as follows:

Year	Recruitment
1991	13000.0
1992	13000.0
1993	13000.0

Proportion of F (fishing mortality) effective before spawning: .2500
Proportion of M (natural mortality) effective before spawning: .2500

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	kilogram
Weight by age group in the stock:	kilogram
Stock biomass:	thousand tonnes
Catch weight:	thousand tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	13000.0	.05	.33	.36	.018	.014
1	7239.0	.11	.33	.66	.034	.015
2	5603.0	.16	.33	.86	.050	.038
3	2593.0	.16	.33	1.00	.059	.050
4	3192.0	.16	.33	1.00	.065	.064
5	1126.0	.16	.33	1.00	.070	.067
6+	1981.0	.16	.33	1.00	.079	.079

Table 2.19

Effects of different levels of fishing mortality on
catch, stock biomass and spawning stock biomass.

SARDINE IN FISHING AREAS VIIIC AND IXA

Year 1991					Year 1992					Year 1993	
fac-tor	ref. F	stock biomass	sp.stock biomass	catch	Basis	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.0	.16	1069	786	143	.0	.00	1047	792	0	1186	910
					F_{med}	.12		771	108	1091	804
					F_{90}	.16		764	141	1062	772
					$F_{0.1}$	.40		723	320	906	607

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1993 has been calculated with the same fishing mortality as for 1992
The reference F is the mean F (non-weighted) for the age group range from 2 to 6

Table 2.20 SARDINE in Divisions VIIIc and IXa. Effects of the F status quo level on catch, stock biomass and spawning stock biomass during 1991-1993.

****

* Year 1991. F-factor 1.000 and reference F .1610 *

****

						at 1 January		at 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	.0507	548.15	9.867	13000.0	182.00	4680.0	65.520	4255.1	59.572
1	.1082	634.19	21.351	7239.0	108.59	4777.7	71.666	4282.0	64.230
2	.1610	712.82	35.879	5603.0	212.91	4818.6	183.106	4262.0	161.955
3	.1610	329.89	19.353	2593.0	129.65	2593.0	129.650	2293.5	114.673
4	.1610	406.09	26.396	3192.0	204.29	3192.0	204.288	2823.3	180.690
5	.1610	143.25	10.028	1126.0	75.44	1126.0	75.442	995.9	66.727
6+	.1610	252.03	19.826	1981.0	156.50	1981.0	156.499	1752.2	138.421
Total		3026.42	142.699	34734.0	1069.38	23168.3	886.171	20663.9	786.267

****

* Year 1992. F-factor 1.000 and reference F .1610 *

****

						at 1 January		at 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	.0507	548.15	9.867	13000.0	182.00	4680.0	65.520	4255.1	59.572
1	.1082	778.31	26.203	8884.0	133.26	5863.4	87.951	5255.0	78.825
2	.1610	594.20	29.908	4670.6	177.48	4016.7	152.635	3552.7	135.003
3	.1610	436.26	25.594	3429.1	171.46	3429.1	171.456	3033.0	151.650
4	.1610	201.89	13.123	1587.0	101.56	1587.0	101.565	1403.6	89.833
5	.1610	248.53	17.397	1953.5	130.89	1953.5	130.888	1727.9	115.768
6+	.1610	241.92	19.031	1901.5	150.22	1901.5	150.221	1681.9	132.868
Total		3049.26	141.123	35425.7	1046.87	23431.3	860.235	20909.2	763.519

****

* Year 1993. F-factor 1.000 and reference F .1610 *

****

						at 1 January		at 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	.0507	548.15	9.867	13000.0	182.00	4680.0	65.520	4255.1	59.572
1	.1082	778.31	26.203	8884.0	133.26	5863.4	87.951	5255.0	78.825
2	.1610	729.22	36.704	5731.9	217.81	4929.4	187.319	4360.0	165.681
3	.1610	363.66	21.335	2858.5	142.92	2858.5	142.923	2528.3	126.413
4	.1610	267.00	17.355	2098.7	134.31	2098.7	134.315	1856.2	118.799
5	.1610	123.56	8.649	971.2	65.07	971.2	65.073	859.0	57.556
6+	.1610	300.16	23.613	2359.4	186.39	2359.4	186.390	2086.8	164.859
Total		3110.06	143.725	35903.6	1061.77	23760.6	869.490	21200.5	771.705

Table 3.1 Landings (tonnes) of HORSE MACKEREL by Sub-area. (Data as estimated by the Working Group).

Sub-area	1979	1980	1981	1982	1983	1984
II	2	-	-	-	412	23
IV	1,412	2,151	7,245	2,788	4,420	25,987
VI	7,791	8,724	11,134	5,036	24,881	31,716
VII	43,525	45,697	34,749	33,478	40,526	42,952
VIII	47,155	37,495	40,073	22,683	28,223	25,629
IX	37,619	36,903	35,873	39,726	48,733	23,178
Total	137,504	130,970	129,074	103,711	147,195	149,485
Sub-area	1985	1986	1987	1988	1989[1]	1990[1]
II	79	214	3,331	6,818	4,809	11,414
IV	24,238	20,746	20,895	62,892	112,047	145,062
VI	32,995	20,455	35,157	45,842	34,870	20,904
VII	39,034	77,628	100,734	90.253	138,890	192,225
VIII	27,740	36,061	37,703	34,177	42,991	47,802
IX	20,237	31,159	34,243	37,888	38,259	24,023
Total	144,323	186,263	232,063	277,870	371,866	441,430

[1] Preliminary.

Table 3.2 Landings (tonnes) of HORSE MACKEREL in Sub-area II by country. (Data as estimated by the Working Group.)

Country	1979	1980	1981	1982	1983	1984
Denmark	-	-	-	-	-	-
France	+	-	-	-	-	1
Germany, Fed. Rep.	2	-	+	-	-	-
Norway	-	-	-	-	412	22
USSR	-	-	-	-	-	-
Total	2	-	+	-	412	23
Country	1985	1986	1987	1988	1989	1990[1]
Faroe Islands	-	-	-	-	-	964
Denmark	-	-[2]	39[2]	-[2]	-	-
France	1	-[2]	-[2]	-[2]	-	-
Germany, Fed. Rep.	-	-	-	64	12	+
Norway	78	214	3,272	6,285	4,770	9,135
USSR	-	-	-	469	27	1,298
UK (England + Wales)	-	-	-	-	-	17
Total	79	214	3,311	6,818	4,809	11,414

[1] Preliminary.
[2] Included in Sub-area IV.

Table 3.3 Landings (tonnes) of HORSE MACKEREL in Sub-area IV by country (Data as estimated by the Working Group).

Country	1979	1980	1981	1982	1983	1984
Belgium	9	8	34	7	55	20
Denmark	496	199	3,576	1,612	1,590	23,730
Faroe Islands	-	260	-	-	-	-
France	221	292	421	567	366	827
Germany, Fed. Rep.	376	+	139	30	52	+
Ireland	-	1,161	412	-	-	-
Netherlands	88	101	355	559	2,029[4]	824[4]
Norway	199	119	2,292	7	322	94
Poland	-	-	-	-	2	-
Sweden	+	-	-	-	-	-
UK (Engl. & Wales)	23	11	15	6	4	3
UK (Scotland)	+	-	-	-	-	489
USSR	-	-	-	-	-	-
Total	1,412	2,151	7,245	2,788	4,420	25,987

Country	1985	1986	1987	1988	1989	1990[1]
Belgium	13	13	9	10	10	13
Denmark	22,495	18,652[2]	7,290[2]	20,323[2]	23,329[2]	20,605[2]
Faroe Islands	-	-	-	-	-	942
France	298	231[3]	189[3]	784[3]	248	220
Germany, Fed. Rep.	+	-	3	153	506	2,469[6]
Ireland	-	-	-	-	-	687
Netherlands	160[4]	600[4]	850[4]	1,060[4]	14,172	1,970
Norway[2]	203	776	11,728[5]	34,425[5]	84,161	117,903[2]
Poland	-	-	-	-	-	-
Sweden	-	2[2]	-	-	-	102
UK (Engl. & Wales)	71	3	339	373	10	10
UK (Scotland)	998	531	487	5,749	2,093	458
USSR	-	-	-	-	-	-
Unallocated+discards	-	-	-	-	-12,482[5]	-317[5]
Total	24,238	20,746	20,895	62,892	112,047	145,062

[1] Preliminary.
[2] Includes Division IIIa.
[3] Includes Division IIa.
[4] Estimated from biological sampling.
[5] Assumed to be misreported.
[6] Includes 13 t from GDR.

Table 3.4 Landings (tonnes) of HORSE MACKEREL in Sub-area VI by country (Data as estimated by the Working Group).

Country	1979	1980	1981	1982	1983	1984
Denmark	443	734	341	2,785	7	-
Faroe Islands	-	-	-	1,248	-	-
France	151	45	454	4	10	14
Ireland	-	-	-	-	15,086	13,858
Germany, Fed. Rep.	155	5,550[2]	10,212[2]	2,113	4,146[2]	130[2]
Netherlands	6,910	2,385[2]	100[2]	50	5,500[2]	17,500[2]
Norway	-	-	5	-	94	-
Spain	20	-	-	-	-	-
UK (Engl. & Wales)	73	9	5	+	-	+
UK (Scotland)	39	1	17	83	38	214
USSR	-	-	-	-	-	-
Total	7,791	8,724	11,134	6,283	24,881	31,716

Country	1985	1986	1987	1988	1989	1990[1]
Denmark	-	-	769[4]	1,655[4]	973	615
Faroe Islands	4,014	1,992[2]	4,450[4]	4,000[4]	3,059	628
France	13	12	20	10	2	17
Ireland	27,102	28,125	29,743	27,872	19,493	15,911
Germany, Fed. Rep.	191[2]	354[2]	174[2]	615[2]	1,162	2,474
Netherlands	18,450[2]	3,450[2]	5,750[2]	3,340[2]	1,907	660
Norway	-	83[3]	75[3]	41[3]	-[3]	-[3]
Spain	-	-[3]	-[3]	-[3]	-[3]	-[3]
UK (Engl. & Wales)	996	198	404	475	44	145
UK (Scotland)	1,427	138	1,027	7,834	1,737	267
USSR	-	-	-	-	-	44
Unallocated+discards	19,168	-13,897	-7,255	-	6,493	143
Total	33,025	20,455	35,157	45,842	34,870	20,904

[1] Preliminary.
[2] Estimated from biological sampling.
[3] Included in Sub-area VII.
[4] Includes Divisions IIIa, IVa,b and VIb.

Table 3.5 Landings (tonnes) of HORSE MACKEREL in Sub-area VII by country. (Data as estimated by the Working Group.)

Country	1979	1980	1981	1982	1983	1984
Belgium	3	-	1	1	-	-
Denmark	4,287	5,045	3,099	877	993	732
France	4,407	1,983	2,800	2,314	1,834	2,387
German Dem. Rep.	-	-	-	-	-	-
Germany, Fed. Rep.	5,333	2,289	1,079	12	1,977	228
Ireland	-	-	16	-	-	65
Netherlands	25,174	23,002	25,000[2]	27,500[2]	34,350[2]	38,700[2]
Norway	959	394	-	-	-	-
Poland	-	-	-	-	-	-
Spain	676	50	234	104	142	560
UK (Engl.& Wales)	2,686	12,933	2,520	2,670	1,230	279
UK (Scotland)	-	1	-	-	-	1
USSR	-	-	-	-	-	-
Total	26,060	43,525	45,697	34,749	33,478	42,952

Country	1985	1986	1987	1988	1989	1990[1]
Faroes	-	-	-	-	-	28
Belgium	+[3]	+[3]	2	-	-	+
Denmark	1,477[3]	30,408[3]	27,368	33,202	37,474	30,954
France	1,881	3,801	2,197	1,523	4,576	2,538
Germany	-	5	374	4,705	7,743	8,109
Ireland	100[2]	703[2]	15[2]	481[2]	12,645	17,887
Netherlands	33,550[2]	40,750[2]	69,400[2]	43,560[2]	43,582	111,900
Norway	-	-	-	-	-	-
Poland	-	-	-	-	-	-
Spain	275	137	148	150	14	16
UK (Engl.& Wales)	1,630	1,824	1,228	3,759	4,488	13,371
UK (Scotland)	1	+	2	2,873	+	139
USSR	120	-	-	-	-	-
Unallocated+discards	-	-	-	-	28,368	7,614
Total	39,034	77,628	100,734	90,253	138,890	192,196

[1] Provisional.
[2] Estimated from biological sampling.
[3] Includes Sub-area VI.

Table 3.6 Landings (tonnes) of HORSE MACKEREL in Sub-area VIII by country. (Data as estimated by the Working Group.)

Country	1979	1980	1981	1982	1983	1984
Denmark	127	-	-	-	-	-
France	4,240	3,361	3,711	3,073	2,643	2,489
German Dem. Rep	-	-	-	-	-	-[2]
Netherlands	-	-	-	-	-	-[2]
Spain	42,766	34,134	36,362	19,610	25,580	23,119
UK (Engl.& Wales)	22	-	+	1	-	1
USSR	-	-	-	-	-	20
Total	47,155	37,495	40,073	22,683	28,223	25,629

Country	1985	1986	1987	1988	1989	1990[1]
Denmark	-	446	3,283	2,793	6,729	5,726
France	4,305	3,534	3,983[2]	4,502	4,719	5,082
German Dem. Rep	-[2]	-[2]	-	-	-	-
Netherlands	23,292[3]	31,033	30,098	26,629	31,475	6,000
Spain	143	392	339	253	68	29,488
UK (Engl.& Wales)	-	656	-	-	-	6
USSR	-	-	-	-	-	-
Unallocated+discards	-	-	-	-	-	1,500
Total	27,740	36,061	37,703	34,177	42,991	47,802

[1] Preliminary.
[2] Included in Sub-area VII.

Table 3.7 Landings (tonnes) of HORSE MACKEREL in Sub-area IX by country. (Data as estimated by the Working Group.)

Country	1979	1980	1981	1982	1983	1984
Portugal	24,489	25,224	23,753	30,886	30,951[2]	17,307[2]
Spain	12,880	11,679	12,120	8,840	17,782[2]	5,871
USSR	250	-	-	-	-	-
Total	37,619	36,903	35,873	39,726	48,733[2]	23,178

Country	1985	1986	1987	1988	1989	1990[1]
Portugal	9,420[2]	17,682[2]	21,444[2]	25,629	25,231[2]	19,958
Spain	10,817[2]	13,477[2]	12,799[2]	12,259	13,028	4,065
USSR	-	-	-	-	-	-
Unallocated+discards	-	-	-	-	-	-
Total	20,237[2]	31,159[2]	34,243[2]	37,888	38,259	24,023

[1] Preliminary
[2] Data provided by the Working Group members.

Table 3.8 Quarterly catches of horse mackerel ('000 t) by division and sub-areas in 1990 (Data submitted by Working Group members).

Division	Quarter 1	2	3	4	Total	Not given by quarter	Σ
IIa	-	-	1	8	9	2	11
IIIa	+	-	+	15	15	-	15
IVa	+	+	8	84	92	1	93
IVb,c	+	1	14	22	37	+	37
VIa	+	1	13	6	20	1	21
VIIa-c,e-k	44	40	34	58	176	15	191
VIId	+	1	+	1	2	-	2
VIIIa-b,d,e	8	3	2	10	23	-	23
VIIIc	6	7	7	5	25	-	25
IXa	4	7	7	6	24	-	24
SUM	62	60	86	215	423	19	442

Table 3.9 Landings and discards of horse mackerel (t) by year, by sub-areas, for the North Sea, Western, and Southern horse mackerel. (Data estimated by the Working Group.)

Year	North Sea horse mackerel				Western horse mackerel							Southern horse mackerel		
	IIIa		IVb,c	VIId	Total	IIa	IVa	VIa	VIIa-c e-k	VIIIa, b,d,e	Discards	Total	VIIIc	IXa	Total
1982	-	2,788	-	1,247	4,035	-	-	6,283	32,231	3,073	-	41,588	19,610	39,726	59,336
1983	-	4,420	-	3,600	8,020	412	-	24,881	36,926	2,643	-	64,862	25,580	48,733	74,313
1984	-	25,893	-	3,585	29,478	23	94	31,716	38,782	2,510	500	73,625	23,119	23,178	46,297
1985	1,138		22,897	2,715	26,750	79	203	33,025	35,296	4,448	7,500	80,551	23,292	20,237	43,529
1986	396		19,496	4,756	24,648	214	776	20,343	72,761	3,071	8,500	105,665	31,033	31,159	60,649
1987	436		9,477	1,721	11,634	3,311	11,185	35,197	99,942	7,605	-	157,240	30,098	34,243	64,341
1988	2,261		18,290	3,120	23,671	6,818	42,174	45,842	81,978	7,548	3,740	188,100	26,629	37,888	62,904
1989	913		25,830	6,522	33,265	4,809	85,304[2]	34,870	131,218	11,516	1,150	268,867	31,475	38,259	69,734
1990	14,872[1]		17,437	1,325	18,762	11,414	112,753[2]	20,794	182,580	21,120	9,930	373,463	25,182	24,023	49,205

[1] Norwegian and Danish catches are included in the Western horse mackerel.
[2] Norwegian catches in Division IVb included in the Western horse mackerel.

Table 3.10 Catches (t) and percentages (%) of Trachurus mediterraneus in relation to total landings of Trachurus sp. in Divisions VIIIa,b and VIIIc and IXa in 1990.

	TRACHURUS MEDITERRANEUS								-T.TRACHURUS-		
	1.Q		2.Q		3.Q		4.Q		Total		
	(t)	(%)	(t)	(%)	(t)	(%)	(t)	(%)	(t)	(%)	(t)
VIIIc (Spain)											
(Eastern subd.)	380	50,5	61	6,8	307	54,7	929	82,4	1677	50,3	1654
(Central subd.)	395	6,1	0	0,0	156	2,0	715	10,5	1266	17,8	5851
(Western subd.)	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	17676
(All subdivis.)	775	12,0	61	0,9	463	7,2	1644	30,7	2943	10,5	25182
IXa (Spain)	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	4065
IXa (Portugal)	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	19958
VIIIa,b (Spain)	168	13,3	8	0,64	27	2,43	96	9,67	298	6,47	4306

Table 3.11 Planned research vessel deployment of the **1992** Mackerel / Horse Mackerel Egg Surveys in the western and southern area.

Area	Participating Country	Participating Ships	Coverage	Egg sampling week no's	Trawl sampling week no's	Latitude to be covered
WESTERN	Germany	"Walter Herwig"	1	14 - 16		44°N - 56°N
(Sub-area VI, VII	Scotland	"Scotia"	2	18 - 20		44°N - 58°N
and Div. VIIIa,b,d)	Ireland	Charter	3	22 - 24		52°N - 58°N
	England	"Cirolana"	3	22 - 24		48°30' - 52°N
	France	"Thalassa"	3	22 - 24		44°N - 48°30'N
	Spain	"Cornide de S."	3	22 - 24	22 - 24	44°N - 47°N
	Netherlands	"Tridens"	3		22 - 24	46°N - 52°30'N
	EC	Charter	3		22 - 24	50°N - 58°N
	Netherlands	"Tridens"	4	26 - 27		44°N - 49°N
	Scotland	Charter	4	26 - 27		49°N - 58°N
	Scotland	Charter	5	28		44°N - 56°N
SOUTHERN	Portugal	"Noruega"	peak-spawning	10 - 13	10 - 13	36°N - 42°N
(Div. VIIIc and IXa)	Spain	"Cornide de S."	peak-spawning	19 - 21	19 - 21	42°N - 44°N

Table 3.12 Annual length distributions (millions) of horse mackerel catches by fleet and by country in 1990.

Length	Ireland	Netherlands	Norway	Germany*	Spain				Portugal		
(cm)	Trawl	Pel. tr.	P.seine	Pel.tr.	Trawl	P.seine	Hook l	Gillnet	Trawl	P.seine	Artisanal
5											
6											
7						0.05					
8						0.93					
9						4.87					
10				0.01		12.70				0.31	0.01
11				0.06	0.12	15.57				0.66	0.01
12				0.10	0.71	17.85			0.28	1.36	0.01
13				0.09	4.32	17.45			1.49	3.30	0.01
14				0.01	9.72	13.95			4.55	14.62	0.05
15					8.06	14.08			9.66	17.17	0.06
16					6.93	13.98			13.99	8.23	0.05
17				0.19	7.04	17.56			11.92	8.53	0.03
18				0.37	6.08	19.76			9.45	5.73	0.08
19				0.59	4.57	10.23			8.01	4.19	0.05
20		0.94		1.65	3.40	6.31			7.65	2.77	0.07
21		6.59		2.95	2.54	6.17	0.02	0.02	5.11	3.12	0.09
22	0.12	17.81		5.24	2.36	8.15	0.01	0.02	2.77	1.27	0.19
23	0.14	42.99		6.86	2.64	9.03	0.01	0.02	2.00	2.23	0.23
24	3.75	63.36	0.02	7.47	3.96	13.84	0.02	0.03	2.33	2.69	0.35
25	15.00	113.28	0.60	5.87	5.01	16.30	0.04	0.06	2.70	2.90	0.61
26	34.22	126.89	1.49	4.98	5.85	13.08	0.08	0.07	3.15	2.57	0.87
27	45.70	127.77	5.71	6.55	5.74	7.84	0.09	0.06	3.50	1.28	1.02
28	35.10	91.70	13.93	7.00	6.82	4.36	0.08	0.06	3.77	0.74	0.93
29	22.63	76.65	46.29	6.81	5.45	3.12	0.08	0.05	3.49	0.30	1.24
30	14.49	51.74	57.63	3.83	4.20	2.03	0.08	0.05	2.94	0.43	1.22
31	7.84	29.31	70.22	5.15	2.64	1.61	0.10	0.04	2.06	0.30	1.17
32	5.34	17.43	63.67	4.30	2.27	0.76	0.15	0.06	1.18	0.08	0.97
33	3.32	12.19	52.51	7.55	2.18	0.93	0.16	0.06	0.73		0.86
34	1.78	9.62	35.16	6.66	2.23	0.68	0.18	0.06	0.44		0.80
35	0.92	4.02	23.65	5.17	2.05	0.54	0.18	0.06	0.25		0.72
36	0.52	3.38	11.68	5.16	1.34	0.26	0.15	0.05	0.21		0.72
37	0.26	1.57	11.25	2.43	0.71	0.16	0.08	0.02	0.19		0.64
38	0.10	1.40	4.35	0.69	0.31	0.13	0.06	0.02	0.17		0.58
39	0.33		5.09	0.19	0.15	0.08	0.03	0.01	0.06		0.26
40		0.48	0.39		0.08	0.03	0.01		0.06		0.10
41			0.08		0.04	0.02	0.01				0.03
42					0.02						0.01
43						0.04					
44						0.02					
45+						0.05	0.01	0.01			
Total	192.25	799.29	403.72	97.93	109.55	254.57	1.65	0.82	104.15	84.78	14.07

*The total annual German catch is based on the length measurements of commercial catches in the ICES regions VII and IV in the fourth quarter provided by the IFH (Rostock).

Table 4.1 Age composition (%) in commercial and research vessel catches of North Sea horse mackerel taken by the Netherlands in 1987-1990.

Age	Year			
	1987	1988	1989	1990
0	0.0	0.0	1.3	0.0
1	0.5	0.0	0.0	5.3
2	2.0	3.5	2.6	2.7
3	0.0	1.6	28.0	9.5
4	0.0	0.0	12.9	9.7
5	27.9	4.0	1.9	4.8
6	2.6	38.4	3.9	0.3
7	5.6	2.4	33.4	4.2
8	18.7	2.9	4.0	39.7
9	2.8	14.2	1.1	5.0
10	3.3	0.3	2.4	2.4
11	5.5	5.4	0.8	7.3
12	4.7	5.6	0.7	1.0
13	1.5	5.8	1.3	1.9
14	2.0	0.8	1.1	1.2
15+	22.8	15.4	4.5	5.0

Table 5.1 Estimates of total egg production of pre-spawning and spawning stock biomass of Western horse mackerel derived from the western egg surveys.

Year	Total egg production (10^{15})	Horse mackerel pre-spawning stock biomass (10^6 t)[1]	Horse mackerel spawning stock biomass (10^6 t)[2]
1977	0.533[3]	0.644	0.676
1980	0.635[3]	0.767	0.806
1983	0.381[3]	0.460	0.483
1986	0.508[3]	0.613	0.645
1989	1.683[4]	2.033	2.134

[1] Using the fecundity weight relationship of 1,655 eggs per g pre-spawning female (Eltink and Vingerhoed, 1989) and a sex ratio of 1:1, Anon., (1990b).
[2] Spawning stock biomass adjusted using the relative weight of pre-spawning and spawning fish on the spawning grounds (increase of 5%) (Eltink and Vingerhoed, 1989).
[3] Eaton, 1989. In 1977, incomplete coverage.
[4] ICES, Anon., (1990b), standard area + area east and south of standard area.

Table 5.2 Catch in numbers ('000) at age and catch in tonnes of western horse mackerel by quarter and by Division(s) in 1990.

Age	IIa 1'st Q catch ('000)	IVa 1'st Q catch ('000)	VIa 1'st Q catch ('000)	VIIb,c,j,k 1'st Q catch ('000)	VIIa,e,f,g,h 1'st Q catch ('000)	VIIIa,b,d,e 1'st Q catch ('000)	All areas 1'st Q catch ('000)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	1,155	1,155
2	0	0	0	0	952	33,578	34,530
3	0	0	0	0	5,667	17,148	22,815
4	0	0	0	636	6,619	3,185	10,439
5	0	0	0	2,766	952	2,174	5,892
6	0	0	0	1,224	0	1,057	2,281
7	0	0	0	1,224	0	921	2,145
8	0	0	0	175,507	9,452	18,106	203,066
9	0	0	0	4,308	0	679	4,988
10	0	0	0	7,393	0	1,343	8,736
11	0	0	0	12,655	0	740	13,394
12	0	0	0	954	0	604	1,557
13	0	0	0	2,178	0	498	2,676
14	0	0	0	1,224	0	996	2,221
15+	0	0	0	6,533	0	3,879	10,413
Total	0	0	0	216,603	23,642	86,063	326,307
Tonnes	0	0	0	41,910	2,163	8,204	52,277

Age	IIa 2'nd Q	IVa 2'nd Q	VIa 2'nd Q	VIIb,c,j,k 2'nd Q	VIIa,e,f,g,h 2'nd Q	VIIIa,b,d,e 2'nd Q	All areas 2'nd Q
0	0	0	0	0	0	0	0
1	0	0	0	0	0	1,066	1,066
2	0	0	0	0	0	1,730	1,730
3	0	0	0	0	0	2,794	2,794
4	0	0	0	0	0	748	748
5	0	0	0	3,509	0	576	4,085
6	0	0	0	1,414	0	313	1,727
7	0	0	0	3,510	0	261	3,770
8	0	0	0	254,105	0	4,889	258,994
9	0	0	0	5,996	0	231	6,227
10	0	0	0	1	0	605	606
11	0	0	0	3,365	0	317	3,682
12	0	0	0	537	0	277	813
13	0	0	0	0	0	222	223
14	0	0	0	1	0	483	484
15+	0	0	0	539	0	1,909	2,449
Total	0	0	0	272,977	0	16,423	289,400
Tonnes	0	0	0	41,125	0	2,812	43,937

Age	IIa 3'rd Q	IVa 3'rd Q	VIa 3'rd Q	VIIb,c,j,k 3'rd Q	VIIa,e,f,g,h 3'rd Q	VIIIa,b,d,e 3'rd Q	All areas 3'rd Q
0	0	0	0	0	0	0	0
1	0	0	0	0	0	7,253	7,253
2	0	0	0	0	0	1,361	1,361
3	0	0	0	2,373	0	429	2,803
4	0	0	0	3,653	0	130	3,782
5	67	0	197	5,025	0	181	5,470
6	0	0	0	2,466	0	40	2,506
7	0	493	197	0	0	190	880
8	3,362	12,713	8,462	244,841	0	2,133	271,512
9	129	493	197	4,747	0	261	5,827
10	67	2,932	0	2,374	0	486	5,859
11	714	3,424	591	4,840	0	133	9,702
12	67	493	197	1,187	0	188	2,132
13	67	1,478	0	0	0	170	1,715
14	0	493	0	1	0	219	713
15+	192	962	0	2,471	0	1,985	5,610
Total	4,665	23,481	9,841	273,979	0	15,159	327,126
Tonnes	1,449	7,447	2,204	45,505	0	1,978	58,583

Age	IIa 4'th Q	IVa 4'th Q	VIa 4'th Q	VIIb,c,j,k 4'th Q	VIIa,e,f,g,h 4'th Q	VIIIa,b,d,e 4'th Q	All areas 4'th Q
0	0	0	0	0	0	0	0
1	0	0	0	0	2,157	7,486	9,643
2	0	0	0	0	1,079	3,491	4,570
3	0	0	0	714	82,223	18,804	101,741
4	0	0	0	4,463	36,163	1,965	42,591
5	0	0	0	1,960	13,415	372	15,747
6	0	0	288	177	2,814	89	3,369
7	1,387	7,941	0	714	2,157	309	12,509
8	29,136	204,935	13,815	159,914	102,300	53,699	563,798
9	2,775	7,941	288	1,430	4,972	225	17,631
10	0	47,263	0	3	3,236	354	50,856
11	1,387	55,204	0	2,321	9,709	105	68,727
12	0	7,941	0	1,430	0	166	9,537
13	0	23,820	0	715	3,236	110	27,882
14	0	7,941	0	2	5,394	180	13,518
15+	0	15,502	0	191	17,261	1,597	34,551
Total	34,685	378,491	14,391	174,034	286,118	88,952	976,671
Tonnes	9,925	120,049	2,789	31,047	44,925	9,598	218,333

Table 5.3 Weight (g) at age of western horse mackerel by quarter and by Division(s) in 1990.

Age	IIa 1'st Q weight (g)	IVa 1'st Q weight (g)	VIa 1'st Q weight (g)	VIIb,c,j,k 1'st Q weight (g)	VIIa,e,f,g,h 1'st Q weight (g)	VIIIa,b,d,e 1'st Q weight (g)	All areas 1'st Q weight (g)
0	0	0	0	0	0	0	0
1	0	0	0	0	0	12	12
2	0	0	0	0	37	26	26
3	0	0	0	0	69	52	56
4	0	0	0	127	98	92	98
5	0	0	0	120	79	107	109
6	0	0	0	132	0	117	125
7	0	0	0	132	0	152	141
8	0	0	0	173	107	148	168
9	0	0	0	166	0	184	168
10	0	0	0	282	0	286	282
11	0	0	0	294	0	307	294
12	0	0	0	344	0	288	322
13	0	0	0	385	0	319	373
14	0	0	0	313	0	314	313
15+	0	0	0	401	0	338	378
0-15+	0	0	0	193	91	92	159

Age	IIa 2'nd Q	IVa 2'nd Q	VIa 2'nd Q	VIIb,c,j,k 2'nd Q	VIIa,e,f,g,h 2'nd Q	VIIIa,b,d,e 2'nd Q	All areas 2'nd Q
0	0	0	0	0	0	0	0
1	0	0	0	0	0	19	19
2	0	0	0	0	0	27	27
3	0	0	0	0	0	70	70
4	0	0	0	0	0	114	114
5	0	0	0	131	0	130	131
6	0	0	0	138	0	145	139
7	0	0	0	123	0	215	129
8	0	0	0	150	0	180	150
9	0	0	0	181	0	228	183
10	0	0	0	335	0	325	325
11	0	0	0	187	0	364	203
12	0	0	0	321	0	323	322
13	0	0	0	358	0	361	361
14	0	0	0	365	0	357	357
15+	0	0	0	301	0	380	363
0-15+	0	0	0	151	0	173	152

Age	IIa 3'rd Q	IVa 3'rd Q	VIa 3'rd Q	VIIb,c,j,k 3'rd Q	VIIa,e,f,g,h 3'rd Q	VIIIa,b,d,e 3'rd Q	All areas 3'rd Q
0	0	0	0	0	0	0	0
1	0	0	0	0	0	23	23
2	0	0	0	0	0	32	32
3	0	0	0	136	0	52	123
4	0	0	0	144	0	119	143
5	200	0	150	141	0	144	142
6	0	0	0	133	0	142	133
7	0	250	171	255	0	178	217
8	275	275	218	165	0	223	174
9	305	305	254	170	0	274	192
10	335	335	0	211	0	324	284
11	360	360	316	220	0	327	287
12	385	385	341	293	0	353	327
13	415	415	0	341	0	334	407
14	0	445	0	354	0	352	416
15+	465	465	0	302	0	347	351
0-15+	300	317	225	167	0	129	180

Age	IIa 4'th Q	IVa 4'th Q	VIa 4'th Q	VIIb,c,j,k 4'th Q	VIIa,e,f,g,h 4'th Q	VIIIa,b,d,e 4'th Q	All areas 4'th Q
0	0	0	0	0	0	0	0
1	0	0	0	0	85	31	43
2	0	0	0	0	132	45	66
3	0	0	0	133	98	95	98
4	0	0	0	140	129	107	129
5	0	0	0	143	122	132	125
6	0	0	122	141	122	131	124
7	250	250	0	131	207	158	234
8	275	275	196	179	156	116	209
9	305	305	216	214	214	242	270
10	0	335	0	338	265	331	331
11	360	360	0	216	303	326	347
12	0	385	0	288	0	367	370
13	0	415	0	308	320	337	401
14	0	445	0	385	336	364	400
15+	0	465	0	343	315	359	384
0-15+	280	317	195	179	156	109	223

Table 5.4 Mean length (cm) at age in the Dutch commercial catch of WESTERN HORSE MACKEREL by year.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990
	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$
0	-[1]	-	-	-	-	-	12.2	-	-
1	18.5	16.9[1]	-	16.5	-	20.0	16.4	-	21.0
2	22.3	24.0	20.8[1]	17.8	-	20.4	21.1	-	23.4
3	25.6	25.1	23.1	22.0[1]	23.5	-	23.8	25.8	23.3
4	28.2	27.4	26.0	26.4	23.7[1]	27.4	25.3	26.0	25.2
5	30.3	30.3	28.6	26.9	27.9	26.2[1]	25.3	25.8	25.6
6	32.0	31.3	30.7	29.4	29.0	27.3	26.8[1]	27.8	25.9
7	32.1	32.9	31.9	31.6	30.5	29.5	28.6	27.2[1]	26.8
8	33.0	32.9	31.9	31.6	30.5	31.6	30.5	28.5	27.6[2]
9	34.5	32.3	31.7	33.5	33.6	32.5	32.0	30.7	28.9
10	35.5	30.8	31.3	32.4	33.0	34.4	33.7	31.0	32.7
11	35.1	32.8	-	30.9	33.7	34.9	33.0	33.5	32.1
12	34.7	34.6	33.9	31.1	33.0	30.5	34.9	34.8	34.7
13	35.1	34.7	30.9	33.8	34.8	34.2	32.4	33.6	34.2
14	35.4	34.6	35.4	35.9	31.2	31.1	34.9	34.2	33.5
15+	36.0	34.9	34.5	34.9	36.3	36.0	36.1	37.2	34.3

[1] 1982 year class.

