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Report of the
Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy

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Parts 1 and 2

International Council for the Exploration of the Sea

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TECHNICAL MINUTES

Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA)

ACFM October 2003

Present:

Sub Group Chair: Carmela Porteiro
Presenter: Dankert Skagen
Reviewers: Colm Lordan, Frans van Beek

General

The review was based on a predraft of the report, which became available only shortly before the ACFM meeting. Some sections were still in disorder with regard to table numbering. Some time should be devoted at the end of the WG to ensure that all tables and figures are there and that they are correctly referred to.

Also more attention should be given to standardise the presentation between the different sections. For instance, it would be helpful to have a (text) table summarising the configuration of the final assessment compared with last years choices (example mackerel). Also a (text)table would be welcome with information on the choice of recruitment for recent years between AM(GM) recruitment, recruitment indicated by the final assessment, recruitment indicated by surveys, and other alternatives.

The reviewers complemented the WG with the report. Some of the comments made last year have been taken into account. This made the report more easy to read. The tables and figures were separated from the text now which made the review somewhat more efficient. The presentation of catch- and sampling information was excellent. Also there appeared to be a lot of working papers which were relevant to the meeting and the results/conclusions were efficiently integrated in the relevant sections in the report. Also the checklists given for the separate stock were useful to the review.

Northeast Atlantic mackerel

The final assessment was based on ICA and was accepted by the reviewers. The main discussion was on the decision by the WG to use the SSB estimates from the egg survey as absolute. The SSB estimated by the survey (4 points) may indicate changes in SSB but also may be just noise. In general the estimate of SSB from the egg survey is higher than by the assessment. The assessment does not follow the SSB estimates of the survey and using these as biomass causes the assessment SSB to adjust to the most recent survey estimated. The WG indicated that this may cause bias, showed in the retrospective analyses. When the survey SSB was used as relative, the bias disappeared but the variation in the retrospective increase. The choice is thus between bias and variation. It appeared that there was a difference of opinion in the WG on the choice. The same difference of opinion was observed in the review group. The reviewers would again ask the WG to explore this next year when a new egg survey estimate becomes available,

It is unclear how ICA deals with the reduced age range in the catch-at-age data in the most earlier years. The reviewers suggested that the WG should explore truncating the time-series to 1980 as was done for the AMCI and ISVPA assessments. The estimates of fishing mortality and SSB are suspicious but (may) have a great impact on the setting of (precautionary) reference points.

The WG indicated that the catch-at-age data give indications for a possible strong 2001 year class. It was noted that, by far, the majority of these catches come from area IXa North and not from other areas. However, survey data indicate that year classes born in 2002 and 2003 were abundantly present in other areas as well.

The analyses of tagging data was appreciated. Some concern was expressed on the indication from these data that F may have increased in recent years.

The WG made a lot of progress in developing a multi-annual advice which takes account for a low probability that this may bring the stock in trouble in the medium-term. The reviewers supported the WG in their opinion that the 3-year advice could be best implemented in the year where the assessment was most accurate (when results of the latest egg survey) are available. The presented HCR is based on a constant TAC for a period of 3 years. The WG is encouraged to propose a number of HCR anticipating on possible management needs in the form of “What if…” scenarios. It was also suggested to investigate the usefulness of retrospective analyses on the proposed HCR (e.g. Would the expectations of the rule be the same if it would be based on previous years data?)

The forecasts based on the assumption of TAC-constraint and F-constraint in the intermediate year were almost similar. The reviewers preferred to base the forecast on the F-constraint assumption. Arguments were that F has been relatively stable over the last 5 years. Also the somewhat higher predicted catch in 2003 would include discards, which are not included in the TAC.

Section 2.11.1 deals with a special request. This section can be pasted into the ACFM advice.

