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

Copenhagen, 20 -29 June 1990

*General Secretary
ICES
Palægade 2-4
DK-1261 Copenhagen K
Denmark

ɜh Stocks do not automatically and invariably renew nselves simply because they are called renewable ɔurces" (Gulland, 1984).

.ng this Working Group meeting, John Gulland died on ı June 1990. All of the Working Group members wish dedicate this report to him in recognition of his ·mous contribution to fisheries science.

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1 INTRODUCTION

1.1 Participants

M.F. Borges	Portugal
A. Eltink (Chairman)	Netherlands
M.T. Garcia	Spain
S.A. Iversen	Norway
E. Kirkegaard	Denmark
P. Lucio	Spain
J. Massé	France
M. Meixide	Spain
G. Pestana	Portugal
C. Porteiro	Spain
P. Prouzet	France
B. Villamor	Spain
A. Uriarte	Spain

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

1.2 Terms of Reference

At the 77th Statutory Meeting in The Hague in 1989, it was decided (C.Res.1989/2:4:17) that the Working Group on the Pelagic Stocks in Divisions VIIIc and IXa and Horse Mackerel (Chairman: Mr A. Astudillo) will be renamed the Working Group on the Assessment of the Stocks of Sardine, Horse Mackerel, and Anchovy and will meet at ICES Headquarters from 20-29 June 1990 to:

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

b) assess the status of and provide catch options for 1991 within safe biological limits for the sardine stock in Divisions VIIIc and IXa, the horse mackerel stocks in Sub-areas IV, VII, and VIII and Divisions IIa, IIIa, VIa, and IXa, and the anchovy stock in Divisions VIIIb,c.

The Chairman of this Working Group, Mr A. Astudillo, had resigned and was not available to chair the meeting of the Working Group. At the 1990 May meeting of ACFM, Mr A. Eltink was elected Chairman, subject to approval by the Council at the Statutory Meeting in October 1990.

2 SARDINE (DIVISIONS VIIIc AND IXa)

2.1 The Fishery

The officially reported total landings in 1989 were 137,126 t, which is 62,874 t lower than the recommended TAC of 200,000 t for that year. Table 2.1 and Figure 2.1 show that the total catches decreased from 1986 to 1989 after a stable level of about 200,000 t during 1980-1985. Relative to this period, the decrease in the 1989 total catches was about 31%.

The Portuguese catches in Division IXa in 1989 were at the same level as in 1987 and 1988. The Spanish catches in Divisions VIIIc and IXa have dereased since 1984, and in 1989 these catches were

43% lower than in 1984 (Figure 2.1). The decrease in the catches is not thought to be due to changes in the market value. The economic target for this species in Spain remained the same as in previous years.

The seasonal pattern of catches by the two countries has been constant since 1979, with about 39% and 64% of the annual catches being landed in the first and in the second half of the year, respectively (Tables 2.2 and 2.3).

The sardine is present along the coast of the Atlantic Iberian shelf waters (Divisions VIIIc and IXa) throughout the year, although abundance and distribution depend on the season.

The abundance of the main part of the sardine population in Portuguese waters was estimated in surveys carried out during November/December (Dias et al., 1989). A survey was also conducted in Spanish waters and the highest concentrations of sardine were found in the Galician waters (Pastor et al., 1986).

The availability of sardine shows seasonal and diurnal patterns being higher in the second half of the year than in the first and higher during sunset and sunrise due to its behaviour (Dias et al., 1989).

The Portuguese landings during November/December decreased in 1989 compared to previous years due to bad sea conditions, but the Spanish landings remained at the same level (Table 2.3 and Table 2.3 in Anon., 1989).

Catch statistics of the 1st quarter of 1990 were available to the meeting (Table 2.4).

Additional information on the French landings of sardine by divisions from Sub-areas VII and VIII were also provided (Table 2.5).

2.2 Effort and Catch per Unit Effort

The available data on fishing effort and CPUE indices for Portuguese and Spanish purse-seiner fleets are shown in Table 2.6. They were rather stable during the period 1980-1988 and similar changes are observed for both fleets. However, in 1989 the Portuguese CPUE increases and the Spanish CPUE decreases.

2.3 Fishery-Independent Information

2.3.1 Acoustic surveys

Due to a serious accident with R/V "Cornide de Saavedra" and bad weather conditions, no joint Spanish-Portuguese acoustic survey was carried out in 1989.

Considering the lack of acoustic abundance estimates for the sardine stock in 1989, which should also provide a recruitment index, efforts were made to carry out a joint acoustic survey for assessment purposes in spring 1990. As R/V "Noruega" was not available, only Spain was able to survey ICES Divisions VIIIc and IXa north of the Portuguese border from 17 April to 7 May. This survey was carried out using the Soviet R/V "Ignat Pawlyn-

chenkov" with an acoustic system similar to the one of R/V "Cornide de Saavedra" and following the methods recommended by the Planning Group (Anon., 1986a). Table 2.7 shows the acoustic abundance estimates of sardine (number and biomass). These estimates are lower than those obtained from earlier surveys (Anon., 1990c).

Two kinds of abundance estimations of sardine were made by Spain for the period 1986-1989, using different calibrations:

1) the 1985 calibration (single beam transducer) was used in the 1986 estimations, and the 1987 calibration (split beam transducer) was used for 1987 and 1988 estimations;

2) the 1986-1988 estimations of sardine abundance using the calibrations done on each cruise (Porteiro et al., WD 1990).

The second option was chosen in this meeting because the results seemed more consistent.

2.3.2 Egg surveys

A cruise was carried out with the purpose of evaluating the spawning biomass of the sardine, using the egg production method (batch fecundity). This cruise was coordinated with the acoustic survey for this stock.

The estimated spawning biomass of sardine in Spanish waters was 180,165 t (cv = 0.50). Maximum biomass estimates occur on the Galician shelf and the western part of the Cantabrian shelf. Biomass estimates decrease towards the east. This trend is similar to the biomass estimate from the acoustic survey (Perez et al., 1989).

The estimates of spawning biomass of sardine from the egg survey in Portuguese coastal waters were as follows: northern region 32,900 t (cv = 6.8); southern region 51,600 t (0.63). These estimates were a quarter of the acoustic survey estimates. The major sources of uncertainty in the biomass estimates from the egg survey have been associated with the estimation of daily egg production (Po) and the batch fecundity (F), which together account for 70% of the sum of squares cvs of the egg production survey parameters (Cunha et al., 1989).

2.4 Length Composition by Fleet and by Country

The 1989 annual length compositions (million of fish in half-cm length groups) by fleet were provided by Portugal and Spain (Table 2.8). The smallest (5.0-8.5 cm) and the largest (>24.5 cm) fish were caught by the Spanish fleet (mean length of 0-group is about 12.0 cm).

2.5 Catch in Numbers

The total catch in numbers at age in Divisions VIIIc and IXa are given in Table 2.9.

The catch in numbers at age in 1989 from Portugal were calculated by quarter and area (northern, central and southern). The Spanish catch in numbers at age were calculated for half-year landings.

The 1987 year class contributes 35% of the total catch in number in 1989, and the strongest year class in the data period, that of 1983, is now included in the 6+ age group.

2.6 Mean Weight at Age

At the 1989 Working Group meeting, the mean weights at age in the catch and in the stock were assumed to be the same for the whole historical series (1976-1988). These values were checked with the observed values and no differences were found. However,the Working Group decided from now on to use the annual available data for mean weights at age in the catch for 1989 to try to obtain more accuracy (Table 2.10). Revised annual catch and stock weights at age based on the available historical data will be provided to the next meeting of the Working Group.

The mean weight at age of the stock adopted for 1989 was the same as for the whole period 1976-1989 (Tables 2.10 and 2.20).

2.7 Maturity at Age

The sardine spawning season occurs mainly between October/ November and April/May. In spring, the major spawning occurs in Cantabrian waters. In winter, there is an important spawning mainly off northern Portugal and off southern Galicia, and there is more widespread peak in the spring off the northern Portuguese coast (Anon., 1988a). This makes determination of the maturity ogive difficult.

New maturity ogives were estimated from samples of the commercial landings from different areas of Division IXa (Portuguese waters) in the 4th quarters of 1987 and 1988. These are shown in the text table below:

Age group	0	1	2	3	4	5
% Maturity						
Anon., 1989	–	65	95	100	100	100
Pestana, 1989	11	40	80	100	100	100

The two maturity ogives appear considerably different. It is necessary to further investigate this problem with samples from the whole area of distribution of the sardine stock.

Maturity at age was assumed to be the same as reported last year (Anon., 1989).

2.8 Fishing Mortality and Tuning of the VPA

Terminal fishing mortality coefficients were estimated by tuning the VPA (Laurec-Shephered method) with catch numbers at age (ages 0-5) and associated effort data for both Spanish and Portuguese

purse-seiner fleets (available for the periods 1981-1989 and 1980-1989, respectively) (Table 2.11). In the absence of 1989 acoustic surveys data, it was not possible to include the results from the Portuguese August surveys (1985-1988) and the Spanish March surveys (1986-1988) in the tuning analysis. A natural mortality of M = 0.4 was assumed. In the absence of acoustic surveys in 1989, it was not possible to include the results of the Portuguese August surveys (1985-1988) and the Spanish March surveys (1986-1988) in the tuning analysis.

Table 2.12 shows the estimated fishing mortality and log catchability at age by fleet and year. Results indicate consistency among estimates (overall sigma-values ranging between 0.50 for age 4 and 0.250 for age 2, except for age 0, which is not fully recruited and which has a value of 1.01). The log-catchability values plot against time for all age groups for each fleet are shown in Figure 2.2. There does not appear any trend with time.

It was decided to use the fishing mortality at age 2 (F = 0.219) and the value of terminal S = 1 to run a SPVA. The results show a very flat exploitation pattern (Table 2.13).

An index of fishing level of F = 0.29 was obtained by dividing the 1988 total catch by the total biomass estimated from the Portuguese and Spanish joint acoustic survey (March/April 1988) (Table 2.14). This is in agreement with the 1988 terminal F for ages 2-5 from the separable VPA (F = 0.22), considering the underestimated biomass obtained from the acoustic surveys.

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 2.15 and 2.16 and Figures 2.3A and B.

The total biomass and spawning stock biomass for 1988 estimated from VPA are in reasonable agreement with the biomass estimates from the March-April 1988 acoustic survey (Table 2.17).

The VPA estimates of recruitment indicate a low level of 12 billion 0-groups in 1985 and 10 billion in 1986 and in 1988. The strongest year class in the historical data series was that of 1983 (36 billion). The 1987 year class is also estimated to be strong (about 19 billion at age 0).

2.9 Recruitment

It was not possible to carry out the joint Portuguese/Spanish acoustic survey for recruitment in November-December 1989 (see Section 2.3.1)

The RCRTINX2 program was used to regress the numbers at age 0 estimated by the final VPA against the 0-group indices from acoustic surveys (Portuguese March/August and November surveys and Spanish March surveys) and indices from Portuguese and Spanish purse-seiners (Table 2.18).

Table 2.19 shows the predicted values for the 1987-1989 year classes. The predicted value for 1987 (18,680 million fish) corresponds to the value of the VPA estimate of 18,548 million fish. The predicted value for 1988 (15,677 million fish) is higher than the estimated year-class strength from the VPA (9,944

million fish). The number at age 1 in 1990 for the predictions was obtained from the predicted recruitment as 0-group in 1989, the fishing mortality from the SVPA, and the natural mortality (Table 2.20).

2.10 Yield per Recruit

The input values for the yield per recruit and catch forecast are given in Table 2.20. The separable exploitation pattern was assumed for the prediction. Plots are shown in Figure 2.3C and $F_{0.1}$ was estimated at 0.5.

2.11 Forecast

Stock numbers for ages 2 and older in 1990 are taken from the final VPA and for ages 0 and 1 from the RCRTINX2 analysis. It was assumed that the recruitment was the same for the period 1990-1992 and equal to the 1989 recruitment (12,949 millions at age 0) predicted by the RCRTINX2 program (see Section 2.9).

Catch predictions for 1991 and 1992 are given in Tables 2.21 and 2.22 and in Figure 2.3D. Fishing at the status quo level produces catches of 145,000 t in both 1990 and 1991. This will leave a spawning stock biomass at spawning time in 1991 of 515,000 t, which is similar to the predicted 1990 spawning stock biomass of 519,000 t, and 508,000 t in 1991. Detailed output of this result is shown in Table 2.22.

2.12 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 1978-1988 (Figure 2.4).

The spawning stock biomass decreased after 1985 despite the occurrence of the strong 1983 year class. The recruitment fluctuated widely during the period 1978-1988.

After the 1983 year class, only the 1987 year class achieved a medium level. The 1984, 1985, 1986, and 1988 year classes were at a low level.

2.13 Management Measures and Considerations

Only one very strong (1983) year class occurred during the last eleven years, and this supported the fishery until 1988. The spawning stock biomass decreased from 1985 onwards. Current fishing mortality (0.23) is estimated to be at about the F_{med} level (0.21).

Compared to the catch of 137,000 t in 1989, the forecast for the catch in 1991 (assuming $F_{91} = F_{90} = F_{89}$) shows an increase to 145,000 t.

Low recruitment levels may lead to over-fishing in the near future and a sharp decrease in spawning stock biomass, therefore, a management regulation should be applied.

3 HORSE MACKEREL - GENERAL

3.1 The Horse Mackerel Fisheries

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 372,000 t in 1989. The catch in 1989 is at the same level as in 1976, which was the highest in the period 1974-1988.

The catch tables (Tables 3.1 - 3.7) are slightly different from last year (Anon., 1989) due to data revisions. The revisions of total catches (Table 3.1) are 0.3 -1.1% for the different years except for 1988, when the catches were increased by 8% compared to that given last year (Anon., 1989).

Division IIa

The catches in Division IIa have been at a low level except in the last three years (Table 3.2). From 1986 to 1988, the catches increased from about 200 t to 6,800 t. In 1989, the catch decreased by 2,000 t to 4,800 t.

Sub-area IV

The catches in Sub-area IV (Table 3.3) have increased from a level of about 20,000 t in the period 1984-1987 to 63,000 t in 1988. In 1989, the catches were 112,000 t, which is almost twice the 1988 level. This was mainly caused by the increasing Norwegian catches.

Sub-area VI

The catches in Sub-area VI are shown in Table 3.4. In the 1980s, the catches increased from about 10,000 t to 45,000 t in 1988. In 1989, the catches decreased to 33,000 t.

Sub-area VII

The catches in Sub-area VII (Table 3.5) fluctuated between 30,000 and 45,000 t in the period 1980-1985. The catches then increased to about 138,000 t in 1989, a catch level similar to that in the mid-1970s.

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 (46,000 t).

Sub-area IX

The catches in Sub-area IX (Table 3.7) have increased from 20,000 t in 1985 to 38,000 t in 1989, which is similar to the catch level in the late 1970s and early 1980s.

Quarterly distribution of the fishery

Based on data submitted by Working Group members, the Working Group was able to distribute 90% of the total catch by quarters and area (Table 3.8). The table demonstrates clearly that the fishery starts in the area south and west of Ireland in the first quarter with rather high catches. The catch in this area declines in the next three quarters, while the fishery starts further north in Division VIa and in Sub-area IV in the third and fourth quarter.

In the southern areas (Divisions VIIIc and IXa), the fishery is more stable throughout the year.

Based on catch data by rectangle submitted by Portugal, Spain, Denmark (except North Sea area), the Netherlands, and Norway, the distribution of the fishery by quarter is given in Figure 3.1a-d.

3.2 Unit Stocks

Egg and larval distributions suggest the existence of three spawning areas (Southern, Western, and North Sea). The main spawning periods are slightly different from area to area. In the southern area the main spawning period is January-August, in the Western area March-July, and in the North Sea May-July (Figure 3.2).

However, outside the spawning season horse mackerel are highly migratory. The distribution of the fisheries in 1989 (Figure 3.1a-d) and survey data provide indications of the migratory routes for the different spawning stocks, and these are summarised in Figure 3.2. In 1989, after spawning in the Western area, horse mackerel moved northwards and were fished in the Norwegian zone in Division IIa by Norwegian purse seiners in July. In August, this fishery also entered the northeastern part of Division IVa. The bulk of the fishery then moved further southwards in September. In October, the fishery progressed further southwards in Division IVa and even into the northeastern part of Division IVb in November.

The Norwegian fishery ended during November, probably because the fish left the Norwegian zone, otherwise the fishery would have continued. During the period July-November 1989, the Norwegian catch accounted for 90,000 t of horse mackerel, which was 77% of the total catch in Division IIa and Sub-area IV. The Working Group assumed that the horse mackerel left the fishing area mainly by a northwestern route via Scotland and Shetland. This suggestion is not supported by an increase in the catches in Division VIa during the fourth quarter (Table 3.8). However, considerable quantities of horse macerel were observed during the Scottish recruitment surveys in the fourth quarter (Anon., 1989). The migration pattern of the Western horse mackerel is assumed by the Working Group to be similar to the Western mackerel (Anon., 1990b).

During, or just after, the main spawning in the North Sea (Figure 3.2), the fishery started in the Channel in June and moved northwards along the Dutch coast in July and along the Danish west coast in August. During August, horse mackerel have been observed during the Danish acoustic surveys carried out in recent

years in this area (see Section 4.2.2). During July, the North Sea component spawns in the German Bight, while the Western component enters the eastern part of Division IIa (see Figure 3.2).

Dutch trawl surveys in the third and fourth quarters in the years 1985-1987 demonstrated that horse mackerel was most abundant in the southern and southeastern part of the North Sea (Figure 3.3). As seen from the figure, only minor catches were taken north of 55^0 30'N.

In October 1989, the fishery moved west and southwards (Figure 3.2) through the Channel.

Results from the 1989 Basque egg surveys (Santiago and Eltink, 1988; Santiago and Sanz, 1989; and Anon., 1990a) in the Bay of Biscay covering the area south of 46^0 30'N and east of 5^0W show a continuous distribution of eggs during May-June, although the egg abundances are relatively low compared to the western spawning area.

Maturity and gonosomatic indices observed in catches from Divisions VIIIa,b,c indicate that the main spawning period is March-July with a peak in May-June (at 15^0-16^0C) (Lucio and Martin, 1989; Lucio, WD 1990). Monthly egg sampling off San Sebastian, Santander, and Vigo in 1987-1989 and the egg surveys in 1987 and 1988 indicate that spawning starts in winter with a peak in March-April off Vigo, and later (April-May) off Santander and San Sebastian. The spawning is both more extensive and intensive in the Cantabrian area than in the Galician area (Solá et al., WD 1990; Lago et al., WD 1990).

Monthly plankton sampling along the Portuguese coast from October 1986 to January 1989 has shown that the main spawning starts in early winter and lasts until August, with a peak in March (Fariñha, WD 1990).

Due to the difference in development of the fishery in the northern area (Divisions IIa, IVa) and in the southern area (Divisions IVb,c and VIId,e), the Working Group suggests that the fisheries in these two areas exploited fish from two different spawning areas. The two components were probably mixing to some extent in parts of Division IVb in the third and fourth quarters and in parts of Division VIIe, mainly in the fourth quarter.

However, further investigations need to be carried out to provide a firmer basis for conclusion about migration patterns and stock separation. The Working Group, therefore, recommends that tagging experiments, parasite studies (Eltink, 1988) as well as studies on fatty acid profiles and genetic variations (Borges et al., WD 1990) should be undertaken.

The age composition in the catches for the three "stocks" in 1989 are shown in Figure 3.4. The age compositions of the catches prior to 1988 in the southern area must be treated with caution, because they will probably be revised after the Otolith Workshop meeting later this year.

Based on the data available, the Working Group maintained the basic assumption of the existence of three "stock units" (Anon., 1988, 1989). 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 catches in Divisions IIIa, IVb,c and VIId were allocated to the North Sea "stock", and the catches in Division VIIIc and IXa to the Southern "stock" (Table 3.9).

3.3 Length Compositions by Fleet and by Country

The 1989 annual length compositions by fleet were provided by Denmark, Ireland, The Netherlands, Norway, Portugal, and Spain. These length distributions were available for all the major fishing fleets accounting for about 85% of the total landings in 1989. The length distributions by country for each fleet (in millions) of fish per cm-length group are shown in Table 3.10 for 1989. The quarterly distributions by fleet are available in the Working Group files from the Netherlands (1982-1989), Norway (1987-1989), Portugal (1989), Spain (1989), and Ireland (1989).

The Working Group examined the level of sampling carried out in 1989 for the different areas. The data, which are summarised in Table 3.11, are based on the details submitted by Working Group members and the administrative report of the Pelagic Fish Committee (Anon., 1990d).

3.4 Age Determination

The otolith exchange programme organised since 1988 by the Working Group, and coordinated by M.F. Borges, INIP, Lisbon, is proceeding in 1990 with new samples as agreed last year, after a first evaluation of partial results from 1988-1989.

Otolith samples are circulated between different countries fishing horse mackerel. Otolith readings should be completed as soon as possible before the next otolith workshop.

Following the recommendation of the 1989 Working Group, it was agreed at the 77th Statutory Meeting (C.Res.1989/2:15) to hold a Workshop on Horse Mackerel Otolith Reading as stated below:

> A Workshop on Horse Mackerel Otolith Reading (Chairman: Ms F. Borges, Portugal) will be held in Lisbon from 21-27 November 1990 at national expense to improve the otolith interpretation among the countries involved in the otolith exchange programme carried out during 1988-1990.

This Working Group recommends that the Workshop should:

a) Evaluate the results of the otolith exchange programme carried out during 1988-1990.

b) Evaluate the different methods of otolith preparation.

c) Advise on for which age groups valid age readings can be achieved.

3.5 Species Mixing

In the minutes of the ACFM meeting of May 1989, it is mentioned that "the presence of T. mediterraneus in the Bay of Biscay must be confusing catch data and the egg survey data and should be examined by the Working Group", and that "for Southern horse mackerel, there is the additional problem of a mixture of two species in the catches". It is also stated in the minutes of the ACFM meeting of October-November 1989 that one other Trachurus species, T. picturatus, may be present in the catches.

All available information concerning species mixing is presented in Appendix A.

In the Western horse mackerel stock, species mixing is regarded as negligible.

In the Southern horse mackerel stock, mixing of Trachurus picturatus is low. Reported landings and biological sample data do not include this species which only occurs in the south of Division IXa.

T. mediterraneus occurs in the southeastern corner of the Bay of Biscay (Divisions VIIIb and c), where relatively high temperatures prevail. In recent years, the occurrence of Trachurus mediterraneus has increased to about 6% of the total landings of southern horse mackerel. T. mediterraneus should not be included in the catch statistics for southern horse mackerel. In the past, the biological samples did not contain T. mediterraneus.

3.6 Discards

The Working Group believes that considerable amounts of horse mackerel might be discarded or slipped at present or in the future when a fishery is closed after reaching the quota. Discarding seems to be very variable depending on the fleet, time period, weather conditions, catch size, loading or freezing capacity, sea area, country, and even the fishing ports involved. The discards were not only confined to juveniles but to every size of horse mackerel, because for some fleets this species is taken only as a by-catch (demersal fisheries).

In Divisions VIIIc and IXa, the discarded catches are expected to be low.

In Sub-areas IV, VI, VII, and VIII (except Divsion VIIIc), discarding is known to occur, but information on the extent to which it occurs is lacking. The fleets fishing horse mackerel for fish meal production are known not to discard.

From most countries the information on discarded catches by different fleets is very scarce. For Sub-area VII and Divisions VIIIa,b, preliminary data have been presented. These discards by Spanish trawlers in Sub-area VII reached nearly 1,000 t in 1988. In Divisions VIIIa,b in 1987, an incomplete estimate of horse mackerel discards by the Spanish trawlers indicated that they were very variable, depending on the time period and also on the ports of origin of the fleet (Igelmo et al.,1988).

The Working Group recommends that in all areas more information about the quantities of discards should be collected.

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

4.1 The Fishery

The horse mackerel fishery by sub-area is described in Section 3.1. The total landings of the North Sea horse mackerel in Divisions IIIa, IVb-c, and VIId by year are shown in Table 3.9. The North Sea horse mackerel catches before 1984 were below 10,000 t. In 1984 the catches increased to 29,000 t, and have been at that level until 1989 except for 1987. In 1989, the catches were 50,000 t, of which 41,000 t were taken in Divisions IVb and c, in the third and fourth quarters (Table 3.8).

Small quantities of this stock were taken in Divisions IIIa (1,000 t) and VIId (6,000 t).

Only the fishery in Division VIId is a directed fishery for horse mackerel, while the catches in Divisions IIIa, IVb, and IVc are taken as by-catches, mainly in the small-meshed industrial fishery.

4.2 Fishery-independent Information

4.2.1 Egg surveys

During the period 10 April to 18 July 1989 the spawning area of North Sea horse mackerel was investigated by research vessels from The Netherlands (Eltink, WD 1990). Based on the plankton samples and temperature observations obtained during this period the egg production was estimated. To estimate the spawning stock biomass, the fecundity-weight relationship of 1,655 eggs per gram pre-spawning female was used; this has been estimated for the Western horse mackerel by Eltink and Vingerhoed (1989). The total number of stage I eggs were converted into a pre-spawning stock biomass, and this was then increased by 5% to obtain the spawning stock biomass (Eltink and Vingerhoed, 1989). The total horse mackerel egg production in 1989 of 171 x 10^{12} stage I eggs represents a spawning stock biomass of 217,000 t, which is about twice as high as the 1988 estimate of 110,000 t (Figure 4.1).

This increase of about 100% in the egg production and biomass from 1988 to 1989 might have been partly caused by relatively more spawning in the English Channel in 1988. This area was not covered in either year. A more northward spawning in 1989 would result then in a higher egg production during the third coverage in the North Sea. However, the higher egg productions during the fourth and fifth coverages in 1989 indicate that spawning took place at a higher level and that spawning continued later until the end of July 1989 (Figure 4.1).

The increase in egg production and biomass from 1988 to 1989 might partly be due to the recruitment of the two good year classes of 1985 and 1986 (Table 4.1). The mean length at age of these year classes was, respectively, 25 cm and 26 cm and already a large proportion could be spawning (see also Section 5.7). This

increase of about 100% cannot have been caused by a large increase in the proportion of mature fish of the 1982 year class from one year to the next year.

4.2.2 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 biomasses of horse mackerel for the standard area (Figure 4.2) are given below:

1985 - 500,000 t
1986 - 523,000 t
1987 - 207,000 t
1988 - 126,000 t
1989 - 6,000 t

The area covered during the survey has been extended since 1985. However, the results given above refer to the standard area along the Danish west coast, where the highest concentration has been seen every year. The total estimated amount of horse mackerel over the whole area covered (Division IVb and Skagerrak) in 1989 was 18,000 t.

There has been no change in the survey strategy since 1985, but the survey conditions were very poor in 1989. Due to bad weather and very high concentrations of jellyfish, the results from this survey are rather uncertain. Compared with previous years' surveys the biomass estimated from 1989 is very low, probably due to a delay in the migration from the spawning area to the north (see Sections 4.2.1 and 4.3).

4.3 Assessment

The spawning stock biomass estimated by the egg survey in 1989 was 217,000 t. Spawning occurs during May-July in the southern and eastern central North Sea, close to the coast. Spawning continued in 1989 until the end of July, about 2 weeks later than in 1988.

The reason for the very low abundance of horse mackerel during the Danish acoustic survey, which covered the area north of the spawning area in late July and early August, may partly be the relatively late spawning in 1989, resulting in a late arrival of the horse mackerel to the surveyed area.

The Working Group considers the egg survey data as the most reliable, indicating a biomass in 1989 in the order of 200,000 t.

Samples taken from the Dutch commercial and research vessel catches indicated a very strong 1982 year class (about 33% in number in 1989) and two relatively strong year classes, 1985 and 1986 (13% and 28%) (Table 4.1). The age composition given in Table 4.1 is 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 three 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 on the North Sea horse mackerel.

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

4.4 Biologically Safe Limits

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

2) There is no indication that an historically low level of SSB will be reached in 1990 or 1991.

4.5 Management Measures and Considerations

The TAC for the North Sea horse mackerel should only apply to the areas where the stock is fished (Divisions IIIa, IVb,c, and VIId).

5 WESTERN HORSE MACKEREL (DIVISIONS IIa IVa, VIa, VIIa-c,e-k, and VIIIa,b,d,e)

5.1 The Fishery

The horse mackerel fishery by sub-area is described in Section 3.1. The total landings of the Western horse mackerel in Divisions IIa, IVa, VIa, VIIa-c,e-k, and VIIIa,b,d,e by year are shown in Table 3.9. The Western horse mackerel catches increased gradually from 40,000 t in 1982 to 250,000 t in 1989.

Divisions IIa and IVa

The catches in these divisions increased from 0 to 73,000 t over the period 1982-1989 (Table 3.9), with Division IVa as the main fishing area.

Division VIa

See Section 3.1.

Divisions VIIa-c,e-k

Catches in Divisions VIIa-c,e-k increased from 32,000 t to 130,000 t from 1982 to 1989. The catches of Division VIId, which amounted to between 1,000 and 6,500 t from 1982 to 1989, were removed from Sub-area VII (Table 3.9) and were allocated to the North Sea horse mackerel area (see Section 3.1).

Divisions VIIIa,b,d,e

Compared to Sub-area VII, the horse mackerel catches in Divisions VIIIa,b,d,e shown in Table 3.9 are relatively low, even if they increased from 3,000 to 12,000 t from 1982 to 1989.

5.2 Fishery-independent Information

5.2.1 Egg surveys

Five coverages of the standard area were carried out during the western egg survey (Anon., 1990a). The total stage I egg production estimate for each survey period was plotted against the mid-cruise date to give a production curve based on only four points as shown in Figure 5.1 (from Anon., 1990a). No data on the egg production in period 1 were available, although it is known that horse mackerel eggs were present in some of the samples of this survey (Anon., 1990a).

In addition, production curves were calculated for the area east and south of the standard area. The values for each area are presented in Table 5.1 (from Anon., 1990a).

Using the data from periods 2 to 5, a total seasonal production of 1.51×10^{15} stage eggs is obtained for the standard area. Including the areas north, east, and south of the standard area increases the estimate by 11% to 1.68×10^{15}. Spawning is also thought to occur to the west of the standard area, but it is unlikely that much egg production was missed.

Table 5.2 shows the estimates of total egg production in 1989 and the revised estimates for earlier years of pre-spawning and spawning stock biomass of Western horse mackerel derived from the western egg survey. For calculation of all total egg productions, the fecundity/weight relationship of 1,655 egg per g female has been applied (Eltink and Vingerhoed, 1989). The arguments for using this fecundity estimate are given in Anon. (1990a). The total fecundity estimate of Nazarov (1977) used in earlier biomass estimates (Anon., 1989) was about half the recent estimate. The spawning stock biomass estimates in this year's report are, therefore, approximately doubled compared to earlier estimates.

5.2.2 Trawl surveys

As pointed out in last year's report (Anon., 1989), trawl surveys in the fourth quarter in the Western areas and the North Sea areas do not accurately indicate the strength of 0- and 1-group horse mackerel. Therefore, these results are not used to estimate recruitment strength.

In accordance with the conclusions of the meeting of the recent Mackerel Working Group (Anon., 1990b), it is recommended that a planning group should be established by ICES, which would study all existing fish surveys carried out in the western areas with a view to establishing a proper standardized international survey which could possibly obtain recruitment indices.

5.3 Catch in Numbers

The landings and discards for the Western horse mackerel areas are given in Table 3.9. However, the estimates of discards are not accurate since only two countries provided data on discards. The horse mackerel is only aged by the Netherlands. Therefore, the total international catch for the Western area (Table 3.9) was raised according to the Dutch catch in numbers by age groups (see also Section 5.6).

The catch statistics were revised for some years (Section 3.1). However, these revisions were minor except for 1988. The catch this year was revised upwards, by 9.4%, and the catch in numbers was revised accordingly.

The percentages of the catches covered by Dutch biological age sampling for the period 1982-1989 are shown in the text table below:

Category	1982	1983	1984	1985	1986	1987	1988	1989
Dutch catch (t)	27,500	36,200	54,700	57,500	51,700	75,150	49,140	80,350
International catch (t)	41,588	64,862	73,625	80,551	105,665	157,240	186,100	248,843
% covered with age sampling	66	56	74	71	49	48	26	32

5.4 Mean Weight at Age

Mean weight at age in the catch

The mean weights at age in the catch from 1982-1989 are shown in Table 5.3 and were based only on Dutch biological sampling (see also Section 5.6). The mean weights at age in the catch decreased markedly for each age group during this period.

Mean weight at age in the stock

The mean weights at age in the stock from 1982-1989 are shown in Table 5.4. They are the weighted means of the mean weights 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 (see also Section 5.6). The mean weights at age in the stock decreased markedly for each age group during this period.

5.5 Mean Length at Age

The mean lengths at age in the catch from 1982-1989 are shown in Table 5.5 and were based only on Dutch biological sampling. The mean length at age decreased markedly for each age group during this period.

5.6 Reliability of the Numbers-at-Age and Weights-at-Age Data

The validity of the numbers at age and the weights at age was questioned at the ACFM meetings in May and November 1989. Therefore, special attention is given to explain how the numbers-at-age and the weights-at-age data are obtained (Eltink, WD 1990).

Until now, the Netherlands is the only country ageing the Western horse mackerel. For the biological market sampling program, most other countries usually collect length distributions by division and by month, and then age/length keys are applied to obtain the numbers at age. Usually the mean weight at age is obtained by applying a length/weight relationship or by using the mean weights of the fish for the age/length key. In the Netherlands, another sampling system is used as explained in Appendix A. The reliability of the numbers-at-age and weight-at-age data is also discussed in Appendix A.

The Working Group regarded the Dutch age/length sampling system as appropriate to achieve reliable numbers at age and mean weights at age for the Dutch catches. The Dutch numbers at age were raised according to the international catch, although the length distributions of some countries/fleets did not fully agree with the Dutch length distributions (see Table 3.10).

5.7 Maturity at Age

The Working Group decided not to change the maturity at age (Table 5.8) during this meeting, although the proportion mature of the 1982 year class in 1986 should be reduced from 0.6 to 0.1 if the spawning stock biomass is to correspond with the estimate from the egg survey (see Section 5.8).

Based on the maturity-at-length data, the length at which 50% is mature was expected to be about 23 cm (Anon., 1986b). The mean length of the 1982 year class in 1986 was 23.7 cm (Table 5.5). Therefore, the proportion mature was assumed to be 0.6 for this year class. Since there has only been one year class (1982) spawning, the increase in the total egg production from 0.5 to 1.7×10^{15} eggs from 1986 to 1989 should be ascribed to an increase in the proportion mature of the 1982 year class. The maturity at length is, therefore, not expected to be a good way of estimating the proportion mature. The potential total fecundity per gram female (estimated before spawning) as used for the conversion of eggs to biomass seems to differ very much from the realized fecundity of first maturing fish. From the mean weight at age in the stock (Table 5.4), it is seen that the mean weight of the 1982 year class in 1986 (105 g) was very low compared to the weight of the 4-year-olds in the previous years.

The Working Group recommended that further investigations should be undertaken to revise the maturity at age for the period 1982-1990 for next year's meeting.

5.8 Fishing Mortality and Tuning of the VPA

To obtain the exploitation pattern, several separable VPAs were run. With a terminal fishing mortality of 0.14, which matched the spawning stock biomass estimate for 1989 based on the egg surveys

and a reference age of 7 (the 1982 year class), the selection patterns for ages 1-14 for four different values of terminal S (0.6, 1.0, 1.4, and 1.8) were obtained (Figure 5.2).

A flat exploitation pattern was assumed for the fully recruited age groups (age 6 and older). However, the year classes older than the strong 1982 year class are all weak except for the 1979, 1970, 1969, and 1968 year classes. The 1982 year class dominated the catches in 1989 (89% of the total catch in numbers) (Figure 5.3 and Table 5.7) as it has done every year since entering the fishery in 1984-1985. A terminal S of 1.0 did not produce a flat exploitation pattern on the fully recruited age groups (Figure 5.2), and this is probably due to sampling and ageing problems. The Working Group decided to run a new separable VPA with a 12+ group to get a better exploitation pattern. The exploitation patterns for three runs with terminal S 0.8, 1.0 and 1.2 are shown in Figure 5.4. Table 5.6 shows the output of the SVPA with terminal F of 0.14, reference age 7 and a terminal S of 1.0.

The exploitation pattern derived from this SVPA was used to generate VPA estimates of the spawning stock biomass to fit that of 2.134 million tonnes from the egg survey in 1989 (Table 5.2). The catch in numbers and maturity by age group are shown in Tables 5.7 and 5.8. The output of the VPA are given in Tables 5.9 and 5.10 and Figures 5.6A and B.

The VPA (Table 5.10) matches the spawning stock size estimate based on the egg surveys rather well both in 1983 and 1989, while it is far out in 1986. This might be caused by a wrong maturity proportion for the strong 1982 year class assumed for that year (Table 5.8) or by the fecundity of the 1982 year class being lower than what was assumed for the spawning stock biomass estimate from the egg surveys (Section 5.2.1). About 75% of the VPA spawning stock in 1986 was the 1982 year class. If the proportion mature for this year class is reduced from 60% to 10%, then the VPA-generated spawning stock biomass matches the egg survey estimate. The growth of the 1982 year class is reduced compared to other year classes and so it may also have matured later. According to Dutch data, the mean length of this year class in 1986 was 23.7 cm (Table 5.5), which is 1.6-4.5 cm less than usual for 4-year-old fish. The length at which 50% of the horse mackerel reach sexual maturity in Division VIa and Sub-area VII is 23-24 cm (Anon., 1986b). Therefore, a maturity of 60% of an average length of 23.7 cm is probably too high (Section 5.7).

5.9 Recruitment

Based on the frequent occurrence of weak year classes (only about 7 strong year classes in the last 50 years, Eltink and Kuiter, 1989), the predicted recruitment at age 1 in 1990, 1991, and 1992 was taken to be the average of the weak 1981, 1983, 1984, 1985, and 1986 year classes, as was assumed by the Working Group last year. Because of the new fecundity estimate used (Section 5.2.1), 1247 million recruits (rounded to 1250) has been used instead of the 100 million calculated last year. This value corresponds to about 3% of the recruitment of the 1982 year class at age 1.

5.10 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 and are shown in Figure 5.6C. The $F_{0.1}$ was estimated to be 0.15 for M = 0.15.

5.11 Forecast

To carry out catch and stock predictions, the following parameters and assumptions were used, together with the parameters given in Table 5.11.

1) The stock size in number at ages 4-12+ at 1 January 1990 was taken from the VPA (Table 5.10).

2) The number of 1-group in 1990, 1991, and 1992 was set at 1250 million (see Section 5.9).

3) The numbers of 2- and 3-groups in 1990 were calculated at 1050 and 900 million, respectively (which is 1250 reduced by M and a low F).

4) The proportion mature at age was assumed to be the same as in 1989.

5) The weights at age in the catch and in the stock were assumed to be the same as in 1989 for ages 1-7; for older ages, weights were estimated from the following regressions based on the weight in the catch and the stock for the last five years from Ducth data (Eltink, pers. comm.):

   1979 year class: Weight in catch = 142.8 + 11.5 x age (r^2 = 0.462)
   1979 year class: Weight in stock = 68.8 + 19.7 x age (r^2 = 0.762)
   1982 year class: Weight in catch = 40.6 + 17.4 x age (r^2 = 0.895)
   1982 year class: Weight in stock = 26.4 + 19.2 x age (r^2 = 0.992)

6) The separable fishing pattern (smoothed) from 1989 was applied (Table 5.6). Since the catches were dominated by the 1982 year class, the status quo fishing mortality was taken to be the weighted F for ages 3-11 in 1989 (Table 5.9).

7) The catch in 1990 was assumed to be about 290,000 t. This assumption is based on the agreed EC TAC of 203,000 t in the western areas plus a Norwegian fishery at a similar level as in 1989 (90,000 t).

The predictions for stock and catch in 1991 and 1992 were calculated for $F_{91} = 0.78 \times F_{89}$, $F_{91} = F_{89}$, and $F_{91} = F_{0.1} = 0.155$. The results are shown in Table 5.12. The options F_{high} and F_{med} are not used because F_{med} is undefined and F_{high} is rather uncertain because of the extremely strong 1982 year class.