Table 5.5 VPA.

Horse Mackerel in Fishing Areas IIa, IVa, VIa, VIIa-c, VIIe-k, VIIIa-b, VIIId-e

CATCH IN NUMBERS UNIT: millions

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	3	6	0	1	0	0	24	0	19
2	14	2	184	4	0	0	5	0	42
3	92	24	3	468	1	0	2	19	130
4	8	38	28	3	489	2	4	17	58
5	9	11	114	32	6	748	17	5	31
6	8	32	17	78	47	2	825	13	10
7	6	38	29	10	79	35	11	1160	19
8	1	13	26	13	19	76	35	11	1297
9	0	2	11	5	15	10	59	54	35
10	1	4	3	7	11	8	9	75	66
11	4	2	0	0	2	16	14	13	96
12+	51	90	44	32	39	36	52	59	116
TOTAL	197	262	459	653	710	935	1057	1425	1920
A) SOP	42	66	73	81	107	157	198	278	372
B) NOMIN.	42	65	74	81	106	156	188	269	373
B/A) %	99	99	101	99	98	100	95	97	100

Table 5.6 SOP check.

Horse Mackerel in Fishing Areas IIa, IVa, VIa, VIIa-c, VIIe-k, VIIIa-b, VIIId-e
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH UNIT: kilogram

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.054	.039	.034	.029	.029	.068	.031	.050	.032
2	.090	.113	.073	.045	.045	.067	.075	.075	.031
3	.142	.124	.089	.087	.110	.110	.114	.149	.090
4	.178	.168	.130	.150	.107	.155	.132	.142	.124
5	.227	.229	.176	.156	.171	.143	.147	.142	.126
6	.273	.247	.216	.199	.196	.174	.157	.220	.129
7	.276	.282	.245	.243	.223	.198	.240	.166	.202
8	.292	.281	.278	.256	.251	.249	.304	.258	.183
9	.305	.254	.262	.294	.296	.264	.335	.327	.227
10	.369	.260	.259	.257	.280	.321	.386	.330	.320
11	.348	.300	.255	.241	.319	.336	.434	.381	.328
12	.348	.310	.344	.251	.287	.244	.404	.400	.355
13	.348	.315	.232	.314	.345	.328	.331	.421	.399
14	.356	.311	.306	.346	.260	.245	.392	.448	.388
15+	.366	.332	.308	.321	.360	.373	.424	.516	.379

Table 5.7 VPA.

Horse Mackerel in Fishing Areas IIa, IVa, VIa, VIIa-c, VIIe-k, VIIIa-b, VIIId-e

MEAN WEIGHT AT AGE OF THE STOCK UNIT: kilogram

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.050	.050	.050	.050	.050	.050	.050	.050	.050
3	.080	.080	.077	.081	.080	.080	.080	.080	.080
4	.207	.171	.122	.148	.105	.105	.105	.105	.105
5	.232	.227	.155	.140	.134	.126	.126	.103	.127
6	.269	.257	.201	.193	.169	.150	.141	.131	.135
7	.280	.276	.223	.236	.195	.171	.143	.159	.124
8	.292	.270	.253	.242	.242	.218	.217	.127	.154
9	.305	.243	.246	.289	.292	.254	.274	.210	.174
10	.369	.390	.338	.247	.262	.281	.305	.252	.282
11	.344	.305	.300	.300	.300	.291	.337	.263	.272
12+	.348	.309	.300	.300	.300	.297	.352	.302	.404

Table 5.8 VPA.

Horse Mackerel in Fishing Areas IIa, IVa, VIa, VIIa-c, VIIe-k, VIIIa-b, VIIId-e

PROPORTIONS OF MATURITY

UNIT:

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.400	.300	.100	.100	.100	.100	.100	.100	.100
3	.800	.700	.600	.400	.400	.400	.400	.400	.400
4	1.000	1.000	.850	.800	.600	.600	.600	.600	.600
5	1.000	1.000	1.000	.950	.900	.800	.800	.800	.800
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 5.9 VPA.

Horse Mackerel in Fishing Areas IIa, IVa, VIa, VIIa-c, VIIe-k, VIIIa-b, VIIId-e

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .15

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	.007	.000	.000	.008	.000	.000	.007	.000	.010
2	.013	.005	.006	.011	.000	.001	.003	.000	.050
3	.050	.026	.012	.019	.004	.000	.006	.014	.050
4	.031	.025	.036	.015	.023	.010	.037	.062	.050
5	.032	.053	.092	.052	.032	.043	.079	.057	.150
6	.030	.144	.102	.080	.094	.010	.058	.079	.150
7	.069	.183	.179	.075	.104	.089	.078	.102	.150
8	.095	.194	.175	.104	.188	.130	.115	.102	.150
9	.011	.279	.245	.042	.168	.136	.134	.245	.500
10	.098	.200	.676	.231	.122	.118	.159	.238	.500
11	.100	.300	.000	.100	.100	.250	.300	.350	.500
12+	.100	.300	.000	.100	.100	.250	.300	.350	.500
(5-11)U	.062	.193	.210	.098	.115	.111	.132	.167	.300
(5-11)W	.041	.140	.115	.073	.103	.048	.063	.109	.167

Table 5.10 VPA.

Horse Mackerel in Fishing Areas IIa, IVa, VIa, VIIa-c, VIIe-k, VIIIa-b, VIIId-e

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: thousand tonnes

ALL VALUES, EXCEPT THOSE REFERRING TO THE SPAWNING STOCK ARE GIVEN FOR 1 JANUARY; THE SPAWNING STOCK DATA REFLECT THE STOCK SITUATION AT SPAWNING TIME, WHEREBY THE FOLLOWING VALUES ARE USED: PROPORTION OF ANNUAL F BEFORE SPAWNING: .450
PROPORTION OF ANNUAL M BEFORE SPAWNING: .450

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	407	36765	440	179	470	2026	3903	1082	2069	0
2	1166	348	31639	378	153	404	1744	3337	931	1763
3	2024	990	298	27062	322	131	348	1496	2872	762
4	276	1657	831	253	22859	276	113	298	1270	2351
5	307	230	1391	689	215	19221	235	94	241	1040
6	290	256	188	1091	563	179	15850	187	76	178
7	97	242	191	146	867	441	152	12879	149	56
8	13	78	174	137	117	673	347	121	10011	110
9	27	10	55	125	106	83	509	267	94	7417
10	13	23	7	37	104	77	62	383	180	49
11	51	10	0	3	25	79	59	46	260	94
12+	575	373	0	356	439	177	217	214	317	301
TOTAL NO	5245	40984	35212	30458	26240	23769	23540	20403	18470	
SPS NO	3413	3320	5544	12560	14976	15851	16135	13627	11578	
TOT.BIOM	688	716	2062	2776	2952	2849	2743	2644	2277	
SPS BIOM	565	605	554	1314	1802	2121	2386	2138	1753	

Table 5.11

List of input variables for the ICES prediction program.

WESTERN HORSE MACKEREL
The reference F is the mean F (non-weighted) for the age group range from 5 to 11

The number of recruits per year is as follows:

Year	Recruitment
1991	500.0
1992	500.0
1993	500.0

Proportion of F (fishing mortality) effective before spawning: .4500
Proportion of M (natural mortality) effective before spawning: .4500

Data are printed in the following units:

Number of fish: millions
Weight by age group in the catch: gram
Weight by age group in the stock: kilogram
Stock biomass: thousand tonnes
Catch weight: tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	500.0	.01	.15	.00	19.000	.000
2	426.0	.05	.15	.10	47.000	.050
3	379.0	.05	.15	.40	80.000	.080
4	286.0	.05	.15	.60	107.000	.105
5	1040.0	.15	.15	.80	131.000	.127
6	178.0	.15	.15	1.00	153.000	.135
7	56.0	.15	.15	1.00	177.000	.124
8	110.0	.15	.15	1.00	195.000	.154
9	7417.0	.15	.15	1.00	212.000	.176
10	49.0	.15	.15	1.00	226.000	.189
11	94.0	.15	.15	1.00	240.000	.203
12+	301.0	.50	.15	1.00	330.000	.276

Table 5.12

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

WESTERN HORSE MACKEREL

Year 1991						Year 1992				Year 1993	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.5	.23	1678	1338	400	.0	.00	1256	1123	0	1189	1059
					$F_{0.1}$ .5	.08		1082	107	1100	941
					1.0	.15		1045	199	1024	844
					1.6	.24		1002	300	940	743
					2.2	.33		957	401	857	646
					3.0	.45		908	505	770	549
					F_{high} 6.7	1.00		703	873	467	255

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for the time of spawning.
The spawning stock biomass for 1993 has been calculated with the same fishing mortality as for 1992.
The reference F is the mean F (non-weighted) for the age group range from 5 to 11

Table 6.1 Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	VIIIc+IXa
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	23,753	28,776[2]	19,330[2]	376[1]	-	48,482[3]	72,235[3]
1982	12,676	9,906	8,304	30,886[3]	-[2]	-[2]	-[2]	-	28,450[3]	59,336[3]
1983	16,768	6,442	7,741	30,951[3]	8,511	34,054	797	-	43,362[3]	74,313[3]
1984	8,603	3,732	4,972	17,307[3]	12,772	15,334	884	-	28,990[3]	46,297[3]
1985	3,579	2,143	3,698	9,420[3]	16,612	16,555	949	-	34,109[3]	43,529[3]
1986	6,456	7,206	4,020	17,682[3]	9,464	32,878	481	143	42,967[3]	60,649[3]
1987	11,457	6,744	3,244	21,445[3]	9,169	31,530	1,094	134	41,927[3]	63,372[3]
1988	11,621	9,067	4,941	25,629[3]	18,585	18,339	276	75	37,275[3]	62,904[3]
1989	12,517	8,203	4,511	25,231	15,104	29,008	324	68	44,503	69,734[3]
1990	10,060	5,985	3,913	19,958	10,876	17,951	262	158	29,247	49,205[3]

[1] Estimated value.
[2] Not available by gear.
[3] Estimated by the Working Group.

Table 6.2 SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries.

Year	Portugal		Spain IXa South Galicia	Spain VIIIc	
	Trawl	Seine	Seine	Trawl	
	kg/h	t/seiner	t/day	Aviles	Coruña
				kg/Hp.day.10^{-2}	kg/Hp.day.10^{-2}
1979	87.7	10.3	-	-	-
1980	69.3	21.7	-	-	-
1981	59.1	26.9	1.2	-	-
1982	56.2	53.8	3.2	-	-
1983	98.0	32.9	2.4	123.46	90.4
1984	55.9	23.2	0.7	142.94	135.87
1985	24.4	11.2	0.7	131.22	118.00
1986	41.6	36.4	1.7	116.90	130.84
1987	71.0	32.4	1.1	109.02	176.65
1988	91.1	43.6	1.0	88.96	146.63
1989	69.5	37.1	0.7	98.24	172.84
1990[1]	98.9	26.8	0.7	247.76	146.27

Table 6.3 SOUTHERN HORSE MACKEREL. Effort data from four fleets.

Year	SPAIN Division VIIIc		PORTUGAL Div. IXa	
	Trawl		Trawl	Purse seine
	Aviles (Cantabrian Sea) (Σ Hpxfishing days x 10^{-2})	La Coruña (North Galicia) (Σ av.Hpxfishing days x 10^{-2})	Hours ('000)	No. of barcos
1981	-	-	-	193
1982	-	-	225.4	184
1983	12568	33999	176.6	196
1984	10185	32487	154	192
1985	9856	30255	147	192
1986	10845	26539	155.3	198
1987	8309	23122	161.3	196
1988	9047	28119	127.6	180
1989	8063	29628	179.5	223
1990	8492	29579	101.7	221

Table 6.4 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

	Portugal IXa			Spain[2] <200
Year	Bottom trawl (20-mm codend)			
	kg/h Jun/Jul	kg/h Oct	n/h (0-group) Oct	kg/h Sep
1979	12.2[3]	5.5[3]	-	-
1980	20.6[3]	2.5[3]	-	24.74
1981	11.6	1.8	22.6	6.42
1982	42.1	36.9	1,215.2	20.10
1983	79.1	24.6	127.9	97.27
1984	-	-	-	8.73
1985	9.5	3.8	41.7	22.14
1986	4.8[3]	23.5	757.4	18.33
1987	-	6.9	88.3	-
1988	-	26.0	-	18.04
1989	14.9	11.7	380.0	9.87
1990	14.4	21.5	369.0	5.1

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

Table 6.5. Southern Mackerel. Recruitment indices.

YEAR	Div.IXa-Portuguese October-Survey 20-500 meters(n/h)		Galicia South + North September-Survey 100-200 meters(n/h)	
	0-group	1-group	0-group	1-group
1982	1215	419	2	0
1983	128	705	51	682
1984	225	291	11	28
1985	42	90	0	29
1986	757	220	4	9
1987	88	59	-	-
1988	38	607	0	2
1989	380	90	4*	0*
1990	369	347	28	0

* another R/V was used.

Table 6.6 Catch in numbers ('000) at age in Southern horse mackerel by quarter and by area in Divisions VIIIc and IXa.

	AGE	East part VIIIc	Cent. part VIIIc	West. part	N. part IXa	Cent. and S. IXa	Total
FIRST QUARTER	0	0	0	0	0	0	0
	1	15	361	2687	112	15502	18677
	2	99	4845	4702	366	8130	18142
	3	195	5047	6791	382	6669	19084
	4	338	674	6275	232	1271	8790
	5	202	157	1373	54	659	2445
	6	146	171	965	78	736	2096
	7	229	269	1585	119	3544	5746
	8	1227	2332	9970	1036	868	15433
	9	55	135	465	57	701	1413
	10	45	255	347	58	177	882
	11	15	71	92	14	228	420
	12	22	114	70	18	281	505
	13	18	106	81	20	118	343
	14	19	126	70	23	48	286
	15	57	391	190	49	231	918
	TOTAL	2683	15054	35663	2619	39163	95182
	TONNES	373	1668	4398	389	3340	10168
	Age	East. part VIIIc	Cent. part VIIIc	West. part	N. part IXa	Cent. and S.IXa	Total
SECOND QUARTER	0	0	0	0	0	0	0
	1	0	382	3267	2060	32564	38273
	2	123	492	6999	5633	18058	31305
	3	1544	1219	4277	4157	6322	17519
	4	465	1360	6138	220	1089	9292
	5	322	353	1447	55	1698	3875
	6	260	394	1232	56	2731	4693
	7	415	575	1867	83	4050	6990
	8	2946	3371	12571	695	1139	20722
	9	133	195	656	50	1263	2297
	10	96	132	398	108	557	1291
	11	29	28	75	38	341	511
	12	19	37	60	56	171	343
	13	17	45	72	61	289	484
	14	23	37	74	62	462	658
	15	63	133	190	135	672	1193
	TOTAL	6497	8754	39324	13468	71406	139449
	TONNES	830	1353	4745	944	5752	13624
	Age	East part VIIIc	Cent. part VIIIc	West. part	North. part IXa	Cent. and S.	Total
THIRD QUARTER	0	0	84	39	19418	2680	22221
	1	638	10485	11223	23432	6770	52548
	2	8	346	1809	192	5377	7732
	3	49	277	2017	201	2795	5339
	4	64	473	5115	503	2818	8973
	5	36	167	1613	166	2123	4105
	6	43	218	1849	202	2273	4585
	7	55	228	588	89	2129	3089
	8	641	2691	12455	1432	6057	23276
	9	42	118	382	52	2773	3367
	10	55	199	603	95	1556	2508
	11	8	29	107	16	1955	2115
	12	16	45	136	27	914	1138
	13	25	27	121	26	732	931
	14	19	35	180	41	691	966
	15	31	81	328	79	1015	1534
	TOTAL	1731	15503	38565	45972	42658	144429
	TONNES	254	1363	4844	1305	5873	13639
	Age	East. part VIIIc	Cent. part VIIIc	West part VIIIc	North part IXa	Cent and S	Total
FOURTH QUARTER	0	0	0	0	13180	12821	26001
	1	191	24815	24908	24954	19347	94215
	2	5	385	3576	2179	6181	12326
	3	31	302	1849	307	5798	8287
	4	91	175	1635	347	5793	8041
	5	56	55	445	104	3081	3741
	6	59	90	574	122	1594	2439
	7	49	84	367	79	1492	2071
	8	536	1318	6426	1164	3345	12789
	9	34	69	217	40	1750	2110
	10	41	152	351	51	824	1419
	11	8	19	43	9	308	387
	12	11	46	75	5	390	527
	13	17	38	62	3	179	299
	14	10	39	56	4	178	269
	15	22	74	107	7	135	345
	TOTAL	1160	27662	40694	42555	63216	175287
	TONNES	198	1469	3689	1428	4992	11776

Table 6.7. Weight (g) at age of Southern horse mackerel by quarter and by sea area in Divisions VIIIc and IXa, in 1990. (Division VIIIc has been separated into three (eastern, central and western) subdivisions).

1st. QUARTER

	SPAIN					
	VIIIc			IXa		
Age	East.p. W (g)	Cent.p. W (g)	West.p. W (g)	Nort.p. W (g)	SPAIN (VIIIc+ +IXa) W (g)	PORTUGAL (IXa) W (g)
0	0	0	0	0	0	0
1	16	40	28	29	30	29
2	36	48	44	46	45	47
3	68	67	95	76	86	70
4	100	137	124	149	127	109
5	115	153	129	155	136	132
6	128	191	167	181	172	167
7	131	194	162	186	169	196
8	142	212	181	196	187	223
9	165	226	189	206	198	228
10	268	328	240	278	265	317
11	293	310	263	297	278	325
12	332	372	332	361	343	342
13	322	343	319	348	327	375
14	307	373	325	362	338	426
15+	326	438	325	361	355	429
0-15+	134	114	124	154	124	79

2nd. QUARTER

	SPAIN					
	VIIIc			IXa		
Age	East.p. W (g)	Cent.p. W (g)	West.p. W (g)	Nort.p. W (g)	SPAIN (VIIIc+ +IXa) W (g)	PORTUGAL (IXa) W (g)
0	0	0	0	0	0	0
1	0	23	30	17	24	36
2	50	49	40	46	43	51
3	60	91	103	64	92	72
4	98	141	133	132	131	96
5	116	143	134	139	134	131
6	136	159	157	183	158	144
7	141	159	157	192	160	188
8	155	172	168	217	173	229
9	166	177	177	247	184	234
10	216	247	218	321	235	259
11	248	294	276	310	280	280
12	325	342	339	348	339	361
13	313	341	329	333	330	381
14	291	343	332	340	331	397
15+	301	454	358	341	367	434
0-15+	127	148	122	70	121	77

3rd. QUARTER

	SPAIN					
	VIIIc			IXa		
Age	East.p. W (g)	Cent.p. W (g)	West.p. W (g)	Nort.p. W (g)	SPAIN (VIIIc+ +IXa) W (g)	PORTUGAL (IXa) W (g)
0	0	13	14	12	13	16
1	34	45	39	26	38	43
2	106	91	91	79	89	56
3	85	75	113	92	102	79
4	156	167	138	144	145	108
5	158	166	139	145	145	130
6	189	176	149	153	156	151
7	211	191	196	185	194	163
8	221	200	174	180	181	189
9	251	218	224	220	223	223
10	266	252	270	284	269	260
11	250	223	240	247	239	261
12	335	310	345	363	342	279
13	340	339	358	376	357	322
14	326	367	389	391	383	350
15+	339	407	385	405	391	363
0-15+	151	91	127	154	126	138

4th. QUARTER

	SPAIN					
	VIIIc			IXa		
Age	East.p. W (g)	Cent.p. W (g)	West.p. W (g)	Nort.p. W (g)	SPAIN (VIIIc+ +IXa) W (g)	PORTUGAL (IXa) W (g)
0	0	0	10	12	8	28
1	30	34	53	27	43	31
2	137	76	81	81	82	67
3	98	58	93	96	86	84
4	141	167	145	144	149	96
5	143	162	147	147	150	110
6	158	192	164	154	168	140
7	188	214	205	189	203	165
8	198	229	187	174	194	174
9	231	256	224	208	228	209
10	260	293	251	217	253	258
11	230	294	243	188	242	277
12	352	325	295	264	297	321
13	371	340	323	336	331	372
14	352	343	321	345	332	384
15+	378	343	385	370	373	420
0-15+	170	51	91	32	72	76

Table 6.8

Southern Horse Mackerel **SHOT forecast spreadsheet version 3**
January 1989

running recruitment weights
older 0.25 **G-M = 0.00**
central 0.50 **exp(d) 1.00**
younger 0.25 **exp(d/ 1.00**

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1982	59			0.30	0.70				198		
1983	74	1215	640	0.30	0.70	109			248		
1984	46	128	424	0.30	0.70	-19			154		
1985	44	225	155	0.30	0.70	37	13	36	145	121	36
1986	61	42	267	0.30	0.70	101	28	39	202	129	39
1987	63	757	411	0.30	0.70	70	63	61	211	205	61
1988	63	88	243	0.30	0.70	62	38	56	210	186	56
1989	70	38	136	0.30	0.70	86	23	51	232	170	51
1990	49	380	292	0.30	0.70	1	57	66	164	220	66
1991		369	370	0.30	0.70		64	54		179	54
1992		360	272	0.30	0.70		47	52		173	52

Table 7.1 Portuguese and Spanish annual landings of anchovy from the purse seiner fleet in Division IXa (from Pestana, 1989 and Working Group members).

Year	Portugal	Spain
1943	9,975	-
1944	6,651	-
1945	992	-
1946	6,520	-
1947	3,392	-
1948	4,938	-
1949	2,684	-
1950	3,377	-
1951	3,594	-
1952	4,415	-
1953	1,033	-
1954	3,919	-
1955	4,523	-
1956	7,898	-
1957	12,610	-
1958	3,030	-
1959	3,788	-
1960	9,503	-
1961	2,492	-
1962	4,446	-
1963	5,714	-
1964	4,181	-
1965	4,460	-
1966	4,460	-
1967	3,818	-
1968	970	-
1969	1,243	-
1970	1,172	-
1971	326	-
1972	207	-
1973	126	-
1974	238	-
1975	372	-
1976	88	-
1977	3,261	-
1978	1,011	-
1979	655	-
1980	980	-
1981	978	-
1982	656	-
1983	673	-
1984	392	-
1985	2,122	-
1986	2,153	-
1987	1,622	-
1988	442	-
1989	823	-
1990	541	5,568

Table 7.2 Catches of European anchovy in Sub-area VIII ('000) as estimated by the Working Group.

Country and division	Year							
	1960	1961	1962	1963	1964	1965	1966	1967
France, VIIIb	1085	1494	1123	652	1973	2615	839	1812
Spain, VIIIb,c	57000	74000	58000	48000	75000	81000	47519	39363
Total	58085	75494	59123	48652	76973	83615	48358	41175

Country and division	1968	1969	1970	1971	1972	1973	1974	1975
France, VIIIb	1190	2991	3665	4825	6150	4395	3835	2913
Spain, VIIIb,c	38429	33092	19820	23787	26917	23614	27282	23389
Total	39619	36083	23845	28612	33067	28009	31117	26302

Country and division	1976	1977	1978	1979	1980	1981	1982	1983
France, VIIIb	1095	3807	3683	1349	1564	1021	381	1911
Spain, VIIIb,c	36166	44384	41536	25000	20538	9794	4610	12242
Total	37261	48191	45219	26349	22102	10815	4991	14153

Country and division	1984	1985	1986	1987	1988	1989	1990	1991
France, VIIIb	1711^	3005^	2311^	5061^	6743^	2200	10598	5500*
Spain, VIIIb,c	33468	8481	5612	9863	8266	8174	23258	6982*
Total	35179	11486	7923	14924	15009	10374	33856	12482*

* Only 1st half year. Preliminary.
^ Official figures.

Table 7.3 Anchovy catch distributions ('000 t) and percentage according to half of the year for the period 1983-1990.

		1st half year^		2nd half year*	
1983	Spain	11000	(90%)	1242	(10%)
1984	Spain	31938	(95.6%)	1485	(4.4%)
1985	Spain	6391	(74.6%)	2173	(25.4%)
1986	Spain	3274	(62.7%)	1947	(37.3%)
1987	Spain	8777	(89%)	1086	(11%)
1988	Spain	6955	(84%)	1311	(16%)
1989	Spain	5377	(65.8%)	2796	(34.2%)
1989	France	1944	(88.4%)	256	(11.6%)
1990	Spain	16401	(70.5%)	6857	(29.5%)
1990	France	2984	(28.2%)	7614	(71.8%)

^ Corresponds to the spring fishery in Divisions VIIIa,b and c.
* Corresponds to the summer and autumn fisheries in Division VIIIc (Spain) or VIIIa (France).

Table 7.4 Distribution of Bay of Biscay anchovy catches in tonnes (%) according to Divisions VIIIa,b,c (from Working Group members).

	1987			1988			1989		
Division	VIIIa	VIIIb^	VIIIc	VIIIa	VIIIb^	VIIIc	VIIIa	VIIIb	VIIIc
France	2024 (40%)	3036 (60%)	*	3740 (55%)	3000 (45%)	*	924 (42%)	1177 (53.5%)	99 (4.5%)
Spain		5290 (53.5%)	4753 (46.4%)		4548 (55%)	3718 (45%)		558 (6.8%)	7615 (93.2%)

	1990		
Division	VIIIa	VIIIb	VIIIc
France	8252 (78%)	2346 (22%)	
Spain		2103 (9%)	21155 (91%)

^ Not taken into account that the main part of the French landings in Division VIIIb are salted.
* Small landings from that area.

Table 7.5 Distribution (in %) EC size categories of the total anchovy landings in Sub-area VIII (from Working Group members).

	Semester 1		Semester 2	
	Spain	France	Spain	France
T1	0.3	0.1	34.0	11.3
T2	66.4	68.5	58.5	81.4
T3	33.2	30.2	7.5	7.2
T4	0.1	1.2	-	0.1
Total in tonnes	16401	2985	6857	7613

T1 = ≤30 fish per kg.
T2 = between 31 and 50 per kg.
T3 = between 51 and 83 per kg.
T4 = >84 per kg.

Table 7.6 Daily Egg Production Method. Egg surveys on Anchovy - Bay of Biscay.

Year	1987	1988	1989	1990	1991[1]
Period of year	2-7 June	21-28 May	10-21 May	4-15 May	16 May-10 June
Positive area (km^2)	23,850	45,384	17,546	57,764	24,264
Surveyed area (km^2)	34,934	59,840	37,930	78,215	83,646
Daily total egg production	$2.198.10^{12}$	$5.015.10^{12}$	$0.73.10^{12}$	$5.12.10^{12}$	
C.V.	0.32	0.21	0.4	0.17	
SSB (t)	29,365	63,500	11,860	97,736	
C.V.	0.48	0.31	0.41	0.18	
Coastal egg production	$2.319.10^{12}$	$5.312.10^{12}$	$0.328.10^{12}$	$3.35.10^{12}$	
No/age : 1	656[2]	2.349[2]	246[3]	5.581	
(millions) 2	331	258	206	184	
3	76	66	18	39	
4	41	2	-		
5	25	-	-		
Biomass referred	30,000	63,000	12,000	97,736	
Egg abundance			$2.61.10^{12}$	$6.9.10^{12}$	

[1] Preliminary data.
[2] Calculated as in Martin and Uriarte (1989).
[3] Revised.

Table 7.7 Evaluation of abundance index from French acoustic surveys

	1983	1984	1989[2]	1990	1991
	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4	6/4-29/4
Surveyed area	3267	3743	5112	3418[3]	3388[3]
Density (t/mille^2)	15.4	10.3	3.0	14.5-32.2[4]	23.6
Biomass (t)	50,000	38,500	15,500	60-110,000[4]	80,000
Number (10^6)	2,600	2,000	805	4,300-7,900[4]	3,750
Number of 1-group (10^6)	1,800[1]	600[1]	400	4,100-7,500[4]	2,000

[1] Rough estimation.
[2] Assumption of overestimate.
[3] Positive area.
[4] Must be revised, data will be available in 1992.

Table 7.8 Summary of egg and acoustic surveys on Bay of Biscay Anchovy.

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991
SSB(tonnes)	-	-	-	-	29,365	63,500	11,860	97,736	- ? -
Positive area for Egg (km^2)	-	-	-	-	23,850	45,384	17,546	57,764	24,264
Acoustic index (tonnes)	50,000	38,500	-	-	-	-	15,500	n.a	80,000
Acoustic index in numbers (millions)	2,600	2,000	-	-	-	-	805	n.a	3.750
Egg survey (1-year-old)	65	-	-	-	656	2,349	209	5,581	-
Acoustic survey (1-year-old)	1,800	600	-	-	-	-	440	n.a	2,000
Y.C.C[0]	1,444	352	177	267	340	542	284	1,383[1]	
Catch	14,153	35,179	11,486	7,923	14,924	15,009	10,374	17,130	

[0] Year class cumulative catches in numbers $\sum_{i=1}^{N} Cij$

Cij: Catch from year class j the year i
N: Number of catch years for the year class j

[1] Incomplete. Y.C.C.; only catch of 1-year-old anchovies.

Table 7.9a Length distribution ('000) of Bay of Biscay ANCHOVY by country, gear and divisions in 1989.

	SEMESTER 1				SEMESTER 2				TOTAL			
Length (cm)	FRANCE P.trawl VIIIa,b	SPAIN Seiner VIIIb	SPAIN Seiner VIIIc	Total	FRANCE P.trawl VIIIa,b	SPAIN Seiner VIIIb	SPAIN Seiner VIIIc	Total	FRANCE P.trawl VIIIa,b	SPAIN Seiner VIIIb	SPAIN Seiner VIIIc	TOTAL VIII
7	0	0	0	0	0	0	14	14	0	0	14	14
7.5	0	0	0	0	0	43	85	128	0	43	85	128
8	0	0	0	0	11	67	1773	1851	11	67	1773	1851
8.5	0	0	0	0	17	238	3738	3993	17	238	3738	3993
9	0	0	0	0	4	625	3850	4479	4	625	3850	4479
9.5	0	4	0	4	15	1117	2708	3840	15	1121	2708	3843
10	60	0	74	135	50	1594	4169	5813	110	1594	4244	5948
10.5	602	66	225	893	282	1718	6277	8276	883	1784	6502	9170
11	2676	88	788	3552	727	1503	9682	11912	3404	1591	10469	15464
11.5	4362	183	1068	5618	825	1119	9447	11391	5187	1306	10514	17008
12	6683	772	2084	9539	1011	752	16796	18559	7694	1524	18880	28098
12.5	6976	304	4140	11420	709	1060	24058	25827	7685	1364	28198	37247
13	8395	914	7052	16362	722	1059	26722	28503	9118	1974	33774	44865
13.5	9283	1006	12064	22357	639	1343	20924	22906	9927	2349	32988	45264
14	7829	1512	18532	27874	896	318	17100	18314	8725	1830	35632	46187
14.5	7409	1703	19654	28765	508	37	7353	7899	7916	1740	27007	36663
15	6357	2346	26892	35596	1529	0	2592	4121	7886	2346	29484	39716
15.5	9999	2750	27390	40138	113	0	934	1046	10111	2750	28323	41184
16	8902	2471	26743	38116	2226	0	845	3071	11128	2471	27588	41187
16.5	5406	2319	21603	29328	652	0	1853	2505	6058	2319	23456	31833
17	3115	1097	14061	18273	1181	0	3656	4838	4296	1097	17717	23111
17.5	1312	342	7633	9287	135	0	3688	3823	1447	342	11321	13110
18	60	156	2386	2602	59	0	2919	2977	119	156	5305	5579
18.5	0	54	438	491	18	0	1731	1748	18	54	2168	2239
19	54	5	350	409	0	0	0	0	54	5	350	409
19.5	0	0	0	0	0	0	0	0	0	0	0	0
Total N	89485	18097	193178	300760	12328	12593	172913	197835	101813	30690	366091	498595
Catch(t)	1944	436	4941	7321	256	122	2674	3052	2200	558	7615	10373
SOP	1895	411	4841	7147	228	112	2669	3009	2123	523	7510	10156
%	97	94	98	98	89	92	100	99	97	94	99	98
L (cm)	14.1	15.1	15.2	14.9	14.2	11.2	12.8	12.8	14.1	13.5	14.1	14.1
w (catch)	21.7	24.1	25.6	24.3	20.6	9.7	15.5	15.4	21.6	18.2	20.8	20.8
w (SOP)	21.2	22.7	25.1	23.8	18.5	8.9	15.4	15.2	20.9	17.0	20.5	20.4

Table 7.9b Length distribution ('000) of Bay of Biscay ANCHOVY by country, gear and divisions in 1990.