North Sea horse mackerel (IIIa excluding western Skagerrak, IVbc, VIId)

No assessment is possible. The statement that F has shown a pronounced increasing trend cannot be supported because there is no time-series of F. There are problems with the basic data. The weight-at-age of ages 1-5 in 2001 are well below any other estimates in other years. However, the same year classes have a normal weight in the next year. There was criticism on the choice of model used for exploring the data. This model assumes selectivity in a non selective fishery. The WG is encouraged to explore models that are more appropriate in this case.

Western horse mackerel

The assessment is based on catch-at-age data and estimates of egg production from surveys. The assessment was not accepted by the reviewers as a basis for calculation of a numerical catch forecast. The assessment is very unstable and sensitive to the choice of the separable period. Uncertainty profiles are highly required but not present. The choice of a 4- or 5 year separable period made a difference in historical SSB of about 1 million ton in a number of years. This may reflect considerable noise in the data. The large change in SSB level in the historical series can only be explained by a different perception of the outstanding 1982 year class. This year class gets a “separate treatment” in the assessment and should not be influenced by percieved changes in the exploitation pattern in recent years, because it entered the +group already in 1992. The WG is asked to explain in what way recent differences in the recent exploitation pattern, as may be indicated by several assumptions on the period where separability can be assumed, affect this year class. Also the different runs show a different direction in the development of recent fishing mortality. The creation of artificial estimates of egg production was also considered questionable particularly since it is now confirmed that horse mackerel are indeterminate spawners.

The SAD model has been set up that it may follow trends in egg production as close as possible. However, there must be considerable CV in the production estimates and also the considerable changes observed in fecundity put serious questions in the egg production as a proxy for spawning stock size. A model, fitting closely to the egg production estimates therefore is not by default the best model. The reviewers suggested to attempt to use or develop a model, using subsets of catch data representing similar exploitation patterns within each subset.

The catch data indicate that a very large year class 2002 may turn up, comparable with the famous 1982 year class. However, it is noted that this perception is only based on large catches made of this year class as 1-group predominantly originating from areas VIIh and VIIIa. It was also noted that in other areas frequently large amount of 0-group horse mackerel were observed which never recruited to the fishery at older ages.

The work done on catch forecasts, taken into account a different exploitation on juveniles and older fish was appreciated and should be further developed. For this it is required that separate F-indicators are used for juveniles (F1-3) and adults (F4-10) comparable to North Sea herring.

The review group requests the WG to propose appropriate management area’s, taking into account the new biological information on stock identity and way of exploitation. This comment applies to all horse mackerel considered by the WG. It was found strange that the catches of IIIa east are attributed to the western stock.

There was considerable discussion on the proposal by the WG to re-establish 500 kt as $\mathbf{B}_{lim}$. Previously this value has been used by ACFM as $\mathbf{B}_{pa}$. Given the large uncertainty of the assessment $\mathbf{B}_{pa}$ based on a $\mathbf{B}_{lim}$ of 500kt would be considerable higher than the previous $\mathbf{B}_{pa}$. The argument of the WG for a this $\mathbf{B}_{lim}$ was based on the SSB estimated by the egg survey and the assessment. However, given the “problems” with fecundity data the SSB from the egg surveys are questionable. The review group was of the opinion that reference points for this stock (which exploitation is not well controlled) are urgently required. Based on the present assessment a $\mathbf{B}_{lim}$ of 500 kt near $\mathbf{B}_{loss}$ would not be unreasonable. Since, assessments, carried out in different years, gave quite different historical results, it was also considered that the estimate of $\mathbf{B}_{lim}$ may differ considerable between years if it would be based on $\mathbf{B}_{loss}$.

The assumption of status quo F in a prediction assuming a very large 2002 year class leads to an expected yield in 2003 of 360 kt. The TAC is 137 kt and there are no indications that this TAC will be substantially overtaken.