The spawning stock will decline under all options; even without a fishery in 1990, the spawning stock will go down. A fishery in 1990 of about 290,000 t corresponds to an increase of F of 24% of F_{89}.

5.12 Biologically Safe Limits

The results of the prediction have to be considered with caution because the stock is dominated by one year class and the recruitment is very low. If the fishery continues in 1990-1992 with the same F as in 1989, the 1982 year class will account for 85%, 77%, and 74% of the catches, respectively, for each of the years in that period (Table 5.13). In 1989, this year class also totally dominated the catches (89%) (Figure 5.3).

Without significant recruitment the stock totally depends on the 1982 year class. To illustrate this, the Working Group ran a one cohort analysis for the 1982 year class. This was run to match the spawning stock biomass of 2.13 million tonnes in 1989 based on the egg surveys. The results are shown in Figure 5.5. The development of this cohort with a yearly fishery of 290,000 t from 1990 and onwards is also shown. The weight in catch and stock are based on the regressions given in Section 5.11. With such a level of fishery, the cohort will last until the middle of the 1990s (Figure 5.5).

Due to individual growth, the biomass increased until 1987. Since then, due to natural mortality and the fishery, the biomass has declined. Therefore, until recruitment improves, the catches of Western horse mackerel taken should be rather conservative.

5.13 Management Measures and Considerations

The TAC set for 1991 should apply to all areas in which Western horse mackerel are caught, i.e., Divisions IIa, IVa, VIa. VIIa-c,e-k, and VIIIa,b,d,e.

Since both the stock and the fishery are rather dependent on the 1982 year class, the fishery should be reduced to a lower level until recruitment improves. The Working Group, therefore, suggests that the catch should be reduced to a level of 10% of the spawning stock size, which means a catch of 170,000 t in 1991 (Table 5.12).

6 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

6.1 The Fishery

Total catches from Portugal and Spain in 1989 were estimated by the Working Group as 69,734 t for Divisions VIIIc and IXa. Tables 3.1, 3.6, and 3.7 present the estimated catch by country in Subareas VIII and IX. Table 3.9 shows the catches by stock from 1982-1989 by division or sub-area. Table 6.1 provides more detailed information concerning Divisions VIIIc and IXa (Spanish area) and Division IXa (Portuguese area) by fleet. In Division VIIIc and IXa (Spanish area), the estimated catch for 1989 shows an increase of 19%, due to an increase in the purse-seine fishery catch of about 11,000 t, and the estimated catch in Division IXa (Portuguese area) is at the same level as in 1988.

It is known that discards are negligible in these divisions and, therefore, the estimated landings from 1981-1989 were adopted by the Working Group to provide the stock assessment of the assumed southern stock.

6.2 Effort and Catch per Unit Effort

Table 6.2 presents the commercial CPUE series from 1979 to 1989 for the Portuguese trawl fleet and for the Spanish and Portuguese purse-seine fleets. The CPUE of the Portuguese purse-seine fleet shows an increase of 17%, while the Portuguese trawl and the Spanish purse-seine CPUE decreased by about 30%. Figure 6.1 shows the effort trends for different fleet and areas. The figure indicates that in the period 1981-1989 the effort has been decreasing slightly. In 1989, the effort only increased in the Portuguese trawl fishery.

6.3 Fishery-independent Information

6.3.1 Trawl surveys

Table 6.2 also shows biomass and abundance indices estimated from June/July and October/November bottom surveys carried out in Division IXa (Portuguese area), and the September survey which covers 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 usual Spanish research vessel in 1989. The biomass index from the Portuguese October survey shows a decrease from 26.0 Kg/h in 1988 to 11.7 Kg/h in 1989.

In Table 6.3, the abundance estimates of these surveys are presented by age group. It can be observed that in 1989 the estimated recruitment index in the October survey is at a higher level than in 1988 and 1987. The 1989 year class is indicated as strong by the CPUE from the Spanish purse seine fleet. The September survey off Galicia confirms a good strength for the 1989 year class.

The 1987 year class, which was indicated to be strong by the October survey in 1988, does not appear strong in the 1989 October survey. The abundance of adult fish (3+) as estimated by the October survey was very high in 1988 as compared to the previous years. In 1989, it returned to its previous level. This indicates that the adult fish (3+) are very much affected by seasonality. CPUE indices from the commercial catches show the same pattern as the survey, but much less pronounced because those data cover the whole year.

6.3.2 Egg surveys

Portugal carried out monthly sampling of horse mackerel larvae from October 1986 to January 1989 along the Portuguese coast (Fariñha, WD 1990). Off the north of Portugal, the peak occurrence of larvae was around April, whereas off the south of Portugal larvae were present throughout the year.

Since 1987, routine monthly ichthyoplankton sampling has been carried out along three transects off the northwest and north of Spain. A higher abundance of eggs was found from February to July (Sola et al., WD 1990; Lago et al., WD 1990).

In April 1987 and April-May 1988, two eggs surveys were carried out along the Spanish coast. Horse mackerel eggs were present

throughout the Cantabrian Sea, but larger concentrations were located off the Asturian coast (Lago et al., WD 1990).

Three other eggs surveys, aimed at sampling anchovy eggs, were conducted in 1987 (May-June), 1988 (May), and 1989 (May-June). The coverage of the area was limited to the eastern part of the Cantabrian Sea, but extended northwards as far as 47°N (Santiago et al., 1988; Santiago et al., 1989; Motos et al., 1990). Relatively low egg abundances were found in all three years in the area covered in Division VIIIc compared to the Western horse mackerel spawning area (Anon., 1990a).

The Working Group recommends that egg surveys should continue to be carried out in Divisions VIIIc and IXa in order to try to estimate the spawning biomass of the Southern horse mackerel stock. For this purpose, the Working Group recommends that the Mackerel/Horse Mackerel Egg Production Workshop to be held at IJmuiden in early 1991 should also include the planning of egg surveys to be carried out in 1992 in Divisions VIIIc and IXa.

The Working Group recommends that complementary studies should be undertaken on the discrimination of eggs of the three Trachurus species present in the Southern waters, i.e. T. trachurus, T. mediterraneus and T. picturatus.

6.4 Catch in Numbers

Catch in numbers at age (Table 6.4) were obtained by applying quarterly age-length keys from Division IXa (Portugal) to the quarterly raised length compositions of Portugal and Spain. These ALKs and the ones used the last year were made using the Dutch ageing method. Catch in numbers at age from Divisions VIIIc and IXa have to be revised for previous years using the 1-ring determination technique. Nevertheless, the indication that the two different methods are in agreement up to age 5, and the fact that the bulk of the catch from the Southern stock is of fish less than 5 years old suggest that the discrepancies in the interpretation would not much change the catch-in-numbers matrix that has been used up to now. However, slight revisions might be necessary for the ALKs in accordance with the results from the Otolith Workshop to be held in November 1990 in Lisbon.

6.5 Mean Weight at Age

The mean weights at age in the catch from 1981-1989 are shown in Table 6.5. They were estimated by weighing the total length frequency distribution for each age group. The length/weight relationship used was the same for the period 1981-1989 (Anon., 1988).

The mean weights at age in the stock were estimated as the mean of the weights in the catch of each two consecutive age groups of the same cohort, following the procedure used last year (Anon., 1989).

In the minutes of the ACFM meeting in November 1989 it is mentioned that "the mean weights for 1984 are very low and this may be a data problem". Because the age/length keys before 1988 were not revised, some errors are expected in the mean weights at age

for these years, and they must be revised after the Workshop on Otolith Reading (see Section 3.4). For the years 1988 and 1989, the age/length keys were made according to the 1-ring-per-year interpretation and so the mean weights at age in these years can be considered more accurate.

6.6 Maturity at Age

Maturity-at-age data were assumed to be the same as used last year in the assessment (Table 6.12).

6.7 Fishing Mortality and Tuning of the VPA

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

- Portuguese October survey (Division IXa)
- Portuguese trawl fleet (Division IXa)
- Spanish purse-seine fleet (Divisions VIIIc and IXa)
- Spanish September survey (Divisions VIIIc, IXa)

Table 6.3 presents the input file used to tune the VPA. A first trial was made using the method of Laurec and Shepherd (1983), and the log-catchability of each age by fleet was plotted (Figure 6.2) against time. These indicated that the assumption of constant catchability could be accepted.

The first run was made assuming F on the oldest age = 3 x F of the five younger ages, an assumption used since 1988 to overcome the drop in the exploitation pattern. However, the dip in the exploitation pattern seems to have changed in recent years (Figure 6.3), and, therefore, the factor determining the F on the oldest age was changed to 2, which seems to be more consistent with the most recent fishing pattern.

The results of the tuning are given in Tables 6.6 and 6.7. These show that the two surveys have high SE(q) values, and so another trial run was made without the surveys but that did not improve the fit. The run including the surveys was adopted as the best available.

Several trials of separable VPA were then run in order to match the fishing mortality array for 1989 of the final VPA to the one derived from the tuning, but given the strange shape of these exploitation patterns, it was not possible to get a close match throughout the age range. Figure 6.4 shows the plot of the exploitation patterns for 1989 derived from the tuning, from the SVPA, and from the final (terminal populations) VPA, which was chosen to match the tuning closest at younger ages because the bulk of the catches are of ages 0-3 and these age groups are not subject to variable availability as are the (adult) fish. The final VPA was derived from separable VPA with a reference F = 0.55 at age 1 and a terminal S = 1.2 (Table 6.8). Tables 6.9 and 6.10 and Figures 6.5A and B show the results of the final VPA.

Consideration was given to using an age range of 1-5 for the reference fishing mortality, but because most of the catches are of young fish, it was decided to use the the age range 1-3.

6.8 Recruitment

Estimates of O-group recruitment were available from the Portuguese October and July bottom trawl surveys, as well as from the Spanish September survey. These indices suggest a higher level for the 1989 year class than the 1988 year class, which was a weak one (see Section 6.3.1).

Numbers at age 0 estimated by final VPA were regressed against the O-group indices from the October and June Portuguese bottom trawl surveys, the Portuguese trawl and Spanish purse-seine fleets and the Spanish September survey using RCRTINX2. Table 6.11 shows the predicted values for the 1988 and 1989 year classes. The estimated value for the 1988 year class (1511 million fish) is three times higher than the estimated year-class strength from VPA (483 million) and the 1989 year class is about 3 times lower (1403 million fish) than the one estimated from VPA (3416 million fish). The VPA value for the 1988 year class (483 million) and the RCRTINX2 value for the 1989 year class (1403 million) were adopted for the prediction.

6.9 Yield per Recruit

The long-term yield per recruit and spawning stock biomass per recruit curves against F, derived using the input data in Table 6.12, are shown in Figure 6.5C. $F_{0.1}$ was estimated to be 0.10 for M = 0.2.

6.10 Prediction

The terminal population from final VPA was used as input to the catch forecast. A geometric mean of 1780 million O-group from 1981-1987 fish were assumed for the recruitment in 1990 and later years. The stock size at age 1 in 1990 was considered to be 1033 million, which was calculated from the predicted value of 1403 at age 0, assuming a fishing mortality of 0.106. The stock size at age 2 was taken to be 160 million as estimated by the final VPA; it was considered that the catch at age 1 provided a better estimate of the strength of this year class than the recruitment indices. Catch and stock weights at age were taken as averages for the years 1988-1989. The separable exploitation pattern was used for the prediction.

Table 6.12 shows the input parameters and Tables 6.13 and 6.14 and Figure 6.5D show the results of the predictions for 1989 and 1990.

At status quo fishing mortality, the predicted catch was estimated to be 69,000 t in 1990 and 63,000 t in 1991, whereas the catches in 1991 at $F_{0.1}$ and F_{med} would be 22,000 t and 47,000 t, respectively. Stock biomass estimates are 186,000 t in 1990 and 163,000 t in 1991 at a status quo F level.

6.11 Biologically Safe Limits

The reference mortality levels of F_{high} and F_{med} are shown in Figure 6.6 which is the plot of spawning stock biomass versus recruitment for the period 1981-1989. There is no evidence of any

stock/recruitment relationship (Figure 6.6).

The spawning stock is at present at a level of 167,000 t. Current fishing mortality (F_{89} = 0.34) is close to F_{high} (= 0.36). To reduce the spawning stock biomass to a historically low level in 1991, the fishing mortality would have to be increased by a factor of 5.6.

6.12 Management Measures and Considerations

There are continuing uncertainties concerning the stock identity and this obviously is of importance for assessment and management. Nevertheless, it would seem advisable to control the juvenile fishery by TAC enforcement. The F status quo is very close to the F_{high}, and it would seem advisable to reduce the fishing mortality to a lower level in 1991.

7 ANCHOVY (SUB-AREA VIII)

7.1 Unit Stocks

New studies concerning morphometric characteristics of the Bay of Biscay anchovy improved our knowledge concerning the phenotypic structure of this stock (Prouzet, WD 1990b). A preliminary study was carried out on samples collected during the French acoustic survey (DAAG89, see Section 7.4.2) in Division VIIIb. The main results showed three geographic groups, well discriminated by linear discriminant function analysis (89% well classified). The preliminary conclusion of this work is that the dynamics of this stock are more complex than previously thought.

The distinction between groups was only based on phenotypic characteristics and the temporal stability of such differences has, therefore, to be further studied. These differences are not necessarily linked to a segregation of different genetic units, but might be caused by temperature, rate of growth, biology of reproduction. It is recommended that further investigations be made before any definitive conclusions are drawn on stock units in these areas. On the other hand, observations on the spawning dynamics of anchovy in the Bay of Biscay (Anon.,1988; Santiago and Eltink, 1988) and the two good recruitments of anchovy in 1983 and 1990 well detected from the Spanish coast to the Gironde estuary seem to indicate a homogeneous stock.

For assessment purposes, the Working Group decided for the present to consider the Bay of Biscay anchovy population as a single unit in Sub-area VIII and not to restrict the assessments to Divisions VIIIb and c. The Working Group assumed that the minor 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 landings in Sub-area VIII amounted to 10,490 t in 1989 (Table 7.2). Spanish landings in 1989 reached 8,174 t (Figure 7.1), the same level as in 1988, but the temporal distribution of

catches is different (only 66% in spring versus 84% in spring 1988) (see Section 7.2.2).

Estimated French landings decreased by at least 65% for Sub-area VIII between 1988 and 1989. This might be due to a different distribution of anchovy during spring; in 1989 fish may have been distributed mainly in Division VIIIc where the French pelagic trawlers are not allowed to fish.

Until now it has not been possible to report the catches of 0- and 1-year-old anchovy caught for live bait for the tuna fishing. Since the catch level in this fishery is about 500 t per year, the Working Group recommends that these data should be made available for future assessments.

Discarding of anchovies by the midwater trawlers might occur in some areas, but the Working Group members could not estimate this. Therefore, the Working Group recommends that this problem should be investigated.

Landings by Divisions

The distribution of Spanish catches in 1989 was totally different from the previous years (1987 and 1988). Nearly all anchovy landings came from Division VIIIc (Table 7.3). Catches in the second half of the year accounted for one third of the total landings. They were caught in Division VIIIc (Table 7.4) very late in the autumn season (November) and were partly unrecorded. Working Group members estimated the unreported component as 9% of the total autumn catches.

Table 7.3 shows that the French fishery in 1989 was distributed mainly in Divisions VIIIa and b as in 1987 and 1988. In 1989, the seasonality of catches was different. One third of the total landings appeared in January, and very small landings were recorded in autumn due to the presence of very small anchovies in Division VIIIa which were not fished by the French fleet.

Landings by EC Categories

Table 7.5 gives the distribution of Spanish and French landings by EC market categories for Divisions VIIIb,c in spring. The main part of the landings consisted of medium size (T2) for both countries.

The temporal distribution is rather different for the two countries. Small anchovies were mainly caught by France in winter (1988 year class) and Spain in autumn (1989 year class).

7.3 Effort and Catch per Unit Effort

Table 7.6 gives a rough idea of the changes in the French fleet. In 1989, there was a strong decrease in fishing effort, due both to a decrease in the number of boats and also to a shorter fishing season.

The total number of Spanish purse seiners has remained more or less the same since 1984 (Table 7.7). However, in 1989 a strike of fishermen in the main harbour of the Basque country during the spring resulted in a strong reduction of the effort. In the

autumn, the effort increased because several purse seiners changed from tuna fishing to anchovy fishing. The same table also shows that the Spanish spring fishing season was more extended in 1990 than in previous years.

7.4 Fishery-Independent Information

7.4.1 Egg surveys

Four egg surveys have been conducted by AZTI/SIO (Spain) using the daily egg production method (batch fecundity method) to estimate the spawning stock biomass of the Bay of Biscay anchovy from 1987 to 1990 (Santiago and Sanz, 1989; Motos and Santagio, WD 1990).

During the 1989 survey (Santiago and Sanz, 1989; Motos and Santiago, WD 1990) the spawning area was covered completely, except for an area close to the French coast which in previous years accounted for about 10% of total egg production. Of the two surveys at peak spawning time (one in May and another in June), the May survey was the only one considered reliable because of poor sampling of adult fish in June. However, the total anchovy egg production in the area was similar for both surveys (Figure 7.2). The spawning stock biomass estimated from the May survey was 11,861 t.

The 1990 surveys ended a couple of weeks before the meeting of the Working Group, therefore only a preliminary index of abundance was submitted (Motos, pers. comm.).

The results from the last four years of egg surveys are given in Table 7.8.

The spawning stock biomass is considered as total stock biomass since less than 1% of 1-year-old anchovies are immature when those surveys take place and their fecundity parameters are not different from those of older anchovies. These estimations were provided as absolute biomass. However, they have to be considered with their coefficients of variation in order to estimate their precision (Figure 7.3).

These results indicate that there have been strong fluctuations of biomass in recent years with peaks in 1988 and 1990. Low recruitments have been detected both in 1987 and 1989. The good recruitment assumed for 1988 in order to explain the huge increase of biomass, was not confirmed in 1989. In last year's report (Anon., 1989), it was suggested that, based on anchovy egg abundances, the 1987 year class could be as strong as the 1982 year class. This might be explained by:

- Non-comparability of 1982 and 1987 year-class data.
- Changes in natural mortality.
- Low precision of the 1988 spawning stock biomass estimate.
- Inappropriate assumptions on parameters of adult fish in the non-sampled area.

The recent preliminary egg survey in 1990 indicates that the 1989 year class is strong.

7.4.2 Acoustic surveys

Five French acoustic surveys have been carried out from 1983 to 1987 in the Bay of Biscay (Massé, 1988). Two other French surveys have been carried out in the south of the Bay of Biscay in cooperation with Spain in 1989 and 1990 with the objective of studying the distribution and the abundance of anchovy in this area at the beginning of the fishing season.

Because of methodological problems encountered during the surveys 1983-1987 (Massé, 1988), the objective of surveys in 1989 and 1990 was to try to establish relative abundance indices rather than absolute estimates.

The results of the two surveys in 1983 and 1984 are comparable with those of 1989 and 1990, because they were carried out at similar times, and the same methods for sampling and computation were applied (Massé, WD 1990). It is important to notice from this comparison (Table 7.9 and Figure 7.4):

- The 1983, 1989 and 1990 surveys occurred at the end of April, whereas the 1984 one occurred at the beginning of May when about 13,000 t had already been landed by the Spanish and French fleets.

- In 1989, the acoustic index is overestimated because of a very low abundance in a multispecies structure where sardine was predominant.

- In 1990, at least 95% of the anchovy observed during the survey were 1989 year class (1-year-olds).

The results given in Table 7.9 confirm the high abundance of the 1982 year class which was predominant in the catches from 1983-1985. It also confirms the weakness of the 1983 and 1988 year classes.

The acoustic surveys seem to provide useful information, in particular 1-group abundance indices are in good agreement with the recruitment. According to this, the 1-group index from the 1990 survey indicates that the 1989 year class might be stronger than the 1982 year class, which was the biggest in the last decade.

7.4.3 Objectives of the egg and acoustic surveys

Egg surveys have already been carried out for four years and acoustic surveys for two years, with the objective of estimating the anchovy abundance in the Bay of Biscay.

At present, the Working Group members agreed that the results of both are encouraging but that a longer time series of data is necessary to verify the reliability of these estimations. Nevertheless, the commercial catches already confirm the level of some year classes from the results of the two methods.

The egg surveys provide estimates of the daily egg production and corresponding stock biomasses. The acoustic surveys provide a relative abundance index of the total biomass, and both methods also provide numbers by age groups. A longer time series could provide more knowledge about the recruitment and the natural mortality by age. For management purposes, the estimate of 1-year-old anchovy is essential because of its influence on the total biomass and on the next year's catches because of the fishing pattern of the fleet (Uriarte and Astudillo, 1987).

The Working Group members recommend that coordinated egg surveys and acoustic surveys should be carried out in future years in order to improve the precision of the results.

7.5 Recruitment

It is noticed from acoustic and egg survey estimates of recruitment (Table 7.10), that the recruitment for 1990 seems larger or roughly similar to those detected in 1983 and 1988. Figure 7.5 shows that the acoustic surveys according to the observations give a good index of the strength of a given cohort (expressed by year class cumulative catches).

For the time being, it seems that both the egg and acoustic surveys indicate a rather good recruitment at age 1 in 1990. This was confirmed by significant catches in 1989 of 0-group and of 1-group in 1990 in the commercial fishery.

7.6 Length Compositions by Fleet and by Country

For the first time, length composition data for catches have been gathered by the two countries and comparisons can be made.

Table 7.11 and Figure 7.6a show the distribution by half year for the two countries and the differences in length distributions. A Kolmogorov-Smirnov test showed that the length distributions of French and Spanish catches are significantly different for the first half of the year.

In spring, French landings have a smaller mean length than the Spanish which suggests that stock composition in Divisions VIIIa,b was of smaller size on average than in Division VIIIc.

Spanish catches in autumn (Figure 7.6b) were taken from the 0-group 1989 year class, and are comparable in terms of numbers to the spring-spawning catches.

7.7 Catch in Numbers

Concerning the French data, a coefficient of conversion from salted weight to fresh weight of the catches was applied. This is the first time that France has provided catch-at-age data (Tables 7.12 and 7.13).

A meeting on the methods used for age determination based on otoliths reading was held in San Sebastian (Astudillo et al., WD 1990). The best agreement was found between two of the three Spanish readers. However, more disagreements were found between

the French and Spanish readers. It was concluded at that meeting to continue the calibration of ageing by the interchange of otoliths.

There are some inconsistencies in the catch-at-age data, mainly in 1983 and 1984. It has to be remembered that in 1983, the catch at age was based on length distributions (Uriarte and Astudillo, 1987) since no age/length key was available. The first year for age reading was 1984 and those age determinations have not been revised. Data on catch at age prior to 1983 are not as reliable as more recent data, therefore the Working Group did not consider them for assessment purposes.

7.8 Mean Weight at Age

For the French estimates, the mean weights at age in the catch were calculated from biological sampling. The rest of the data came from analyses of commercial catches. Spanish mean weights at age in the catch were calculated from routine biological sampling (Tables 7.14 and 7.15).

7.9 Maturity at Age

The biological samples confirmed the observations made in last year's report that all age groups except 0-groups are totally mature.

7.10 Natural Mortality

In Figure 7.8, it can be clearly seen that for the last four years there have been wide stock biomass fluctuations which cannot be explained by variation in rates of exploitation. They may be partly due to inaccuracy of biomass estimates, natural mortality, and great variations in the level of recruitment (by a factor from 1 to 100).

Several estimates of the natural mortality have been made based on the numbers at age from egg survey estimates and catches (Figure 7.9). The main results obtained show that the natural mortality is always 2 to 3 times higher (for the central values of biomass) than the fishing mortality (Figure 7.9). Natural mortality varies from year to year. However, some of the higher values of M do not seem realistic. At present it is not possible to draw any conclusions on the absolute values of M and F.

7.11 Assessment

Several trials of VPA were performed as a first exercise using the numbers from the egg survey results and catch per unit effort for tuning purposes.

However, considering the high and fluctuating natural mortality among years, it was decided to reject the results obtained by VPA analysis. There was no way for the resulting biomasses to follow the trend of SSB estimated by the survey.

For assessment purposes, the Working Group decided to run a VPA (according to Pope's formula) from a synthetic cohort built from the mean catch at age of the period 1983-1989. For a given M, two criteria have been chosen:

H1 : F for the age groups 2, 3, and 4 roughly similar
H2 : F for the age groups 3 and 4 similar

The results are given in Table 7.16 and show that the rate of exploitation of 1-year-old at any M is low. For the 2-year-olds according to M chosen, the range of F is between 0.1-0.56. These results seem to be in agreement with the exploitation pattern observed for anchovy in the Bay of Biscay.

7.12 Trends in Biomass and Recruitment

As discussed in last year's report (Anon., 1989), it is clear that at the present time we are on the lowest range of biomasses of the anchovy stock since 1960 (Figure 7.1).

Recruitment at age 1 in 1991 is difficult to predict. No clear relationship exists between stock and recruitment and this is normal for short-living species.

The analyses of catch data (Figure 7.10) show that no clear relationship can be established between the abundance index at age 1 and age 2 and even between the ages of 2 and 3. This is not surprising for ages 1 to 2 because of the wide fluctuation of natural mortality, mentioned in Section 7.10, and because age 1 is not fully recruited to the fishery. However, ages 2 and 3 are fully recruited to the fishery but still no relationship appears.

7.13 Catch Forecast

1) For the time being, the uncertainties concerning natural mortality and the exploitation rate as well as the inaccuracy of the independent stock estimates make it difficult to predict the catch levels for 1991. Several attempts were made which produced too wide a range in predicted catches for any reliable catch forecast.

2) It is estimated that in 1990, 95% of the stock belongs to the 1989 year class, therefore, catches in 1991 will consist almost entirely of this year class and of the incoming recruits of 1-year-olds.

3) The strength of the 1989 year class can be compared to previous ones in Figure 7.7, which shows indices of 1-year-old recruits. This year class in 1990 (age 1) seems to be at least as abundant as the 1982 year class in 1983 or the 1987 year class in 1988. The 1982 year class gave significant catches in 1984, but the 1987 year class did not produce significant catches.

4) The catch corresponding to 1-year-old anchovies in 1991 is uncertain. As stated in Section 7.10, the recruitment produced by a given spawning stock biomass can vary widely (factor 1 to 100) and consequently it is impossible to forecast. For example, the catch levels of 1-year-olds during the period 1983-1990 were as much as 15,000 t one year, between 5,000-12,000 t in two years, an below 4,000 t in five years.

5) At the end of October, when the results from the egg surveys are available, the estimate of the SSB will be provided to the November 1990 ACFM meeting.

7.14 Biologically Safe Limits

Biologically safe limits are, presently, difficult to define. From the data obtained from acoustic or egg 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 very low spawning stock biomass in 1989 produced a rather good recruitment in 1990 compared to the last ten years. The current spawning stock biomass does not seem to be larger than the average for previous years. However, on a long-term basis, it seems that the spawning stock biomass is at present at a rather low level. Whether this is caused by adverse environmental conditions or not is uncertain.

7.15 Management Measures and Considerations

It is important to recall that:

- Natural mortality is high and fluctuates according to years
- Fishing mortality seems to be much lower than M during the years 1987-1989
- The exploitation pattern seems to be appropriate to the stock dynamics since the major fishing pressure is on the older age groups
- The influence of environmental conditions on recruitment is obvious
- There is no clear stock/recruitment relationship.

For these reasons, and in order to stabilize the fishing effort in order to maintain biomass at a safe level so as to to secure recruitment, a seasonal and/or a minimum fish size regulation would be more appropriate for the time being rather than regulation by TAC.

Some possibilities can be mentioned:

- a minimum landing size for anchovy to protect 0-group and 1-group,

- a limited or delayed fishing period to protect the spawning stock biomass at the beginning of the spawning season.

8 DEFICIENCIES IN DATA

8.1 Sardine

- Information on sardine from the south of Division IXa (Gulf of Cadiz) is lacking.

- Proportions mature at age for sardine are not representative for the whole area.

8.2 Horse Mackerel

Ageing

For the Western and Southern horse mackerel, only 32% and 36%, respectively, of the catches were covered by age sampling.

Stock separation

Still more information on stock separation is required.

Catches

Catches by countries are only reported annually, whereas catches on quarterly and even rectangle basis are needed.

Maturity

Proportions mature at age appear to be unreliable, because first maturing fish seem to produce less eggs than expected.

Discards

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

Distribution of horse mackerel

Distribution of 0-, 1-, and 2+ group horse mackerel by rectangle were only available from a limited number of surveys.

Length distribution

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 peninsular is unknown.

Recruitment

Recruitment surveys on which horse mackerel is caught did not indicate recruitment strength in the western and North Sea areas.

Acoustic surveys

Acoustic surveys in the North Sea do not cover the total horse mackerel distribution. Acoustic surveys for horse mackerel are lacking in the western area.

8.3 Anchovy

Ageing - There is a necessity to calibrate the age determination between Spain and France to improve the accuracy of the age readings.

Unknown Catches - Data are lacking on discards in the French fleet and catches from live bait tuna fishery in the Spanish fleet.

Recruitment and Natural Mortality - The extent of variation in natural mortality and the impact of environmental factors on the recruitment success are unknown.

9 RECOMMENDATIONS

9.1 Research Recommendations

Acoustic Surveys for Sardine

The Working Group recommends that a joint acoustic survey for sardine be undertaken by Spain and Portugal in the period September-December 1990 in order to obtain stock abundance and recruitment estimates.

Acoustic surveys to be carried out by Spain (Divisions VIIIc and IXa) in March/April and by Portugal (Division IXa) in August-September are necessary to maintain the historical data series to be used in the assessment.

Maturity Ogive for Sardine

The Working Group recommends further investigations on sexual maturity in order to obtain a proper maturity ogive.

Sardine Data First Quarter 1991

It is recommended that all sardine data for the first quarter of 1991 should be provided to the next Working Group meeting.

Anisakis Investigations on Horse Mackerel

The Working Group recommends that the infestation of Anisakis in horse mackerel should be investigated in Divisions IIa + IVa (feeding season), Division VIIj (spawning season) and in Divisions IVb+c (spawning season) to obtain information on stock identity of the horse mackerel catches in Divisions IIa and IVa.

The Batch Fecundity Method for Horse Mackerel

The Working Group recommends that the comparison between the total fecundity method and batch fecundity method for estimating the horse mackerel biomass should be carried out in 1992.

Western Recruitment Surveys

The Working Group recommends that a planning group should be established by ICES, which would study all existing fish surveys carried out in the Western areas with a view to establishing a proper standardized international survey which could obtain recruitment indices for as many species as possible.

Maturity at Age for Horse Mackerel

The Working Group recommends that further investigations should be undertaken to revise the maturity-at-age table for the period 1982-1990.

Unit Stocks of Horse Mackerel

The Working Group recommends that further investigations be carried out to provide a better basis for determining migration patterns and stock separations (e.g., tagging experiments, parasite studies, L_1 studies, genetic differences, etc.).

Horse Mackerel/Mackerel Egg Surveys in Divisions VIIIc and IXa

The Working Group recommends that egg surveys in Divisions VIIIc and IXa be continued in order to try to estimate the spawning biomass of the Southern horse mackerel stock. For this purpose, the Working Group recommends that the Mackerel/Horse Mackerel Egg Production Workshop, to be held at IJmuiden in early 1991, should also include the planning of egg surveys to be carried out in 1992 in Divisions VIIIc and IXa.

Egg Discrimination of Different Trachurus Species

The Working Group recommends that studies should be undertaken on the discrimination of eggs of the three Trachurus species present in the southern waters, i.e., Trachurus trachurus, Trachurus mediterraneus, and Trachurus picturatus. Maturity studies on these species could indicate any overlap in spawning.

Discards of Horse Mackerel

The Working Group recommends that more information on the quantities of discards should be collected in all areas.

Mixing of Horse Mackerel Species

The Working Group recommends that catches, length distributions, and numbers at age of Trachurus trachurus provided to the Working Group should not include T. mediterraneus and T. picturatus.

Egg and Acoustic Surveys - Anchovy

It is strongly recommended that both egg surveys and acoustic surveys should be carried out for assessment purposes in future years and should be planned and coordinated by Spain and France.

Age Determination - Anchovy

The accuracy and consistency of age determination by Spain and France should be improved by means of otolith reading exercises.

Natural Mortality - Anchovy

Considering the high variation of natural mortality, the Working Group recommends that studies be undertaken on biological and environmental factors responsible for this variation

Stock Discrimination - Anchovy

To improve the stock discrimination of the anchovy population in the Bay of Biscay, the Working Group recommends that phenotypic studies be continued and, if possible, the results compared to those from genetic studies.

Discards of Anchovy

More information should be provided on discards, and estimates of the catches of live bait for the tuna fishery should be made available.

9.2 Management Recommendations

The TAC for the North Sea horse mackerel should only apply to the areas where it is fished (Divisions IIIa, IVb,c, and VIId).

The TAC for the Western horse mackerel should apply to all areas where it is fished (Divisions IIa, IVa, VIa, VIIa-c, e-k, VIIIa, b,d,e).

The TAC for the Western horse mackerel should not be set at the catch corresponding to $F_{0.1}$, because almost no fish younger than the 1982 year class have recruited to the spawning stock, and the stock mainly consists almost entirely of only one year class. The catches should be reduced to a level of 10% of the spawning stock size until a good year class recruits to the spawning stock.

10 WORKING DOCUMENTS

Astudillo, A., Lucio, P., Prouzet, P. and Uriarte, A. WD 1990. Summary of results concerning the otolith reading exercise held in San Sebastian (Spain) in January 1990.

Borges, M.F., Turner, R.J. and Casey, J. WD 1990. Plasma transferrin polymorphismus in read (Trachurus trachurus L.) populations from the Northeast Atlantic.

Dias, Afonso C.M. and Marques, V. WD 1990. R.V. "Noruega" (INIP) acoustic system calibration with a standard target.

Eltink, A. WD 1990a. Horse mackerel egg production and spawning stock size in the North Sea in 1989.

Eltink, A. WD 1990b. Reliability of the numbers-at-age and weights-at-age data of the western horse mackerel.

Farinha, A. WD 1990. Preliminary results on the horse mackerel spawning area from Portuguese larvae surveys.

Lago de Lanzós, A., Franco, C., and Solá, A. 1990. WD 1990. Spatial and temporal distribution of Trachurus trachurus (Linnaeus, 1758).

Lucio, P. WD 1990. New notes on the fishery of Mediterranean horse mackerel (Trachurus mediterraneus, Steindachner, 1868) in the Bay of Biscay in 1982-1983 and 1989.

Lucio, P. WD 1990. Some biological data on horse mackerel, Trachurus trachurus, in the Bay of Biscay in 1982-1983 and 1989.

Massé, J. WD 1990. Anchovy abundance in the south of the Bay of Biscay during French acoustic surveys

Motos, L. and Santiago, J. WD 1990. An egg production estimate of biomass of the Bay of Biscay anchovy in 1989.

Porteiro, C., Miguel, J., and Carrera, P. WD 1990. Acoustic estimates of sardine abundance during cruises in spring 1986, 1987, and 1988.

Prouzet, P. WD 1990a. French anchovy fishery in 1989.

Prouzet, P. WD 1990b. Studies concerning morphometrics and meristics characteristics of anchovy samples collected during the cruise of "Thalassa" in the Gulf of Biscay in 1989.

Solá, A., Motos, L., Franco, C., and Lago, A. WD 1990. Seasonal occurrence of pelagic fish eggs and larvae in the Cantabrian Sea and Galicia during 1987-1989.

11 REFERENCES

Anon., 1986a. Report of the Planning Group for Acoustic Surveys in ICES Sub-areas VIII and IX. ICES, C.M.1986/H:27.

Anon., 1986b. Report of the Working Group on the Appraisal of Sardine Stocks in Divisions VIIIc and IXa. ICES, C.M. 1986/Assess:23.

Anon., 1988. Report of the Working Group on the Assessment of Pelagic Stocks in Divisions VIIIc and IXa and Horse Mackerel. ICES, C.M.1988/Assess:22.

Anon., 1989. Report of the Working Group on the Assessment of Pelagic Stocks in Divisions VIIIc and IXa and Horse Mackerel. ICES, C.M.1989/Assess:19. 109 pp. (mimeo.)

Anon., 1990a. Report of the Mackerel/Horse Mackerel Egg Production Workshop. ICES, C.M.1990/H:2. 89 pp. (mimeo.)

Anon., 1990b. Report of the Mackerel Working Group. ICES, C.M. 1990/Assess:19. 109 pp. (mimeo.)

Anon., 1990c. Report of the Planning Group for Acoustic Surveys in ICES Sub-areas VIII and IX. ICES, C.M.1990/H:35.

Anon., 1990. Report of Activity of the Pelagic Fish Committee. ICES, C.M.1990/H:1 (mimeo.).

Beamish, R.J. and Fournier, D.A. 1981. A method for comparing the precision of a set of age determinations. Can. J. Fish. Aquat. Sci., 38:982-983.

Chang, W.Y.B. 1982. A statistical method for evaluating the reproducibility of age determination. Can. J. Fish. Aquat. Sci., 39:1208-1210.

Cunha, M.E., Figueiredo, J., Farinha, A., and Santos, M. 1989. Estimation of sardine spawning biomass off Portugal by egg production method. ICES, C.M.1989/H:41.

Dias, A.C., Soares, E. and Marques, V. Acoustic abundance estimation of sardine (Sardina pilchardus Walb.) off the Portuguese coast - July-August 1988. ICES, C.M.1989/H:52.

Eaton, D. R. 1989. Spawning stock biomass of scad (Trachurus trachurus L.) to the west of the British Isles, as indicated by egg surveys. ICES, J. Cons. int. Exp. Mer, 45:231-247.

Eltink, A. 1988. Anisakis larvae (Nematoda:Ascaridida) in mackerel, Scomber scombrus L., in ICES Sub-areas IV, VI, VII, and VIII in 1970-1971 and 1982-1984. ICES, C.M.1988/H:23. 27 pp. (mimeo.)

Eltink, A. and Kuiter, C.J. 1989. Validation of ageing techniques on otoliths of horse mackerel (Trachurus trachurus L.). ICES, C.M.1989/H:43. 15 pp.

Eltink, A. and Vingerhoed, B. 1989. The total fecundity of Western horse mackerel (Trachurus trachurus L.). ICES, C.M.1989/H:44. 11 pp. (mimeo.)

Igelmo, A., Legarra, J. and Lerga, S. 1988. Estudio de la problemática del by-catch y pescado descartado en les pesquerias vascas. Ondarroa, 1988 (mimeo.).

Iversen, S.A., Eltink, A., Kirkegaard, E., and Skagen, D.W. 1989. The egg production and spawning stock size of the North Sea mackerel and horse mackerel stocks in 1988. ICES, C.M.1989/H:16. 22 pp. (mimeo.)

Laurec, A. and Shepherd, J.G. 1983. On the analysis of catch and effort data. ICES,J. Cons. int. Exp. Mer, 41:81-84.

Lucio, P. and Martin, I. 1989. Biological aspects of horse mackerel (Trachurus trachurus L.1758) in the Bay of Biscay in 1987 and 1988. ICES, C.M.1987/H:28.

Martin, I. 1989. The fisheries of Mediterranean horse mackerel (Trachurus mediterraneus Steindachner 1868) and Spanish mackerel (Scomber scombrus Houttuyn, 1782) in the Basque country in 1987 and 1988. ICES, C.M. 1989/H:29.

Martin, I. and Uriarte, A. 1989. Stock assessment of the Bay of Biscay anchovy and catch predictions for 1989. ICES, C.M.1989/H:24.

Massé, J. 1988. Utilisation de l'echo-integration en recherche halieutique (analyse des campagnes effectuées dans le Golfe de Gascogne de 1983 à 1987). Direction des Ressources Vivantes. IFREMER.

Motos, L., Uriarte, A. and Valencia, V. 1990. Preliminary results on mackerel and horse mackerel from AZTI-SIO 1989 egg surveys. Working document presented to the Mackerel and Horse Mackerel Egg Production Workshop, Lowestoft, 29 January - 2 February 1990.

Nazarov, N.A. 1977. A morphohistological description of the ovaries of horse mackerel (Trachurus trachurus L.) from the Celtic Sea. J. Ichthyol., 17(3):147-423.