	SEMESTER 1				SEMESTER 2				TOTAL			
Length (cm)	FRANCE P.trawl VIIIb	SPAIN Seiner VIIIb	SPAIN Seiner VIIIc	Total	FRANCE P.trawl VIIIb	SPAIN Seiner VIIIb	SPAIN Seiner VIIIc	Total	FRANCE P.trawl VIIIb	SPAIN Seiner VIIIb	SPAIN Seiner VIIIc	TOTAL VIII
7	0	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	2	0	0	2	2	0	0	2
8	0	0	0	0	64	0	0	64	64	0	0	64
8,5	0	0	0	0	100	0	0	100	100	0	0	100
9	0	0	1	1	22	0	0	22	22	0	1	23
9,5	18	38	8	64	11	0	0	11	29	38	8	75
10	135	346	249	731	69	0	0	69	205	346	249	800
10,5	1358	1421	287	3067	78	0	0	78	1436	1421	287	3145
11	2941	1731	1752	6424	32	0	65	96	2972	1731	1817	6520
11,5	5641	3349	2665	11655	550	0	382	932	6192	3349	3047	12588
12	10264	6734	13663	30661	2143	4	978	3126	12408	6738	14640	33786
12,5	11934	9042	24214	45190	4237	16	1904	6156	16171	9057	26117	51346
13	13268	15050	42506	70824	15928	22	4508	20459	29196	15072	47015	91293
13,5	13519	16315	63515	93349	7969	51	7472	15492	21488	16366	70987	108841
14	17722	20354	88754	126830	8136	40	16498	24674	25858	20394	105253	151504
14,5	15602	16407	104206	136215	13530	42	24502	38075	29132	16449	128709	174290
15	13076	14496	109875	137447	40503	9	30695	71207	53579	14505	140570	208654
15,5	15782	5807	84939	106528	66603	9	29074	95686	82385	5815	114014	202214
16	7168	3184	60961	71312	69266	7	37699	106971	76434	3190	98659	178284
16,5	5838	767	30240	36845	57874	0	32844	90718	63712	767	63084	127563
17	3552	1153	17305	22011	31065	4	33536	64605	34617	1158	50841	86616
17,5	1604	617	7236	9457	6711	0	24257	30967	8315	617	31493	40425
18	0	84	2101	2185	1091	0	11610	12701	1091	84	13711	14886
18,5	0	0	731	731	546	0	3248	3793	546	0	3978	4524
19	0	57	147	204	0	0	817	817	0	57	963	1020
19,5	0	0	544	544	0	0	251	251	0	0	795	795
20	0	0	473	473	0	0	0	0	0	0	473	473
20,5	0	0	743	743	0	0	0	0	0	0	743	743
21	0	0	676	676	0	0	0	0	0	0	676	676
21,5	0	0	338	338	0	0	0	0	0	0	338	338
Total N	139423	116953	658129	914505	326530	204	260339	587074	465954	117157	918469	1501579
Catch(t)	2984	2099	14302	19385	7614	4	6853	14471	10598	2103	21155	33856
SOP	2532	1970	13783	18285	7931	3	6744	14677	10801	1951	20681	33434
%	85	94	96	94	104	84	98	101	102	93	98	99
-	14,0	13,8	14,7	14,5	15,6	14,0	15,9	15,7	15,1	13,8	15,0	14,9
% (catch)	21,4	17,9	21,7	21,2	23,3	19,6	26,3	24,6	22,7	18,0	23,0	22,5
% (SOP)	18,2	16,8	20,9	20,0	24,3	16,4	25,9	25,0	23,2	16,7	22,5	22,3

Table 7.10a ANCHOVY in the Bay of Biscay. Spanish half yearly catches (Semester 2) by age ('000) of Bay of Biscay anchovy, of the live bait tuna fishing boats.

CATCH IN NUMBERS

AGE	1987	1988	1989	1990
0	10020	97581	N.A.	27993
1	24975	17353	N.A.	22238
2	1461	203	N.A.	109
3	912	3	N.A.	
4			N.A.	
5+			N.A.	
TOTAL N#	37368	115140		50340
CATCH (t)	546	493		416
$\bar{w}$	14.6	4.3		8.3

Table 7.10b ANCHOVY in the Bay of Biscay. Half yearly catches and at age ('000) of Bay of Biscay anchovy, by country and divisions in 1989.

CATCH IN NUMBERS

AGE	SEMESTER 1				SEMESTER 2				TOTAL			TOTAL
	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	VIII
0	0	0	0	0	6516	12593	156096	175205	6516	12593	156096	175205
1	46334	8051	102135	156520	2055	0	5659	7714	48389	8051	107794	164234
2	37309	9631	83117	130057	3575	0	7954	11529	40884	9631	91071	141586
3	5842	415	7874	14131	181	0	3204	3385	6023	415	11078	17516
4	0	0	52	52	0	0	0	0	0	0	52	52
5	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL N#	89485	18097	193178	300760	12327	12593	172913	197833	101812	30690	366091	498593
CATCH (t)	1944	436	4941	7321	256	122	2674	3052	2200	558	7615	10373
SOP	1895	411	4841	7147	228	112	2669	3009	2123	523	7510	10156
%	97.48	94.27	97.98	97.62	89.06	91.80	99.81	98.59	96.50	93.73	98.62	97.91

Table 7.10c ANCHOVY in the Bay of Biscay. Half yearly landings and at age ('000) of Bay of Biscay anchovy, by country and divisions in 1990.

CATCH IN NUMBERS

AGE	SEMESTER 1				SEMESTER 2				TOTAL			TOTAL
	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	VIII
0	0	0	0	0	4940	0	0	4940	4940	0	0	4940
1	122700	112538	607141	842379	306400	203	212277	518880	429100	112741	819418	1361259
2	14900	4114	43152	62166	15200	1	43064	58265	30100	4115	86216	120431
3	1915	302	7836	10053	0	0	5000	5000	1915	302	12836	15053
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL N(	139515	116954	658129	914598	326540	204	260341	587085	466055	117158	918470	1501683
CATCH (t)	2984	2099	14302	19385	7614	4	6853	14471	10598	2103	21155	33856
SOP	2532	2062	14442	19036	7931	4	6795	14730	10463	2066	21237	33766
	84,85	98,24	100,98	96,20	104,16	100,00	99,15	101,79	98,73	98,24	100,39	99,73

Table 7.11 Catch in numbers (millions) of ANCHOVY in the Bay of Biscay.

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	776	0	156	31	0	1	14	3	0	388	161	53
2	602	861	1322	1687	1307	405	688	0	25	166	813	105
3	0	77	262	435	574	535	267	330	133	69	309	177
4	0	0	0	0	7	7	0	0	0	10	46	4
5+	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1378	938	1740	2153	1888	948	969	333	158	633	1329	339

	1986	1987*	1988*	1989*	1990*
0		31	128	175	33
1	52	220	385	164	1383
2	80	187	128	142	120
3	63	42	29	18	15
4	54	22	3	0	0
5+	0	12	1	0	0
TOTAL	249	514	674	499	1551

* Including Spanish lave bait catches and previously no reported landing for group.

Table 7.12a Half yearly mean weights at age (g) of Bay of Biscay anchovy, by country and divisions in 1989.

MEAN WEIGTH AT AGE IN THE CATCH

AGE	SEMESTER 1				SEMESTER 2				TOTAL			TOTAL
	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	VIII
0	0.00	0.00	0.00	0.00	10.00	9.82	13.20	12.84	10.00	9.82	13.20	12.84
1	17.70	16.65	21.16	19.96	25.00	0.00	26.96	26.44	18.20	16.65	21.46	20.26
2	24.50	26.11	29.61	27.88	29.20	0.00	38.64	35.71	24.91	26.11	30.40	28.52
3	26.00	24.22	27.80	26.95	37.00	0.00	42.74	42.44	26.33	24.22	32.12	29.94
4	0.00	0.00	27.59	27.59	0.00	0.00	0.00	0.00	0.00	0.00	27.59	27.59
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 7.12b Half yearly mean weights at age (g) of Bay of Biscay anchovy, by country and divisions in 1990.

MEAN WEIGTH AT AGE IN THE CATCH

AGE	SEMESTER 1				SEMESTER 2				TOTAL			TOTAL
	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	VIII
0	0,00	0,00	0,00	0,00	10,40	0,00	0,00	10,40	10,40	0,00	0,00	10,40
1	20,00	17,17	21,15	20,45	23,40	19,20	25,21	24,14	22,43	17,17	22,20	21,86
2	27,00	29,05	29,04	28,55	27,00	35,24	28,85	28,37	27,00	29,05	28,95	28,46
3	32,40	32,29	45,12	42,31	0,00	0,00	40,36	40,36	32,40	32,29	43,27	41,66
4	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Table 7.13 **Estimations of catch and biomass levels from different stock abundance at the beginning of the year and different rate of exploitation.**

	MINIMUM BIOMASS			MAXIMUM BIOMASS		
INITIAL BIOMASS	21,000T			145,000T		
M	1.0			1.0		
F	0.0	0.39	1.0	0.0	0.39	1.0
CATCH	0	4,900T	9,938T	0	39,000T	77,750T
FINAL BIOMASS	9,700T	6,860T	3,727T	97,530T	66,030T	35,880T

Tab. 8.1. - Summary of commercial sardine fishery samples taken by quarter and division during 1990

DIVISION	QUARTER	1990 Catches (10^3 t.)	Number of samples TOTAL	Number of samples per 10^3 t.	Number measured Total	Number measured per 10^3 t	Number measured per sampl	Number aged TOTAL	Number aged per 10^3 t	Number aged per sampl
VII d	1	.0	0	.0	0	.0	0	0	.0	0
	2	.0	0	.0	0	.0	0	0	.0	0
	3	.0	2	117.6	402	23,647.1	201	96	5,647.1	48
	4	.0	0	.0	0	.0	0	0	.0	0
	1-4	.1	2	29.9	402	6,000.0	201	96	1,432.8	48
VII e	1	?	0	?	0	?	?	0	?	?
	2	?	0	?	0	?	?	0	?	?
	3	?	6	?	697	?	?	0	?	?
	4	?	0	?	0	?	?	0	?	?
	1-4	?	6	?	697	?	?	0	?	?
VIII a,b	1	.0	0	.0	0	.0	0	0	.0	0
	2	.0	0	.0	0	.0	0	0	.0	0
	3	.0	0	.0	0	.0	0	0	.0	0
	4	.0	0	.0	0	.0	0	0	.0	0
	1-4	9.0	0	.0	0	.0	0	0	.0	0
VIII c	1	7.2	92	12.8	4814	668.3	52	0	.0	0
	2	4.6	72	15.5	4005	864.3	56	120	25.9	2
	3	8.5	62	7.3	4232	497.2	68	0	.0	0
	4	7.2	39	5.5	2614	365.5	67	200	28.0	5
	1-4	27.5	265	9.6	15665	569.6	59	320	11.6	1
IX a	1	15.8	109	6.9	10250	650.3	94	1082	68.6	10
	2	27.0	149	5.5	14345	530.5	96	1066	39.4	7
	3	34.1	174	5.1	14538	426.6	84	1004	29.5	6
	4	34.7	110	3.2	8865	255.5	81	788	22.7	7
	1-4	111.6	542	4.9	47998	430.2	89	3940	35.3	7
Grand TOTAL		148.1	815	5.5	64762	437.2	79	4356	29.4	5

Tab. 8.2. - Summary of commercial Horse Mackerel fishery samples taken by quarter and division during 1990

DIVISION	QUARTER	1990 Catches (10^3 t.)	Number of samples TOTAL	Number of samples per 10^3 t.	Number measured Total	Number measured per 10^3 t	Number measured per sampl	Number aged TOTAL	Number aged per 10^3 t	Number aged per sampl
II a	1	.0	0	.0	0	.0	0	0	.0	0
	2	.0	0	.0	0	.0	0	0	.0	0
	3	1.4	4	2.8	330	227.7	83	75	51.8	19
	4	9.9	3	.3	240	24.2	80	25	2.5	8
	1-4	11.4	7	.6	570	50.1	81	100	8.8	14
IV a	1	.1	0	.0	0	.0	0	0	.0	0
	2	.0	0	.0	0	.0	0	0	.0	0
	3	7.4	7	.9	610	81.9	87	0	.0	0
	4	120.0	41	.3	4144	34.5	101	125	1.0	3
	1-4	127.6	48	.4	4754	37.3	99	125	1.0	3
IV b	1	.0	0	.0	0	.0	0	0	.0	0
	2	.0	0	.0	0	.0	0	0	.0	0
	3	1.4	8	5.7	852	608.6	107	200	142.9	25
	4	.0	6	?	620	?	?	0	?	?
	1-4	1.4	14	10.0	1472	1,051.4	105	200	142.9	14
IV c	1	.0	0	.0	0	.0	0	0	.0	0
	2	.0	0	.0	0	.0	0	0	.0	0
	3	.0	0	.0	0	.0	0	0	.0	0
	4	.9	2	2.2	181	203.4	91	58	65.2	29
	1-4	.9	2	2.2	181	203.4	91	58	65.2	29
VI a	1	.0	13	371.4	2065	59,000.0	159	0	.0	0
	2	.5	32	64.0	6915	13,830.0	216	25	50.0	1
	3	12.5	19	1.5	3155	252.2	166	100	8.0	5
	4	6.2	20	3.2	4489	725.6	224	150	24.2	8
	1-4	19.2	84	4.4	16624	864.4	198	275	14.3	3
VII a-c	1	12.1	9	.7	1102	90.7	122	200	16.5	22
	2	8.9	30	3.4	2472	278.7	82	50	5.6	2
	3	31.1	36	1.2	6575	211.7	183	250	8.0	7
	4	29.0	52	1.8	7170	246.9	138	275	9.5	5
	1-4	81.1	127	1.6	17319	213.5	136	775	9.6	6
VII d	1			.0		.0	0		.0	0
	2	.5	1	2.1	148	316.2	148	97	207.3	97
	3	.3	1	3.7	64	235.3	64	64	235.3	64
	4	.2	1	5.0	137	685.0	137	25	125.0	25
	1-4	.9	3	3.2	349	371.3	116	186	197.9	62
VII e	1	2.2	1	.5	208	96.2	208	25	11.6	25
	2	.0		.0		.0	0		.0	0
	3	.0		.0		.0	0		.0	0
	4	42.9	44	1.0	9553	222.6	217	459	10.7	10
	1-4	45.1	45	1.0	9761	216.5	217	484	10.7	11

Tab. 8.2. (continued) - Summary of commercial Horse Mackerel fishery samples taken by quarter and division during

DIVISION	QUARTER	1990 Catches (10^3t.)	Number of samples TOTAL	Number of samples per 10^3t.	Number measured Total	Number measured per 10^3t	Number measured per sampl	Number aged TOTAL	Number aged per 10^3t	Number aged per sampl
VII f	1	.0		.0		.0	0		.0	0
	2	.0		.0		.0	0		.0	0
	3	.0		.0		.0	0		.0	0
	4	2.0	2	1.0	364	182.0	182	58	29.0	29
	1-4	2.0	2	1.0	364	182.0	182	58	29.0	29
VII j-k	1	29.8	15	.5	2423	81.4	162	150	5.0	10
	2	32.3	14	.4	2054	63.7	147	275	8.5	20
	3	14.4	10	.7	1887	130.6	189	137	9.5	14
	4	2.0	30	14.9	5050	2,513.7	168	0	.0	0
	1-4	78.5	69	.9	11414	145.5	165	562	7.2	8
VIII a-b, d-e	1	8.2	32	3.9	2811	342.6	88	181	22.1	6
	2	2.8	14	5.0	1723	612.7	123	335	119.1	24
	3	2.0	14	7.1	1426	720.9	102	258	130.4	18
	4	9.6	23	2.4	2178	226.9	95	295	30.7	13
	1-4	22.6	83	3.7	8138	360.2	98	1069	47.3	13
VIII c	1	6.0	120	20.0	7965	1,327.5	66	341	56.8	3
	2	7.0	130	18.6	6747	963.9	52	485	69.3	4
	3	7.0	110	15.7	6696	956.6	61	205	29.3	2
	4	5.0	101	20.2	3811	762.2	38	244	48.8	2
	1-4	25.0	461	18.4	25219	1,008.8	55	1275	51.0	3
IX a	1	4.0	283	70.8	23118	5,779.5	82	642	160.5	2
	2	7.0	332	47.4	29333	4,190.4	88	455	65.0	1
	3	7.0	264	37.7	21704	3,100.6	82	898	128.3	3
	4	6.0	364	60.7	45927	7,654.5	126	1328	221.3	4
	1-4	24.0	1243	51.8	120082	5,003.4	97	3323	138.5	3
Grand TOTAL		439.7	2188	5.0	216247	491.9	99	8490	19.3	4

Tab. 8.3. - Summary of commercial anchovy fishery samples taken by quarter and division during 1990

DIVISION	QUARTER	1990 Catches (10^3 t.)	Number of samples TOTAL	Number of samples per 10^3 t.	Number measured Total	Number measured per 10^3 t	Number measured per sampl	Number aged TOTAL	Number aged per 10^3 t	Number aged per sampl
VIII a-b	1	1.2	21	17.1	1764	1,434.1	84	547	444.7	26
	2	3.9	21	5.3	1971	500.6	94	996	253.0	47
	3	5.5	10	1.8	362	66.4	36	421	77.2	42
	4	2.2	3	1.4	90	41.6	30	120	55.4	40
	1-4	12.8	55	4.3	4187	327.5	76	2084	163.0	38
VIII c	1	1.0	53	51.0	3606	3,470.6	68	389	374.4	7
	2	13.3	165	12.4	5665	427.1	34	732	55.2	4
	3	6.7	98	14.6	5740	856.2	59	1458	217.5	15
	4	.1	9	60.4	669	4,489.9	74	180	1,208.1	20
	1-4	21.2	325	15.4	15680	741.2	48	2759	130.4	8
IX a	1	?	?	?	?	?	?	?	?	?
	2	?	?	?	?	?	?	?	?	?
	3	?	?	?	?	?	?	?	?	?
	4	?	?	?	?	?	?	?	?	?
	1-4	5.9	63	10.6	11842	1,999.3	188	1216	205.3	19
Grand TOTAL		39.9	443	11.1	31709	795.4	72	6059	152.0	14

FIGURE 2.1. SARDINE – DIV. VIIIc AND IXa

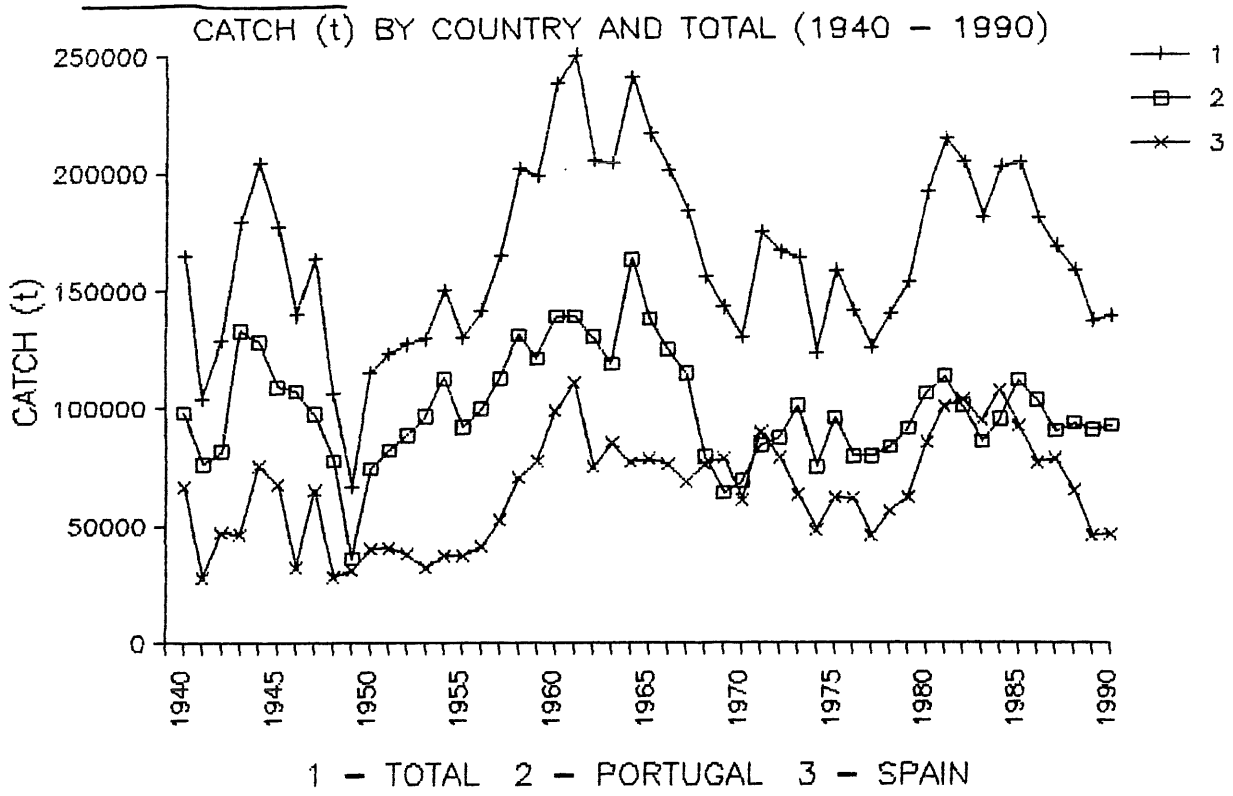


Figure 2.2. Catches (t) of SARDINE from Spanish and Portuguese fleets by quarter in 1990.

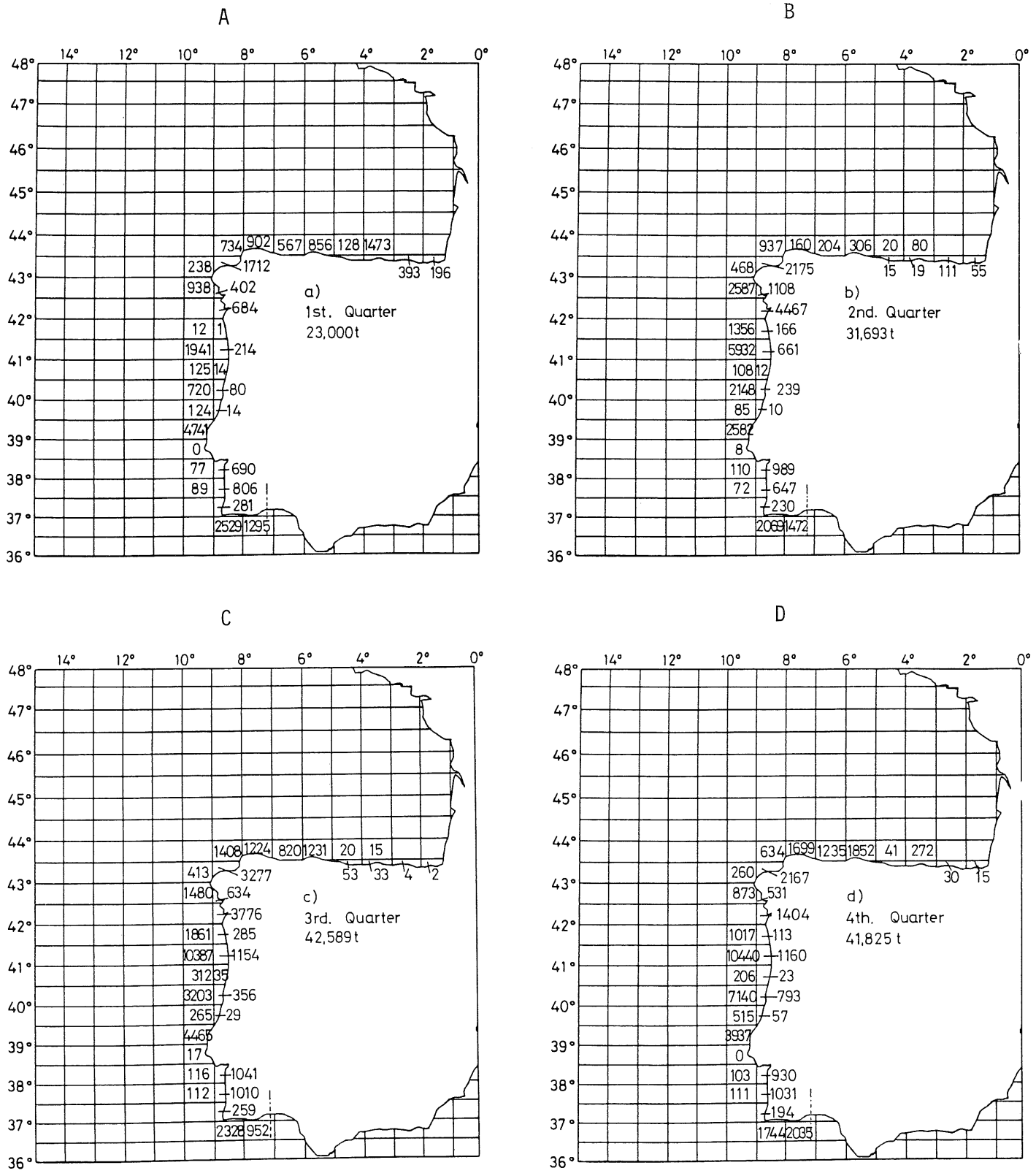


Figure 2.3 Distribution area of SARDINE by echo density integrated during the March/April Spanish survey in 1991.

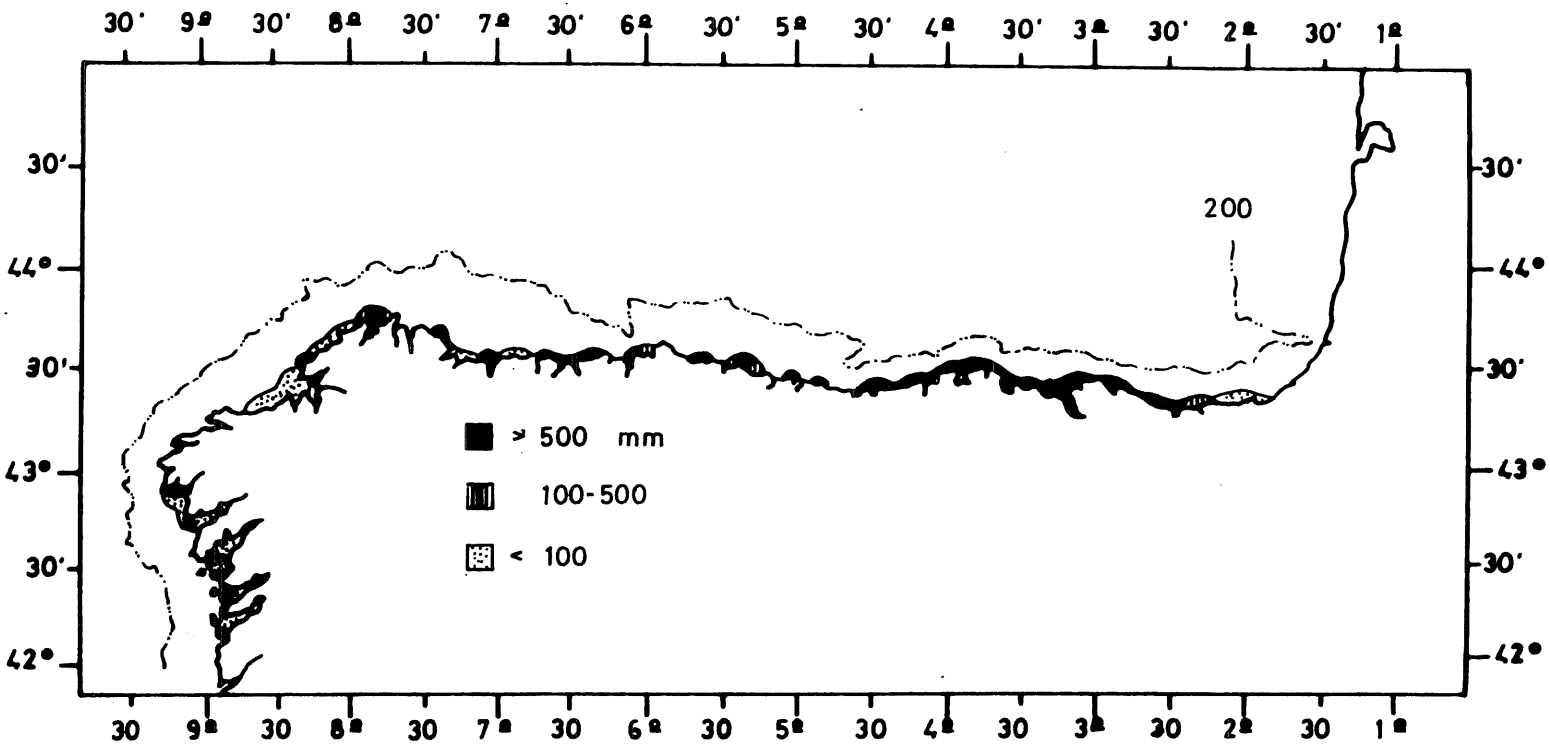


Figure 2.4.A Catchability plot by age.