The WG is requested to include in the report an update of the description of the fisheries including the main gears used, targeting juveniles or adults, and destination of the landings (HC, industrial)

Southern horse mackerel (Divisions VIIIc and IXa)

No assessment was attempted for this stock. Based on the results of the HOMSIR there are indications that the mackerel present in the management area originate from at least two different stock. The review group saw some confirmation of this conclusion in the diagnostics presented on the catches. The bubble plots were considered to be informative. The stock identity problem should be solved first before new assessment attempts are carried out. The ongoing collection of data should be continued to make future assessments possible.

It was noted that the weight-at-age in 2002 for most age was historically low or amongst the lowest observed in the time-series.

The WG should try to refrain from giving TAC advice. This is the responsibility of ACFM.

Sardine in VIIIc and IXa

The assessment is based on catch-at-age data, estimates of biomass from acoustic and egg surveys. The AMCI assessment was accepted by the reviewers. The WG was complemented for the progress it made with this assessment in the past years. The exploration of the data and different models was very relevant with regard to assumptions on possible exploitation patterns. Tables of fishing mortality and stock number by age should be included in the report.

There appear to be conflicting trends in SSB estimated by acoustic surveys and egg surveys historically but both all surveys indicate that the stock may be above average in 2002 and 2003.

The WG is requested to try to present retrospective analyses with the AMCI assessment, if possible. An also to evaluate the sensitivity of the AMCI assessment to inclusion of the egg survey data which was not explored. The reviewers appreciated the work to improve the egg survey estimates but would also encourage the WG to explore further the integration of the Spanish and Portuguese surveys.

The uncertainly of the assessment was indicated by a bootstrap procedure. It was noted that this only cover part of the uncertainty and that the uncertainty arising from the choice of model or model configuration is not included in this analyses.

The short-term catch forecast was based on the assumption of a TAC constraint of 100 kt in the midyear. However, there is not TAC for sardine and there has never been one. The assumption of 100 kt corresponds with a lower fishing mortality in 2003 compared to 2002.

This was accepted by the reviewers because the fishery in 2003 has been closed for two months as a consequence of the "Prestige" oil spill. Carmela may have some points here – the fishery was stopped for 4 months.

Since the assessment has been accepted by the ACFM the following are required; detailed management option tables, longer term YPR analysis, some evaluation of potential PA points for this stock.

Anchovy VIII

The assessments are based on catch-at-age data, acoustic and egg surveys. The ICA assessment by the WG was accepted by the reviewers. The assessment is consistent with last year. Progress was made to assess the stock with a biomass model. The signals from the ICA and biomass model are the same The usage of a biomass model was considered to be probably more appropriate for this stock. Further development of this model is encouraged. The results of the assessment are not considered useful as a basis for providing TAC advise for 2004. This, because the forecasts are predominantly affected by the assumptions on recruitment of 1-year olds in the TAC year. No information on this age group is available until July in the TAC year.

All indications suggest that SSB in 2002 and 2003 is very low. The reviewers were of the opinion that TAC advice could only be provided based on current year information. This would be at a moment that a large part of the catch had already be taken. Therefore TAC management would not be the most appropriate tool to manage the fishery.

The WG proposed to reject the present $\mathbf{B}_{pa}$ for this stock. After discussion in the review group it was concluded that a $\mathbf{B}_{pa}$ is required for the qualification of the status of the stock until a HCR is established

The HCR was addressed by the WG, but they were not considered by the review group because of time constraints.

YPR reference points and tables have note been provided. These are required by ACFM.

Anchovy IXa

No assessment was carried out for this stock. Due to time constraints by the subgroup, the stock was not reviewed.