Pastor, X., Porteiro, C., Alvarez, F., and Miquel, S. 1986. Acoustic abundance estimation of sardine (Sardina pilchardus Walb.) of Cantabrian and Galician waters. March 1986. ICES, C.M.1986/H:20.

Pérez, N. and Moquedet, Ph. 1989. Estimates of the horse mackerel (Trachurus trachurus) discards from the Spanish trawler fleet in ICES Sub-area VII. Working document presented to the Working Group on the Assessment of Pelagic Stocks in Divisions VIIIc and IXa and Horse Mackerel. Copenhagen, 10-19 May 1989 and February 1990.

Pérez, N., Garcia, A., Lo, N.H.C. and Franco, C. 1989. The egg production method applied to the spawning biomass estimation of sardine (Sardina pilchardus Walb.) at the North Atlantic Spanish coasts. ICES, C.M. 1989/H:23.

Pestana, G. 1989. Manancial Ibero-Atlantico de sardinha (Sardina pilchardus Walb.) sua avaliaçao e medidas de gestâo. INIP. 192 pp. (Thesis)

Prouzet, P., Astudillo, A., Giralder, A. and Lucio, C. 1990. Analyse des caractéristiques biologiques d'anchois récoltés durant la campagne DAAG89. Rapp. IFREMER RIDRV-90.37-RH/St.Pée sur Nivelle. 58 pp.

Santiago, J. Artexte, I. and Zamakona, A. 1988. Distribution and abundance of mackerel, horse mackerel, and pilchard eggs in the southern Bay of Biscay in 1987. ICES, C.M.1988/H:10.

Santiago, J. and Lucio, P. 1989. Distribution and abundance of mackerel, horse mackerel, and pilchard eggs in the southern Bay of Biscay in May 1989. ICES, C.M. 1989/H:30.

Santiago, J. and Eltink, A. 1988. Distribution and abundance of anchovy eggs in the Bay of Biscay in 1987 in comparison with 1983 and 1986. ICES, C.M.1988/H:9.

Santiago, J. and Sanz, A. 1989. Egg production of the Bay of Biscay anchovy in 1987 and 1988, and spawning stock size estimates. ICES, C.M.1989/H:25.

Uriarte, A. and Astudillo, A. 1987. The anchovy in the Bay of Biscay: new data and analysis of the fishery 1974-1987. ICES, C.M.1987/H:20.

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

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

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

Table 2.3 SARDINE. Monthly catches (t) by gear by Spanish and Portuguese fleets in 1989.

Country	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Portugal	91,091	8,218	2,700	4,710	3,613	6,266	9,030	9,251	12,087	13,297	11,536	8,925	1,458
P. seiner	85,342	7,605	2,493	4,488	3,490	6,017	8,664	8,695	11,236	12,339	10,722	8,349	1,243
Artisanal	5,284	572	105	157	98	237	355	540	835	947	786	527	126
Trawl	465	40	103	65	24	13	12	17	16	10	27	49	89
Spain													
P.seiner	46,035	3,089	2,726	3,447	2,072	2,930	5,242	4,473	5,762	5,193	5,819	2,494	2,589

Table 2.4 SARDINE. Catches (t) from Portuguese and Spanish fleets in the 1st quarter[1] during 1981-1990.

Year Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Portugal (Div. IXa)	17,038	17,547	13,953	14,740	16,595	14,908	11,181	13,884	15,628	13,773
P.Seiner	14,689	14,946	11,545	13,191	14,966	14,139	10,218	13,261	14,586	12,761
Artisanal	1,362	2,286	646	882	668	369	437	486	834	690
Trawl	987	315	1,762	667	961	400	526	137	208	322
Spain (Divs.VIIIc,IXa)										
P.seiner	13,462	16,376	13,426	19,686	15,568	16,078	14,532	15,348	9,262	9,630
Total	30,500	33,923	27,379	34,426	32,613	30,986	25,713	29,232	24,890	23,403
% total catch	14	16	15	17	16	17	15	18	18	-

[1] In the north of Portugal, during two months in the 1st quarter the fisherman close the fishery voluntarily.

Table 2.5 SARDINE. French landings (tonnes) by division and total during 1981-1989.

Year	Total	Division							
		VIId	VIIe	VIIf	VIIg	VIIh	VIIIa	VIIIb	VIIIc
1981	10,800	172	952	0	0	0	8,482	1,194	0
1982	6,835	59	828	20	0	0	5,928	0	0
1983	7,269	211	590	0	0	2	6,013	454	0
1984	5,300	147	661	0	1	0	4,472	19	0
1985	10,258	465	1,624	0	0	0	8,090	79	0
1986	12,799	512	2,058	0	0	0	10,186	43	0
1987	8,673	67	682	0	0	216	7,631	77	0
1988	10,394	29	438	0	0	2,119	7,770	38	0
1989[1]	9,199	88	66	0	0	957	7,997	85	6

[1] Preliminary.

Table 2.6 Number of Portuguese purse seiners and Portuguese catch per purse seiner and number of Spanish fishing days and catch per fishing days in 1980-1989.

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Portugal (Division IXa)										
No. of purse s.	211	193	184	196	192	192	198	196	180	161
Tonnes/purse s.	427	557	521	399	441	582	496	460	520	566
Spain[1] (Divs. VIIIc, IXa)										
No. of fishing days	11,585	12,164	7,064	7,866	8,369	5,731	3,541	4,729	3,601	3,059
Tonnes/Fishing day	4.33	5.15	5.30	4.02	4.65	4.86	4.22	4.08	5.06	4.04

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

Table 2.7 Sardine in Divisions VIIIc and IXa. Abundance estimates from acoustic surveys 1986-1990.

Age	1986				1987			1988			1990
	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
	Mar[1]	Mar	Aug	Dec	Mar[1]	Aug	Nov	Apr[1]	Mar	Aug	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
2	21	4,124	2,504	1,503	257	1,482	1,355	63	2,684	987	56
3	1,040	1,496	615	610	27	1,230	932	72	1,617	801	274
4	215	467	41	309	2,390	802	643	64	1,447	426	55
5	409	486	3	123	586	249	245	858	804	70	88
6	279	21	3	48	481	104	78	175	425	9	134
7	192	-	-	-	528	-	-	310	104	-	249
8	50	-	-	-	159	-	-	342	-	-	70
9	36	-	-	-	61	-	-	53	-	-	49
10	12	-	-	-	25	-	-	18	-	-	46
11	3	-	-	-	4	-	-	-	-	-	23
12	-	-	-	-	-	-	-	-	-	-	8
Total biom.	161	318	331	258	363	325	331	176	481	243	97

Numbers in millions.
Biomass in thousands tonnes.
[1] Revised data

Table 2.8 Sardine in Divisions VIIIc and IXa. Catch/length composition by country during 1989.

L(cm)	Portugal[1] Division IXa All gears	Spain Divisions VIIIc+IXa P. seiner	Total stock No. ($*10^6$)
5.0	0	0	0
5.5	0	2226	2226
6.0	0	9090	9090
6.5	0	6678	6678
7.0	0	6122	6122
7.5	0	2041	2041
8.0	0	5380	5380
8.5	0	1670	1670
9.0	272	1124	1396
9.5	979	576	1554
10.0	5158	4042	9200
10.5	11247	16271	27519
11.0	7493	29840	37333
11.5	7018	23942	30960
12.0	7781	28241	36022
12.5	10341	16199	26540
13.0	13644	14185	27829
13.5	14172	5496	19668
14.0	11932	4348	16280
14.5	13368	7109	20476
15.0	27972	5808	33780
15.5	29164	4532	33696
16.0	63938	3529	67467
16.5	94790	4278	99068
17.0	134300	6686	140985
17.5	141799	27160	168959
18.0	164482	23668	188151
18.5	203893	60797	264690
19.0	213720	55569	269289
19.5	200141	62497	262638
20.0	175031	56626	231657
20.5	98554	44749	143303
21.0	56288	47952	104240
21.5	15868	47311	63179
22.0	5368	49754	55122
22.5	837	37533	38370
23.0	501	27385	27886
23.5	16	12835	12851
24.0	64	5589	5633
24.5	0	2275	2275
25.0	0	628	628
25.5	176	108	284
26.0	0	56	56
26.5	0	4	4
27.0	3	23	26
27.5	0	0	0
28.0	0	3	3
Total	1730309	771930	2502239

[1] Includes all the Portuguese fleets (purse seiner catch 90% of the total anual).

Table 2.9 VIRTUAL POPULATION ANALYSIS

SARDINE IN FISHING AREAS VIIIC AND IXA

CATCH IN NUMBERS UNIT: millions

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	854	643	842	1021	60	1061	109	258	238	1401	439	244
1	2145	1479	1997	1920	769	553	3289	527	702	512	979	512
2	913	935	1542	1720	1854	838	470	2343	987	615	525	895
3	281	423	372	666	701	795	488	457	903	520	428	381
4	127	187	155	192	350	322	295	290	322	521	303	215
5	40	93	47	102	130	140	176	197	194	147	291	198
6+	16	36	30	76	129	139	116	101	166	170	189	183
TOTAL	4376	3796	4985	5697	3993	3848	4943	4173	3512	3886	3154	2628

Table 2.10 SUM OF PRODUCTS CHECK

SARDINE IN FISHING AREAS VIIIC AND IXA
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH UNIT: kilogram

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017	.013
1	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034	.035
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	.059
4	.068	.068	.068	.068	.068	.068	.068	.068	.068	.068	.068	.066
5	.072	.072	.072	.072	.072	.072	.072	.072	.072	.072	.072	.071
6+	.079	.079	.079	.079	.079	.079	.079	.079	.079	.079	.079	.089

Table 2.11 Sardine - VPA tuning data.

```
SARDINE IN DIVISIONS VIIIC AND IXA
102
PORTUGUESE FLEET
81,89
1,1
0,5
557,579,1495,991,376,81,40
521,17,506,1317,305,88,18
399,399,513,590,478,135,46
441,108,716,298,242,104,41
582,222,482,1404,302,101,39
496,166,502,764,444,193,54
460,418,460,501,431,226,76
520,394,705,446,294,208,66
566,53,476,699,310,165,139
SPANISH FLEET
80,89
1,1
0,5
4.33,345,400,450,164,81,28
5.15,447,350,595,197,94,48
5.3,44,277,535,408,278,115
4.02,662,40,248,317,187,94
4.65,.449,1572,172,249,191,136
4.86,85,156,1432,252,250,201
4.22,53,144,143,385,103,124
4.08,983,52,114,89,294,71
5.06,59,330,92,162,114,245
4.04,191,36,196,71,51,59
```

Table 2.12 Sardine - tuning analysis.

```
Module run at 18.46.07  24 JUNE 1990
DISAGGREGATED Qs
LOG TRANSFORMATION
NO explanatory variate (Mean used)
Fleet  1 ,PORTUGUESE FLEET    , has terminal q estimated as the mean
Fleet. 2 ,SPANISH FLEET       , has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
     , 1.000, 1.000, 1.000, 1.000, 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,    81,    82,    83,    84,    85,    86,    87,    88,    89,

    0,  .074,  .006,  .040,  .009,  .031,  .032,  .114,  .061,  .061,
    1,  .168,  .090,  .080,  .207,  .064,  .137,  .110,  .135,  .116,
    2,  .256,  .303,  .165,  .112,  .280,  .203,  .213,  .195,  .219,
    3,  .255,  .196,  .258,  .170,  .188,  .206,  .195,  .282,  .264,
    4,  .200,  .259,  .161,  .178,  .179,  .244,  .219,  .207,  .280,
    5,  .237,  .253,  .195,  .153,  .216,  .218,  .209,  .228,  .254,

Log catchability estimates

 Age  0
 Fleet,    81,    82,    83,    84,    85,    86,    87,    88,    89
_______,______,______,______,______,______,______,______,______,______
    1 , -9.50,-12.70,-10.19,-10.86, -9.98,-10.01, -9.51, -9.16,-10.66
    2 , -5.07, -7.16, -5.09,-11.79, -6.16, -6.39, -3.93, -6.43, -4.43
```

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-10.28	1.116	.0193	.0890	.000E+00	.000E+00	-10.285	.353
2	-6.27	2.443	.0076	.0098	.000E+00	.000E+00	-6.271	.773

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.061	1.01	.835	1.01	.677

cont'd.

Table 2.12 cont'd.

Age 1

Fleet	81	82	83	84	85	86	87	88	89
1	-8.36	-9.08	-8.59	-9.19	-9.20	-8.53	-8.45	-8.59	-8.57
2	-5.13	-5.10	-6.54	-3.85	-5.55	-5.01	-5.90	-4.71	-6.21

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-8.73	.350	.0917	.0986	.000E+00	.000E+00	-8.728	.111
2	-5.33	.865	.0195	.2775	.000E+00	.000E+00	-5.333	.273

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.114	.325	.360	.360	1.230

Age 2

Fleet	81	82	83	84	85	86	87	88	89
1	-8.24	-7.79	-8.14	-8.74	-8.15	-8.06	-7.88	-8.05	-8.11
2	-4.06	-4.10	-4.41	-4.73	-3.35	-4.96	-4.64	-5.00	-4.44

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-8.13	.281	.1670	.2139	.000E+00	.000E+00	-8.128	.089
2	-4.41	.547	.0491	.2242	.000E+00	.000E+00	-4.410	.173

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.216	.250	.191E-01	.250	.006

Age 3

Fleet	81	82	83	84	85	86	87	88	89
1	-8.26	-8.72	-7.85	-8.56	-8.45	-8.50	-7.95	-7.90	-7.88
2	-4.22	-3.84	-3.67	-3.98	-3.85	-3.87	-4.80	-3.86	-4.41

cont'd.

Table 2.12 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-8.23	.359	.1509	.1854	.000E+00	.000E+00	-8.230	.113
2	-4.06	.378	.0700	.3754	.000E+00	.000E+00	-4.056	.120

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.259	.260	.352	.352	1.831

Age 4

Fleet	81	82	83	84	85	86	87	88	89
1	-8.79	-8.99	-8.69	-8.86	-9.14	-8.13	-8.49	-8.20	-7.88
2	-3.96	-3.25	-3.76	-3.70	-3.45	-3.99	-3.50	-4.17	-4.11

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-8.57	.451	.1070	.1394	.000E+00	.000E+00	-8.573	.142
2	-3.77	.337	.0936	.3944	.000E+00	.000E+00	-3.765	.106

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.272	.270	.499	.499	3.417

Table 2.13 Separable exploitation pattern and log catch residuals. Sardine in Divisions VIIIc and IXa.
from 78 to 89 on ages 0 to 5
with Terminal F of .219 on age 2 and Terminal S of 1.000

Initial sum of squared residuals was 34.485 and
final sum of squared residuals is 8.902 after 129 iterations

Matrix of Residuals

Years / Ages	78/79
0/ 1	.300
1/ 2	.770
2/ 3	.135
3/ 4	-.227
4/ 5	-.277
	.000
WTS	1.000

Years / Ages	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
0/ 1	-.628	-.036	1.014	-1.482	-.466	-.588	-.006	.019	1.191	.681	.000	.162
1/ 2	-.438	.056	-.112	-.217	-.033	.467	-.504	.038	-.071	.044	.000	.348
2/ 3	-.053	.184	.191	.159	-.208	-.391	.524	-.014	-.243	-.284	.000	.471
3/ 4	.029	.005	-.065	.089	.240	.100	-.080	-.106	-.066	.082	.000	1.000
4/ 5	.453	-.191	-.271	.274	-.100	.030	.018	.175	.023	-.134	.000	.553
	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
WTS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	78	79
F-values	.2800	.2988

	80	81	82	83	84	85	86	87	88	89
F-values	.2217	.2164	.1984	.1823	.1542	.1809	.2164	.2101	.2140	.2190

Selection-at-age (S)

	0	1	2	3	4	5
S-values	.1663	.6054	1.0000	.9871	.9701	1.0000

Table 2.14 Total biomass (B) from acoustic surveys, catches (Y) by countries and the ratio Y/B as an index of F for SARDINE in Divisions VIIIc and IXa ('000 tonnes). (TS = 20 log L - 72.6 dB.).

Parameter	Country	1986	1987			1988
		Mar	Mar	Aug	Nov	Mar/Apr
B	Portugal	318	-	325	331	481
	Spain	161[1]	363[1]	-	-	176[1]
	Total	479	688			657
Y	Portugal	103		90		94
	Spain	77		79		65
	Total	180		169		159
Index of av. F	Portugal	0.32	-	0.28	0.27	0.20
	Spain	0.48	0.25	-	-	0.37
	Total	0.38		0.26		0.29

[1] Revised data.

Table 2.15 VIRTUAL POPULATION ANALYSIS

SARDINE IN FISHING AREAS VIIIC AND IXA

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .40

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.050	.032	.039	.072	.006	.037	.009	.028	.031	.096	.055	.036
1	.304	.140	.163	.144	.088	.084	.190	.066	.120	.106	.111	.103
2	.303	.263	.265	.257	.252	.162	.118	.251	.211	.181	.186	.173
3	.265	.281	.197	.218	.197	.203	.165	.199	.180	.204	.231	.250
4	.235	.357	.196	.184	.212	.162	.133	.173	.263	.186	.219	.217
5	.279	.341	.176	.238	.227	.152	.155	.153	.209	.229	.186	.273
6+	.279	.341	.176	.238	.227	.152	.155	.153	.209	.229	.186	.273
(2- 5)U	.270	.310	.209	.224	.222	.170	.143	.194	.216	.200	.206	.228

Table 2.16 VIRTUAL POPULATION ANALYSIS

SARDINE IN FISHING AREAS VIIIC AND IXA

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: .250
PROPORTION OF ANNUAL M BEFORE SPAWNING: .250

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	21409	24664	26784	17709	12466	35468	14990	11530	9506	18547	9943	8272
1	9837	13657	16010	17270	11042	8307	22913	9959	7519	6179	11296	6308
2	4193	4867	7957	9117	10022	6778	5120	12701	6248	4471	3727	6779
3	1453	2076	2509	4091	4724	5223	3866	3051	6624	3391	2500	2074
4	730	747	1051	1381	2204	2600	2859	2197	1676	3710	1853	1330
5	198	387	351	579	770	1195	1483	1677	1238	864	2066	998
6+	79	150	224	431	765	1186	977	860	1059	999	1342	922
TOTAL NO	37898	46547	54885	50578	41994	60759	52207	41975	33871	38161	32727	26683
SPS NO	10790	14488	19004	22705	21716	19206	25124	22755	18510	14925	16186	13721
TOT.BIOM	446	579	776	971	1036	984	1091	1106	955	806	799	681
SPS BIOM	325	424	580	740	823	805	837	886	778	660	633	545

	1990	1978-89
0	0	17607
1	5347	11692
2	3814	6832
3	3820	3465
4	1083	1862
5	718	984
6+	980	750

Table 2.17 Sardine in Divisions VIIIc and IXa. Biomass ('000 t). Estimated by egg and acoustic surveys carried out in the same spawning season (March/April 1986, 1988).

	1986			1988		
	Spain (VIIIc, IXa)	Portugal (IXa)	Stock	Spain (VIIIc, IXa)	Portugal (IXa)	Stock
Acoustic survey:						
SSB	161	294	455	173	325	498
Tot. biomass	161	318	479	176	481	661
Egg survey:						
SSB	-	-	-	181 (CV = 0.50)	81 (CV = 0.63)	262[1]

[1] Assumed to be underestimated.

Table 2.18 Input data for RCRTINX2 analysis.

```
SARDINE DIV VIIIC IXA : RECRUITS AGE 0
6,12,2       (no. surveys, no. of years, no. of vpa column)
1978, 21409,  -11,  -11,  -11,  -11, 133, 721
1979, 24664,  -11,  -11,  -11,  -11, 456, 187
1980, 26784,  -11,  -11,  -11,  -11, 497, 345
1981, 17709,  -11,  -11,  -11,  -11, 601, 420
1982, 12466,  -11,  -11,  -11,  -11,  17,  43
1983, 35468,  -11,  -11,  -11,  -11, 399, 662
1984, 14990,  -11,  -11,  -11, 2971, 108,   1
1985, 11530,  292,   55, 2326, 2061, 186,  72
1986,  9506, 3949,  632,  -11, 3545, 181,  57
1987, 18547, 4185,  221, 7743, 3690, 418, 983
1988,  9943, 3139,  -11,  -11,  -11, 394,  45
1989,  8272,  -11,   69,  -11,  -11   53, 191
PAUGS
SMARS
PMARS
PNOVS
PSEINE
SSEINE
```

Table 2.19

Analysis by RCRTINX2 of data from file recruit90
SARDINE DIV VIIIC IXA : RECRUITS AGE 0

Data for 6 surveys over 12 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 4 POINTS USED FOR REGRESSION

Yearclass = 1987

Survey/ Series	Index Value	Slope	Inter-cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
PAUGS	8.3395	.000	.000	.0000	0	.0000	.00000	.00000	.00000
SMARS	5.4027	.000	.000	.0000	0	.0000	.00000	.00000	.00000
PMARS	8.9547	.000	.000	.0000	0	.0000	.00000	.00000	.00000
PNOVS	8.2137	.000	.000	.0000	0	.0000	.00000	.00000	.00000
PSEINE	6.0379	1.090	4.098	.1927	9	10.6823	1.21397	1.47253	.09533
SSEINE	6.8916	.516	7.566	.2051	9	11.1247	1.16748	1.54500	.08659
MEAN						9.6000	.50266	.50266	.81808

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter-cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
PAUGS	8.0520	.000	.000	.0000	0	.0000	.00000	.00000	.00000
SMARS									
PMARS									
PNOVS									
PSEINE	5.9789	1.096	3.813	.2267	10	10.3679	.98379	1.16542	.11507
SSEINE	3.8286	.419	7.741	.2098	10	9.3440	1.03367	1.15064	.11805
MEAN						9.6024	.45145	.45145	.76688

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
PMARS									
PNOVS									
PSEINE	3.9890	2.348	-3.481	.0730	11	5.8874	1.68254	2.85355	.01660
SSEINE	5.2575	.407	7.687	.2267	11	9.8279	.87225	.98224	.14007
MEAN						9.4796	.40030	.40030	.84334

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1987	9.84	18680.25	.45	.36	9.8318548.00	.79
1988	9.66	15677.18	.40	.19	9.20 9944.01	.48
1989	9.47	12948.77	.37	.34	9.02 8273.00	.92

Table 2.20

List of input variables for the ICES prediction program.

SARDINE IN FISHING AREAS VIIIC AND IXA
The reference F is the mean F for the age group range from 2 to 5

The number of recruits per year is as follows:

Year	Recruitment
1990	12949.0
1991	12949.0
1992	12949.0

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	12949.0	.04	.40	.00	.013	.000
1	8373.0	.14	.40	.65	.035	.015
2	3814.0	.23	.40	.95	.052	.038
3	3820.0	.23	.40	1.00	.059	.050
4	1083.0	.23	.40	1.00	.066	.064
5	718.0	.23	.40	1.00	.071	.067
6+	980.0	.23	.40	1.00	.089	.079

Table 2.21

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

SARDINE IN FISHING AREAS VIIIC AND IXA

Year 1990					Year 1991				Year 1992	
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	.23	656	519	146	-	.00	652	542	0	763	640
					F_{med}	.21		516	132	655	518
					F_{89}	.23		514	145	644	506
					$F_{0.1}$	.51		481	287	529	385

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 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 2 to 5

Table 2.22 Effects of the F status quo level on catch, stock biomass and spawning stock biomass during 1990-1992. Sardine in Divisions VIIIc and IXa.

****
* Year 1990. F-factor 1.000 and reference F .2280 *
****

						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	.0380	398.45	5.060	12949.0	.000	.0	.000	.0	.000
1	.1400	905.76	32.064	8373.0	125.595	5442.5	81.637	4755.2	71.327
2	.2280	645.74	33.837	3814.0	144.932	3623.3	137.685	3096.8	117.680
3	.2280	646.76	38.159	3820.0	191.000	3820.0	191.000	3265.0	163.248
4	.2280	183.36	12.102	1083.0	69.312	1083.0	69.312	925.6	59.241
5	.2280	121.56	8.595	718.0	48.106	718.0	48.106	613.7	41.116
6+	.2280	165.92	14.850	980.0	77.420	980.0	77.420	837.6	66.171
Total		3067.56	144.667	31737.0	656.365	15666.7	605.160	13493.9	518.785

cont'd.

Table 2.22 cont'd.

****
* Year 1991. F-factor 1.000 and reference F .2280 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
0	.0380	398.45	5.060	12949.0	.000	.0	.000	.0	.000
1	.1400	903.96	32.000	8356.3	125.345	5431.6	81.474	4745.7	71.185
2	.2280	826.12	43.289	4879.4	185.415	4635.4	176.145	3961.9	150.552
3	.2280	344.61	20.332	2035.4	101.769	2035.4	101.769	1739.6	86.982
4	.2280	345.15	22.780	2038.6	130.469	2038.6	130.469	1742.4	111.512
5	.2280	97.85	6.918	578.0	38.723	578.0	38.723	494.0	33.096
6+	.2280	153.42	13.731	906.2	71.586	906.2	71.586	774.5	61.185
Total		3069.55	144.110	31742.7	653.306	15625.0	600.165	13458.1	514.512

****
* Year 1992. F-factor 1.000 and reference F .2280 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
0	.0380	398.45	5.060	12949.0	.000	.0	.000	.0	.000
1	.1400	903.96	32.000	8356.3	125.345	5431.6	81.474	4745.7	71.185
2	.2280	824.47	43.202	4869.6	185.046	4626.2	175.794	3954.0	150.252
3	.2280	440.86	26.011	2603.9	130.195	2603.9	130.195	2225.6	111.278
4	.2280	183.90	12.138	1086.2	69.516	1086.2	69.516	928.4	59.416
5	.2280	184.19	13.022	1087.9	72.889	1087.9	72.889	929.8	62.299
6+	.2280	134.09	12.001	792.0	62.568	792.0	62.568	676.9	53.477
Total		3069.93	143.435	31745.0	645.560	15627.8	592.437	13460.4	507.907

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

Sub-area	1978	1979	1980	1981	1982	1983
II	50	2	-	-	-	412
IV	4,920	1,412	2,151	7,245	2,788	4,420
VI	408	7,791	8,724	11,134	5,036	24,881
VII	26,060	43,525	45,697	34,749	33,478	40,526
VIII	84,823	47,155	37,495	40,073	22,683	28,223
IX	45,371	37,619	36,903	35,873	39,726	48,733
Total	161,632	137,504	130,970	129,074	103,711	147,195
Sub-area	1984	1985	1986	1987	1988	1989[1]
II	23	79	214	3,331	6,818	4,809
IV	25,987	24,238	20,746	20,895	62,892	112,047
VI	31,716	32,995	20,455	35,157	45,842	33,054
VII	42,952	39,034	77,628	100,734	90.253	137,712
VIII	25,629	27,740	36,061	37,703	34,177	45,918
IX	23,178	20,237	31,159	34,243	37,888	38,259
Total	149,485	144,323	186,263	232,063	277,870	371,799

[1] Preliminary.

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

Country	1978	1979	1980	1981	1982	1983
Denmark	-	-	-	-	-	-
France	-	+	-	-	-	-
Germany, Fed. Rep.	2	2	-	+	-	-
Norway	48	-	-	-	-	412
USSR	-	-	-	-	-	-
Total	50	2	-	+	-	412
Country	1984	1985	1986	1987	1988	1989[1]
Denmark	-	-	-[2]	39[2]	-[2]	-
France	1	1	-[2]	-[2]	-[2]	-
Germany, Fed. Rep.	-	-	-	-	64	12
Norway	22	78	214	3,272	6,285	4,770
USSR	-	-	-	-	469	27
Total	23	79	214	3,311	6,818	4,809

[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	1978	1979	1980	1981	1982	1983
Belgium	15	9	8	34	7	55
Denmark	1,543	496	199	3,576	1,612	1,590
Faroe Islands	3	-	260	-	-	-
France	182	221	292	421	567	366
Germany, Fed. Rep.	1,993	376	+	139	30	52
Ireland	-	-	1,161	412	-	-
Netherlands	106	88	101	355	559	2,029[4]
Norway	1,037	199	119	2,292	7	322
Poland	-	-	-	-	-	2
Sweden	-	+	-	-	-	-
UK (Engl. & Wales)	36	23	11	15	6	4
UK (Scotland)	5	+	-	-	-	-
USSR	-	-	-	-	-	-
Total	4,920	1,412	2,151	7,245	2,788	4,420

Country	1984	1985	1986	1987	1988	1989[1]
Belgium	20	13	13	9	10	10
Denmark	23,730	22,495	18,652[2]	7,290[2]	20,323[2]	23,329[2]
Faroe Islands	-	-	-	-	-	-
France	827	298	231[3]	189[3]	784[3]	248
Germany, Fed. Rep.	+	+	-	3	153	506
Ireland	-	-	-	-	-	-
Netherlands	824[4]	160[4]	600[4]	850[4]	1,060[4]	14,172
Norway[2]	94	203	776	11,728[5]	34,425[5]	84,161
Poland	-	-	-	-	-	-
Sweden	-	-	2[2]	-	-	-
UK (Engl. & Wales)	3	71	3	339	373	10
UK (Scotland)	489	998	531	487	5,749	2,093
USSR	-	-	-	-	-	-
Unallocated+discards	-	-	-	-	-	-12,482[5]
Total	25,987	24,238	20,746	20,895	62,892	112,047

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

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

Country	1978	1979	1980	1981	1982	1983
Denmark	-	443	734	341	2,785	7
Faroe Islands	-	-	-	-	1,248	-
France	91	151	45	454	4	10
Ireland	59	-	-	-	-	15,086
Germany, Fed. Rep.	-	155	5,550	10,212	2,113	4,146
Netherlands	114	6,910	2,385[2]	100[2]	50	5,500[2]
Norway	-	-	-	5	-	94
Spain	91	20	-	-	-	-
UK (Engl. & Wales)	44	73	9	5	+	-
UK (Scotland)	9	39	1	17	83	38
USSR	-	-	-	-	-	-
Total	408	7,791	8,724	11,134	6,283	24,881

Country	1984	1985	1986	1987	1988	1989[1]
Denmark	-	-	-	769	1,655	973
Faroe Islands	-	4,014	1,992[2]	4,450[4]	4,000[4]	3,059
France	14	13	12	20	10	2
Ireland	13,858	27,102	28,125	29,743	27,872	17,677
Germany, Fed. Rep.	130	191	354	174	615	1,162
Netherlands	17,500[2]	18,450[2]	3,450[2]	5,750[2]	3,340[2]	1,907
Norway	-	-	83[3]	75[3]	41[3]	-[3]
Spain	-	-	-	-	-	-
UK (Engl. & Wales)	+	996	198	404	475	44
UK (Scotland)	214	1,427	138	1,027	7,834	1,737
USSR	-	-	-	-	-	-
Unallocated+discards	-	-19,168	-13,897	-7,255	-	6,493
Total	31,716	33,025	20,455	35,157	45,842	33,054

[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	1978	1979	1980	1981	1982	1983
Belgium	1	3	-	1	1	-
Denmark	2,104	4,287	5,045	3,099	877	993
France	3,564	4,407	1,983	2,800	2,314	1,834
German Dem. Rep.	-	-	-	-	-	-
Germany, Fed. Rep.	2,923	5,333	2,289	1,079	12	1,977
Ireland	3,388	-	-	16	-	-
Netherlands	10,556	25,174	23,002	25,000[2]	27,500[2]	34,350[2]
Norway	29	959	394	-	-	-
Poland	61	-	-	-	-	-
Spain	516	676	50	234	104	142
UK (Engl.& Wales)	2,918	2,686	12,933	2,520	2,670	1,230
UK (Scotland)	-	-	1	-	-	-
USSR	-	-	-	-	-	-
Total	28,855	26,060	43,525	45,697	34,749	33,478

Country	1984	1985	1986	1987	1988	1989[1]
Belgium	-	+	+	2	-	-
Denmark	732	1,477[3]	30,408[3]	27,368	33,202	37,474
France	2,387	1,881	3,801	2,197	1,523	4,576
German Dem. Rep.	-	-	-	-	-	-
Germany, Fed. Rep.	228	-	5	374	4,705	7,743
Ireland	65	100	703	15	481	11,467
Netherlands	38,700[2]	33,550[2]	40,750[2]	69,400[2]	43,560[2]	43,582
Norway	-	-	-	-	-	-
Poland	-	-	-	-	-	-
Spain	560	275	137[3]	148[3]	150	14
UK (Engl.& Wales)	279	1,630	1,824	1,228	3,759	4,488
UK (Scotland)	1	1	+	2	2,873	+
USSR	-	120	-	-	-	-
Unallocated+discards	-	-	-	-	-	28,368
Total	42,952	39,034	77,628	100,734	90,253	137,712

[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	1978	1979	1980	1981	1982	1983
Denmark	-	127	-	-	-	-
France	4,662	4,240	3,361	3,711	3,073	2,643
German Dem. Rep	-	-	-	-	-	-
Netherlands	19	-	-	-	-	-
Spain	80,139	42,766	34,134	36,362	19,610	25,580
UK (Engl.& Wales)	-	22	-	+	1	-
USSR	3	-	-	-	-	-
Total	84,823	47,155	37,495	40,073	22,683	28,223

Country	1984	1985	1986	1987	1988	1989[1]
Denmark	-	-	446	3,283	2,793	6,729
France	2,489	4,305	3,534	3,983	4,502	4,719
German Dem. Rep	-[2]	-[2]	-[2]	-[2]	-	-
Netherlands	-	-	-	-	-	-
Spain	23,119[3]	23,292[3]	31,033	30,098	26,629	34,402
UK (Engl.& Wales)	1	143	392	339	253	68
USSR	20	-	656	-	-	-
Unallocated+discards	-	-	-	-	-	-
Total	25,629	27,740	36,061	37,703	34,177	45,918

[1] Preliminary.
[2] Included in Sub-area VII.
[3] Data provided by the Working Group members.

Table 3.8 Quarterly catches of horse mackerel ('000 t) by division and sub-areas in 1989 (Data submitted by Working Group members).

Division	Quarter				Total
	1	2	3	4	
IIa	-	-	5	+	5
IIIa	-	+	+	1	1
IVa	-	-	7	59	66
IVb,c	-	+	20	21	41
VIa	+	1	21	5	27
VIIa-c,e-k	40	29	24	23	116
VIId	2	-	1	3	6
VIIIa-b,d,e	1	1	1	1	4
VIIIc	8	8	7	9	32
IXa	7	11	12	7	37
SUM	58	50	98	129	335
Not given by quarter	-	-	-	-	37
TOTAL					372

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		20,290	3,120	25,671	6,818	40,174	45,842	81,978	7,548	3,740	186,100	26,629	37,888	62,904
1989	913		42,860	6,522	50,295	4,809	68,274	33,054	130,040	11,516	1,150	248,843	34,402	38,259	72,661

Table 3.10 Annual length distributions (millions) of horse mackerel catches by fleet by country in 1989.

Length	Denmark	Ireland	Netherlands	Norway	Spain				Portugal		
(cm)	Pel.tr.	trawl	Pel. tr.	P.seine	Trawl	P.Seine	Hook l	Gillnet	Trawl	P.seine	Artisanal
5	-	-	-	-	-	-	-	-	-	-	3.52
6	-	-	-	-	-	0.01	-	-	-	-	3.19
7	-	-	-	-	-	0.03	-	-	-	-	2.69
8	-	-	-	-	-	2.66	-	-	-	-	-
9	-	-	-	-	0.07	25.74	-	-	-	-	-
10	-	-	-	-	0.30	83.47	-	-	0.64	-	-
11	-	-	-	-	0.56	73.72	-	-	0.64	-	-
12	-	-	-	-	0.80	68.91	-	-	1.98	-	0.02
13	-	-	-	-	2.22	60.05	-	-	3.76	0.18	0.03
14	-	-	-	-	4.81	31.86	-	-	6.75	0.34	0.15
15	0.55	-	-	-	6.64	26.86	-	-	9.00	0.82	0.25
16	-	-	-	-	8.17	30.43	-	-	12.95	1.43	0.29
17	-	-	-	-	8.86	21.58	-	-	12.16	1.95	0.50
18	-	-	-	-	5.36	21.13	-	-	11.40	3.89	1.34
19	1.64	-	-	-	3.06	23.87	-	-	12.83	7.51	1.99
20	10.37	-	-	-	3.52	20.33	-	-	12.57	8.86	2.18
21	28.39	-	-	-	2.58	15.42	-	-	6.78	7.96	1.23
22	61.68	0.02	1.93	-	2.89	17.15	-	-	4.04	6.60	1.09
23	104.26	0.88	10.23	-	4.44	16.90	-	-	2.58	8.13	2.20
24	94.98	8.71	51.34	-	6.35	14.73	-	-	3.07	8.84	1.51
25	69.87	29.54	90.26	0.34	7.23	15.11	-	-	3.53	8.98	0.94
26	30.57	43.02	92.92	1.81	9.24	13.59	0.06	-	3.92	6.21	0.82
27	15.83	40.00	77.76	8.02	9.80	10.21	0.08	-	4.46	4.34	0.74
28	8.19	22.02	61.25	28.19	10.02	6.03	0.06	-	4.00	2.55	0.89
29	4.37	8.23	45.85	55.45	8.75	4.77	0.08	-	3.04	0.61	1.16
30	2.18	2.92	25.61	69.55	6.95	2.74	0.09	-	2.41	0.23	1.18
31	1.09	1.49	13.76	65.51	5.02	1.84	0.11	0.01	1.84	0.18	0.84
32	0.55	1.02	12.97	43.24	3.02	1.57	0.15	0.02	1.23	0.05	0.63
33	2.73	0.51	5.71	21.89	2.57	1.32	0.17	0.02	1.26	0.18	0.45
34	1.64	0.39	2.91	9.90	2.04	1.12	0.22	0.03	1.14	0.33	0.35
35	1.09	0.13	2.55	8.90	1.72	1.03	0.21	0.01	1.50	0.40	0.30
36	-	0.16	1.15	3.36	1.42	0.51	0.16	0.02	0.92	0.51	0.33
37	-	0.24	1.79	7.45	0.87	0.31	0.09	0.01	0.78	0.31	0.32
38	-	0.03	0.93	0.82	0.67	0.31	0.06	0.02	0.36	0.11	0.26
39	-	0.01	0.55	-	0.35	0.07	0.03	-	0.18	0.03	0.15
40	-	-	0.06	-	0.16	0.02	0.02	0.01	0.08	0.03	0.07
41	-	-	-	-	0.07	0.01	-	-	0.03	-	0.04
42	-	-	-	-	-	0.05	-	-	0.01	-	0.01
43	-	-	-	-	0.01	0.01	0.01	-	0.02	0.03	-
44	-	-	-	-	-	-	-	-	-	-	-
45+	-	-	-	-	-	-	0.02	-	-	-	-
Total	439.98	159.32	499.52	324.43	130.54	615.88	1.70	0.19	131.82	81.57	31.67

Table 3.11 Quarterly sampling data on horse mackerel from commercial catches and surveys in 1989, provided by different countries to the ICES Pelagic Fish Committee and and total catches (in tonnes) estimated by the Working Group for this year.
+ = sampling data from commercial catches.
(+) = sampling data from surveys.

Div./Quarter		Denm.	France	Germany F.R.	Irel.[1]	Netherl.	Norway	Portugal	Spain	UK	Total catch
IIa	1										
	2										
	3						+				4,809
	4										
IVa	1										
	2										
	3					+	+			(+)	
	4					+	+				
IVb	1			(+)							
	2			(+)							
	3			(+)		+				(+)	112,047
	4					+ (+)	+				
IVc	1										
	2										
	3					+					
	4					+ (+)					
VI	1			(+)							
	2			(+)							
	3				+	+					33,054
	4					+					
VIIa, d-h	1	+								(+)	
	2		+	(+)							
	3									(+)	
	4		(+)			(+)					137,712
VIIb,c, j,k	1					+					
	2			(+)	+	+ (+)			(+)	(+)	
	3				+	+ (+)			(+)		
	4					+ (+)			(+)		
VIII a,b,d,e	1	+							+	(+)	
	2			(+)		(+)			+		
	3					(+)			+		14,443
	4		(+)						+		
VIIIc	1								+		
	2								+		31,475
	3								+		
	4								+ (+)		
IXa	1							+	+		
	2							+	+		
	3							+ (+)	+ (+)		38.259
	4							+ (+)	+		

Table 4.1 Age composition (%) in commercial and research vessel catches of North Sea horse mackerel taken by the Netherlands in 1987-1989.