Portuguese purse seine (fleet 1)

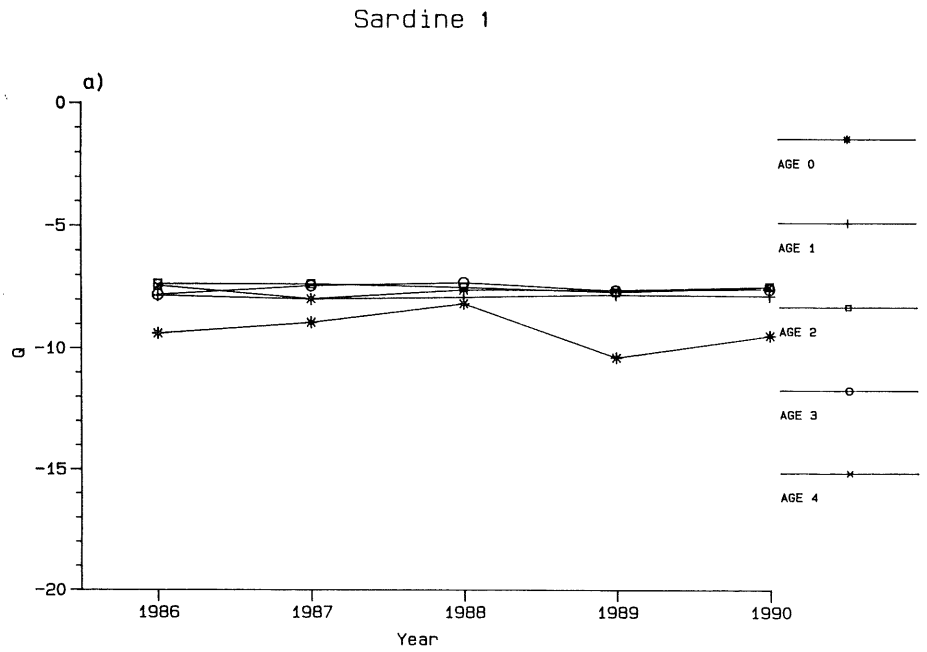


Figure 2.4.B Sardine 2

Spanish purse seine (fleet 2)

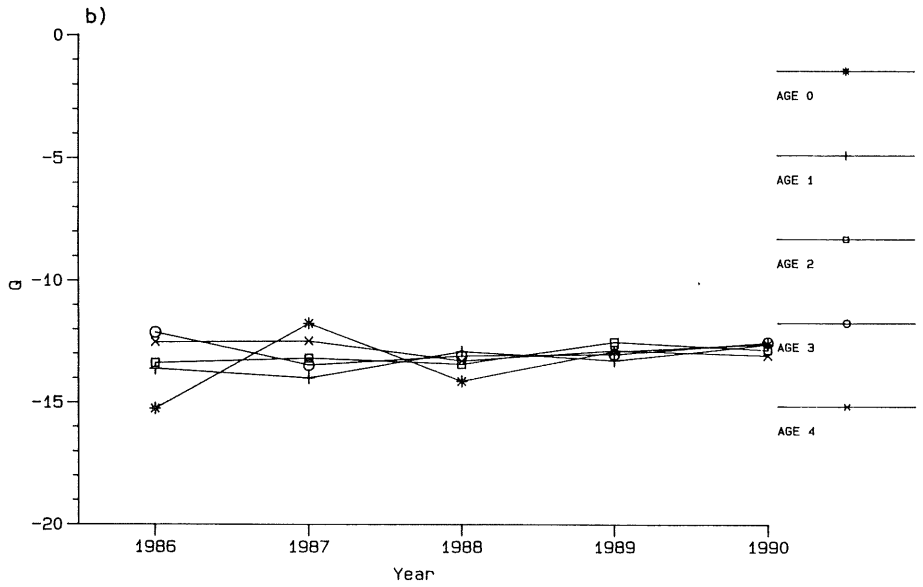


Figure 2.4.C Sardine 3

Spanish survey (fleet 3)

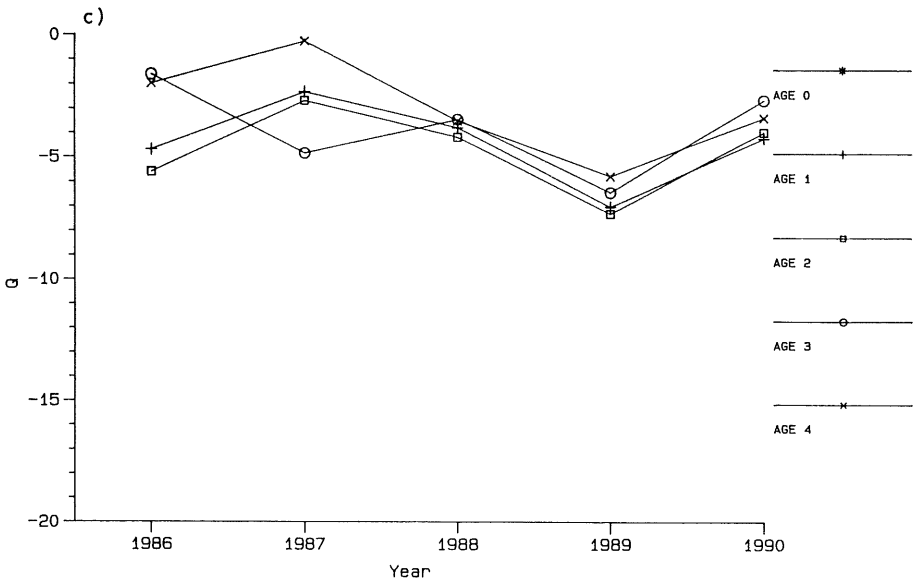
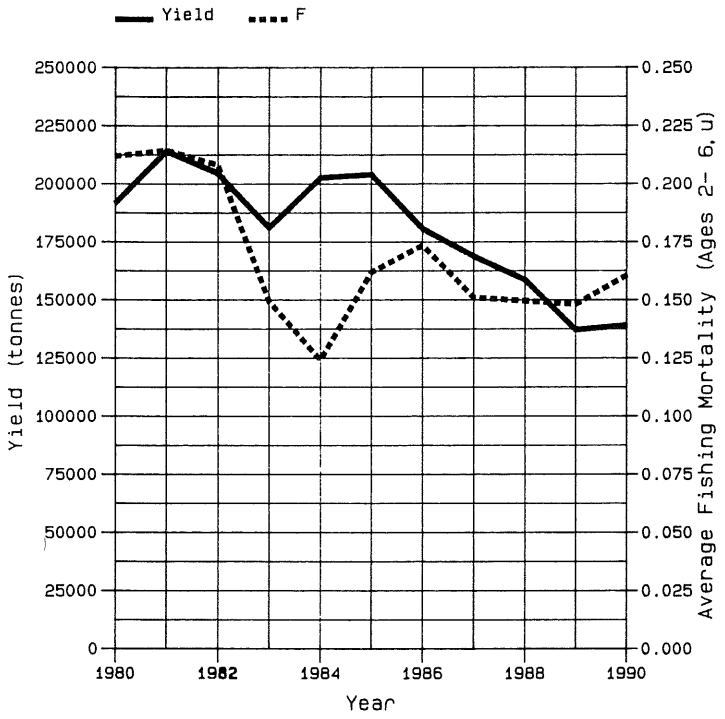


Figure 2.5

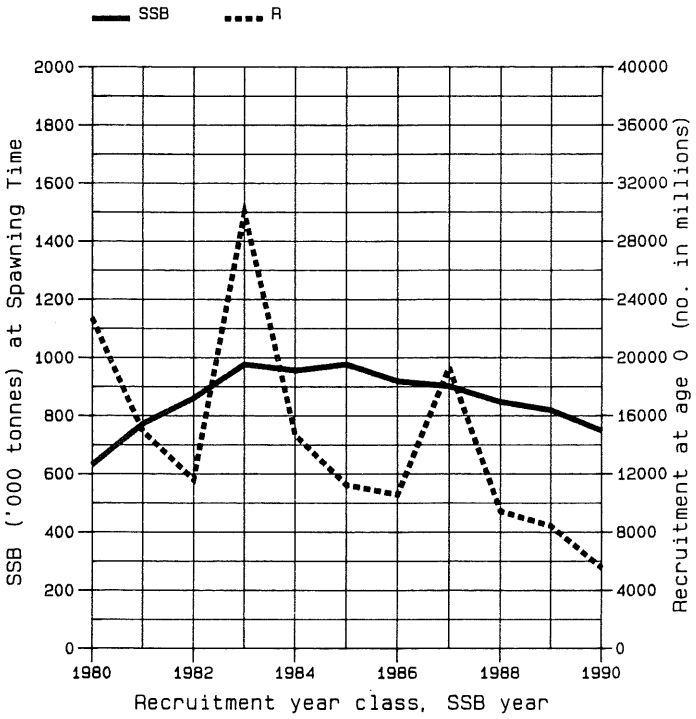
FISH STOCK SUMMARY
Sardine in Fishing Areas VIIIc and IXa
25-06-1991

Trends in yield and fishing mortality (F)



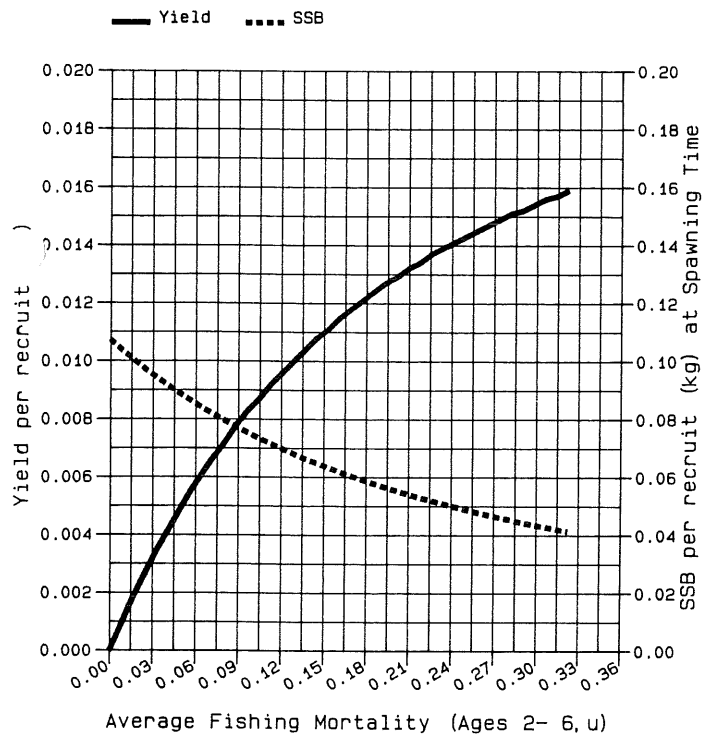
A

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



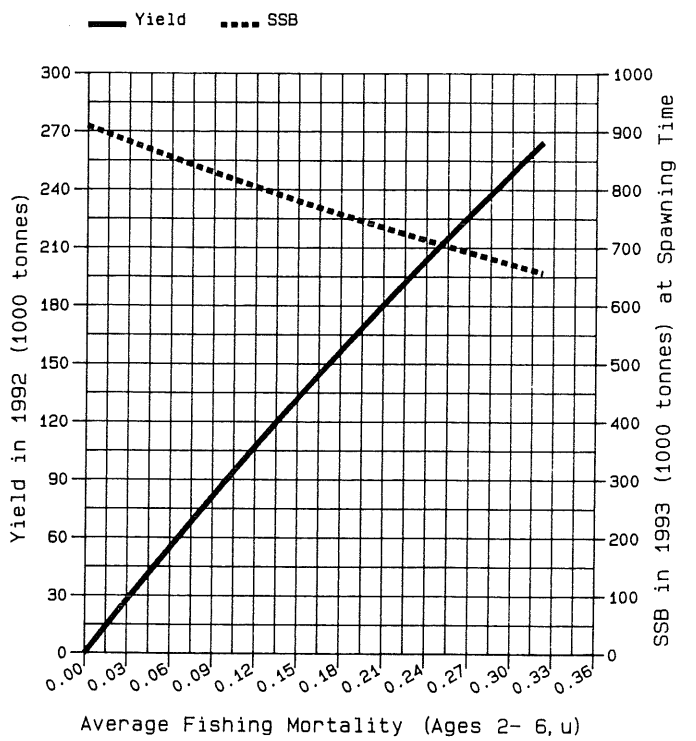
B

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

Figure 2.6 – SARDINE – RECRUITMENT vs.
SPAWNING STOCK BIOMASS AT SPAWNING TIME

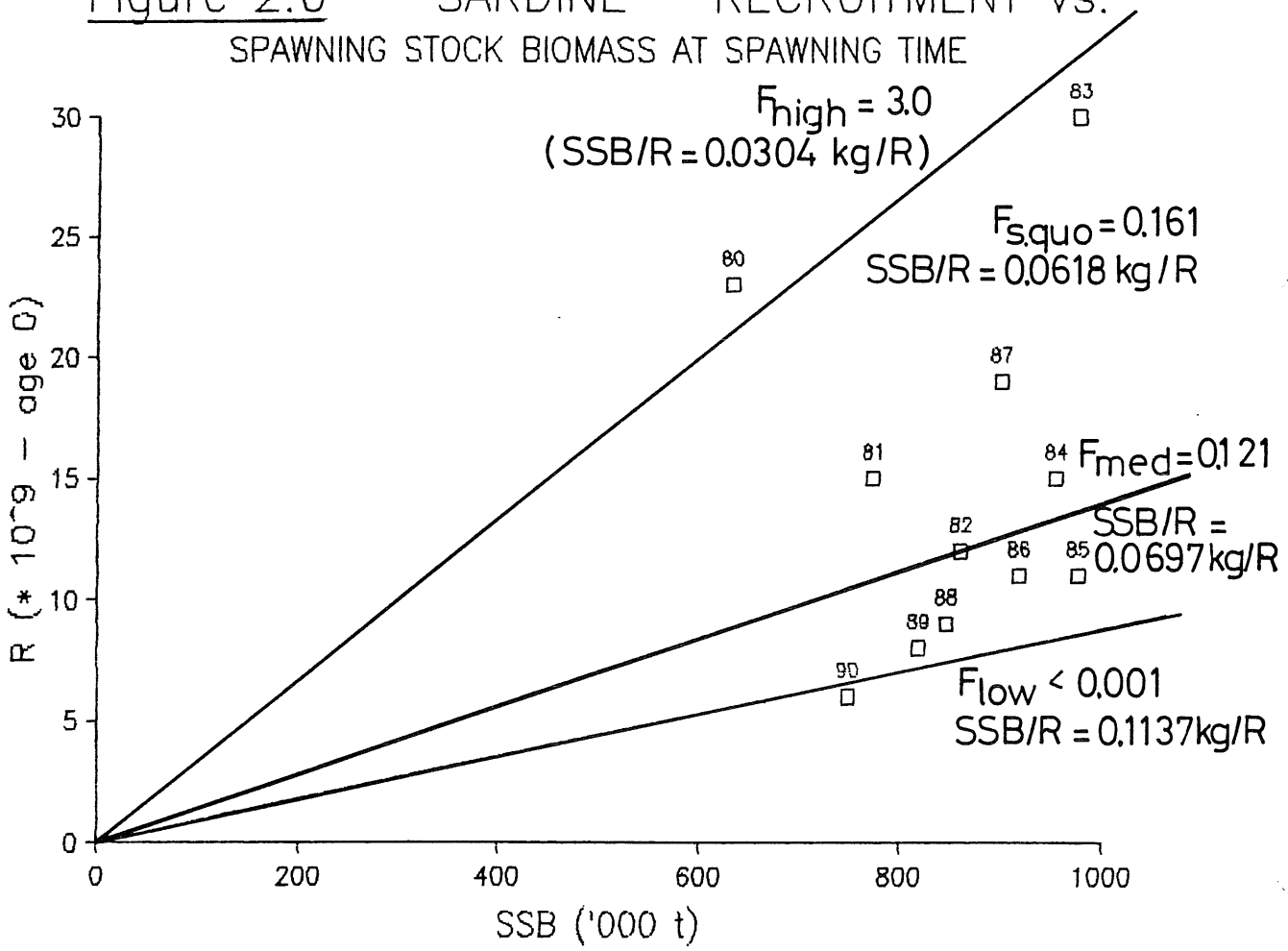
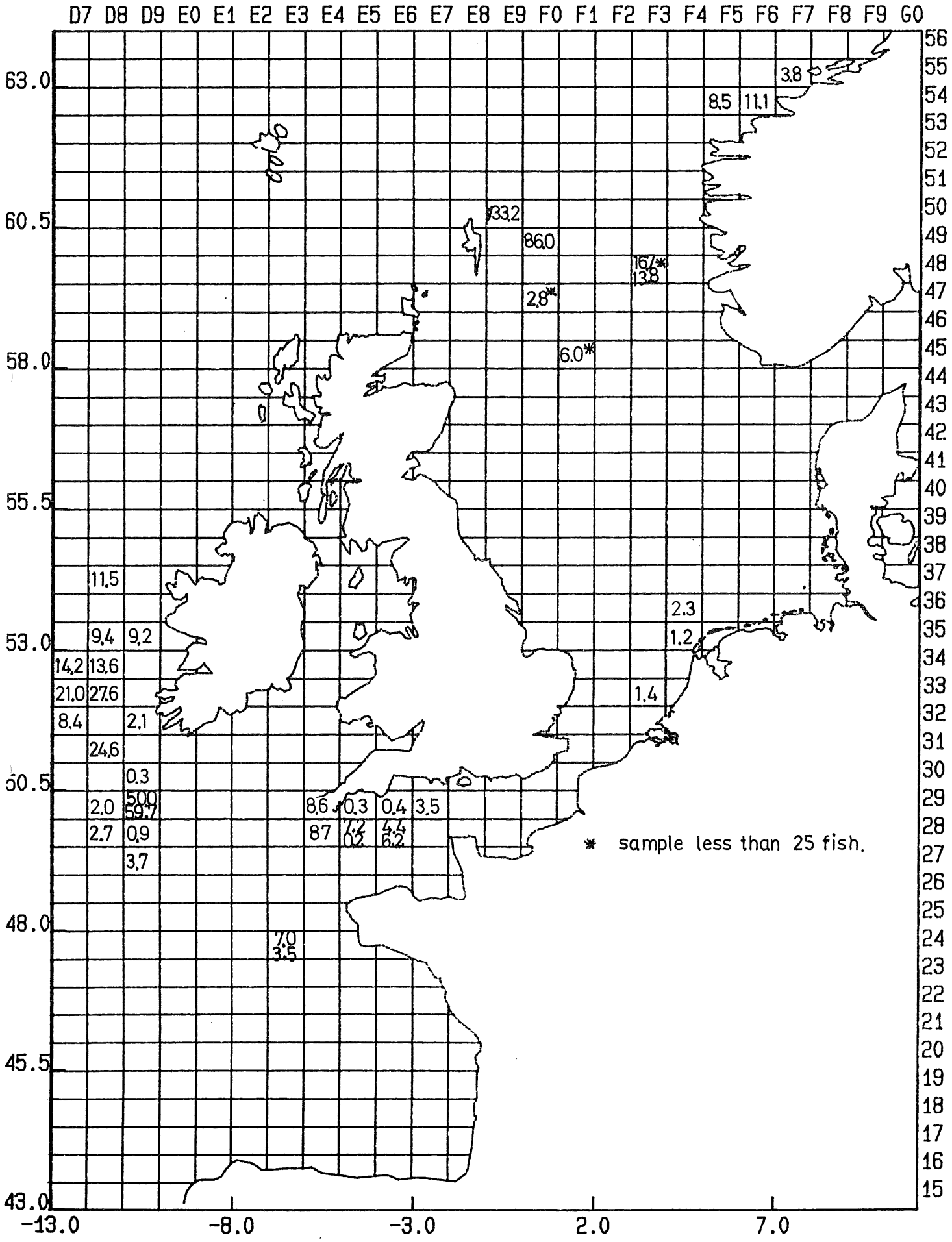


Figure 3.1 Anisakis infestation in HORSE MACKEREL during the period August 1990-March 1991. Based on Dutch and Norwegian fish samples of 25 fish.

66.9 66G1



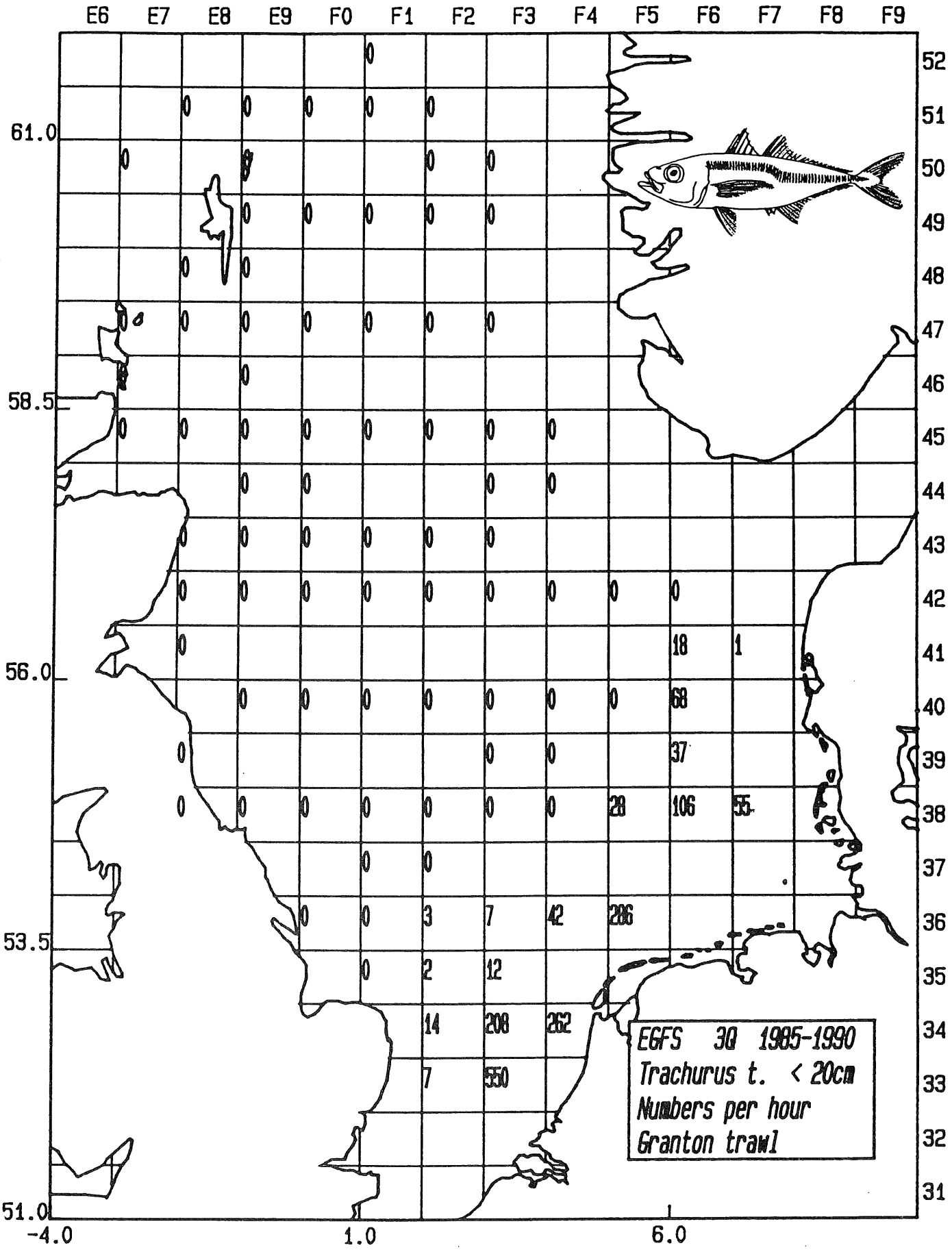


Figure 3.2 Average distribution of HORSE MACKEREL smaller than 20 cm obtained from the English Groundfish Surveys in the third quarter over the period 1985-1990.

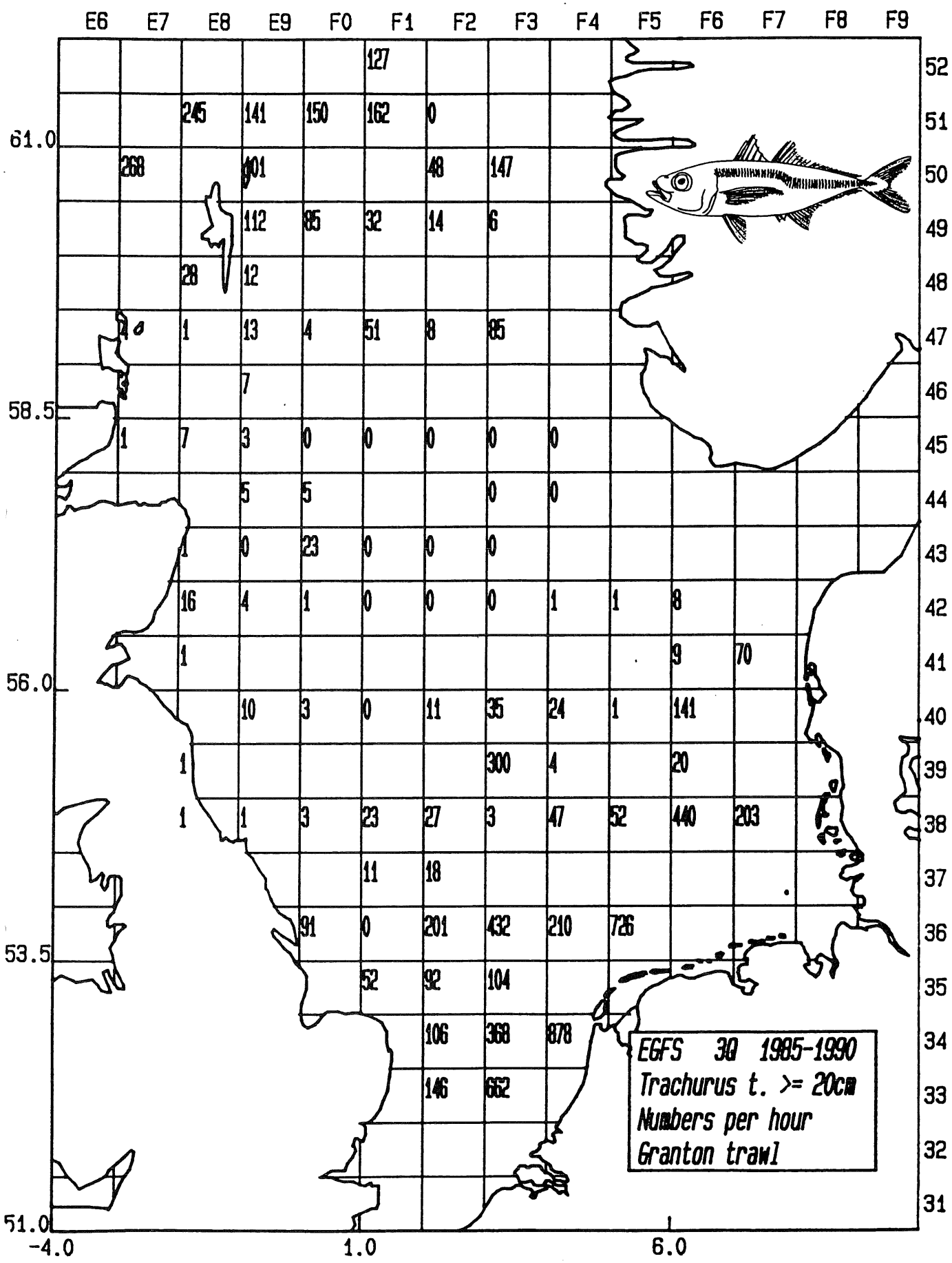


Figure 3.3 Average distribution of HORSE MACKEREL larger than 19 cm obtained from the English Groundfish Surveys in the third quarter over the period 1985-1990.

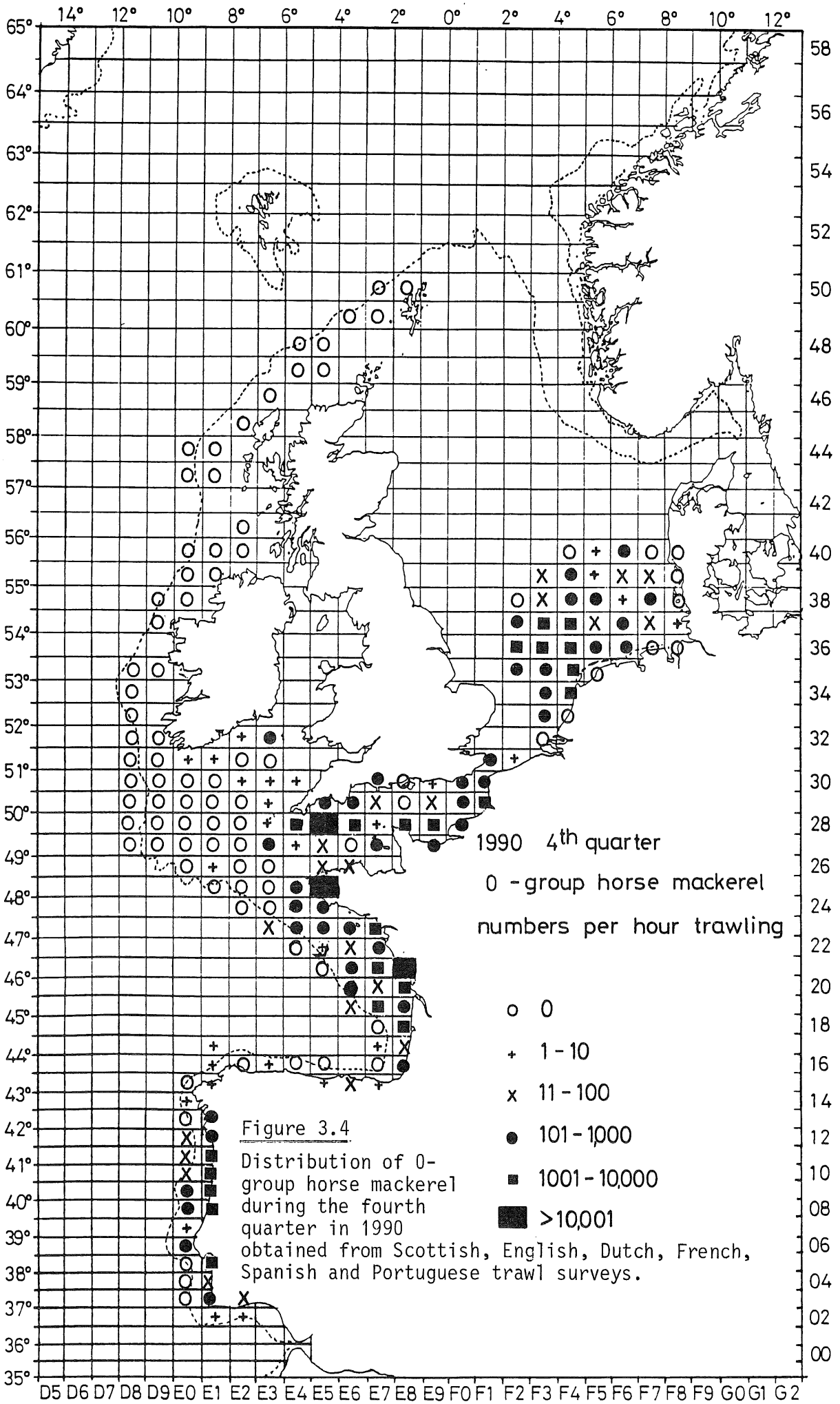


Figure 3.4

Distribution of 0-group horse mackerel during the fourth quarter in 1990 obtained from Scottish, English, Dutch, French, Spanish and Portuguese trawl surveys.

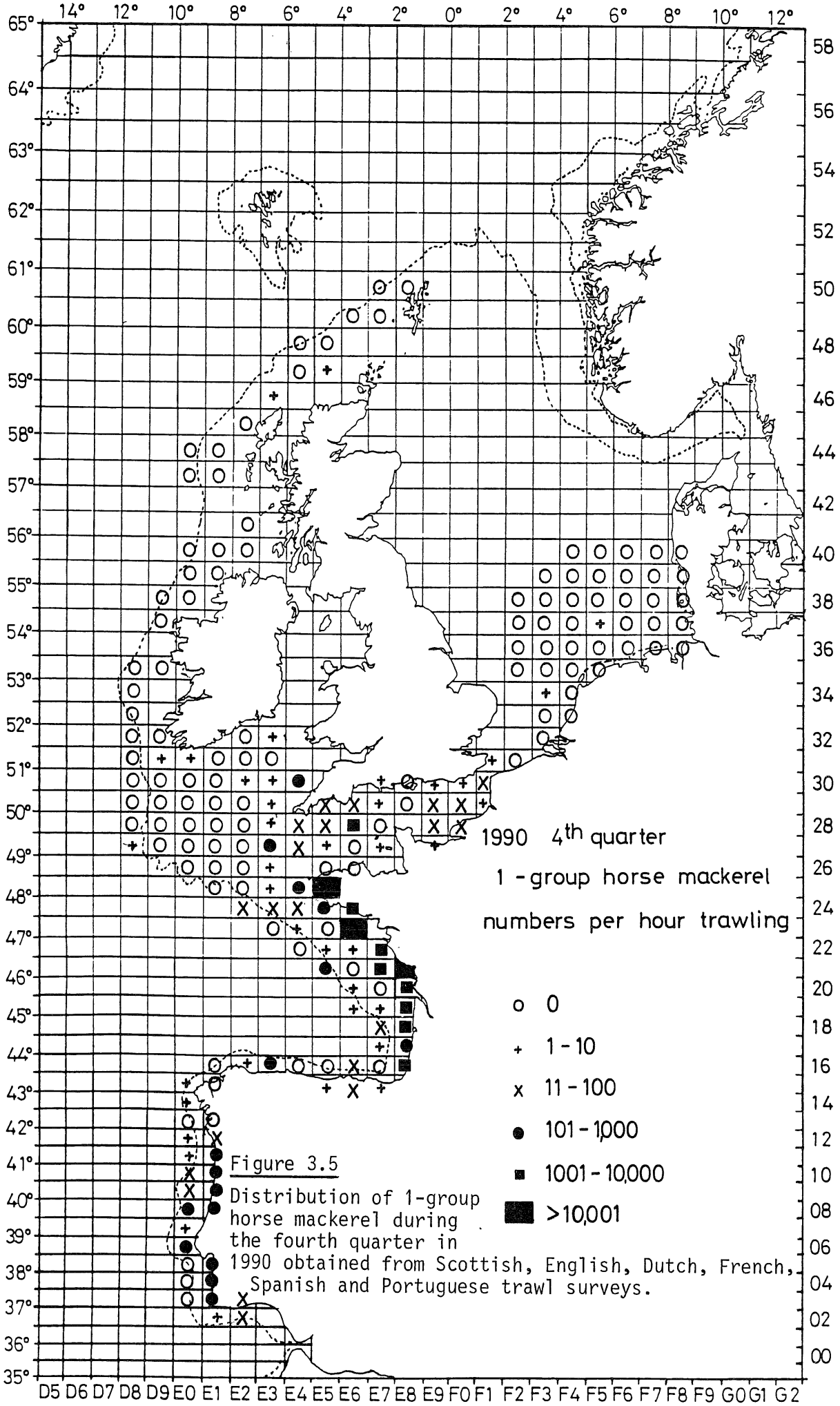


Figure 3.5

Distribution of 1-group horse mackerel during the fourth quarter in 1990 obtained from Scottish, English, Dutch, French, Spanish and Portuguese trawl surveys.

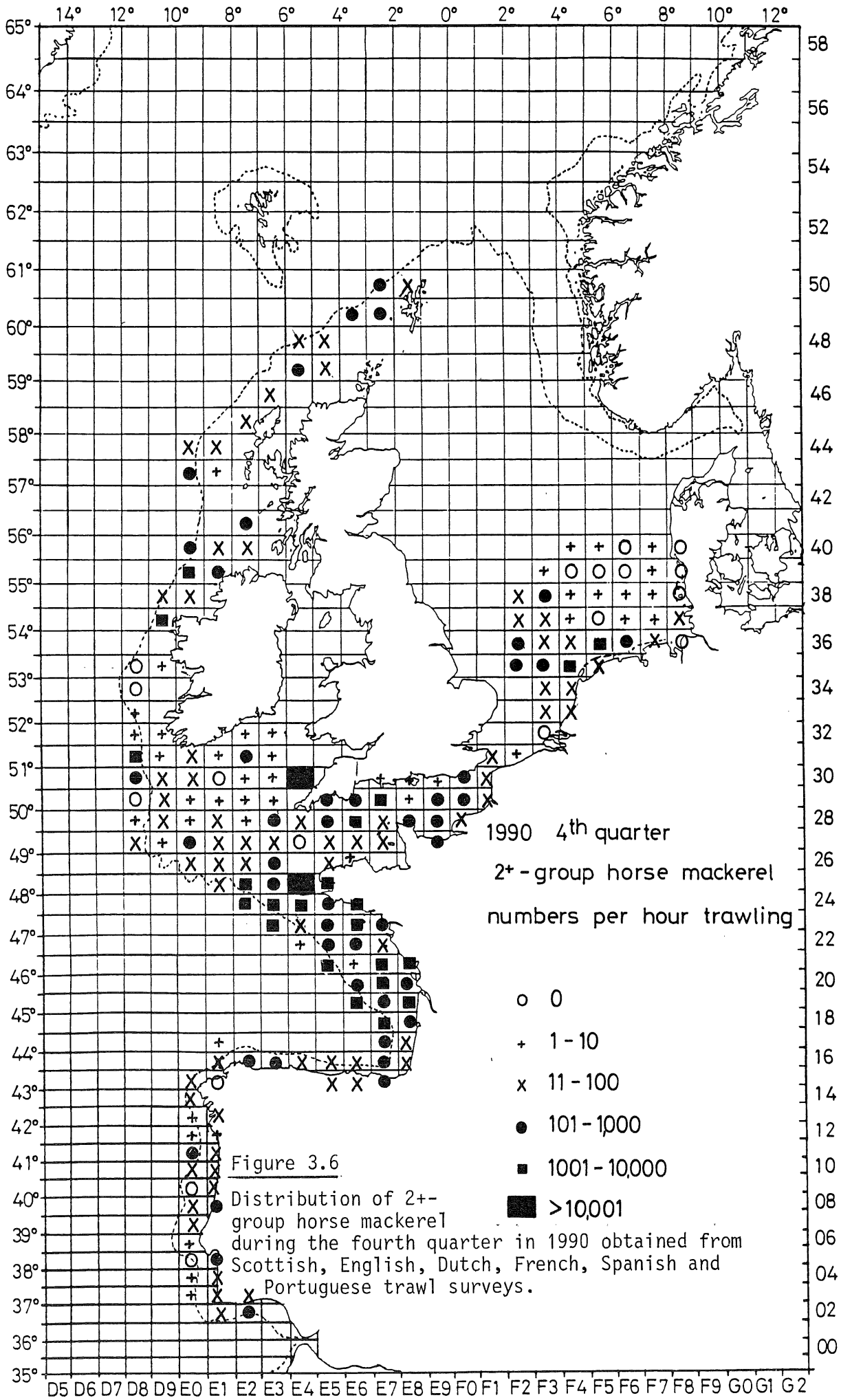


Figure 3.6

Distribution of 2+- group horse mackerel during the fourth quarter in 1990 obtained from Scottish, English, Dutch, French, Spanish and Portuguese trawl surveys.