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1 INTRODUCTION

1.1 Terms of Reference

The **Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy** [WGMHSA] met at ICES Headquarters from 9–18 September 2003 to address the following terms of reference, as decided by the 90th Statutory Meeting:

a) assess the status of and provide catch options for 2004 for the stocks of mackerel and horse mackerel (defining stocks as appropriate);
b) assess the status of and provide catch options for 2004 for the sardine stock in Divisions VIIIc and IXa;
c) assess the status of and provide catch options for 2004 for the anchovy stocks in Subarea VIII and Division IXa;
d) for sardine update information on the stock identification, composition, distribution and migration in relation to oceanographic effects;
e) continue the evaluation of harvest control rule for anchovy fishing;
f) provide specific information on possible deficiencies in the assessments including at least: Major inadequacies in the data on catches, effort or discards; major inadequacies if any in research vessel surveys data and major difficulties if any in model formulation; including inadequacies in available software. The Group should clarify the consequences from these deficiencies for a) assessment of the status of the stocks and b) for the projection;
g) for stocks for which a full analytical assessment is presented, comment on this meeting's assessments compared to the last assessment of the same stock;
h) comment on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management;
i) structure the assessment report following the guidelines as adopted by ACFM in October 2002 with special attention to the quality issues.

Terms of reference a – e, and g are addressed under the respective stocks. Term of reference f is also addressed specifically for each stock. In addition, and overview of the input data and their shortcomings is given in Section 1.3, and an overview of the assessment methods in Section 1.4. Term of reference h is addressed in Section 1.7.

The present report is structured as in previous years. This was decided in consultation with the ICES Fisheries Advisor.

The following request was received from The Norwegian Ministry of Fisheries, on behalf of the Coastal States for the NEA Mackerel stock:

At present ICES gives TAC advise for mackerel by two areas: the Southern area (Divisions VIIIc and IXa) and the rest of the distribution area.

In the ICES Cooperative Research Report No. 255 on the mackerel stock (combined Southern, Western and Southern spawning components) the following is stated:

"Tagging experiments have demonstrated that after spawning, fish from Southern and Western areas migrate to feed in the Norwegian Sea and the North Sea during the second half of the year, in the North Sea they mix with the North Sea component. Since it is at present impossible to allocate catches to stocks previously considered by ICES, they are at present, for practical reasons, considered as one stock: the North East Atlantic Mackerel Stock."

In this context ICES is requested to:

comment on the biological rationale for setting TACs by areas

identify the implications for the TAC advise for the remaining part of the distribution area, considering a range of TAC options for the Southern area.

The response by the Working Group to this request is given in Section 2.11.

1.2 Participants

Pablo Abaunza	Spain
Sergei Belikov	Russia
Miguel Bernal	Spain
Maurice Clarke	Ireland
Mark Dickey-Collas	Netherlands
Guus Eltink	Netherlands
Emma Hatfield	UK (Scotland)
Leire Ibaibarriaga	Spain
Svein A. Iversen	Norway
Jan Arge Jacobsen (part time)	Faroe Islands
Ciarán Kelly	Ireland
Jacques Massé (part time)	France
Manuel Meixide	Spain
Alberto Murta	Portugal
José de Oliveira	UK (England and Wales)
Fernando Ramos	Spain
David Reid	UK (Scotland)
Beatriz Roel	UK (England and Wales)
Maria Santos	Spain
Eugeny Shamrai	Russia
Alexandra Silva	Portugal
Aril Slotte	Norway
Per Sparre	Denmark
Dankert W. Skagen (Chair)	Norway
Jens Ulleweit	Germany
Andres Uriarte	Spain
Dimitri Vasilyev	Russia
Begoña Villamor	Spain
Christopher Zimmermann	Germany

1.3 Quality and Adequacy of Fishery and Sampling data.

1.3.1 Sampling data from commercial fishery

The Working Group again carried out a brief review of the sampling data and the level of sampling on the commercial fisheries. Sampling levels have increased again for mackerel (to 87%) and are now slightly above the long term average. The proportion of the sampled horse mackerel catch has again increased after the low sampling intensity in 1999. In 2002 the sampling level was 72% which still is considered inadequate for some Divisions and periods. Sardine stocks continue to be well sampled. However samples should be obtained from all areas where sardines are caught. Anchovy sampling has improved since last year. A short summary of the data, similar to that presented in recent Working Group is shown for each stock. Sampling programmes by EU countries have been partially funded under the new EU sampling directive (Council Regulation EEC N° 1543/2000) this has contributed to the improvment in sampling levels.