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

Table 5.1 Summary of the Western horse mackerel stock total egg production and spawning stock size estimate in 1989.

Area	Total egg production x 10^{15}	Spawning stock biomass x 10^6 t of late pre-spawning fish (using fecundity of 1,655 eggs per g female)	Spawning stock biomass x 10^6 at spawning time
Standard area 56^0N-$44^0$30'N	1.507[1]	1.821	1.912
North of standard area North 56^0N	0	0	0
Western Channel East of $7^0$30'W	0.121[2]	0.146	0.153
South of standard area south $44^0$30'N	0.055	0.066	0.069
Total	1.683	2.033	2.134

[1] No estimate available for the first period.
[2] 1988 egg production figures.

Table 5.2 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 (C.M.1990/H:2).
[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, C.M.1990/H:2, standard area + area east and south of standard area.

Table 5.3 Mean weight at age in the catch (g) of Western horse mackerel and between brackets the number of weight measurements.

	1982	1983	1984	1985	1986	1987	1988	1989
1	54 (5)	39 (19)	34	29 (1)	29 (0)	68 (2)	31 (94)	50 (0)
2	90 (28)	113 (6)	73(148)	45 (3)	45 (0)	67 (10)	75 (21)	75 (0)
3	142(150)	124 (69)	89 (5)	87(724)	110 (5)	110 (0)	113 (6)	149 (10)
4	178 (13)	168 (87)	130 (46)	150 (8)	107(658)	155 (3)	132 (5)	144 (12)
5	227 (26)	229 (28)	176(282)	156 (78)	171 (16)	143(749)	130 (23)	142 (4)
6	273 (30)	247 (74)	216 (46)	199(198)	196 (95)	174 (9)	147(904)	164 (5)
7	276 (23)	282 (96)	245 (83)	243 (26)	223(161)	198 (40)	193 (19)	154 (1143)
8	292 (4)	281 (35)	278 (71)	256 (44)	251 (21)	249(124)	228 (30)	168 (4)
9	305 (1)	254 (5)	262 (30)	294 (15)	296 (33)	264 (15)	270 (74)	221 (28)
10	369 (4)	260 (11)	259 (9)	257 (19)	280 (22)	321 (17)	313 (10)	233 (47)
11	348 (19)	300 (6)	255 (0)	241 (2)	319 (11)	336 (30)	306 (14)	282 (13)
12	348 (57)	310 (30)	344 (2)	251 (5)	287 (4)	244 (10)	357 (26)	324 (9)
13	348 (97)	315 (47)	232 (5)	314 (11)	345 (4)	328 (3)	300 (12)	312 (17)
14	356 (67)	311 (70)	306 (19)	346 (5)	260 (3)	245 (5)	355 (8)	333 (8)
15+	366 (26)	332 (92)	308(129)	321 (86)	360 (67)	373 (58)	384 (51)	383 (25)

Table 5.4 Mean weight at age in the stock (g) of Western horse mackerel and between brackets the number of weight measurements.

	1982	1983	1984	1985	1986	1987	1988	1989
1	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2	50 (0)	50 (0)	50 (0)	50 (0)	50 (0)	50 (0)	50 (0)	50 (0)
3	80 (0)	80 (0)	77 (2)	81(164)	80 (0)	80 (0)	80 (0)	80 (0)
4	207 (3)	171 (1)	122 (21)	148 (5)	105(100)	105 (0)	105 (0)	105 (0)
5	232 (22)	227 (6)	155(162)	140 (40)	134 (2)	126(199)	126 (0)	103 (1)
6	269 (25)	257 (21)	201 (31)	193(118)	169 (23)	150 (2)	141(358)	131 (2)
7	280 (18)	276 (36)	223 (37)	236 (17)	195 (44)	171 (13)	143 (2)	159(380)
8	292 (4)	270 (9)	253 (34)	242 (23)	242 (15)	218 (40)	217 (13)	127 (1)
9	305 (1)	243 (2)	246 (8)	289 (6)	292 (9)	254 (9)	274 (25)	210 (13)
10	369 (4)	390 (1)	338 (2)	247 (11)	262 (7)	281 (5)	305 (4)	252 (25)
11	344 (15)	305 (1)	300 (0)	300 (0)	300 (0)	291 (11)	337 (4)	263 (8)
12	348 (41)	309 (15)	300 (0)	300 (0)	300 (0)	297 (0)	352 (14)	302 (5)
13	348 (61)	311 (20)	300 (2)	325 (4)	300 (0)	303 (1)	361 (2)	411 (12)
14	361 (38)	312 (33)	305 (11)	325 (4)	300 (0)	303 (0)	352 (4)	383 (5)
15+	364 (18)	310 (30)	285 (65)	303 (58)	346 (23)	339 (7)	390 (24)	358 (23)

Table 5.5 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
	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$	$\bar{L}$
0	-[1]	-	-	-	-	-	12.2	-
1	18.5	16.9[1]	-	16.5	-	20.0	16.4	-
2	22.3	24.0	20.8[1]	17.8	-	20.4	21.1	-
3	25.6	25.1	23.1	22.0[1]	23.5	-	23.8	25.8
4	28.2	27.4	26.0	26.4	23.7[1]	27.4	25.3	26.0
5	30.3	30.3	28.6	26.9	27.9	26.2[1]	25.3	25.8
6	32.0	31.3	30.7	29.4	29.0	27.3	26.8[1]	27.8
7	32.1	32.9	31.9	31.6	30.5	29.5	28.6	27.2[1]
8	33.0	32.9	31.9	31.6	30.5	31.6	30.5	28.5
9	34.5	32.3	31.7	33.5	33.6	32.5	32.0	30.7
10	35.5	30.8	31.3	32.4	33.0	34.4	33.7	31.0
11	35.1	32.8	-	30.9	33.7	34.9	33.0	33.5
12	34.7	34.6	33.9	31.1	33.0	30.5	34.9	34.8
13	35.1	34.7	30.9	33.8	34.8	34.2	32.4	33.6
14	35.4	34.6	35.4	35.9	31.2	31.1	34.9	34.2
15+	36.0	34.9	34.5	34.9	36.3	36.0	36.1	37.2

[1] 1982 year class.

Table 5.6

Title : HORSE MACKEREL IN FISHING AREAS IIA, IVA, VIA, VIIA-C,E-K,VIIIA-B,D-E
At 15.12.11 25 JUNE 1990
from 82 to 89 on ages 1 to 11
with Terminal F of .140 on age 7 and Terminal S of 1.000

Initial sum of squared residuals was 324.995 and
final sum of squared residuals is 271.497 after 134 iterations

Matrix of Residuals

Years / Ages	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
1/ 2	1.652	-3.186	-6.368	5.304	-3.995	-3.306	8.366	.000	.067
2/ 3	1.029	-.124	-.860	1.814	.231	-.299	-.887	.000	.366
3/ 4	3.741	1.792	1.403	1.900	.795	-3.615	-.488	.000	.157
4/ 5	1.293	-.388	.036	.125	-.048	-.389	.274	.000	.638
5/ 6	-.669	-.794	-.480	-.686	.634	.280	.253	.000	.627
6/ 7	-.389	.303	.279	.258	.240	-.544	-.234	.000	1.000
7/ 8	-.136	.012	.001	-.907	-.560	.960	.506	.000	.584
8/ 9	-.310	-.428	.640	-.665	-.166	.784	-.593	.000	.623
9/10	-1.861	-.483	-.221	-.931	.217	1.028	-.091	.000	.401
10/11	-.448	5.480	1.312	.580	-1.296	.322	-.923	.000	.159
	.000	.000	.000	.000	.000	.000	.000	6.080	
WTS	.001	.001	1.000	1.000	1.000	1.000	1.000		

Fishing Mortalities (F)

	82	83	84	85	86	87	88	89
F-values	.1018	.2434	.2317	.1294	.1210	.0789	.1702	.1400

Selection-at-age (S)

	1
S-values	.0065

	2	3	4	5	6	7	8	9	10	11
S-values	.0107	.0240	.2112	.5686	.5543	1.0000	1.0839	.9624	1.2413	1.0000

Table 5.7 VIRTUAL POPULATION ANALYSIS

HORSE MACKEREL IN FISHING AREAS IIA, IVA, VIA, VIIA-C,E-K,VIIIA-B,D-E

CATCH IN NUMBERS UNIT: millions

	1982	1983	1984	1985	1986	1987	1988	1989
1	2.5	5.7	.0	1.3	.0	.1	30.8	.0
2	14.3	1.6	183.7	3.8	.0	.4	6.9	.0
3	91.6	23.6	3.4	467.7	1.1	.0	2.3	26.5
4	7.8	38.4	27.6	3.5	489.4	2.5	5.0	23.3
5	9.0	11.0	114.0	32.4	6.3	748.4	17.3	6.8
6	8.0	31.9	17.0	77.9	47.1	1.7	955.7	8.5
7	6.0	37.8	29.1	9.8	79.4	34.9	9.0	1373.5
8	1.1	12.9	25.9	12.5	18.6	76.2	23.6	3.5
9	.3	2.4	11.2	4.8	15.3	9.9	50.7	22.9
10	1.1	3.9	3.1	7.2	11.1	8.0	7.3	42.9
11	4.5	2.4	.0	.3	2.3	16.3	7.6	8.8
12+	50.8	90.2	44.4	31.5	38.9	36.4	56.6	30.3
TOTAL	197.0	261.8	459.5	652.7	709.5	934.8	1172.9	1547.0
A) SOP	42	66	73	81	107	157	191	250
B)NOMIN.	42	65	74	81	106	156	186	249
(B/A) %	99	99	101	99	98	100	97	100

Table 5.8 VIRTUAL POPULATION ANALYSIS

HORSE MACKEREL IN FISHING AREAS IIA, IVA, VIA, VIIA-C,E-K,VIIIA-B,D-E

PROPORTIONS OF MATURITY
UNIT:

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

Table 5.9 VIRTUAL POPULATION ANALYSIS

HORSE MACKEREL IN FISHING AREAS IIA, IVA, VIA, VIIA-C,E-K,VIIIA-B,D-E

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

	1982	1983	1984	1985	1986	1987	1988	1989
1	.017	.000	.000	.015	.000	.000	.010	.000
2	.016	.013	.006	.012	.000	.001	.002	.000
3	.053	.031	.031	.019	.004	.000	.005	.008
4	.030	.027	.044	.038	.023	.011	.095	.056
5	.032	.052	.098	.063	.087	.042	.095	.172
6	.035	.146	.100	.086	.116	.029	.066	.059
7	.064	.214	.181	.073	.112	.111	.197	.122
8	.084	.178	.211	.105	.183	.142	.097	.105
9	.011	.239	.221	.052	.171	.132	.125	.122
10	.101	.200	.534	.202	.154	.120	.130	.140
11	.102	.312	.000	.072	.086	.334	.152	.215
12+	.102	.312	.000	.072	.086	.334	.152	.215
(3-11)U	.057	.155	.158	.079	.104	.102	.107	.111
(3-11)W	.048	.058	.097	.023	.030	.047	.068	.097

Table 5.10 VIRTUAL POPULATION ANALYSIS

HORSE MACKEREL IN FISHING AREAS IIA, IVA, VIA, VIIA-C,E-K,VIIIA-B,D-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
1	165	37078	384	94	722	4870	3334	0	0
2	986	139	31908	330	79	622	4192	0	0
3	1913	835	118	27293	281	68	535	3602	0
4	282	1562	697	99	23058	241	59	458	3075
5	304	235	1309	574	82	19393	205	46	373
6	253	253	192	1021	464	65	15998	160	33
7	105	210	189	150	807	356	54	12885	130
8	15	85	146	135	120	621	274	38	9819
9	27	12	61	102	105	86	464	214	30
10	13	23	8	42	83	76	65	352	163
11	50	10	0	4	30	61	58	49	263
12+	565	361	0	488	510	137	432	168	151
TOTAL NO	4676	40804	35012	30332	26341	26596	25669	17973	
SPS NO	3230	3039	5269	12467	14857	15669	16469	13889	
TOT.BIOM	660	667	2028	2775	2937	2813	2926	2613	
SPS BIOM	545	570	518	1309	1787	2079	2443	2145	

Table 5.11

List of input variables for the ICES prediction program.

WSETERN HORSE MACKEREL
The reference F is the mean F for the age group range from 3 to 11

The number of recruits per year is as follows:

Year	Recruitment
1990	1250.0
1991	1250.0
1992	1250.0

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: 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
1	1250.0	.00	.15	.00	.050	.000
2	1050.0	.00	.15	.10	.075	.050
3	900.0	.00	.15	.40	.149	.080
4	3075.0	.03	.15	.60	.144	.105
5	373.0	.08	.15	.80	.142	.103
6	33.0	.08	.15	1.00	.164	.131
7	130.0	.14	.15	1.00	.154	.159
8	9819.0	.14	.15	1.00	.180	.180
9	30.0	.14	.15	1.00	.197	.199
10	163.0	.14	.15	1.00	.215	.218
11	263.0	.14	.15	1.00	.269	.286
12+	151.0	.14	.15	1.00	.281	.305

Table 5.12

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

WSETERN HORSE MACKEREL

Year 1990						Year 1991				Year 1992	
fac-tor	ref. F	stock biomass	sp.stock biomass	catch	Basis	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.2	.12	2441	1936	291	-	.00	2090	1788	0	2090	1823
					.8F	.08		1712	172	1918	1594
					F_{89}	.10		1691	217	1873	1535
					$F_{0.1}$	.15		1638	329	1762	1395

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 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 3 to 11

Table 5.13 Western horse mackerel.

****
* Year 1990. F-factor 1.000 and reference F .0970 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0000	.00	.000	1250.0	.00	.0	.00	.0	.00
2	.0000	.00	.000	1050.0	52.50	105.0	5.25	98.1	4.91
3	.0000	.00	.000	900.0	72.00	360.0	28.80	336.5	26.92
4	.0273	76.93	11.077	3075.0	322.88	1845.0	193.73	1703.5	178.87
5	.0818	27.23	3.867	373.0	38.42	298.4	30.74	268.8	27.69
6	.0818	2.41	.395	33.0	4.32	33.0	4.32	29.7	3.89
7	.1364	15.42	2.374	130.0	20.67	130.0	20.67	114.3	18.17
8	.1364	1164.59	209.627	9819.0	1767.42	9819.0	1767.42	8631.7	1553.70
9	.1364	3.56	.701	30.0	5.97	30.0	5.97	26.4	5.25
10	.1364	19.33	4.157	163.0	35.53	163.0	35.53	143.3	31.24
11	.1364	31.19	8.391	263.0	75.22	263.0	75.22	231.2	66.12
12+	.1364	17.91	5.033	151.0	46.06	151.0	46.06	132.7	40.49
Total		1358.57	245.622	17237.0	2440.98	13197.4	2213.70	11716.3	1957.25

****
* Year 1991. F-factor 1.000 and reference F .0970 *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0000	.00	.000	1250.0	.00	.0	.00	.00	.00
2	.0000	.00	.000	1075.9	53.79	107.6	5.38	100.57	5.03
3	.0000	.00	.000	903.7	72.30	361.5	28.92	337.90	27.03
4	.0273	19.38	2.791	774.6	81.34	464.8	48.80	429.14	45.06
5	.0818	188.03	26.701	2575.4	265.27	2060.3	212.21	1856.24	191.19
6	.0818	21.60	3.542	295.8	38.75	295.8	38.75	266.53	34.91
7	.1364	3.10	.478	26.2	4.16	26.2	4.16	23.01	3.66
8	.1364	11.58	2.084	97.6	17.57	97.6	17.57	85.82	15.45
9	.1364	874.56	172.289	7373.7	1467.37	7373.7	1467.37	6482.07	1289.93
10	.1364	2.67	.574	22.5	4.91	22.5	4.91	19.80	4.32
11	.1364	14.52	3.905	122.4	35.01	122.4	35.01	107.61	30.78
12+	.1364	36.87	10.362	310.9	94.82	310.9	94.82	273.30	83.36
Total		1172.32	222.727	14828.8	2135.29	11243.3	1957.91	9981.98	1730.71

cont'd.

Table 5.13 cont'd.

****
* Year 1992. F-factor 1.000 and reference F .0970 *
****

						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
1	.0000	.000	.000	1250.0	.00	.00	.00	.00	.00
2	.0000	.000	.000	1075.9	53.79	107.59	5.38	100.57	5.03
3	.0000	.000	.000	926.0	74.08	370.41	29.63	346.23	27.70
4	.0273	19.460	2.802	777.9	81.68	466.72	49.01	430.93	45.25
5	.0818	47.368	6.726	648.8	66.82	519.02	53.46	467.61	48.16
6	.0818	149.130	24.457	2042.6	267.58	2042.56	267.58	1840.24	241.07
7	.1364	27.828	4.285	234.6	37.31	234.62	37.31	206.25	32.79
8	.1364	2.331	.420	19.7	3.54	19.65	3.54	17.28	3.11
9	.1364	8.695	1.713	73.3	14.59	73.31	14.59	64.45	12.83
10	.1364	656.765	141.204	5537.4	1207.15	5537.37	1207.15	4867.79	1061.18
11	.1364	2.007	.540	16.9	4.84	16.92	4.84	14.87	4.25
12+	.1364	38.594	10.845	325.4	99.25	325.40	99.25	286.05	87.24
Total		952.178	192.993	12928.4	1910.61	9713.57	1771.71	8642.26	1568.61

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

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
1962	7,231	46,345	3,400	56,976	-	-	-	-	53,202	110,778
1963	6,593	54,267	3,900	64,760	-	-	-	-	53,420	118,180
1964	8,983	55,693	4,100	68,776	-	-	-	-	57,365	126,141
1965	4,033	54,327	4,745	63,105	-	-	-	-	52,282	115,387
1966	5,582	44,725	7,118	57,425	-	-	-	-	47,000	104,425
1967	6,726	52,643	7,279	66,648	-	-	-	-	53,351	119,999
1968	11,427	61,985	7,252	80,664	-	-	-	-	62,326	142,990
1969	19,839	36,373	6,275	62,487	-	-	-	-	85,781	148,268
1970	32,475	29,392	7,079	59,946	-	-	-	-	98,418	158,364
1971	32,309	19,050	6,108	57,467	-	-	-	-	75,349	132,816
1972	45,452	28,515	7,066	81,033	-	-	-	-	82,247	163,280
1973	28,354	10,737	6,406	45,497	-	-	-	-	114,878	160,375
1974	29,916	14,962	3,227	48,105	-	-	-	-	78,105	126,210
1975	26,786	10,149	9,486	46,421	-	-	-	-	85,688	132,109
1976	26,850	16,833	7,805	51,488	89,197	26,291	376[1]	-	115,864	167,352
1977	26,441	16,847	7,790	51,078	74,469	31,431	376[1]	-	106,276	157,354
1978	23,411	4,561	4,071	32,043	80,121	14,945	376[1]	-	95,442	127,485
1979	19,331	2,906	4,680	26,917	48,518	7,428	376[1]	-	56,322	83,239
1980	14,646	4,575	6,003	25,224	36,489	8,948	376[1]	-	45,813	71,037
1981	11,917	5,194	6,642	23,753	28,776	19,330	376[1]	-	48,482[3]	72,235[3]
1982	12,676	9,906	8,304	30,886	-[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]

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

Table 6.2 SOUTHERN HORSE MACKEREL. Biomass indices in commercial fisheries, CPUE and survey indices.

Year	Portugal IXa		Spain IXa South Galicia	Portugal IXa			Spain[2] >200
	Trawl	Seine	Seine	Bottom trawl (20-mm codend)			
	kg/h	t/seiner	t/day	kg/h Jun/Jul	kg/h Oct	n/h (0-group) Oct	kg/h Sep
1979	87.7	10.3	-	12.2[3]	5.5[3]	-	-
1980	69.3	21.7	-	20.6[3]	2.5[3]	-	24.74
1981	59.1	26.9	1.2	11.6	1.8	22.6	6.42
1982	56.2	53.8	3.2	42.1	36.9	1,215.2	20.10
1983	98.0	32.9	2.4	79.1	24.6	127.9	97.27
1984	55.9	23.2	0.7	-	-	-	8.73
1985	24.4	11.2	0.7	9.5	3.8	41.7	22.14
1986	41.6	36.4	1.7	4.8[3]	23.5	757.4	18.33
1987	71.0	32.4	1.1	-	6.9	88.3	-
1988	91.1	43.6	1.0	-	26.0	-	18.04
1989[1]	69.5	50.9	0.7	14.9	11.7	380.0	9.87

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

Table 6.3 Southern horse mackerel - tuning data.

```
HORSE MACKEREL IN DIVISIONS VIIIc AND IXa
104
portuguese october survey
82,89
1,1
0,7
1.0,   1215.167, 419.157, 17.690, 1.199, 1.287, 2.951, 2.138, 1.015
1.0,   127.925,  704.787, 15.923, 0.801, 0.088, 0.174, 0.668, 0.187
1.0,   224.714,  291.439, 57.102, 5.668, 1.370, 0.525, 0.823, 0.891
1.0,   41.675,   90.288,  3.495,  1.176, 0.102, 0.065, 0.038, 0.010
1.0,   757.398,  219.935, 11.318, 3.380, 2.310, 0.215, 1.135, 0.522
1.0,   88.344,   58.626,  23.535, 5.311, 2.688, 1.139, 1.284, 0.183
1.0,   38.260,   607.268, 124.598,24.843,24.948,13.477,17.905,9.745
1.0,   380,      90,      41,     41,    7,     4,     4,     3
portuguese trawl fleet
82,89
1,1
0,7
225.4, 54515,    55612,    20649,  4437,   2611,   5804,   8166,   7562
176.6, 22359,    376143,   26109,  4664,   2571,   3247,   4300,   2565
154.0, 7572,     29975,    105505, 10521,  1015,   836,    1360,   1749
147.0, 41816,    34936,    6539,   7675,   739,    272,    612,    474
155.3, 72194,    48888,    11188,  6431,   10128,  1765,   2407,   1171
161.3, 59589,    185359,   22601,  4690,   5933,   7080,   1169,   726
127.6, 2147,     82971,    29365,  14005,  6067,   4121,   10559,  7191
179.5, 3134,     39127,    37506,  11663,  5887,   2236,   6029,   6134
spanish purse seine fleet
82,89
1,1
0,7
1.0,   354.9,    547.1,    1555.1, 686.2,  72.8,   39.7,   37.1,   23.6
1.0,   560.5,    3038.4,   171.4,  47.9,   114.8,  75.7,   73.6,   67.0
1.0,   0.1,      125.2,    739.3,  130.7,  12.5,   11.4,   26.7,   32.3
1.0,   1694.1,   632.2,    203.1,  236.8,  69.1,   10.8,   2.0,    5.0
1.0,   1148.8,   1639.8,   191.7,  233.6,  146.3,  35.4,   12.9,   10.6
1.0,   46.8,     644.5,    1074.4, 80.5,   80.4,   77.0,   21.2,   1.5
1.0,   41.0,     360.1,    462.7,  153.4,  111.6,  80.0,   95.6,   93.0
1.0,   1435.8,   332.5,    218.2,  128.4,  50.3,   14.9,   12.4,   18.4
spanish survey
82,89
1,1
0,7
1.0,   2,   0,   6,   8,   4,   13,   23,   14,
1.0,   51,  682, 323, 13,  6,   10,   23,   25,
1.0,   11,  28,  387, 96,  4,   3,    12,   26,
1.0,   0,   29,  54,  89,  26,  5,    2,    4,
1.0,   4,   9,   3,   13,  21,  9,    4,    3,
1.0,  -11, -11, -11, -11, -11, -11,  -11,  -11,
1.0    0,   2,   4,   8,   20,  16,   26,   34,
1.0    4,   0,   0,   0,   0,   1,    3,    13,
```

Table 6.4 SUM OF PRODUCTS CHECK

HORSE MACKEREL IN FISHING AREAS VIIIC AND IXA
CATEGORY: TOTAL

CATCH IN NUMBERS UNIT: millions

	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	54	105	182	12	483	592	122	17	311
1	316	123	1109	71	203	358	855	302	170
2	136	115	75	460	101	118	112	101	144
3	59	78	24	41	112	52	40	52	78
4	20	27	23	4	11	82	44	26	58
5	48	22	32	9	8	27	41	24	38
6	35	28	35	22	15	27	11	63	47
7	23	28	21	20	9	13	6	52	41
8+	24	28	20	18	7	10	8	72	73
TOTAL	715	553	1520	656	949	1279	1239	709	960

Table 6.5 SUM OF PRODUCTS CHECK

HORSE MACKEREL IN FISHING AREAS VIIIC AND IXA
CATEGORY: TOTAL

MEAN WEIGHT AT AGE IN THE CATCH UNIT: kilogram

	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.023	.020	.013	.015	.010	.013	.017	.013	.013
1	.040	.033	.028	.025	.036	.034	.035	.030	.032
2	.067	.082	.061	.049	.070	.055	.069	.053	.059
3	.097	.115	.125	.080	.097	.093	.105	.071	.078
4	.174	.152	.159	.124	.158	.122	.124	.091	.105
5	.254	.226	.225	.178	.240	.175	.161	.107	.131
6	.292	.261	.267	.246	.281	.267	.230	.132	.158
7	.341	.296	.294	.275	.326	.312	.313	.159	.172
8+	.407	.363	.361	.331	.397	.351	.380	.252	.257

Table 6.6 Southern horse mackerel. Results of tuning analysis.

Module run at 17.56.54 27 JUNE 1990
DISAGGREGATED Qs
LOG TRANSFORMATION
NO explanatory variate (Mean used)
Fleet 1 ,portuguese october s, has terminal q estimated as the mean
Fleet 2 ,portuguese trawl fle, has terminal q estimated as the mean
Fleet 3 ,spanish purse seine , has terminal q estimated as the mean
Fleet 4 ,spanish survey , has terminal q estimated as the mean
FLEETS COMBINED BY ** VARIANCE **

Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000,
Oldest age F = 2.000*average of 5 younger ages. Fleets combined by variance of predictions
Fishing mortalities

Age,	82,	83,	84,	85,	86,	87,	88,	89,
0,	.034,	.193,	.015,	.372,	.276,	.097,	.030,	.366,
1,	.166,	.587,	.107,	.371,	.524,	.810,	.368,	.477,
2,	.541,	.145,	.519,	.217,	.383,	.305,	.202,	.300,
3,	.488,	.207,	.110,	.228,	.164,	.218,	.227,	.237,
4,	.202,	.254,	.045,	.039,	.260,	.206,	.210,	.426,
5,	.177,	.383,	.150,	.124,	.125,	.202,	.169,	.553,
6,	.399,	.461,	.494,	.389,	.798,	.070,	.535,	.557,
7,	.723,	.580,	.527,	.399,	.692,	.400,	.537,	.829,

Log catchability estimates

Age 0

Fleet,	82,	83,	84,	85,	86,	87,	88,	89
1 ,	-.93,	-2.00,	-1.27,	-3.44,	-1.04,	-2.65,	-2.67,	-.80
2 ,	-2.54,	-2.01,	-2.79,	-1.52,	-1.53,	-1.22,	-3.49,	-3.88
3 ,	-2.16,	-.52,	-8.99,	.27,	-.63,	-3.29,	-2.60,	.53
4 ,	-7.34,	-2.92,	-4.29,	-8.78,	-6.29,	-8.74,	-7.92,	-5.36

cont'd.

Table 6.6 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-1.85	1.044	.1572	.1286	.000E+00	.000E+00	-1.850	.348
2	-2.37	1.033	******	1.6589	.000E+00	.000E+00	-2.373	.344
3	-2.17	3.262	.1138	.0246	.000E+00	.000E+00	-2.173	1.087
4	-6.45	2.267	.0016	.1224	.000E+00	.000E+00	-6.453	.756

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.364	.683	.795	.795	1.354

Age 1

Fleet	82	83	84	85	86	87	88	89
1	-.56	-.99	-.82	-1.80	-1.13	-2.89	-.30	-1.37
2	-1.09	.12	-1.23	-.83	-.78	.09	-.23	-.49
3	-.30	.48	-1.67	.15	.87	-.49	-.82	-.07
4	-8.21	-1.02	-3.17	-2.94	-4.33	-8.57	-6.02	-7.48

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-1.23	.864	.2911	.5495	.000E+00	.000E+00	-1.234	.288
2	-.56	.544	******	.4471	.000E+00	.000E+00	-.556	.181
3	-.23	.839	.7932	.4053	.000E+00	.000E+00	-.232	.280
4	-5.22	2.941	.0054	4.6086	.000E+00	.000E+00	-5.217	.980

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.477	.400	.189	.400	.225

Age 2

Fleet	82	83	84	85	86	87	88	89
1	-2.49	-3.48	-2.74	-4.89	-3.30	-2.74	-1.39	-2.46
2	-.84	-1.25	-.26	-2.34	-1.45	-.96	-.78	-.83
3	1.99	-1.10	-.18	-.83	-.47	1.08	-.08	-.79
4	-3.57	-.47	-.83	-2.15	-4.63	-7.51	-4.83	-7.78

cont'd.

Table 6.6 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-2.94	1.070	.0531	.1861	.000E+00	.000E+00	-2.936	.357
2	-1.09	.654	******	.2316	.000E+00	.000E+00	-1.089	.218
3	-.05	1.125	.9534	.6283	.000E+00	.000E+00	-.048	.375
4	-3.97	2.942	.0189	******	.000E+00	.000E+00	-3.971	.981

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.300	.493	.447	.493	.822

Age 3

Fleet	82	83	84	85	86	87	88	89
1	-4.89	-4.99	-4.18	-6.04	-4.53	-3.55	-2.22	-2.09
2	-2.09	-1.50	-1.69	-2.24	-2.02	-1.85	-.74	-1.63
3	1.46	-.90	-1.04	-.73	-.29	-.83	-.40	-.95
4	-2.99	-2.20	-1.35	-1.71	-3.18	-6.83	-3.35	-7.41

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.06	1.458	.0172	.0329	.000E+00	.000E+00	-4.061	.486
2	-1.72	.499	******	.2160	.000E+00	.000E+00	-1.720	.166
3	-.46	.869	.6305	.3850	.000E+00	.000E+00	-.461	.290
4	-3.63	2.409	.0265	******	.000E+00	.000E+00	-3.630	.803

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.237	.409	.509	.509	1.547

Age 4

Fleet	82	83	84	85	86	87	88	89
1	-4.64	-6.92	-4.12	-7.92	-4.92	-4.37	-1.59	-2.97
2	-2.45	-1.81	-2.55	-4.03	-1.58	-1.76	-.94	-1.43
3	-.61	.25	-1.91	-1.41	-.77	-.98	-.09	-1.00
4	-3.51	-2.70	-3.05	-2.38	-2.71	-6.97	-1.81	-6.53

cont'd.

Table 6.6 cont'd.

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.68	2.140	.0092	.0768	.000E+00	.000E+00	-4.683	.713
2	-2.07	1.006	******	.2240	.000E+00	.000E+00	-2.068	.335
3	-.81	.731	.4432	.5119	.000E+00	.000E+00	-.814	.244
4	-3.71	2.061	.0245	7.1249	.000E+00	.000E+00	-3.708	.687

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.426	.549	.548	.549	.994

Age 5

Fleet	82	83	84	85	86	87	88	89
1	-3.75	-6.16	-4.73	-6.89	-6.90	-5.19	-2.37	-2.85
2	-1.59	-1.50	-2.39	-3.54	-2.93	-1.54	-1.50	-1.72
3	-1.15	-.08	-1.65	-1.78	-1.79	-.98	-.59	-1.54
4	-2.27	-2.11	-2.99	-2.55	-3.16	-6.93	-2.20	-4.24

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.86	1.860	.0078	.0747	.000E+00	.000E+00	-4.856	.620
2	-2.09	.831	******	.3818	.000E+00	.000E+00	-2.089	.277
3	-1.20	.655	.3023	.7791	.000E+00	.000E+00	-1.196	.218
4	-3.31	1.722	.0367	1.4075	.000E+00	.000E+00	-3.306	.574

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.553	.476	.382	.476	.642

cont'd.

Table 6.6 cont'd.

Age 6

Fleet	82	83	84	85	86	87	88	89
1	-3.49	-4.73	-3.97	-6.89	-3.41	-4.81	-1.89	-3.04
2	-.66	-1.13	-1.60	-2.20	-.79	-3.08	-.36	-.92
3	-.64	-.03	-.49	-2.93	-.98	-2.01	-.21	-1.91
4	-1.11	-1.19	-1.29	-2.93	-2.15	-6.67	-1.51	-3.33

SUMMARY STATISTICS

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-4.03	1.581	.0178	.2080	.000E+00	.000E+00	-4.030	.527
2	-1.34	.965	******	.3640	.000E+00	.000E+00	-1.342	.322
3	-1.15	1.087	.3167	1.1954	.000E+00	.000E+00	-1.150	.362
4	-2.52	1.983	.0801	1.2499	.000E+00	.000E+00	-2.524	.661

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.557	.623	.401	.623	.414

Table 6.7 VIRTUAL POPULATION ANALYSIS from tuning.

HORSE MACKEREL IN FISHING AREAS VIIIC AND IXA

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .20

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1987-89
0	.054	.034	.193	.015	.372	.276	.097	.030	.364	.164
1	.661	.166	.587	.107	.371	.524	.810	.368	.477	.552
2	.441	.541	.145	.519	.217	.383	.305	.201	.300	.269
3	.282	.488	.207	.110	.228	.164	.218	.227	.237	.227
4	.115	.202	.254	.045	.039	.260	.206	.210	.426	.280
5	.379	.177	.383	.150	.124	.125	.202	.168	.553	.308
6	.419	.399	.461	.494	.389	.798	.070	.535	.557	.387
7	.659	.723	.580	.527	.399	.692	.400	.537	.829	.589
8+	.659	.723	.580	.527	.399	.692	.400	.537	.829	.589
(1- 3)U	.461	.398	.313	.245	.272	.357	.444	.265	.338	
(1- 5)U	.376	.315	.315	.186	.196	.291	.348	.235	.398	

Table 6.8 Southern horse mackerel. Separable VPA results.

from 81 to 89 on ages 0 to 7
with Terminal F of .550 on age 1 and Terminal S of 1.200

Initial sum of squared residuals was 70.963 and
final sum of squared residuals is 31.635 after 93 iterations

Matrix of Residuals

Years / Ages	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89		WTS
0/ 1	.291	-1.075	1.594	-1.286	1.952	.362	.289	-.653	.000	.291
1/ 2	-.434	-.752	-1.080	-1.311	-.270	-.733	.798	-.061	.000	.517
2/ 3	-.215	.964	-.688	1.043	.488	-.135	.052	.081	.000	.572
3/ 4	.536	1.178	1.103	1.455	.647	-.502	.265	.232	.000	.541
4/ 5	-.453	-.337	.052	-.692	-.660	-.102	.283	-.179	.000	1.000
5/ 6	.514	-.294	-.131	-.089	-.693	.451	-.359	-.091	.000	.846
6/ 7	-.021	.254	-.126	1.117	.485	.877	-1.660	.781	.000	.391
	.000	.000	.000	.000	.000	.000	.000	.000	3.062	
WTS	.001	.001	.001	.001	.001	1.000	1.000	1.000		

Fishing Mortalities (F)

	81	82	83	84	85	86	87	88	89
F-values	.4840	.4481	.5010	.2692	.3515	.5824	.3543	.3325	.5500

Selection-at-age (S)

	0	1	2	3	4	5	6	7
S-values	.1920	1.0000	.4435	.3232	.3951	.4374	.7376	1.2000

Table 6.9 VIRTUAL POPULATION ANALYSIS from separable VPA.

HORSE MACKEREL IN FISHING AREAS VIIIC AND IXA

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .20

	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	.063	.032	.174	.012	.294	.222	.084	.039	.106
1	.640	.199	.550	.095	.276	.370	.574	.308	.668
2	.440	.510	.179	.465	.189	.255	.187	.120	.236
3	.228	.486	.191	.140	.196	.140	.130	.124	.128
4	.109	.155	.253	.041	.051	.215	.169	.114	.200
5	.328	.165	.273	.149	.112	.168	.159	.134	.249
6	.352	.325	.421	.305	.387	.682	.097	.386	.407
7	.577	.540	.422	.455	.203	.686	.307	.875	.474
8+	.577	.540	.422	.455	.203	.686	.307	.875	.474
(1- 3)U	.436	.399	.307	.234	.220	.255	.297	.184	.344
(1- 5)U	.349	.303	.289	.178	.165	.229	.244	.160	.296

Table 6.10 VIRTUAL POPULATION ANALYSIS from separable VPA.

HORSE MACKEREL IN FISHING AREAS VIIIC AND IXA

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: .080
PROPORTION OF ANNUAL M BEFORE SPAWNING: .080

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	971	3614	1254	1142	2084	3265	1659	483	3416	0
1	729	746	2865	863	924	1272	2140	1248	381	2517
2	419	315	501	1353	642	574	719	987	751	160
3	317	221	155	343	695	435	364	488	717	485
4	218	206	111	105	244	468	310	262	353	516
5	188	160	145	71	82	190	309	214	191	237
6	129	111	111	90	50	60	131	216	153	122
7	57	74	66	60	54	28	25	98	120	84
8+	60	72	64	54	40	22	33	134	211	169
TOTAL NO	3088	5521	5272	4080	4816	6314	5690	4130	6293	
SPS NO	1107	979	1235	1273	1323	1439	1644	1803	1813	
TOT.BIOM	211	185	198	156	199	188	241	210	214	
SPS BIOM	163	144	129	103	140	132	159	145	167	

Table 6.11

Analysis by RCRTINX2 of data from file RECRUIT3-DATA
SOUTHERN HORSE MACKEREL : RECRUITS AS 0 YEARS-OLD

Data for 5 surveys over 9 years
REGRESSION TYPE = P
TAPERED TIME WEIGHTING NOT APPLIED
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 .50
MINIMUM OF 4 POINTS USED FOR REGRESSION

Yearclass = 1988

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
Port-0	3.6702	.240	6.405	.5947	5	7.2873	.32878	.40931	.23740
Port-J									
Port-T	2.8792	.484	4.949	.5428	7	6.3419	.38067	.62121	.15380
Spain-	3.7377	.108	6.937	.2800	7	7.3406	.47769	.52110	.21857
Spain-	.0000	-.223	8.028	.3916	5	8.0276	.47679	.59884	.16550
MEAN						7.4853	.51391	.51391	.22473

Yearclass = 1989

Survey/ Series	Index Value	Slope	Inter- cept	Rsquare	No. Pts	Predicted Value	Sigma	Standard Error	Weight
Port-0	5.9428	.387	5.474	.5892	6	7.7752	.52734	.58623	.20085
Port-J	4.0570	-.061	8.092	.0404	4	7.8468	.58017	.70663	.13824
Port-T	2.9156	.522	4.738	.7609	8	6.2611	.34979	.44343	.27611
Spain-	7.2702	.142	6.623	.2612	8	7.6587	.61491	.69189	.14419
Spain-	1.6094	.019	7.352	.0015	6	7.3825	.84279	.91056	.08325
MEAN						7.3224	.66231	.66231	.15736

Yearclass		Weighted Average Prediction	Internal Standard Error	External Standard Error	Virtual Population Analysis	Ext.SE/ Int.SE
1988	7.32	1511.03	.24	.24	6.18 484.00	1.00
1989	7.25	1402.88	.26	.28	8.14 3417.00	1.08

Table 6.12

List of input variables for the ICES prediction program.

HORSE MACKEREL SOUTHERN STOCK
The reference F is the mean F for the age group range from 1 to 3

The number of recruits per year is as follows:

Year	Recruitment
1990	1780.0
1991	1780.0
1992	1780.0

Proportion of F (fishing mortality) effective before spawning: .0800
Proportion of M (natural mortality) effective before spawning: .0800

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	1780.0	.11	.20	.00	.013	.000
1	1033.0	.58	.20	.17	.031	.021
2	160.0	.25	.20	.42	.056	.042
3	458.0	.19	.20	.70	.074	.063
4	516.0	.23	.20	.92	.098	.082
5	237.0	.26	.20	1.00	.119	.103
6	122.0	.43	.20	1.00	.145	.123
7	84.0	.70	.20	1.00	.165	.148
8+	169.0	.70	.20	1.00	.255	.206

Table 6.13 Southern horse mackerel.