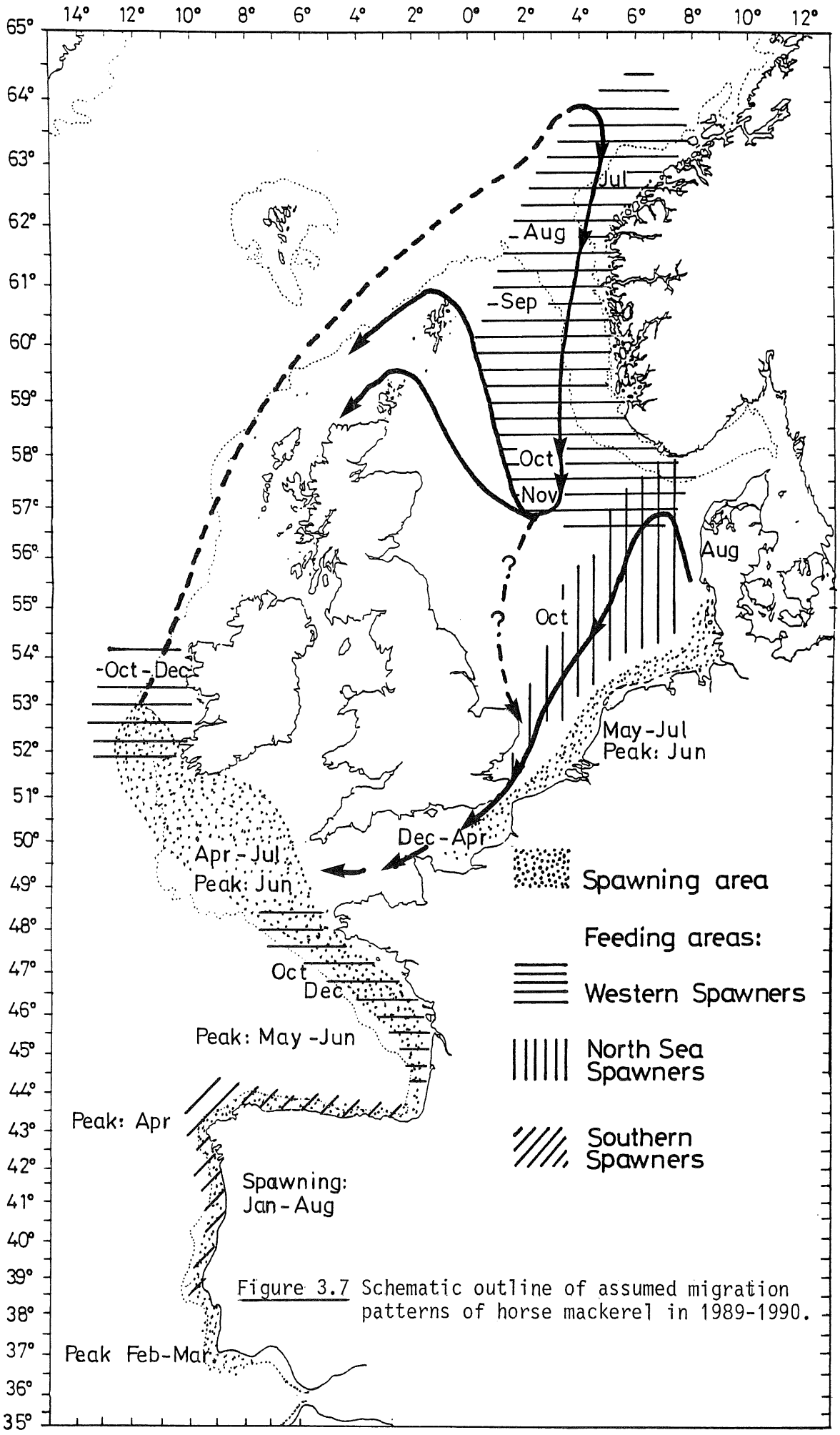


Figure 3.7 Schematic outline of assumed migration patterns of horse mackerel in 1989-1990.

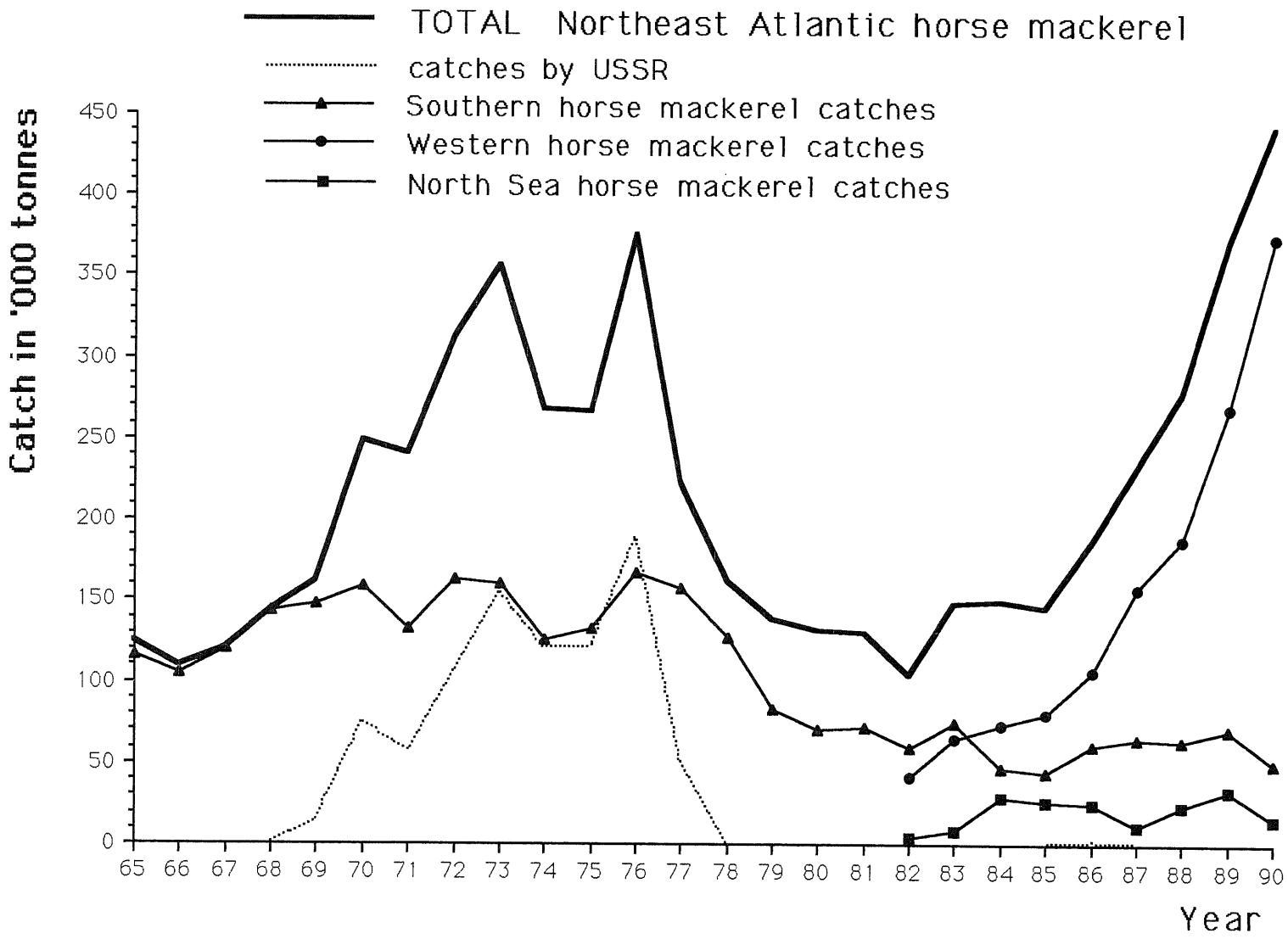


Figure 3.8 Total catches of horse mackerel in the northeast Atlantic from 1965-1990. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches.

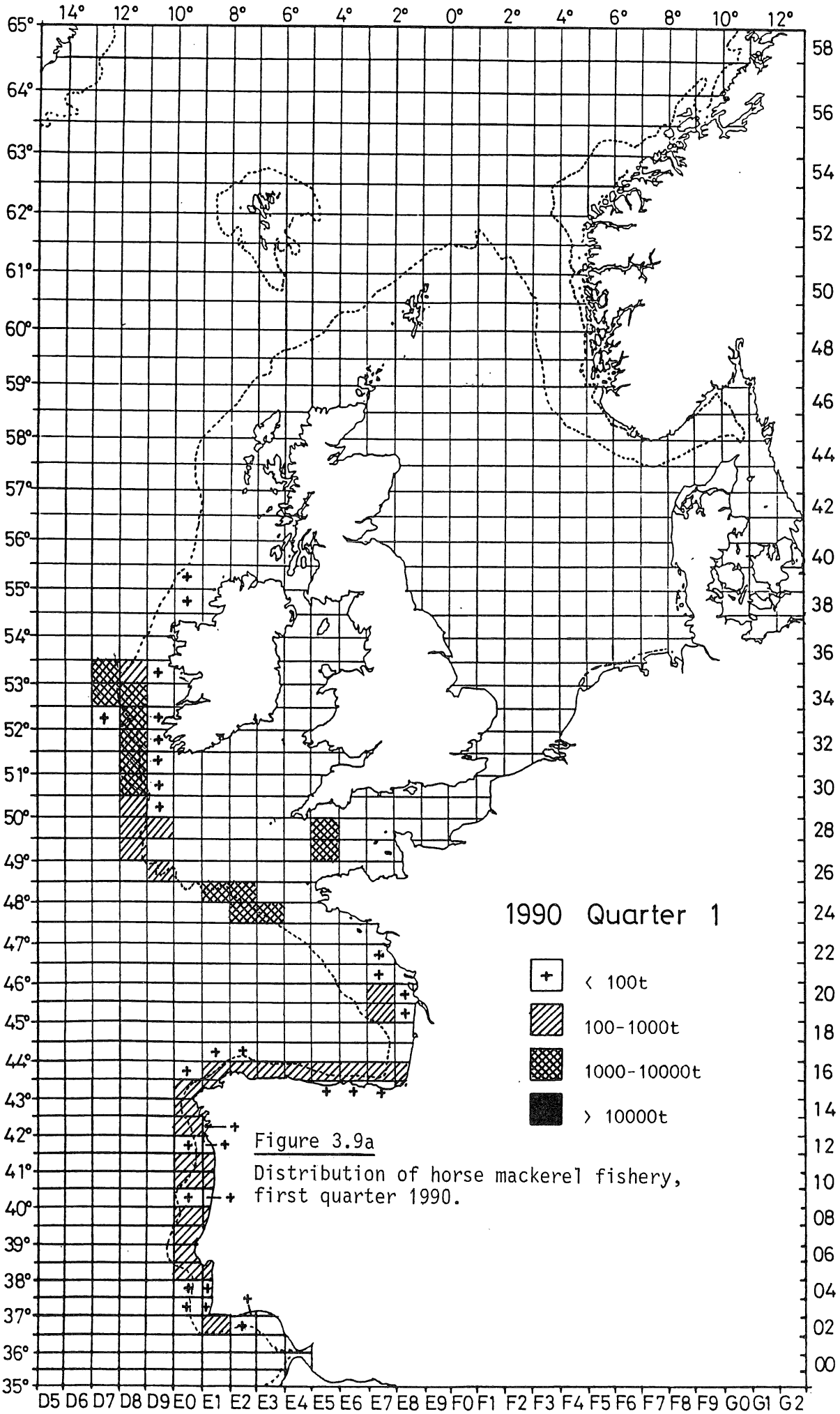


Figure 3.9a

Distribution of horse mackerel fishery, first quarter 1990.

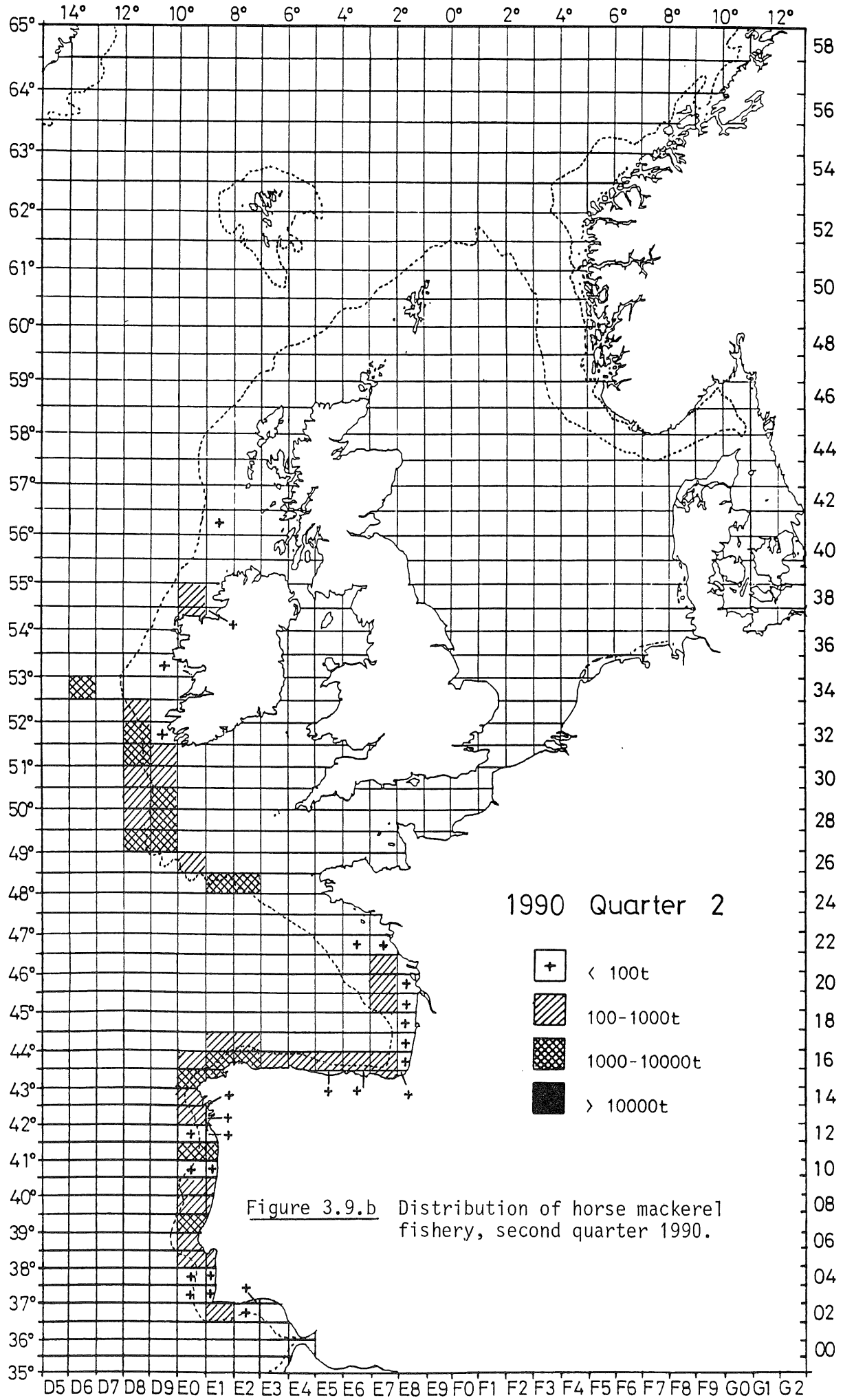


Figure 3.9.b Distribution of horse mackerel fishery, second quarter 1990.

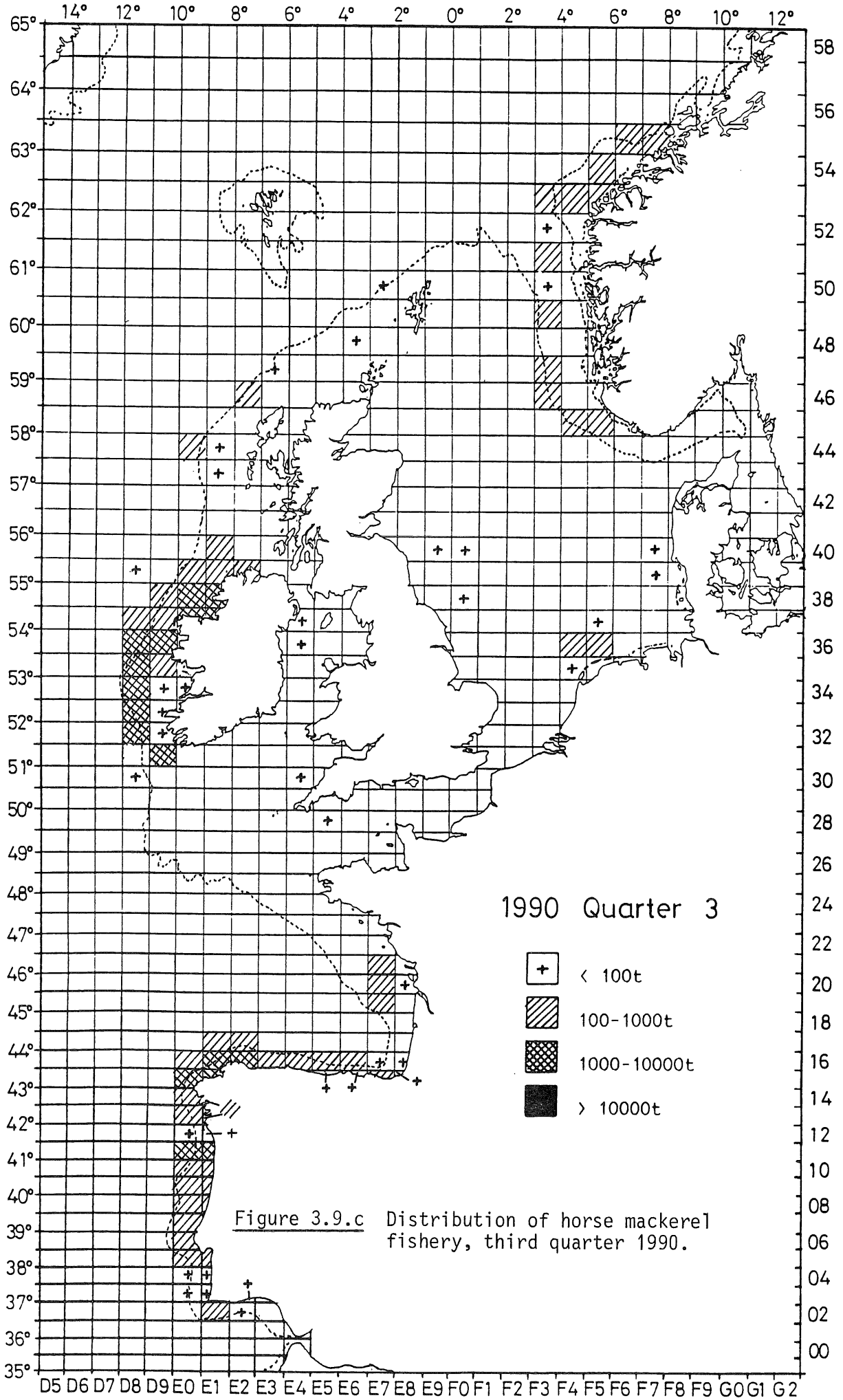


Figure 3.9.c Distribution of horse mackerel fishery, third quarter 1990.

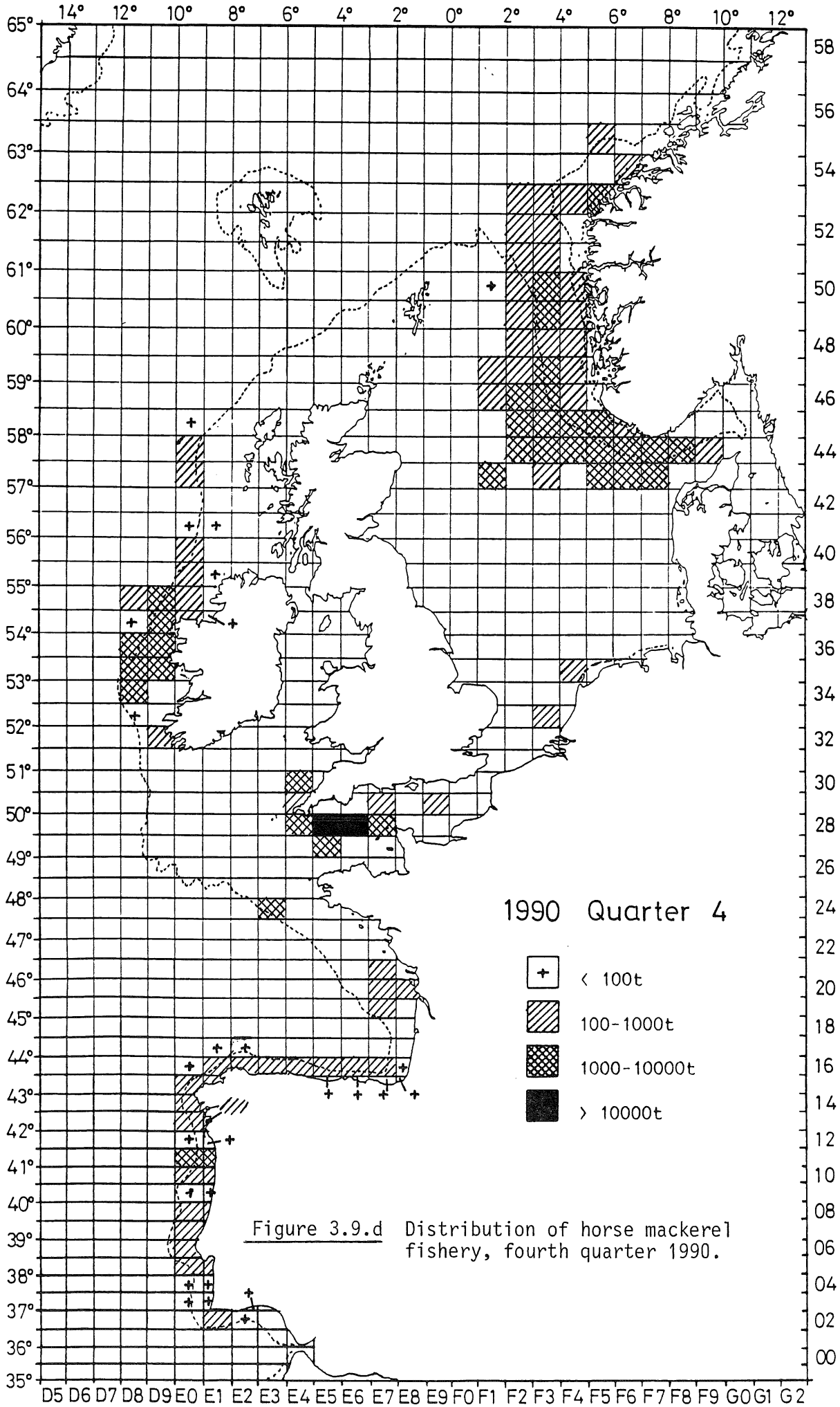
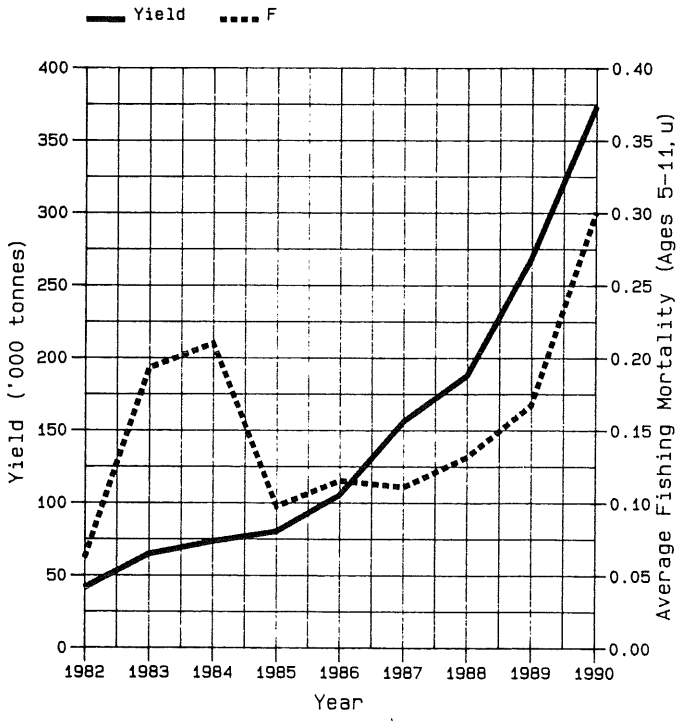


Figure 3.9.d Distribution of horse mackerel fishery, fourth quarter 1990.

Figure 5.1

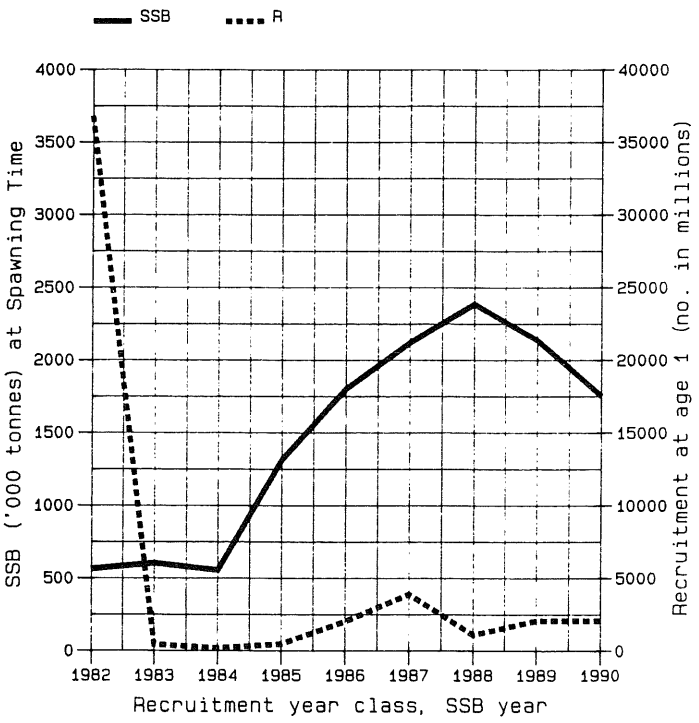
FISH STOCK SUMMARY
Western Horse Mackerel
19-07-1991

Trends in yield and fishing mortality (F)



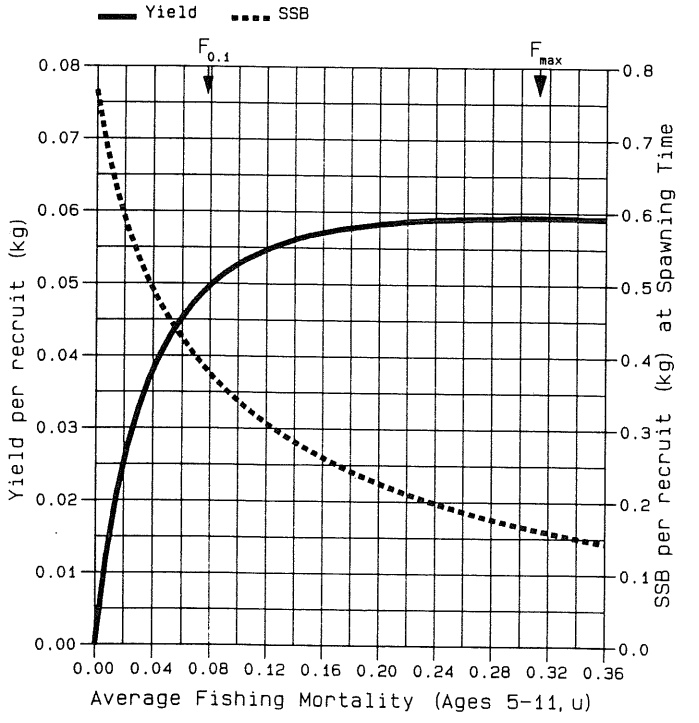
A

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



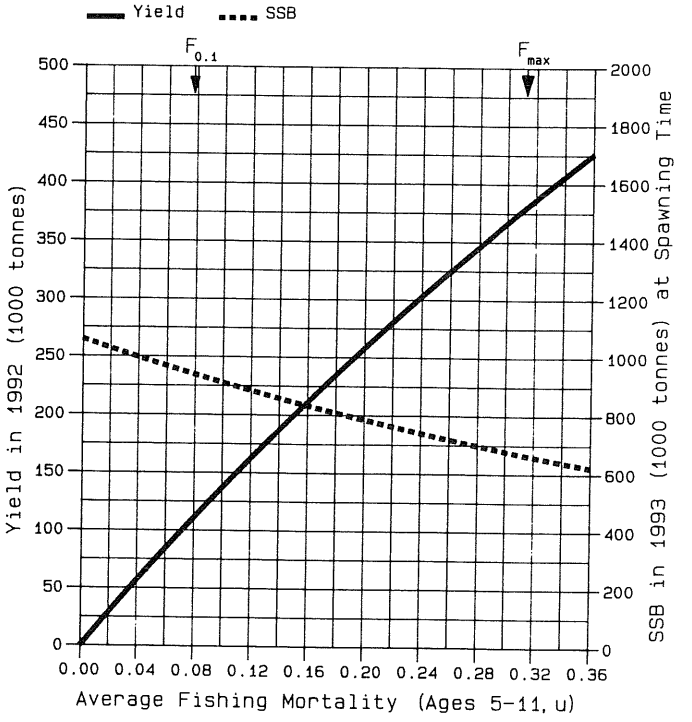
B

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

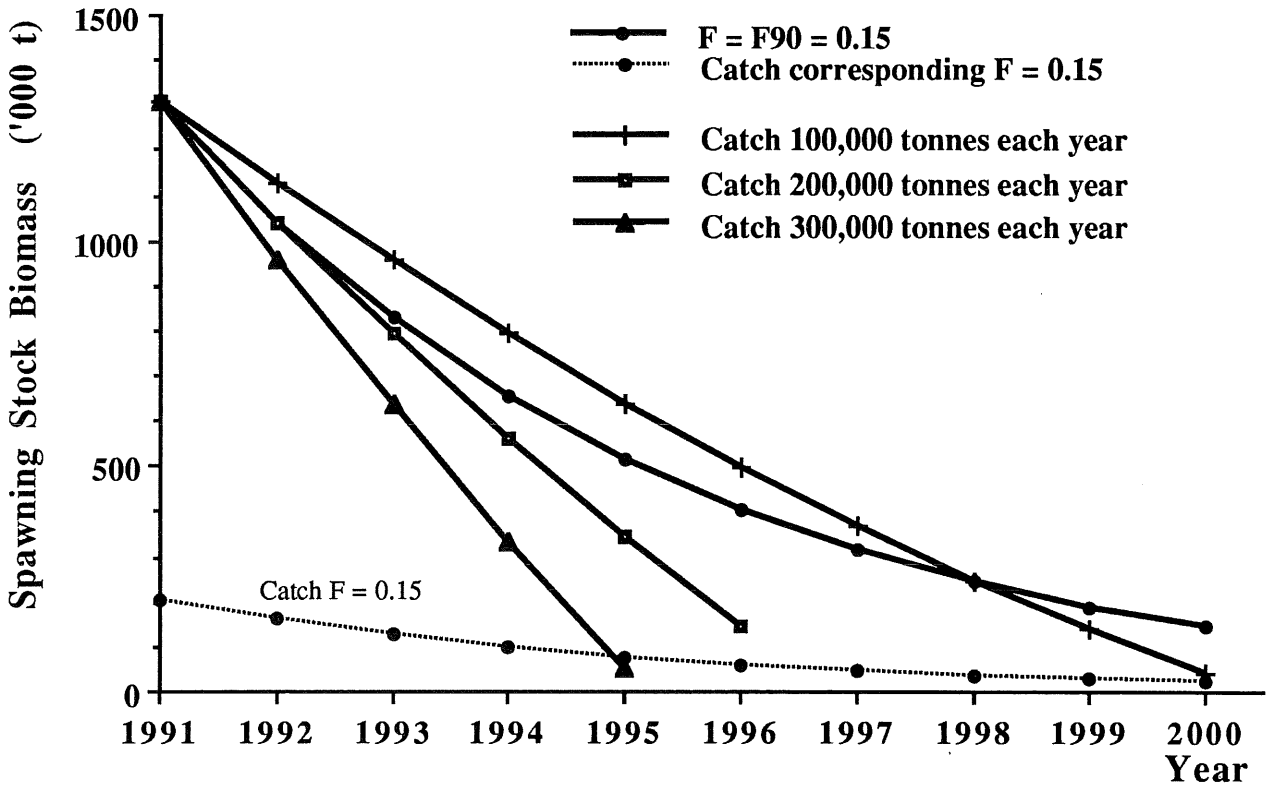


Figure 5.2 Development of the 1982 cohort (SSB) of western horse mackerel under four different management options.