The sampling programmes on the various species are summarised as follows.

Mackerel

Year	Total catch t	% Catch covered by sampling programme	Samples	Measured	Aged
1992	760,000	85	920	77,000	11,800
1993	825,000	83	890	80,411	12,922
1994	822,000	80	807	72,541	13,360
1995	755,000	85	1,008	102,383	14,481
1996	563,600	79	1,492	171,830	14,130
1997	569,600	83	1,067	138,845	16,355
1998	666,700	80	1,252	130,011	19,371
1999	608,928	86	1,109	116,978	17,432
2000	667,158	76	1,182	122,769	15,923
2001	677,708	83	1,419	142,517	19,824
2002	717,882	87	1,450	184,101	26,146

In 2002 87% of the total catch was covered by the sampling programmes. This represents an increase since last year. The number of samples, aged and measured fish has increased again. Spain and Portugal and Russia carry out extremely intensive programme on their catches. Germany and Denmark increased the proportion of the catch sampled over 2001. England and Faroe Islands sampled just less than 15% of their catches in 2002, this represents a halving of the proportion sampled by England, but the first time that the Faroe islands have sampled their catches. France, Belgium Iceland and Sweden did not sample any catches, however of these only France take significant catches (80% of unsampled catches of 27,185t.). Norway, Portugal, Scotland, Spain, Russia and the Netherlands continue to sample the entire catch thoroughly.

There were less areas than in previous years which were not adequately sampled. In general these areas were in the Celtic sea, southern North Sea, English channel and north Biscay (with the exception of VIIIb)

- Less than 50% of the catch was smapled in VIIa,d,e,g,j,k IVb,c IIIa and VIIIa,d,e
- Of these areas, significant catches of about 42,000t were insufficiently sampled in VIIIa and VIIj
- No sampling of catches was carried out in VIIa,e,g,k and IIIa,c however these areas represent only minor catches of about 2,500t

See Figures 1.3.6.1 and 1.3.6.2 for a map of sampling levels relative to catch.

The sampling summary of the all mackerel catching countries are shown in the following table.

Country	Official Catch	% of catch sampled	No. samples	No.measured	No. Aged
Belgium	22	0%	0	0	0
Denmark	34,376	90%	20	1,432	1,341
England & Wales	26,082	14%	35	3,814	1,082
Faroe Islands	19,768	13%	8	177	176
France	21,878	0%	0	0	0
Germany	26,532	74%	109	36,740	1,465
Iceland	53	0%	0	0	0
Ireland	72,172	79%	56	7,163	1,990
NORWAY	184,291	100%	252	24,759	3,909
Portugal	2,934	100%	313	29,176	2,631
Russia	45,811	100%	122	27,727	1,899
Scotland	165,018	99%	163	27,630	6,120
Spain	50485*	100%	270	17,627	3,007
Sweden	5,232	0%	0	0	0
The Netherlands	33,450	100%	102	7,856	2,526
Total	637,620	87%	1,450	184,101	26,146

∗Unoffical catches

Horse Mackerel

The following table shows a summary of the overall sampling intensity on horse mackerel catches in recent years.

Year	Total catch t	% Catch covered by sampling programme	Samples	Measured	Aged
1992	436,500	45	1,803	158,447	5,797
1993	504,190	75	1,178	158,954	7,476
1994	447,153	61	1,453	134,269	6,571
1995	580,000	48	2,041	177,803	5,885
1996	460,200	63	2,498	208,416	4,719
1997	518,900	75	2,572	247,207	6,391
1998	399,700	62	2,539	245,220	6,416
1999	363,033	51	2,158	208,387	7,954
2000	272,496	56	1,610	186,825	5,874
2001	283,331	64	1,502	204,400	8,117
2002	241,336	72	1,758	235,697	8,561

The overall sampling levels on horse mackerel appear to have increased in 2002. The large numbers of samples and measured fish are due mainly to intensive length measurement programs in the southern areas. In 2002, 65 % of the horse mackerel measured were from Division IXa.