****
* Year 1990. F-factor 1.000 and reference F .3400 *
****

					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	.1100	168.358	2.1887	1780.00	.000	.00	.000	.00	.000
1	.5800	416.014	12.8964	1033.00	22.209	175.61	3.776	164.99	3.547
2	.2500	32.211	1.8038	160.00	6.640	67.20	2.789	64.82	2.690
3	.1900	72.058	5.3683	458.00	28.625	320.60	20.038	310.75	19.422
4	.2300	96.459	9.4530	516.00	42.312	474.72	38.927	458.67	37.611
5	.2600	49.392	5.8776	237.00	24.411	237.00	24.411	228.44	23.529
6	.4300	38.921	5.6435	122.00	14.945	122.00	14.945	116.00	14.210
7	.7000	38.771	6.4166	84.00	12.474	84.00	12.474	78.16	11.607
8+	.7000	78.003	19.8518	169.00	34.814	169.00	34.814	157.26	32.396
Total		990.187	69.4998	4559.00	186.430	1650.13	152.173	1579.09	145.013

****
* Year 1991. F-factor 1.000 and reference F .3400 *
****

					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	.1100	168.36	2.1887	1780.00	.000	.00	.000	.00	.000
1	.5800	525.77	16.2989	1305.54	28.069	221.94	4.772	208.52	4.483
2	.2500	95.33	5.3385	473.53	19.652	198.88	8.254	191.85	7.962
3	.1900	16.05	1.1958	102.02	6.376	71.41	4.463	69.22	4.326
4	.2300	57.97	5.6808	310.09	25.428	285.28	23.393	275.64	22.602
5	.2600	69.95	8.3245	335.66	34.573	335.66	34.573	323.53	33.324
6	.4300	47.73	6.9209	149.61	18.328	149.61	18.328	142.26	17.427
7	.7000	29.99	4.9634	64.98	9.649	64.98	9.649	60.46	8.979
8+	.7000	47.48	12.0828	102.86	21.190	102.86	21.190	95.72	19.718
Total		1058.63	62.9943	4624.30	163.264	1430.64	124.622	1367.20	118.821

cont'd.

Table 6.13 cont'd.

****
* Year 1992. F-factor 1.000 and reference F .3400 *
****

						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	.1100	168.36	2.1887	1780.00	.000	.00	.000	.00	.000
1	.5800	525.77	16.2989	1305.54	28.069	221.94	4.772	208.52	4.483
2	.2500	120.48	6.7470	598.47	24.836	251.36	10.431	242.47	10.062
3	.1900	47.50	3.5391	301.94	18.871	211.36	13.210	204.86	12.804
4	.2300	12.91	1.2654	69.07	5.664	63.55	5.211	61.40	5.035
5	.2600	42.04	5.0026	201.72	20.777	201.72	20.777	194.43	20.026
6	.4300	67.60	9.8021	211.90	25.958	211.90	25.958	201.48	24.682
7	.7000	36.78	6.0868	79.68	11.833	79.68	11.833	74.15	11.011
8+	.7000	31.50	8.0157	68.24	14.057	68.24	14.057	63.50	13.080
Total		1052.94	58.9462	4616.55	150.065	1309.74	106.248	1250.80	101.184

Table 6.14

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

HORSE MACKEREL SOUTHERN STOCK

Year 1990					Year 1991					Year 1992	
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	.34	186	145	69	$F_{0.1}$	.10	163	121	22	191	133
					F_{med}	.24		120	47	166	114
					$F_{91}=F_{89}$	.34		119	63	150	101
					$C_{91}=C_{89}$	.37		118	68	145	97

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 1992 has been calculated with the same fishing mortality as for 1991.
The reference F is the mean F for the age group range from 1 to 3

Table 7.1 Portuguese annual landings of anchovy from the purse seine fleet in Division IXa (from Pestana, 1989).

Year	Anchovy
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

Table 7.2 European anchovy in Sub-area VIII (in tonnes) as estimated by the Working Group.

Country and division	Year							
	1960	1961	1962	1963	1964	1965	1966	1967
France, VIIIb	1,085	1,494	1,123	652	1,973	2,615	839	1,812
Spain, VIIIb,c	57,000	74,000	58,000	48,000	75,000	81,000	47,519	39.363
Total	58,085	75,494	59,123	48,652	76,973	83,615	48,358	41,175

Country and division	1968	1969	1970	1971	1972	1973	1974	1975
France, VIIIb	1,190	2,991	3,665	4,825	6,150	4,395	3,835	2,913
Spain, VIIIb,c	38,429	33,092	19,820	23,787	26,917	23,614	27,282	23,389
Total	39,619	36,083	23,845	28,612	33,067	28,009	31,117	26,302

Country and division	1976	1977	1978	1979	1980	1981	1982	1983
France, VIIIb	1,095	3,807	3,683	1,349	1,564	1,021	381	1,911
Spain, VIIIb,c	36,166	44,384	41,536	25,000	20,538	9,794	4,610	12,242
Total	37,261	48,191	45,219	26,349	22,102	10,815	4,991	14,153

Country and division	1984	1985	1986	1987	1988	1989	1990
France, VIIIa,b,c	1,711[2]	3,005[2]	2,311[2]	5,061[2]	6,743[2]	2,200	2,130[1]
Spain, VIIIb,c	33,468	8,481	5,612	9,863	8,266	8,174	15,000[1]
Total	35,179	11,486	7,923	14,924	15,009	10,374	17,130[1]

[1] Only 1st half year. Preliminary.
[2] Official figures.

Table 7.3 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[1]	VIIIc	VIIIa	VIIIb[1]	VIIIc	VIIIa	VIIIb	VIIIc
France	2,024 (40%)	3,036 (60%)	[2]	3,740 (55%)	3,000 (45%)	[2]	924 (42%)	1,177 (53.5%)	99 (4.5%)
Spain		5,290 (53,5%)	4,753 (46.4%)		4,548 (55%)	3,718 (45%)		558 (6.8%)	7,615 (93.2%)

[1] Not taken into account that the main part of the French landings in Division VIIIb are salted.
[2] Small landings from that area.

Table 7.4 Anchovy catch distributions (in tonnes) according to half of the year for the period 1983-1989.

		1st half year[1]		2nd half year[2]	
1983	Spain	11,000	(90%)	1,242	(10%)
1984	Spain	31,938	(95.6%)	1,485	(4.4%)
1985	Spain	6,391	(74.6%)	2,173	(25.4%)
1986	Spain	3,274	(62.7%)	1,947	(37.3%)
1987	Spain	8,777	(89%)	1,086	(11%)
1988	Spain	6,955	(84%)	1,311	(16%)
1989	Spain	5,377	(65.8%)	2,796	(34.2%)
1989	France	1,944	(88.4%)	256	(11.6%)

[1] Corresponds to the spring fishery in Divisions VIIIa,b and c.
[2] Corresponds to the summer and autumn fisheries in Divisions VIIIc (Spain) or VIIIa (France).

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

	T1	T2	T3	T4
France (2,200 t)	6.3	70.2	13	10.5
Spain (8,173 t)	13.4	58.4	18.4	9.8

T1 = ⩽ 30 per kg.
T2 = between 31 and 50 per kg.
T3 = between 51 and 83 per kg.
T4 = ⩾ 84 per kg.

Table 7.6 Evolution of the French fleet for anchovy (from Working Group members).

	1960[1]	1972[1]	1976[1]	1980[1]	1984[1]	1987[1]	1988[2]	1989[2]
Purse seiners	52	35	24	14	n/a	9	10	2
Mid-Water trawlers	0	0	0	n/a	4	36	61	51

[1] Only St. Jean de Luz + Hendaye.
[2] Provisional figure for the whole French fleet in the Gulf of Biscay.
n/a = Not available.

Table 7.7 Numbers of Spanish purse seiners by year on the Cantabrian coast and estimate of the duration of the main fishing season in spring (from Working Group members).

Year	Number of Boats	Days
1966	571	
1967	574	
1968	580	
1969	569	
1970	550	
1971	519	
1972	492	
1973	451	
1974	433	
1975	390	
1976	354	
1977	338	
1978	323	
1979	308	
1980	293	
1981	281	
1982	280	
1983	278	
1984	269	
1985	269	30
1986	269	20
1987	269	28
1988	267	38
1989	210	34
1990[1]	265	42

[1] Preliminary.

Table 7.8 Daily Egg Production Method - AZTI/SIO. Egg surveys on Anchovy - Bay of Biscay.

Year	1987	1988	1989	1990
Period of year	2-7 June	21-28 May	10-21 May	Average of two surveys
Positive area (km^2)	23.850	45.384	17.546	47.000[1]
Surveyed area (km^2)	34.934	59.840	37.930	79.000[1]
Daily total egg production	$2.198.10^{12}$	$5.015.10^{12}$	$0.73.10^{12}$	
C.V.	0.32	0.21	0.4	
SSB (t)	29.365	63.500	11.860	
C.V.	0.48	0.31	0.41	
Total	1.129	2.673	419	
Coastal egg production	2.319	5.312	328	
No/age : 1	656[2]	2.349[2]	209[3]	
2	331	258	194	
3	76	66	16	
4	41	2	-	
5	25	-	-	
Biomass referred	30.000	63.000	12.000	
Egg abundance			$2.61.10^{12}$	$6.9.10^{12}$

[1] Preliminary data.
[2] Calculated as in Martin and Uriarte (1989).
[3] From sea survey results and commercial catches.

Table 7.9 Evaluation of abundance index from French acoustic surveys

	1983	1984	1989[2]	1990
	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4
Area	3267	3743	5112	3418
Density (t/mille^2)	15.4	10.3	3.0	12.9
Biomass (t)	50,000	38,500	15,500	44,100
Number (10^6)	2,600	2,000	805	3,150
Number of 1-group (10^6)	1,800[1]	600[1]	400	3,000

[1] Rough estimation.
[2] Assumption of overestimate.

Table 7.10 Summary of egg and acoustic surveys on Bay of Biscay Anchovy.

Year	1983	1984	1985	1986	1987	1988	1989	1990
SSB(tonnes)	-	-	-	-	29,365	63,500	11,860	(---?)
Positive area for Egg (km^2)	-	-	-	-	23,850	45,384	17,546	47,000
Acoustic biomass (tonnes)	50,000	38,500	-	-	-	-	15,500	44,100
Acoustic stock in numbers (millions)	2,600	2,000	-	-	-	-	805	3,150
Egg survey (1-year-old)	65	-	-	-	656	2,349	209	?
Acoustic survey (1-year-old)	1,800	600	-	-	-	-	440	3,000
Y.C.C[0]	1,444	352	177	267	340	505[1]	157[2]	890[2]
Catch	14,153	35,179	11,486	7,923	14,924	15,009	10,374	17,130

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

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 1 and 2 year old anchovies.
[2] Incomplete Y.C.C. only 1 year old anchovies.

Table 7.11. 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	17	86	103	0	17	86	103
8	0	0	0	0	11	27	1577	1615	11	27	1577	1615
8.5	0	0	0	0	17	119	3368	3504	17	119	3368	3504
9	0	0	0	0	4	420	3587	4011	4	420	3587	4011
9.5	0	4	0	4	15	738	3443	4197	15	743	3443	4201
10	60	0	77	137	50	1132	7485	8667	110	1132	7562	8804
10.5	602	76	229	907	282	1220	11739	13241	883	1296	11969	14148
11	2676	98	798	3573	727	1208	12815	14750	3404	1306	13613	18324
11.5	4362	215	1007	5585	825	1094	10465	12384	5187	1309	11472	17968
12	6683	1536	1881	10100	1011	1076	16658	18746	7694	2612	18539	28845
12.5	6976	465	3348	10789	709	1285	25295	27289	7685	1750	28643	38078
13	8395	1326	6281	16003	722	1320	26628	28671	9118	2646	32910	44673
13.5	9288	1072	10754	21114	639	969	21972	23580	9927	2041	32726	44694
14	7829	1870	16760	26459	896	611	14990	16496	8725	2481	31750	42955
14.5	7409	1288	17425	26122	508	169	6348	7024	7916	1457	23773	33146
15	6357	1618	23779	31755	1529	35	2281	3845	7886	1653	26061	35600
15.5	9999	2506	24281	36786	113	10	874	997	10111	2516	25156	37783
16	8902	2277	23160	34339	2226	31	788	3045	11128	2308	23948	37384
16.5	5406	2020	18355	25781	652	10	1724	2386	6058	2030	20079	28167
17	3115	605	12266	15986	1181	20	3241	4442	4296	625	15506	20428
17.5	1312	271	6772	8355	135	0	3427	3562	1447	271	10199	11917
18	60	56	2200	2317	59	0	2712	2770	119	56	4912	5087
18.5	0	79	411	489	18	0	1608	1626	18	79	2019	2115
19	54	4	352	410	0	0	0	0	54	4	352	410
19.5	0	0	0	0	0	0	0	0	0	0	0	0
Total N	89485	17387	170138	277009	12328	11511	183126	206966	101813	28898	353264	483975
Catch(t)	1944	436	4941	7321	256	122	2674	3052	2200	558	7615	10373
SOP	1986	431	4633	7050	283	143	2970	3395	2268	574	7603	10445
%	102	99	94	96	110	117	111	111	103	103	100	101

Table 7.12 Anchovy in the Bay of Biscay.

CATCH IN NUMBERS UNIT: millions

	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
1	52	195	368	157
2	80	186	128	137
3	63	41	29	17
4	54	22	3	0
5+	0	12	1	0
TOTAL	249	456	529	311

Table 7.13. Half yearly catches and at age ('000) of Bay of Biscay anchovy, by country and divisions in 1989.

ANCHOVY IN THE BAY OF BISCAY

CATCH IN NUMBERS

AGE	SEMESTER 1				SEMESTER 2				TOTAL		
	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL VIII
0	0	0	0	0	6516	11511	155004	173031	6516	11511	155004	173031
1	46334	9005	94060	149399	2055	0	5360	7415	48389	9005	99420	156814
2	37309	8197	79733	125239	3575	0	7814	11389	40884	8197	87547	136628
3	5842	348	7431	13621	181	0	3204	3385	6023	348	10635	17006
4	0	0	56	56	0	0	0	0	0	0	56	56
5	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL Nº	89485	17550	181280	288315	12327	11511	171382	195220	101812	29061	352662	483535
CATCH (t)	1944	436	4941	7321	256	122	2674	3052	2200	558	7615	10373
SOP	1895	374	4588	6857	228	114	2655	2997	2123	488	7243	9854
%	97.48	85.78	92.86	93.66	89.06	93.44	99.29	98.20	96.50	87.46	95.11	95.00

Table 7.14 Anchovy in the Bay of Biscay.

MEAN WEIGHT AT AGE IN THE CATCH UNIT: kilogram

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	.018	.018	.009	.009	.009	.009	.009	.018	.018	.018	.017	.017
2	.029	.029	.021	.021	.021	.021	.021	.029	.029	.029	.028	.028
3	.034	.034	.034	.034	.034	.034	.034	.034	.034	.034	.030	.033
4	.041	.041	.051	.051	.051	.051	.051	.041	.041	.041	.029	.044
5+	.042	.042	.051	.051	.051	.051	.051	.042	.042	.042	.042	.042

	1986	1987	1988	1989
1	.016	.021	.021	.019
2	.028	.033	.031	.027
3	.035	.038	.035	.029
4	.037	.041	.040	.027
5+	.042	.042	.039	.040

Table 7.15. 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

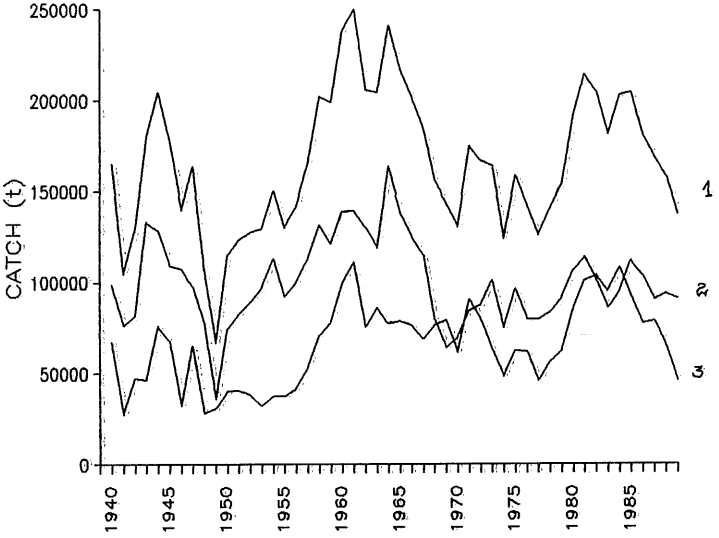
AGE	SEMESTER 1				SEMESTER 2				TOTAL			
	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL	FRANCE VIIIab	SPAIN VIIIb	SPAIN VIIIc	TOTAL VIII
0	0.00	0.00	0.00	0.00	10.00	9.82	13.23	12.88	10.00	9.82	13.23	12.88
1	17.90	16.34	21.33	19.96	25.00	0.00	28.54	27.56	18.20	16.34	19.27	18.77
2	24.50	26.63	29.77	27.99	29.20	0.00	39.38	36.19	24.91	26.64	27.60	26.74
3	26.00	24.52	27.98	27.04	37.00	0.00	42.74	42.44	26.33	24.52	30.21	28.72
4	0.00	0.00	27.46	27.46	0.00	0.00	0.00	0.00	0.00	0.00	27.46	27.46
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 7.16 Estimation of F for the different age groups from a synthetic cohort of anchovy with different assumptions for M (0.6 - 1.2)

Age	Mean Catch (1983-1989) in millions	M = 0.6		M = 0.8		M = 1.0		M = 1.2	
		H1	H2	H1	H2	H1	H2	H1	H2
1	196	0.17	0.18	0.10	0.12	0.06	0.07	0.02	0.04
2	230	0.50	0.56	0.33	0.42	0.23	0.28	0.09	0.16
3	101	0.73	0.91	0.48	0.71	0.36	0.50	0.16	0.28
4	22	0.55	0.90	0.35	0.70	0.30	0.48	0.13	0.27

H1 = F similar for ages 2, 3 and 4.
H2 = F similar for ages 3 and 4.

FIGURE 2.1. SARDINE - TOTAL CATCH
AND BY COUNTRY DURING 1940 - 1989



1 - TOTAL 2 - PORTUGAL 3 - SPAIN

FIGURE 2.2.- LOG CATCHABILITY PLOT
AGE 0

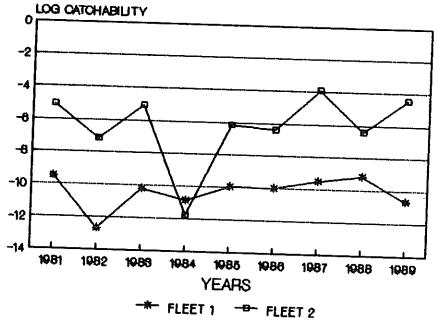


FIGURE 2.2.- LOG CATCHABILITY PLOT
AGE 1

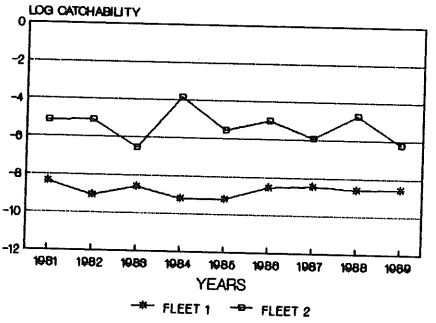


FIGURE 2.2 - LOG CATCHABILITY PLOT
AGE 2

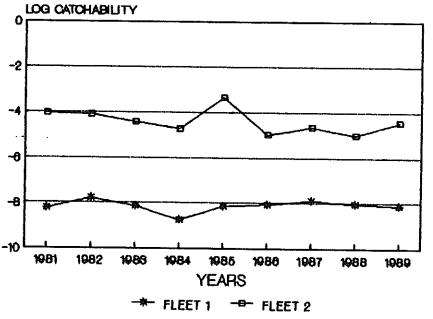


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FIGURE 2.2.- LOG CATCHABILITY PLOT
AGE 3

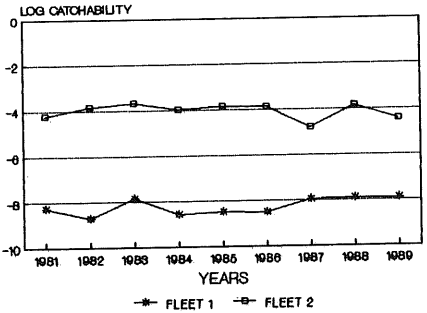


FIGURE 2.2.- LOG CATCHABILITY PLOT
AGE 4

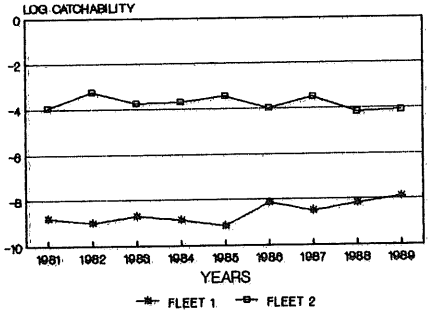
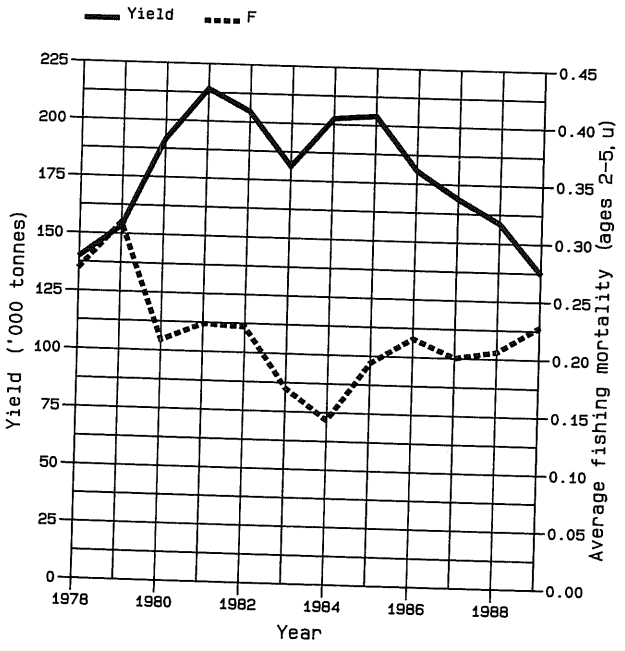


Figure 2.3

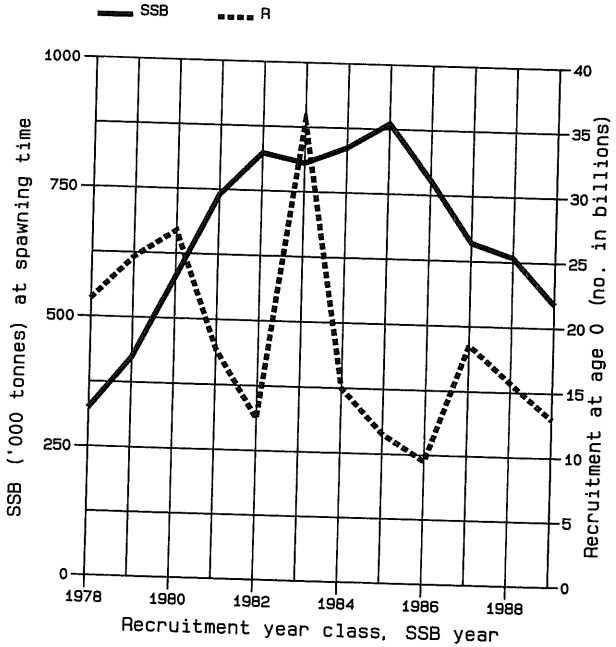
FISH STOCK SUMMARY
STOCK: Sardine – VIIIc and IXa
18-07-1990

Trends in yield and fishing mortality (F)



A

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



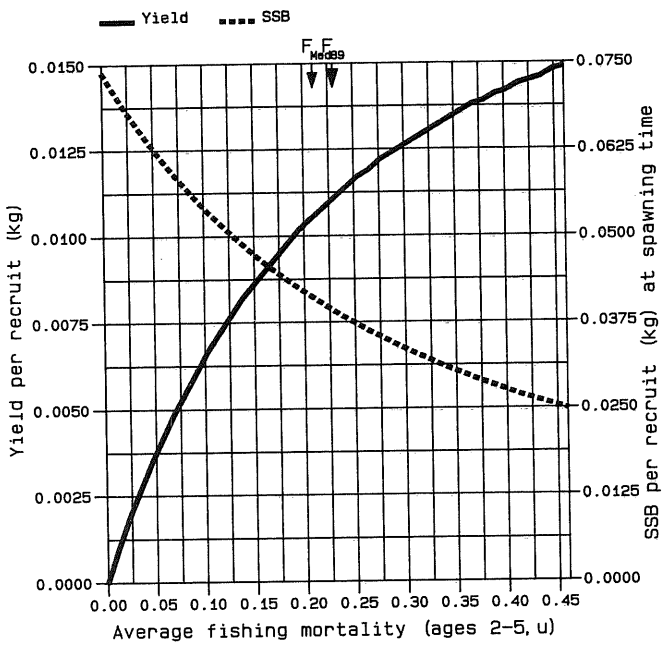
B

cont'd.

Figure 2.3 cont'd.

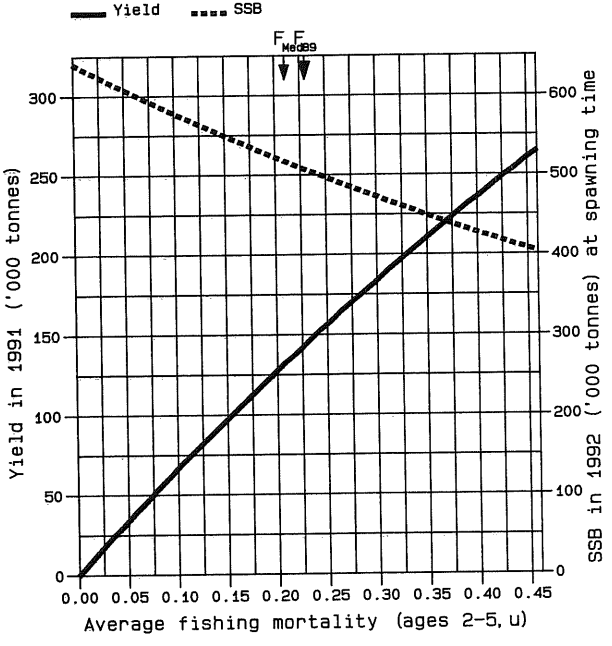
FISH STOCK SUMMARY
STOCK: Sardine – VIIIc and IXa
18–07–1990

Long-term yield and spawning stock biomass



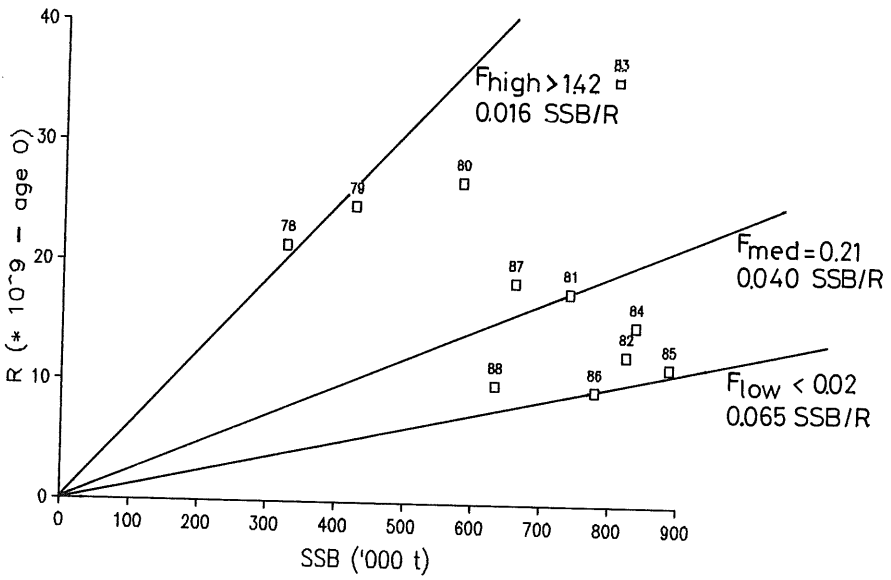
C

Short-term yield and spawning stock biomass



D

Figure 2.4 – SARDINE – RECRUITMENT vs.
SPAWNING STOCK BIOMASS AT SPAWNING TIME



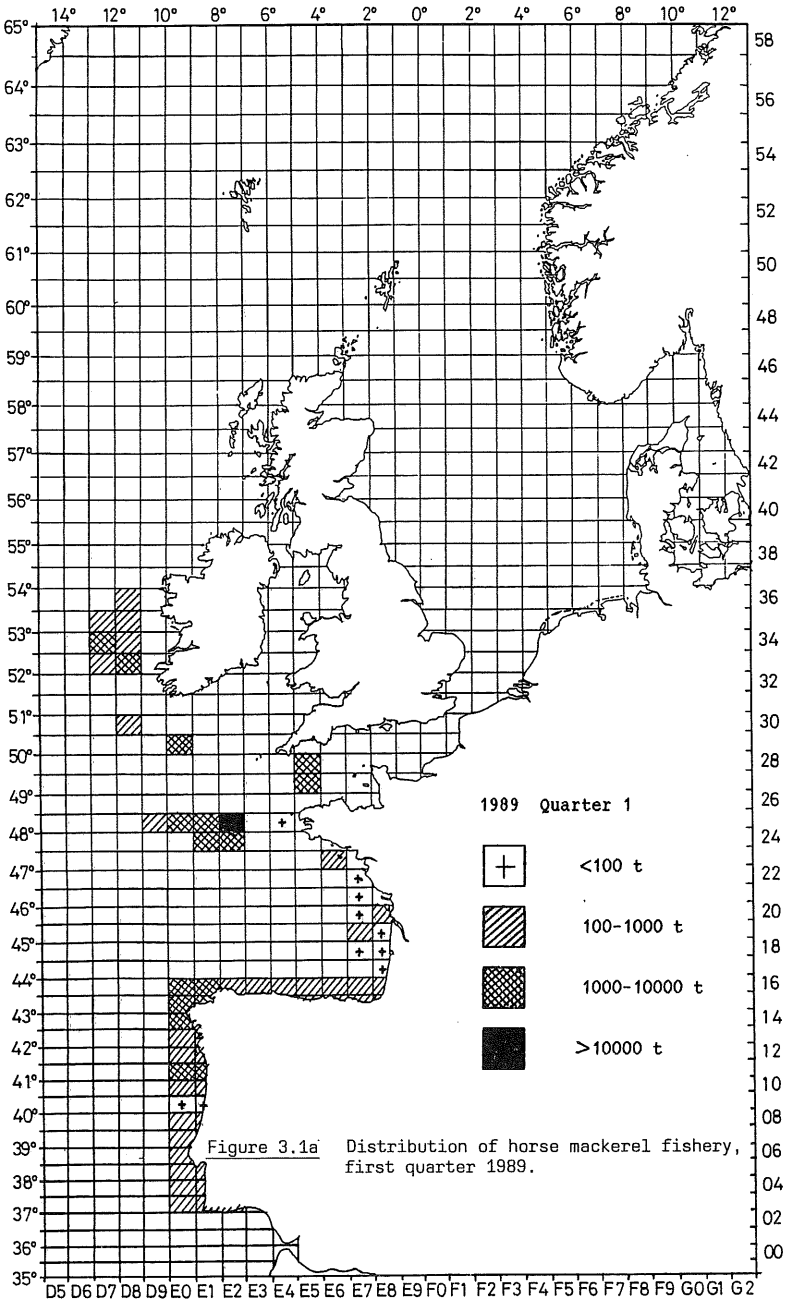


Figure 3.1a Distribution of horse mackerel fishery, first quarter 1989.

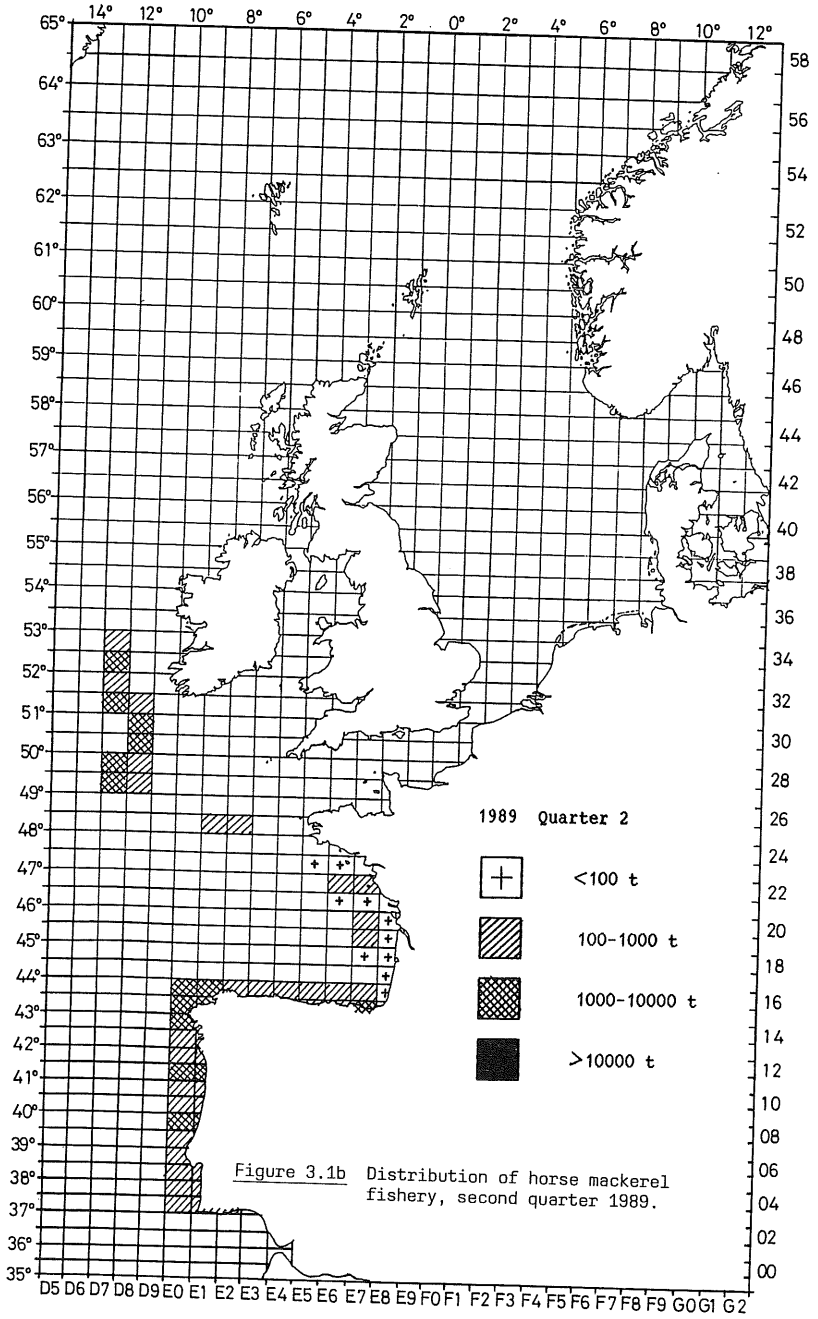


Figure 3.1b Distribution of horse mackerel fishery, second quarter 1989.

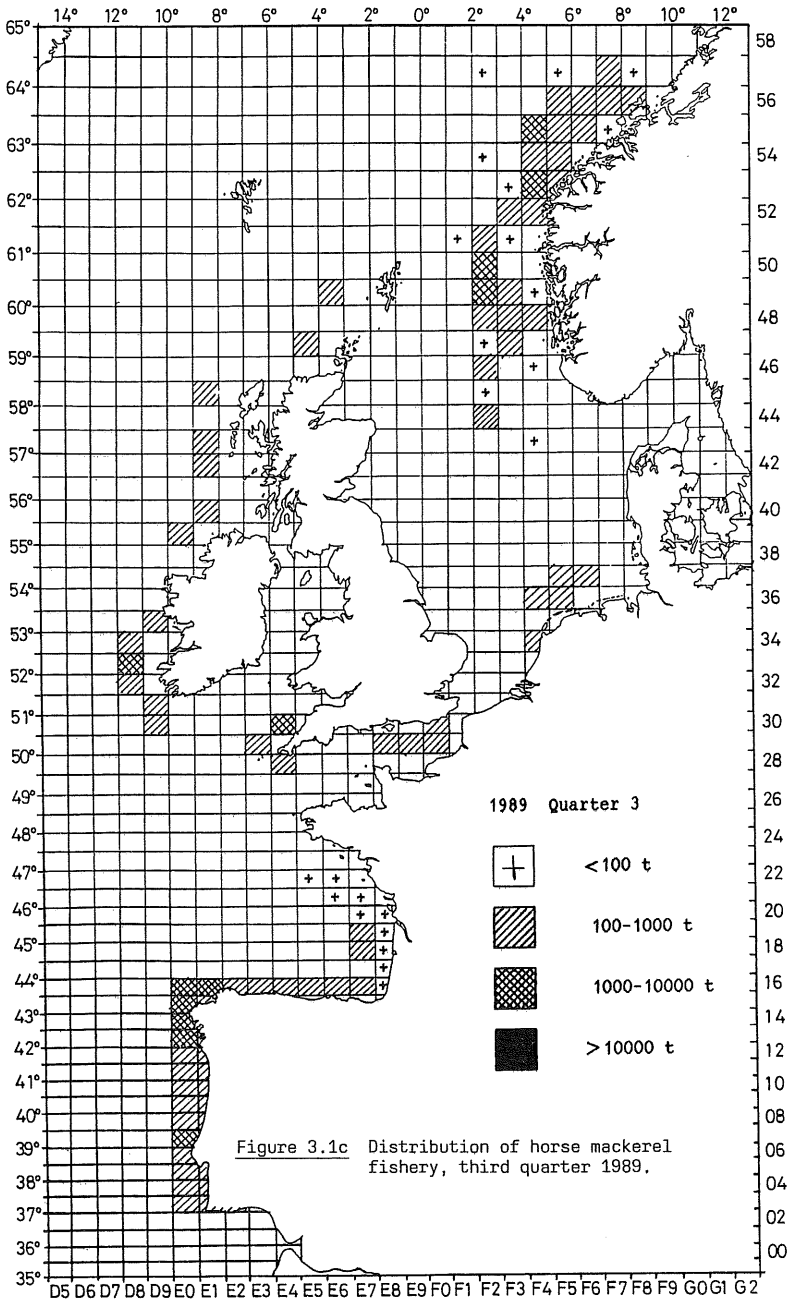


Figure 3.1c Distribution of horse mackerel fishery, third quarter 1989.