Figure 5.3

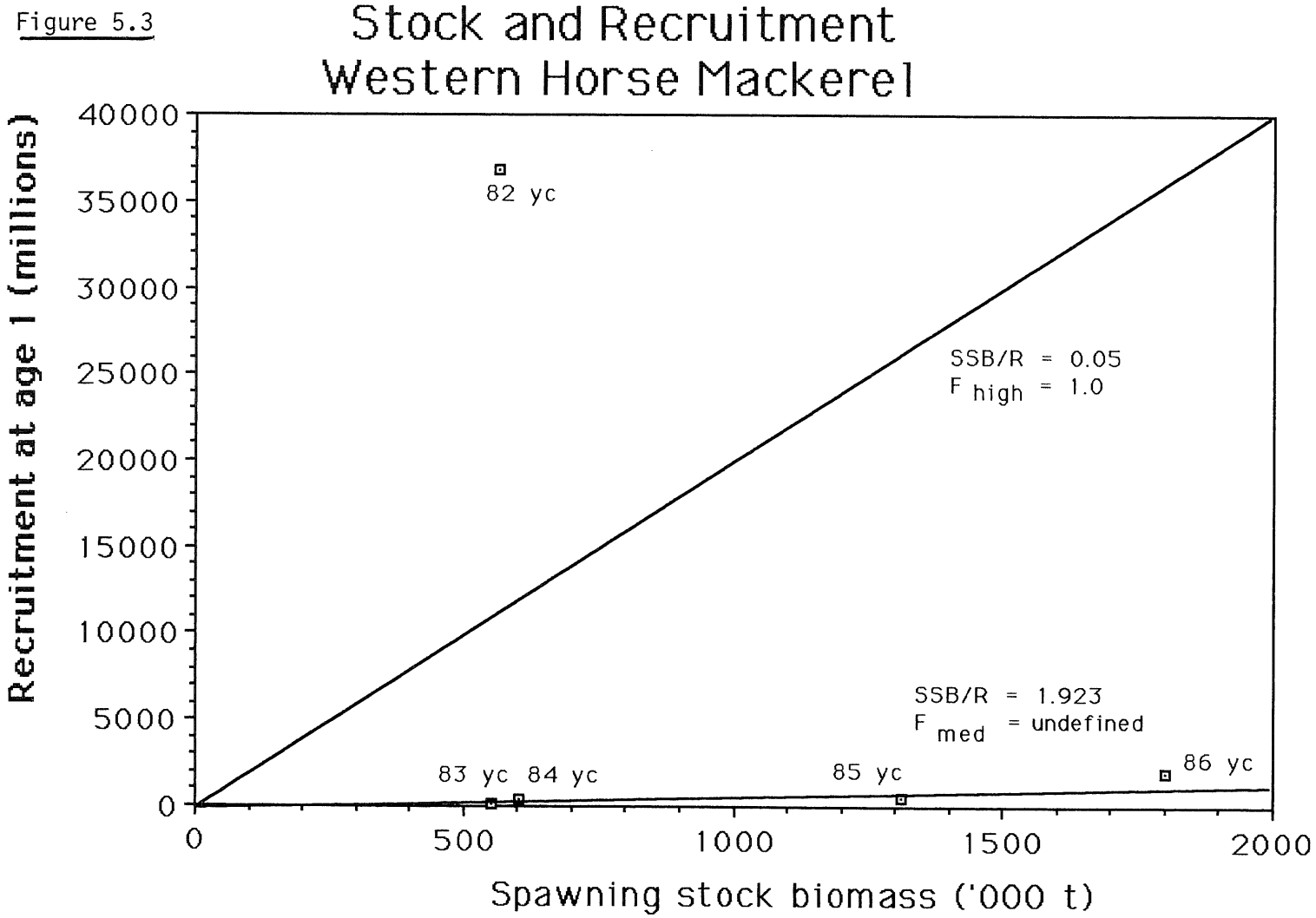
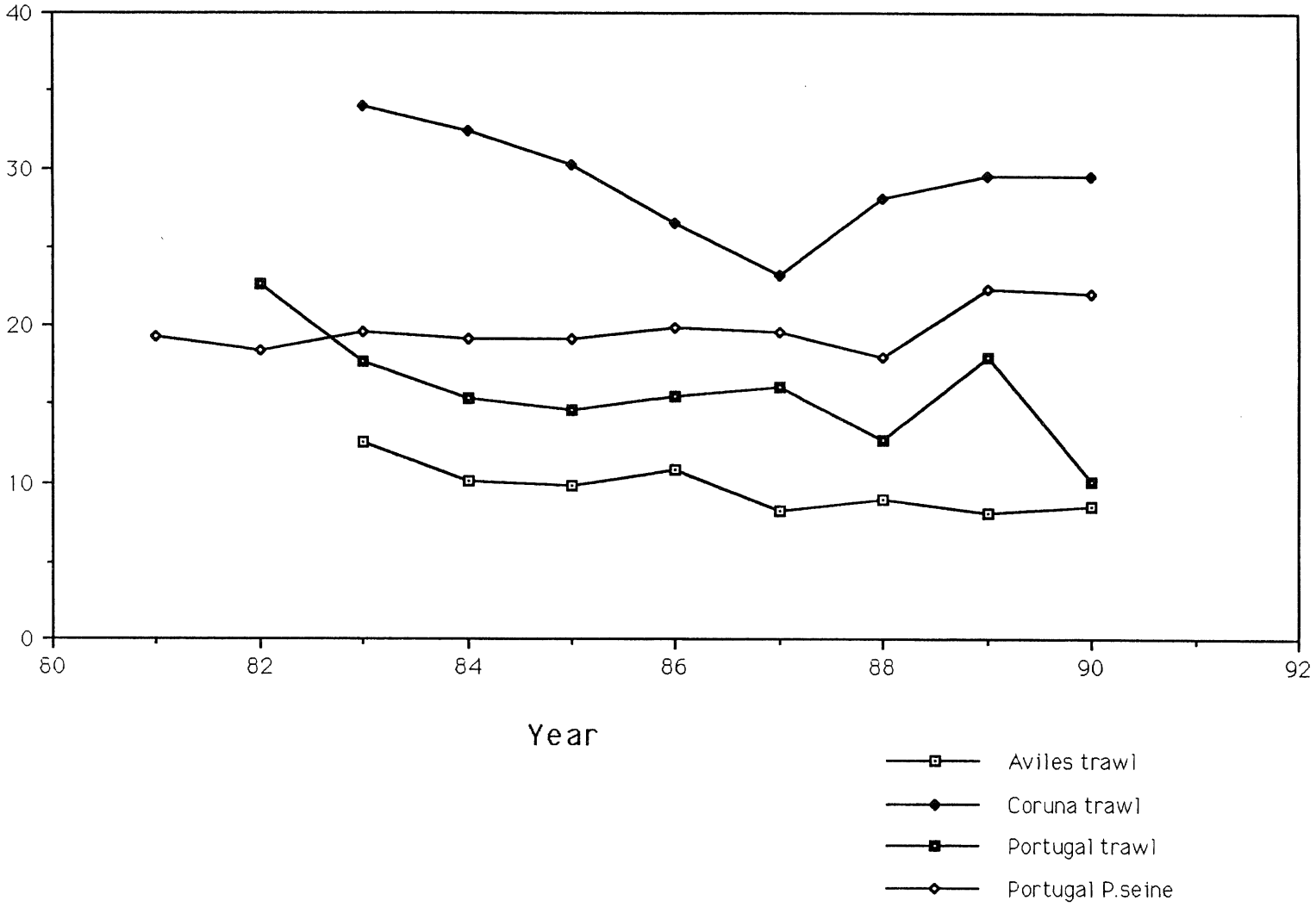

Stock and Recruitment
Western Horse Mackerel
Recruitment at age 1 (millions)
40000
35000
30000
25000
20000
15000
10000
5000
0
82 yc
SSB/R = 0.05
F high = 1.0
SSB/R = 1.923
F med = undefined
83 yc
84 yc
85 yc
86 yc
0
500
1000
1500
2000
Spawning stock biomass ('000 t)

Figure 6.1 : Southern horse mackerel. Effort data from four fleets"



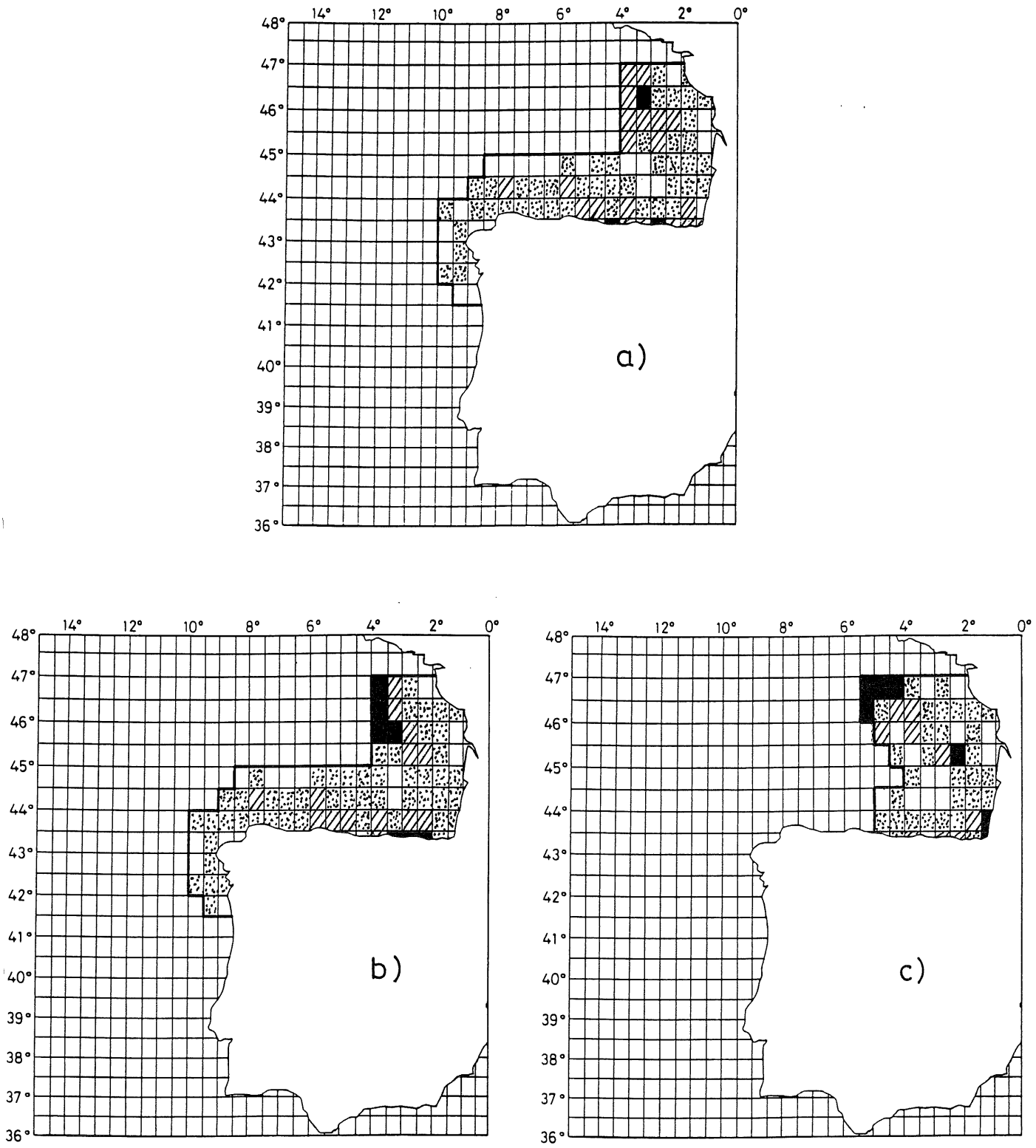


Figure 6.2 Results from southern horse mackerel egg surveys in the northern part of Division IXa and Divisions VIIIb,c in 1990 (from Franco et al., WD. 1991):

a) Daily egg production per rectangle in April-May 1990
b) Egg distribition in April-May 1990
c) Egg distribution in June 1990

Figure 6.3.a

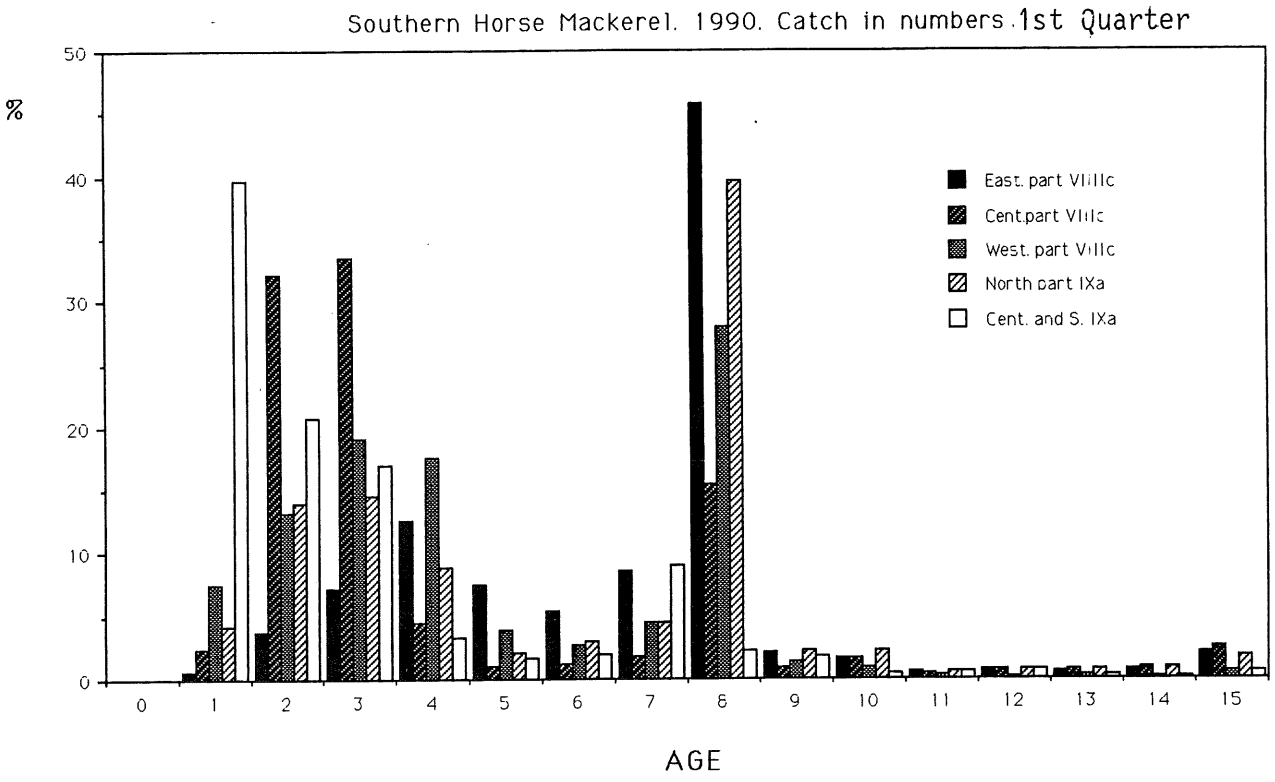


Figure 6.3.b

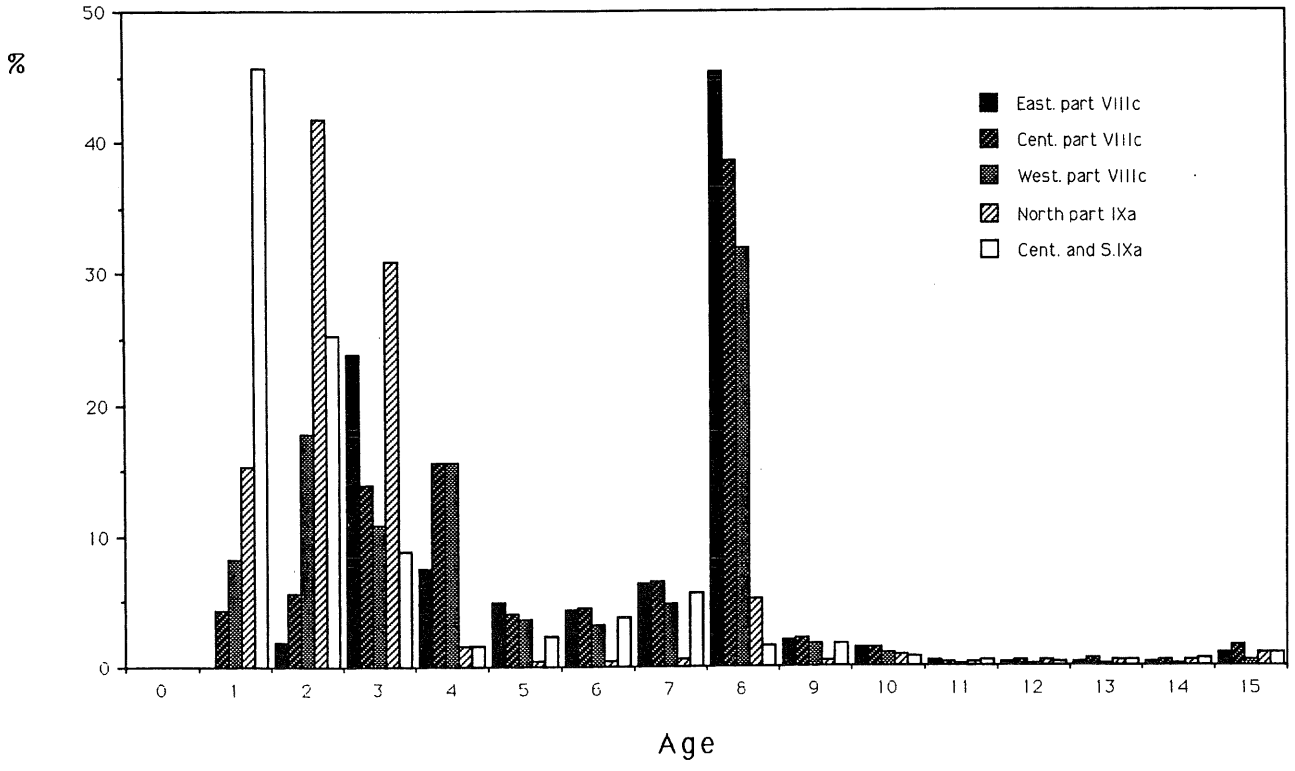


Figure 6.3.c

Southern Horse Mackerel.1990. Catch in numbers . 3rd Quarter

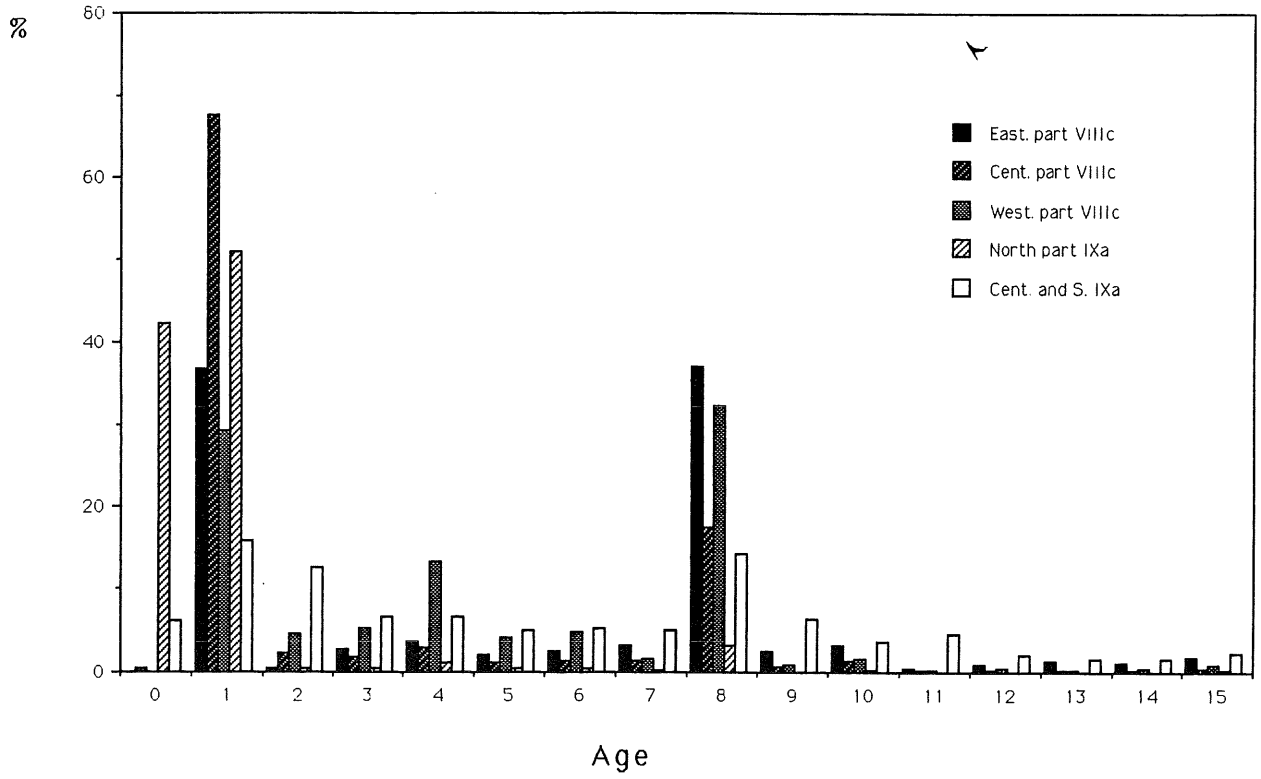
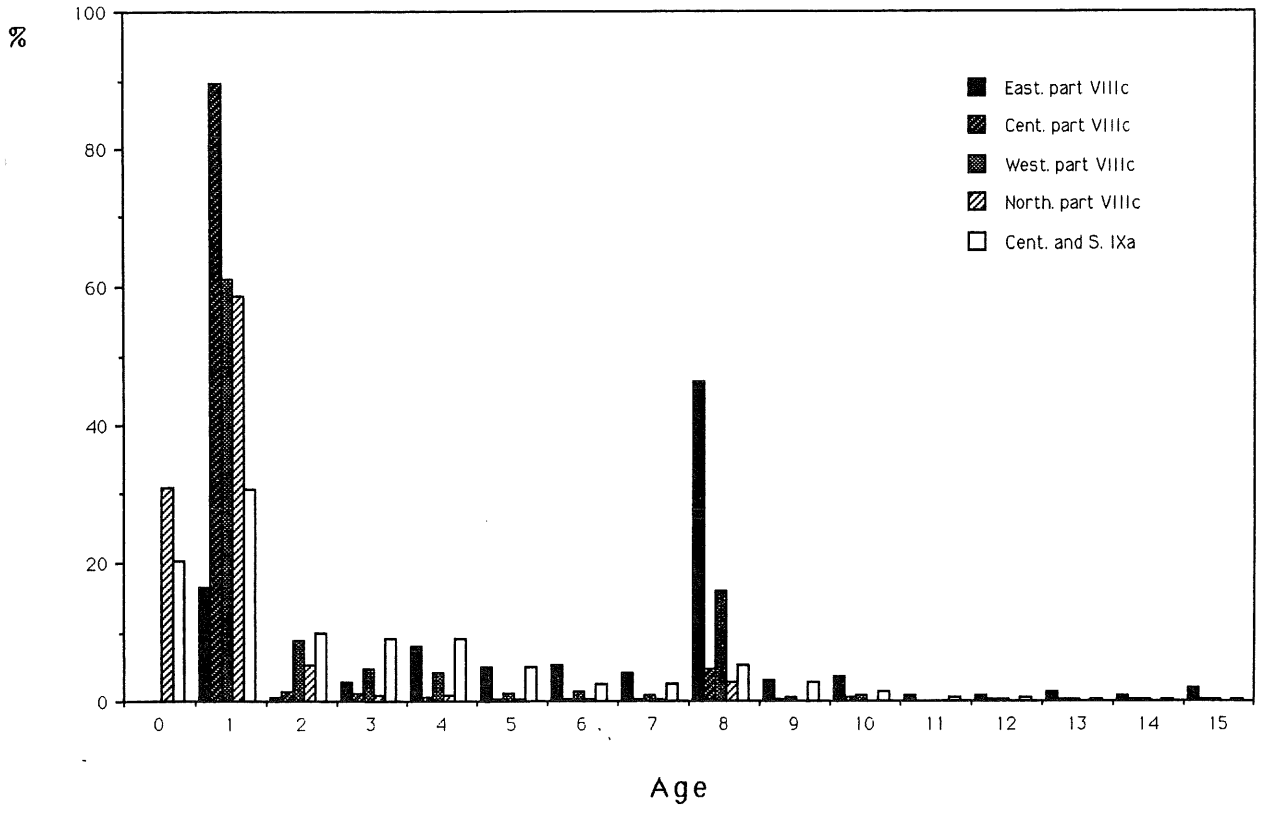
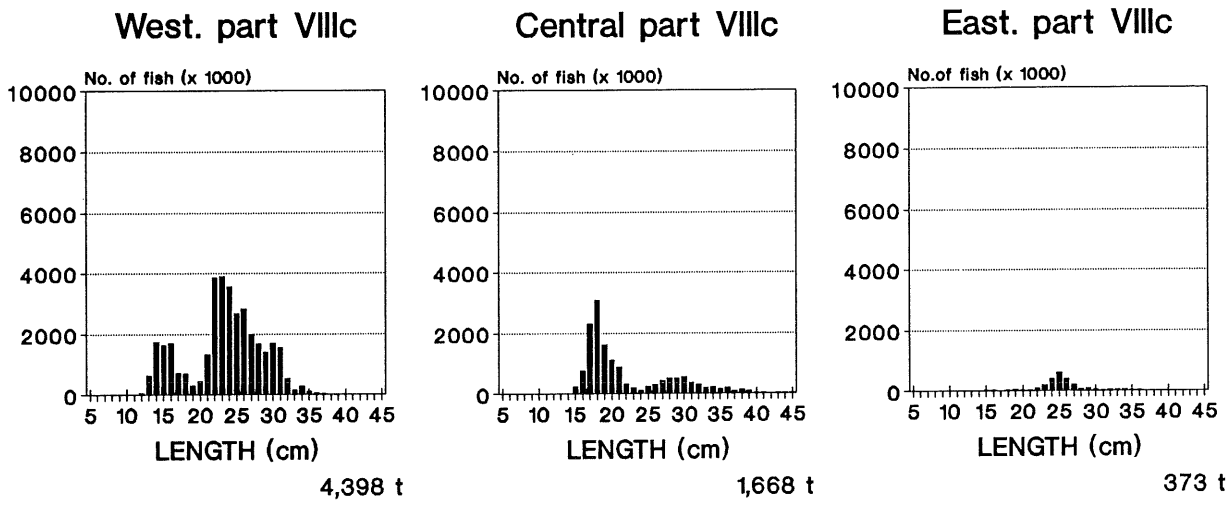
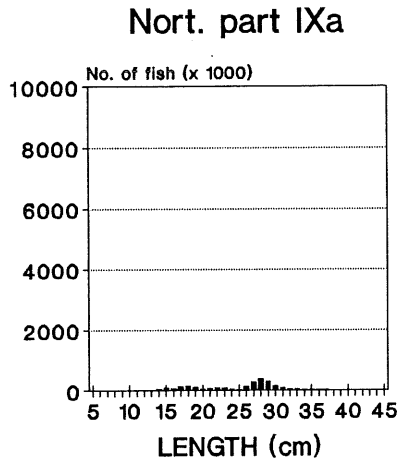


Figure 6.3.d

Southern Horse Mackerel. 1990. Catch in numbers. 4th Quarter







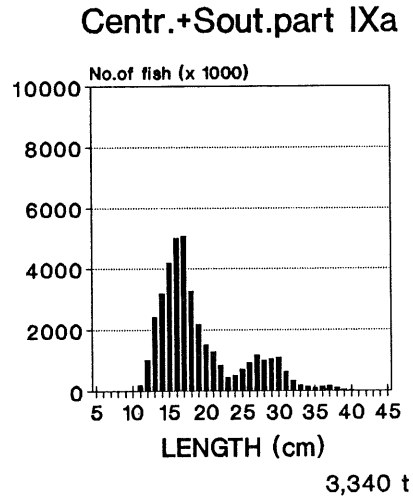
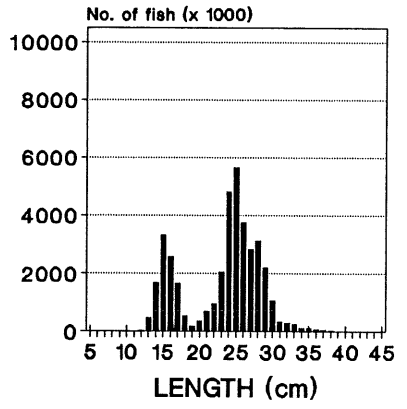


FIGURE 6.4a. Horse mackerel quarterly length distributions (x 1000) and catches in tons, by different parts of Divisions VIIIc and IXa.

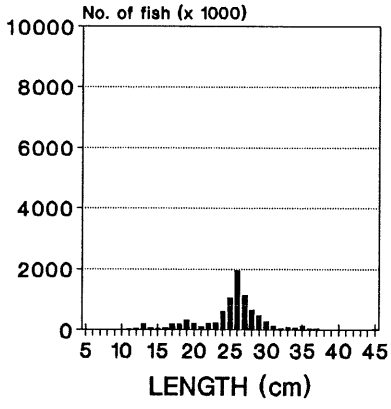
1st QUARTER - 1990

West. part part VIIIc



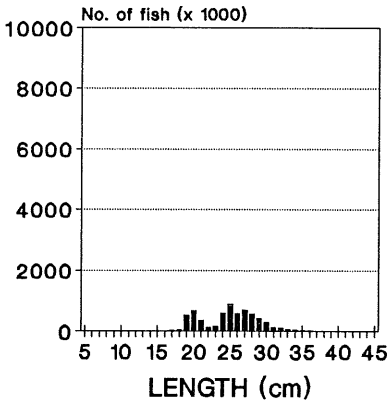
4,744 t

Central part VIIIc



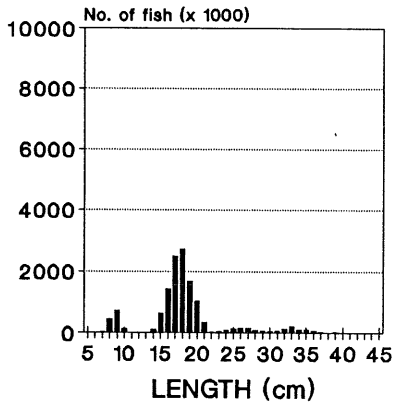
1,353 t

East. part VIIIc



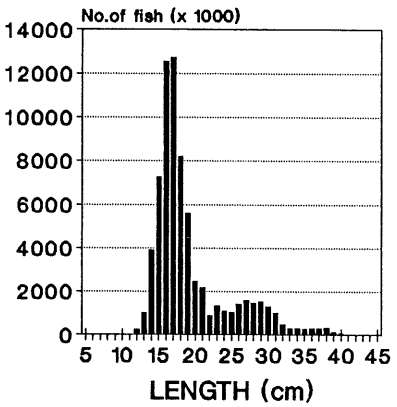
830 t

Nort. part IXa



944 t

Centr.+Sout.part IXa



5,752 t

FIGURE 6.4b. Horse mackerel quarterly length distributions (x 1000) and catches in tons, by different parts of Divisions VIIIc and IXa.