Countries that carried out comprehensive sampling programmes in 2002 were Netherlands, Portugal, Spain and Norway. Sampling intensity from Ireland was slightly higher than last year (68%). Germany increased their sampling intensity considerably, from 2% in 2001 to 58% in 2002. UK, France, and Denmark continue to take considerable catches but do not carry out any sampling programmes whatsoever. The lack of sampling data for relatively large portions of the horse mackerel catch continues to have a serious effect on the accuracy and reliability of the assessment and the Working Group remain concerned about the low number of fish that are aged.

The following table shows the most important horse mackerel catching countries and the summarised details of their sampling programme in 2002.

Horse mackerel sampling

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Belgium	30	0.0	0	0	0
Denmark	12462	0.0	0	0	0
England+Wales	8294	0.0	0	0	0
Faroe Islands	699				
France	20197	0.0	0	0	0
Germany	15881	58	78	27695	359
Ireland	36483	68	26	4749	1150
Norway	36689	98	38	2762	964
Portugal	14270	93	991	137934	1492
Russia	3	0.0	0	0	0
UK (Scotland)	2907	0.0	0	0	0
Spain*	31504	96	512	36282	1771
Sweden	575	0.0	0	0	0
The Netherlands	57206	96	113	26275	2825
Total	241336	72	1758	235697	8561

∗ Unofficial catches

In spite of the improvement the **Working Group, once again, strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.**

The horse mackerel sampling intensity for the western fisheries was as follows:

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Belgium	0				
Denmark	10152	0	0	0	0
England & Wales	5971	0	0	0	0
Faroes Islands	699	0	0	0	0
France	18951	0			
Germany	12614	73	48	26157	359
Ireland	36483	83	26	4749	1150
Norway	36689	98	38	2762	964
Russia	3	0	0	0	0
Scotland	2907	0	0	0	0
Spain*	1105	100	64	3313	573
Sweden	575	0	0	0	0
The Netherlands	42019	95	69	17676	1725
Total	172182	66	245	54657	4771

∗ Unofficial catches

The horsemackerel sampling intensity for the North Sea (IVbc VIId and the eastern part of IIIa) fishery was as follows:

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Belgium	30	0	0	0	0
Denmark	2310	0	0	0	0
England & Wales	2323	0	0	0	0
France	1246	0	0	0	0
Germany	3267	0	30	1538	0
Ireland	0	0	0	0	0
Norway	0	0	0	0	0
Sweden	14	0	0	0	0
The Netherlands	15187	100	44	8599	1100
Total	23379	61	74	10137	1100

The sampling intensity for the Southern fishery was as follows:

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Portugal	14270	100	10573	137934	1492
Spain*	31504	96	448	32969	1198
Total	45775	97	11021	170903	2690

* Unofficial catches

It should be noted that the definition of samples is not consistent, nor the method of assigning samples to landings. This should be considered when reading these tables.

In spite of the improvement the **Working Group, once again, strongly recommends that all countries with relatively high horse mackerel catches should sample for age at an adequate level.**

<u>Sardines</u>

The sampling programmes on the assessed sardine stock in VIIIc and IXa are summarised as follows.

Year	Total catch t	% Catch covered by sampling programme	Samples	Measured	Aged
1992	164,000	79	788	66,346	4,086
1993	149,600	96	813	68,225	4,821
1994	162,900	83	748	63,788	4,253
1995	138,200	88	716	59,444	4,991
1996	126,900	90	833	73,220	4,830
1997	134,800	97	796	79,969	5,133
1998	209,422	92	1,372	123,754	12,163
1999	101,302	93	849	91,060	8,399
2000	91,718	94	777	92,517	7,753
2001	110,276	92	874	115,738	8,058
2002	99,673	100	814	96,968	10,231

The summarised details of individual sampling programmes in 2002 are shown below. These catches cover all areas where sardine is caught (VII, VIII and IXa.)