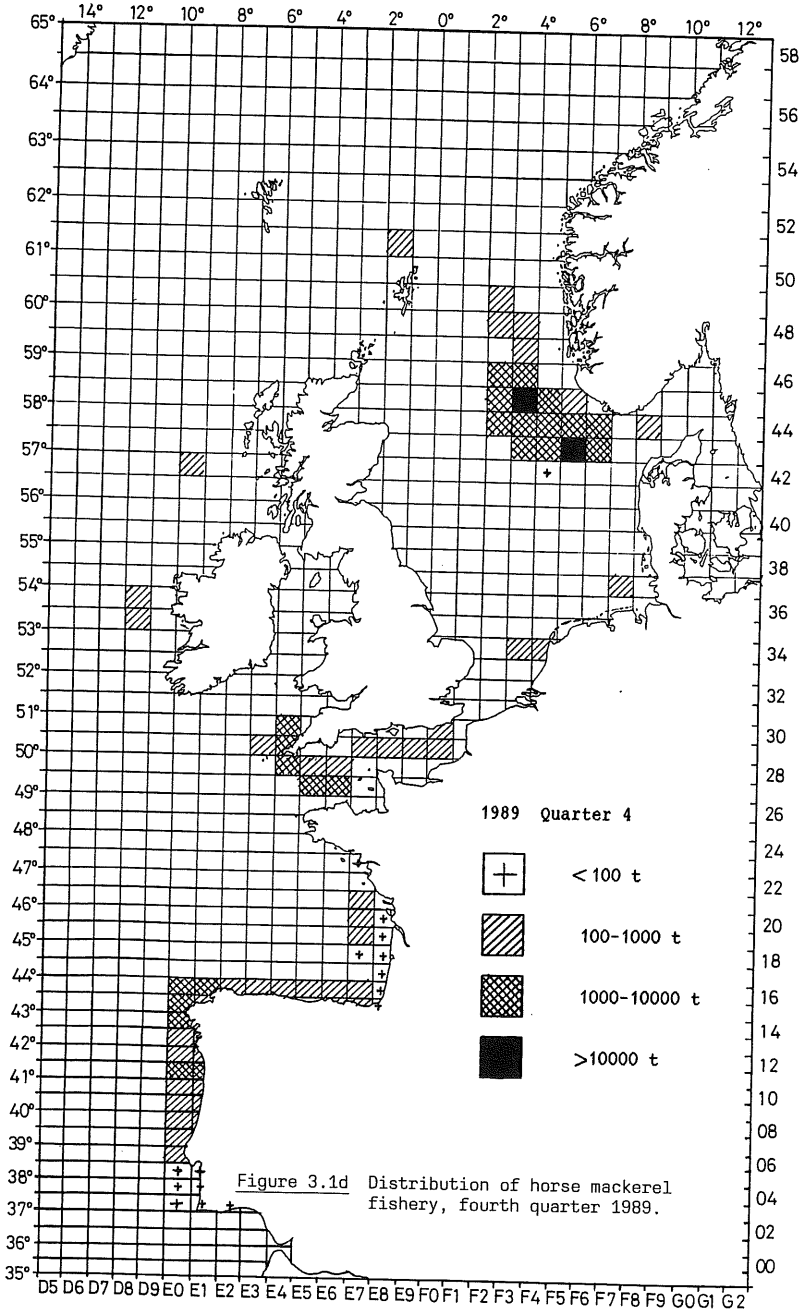


Figure 3.1d Distribution of horse mackerel fishery, fourth quarter 1989.

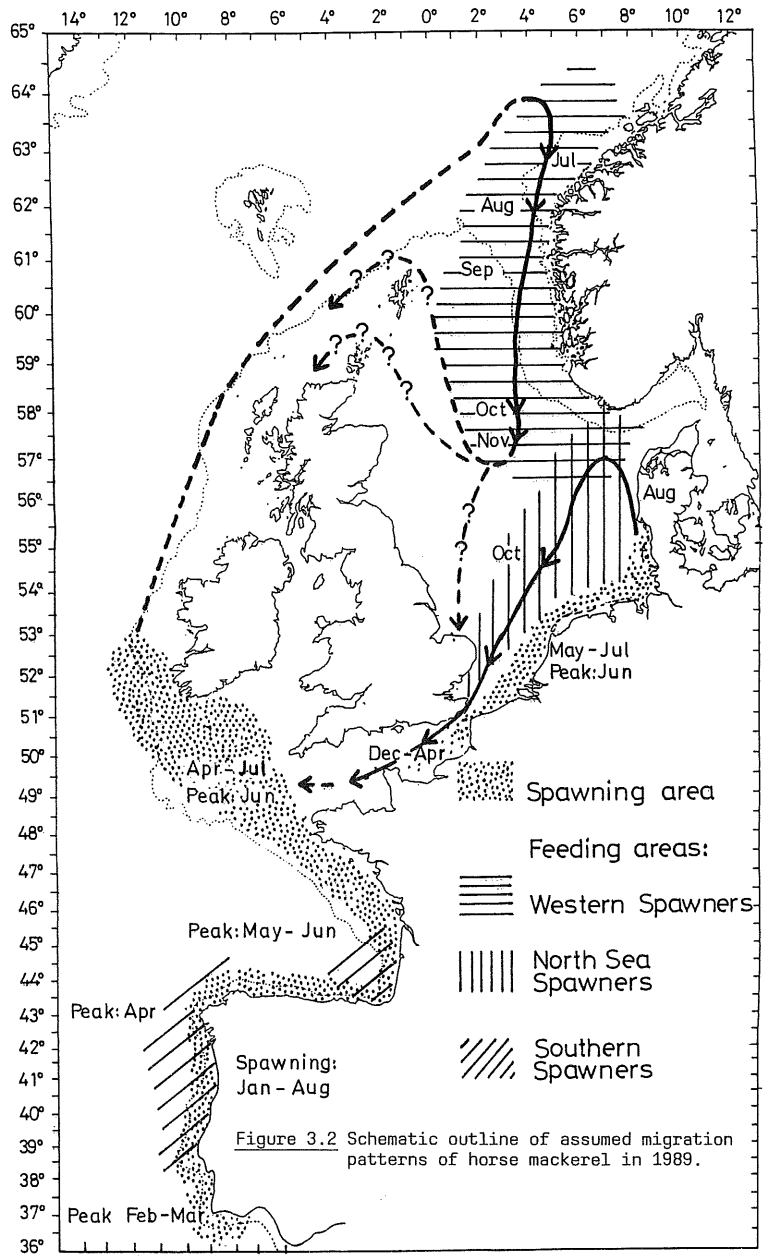


Figure 3.2 Schematic outline of assumed migration patterns of horse mackerel in 1989.

Figure 3.3 Catches of horse mackerel from Dutch GOV trawl surveys in the third and fourth quarter during the years 1985-1987.

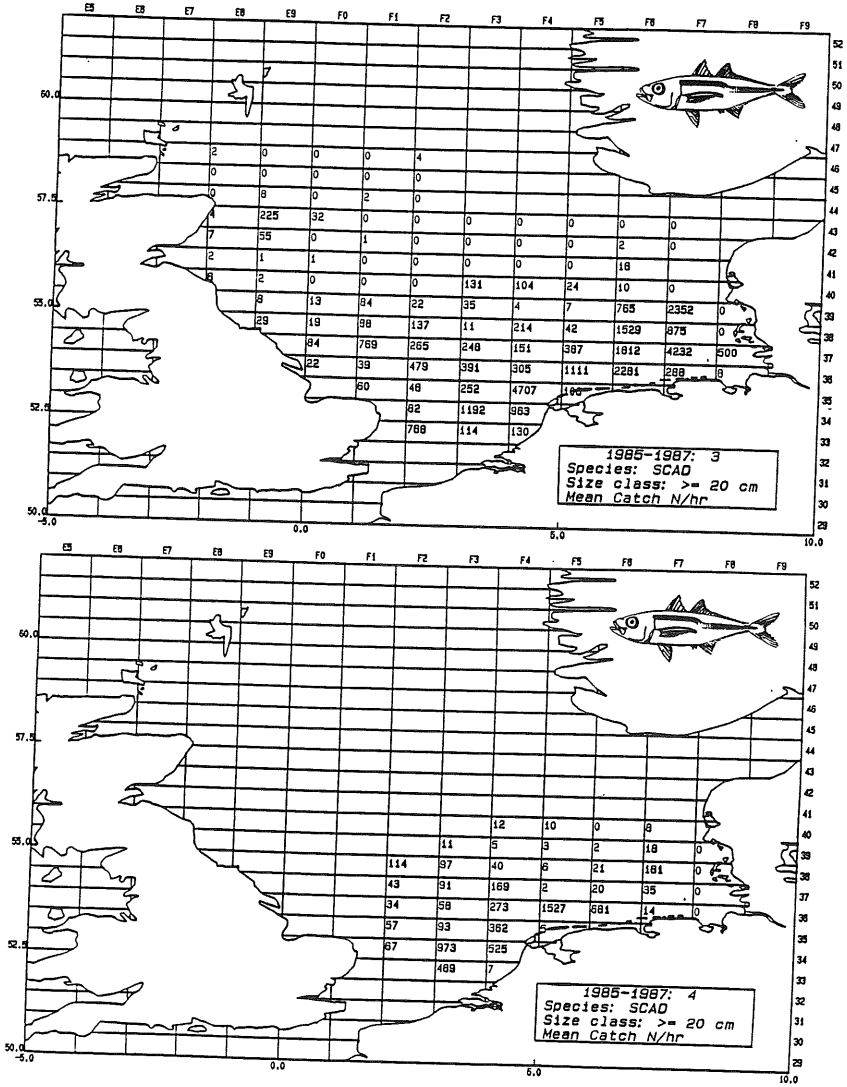


Figure 3.4 Age compositions in percentage of the catch of the North Sea, Western and Southern horse mackerel in 1980.

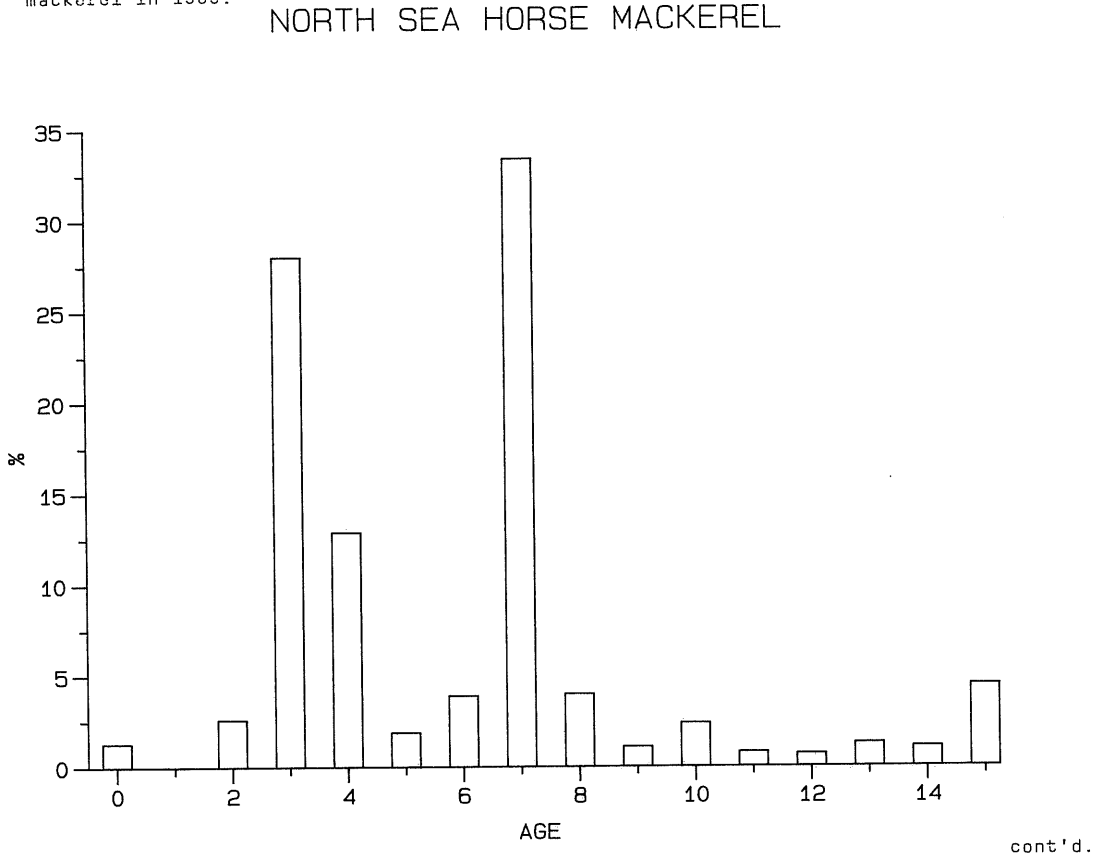


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Figure 3.4 cont'd.

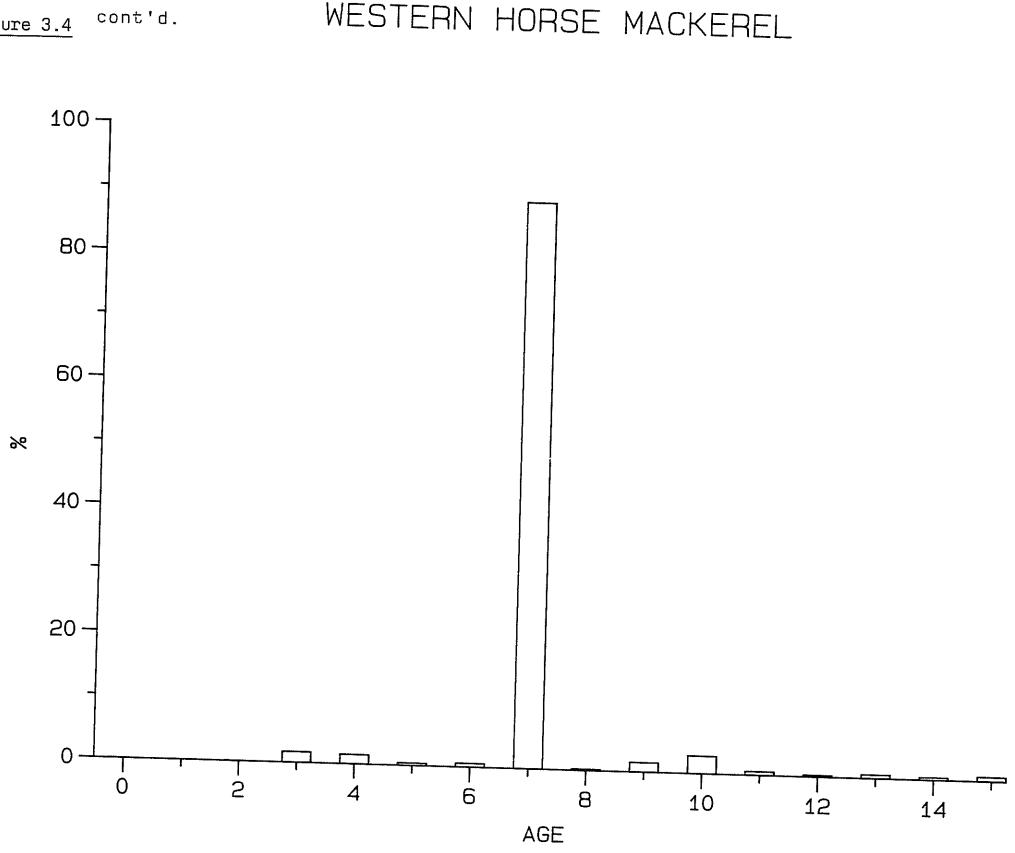

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Figure 3.4 cont'd.

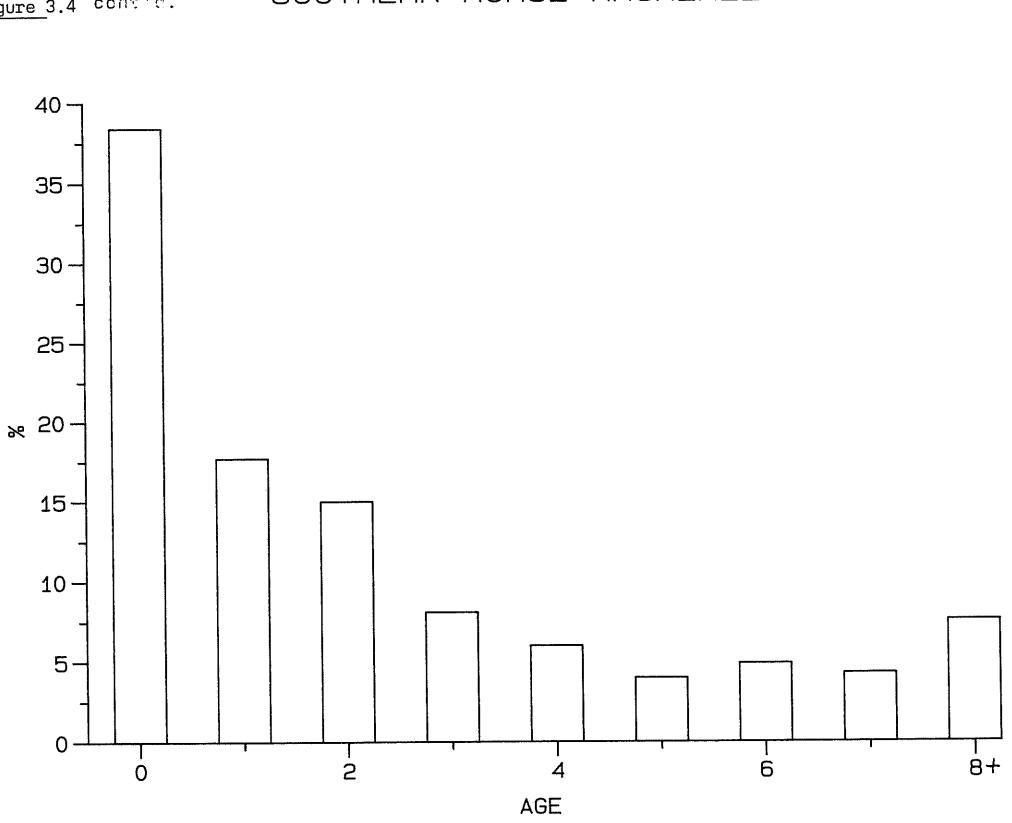


Figure 4.1 Production curves for stage I horse mackerel eggs for the total area covered by egg surveys in the North Sea in 1988 and 1989.

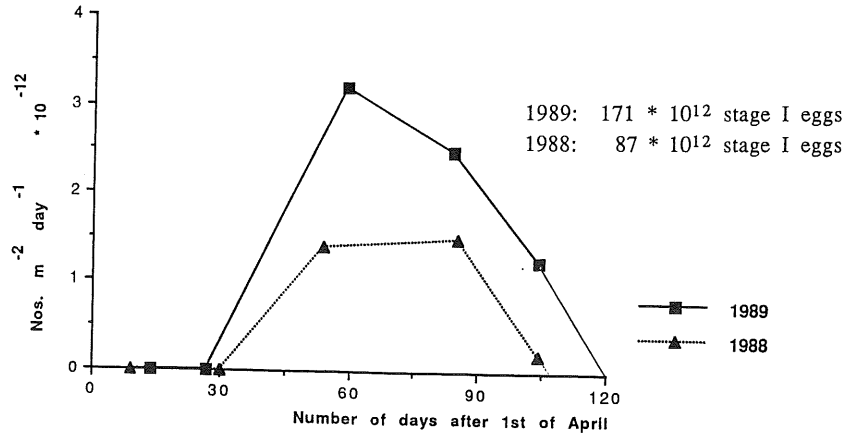
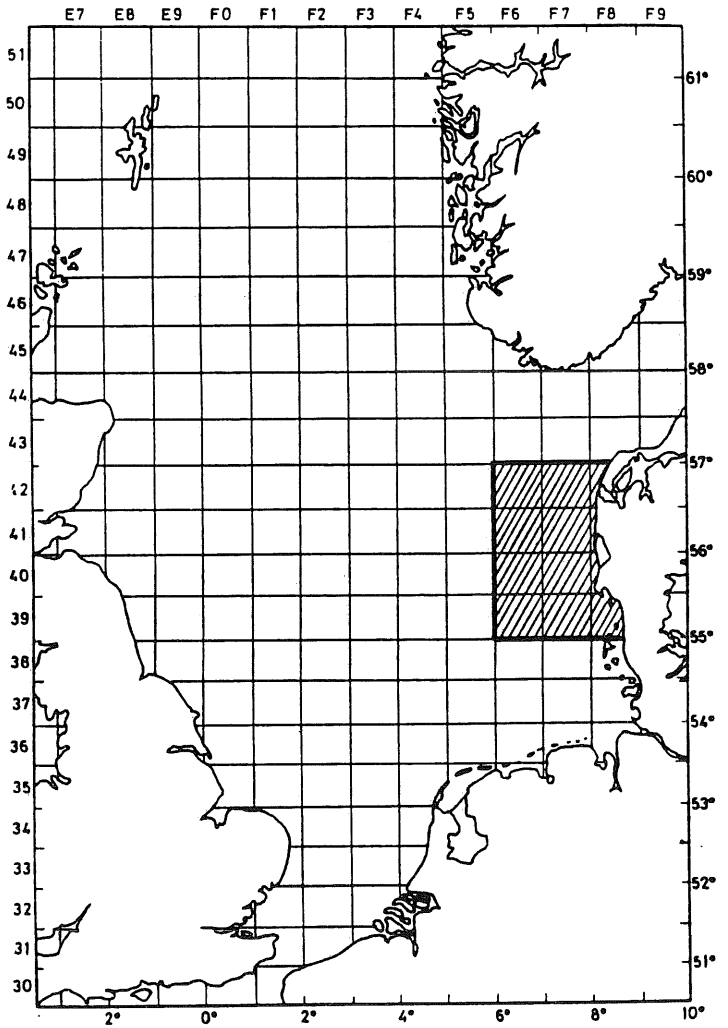


Figure 4.2 The standard area covered by the Danish acoustic surveys in 1985-1989.



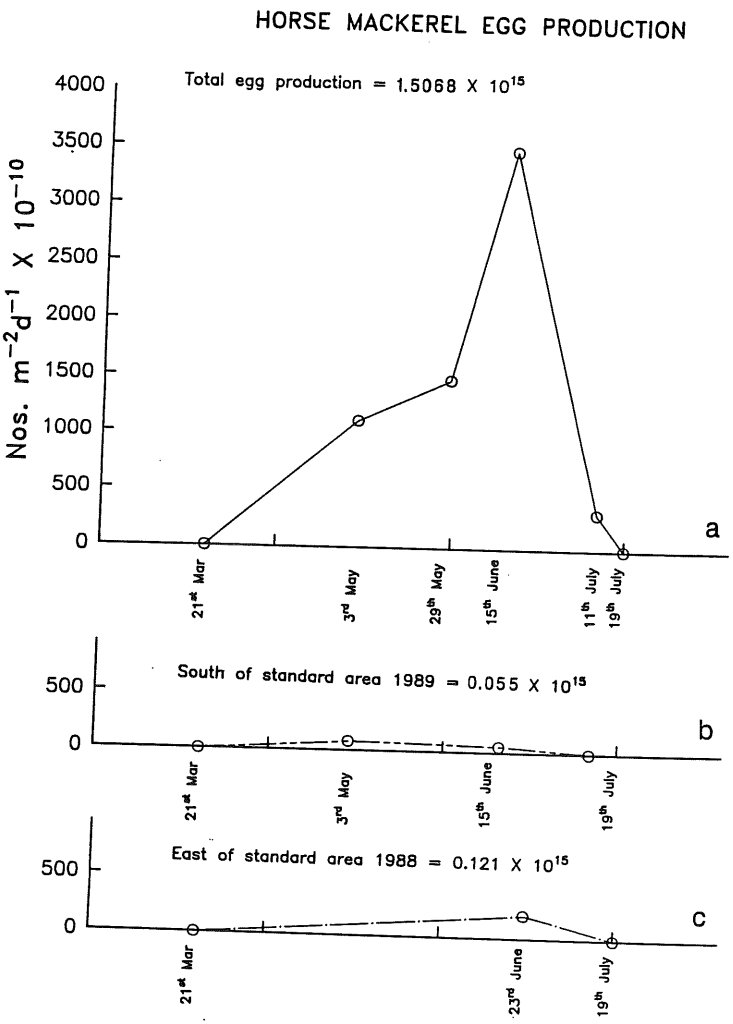


Figure 5.1 Production curves for stage I horse mackerel eggs for a) the standard survey area in 1989; b) the area south of the standard area (S of 44°30'N) in 1989; c) the area east of the 1989 sampled area in 1988.

Figure 5.2 Horse mackerel Western stock. Selection patterns assuming various terminal S values.

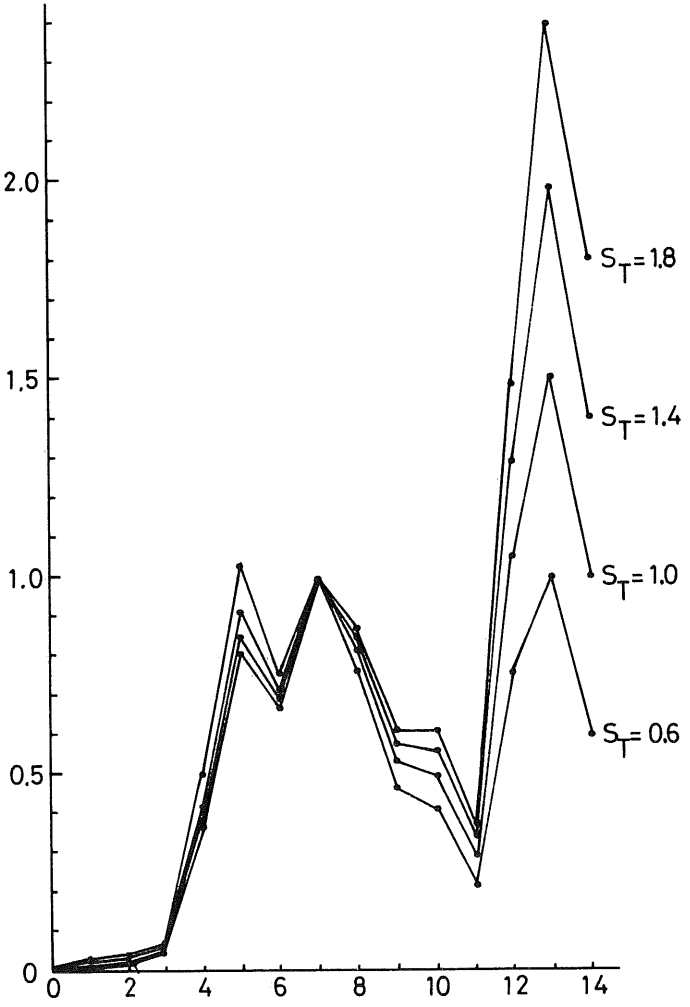


Figure 5.3 Age composition of horse mackerel in the Dutch catches in Sub-areasVI and VII in 1989.

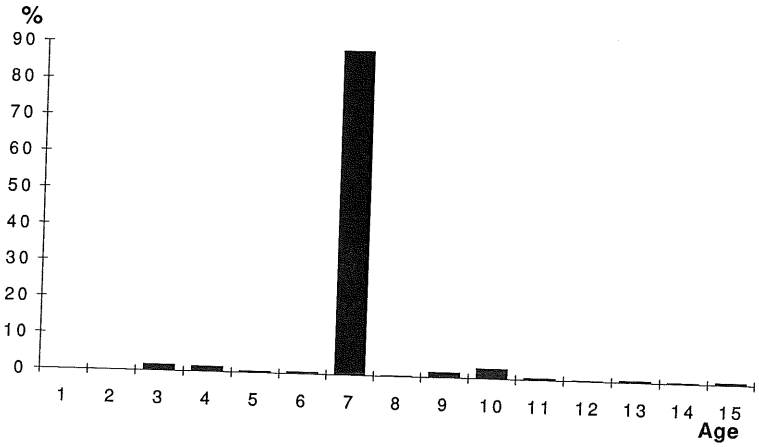


Figure 5.4 Horse mackerel Western stock. Selection patterns assuming three different terminal S values.

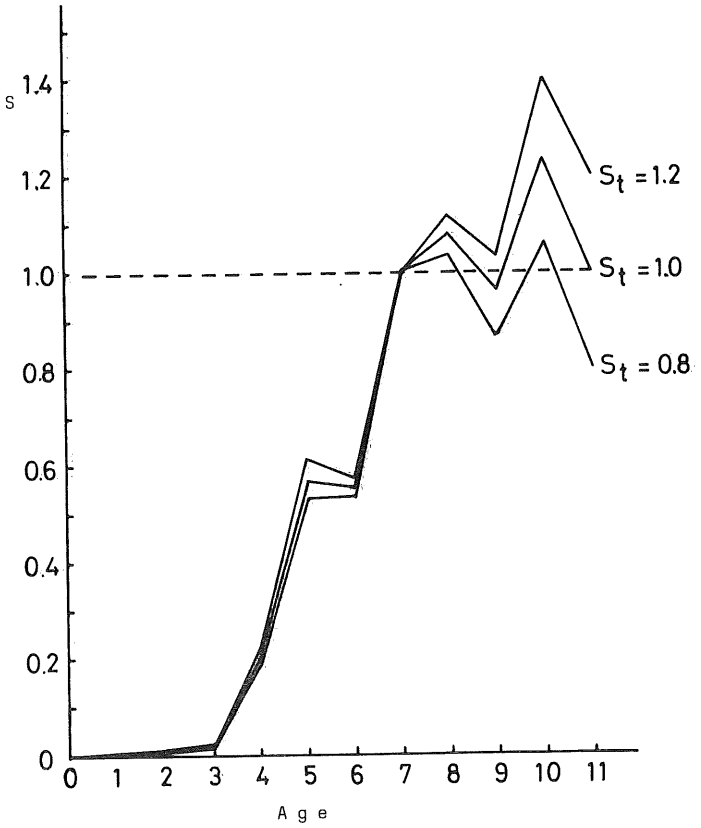


Figure 5.5 Development of the biomass of Western horse mackerel treated as one cohort (1982 year class) with a yearly catch of 300,000 t from 1990 and onwards.

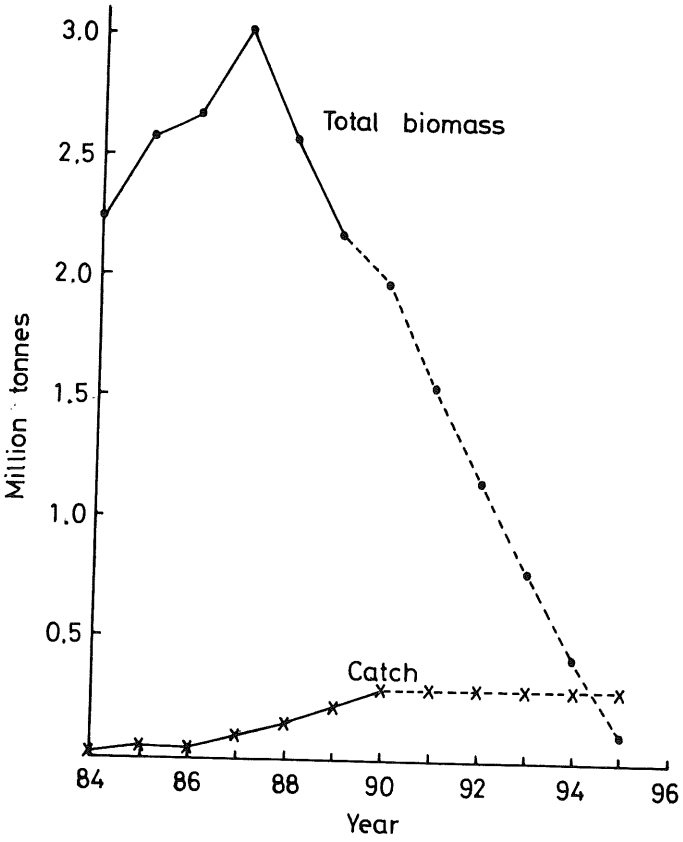
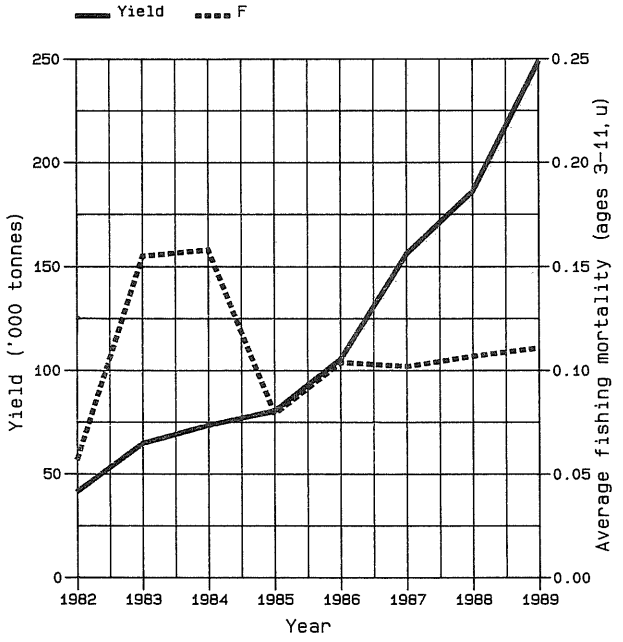


Figure 5.6

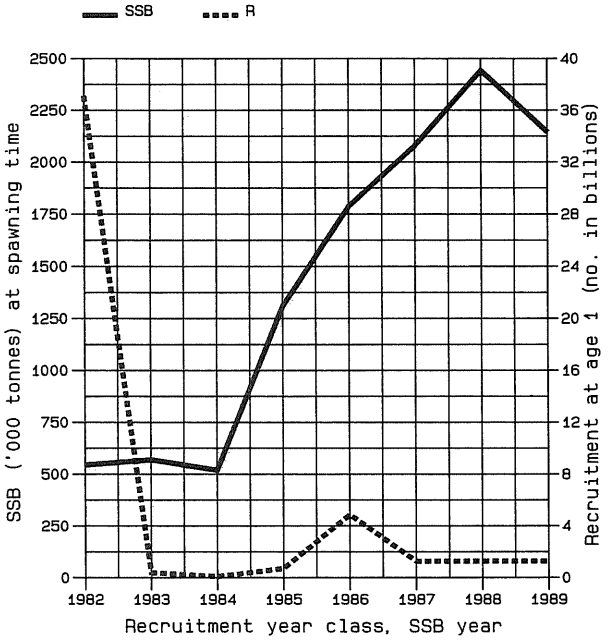
FISH STOCK SUMMARY
STOCK: Western Horse Mackerel
19-07-1990

Trends in yield and fishing mortality (F)



A

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

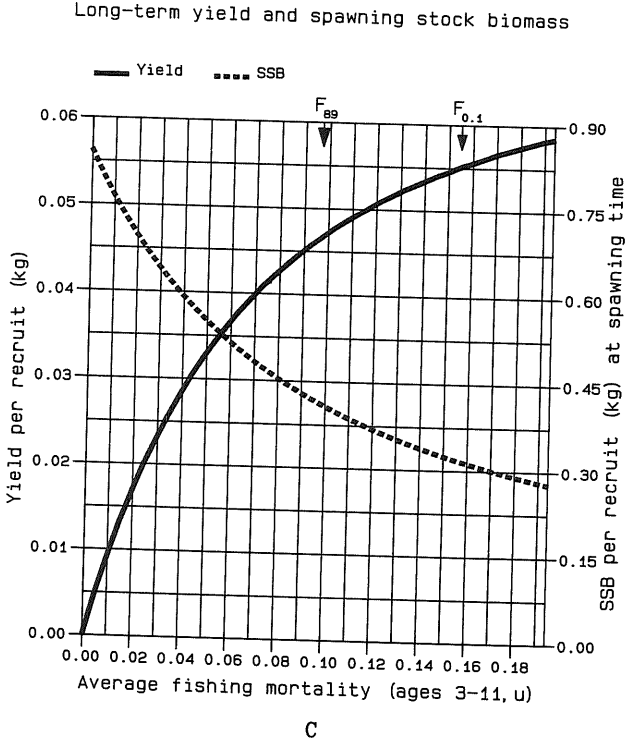


B

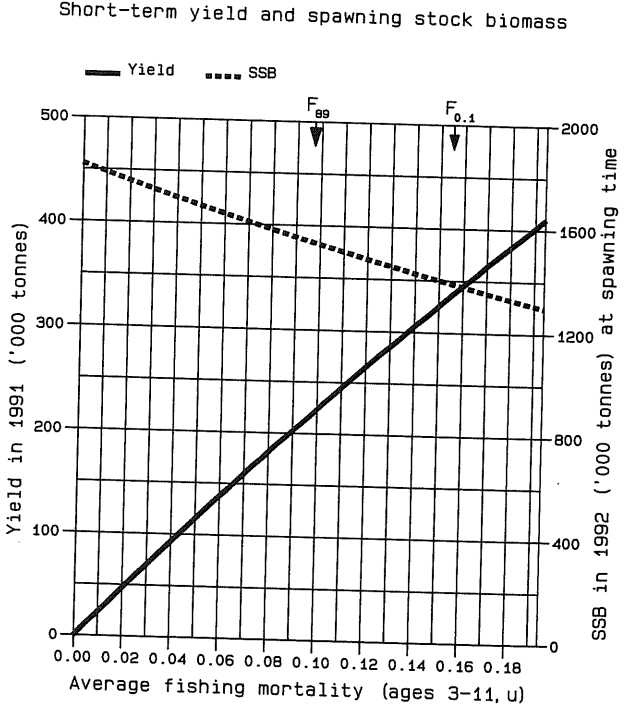
cont'd.

Figure 5.6 cont'd.

FISH STOCK SUMMARY
STOCK: Western Horse Mackerel
19-07-1990



C



D

Figure 6.1 Southern horse mackerel.

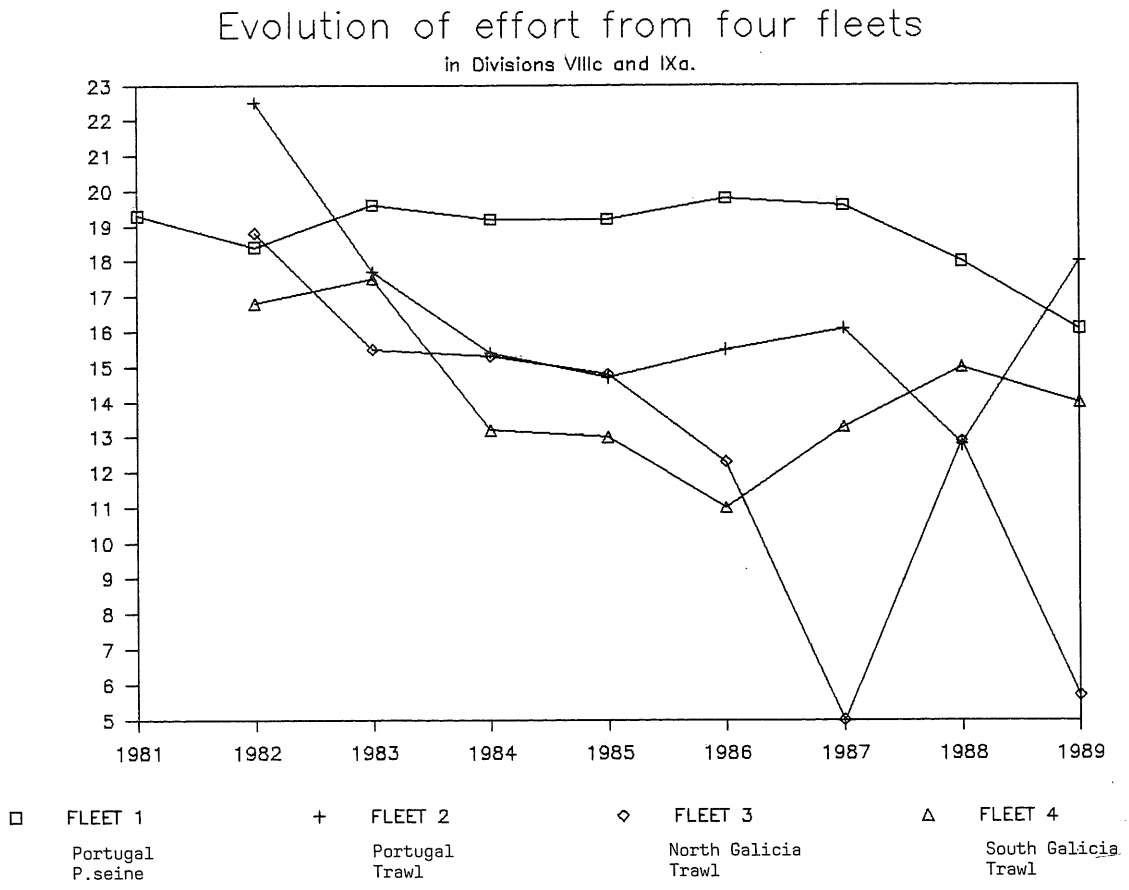


Figure 6.2 Southern horse mackerel.