2nd QUARTER - 1990

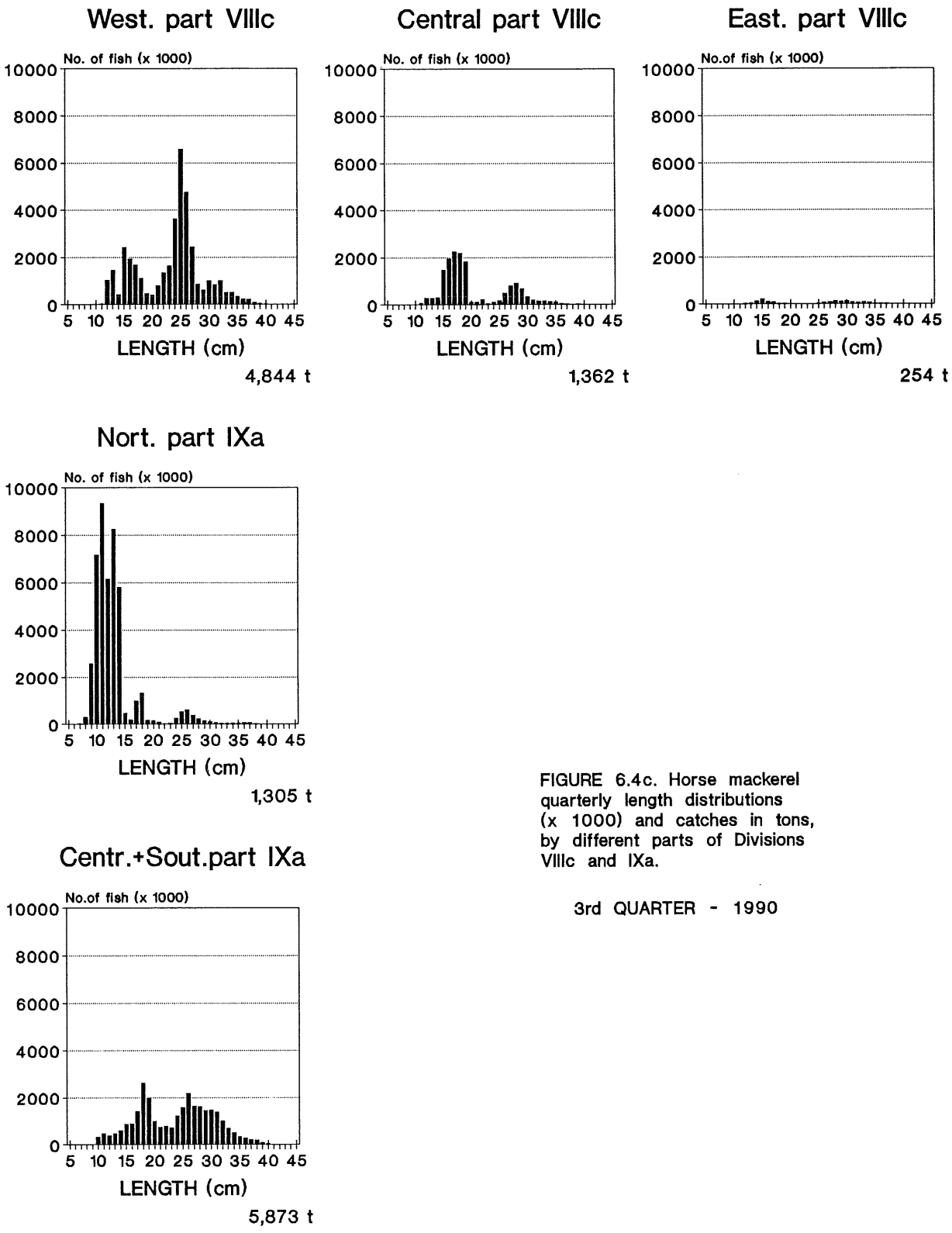
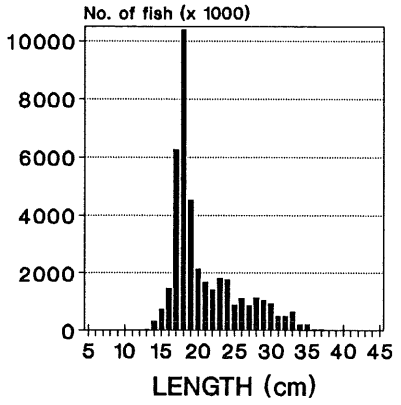


FIGURE 6.4c. Horse mackerel quarterly length distributions (x 1000) and catches in tons, by different parts of Divisions VIIIc and IXa.

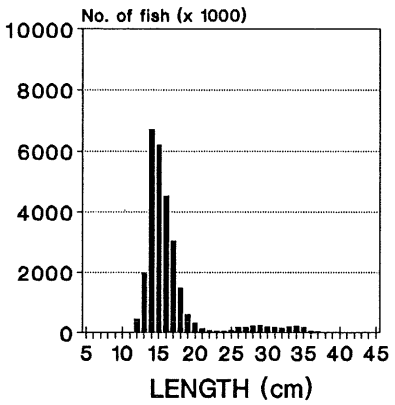
3rd QUARTER - 1990

West. part VIIIc



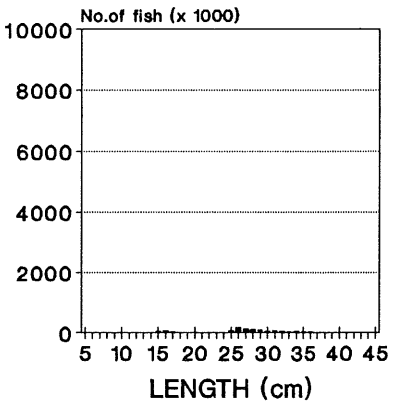
3,689 t

Central part VIIIc



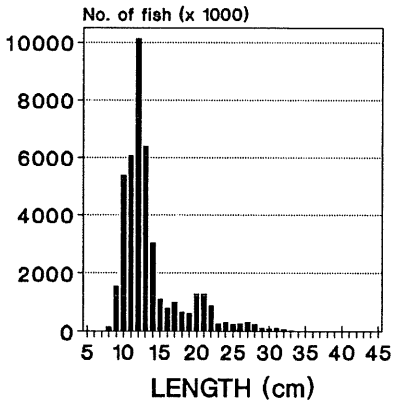
1,468 t

East. part VIIIc



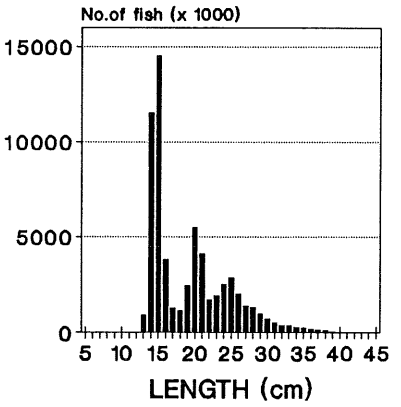
198 t

Nort. part IXa



1,428 t

Centr.+Sout.part IXa



4,992 t

FIGURE 6.4d. Horse mackerel quarterly length distributions (x 1000) and catches in tons, by different parts of Divisions VIIIc and IXa.

4th QUARTER - 1990

Fig 6.5 SHOT Forecast for Southern Horse Mackerel

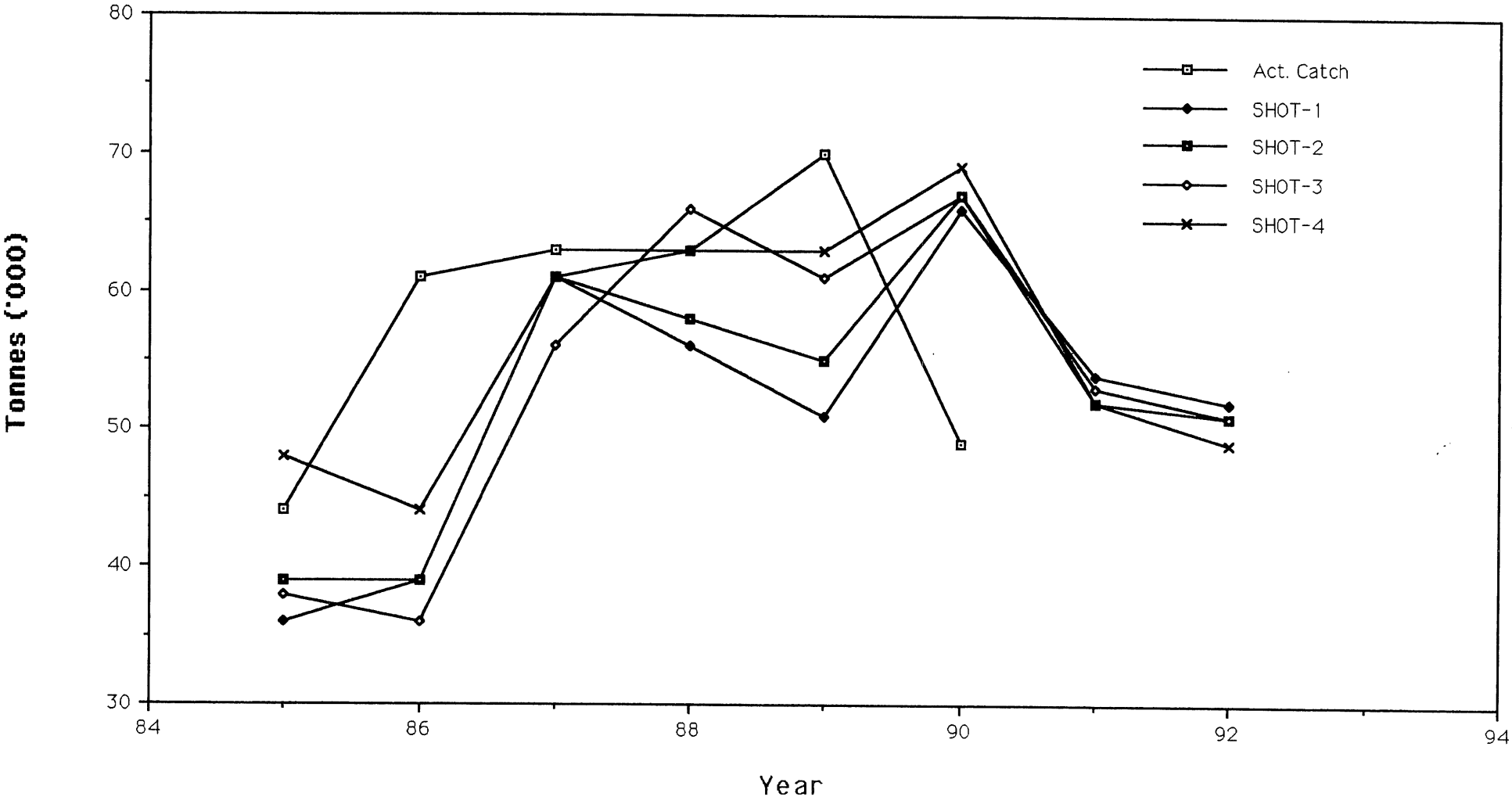


Figure 7.1 Bay of Biscay anchovy. Historical evolution of the Spanish purse seine fishery, the main events are marked.

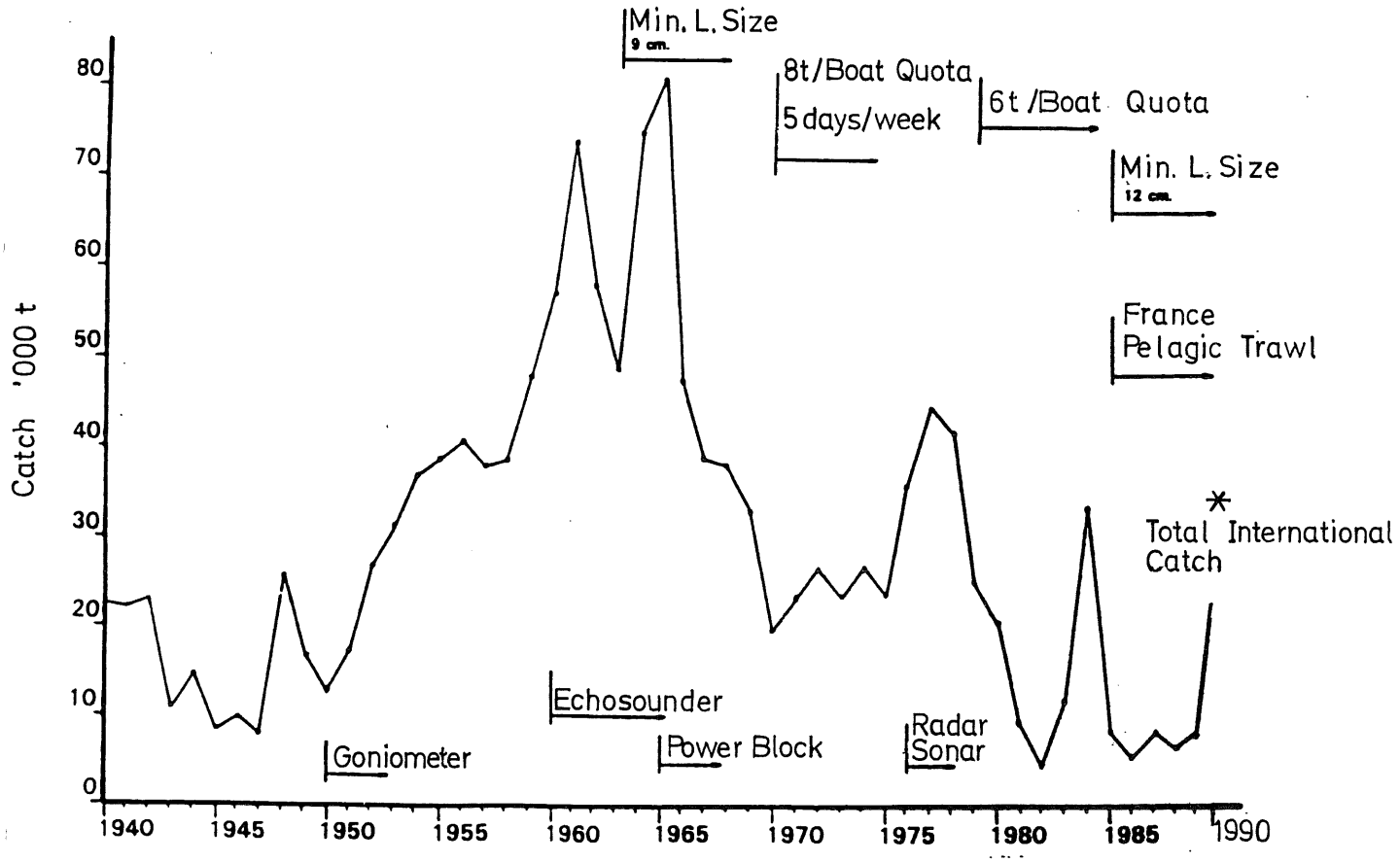
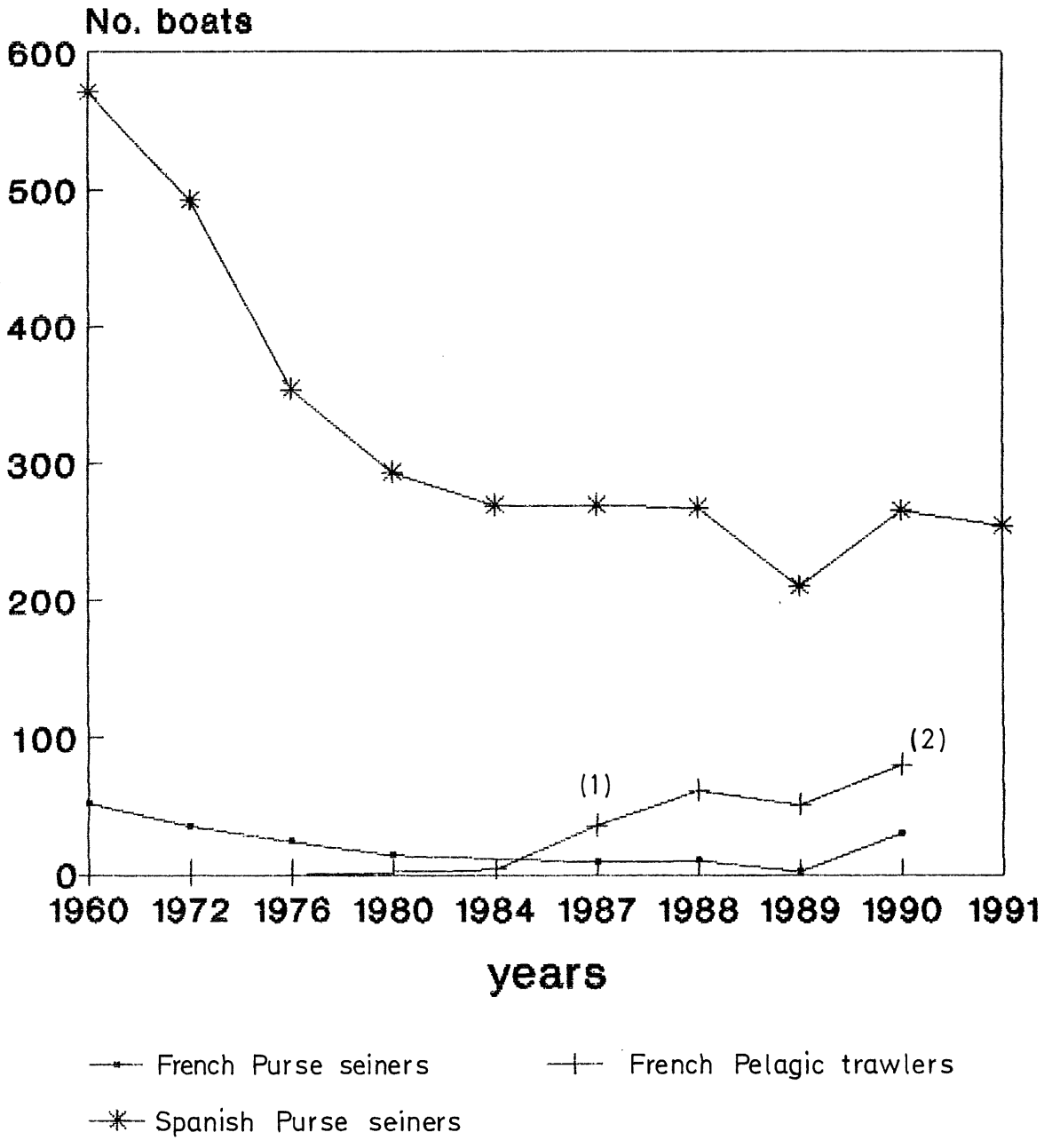
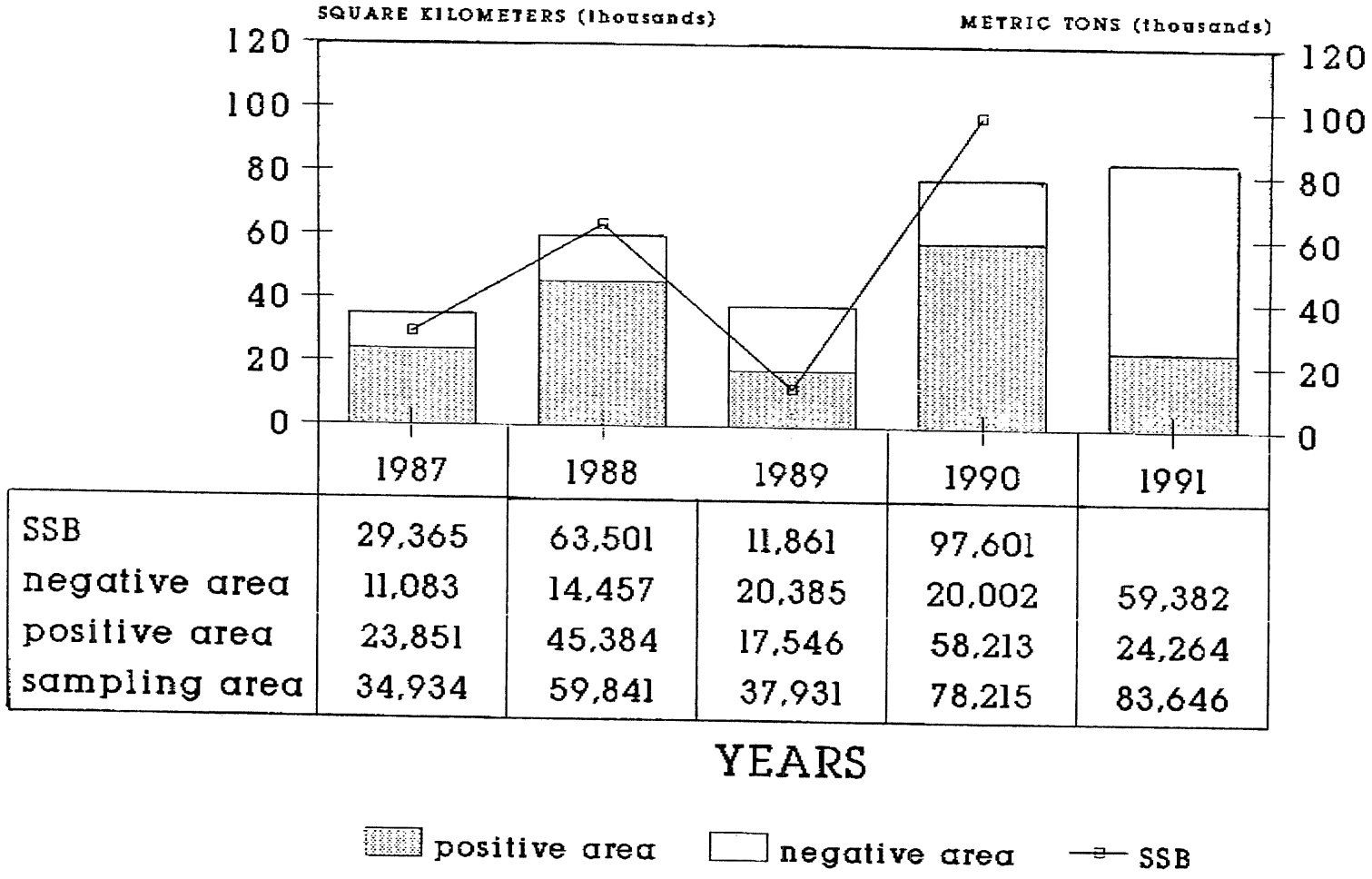


Figure 7.2 Evolution of the French and Spanish fleet for anchovy (from Working Group members).
1) From 1960 to 1987 only the Basque country fleet
2) Number of boats, only 48 trawls used





	1987	1988	1989	1990	1991
SSB	29,365	63,501	11,861	97,601	
negative area	11,083	14,457	20,385	20,002	59,382
positive area	23,851	45,384	17,546	58,213	24,264
sampling area	34,934	59,841	37,931	78,215	83,646

* 1991 = provisional results

Figure 7.3 Positive area and SSB relationship for the different egg surveys on the Bay of Biscay anchovy(from Notos, Franco and Garcia pers. comm.)

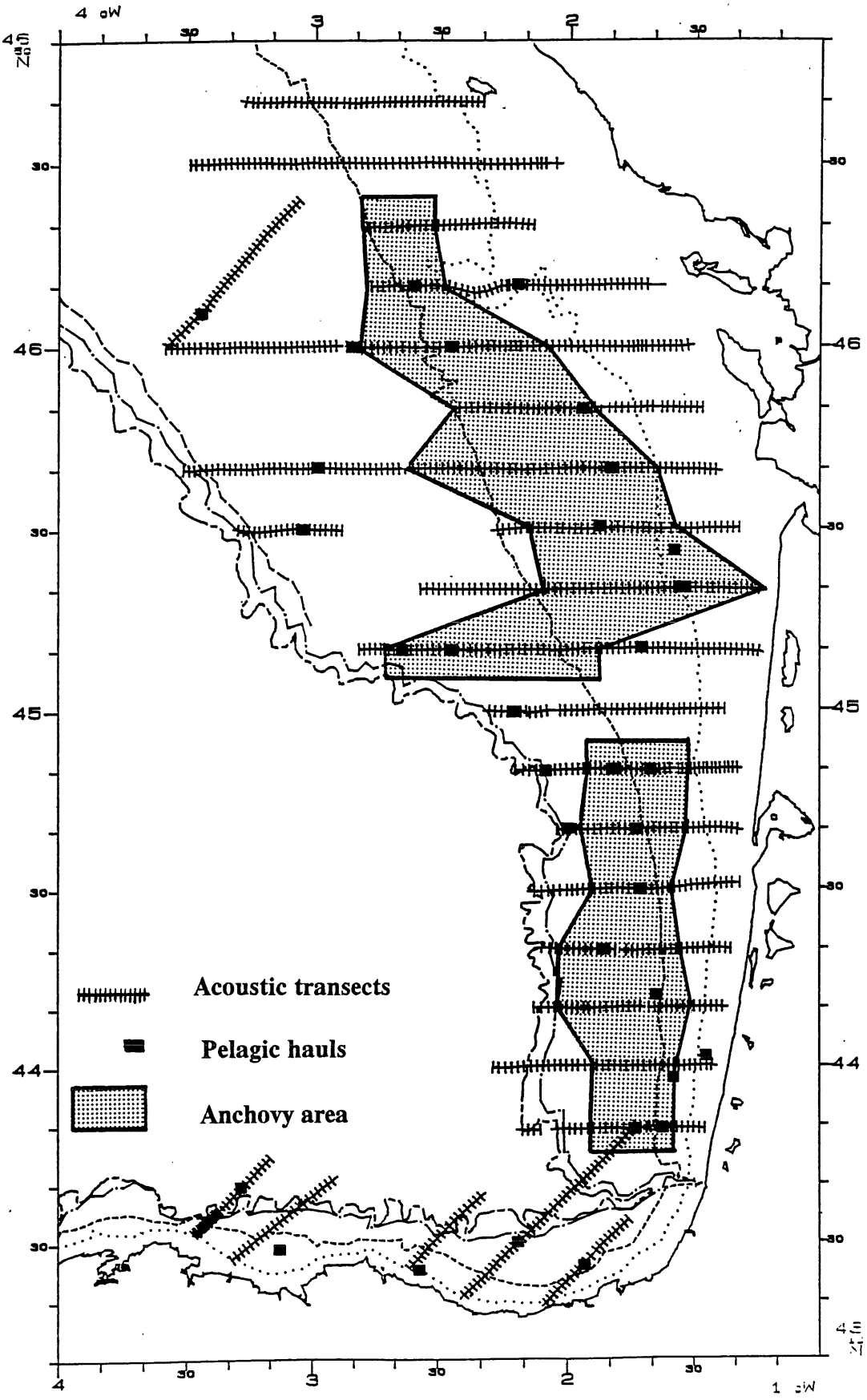


Fig. 7.4. French acoustic survey (April 1991)

Figure 7.5 Variation of the recruitment level (expressed as the number of 1-year old in million per 1,000 tonnes of SSB the year before) during the 1987-1990 period.

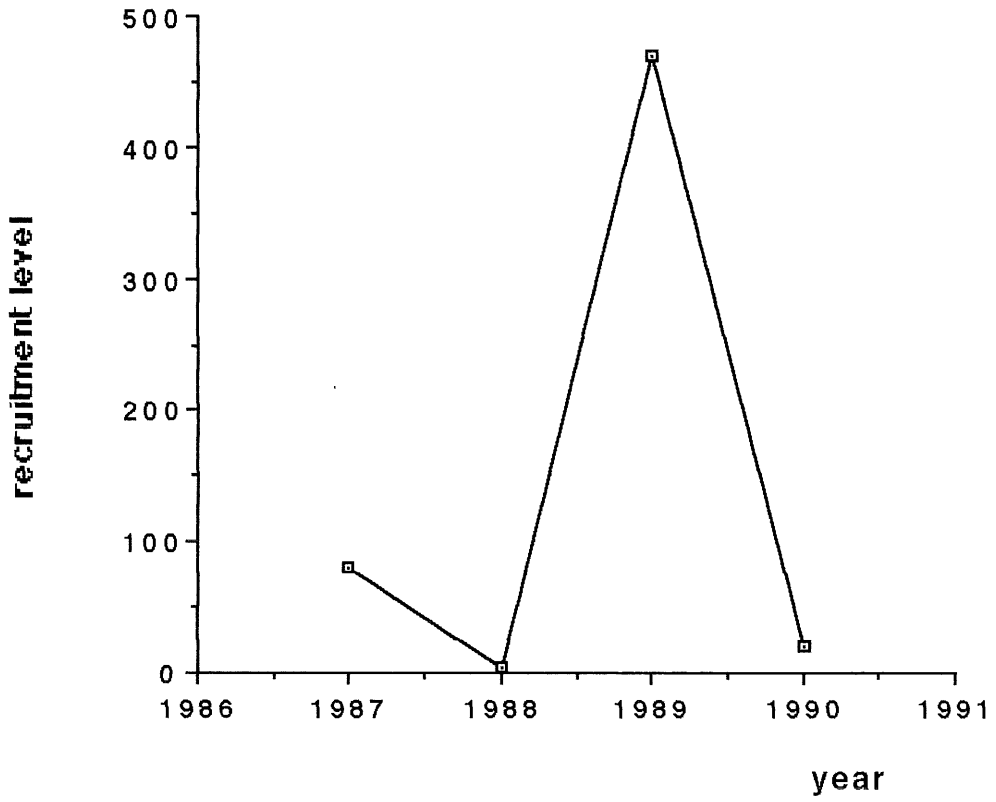


Figure 7.6.a Length distributions of landings of Bay of Biscay anchovy (January-June) in Divisions VIIIa,b and c.

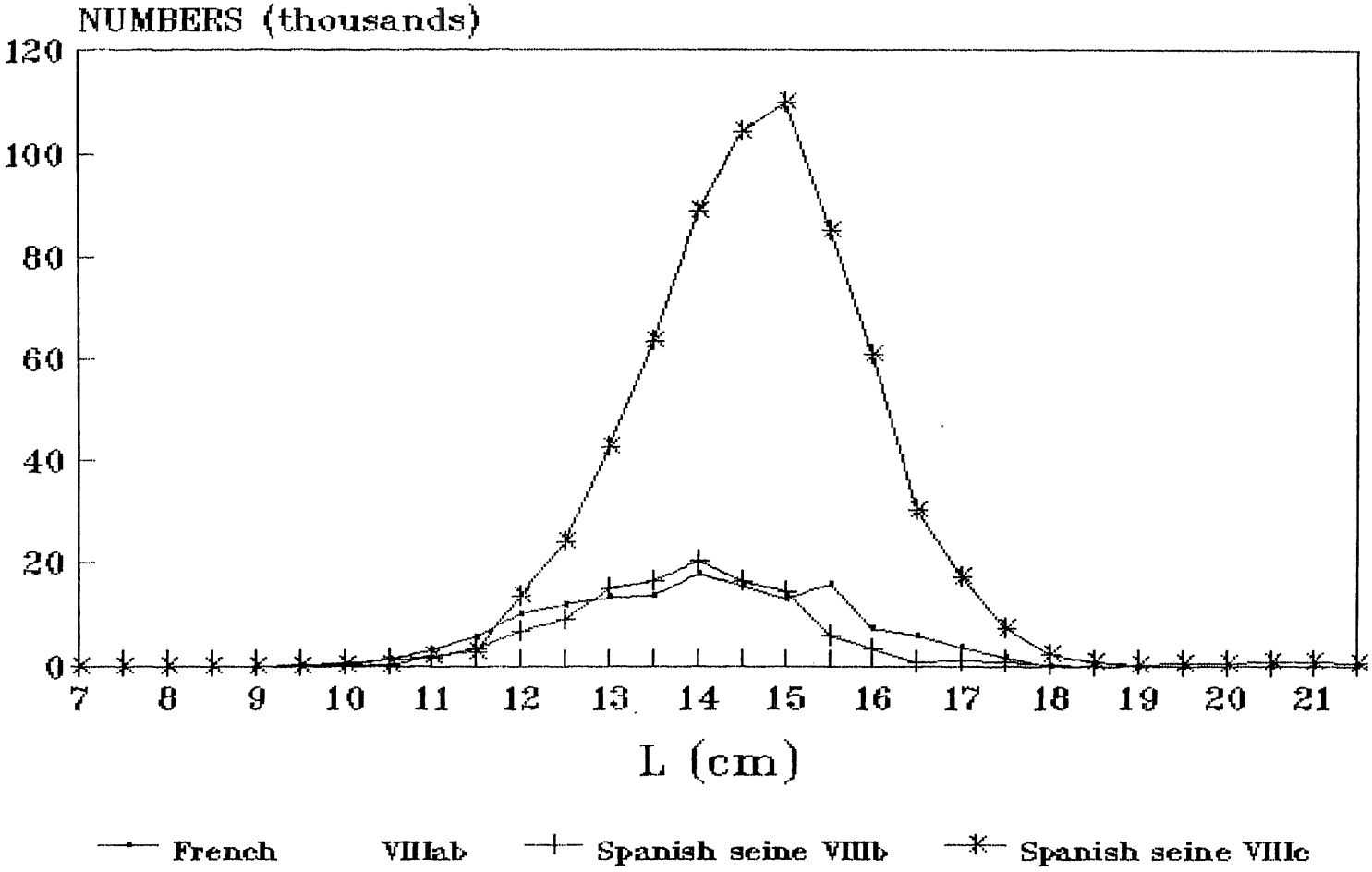


Figure 7.6.b Length distributions of landings of Bay of Biscay anchovy (July-December) in Divisions VIIIc,b and c in 1990.

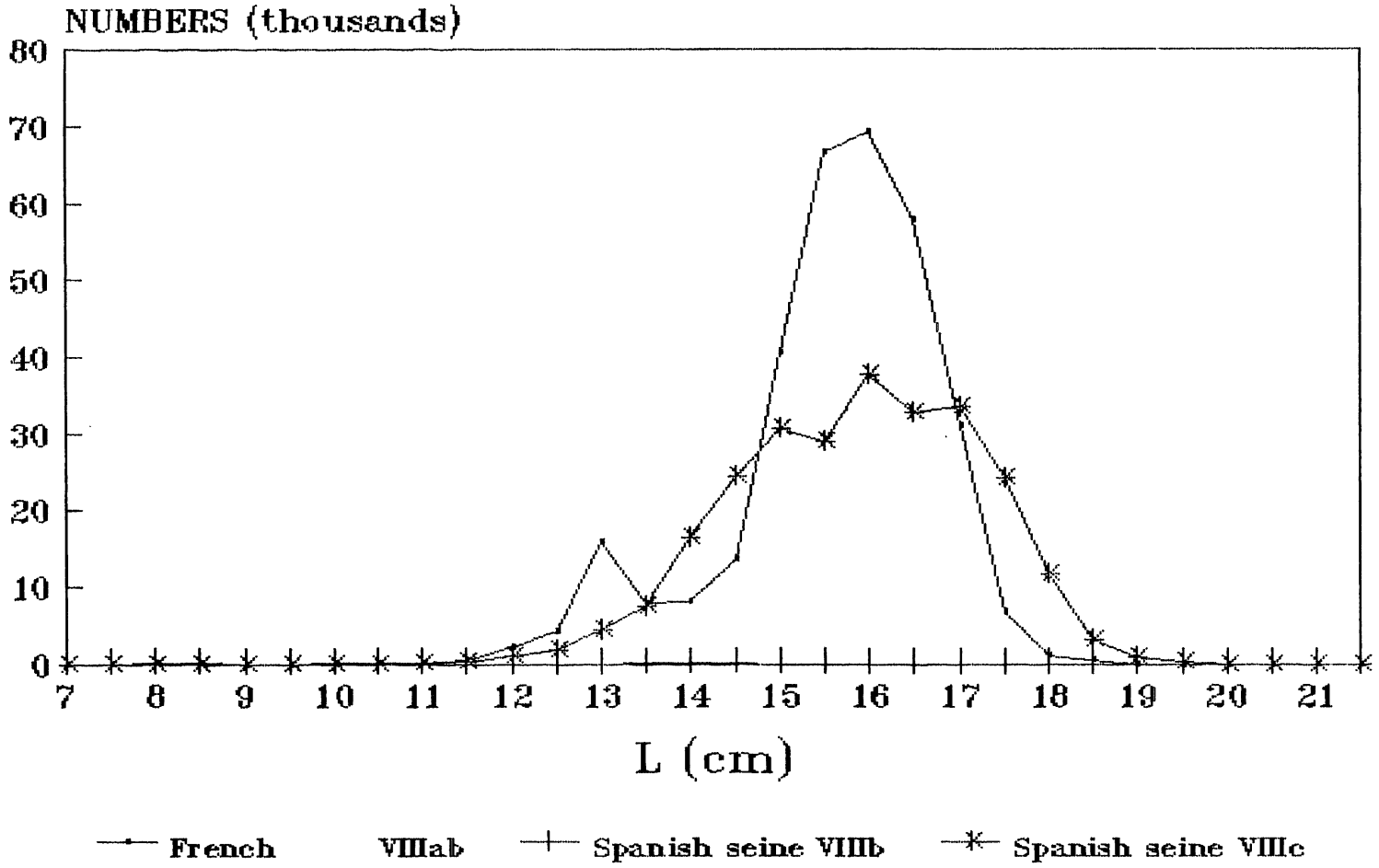


Figure 7.7 Values of F and M observed from catches and fishery independent observations (egg and acoustic surveys).