Country	Official catch t	% Catch covered by sampling programme	Samples	Measured	Aged
Spain	32,137	100	241	23,278	1,741
Portugal	67,536	100	573	73,690	8,490
England &Wales	8,179	0	0	0	0
Ireland	6,100	0	0	0	0
Germany	133	20	4	1,034	110
Total	114,112	87	818	98,002	10,341

∗ Unofficial catches

The overall sampling levels for sardine are adequate for areas VIIIc and IXa. There may also be catches of Sardine by France in areas VIIIa,b which are not reported to the WG. Catches of sardine in Area VII should be sampled.

Anchovy

The sampling programmes carried out on anchovy in 2002 are summarised below. The programmes are shown separately for Sub area VIII and for Division IX a. Sampling throughout Divisions VIIIa+b and VIIIc appear to be satisfactory.

The overall sampling levels for recent years are shown below

Year	Total catch XIII+IXa	% Catch covered by sampling programme	Samples	Measured	Aged
1992	40,800	92	289	17,112	3,805
1993	39,700	100	323	21,113	6,563
1994	34,600	99	281	17,111	2,923
1995	42,104	83	?	?	?
1996	38,773	93	214	17,800	4,029
1997	27,440	76	258	18,850	5,194
1998	31,617	100	268	15,520	5,181
1999	40,156	100	397	33,778	10,227
2000	39,497	99	209	18,023	4,713
2001	49,247	58	317	28,615	4,683
2002	26,313	94	216	45,909	4,685

The sampling programmes for France and Spain are summarised below.

Country	Division	Official catch	% Catch covered by sampling programme	Samples	Measured	Aged
France	VIII a, b	10,988	93	17	6,031	969*
Spain∗	VIII a	886	100	8	834	209
Spain∗	VIII b	1,920	100	54	2,533	350
Spain∗	VIII c east	3,713	100	63	4,110	922
Total	VIII	17,507	95	142	36,308	2,450

∗ Unofficial catches *800 from the scientific survey

The level of sampling for VIII catches by France should be improved in the future.

The sampling programmes for the fisheries in Division IXa are summarised below.

Country	Division	Official catch	% Catch covered by sampling programme	Samples	Measured	Aged
Spain∗	IXa	7,891	100	74	9,601	2,235
Portugal	IXa	915	0	0	0	0
Total	IXa	8,806	90	74	9,601	2,235

∗ Unofficial catches

No catches from Portugal were sampled for length and age in Division IXa in 2002.

1.3.2 Catch data

Recent working groups have on a number of occasions discussed the accuracy of the catch statistics and the possibility of large scale underreporting or species and area misreporting. These discussions applied particularly to mackerel and horsemackerel in the northern areas.

For mackerel and horse mackerel it was concluded that in the southern areas the catch statistics appear to be satisfactory. In the northern areas it was concluded that since 1996 there has been a considerable improvement in the accuracy of the total landing figures, this continues to be the case. The reason for the improvement in catch statistics are given as; tighter enforcement of the management measures in respect of the national quota and increasing awareness of the importance of accurate catch figures for possible zonal attachment of some stocks. In 2002 the misreporting of catches from Division IVa into VIa is at the same level as last year. Underreporting of catches because of transhipping of catches at sea has decreased in recent years because most of the catches are now landed to factories ashore.

There remains a problem with the French which were not made available to the WGMHSA, particularly for mackerel and horse mackerel and Sardine. The figures used by this working group may be inaccurate. The working group recommends that this data are made available by next year.

Discarding information was reported to the WG this year by Scotland and The Netherlands (See section 1.3.3. below).