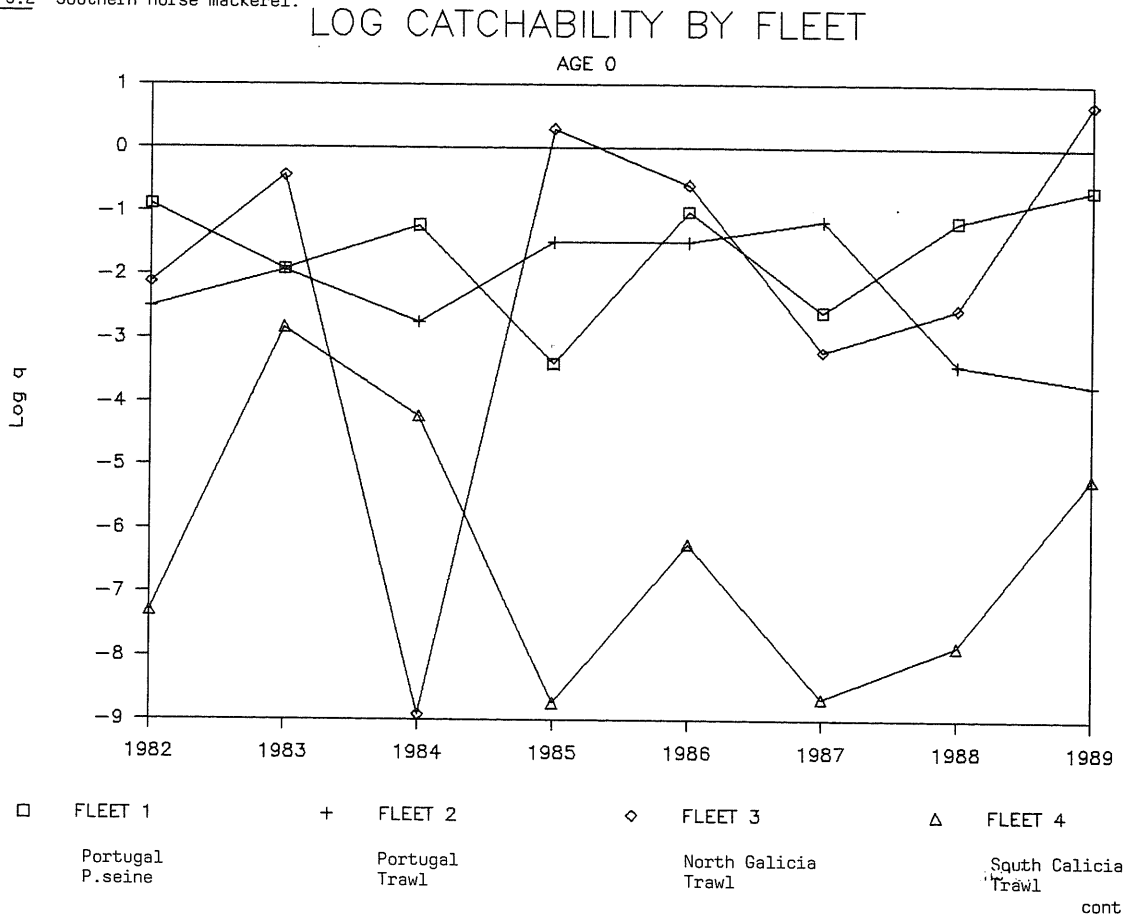


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Figure 6.2 cont'd.

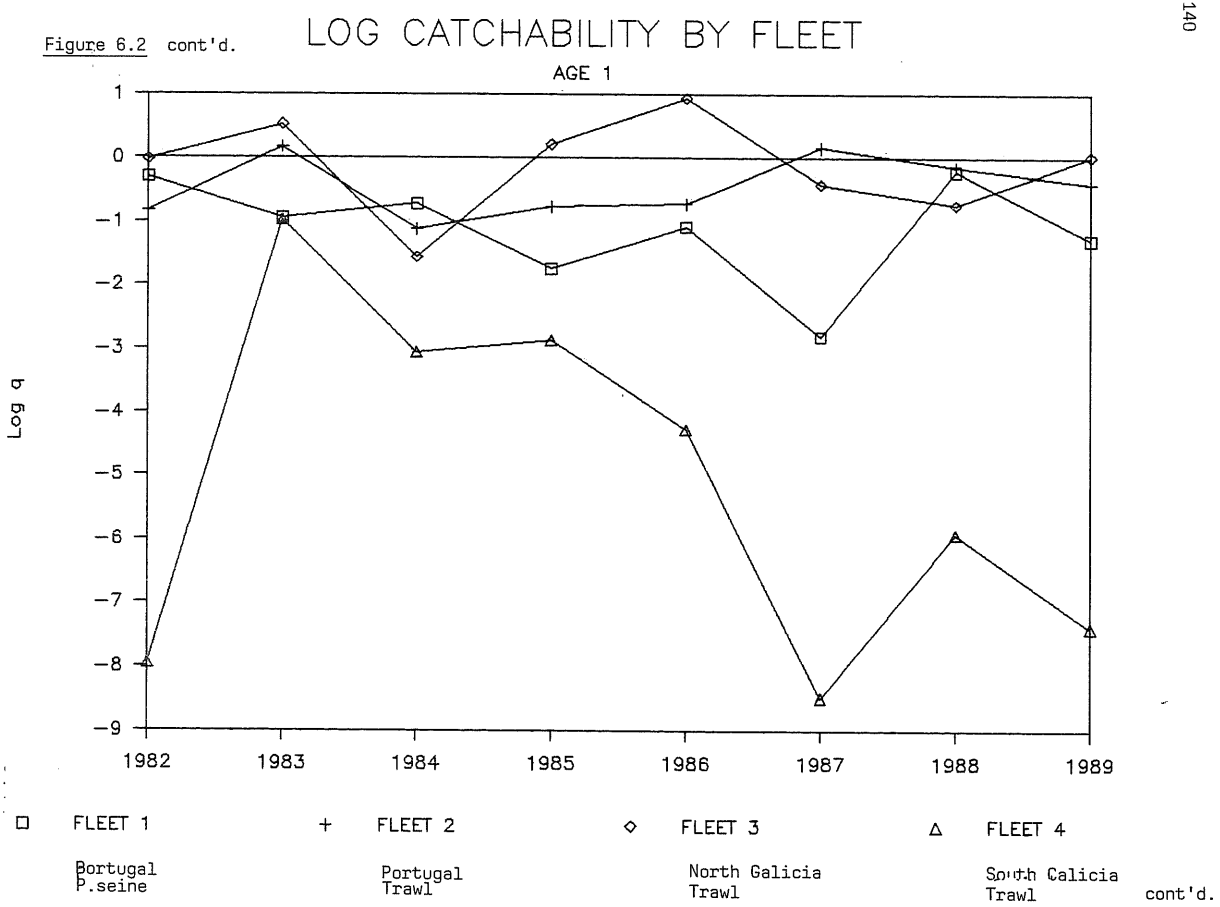

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Figure 6.2 cont'd.

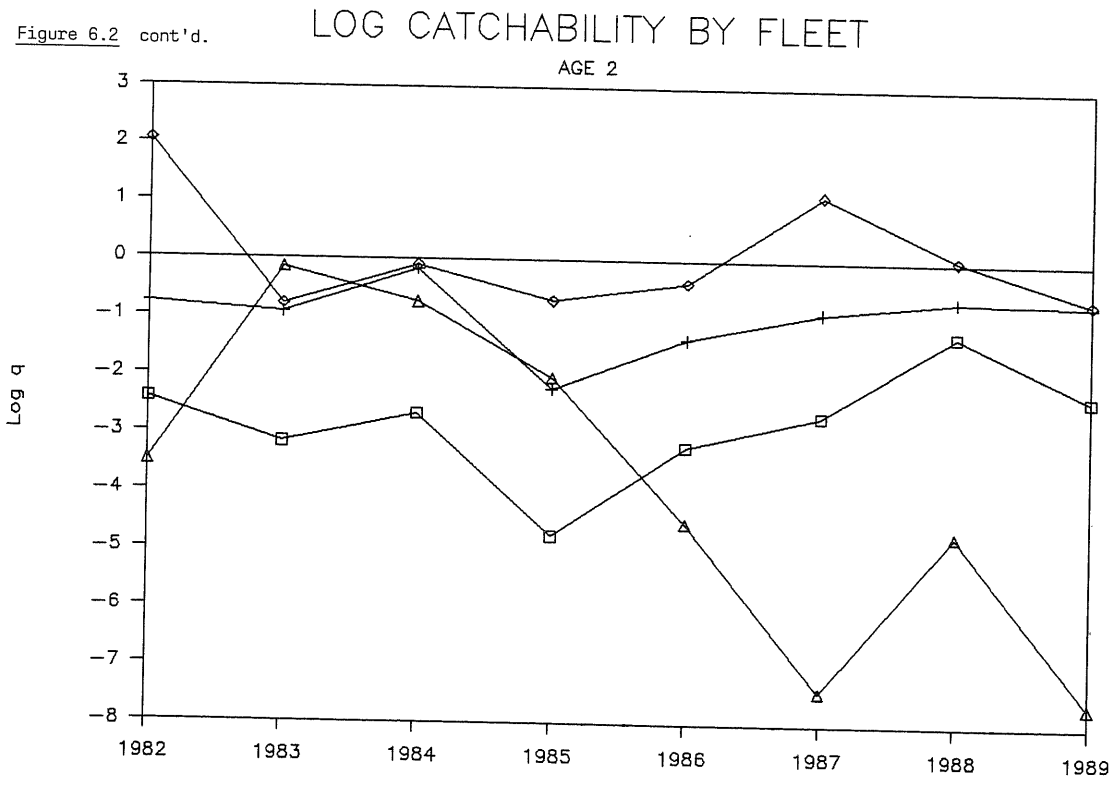

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Figure 6.2 cont'd.

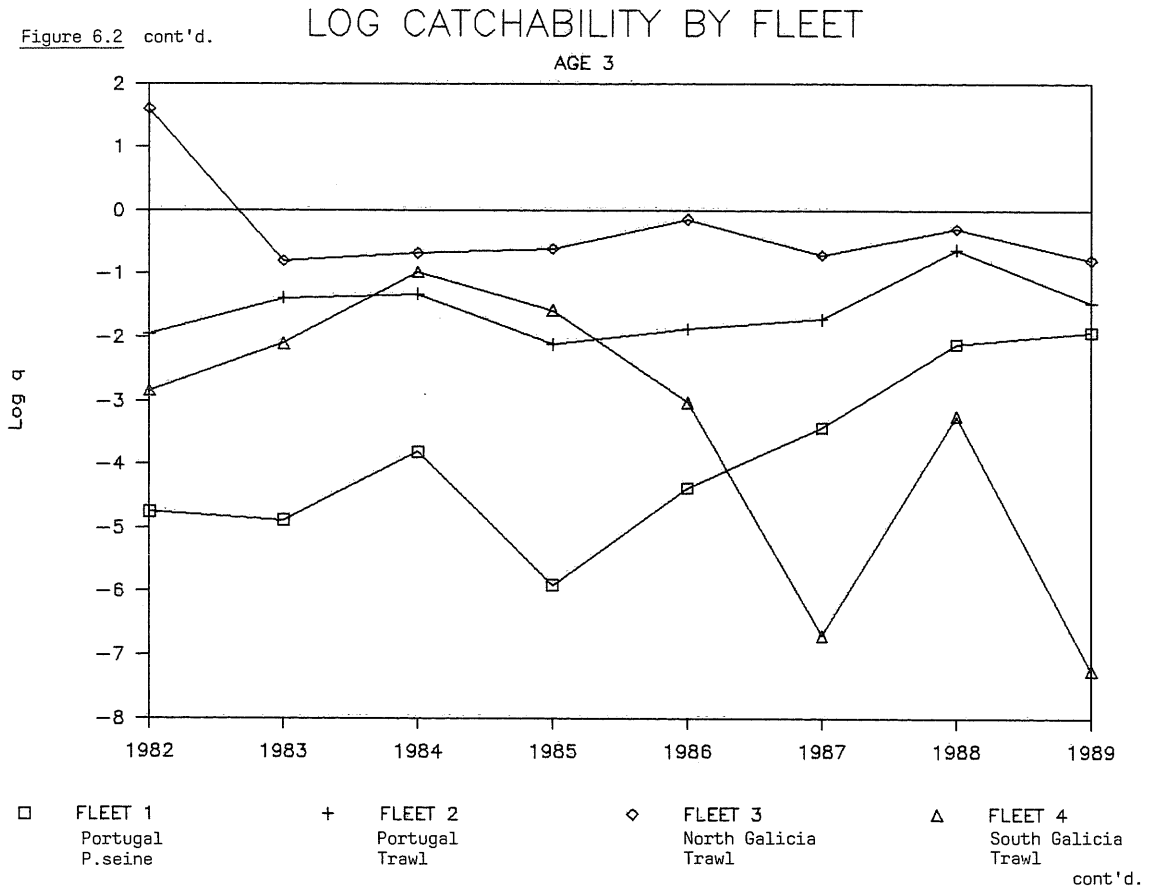

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Figure 6.2 cont'd.

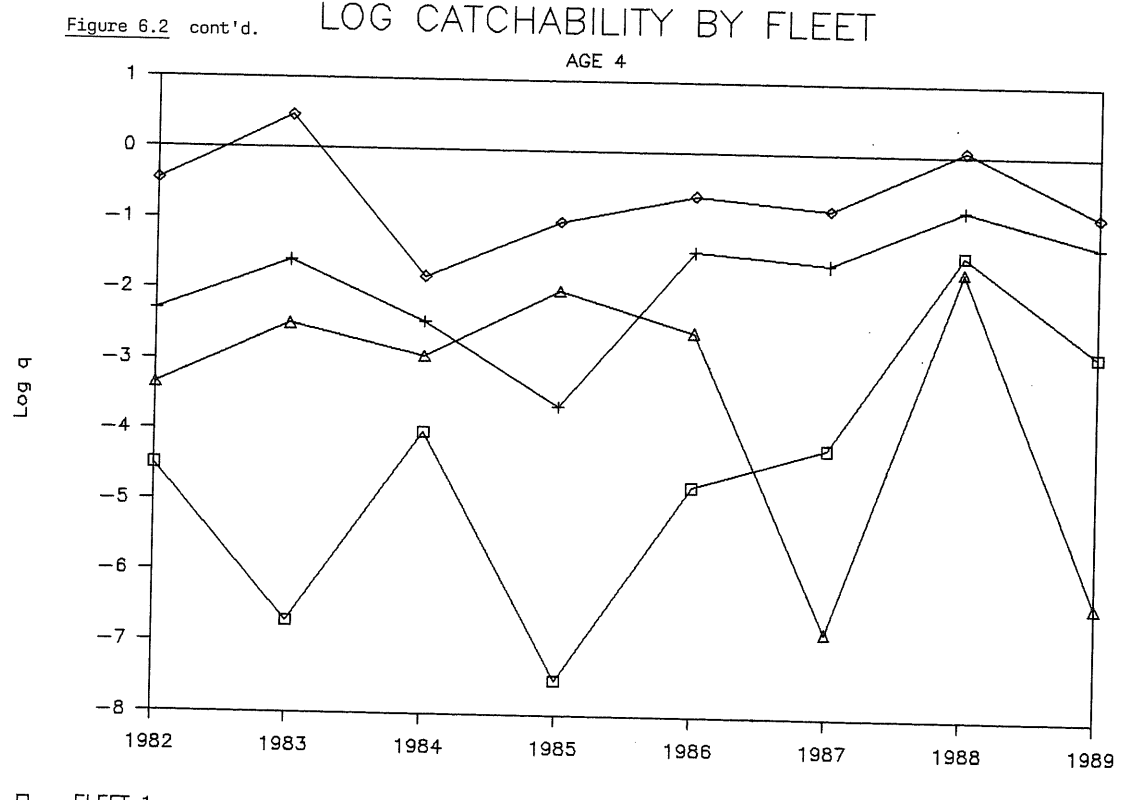

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Figure 6.2 cont'd.

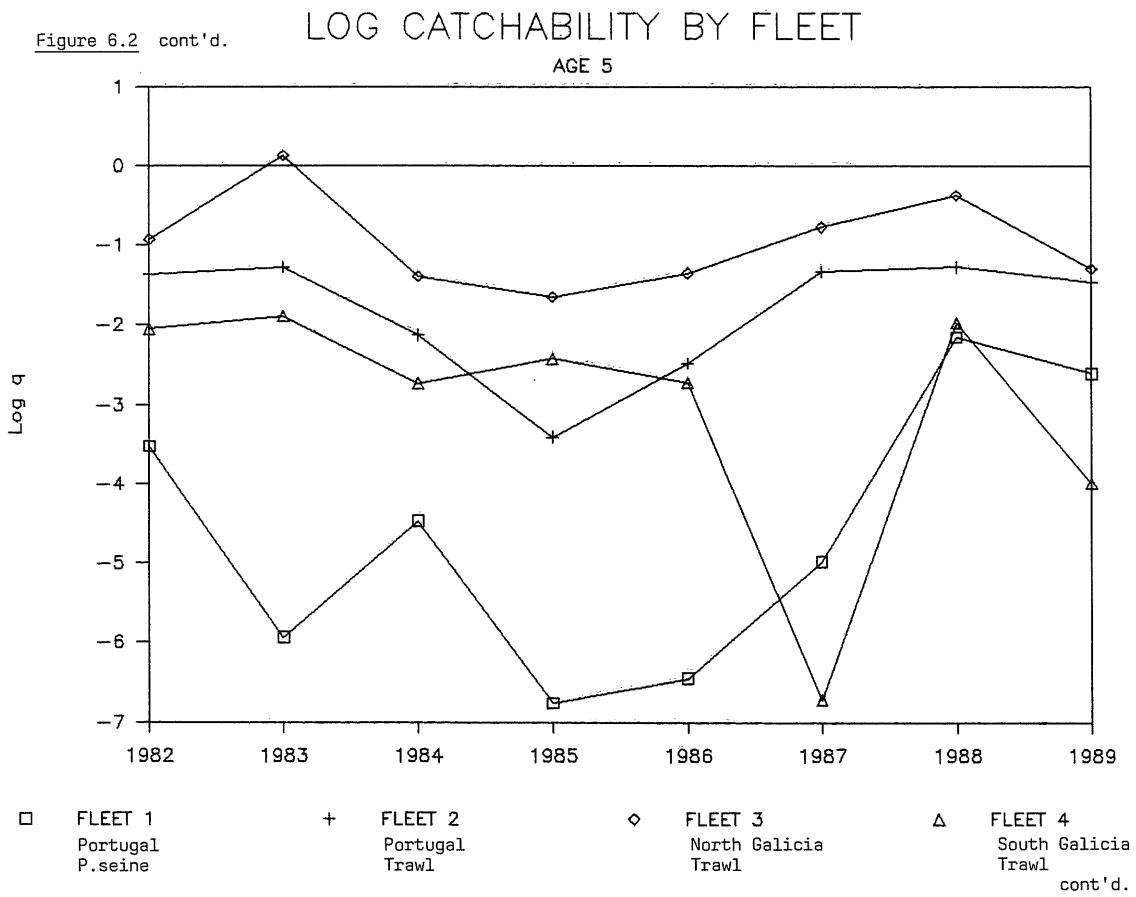

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Figure 6.2 cont'd.

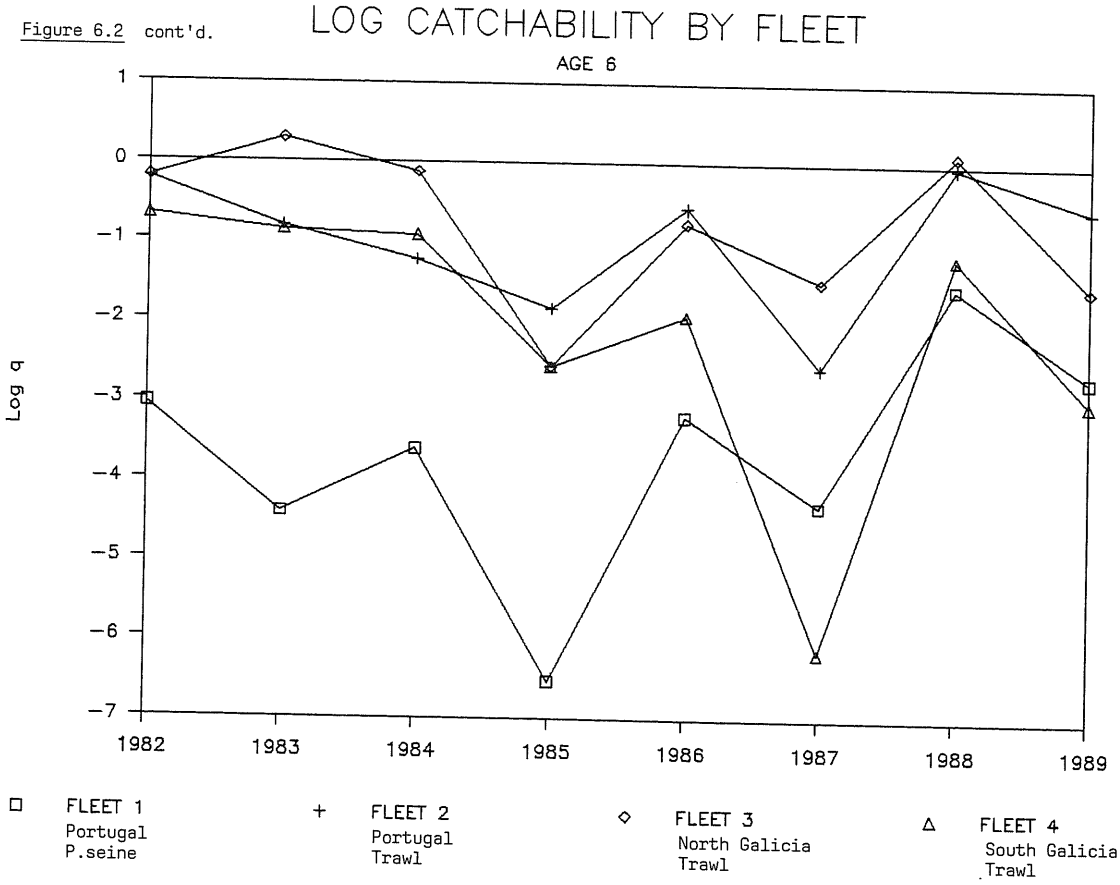


Figure 6.3

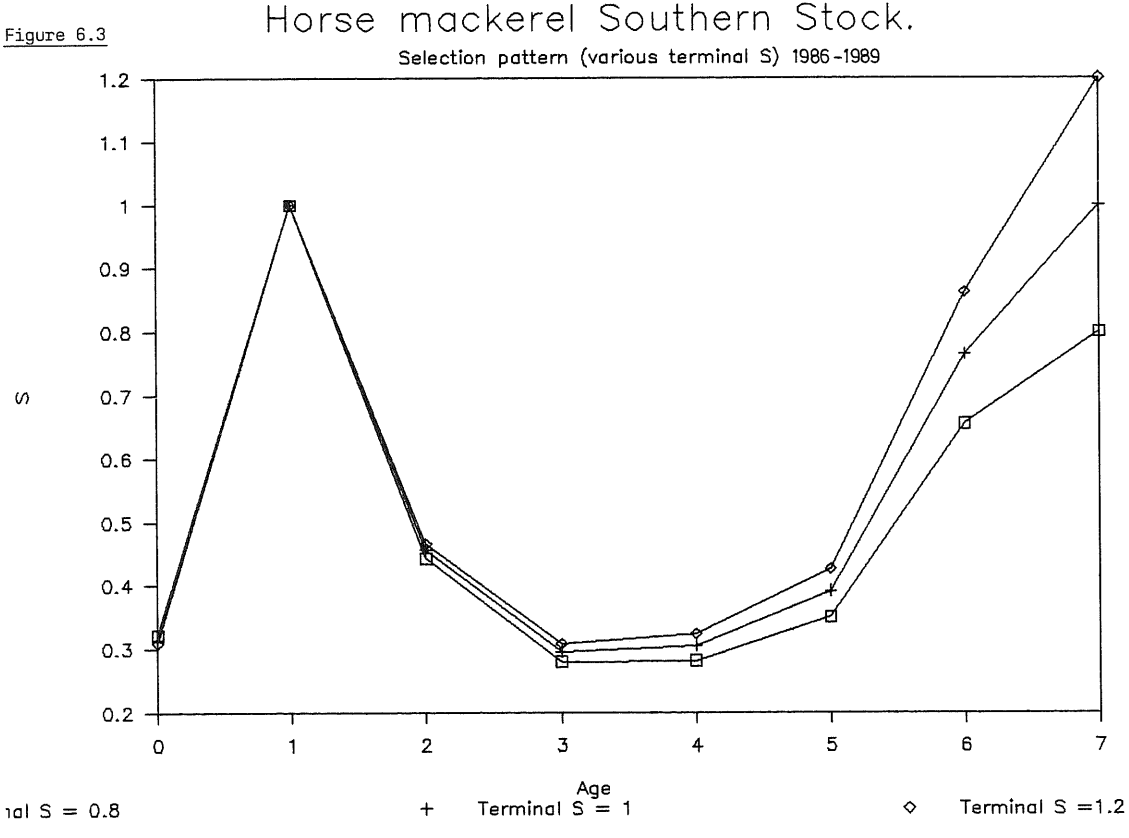

Horse mackerel Southern Stock.
Selection pattern (various terminal S) 1986-1989
S
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
1
2
3
4
5
6
7
Age
ıal S = 0.8
+ Terminal S = 1
◇ Terminal S =1.2

Figure 6.4

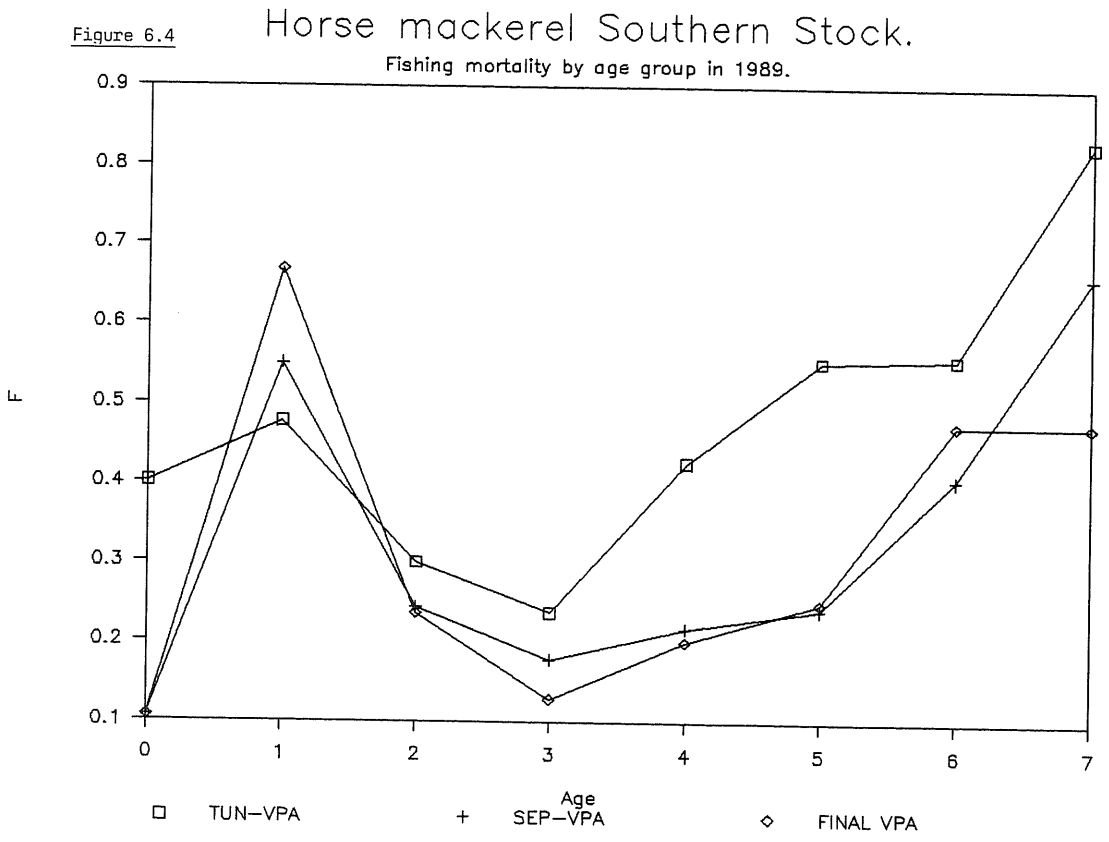
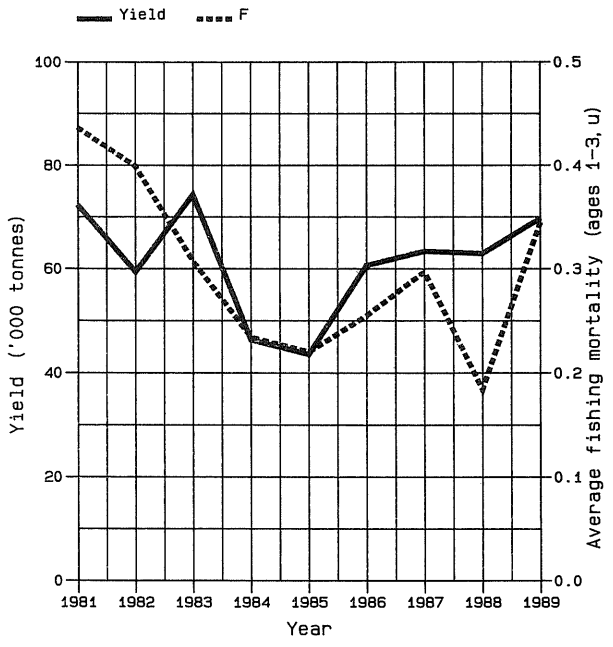

Horse mackerel Southern Stock.
Fishing mortality by age group in 1989.
F
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
Age
TUN–VPA
SEP–VPA
FINAL VPA

Figure 6.5

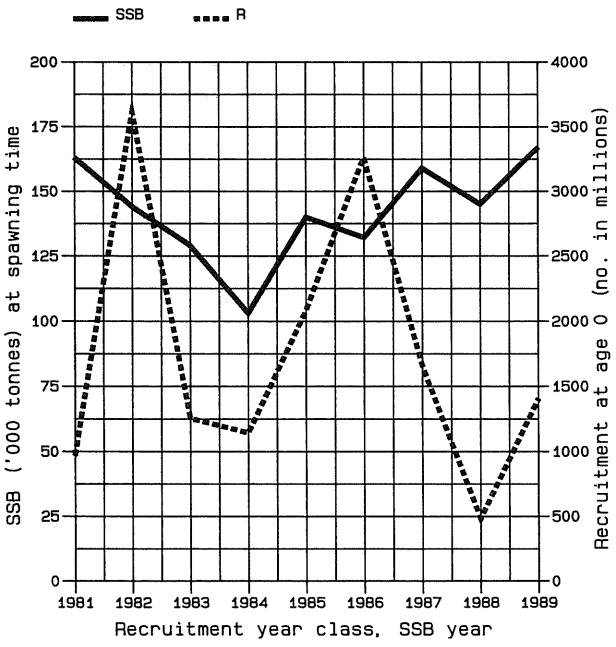
FISH STOCK SUMMARY
STOCK: Southern Horse Mackerel
19-07-1990

Trends in yield and fishing mortality (F)



A

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



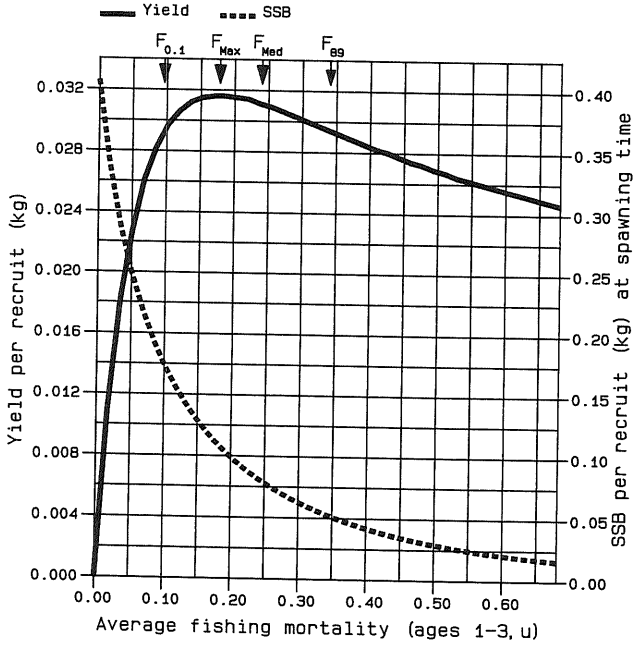
B

cont'd.

Figure 6.5 cont'd.

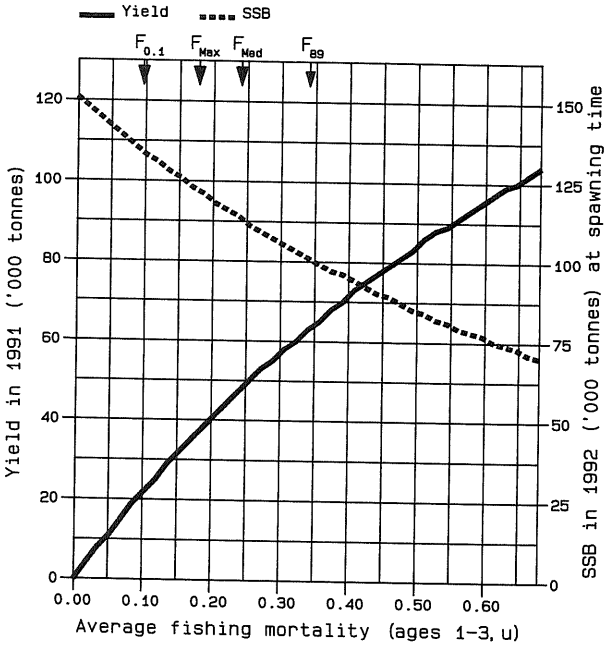
FISH STOCK SUMMARY
STOCK: Southern Horse Mackerel
19-07-1990

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

Figure 6.6

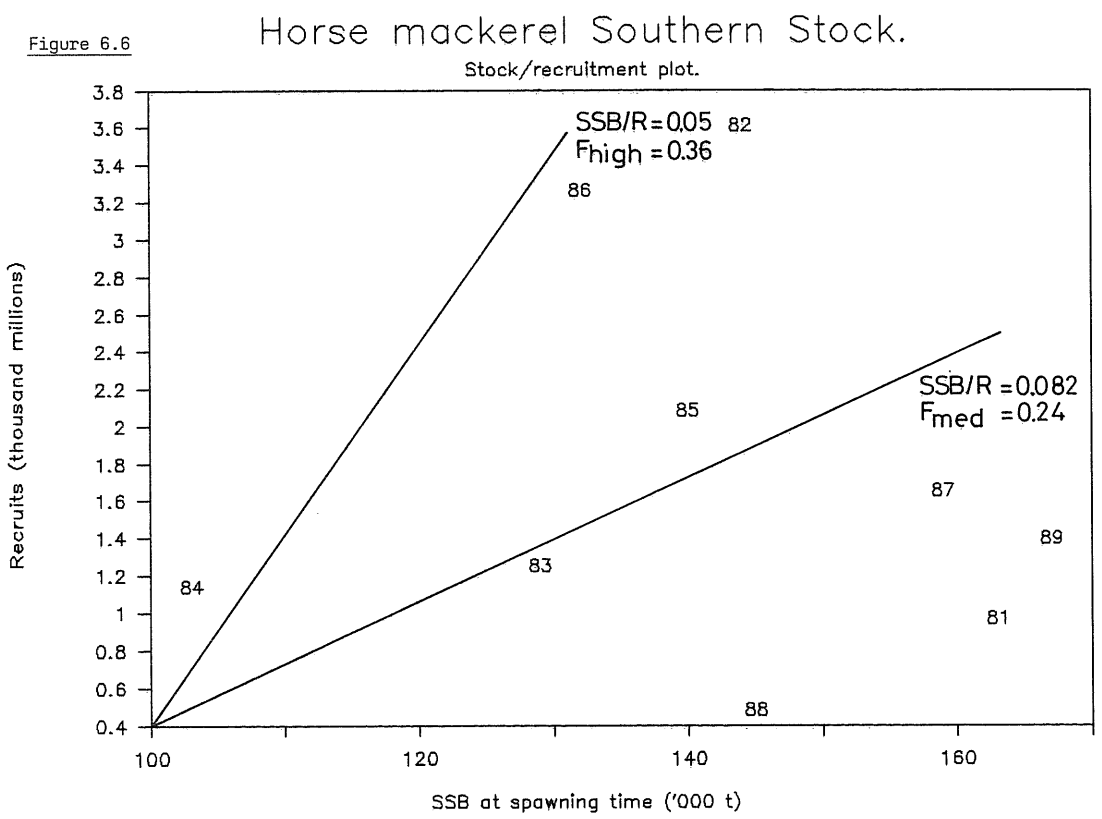

Horse mackerel Southern Stock.
Stock/recruitment plot.
SSB/R=0.05 82
Fhigh =0.36
86
85
SSB/R =0.082
Fmed =0.24
87
89
83
84
81
88
Recruits (thousand millions)
SSB at spawning time ('000 t)
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
100
120
140
160

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

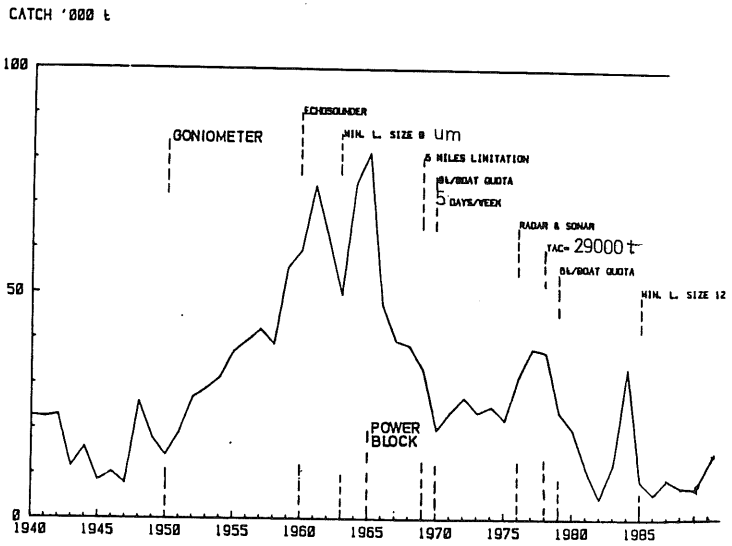


Figure 7.2 Positive and surveyed areas for the different egg surveys on the Bay of Biscay anchovy (from MOTOS personal communication).

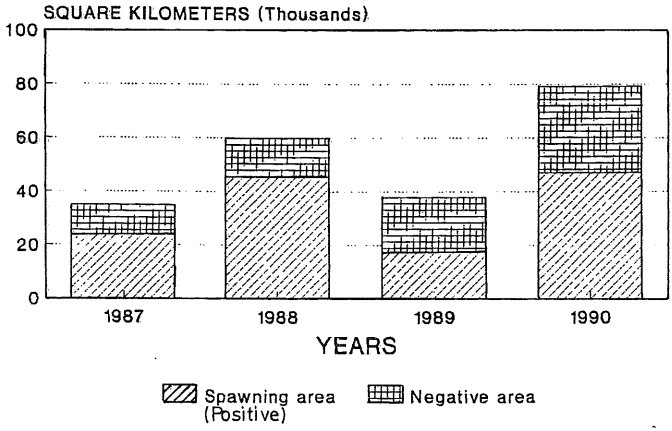
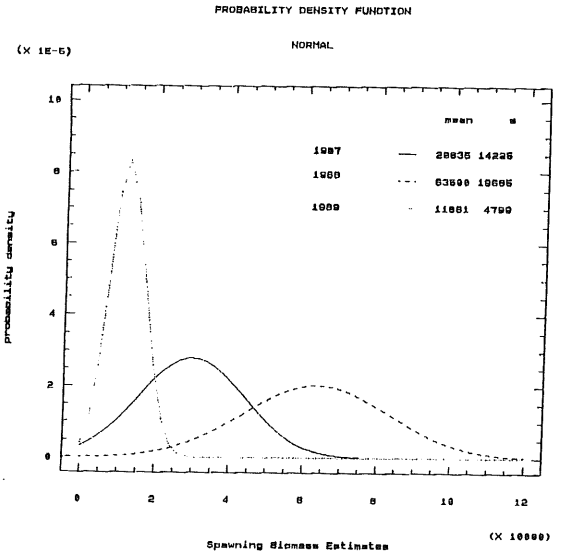


Figure 7.3 Probability density function for SSB estimates for the Bay of Biscay anchovy (from MOTOS and Santiago W.D., 1990).