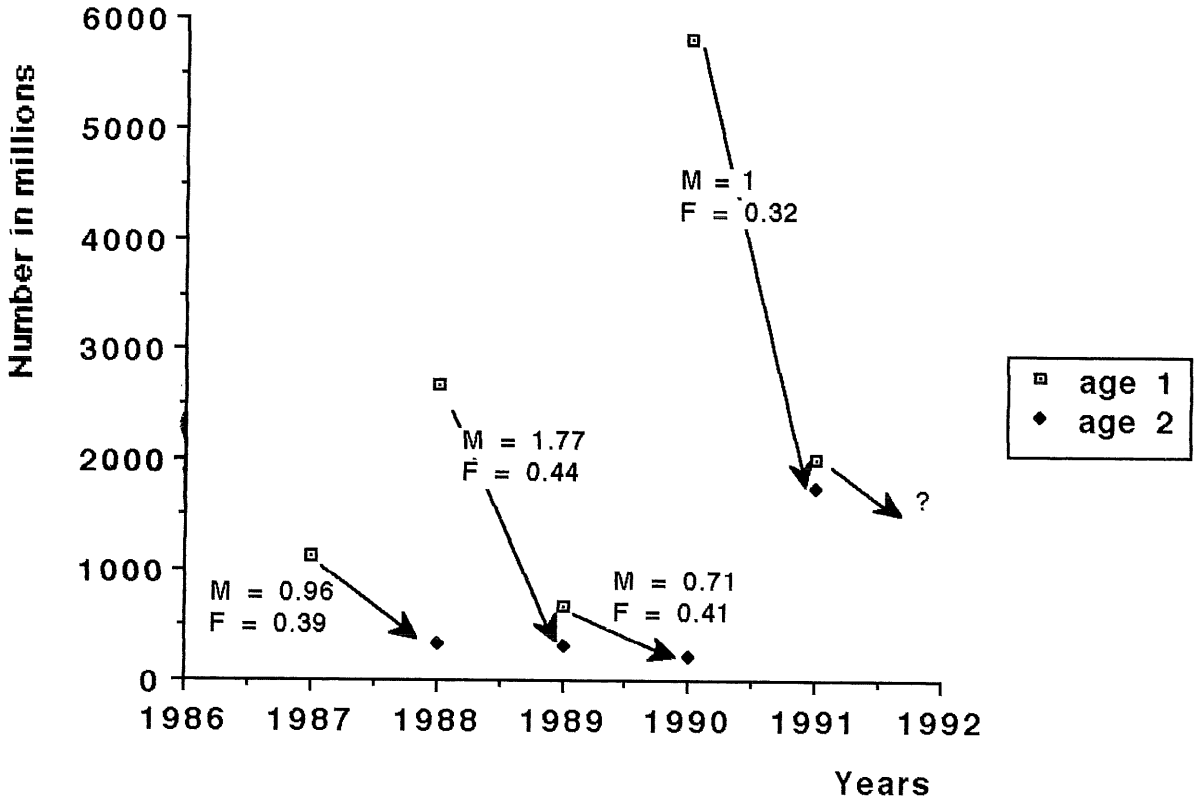
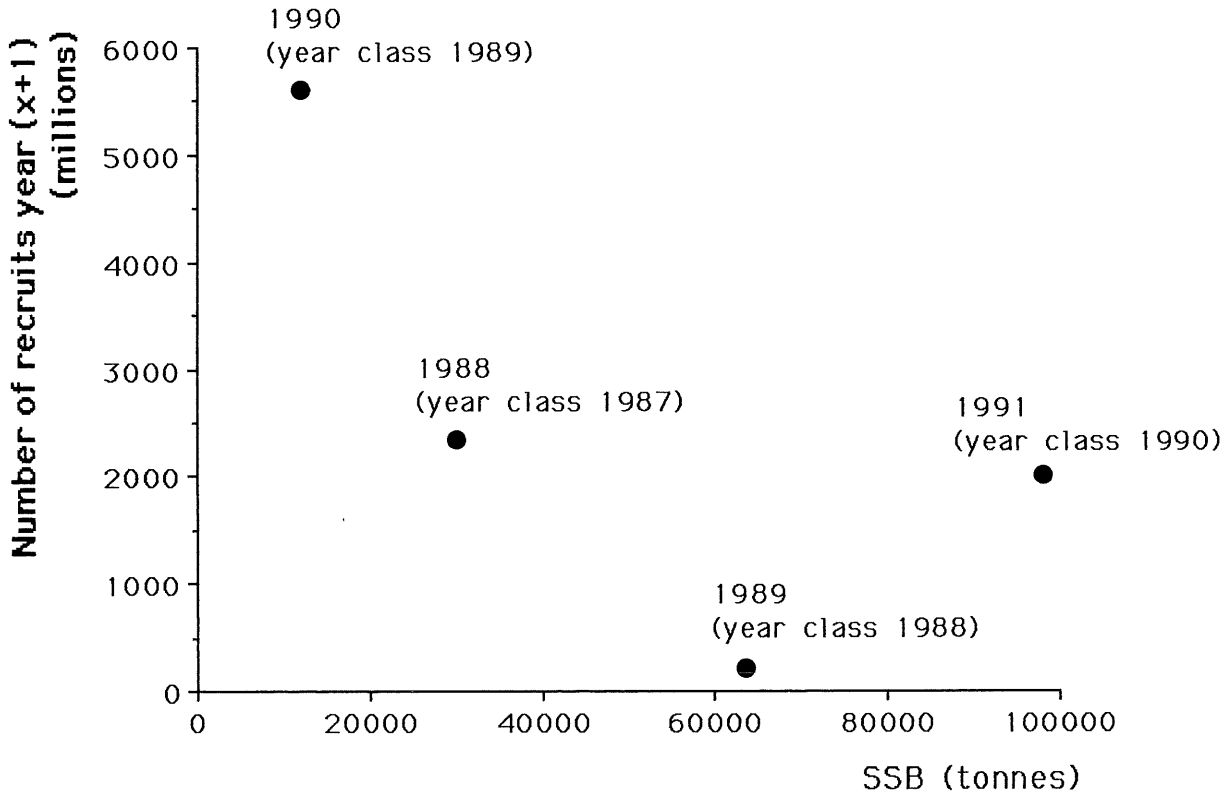


Figure 7.8 Relationship between number of recruits(1-year old) and the SSB estimated from direct estimation methods.



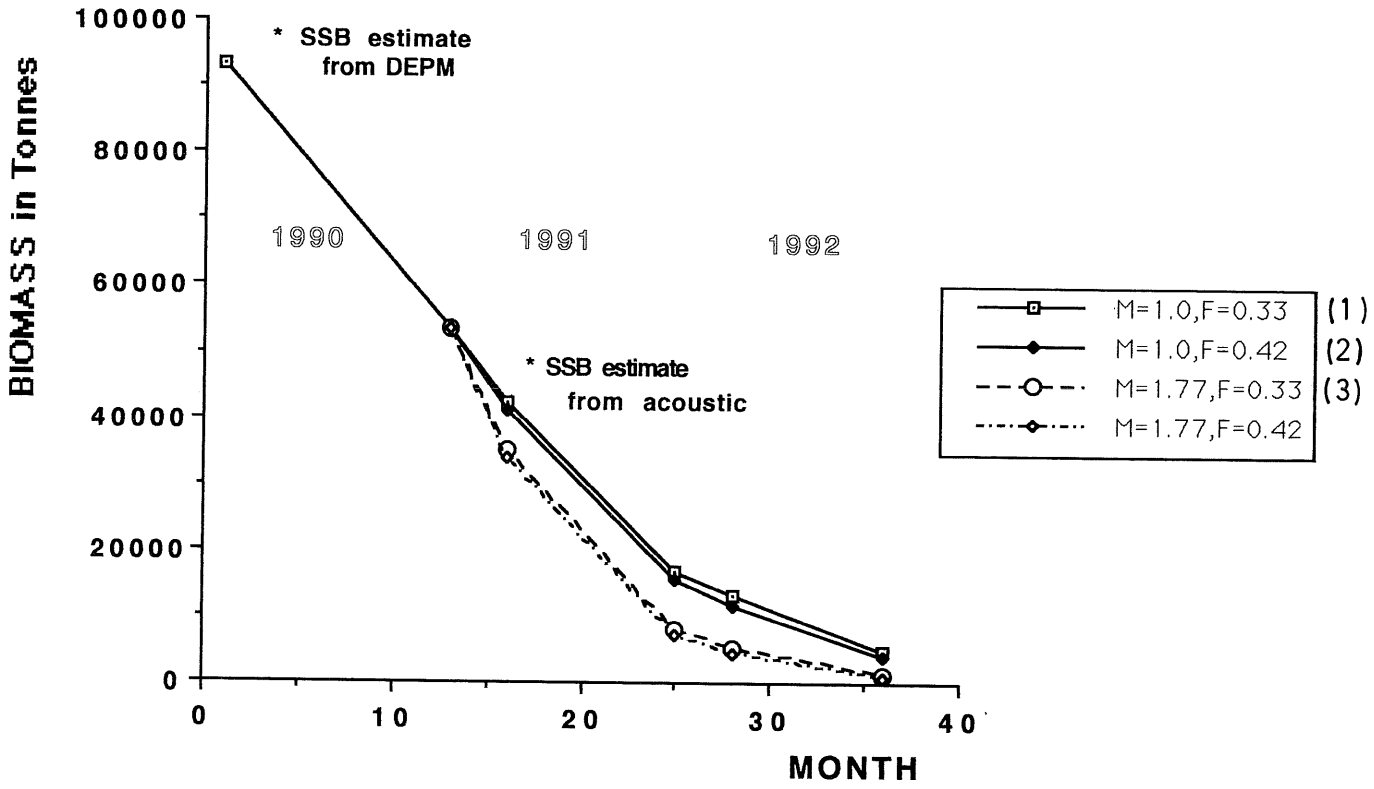


Figure 7.9 Trends in biomass of the 1989 year class (in tonnes) according to different values of M and F

(1) 1990 values; (2) F equal to the mean of the 1987-1990 period;
(3) M equal to the highest value of the 1987-1990 period

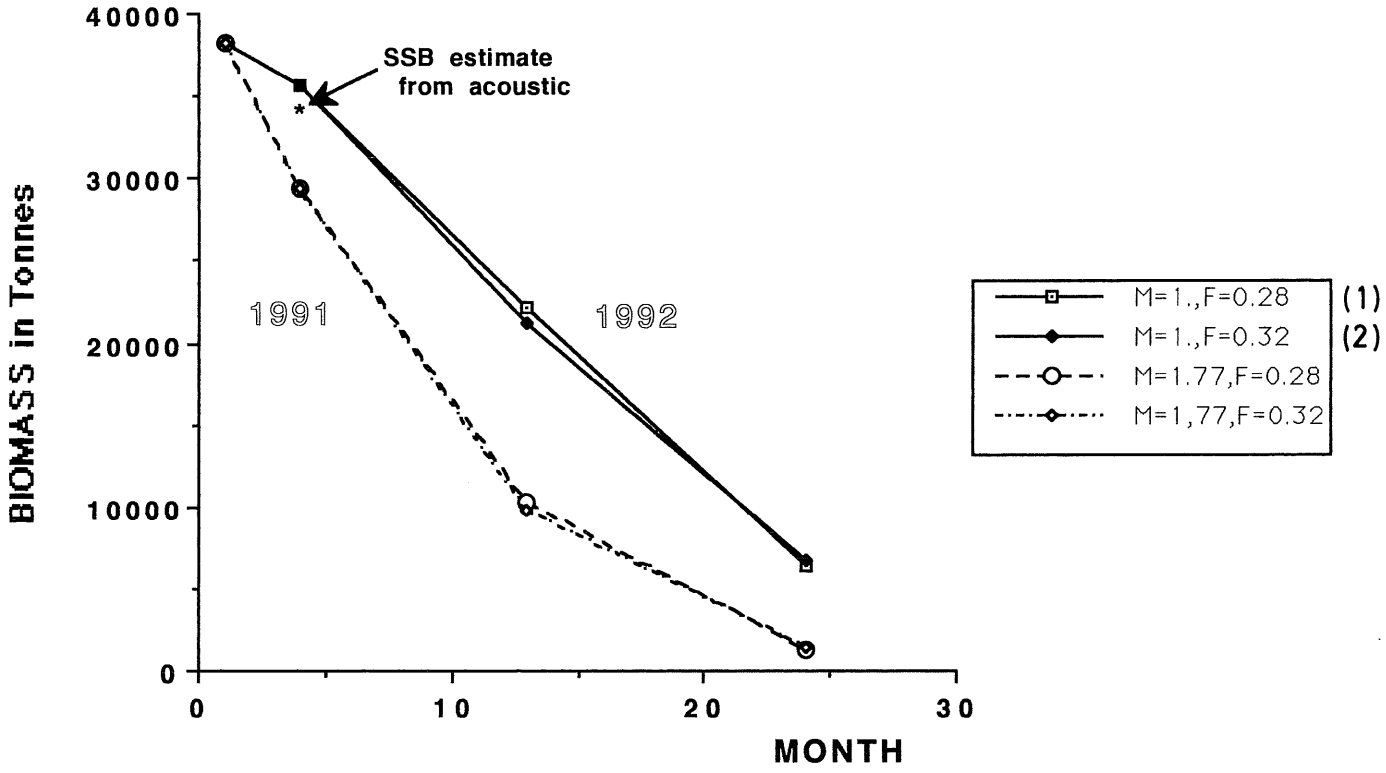


Figure 7.10 Trends in biomass of the 1990 year class according to different values of M and F.

(1) F equal to the mean estimate of the 2nd semester of the 1987-1990 period
(2) F equal to the 1990 value of the 2nd semester.

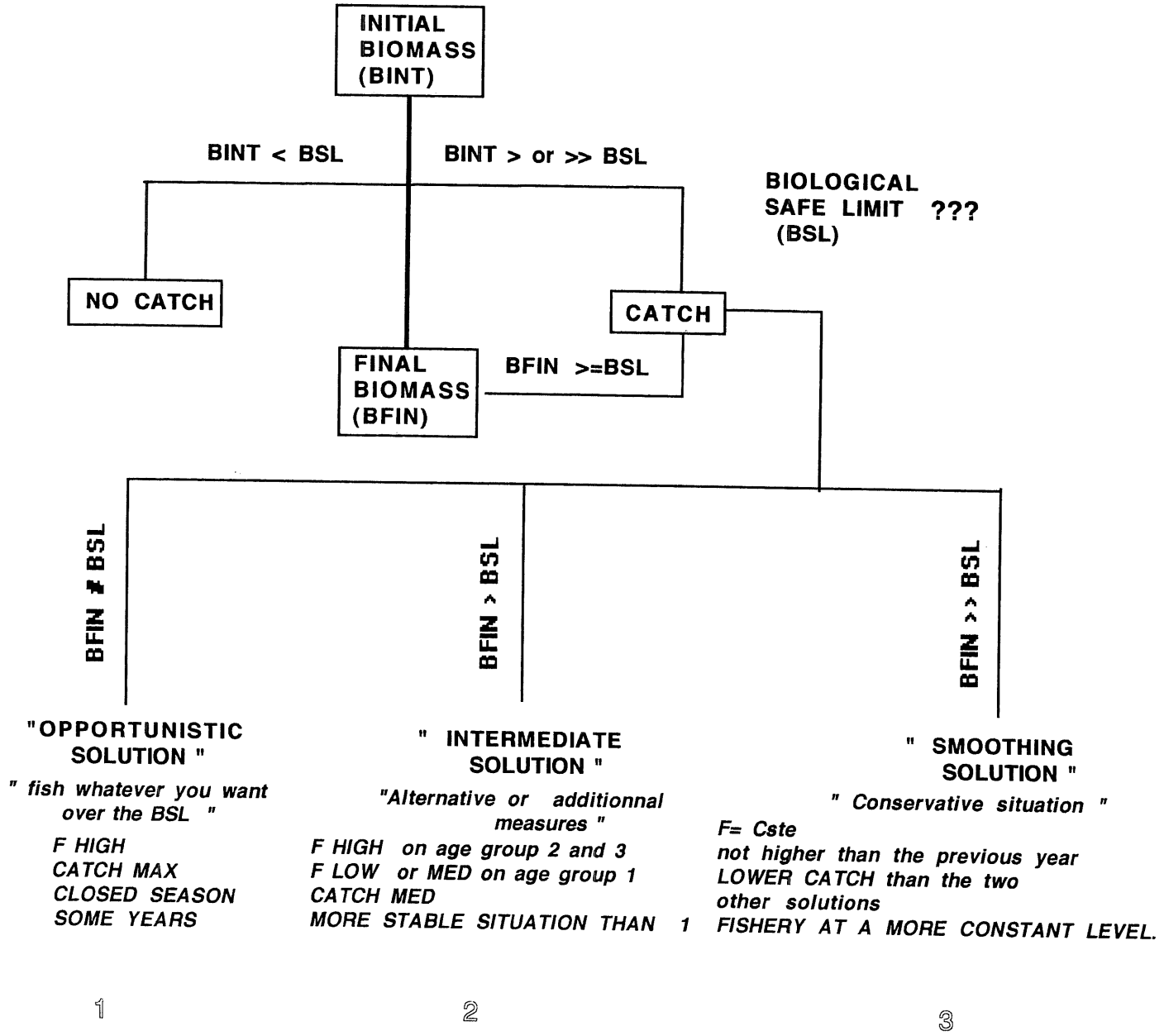
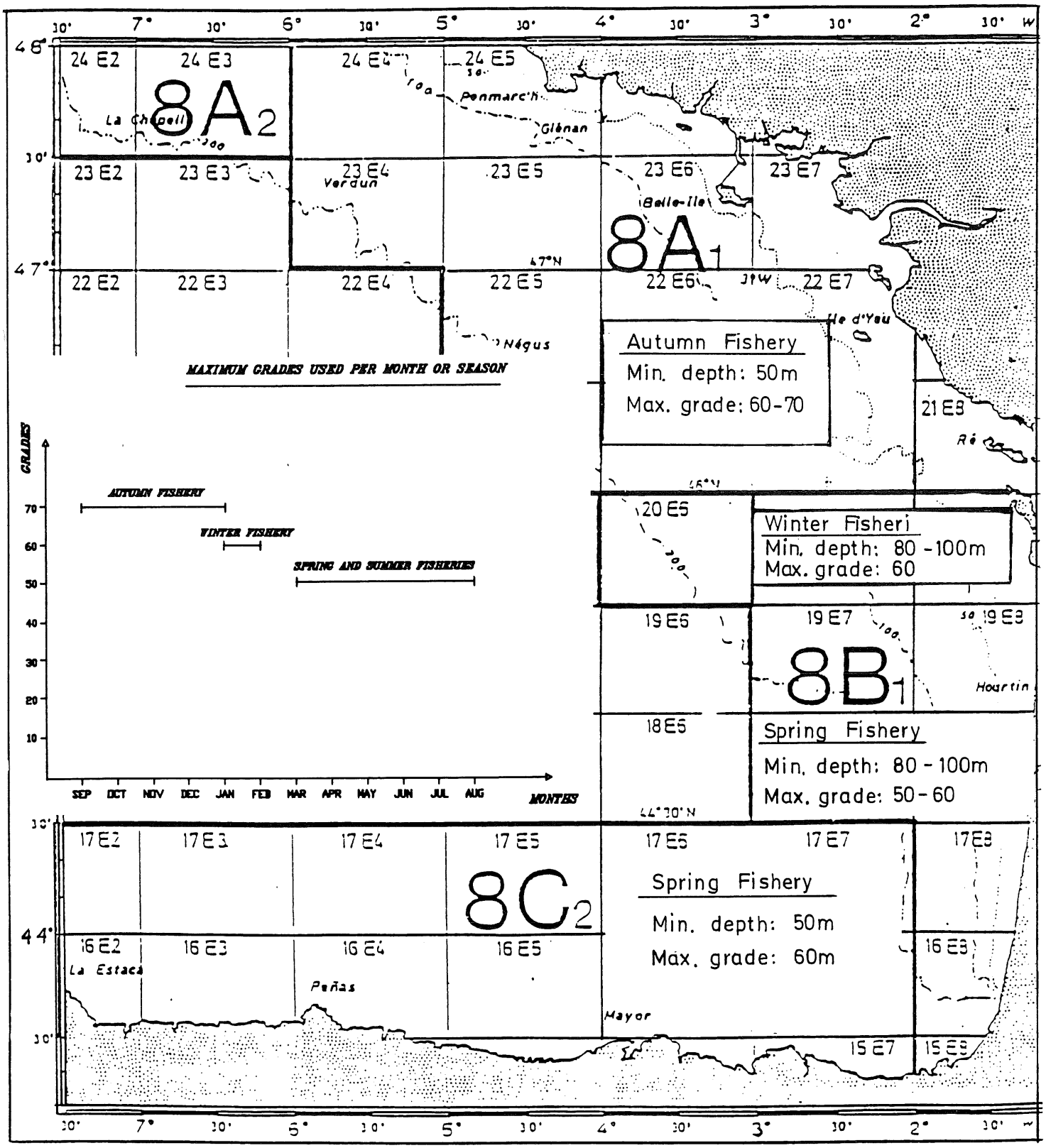


Figure 7.11 Diagram showing the different options from management measures.

Figure 7.12 Practical management measures for the anchovy of the Bay of Biscay.



ANNEX 1

M Cadima's formula (unpublished)

Estimates of M are made using the population structure in number at age at the start (N_i) and at the end (N_i+1) of the year and the catch in number at age (C_i), caught during the year.

The relationship between the natural (M) and total (Z) mortality coefficient is equal to the relation between the number of fish deaths due to natural causes and the number of fish deaths due to total causes.

The total mortality coefficient during the year (i), Z_i, is:

$$Z_i. = 1n\ N_i - N_{i+1}$$

During the year, i, the total number of deaths (D_i) will be:

$$N_i - N_{i+1}$$

and the number of deaths due to natural causes will be:

$$N_i - N_{i+1} - C_i$$

So, M_i can be expressed by the following:

$$M_i = (\ln N_i - \ln N_{i+1}) * (1 - \frac{Ci}{N_i - N_i})$$

ANNEX 2

SIMULTANEOUS ESTIMATION OF NATURAL AND FISHING MORTALITY FROM DIRECT ESTIMATES OF STOCK AND CATCHES OF THE BAY OF BISCAY ANCHOVY

Stock estimates of anchovy in the Bay of Biscay during the spring for the period 1987-1991, both in biomass and in numbers from the DEPM or acoustic methods (see Section 7.4).

Natural and fishing mortalities were estimated as follows: Two consecutive biomass estimations provide the numbers at age of the 1 year and older anchovies (group 1+) at the spring of year Y and numbers at age 2 and olders (group 2+) at the spring of the following year Y+1. Since the numbers at age of anchovies caught in the middle of those periods are known, there is only one solution for natural and fishing mortality (M,F) which can explain the decrease in numbers in the sea together with catches in the intevening period, using catch and survivorship equations.

Numbers from the biomass estimations are given in Table A.2.1 and these have been taken from Tables 7.6 and 7.7 of the report. For the year 1989, instead of taking the central DEPM SSB No at age from Table 7.6 directly, those numbers were raisedby 1+ coefficient of variation of the SSB estimate (No=No initial * (1+C.V.)) because the acoustic biomass gave 15,000 t instead of 12,000 of SSB, and because the authors (Motos and Santiago, 1990) accepted at least a 12% of under-estimation. Therefore, the reference SSB for 1989 was 16,900 t instead of 12,000 t. With such a change, estimations of annual M and F were more homogeneus and consistent than with the unadjusted central 1989 SSB estimate.

Table A.2.2 shows the catch in numbers obtained between estimations of group 1+ in year Y and group 2+ of year Y+1. Gulland's VPA was applied by sub-periods to these data, from the estimation of survivors (2+) in year Y+1 to initial numbers (1+) at the time of the previous year's estimation. Several runs were performed until initial and final numbers at sea corresponded to the survey estimates. Estimated F values by periods and total annual M and F (as summation of the sub-period Fs) are given in Table A.2.3, and these correspond with those given in Figure 7.7 of the report.

Table A2.1: Initial and final numbers at sea (in millions) of groups 1+ to 2+, from the direct biomass estimations.

Starting Point (Start)			Final Point (Final)		
YY/MM/DD	Source	No 1+	YY/MM/DD	Source	No 2+
87-06-01	DEPM SSB	1129	88-06-01	DEPM SSB	326
88-06-01	DEPM SSB	2675	89-05-15	DEPM SSB	316
89-05-15	DEPM SSB	663	90-05-10	DEPM SSB	223
90-05-10	DEPM SSB	5804	91-04-31	ACOUSTIC	1750

Table A2.2: Catches of groups 1+ and 2+ of years Y and Y+1 between Biomass estimations of Table A1, by monthly subperiods. No in milliards.

Catches group 1+			Catches 2+		
Year/Month	Start-06	07-10	11-12	01-03	04-Final
1987-1988	28420	(81209)		480	109750
1988-1989	170954	236928	3802	17870	65966
1989-1990	129862	22171	457	0	34149
1990-1991	497522	573656	30835	92000	Final

Table A2.3: Estimates of partial F by subperiods between surveys and total annual M and F (as summation of partial Fs).

F Group 1+			F Group 2+			Annual	
Year/Month	Start-06	07-10	11-12	01-03	04-Final	M	F
1987-1988	0.02	(0.10)		0	0.27	0.96	0.39
1988-1989	0.07	0.16	0.01	0.03	0.17	1.77	0.44
1989-1990	0.23	0.05	~0	0	0.13	0.71	0.41
1990-1991	0.10	0.16	0.01	0.05	Final	1	0.32

ANNEX 3

Advantages and disadvantages of different management options

The trends in biomass of an unit of 100,000 t of O group in October is simulated using RICKER's exponential model. The theoretical biologically safe limit is chosen at 30,000 t, higher than that agreed by the Working Group members.

Figure 7.11 and the Table below show the results obtained from this simulation. The main conclusions that we can draw are:

a) with an M equal to 1.0 (1990 value), a low F (0.32) allows a catch of 30% less than with a medium F (0.50; average of all the values observed on all the age groups)or 80% with a less than high F (equal to M). However, this situation seems to constitute a kind of "Smoothing solution" because it allows 3 opportunities to have a biomass higher than 30,000 t against 2 for the two other solutions. The medium F solution could define the "Intermediate solution".

b) with an M equal to 1.77 (highest value observed during the 1987-1990 period), it seems that the solution close to high F ("Opportunistic solution") would be the best. As with the two others, it would allow an opportunity to get a biomass higher than the theoretical biologically safe limit (BSL), but with a catch double that at low F.

If the "Intermediate solutions" is undertaken, the fishing mortality can be kept constant or the fishing pressure on young anchovies could be reduced. An example of such a solution is as follows:

Fishing Mortalities/Age:		0	1	2	3
Option a:	current F	0.03	0.37	0.42	0.42
Option b:	Reduced F1[1]	0.01	0.15	0.36	0.36

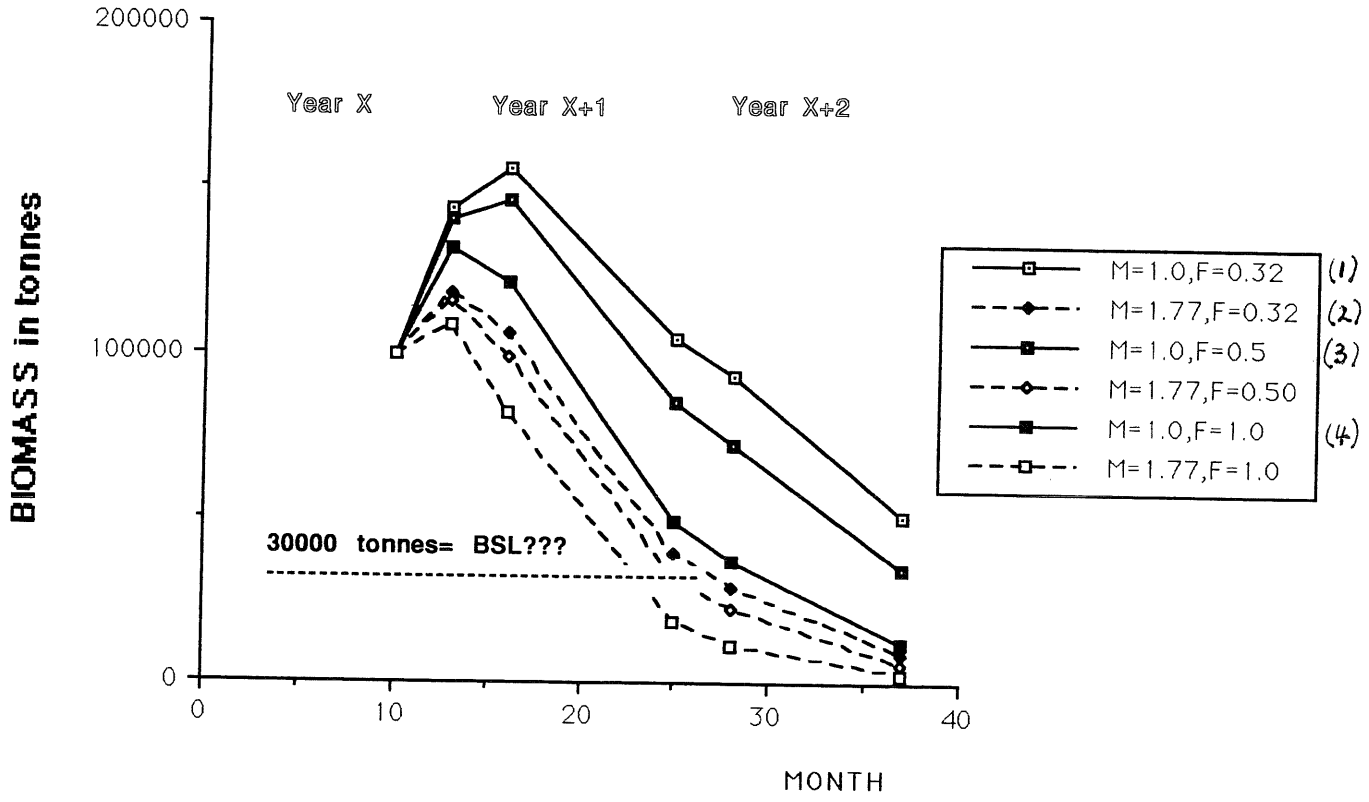
[1]to half and no winter fishery untill 1st. April.

The losses and gains associated with changing the fishing pattern from current situation "a" to fishing pattern "b" are listed below, in terms of percentage of average biomass and losses in catches and economic return to fishermen.

Benefits of Option B in Comparison to Current Situation A.

	VAR(%) in SSB	VAR(%) in CATCH	VAR(%) in $ VALUE
M=1	+20%	-30%	-19%
M=1.77	+16%	-45%	-36%

It is clear that with very high natural mortalities, the social cost of "Intermediate solutions" is very high in relation to the benefits to the stock. Thus, it is important to get a longer set of natural mortality estimations, from direct sotck biomass estimations, in order to properly assess the benefits of this measures.



simulation Tue, Jun 25, 1991 20:54

MONTH	M=1.0,F=0.32	M=1.77,F=0.32	M=1.0,F=0.5	M=1.77,F=0.50	M=1.0,F=1.0	M=1.77,F=1.0	
10	100000,000	100000,000	100000,000	100000,000	100000,000	100000,000	
13	143616,000	118172,000	140210,000	115369,000	131649,000	108325,000	
16	156209,000	105762,000	145794,000	98710,000	121049,000	81957,000	
25	104766,000	39517,000	85433,000	32224,000	49044,000	18499,000	
28,	92830,000	28811,000	72368,000	22460,000	36736,000	11401,000	
37,.	50515,000	8734,000	34407,000	5949,000	12076,000	2088,000	
	73017,000	36486,000	97348,000	50786,000	132642,000	76249,000	(5)
	3,000	1,000	2,000	1,000	2,000	1,000	(6)

Figure A3.1 Trends in biomass of one cohort (100,000 t) according to different values of M and F. (1) 1990 values, (2) Higher M of the period 1987-1990, (3) Medium F, (4) High F, (5) Total catches, (6) Number of spawning seasons where the biomass is higher than 30,000 t, (7) Spawning season.