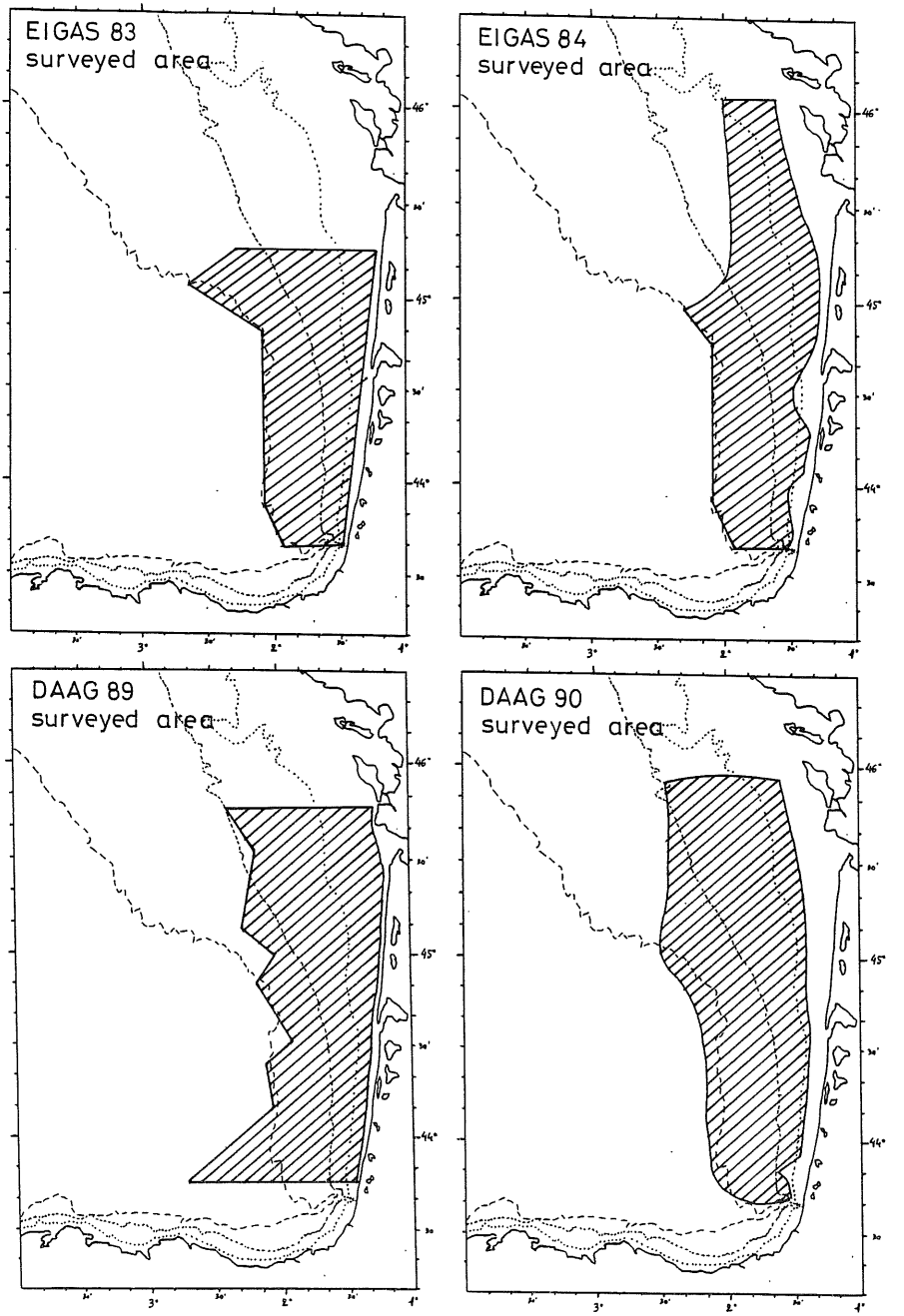
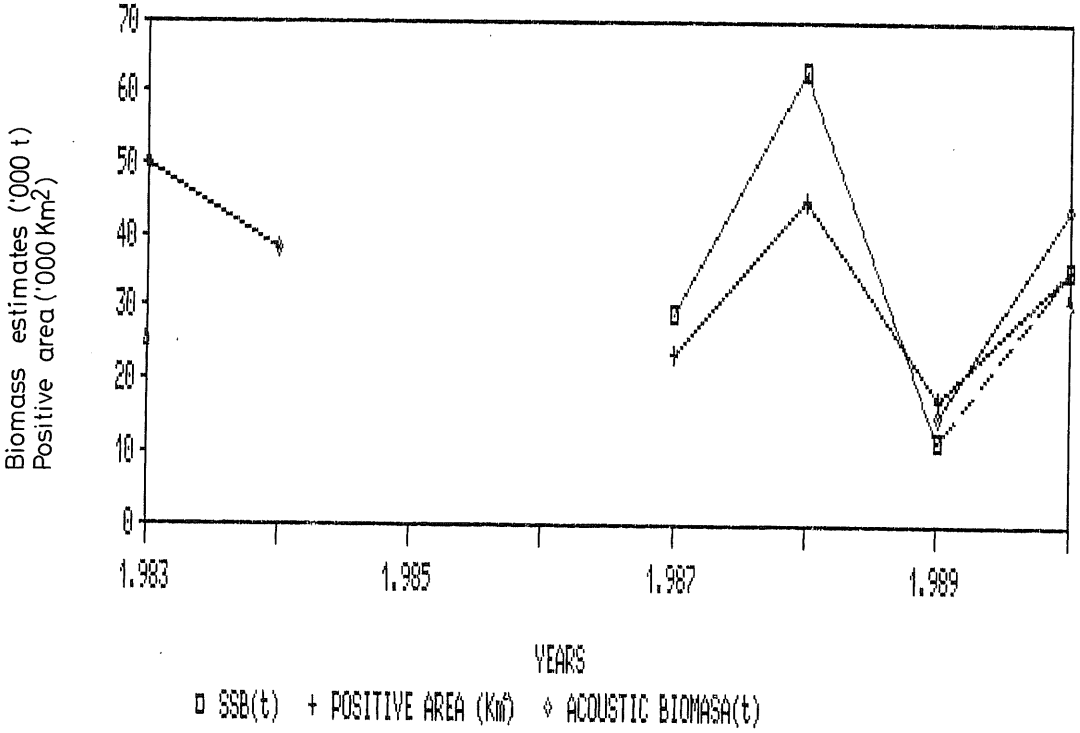


Figure 7.4 Areas covered during the French acoustic surveys in the south of the Bay of Biscay.

Figure 7.5 Comparison of results from egg and acoustic surveys.



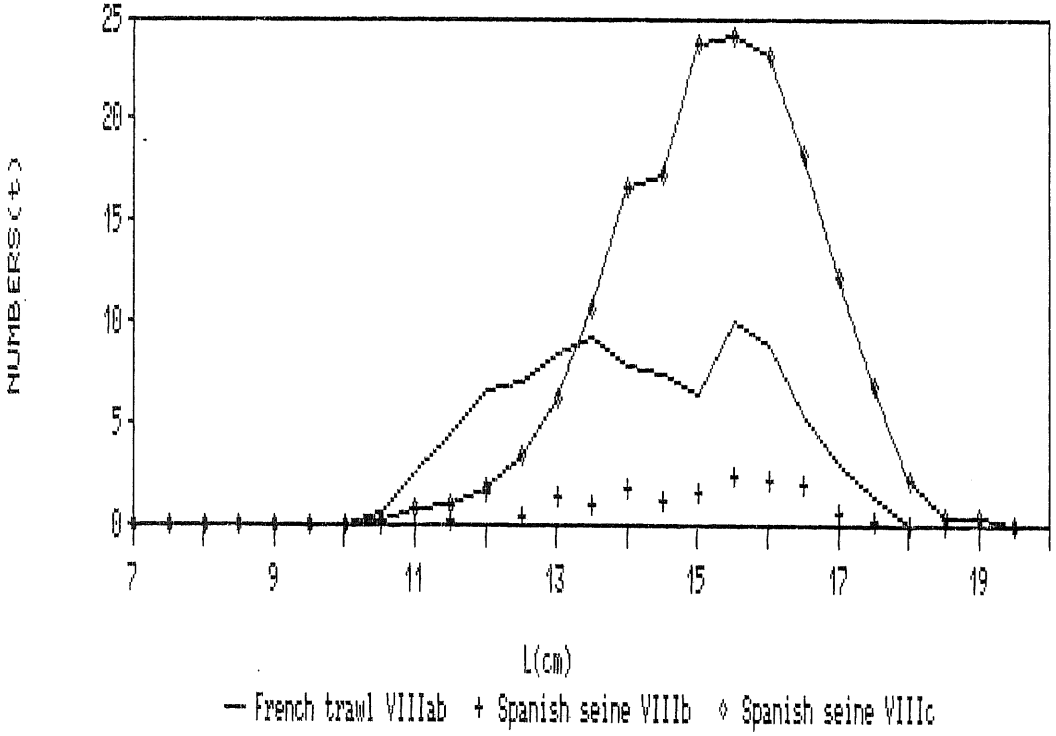


Figure 7.6a Length distributions of landings of Bay of Biscay anchovy (Janurary-June) in Divisions VIIIa,b,c.

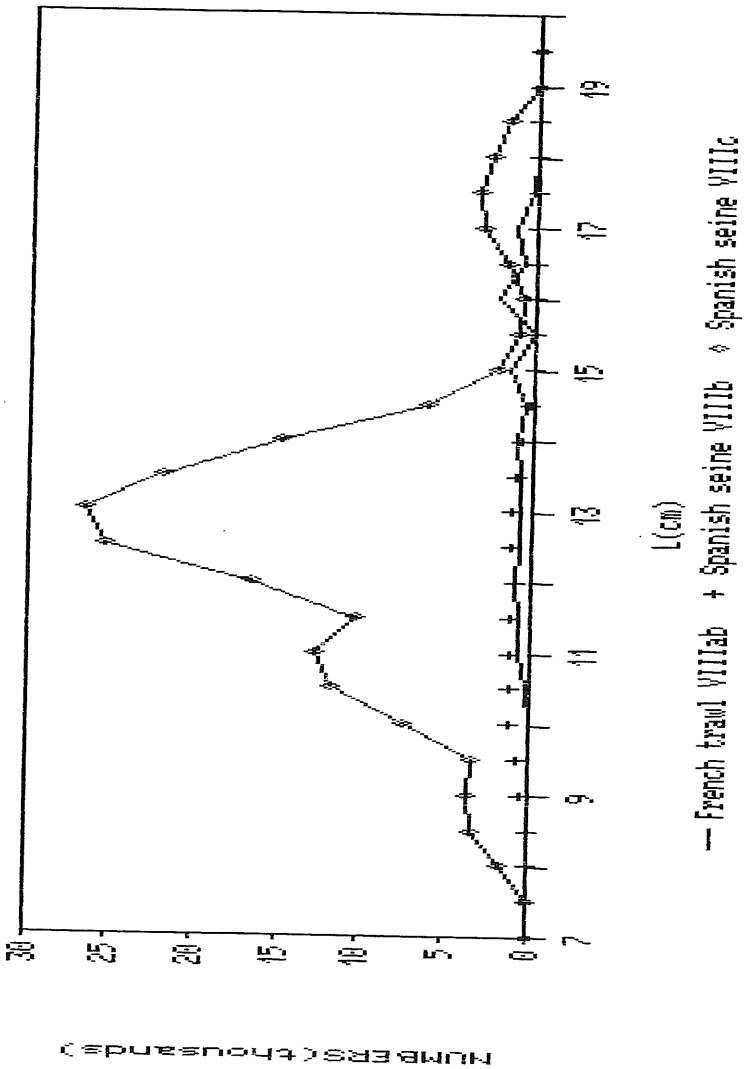


Figure 7.6b Length distributions of landings of Bay of Biscay anchovy (July-December) in Divisions VIIIa,b and c.

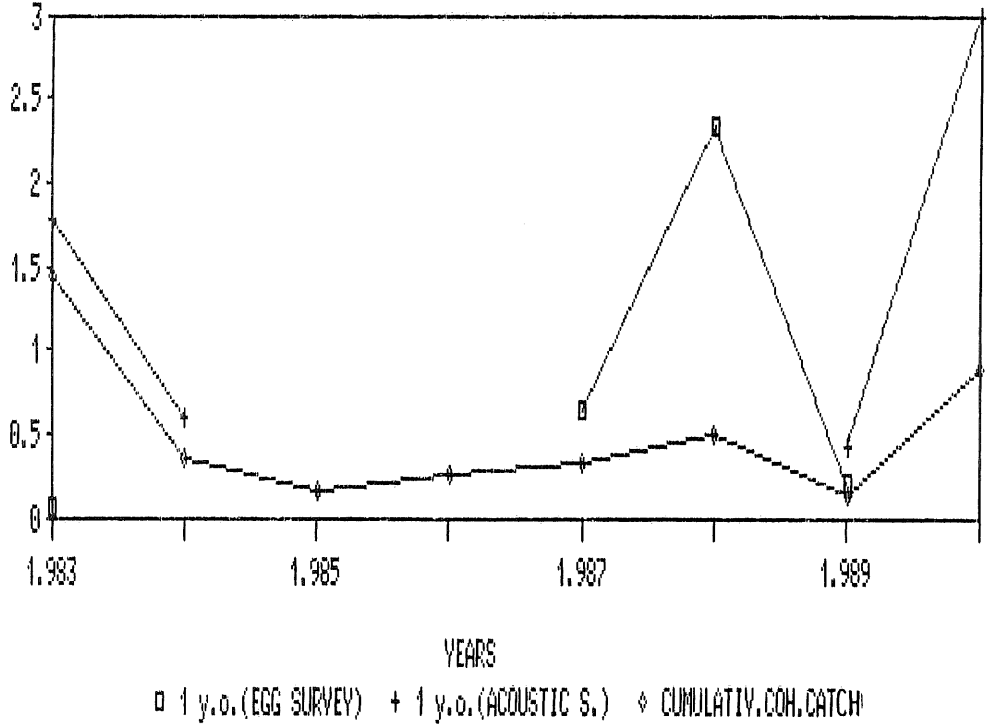
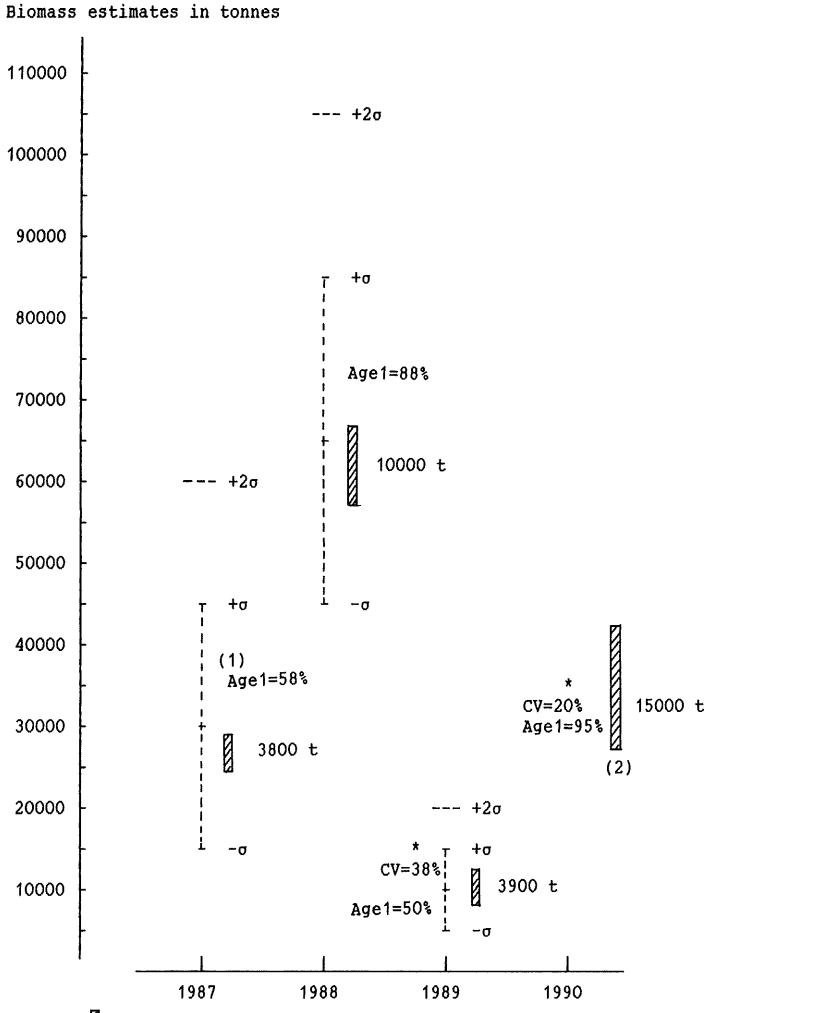


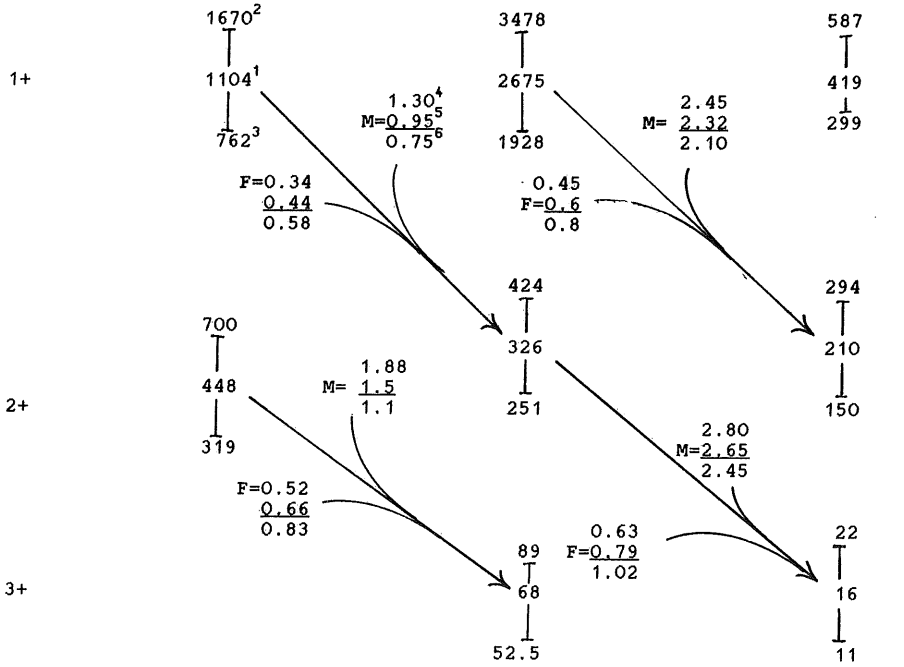
Figure 7.7 Summary of egg and acoustic surveys; recruitment index. (see Table 7.10 for index explanations.)

Figure 7.8 Estimates of anchovy biomass from direct observations (egg and acoustic surveys) for the last four years in the Bay of Biscay.



Catch levels in the same year after the period of Biomass estimate
(1) % in number of Age 1 in the SSB estimate
(2) Provisional figure
* Estimates from French acoustic surveys
CV Coefficient of variation. (Minimum estimate)

Figure 7.9 Values of F and M observed from catches and fishery-independent observations (egg surveys).



[1] Central value (CVA); [2] Central value + σ; [3] Central value - σ

[4] Value corresponding to $(CVA + \sigma)_i \rightarrow (CVA - \sigma)_{i+1}$

[5] Value corresponding to $(CVA)_i \rightarrow (CVA)_{i+1}$

[6] Value corresponding to $(CVA-\sigma)_i \rightarrow (CVA + \sigma)_{i+1}$

[7] 1+ ⟶ 1 and plus year old anchovies in numbers, 2+ idem for 2 and plus y.o., 3+ idem.

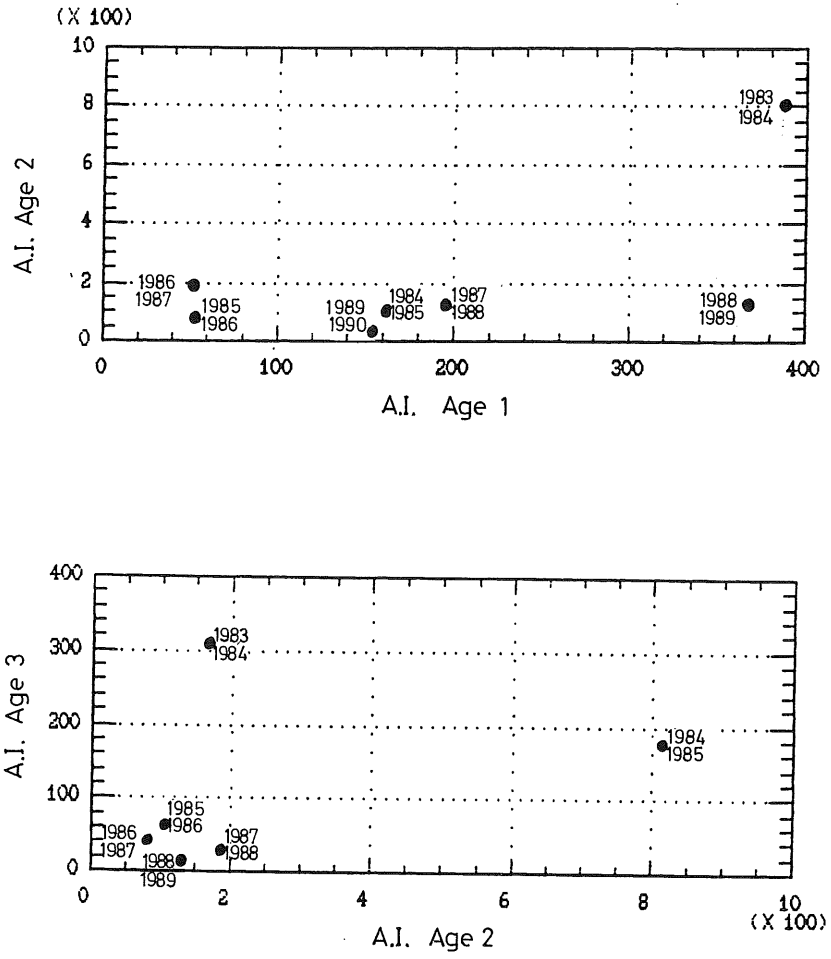


Figure 7.10 Relationship between abundance index (A.I.) (numbers at age in millions in the catches) for two consecutive age groups.

APPENDIX A

SPECIES MIXING IN THE HORSE MACKEREL FISHERIES

Sub-area VIII

Quarterly and annual landing estimates and length distributions data on T. mediterraneus were presented by Spain from Division VIIIc (eastern, central and western parts) and from Divisions VIIIa,b in 1989 (Lucio, WD 1990). These estimates were obtained from the most important fishing ports. Length sampling was carried out for T. trachurus and T. mediterraneus (Table A.1). The data presented from the central and eastern parts of Division VIIIc and Divisions VIIIa,b, are available in the Working Group file.

It appears that important catches of T. mediterraneus come from Division VIIIc, eastern and central parts, mainly from the purse-seiner fleet, but they are not present in the western part (Table A.1). However, the importance of the catches of T. mediterraneus in relation to the total catches of Trachurus sp. seems to be low (near to 12%) for total Division VIIIc, and even lower (less than 6%) in the total catches of the Southern stock.

The amounts and timing of the landings of T. mediterraneus in the eastern part of Division VIIIc in 1987-1988 (Martin, 1989) were rather similar to the values found in 1989 (Lucio, WD 1990). But in the period 1982-1983, the landings were much lower and restricted mainly to the winter season (Figure A.1). On the other hand, species mixing in length sampling can be considered as negligible during the 1980s in the eastern part.

Data on T. mediterraneus landings by commercial ships (mainly trawlers) in Divisions VIIIa,b were presented by Spain for both 1988 and 1989 (Lucio, WD 1990; Martin, 1989). In both years the landings of this species were very low (less than 1% of total Trachurus sp. landed). It is possible that some of the catches by the purse seiners, which are normally located to the eastern part of Division VIIIc, could originate from the southern part of Division VIIIb.

Information from bottom trawl (in autumn 1989) and acoustic surveys (in spring 1990) in Divisions VIIIa,b was also presented by France. It demonstrates the presence of T. mediterraneus in the Bay of Biscay in both time periods (Massé, pers. com.), but restricted mainly to the southern part of Division VIIIb and to the coastal waters (less than 80 m depth) (Figure A.2).

The distribution of T. mediterraneus is restricted to the corner in the Bay of Biscay, near the French and Spanish border and its abundance decreases further to the north and west. Its distribution is related to the highest temperatures in this part of the Bay of Biscay.

The mixing species (T. trachurus and T. mediterraneus) in the total Western stock can be considered as negligible. In the Southern stock the landings of T. mediterraneus, important in the eastern and central parts of Division VIIIc, but representing

only less than the 6% of total catches, ought to be taken into account in the future, if the trend of increasing catches of T. mediterraneus continues.

In relation to the mixing of T. picturatus with T. trachurus in Divisions VIIIa,b and c, the Working Group considered that the former species does not appear in the commercial catches of Subarea VIII.

In future years in Divisions VIIIc (eastern and western part) and in Division VIIIb, special attention should be given to the estimation of the catches of T. mediterraneus in each quarter. Species mixing in the length sampling should be specially avoided, as at present. All information available from past years on the catches and length distributions of T. mediterraneus should be made available.

To avoid errors in the biomass estimates from egg surveys, biological sampling on maturity stages ought be carried out on T. mediterraneus in the Bay of Biscay in order to define the spawning season of this species. Complementary studies on the accurate egg discrimination of both Trachurus species should be carried out.

Division IXa

In Division IXa, significant catches of T. mediterraneus have not been detected in either Spanish or Portuguese waters.

T. picturatus is nonexistant in the northern part of the Division. In the southern part, its presence is variable from year to year (Borges, pers. comm.) It has been observed in the groundfish surveys in the Portuguese area, but only in some years. In the past, the Portuguese annual landings of T. trachurus have been estimated taking out the amounts of T. picturatus.

In future years in Division IXa (southern part), special attention should be given to the catches of T. picturatus in each quarter, and species mixing in length sampling should be avoided.

Table A.1 Percentages of T. mediterraneus in relation to total landings of Trachurus sp. in the Divisions VIIIc and IXa (Southern "stock") and in Division VIIIa,b (Western stock) in 1989. Division VIIIc has been separated into three (eastern, central and western) sub-divisions.

Division	% T. medit./Trachurus sp. 1Q	2Q	3Q	4Q	1989	Trachurus sp. annual landings (t)
VIIIc						
(eastern subd.)	59.5	5.8	36.7	56.2	41.5	5,914
(central subd.)	21.4	0.2	24.1	34.9	22.4	6,467
(western subd.)	0.0	0.0	0.0	0.0	0.0	17,802
VIIIc (all Subd.)	14.7	1.0	12.9	19.7	12.4	31,475
IXa (Spain)	0.0	0.0	0.0	0.0	0.0	13,028
VIIIc+IXa (Spain)	10.4	0.8	8.4	14.2	8.8	44,503
IXa (Portugal)	0.0	0.0	0.0	0.0	0.0	25,231
VIIIc+IXa (Portugal+Spain)					5.6	69,734
VIIIa,b (Spain)	1.8	0.1	0.2	0.2	0.8	2,927

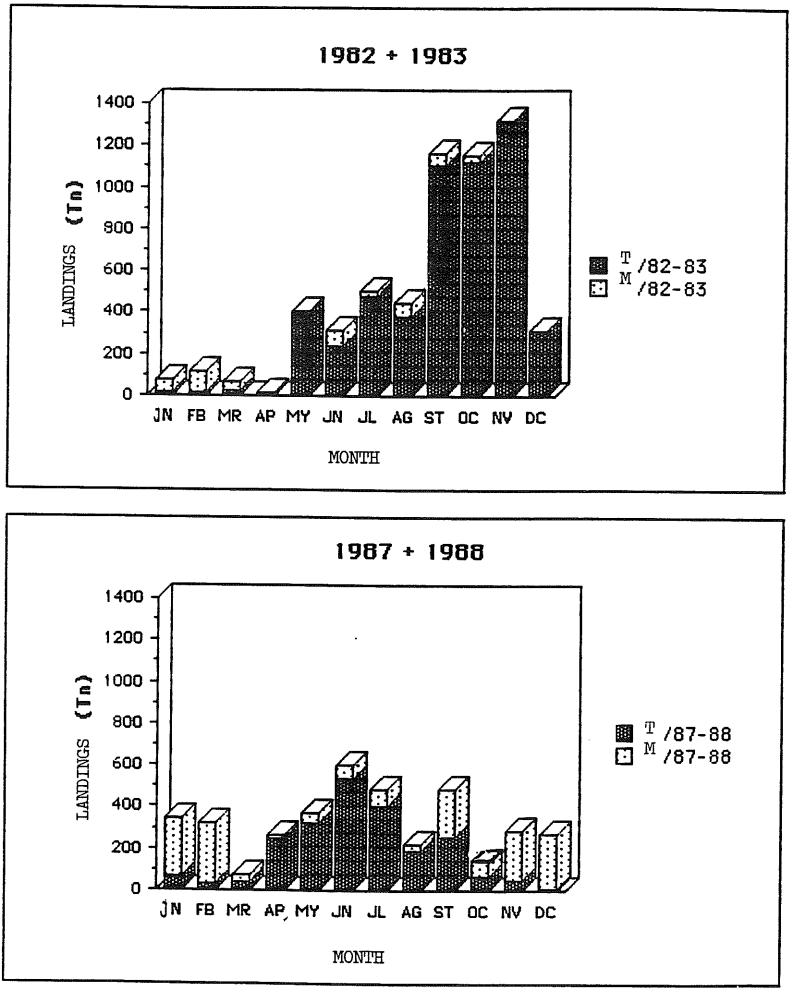


FIGURE A.1 Mean monthly landings of T.mediterraneus (dotted bars) and T.trachurus (dark bars), by the purse seiners in the Basque Country (Spain), mainly from the Division VIIIc (eastern part), in two periods: a) 1982-83, b) 1987-88.

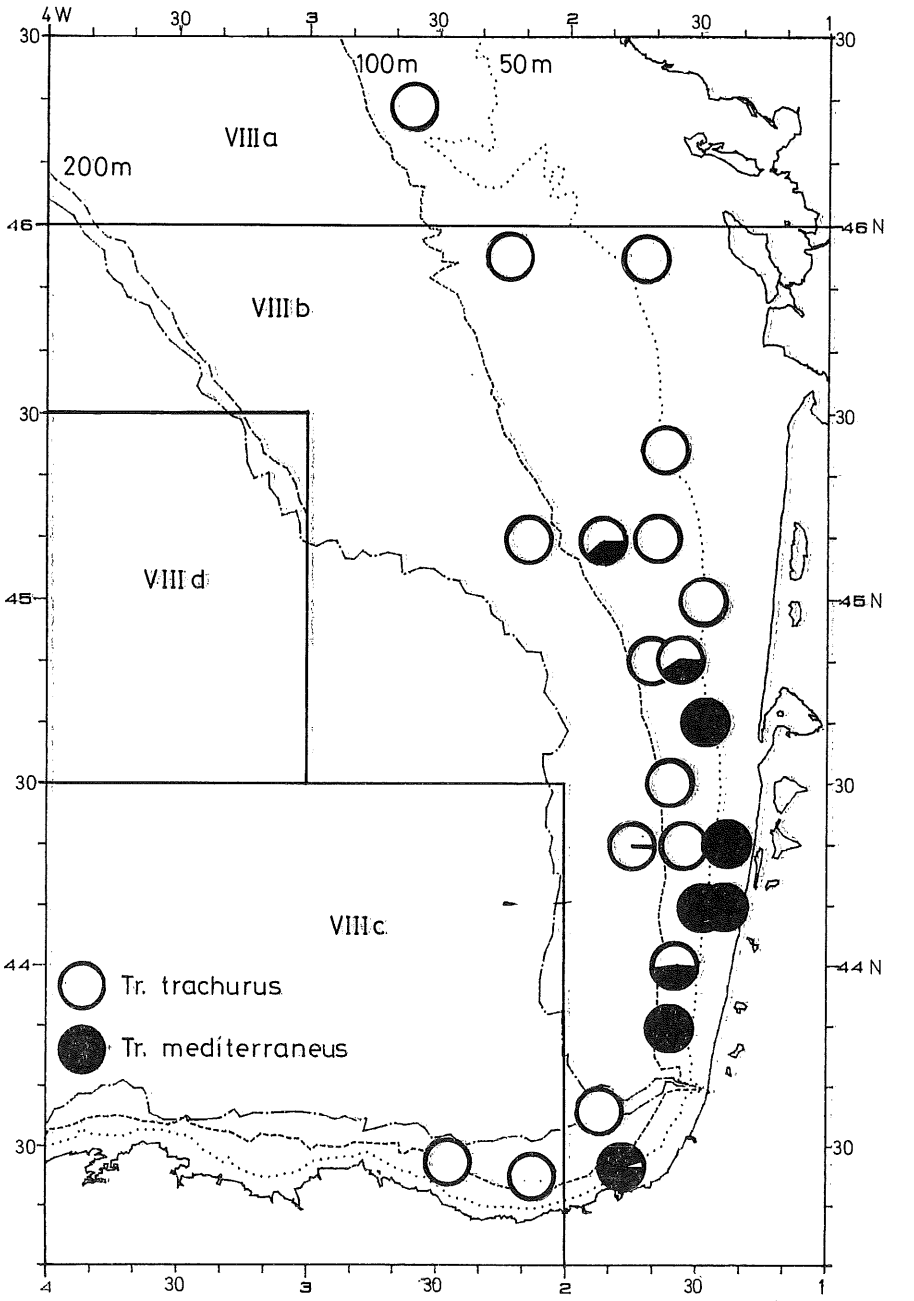


Figure A.2 Distribution of T. trachurus (white circles) and T. mediterraneus (black circles) as determined from the French acoustic survey in April 1990 (J. Massé, pers. comm.).

APPENDIX B

RELIABILITY OF THE NUMBERS-AT-AGE AND WEIGHTS-AT-AGE DATA OF THE WESTERN HORSE MACKEREL

The Dutch fleet is operating in most of the ICES divisions in Sub-areas IV, VI, and VII. A large number of age/length keys are required if the numbers at age are to be worked up by month and by division or sub-division. This would require a large number of length measurements and many fish to be aged if empty cells are to be avoided in these age/length keys (especially when 90% of the otoliths belong to one year class). An alternative biological sampling system has been developed at the Netherlands Institute for Fishery Investigations, which requires only low biological sampling in those divisions whith low commercial catches but which has a high biological sampling level where large commercial catches occur (both the number of length and weight measurements and ageings increase). In the Netherlands, a sample of a catch at a known position of about 200 fish is measured and sorted into cm-groups. A representative sample of only 25 fish is taken from this original sample. The text table below shows an example:

Length	Number in original sample		Number in representative sample
20	2	)	
21	3	)1.114[1]	1[3]
22	4	)	
23	11	1.361	1
24	29	3.589	4
25	33	4,084	4
26	46	5.693	6
27	30	3.713	4
28	15	1.856	2
29	11	1.361	1
30	9	1.114	1
31	6	)	
32	0	)1.114[1]	1[2]
33	3	)	
Total	202	divided by 8.08[4]	25

[1] Numbers are combined when there are less fish than the number you are dividing by.
[2] Depending on the random number it will be a fish of 32 or 33 cm.
[3] Depending on the random number it will be a fish of 20, 21, or 22 cm.
[4] 202/25 = 8.08.

For example, the 46 fish in the 26-cm group should be reduced to 6. A random number below 11 (usually the last digit of the sample number) is used to get the first fish to take and from then onwards every 8th fish (because you divide by 202/25 = appr. 8) should be taken until you have 6 fish collected. Of this reduced representative sample, the length, weight, sex, maturity, age, etc., are estimated of all 25 fish. The larger the commercial

catches are in a particular division in a particular month, the higher the number of representative samples taken. All biological information is obtained from one or more of these representative samples. The age and length composition, the sex ratio, the mean weight at age, mean length at age, maturity at age or length, etc., can be estimated from these samples, which should be representative for the catches in that division and month.

Table B.1 shows theotoliths and weight measurements taken by year and by age from the Dutch horse mackerel catches in Sub-areas VI and VII, both in terms of number and percentage. Because the otoliths are taken representatively, 86% of all otoliths are of the extremely strong 1982 year class and only 14% of the otoliths are of the 15 other age groups. The age composition of these other age groups is based on a relatively low number of otoliths (in 1989, 182 otoliths of the other age groups were collected compared to 1,143 otoliths of the 1982 year class). One would need to intensify sampling by a factor of about 10 to achieve a more accurate age composition of these other age groups, while these only account only for a relatively small proportion of the total biomass. This relatively low number of ageings of these other year classes probably explains why problems exist with the SVPA. Only the two cohorts of the 1982 and 1979 year classes are sampled well enough, but these account for about 90% of the spawning stock biomass.

The reliability of the mean weights at age should increase with the strength of a year class, because this mean weight at age will determine a large proportion of the calculated total biomass. The mean weights at age of the extremely strong 1982 year class should, therefore, be based on a very large number of weight measurements, when using the mean weights at age in the catch and in the stock for the SOP check and, respectively, for estimating the spawning stock biomass. For example, the mean weight in the catch and in the stock of the extremely strong 1982 year class is based in 1989 on, respectively, 1,143 and 380 real weight measurements of fish of that particular year class (the age/length key method would use some general length/weight relationship to obtain these or if the fish of the age/length key are weighted, the number of weight measurements would be much lower).

At the ACFM meeting in November 1989, the Working Group was requested to examine the mean weights at age for ages 1, 2, and 3 to see if they can be improved. As explained above, only mean weights of a certain age group can be obtained in a certain year if this age group occurs in the representative samples during that particular year. If certain age groups are not present in the catches, then no data are available, and a mean weight has to be assumed. The proportion of the total biomass, which is determined by this extremely weak age group, will only be low.

Table B.1 Otoliths and weight measurements taken by year and by age from the Dutch horse mackerel catches in Sub-areas VI and VII.
A. In numbers. B. In percentage.

A

AGE	1982	1983	1984	1985	1986	1987	1988	1989
0	0	0	0	0	0	0	3	0
1	5	19	0	1	0	2	94	0
2	28	6	148	3	0	10	21	0
3	150	69	5	724	5	0	6	10
4	13	87	46	8	658	3	5	12
5	26	28	282	78	16	749	23	4
6	30	74	46	198	95	9	904	5
7	23	96	83	26	161	40	19	1143
8	4	35	71	44	21	124	30	4
9	1	5	30	15	33	15	74	28
10	4	11	9	19	22	17	10	47
11	19	6	0	2	11	30	14	13
12	57	30	2	5	4	10	26	9
13	97	47	5	11	4	3	12	17
14	67	70	19	5	3	5	8	8
15+	26	92	129	86	67	58	51	25
Total	550	675	875	1225	1100	1075	1300	1325

B

AGE	1982	1983	1984	1985	1986	1987	1988	1989
0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
1	0.9	2.8	0.0	0.1	0.0	0.2	7.2	0.0
2	5.1	0.9	16.9	0.2	0.0	0.9	1.6	0.0
3	27.3	10.2	0.6	59.1	0.5	0.0	0.5	0.8
4	2.4	12.9	5.3	0.7	59.8	0.3	0.4	0.9
5	4.7	4.1	32.2	6.4	1.5	69.7	1.8	0.3
6	5.5	11.0	5.3	16.2	8.6	0.8	69.5	0.4
7	4.2	14.2	9.5	2.1	14.6	3.7	1.5	86.3
8	0.7	5.2	8.1	3.6	1.9	11.5	2.3	0.3
9	0.2	0.7	3.4	1.2	3.0	1.4	5.7	2.1
10	0.7	1.6	1.0	1.6	2.0	1.6	0.8	3.5
11	3.5	0.9	0.0	0.2	1.0	2.8	1.1	1.0
12	10.4	4.4	0.2	0.4	0.4	0.9	2.0	0.7
13	17.6	7.0	0.6	0.9	0.4	0.3	0.9	1.3
14	12.2	10.4	2.2	0.4	0.3	0.5	0.6	0.6
15+	4.7	13.6	14.7	7.0	6.1	5.4	3.9	1.9
Total	100	100	100	100	100	100	100	100