1.3.3 Discards

Mackerel

Discarding of small mackerel has historically been a major problem in the mackerel fishery and was largely responsible for the introduction of the south west mackerel box. In the years prior to 1994 there was evidence of large-scale discarding and slipping of small mackerel in the fisheries in Division IIa and Sub-area IV, mainly because of the very high prices paid for larger mackerel (>600 g) for the Japanese market. This factor was put forward as a possible reason for the very low abundance of the 1991 year class in the 1993 catches in numbers at age. The difference in prices has decreased since 1994 and the Working Group assumed that discarding may have been reduced in these areas.

In some of the horse mackerel directed fisheries e.g. those in Subareas VI and VII mackerel is taken as by-catch. Reports from these fisheries have suggested that discarding may be significant because of the low mackerel quota relative to the high horse mackerel quota - particularly in those fisheries carried out by freezer trawlers. The level of discards is greatly influenced by the market price and by quotas.

Three nations provided discard data for 2002: Age disaggregated discard data from Scottish fisheries in the first quarter in areas IVa, VIa and VIIj and in the fourth quarter in area IVa were available to the working group. No information on the fleet segment was available. In Division VIa in the 1st quarter, the discard of 12,000 tonnes consisted mainly of the 1999 and 2001 year classes, while in IVa in the 4th quarter discards of 7,700 tonnes mainly consisted of the 2001 year class.

Dutch trawlers discarded 2642 tonnes of mackerel in Divisions VIIh, IVa, VIa and VIIIa.

Data from German commercial cruises in 2002 obtained no discarding of mackerel in the horse mackerel fishery but discard rates of up to 5% in the mackerel fishery. Mackerel discards were even higher in the herring fishery in quarter 3 in VIa. Discarding mainly of small fish was observed.

The Working Group highlights the possibility that discarding of small mackerel may again become a problem in all areas, particularly if a strong year class enters the fishery. There are indications for upcoming stronger year classes (see Sect. 2.4 and 2.10). Discarding should therefore be carefully monitored in the next years.

An EU programme carried out by Spain studied the rate of discards of all species taken by the Spanish bottom trawl fleets, fishing in Subareas VI, VII, VIIIc and IXa. The results of this study (Perez *et. al.* 1994) showed that the discard rates varied by species and by area and fishing fleet. The observed levels of discards were between 0.2% - 25.7% for horsemackerel, between 0.1% and 8.1% for mackerel and less than 1% for sardine.

Horse Mackerel

Discard information for horse mackerel was available from the Netherlands and Germany for 2002. The Netherlands reported 307 t of horse mackerel discards taken in Divisions VIIh and VIIIa. German onboard sampling demonstrated that discards were inexistent in the pelagic fishery. In the North Sea demersal fishery mackerel and horse mackerel were only caught occasionally. Here, high rates of adult horse mackerel discards occurred in the 2nd quarter by the twin rig and seine fleet (targeting red mullet).

Because of the potential importance of significant discards levels on the mackerel and horsemackerel assessments the **Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. Existing observer programmes should be continued, and in the light of potentially upcoming strong year classes be intensified.**

Sardine

No observer programm has been conducted to collect more information on the importance of slipping but research on the effects of slipping on sardine survival are in progress.

Anchovy

There are no estimates of discards in the anchovy fishery.

1.3.4 Age-reading

Reliable age data are an important pre-requisite in the stock assessment process. The accuracy and precision of these data, for the various species, is kept under constant review by the Working Group.

Mackerel

At last year's meeting the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy recommended that institutes examine their otolith preparation technique for mackerel and that a new mackerel otolith exchange be carried out to evaluate the otolith processing techniques of all institutes that are providing age data to this Working Group.

This recommendation was based on the analysis of the 2001 otolith exchange (EU-contract SAMFISH 2000/2001), which, however, only included age readers from Spain, Portugal, the Netherlands, England and Scotland. The age reading results were also examined by group of otoliths prepared by an institute in order to evaluate the different otolith processing techniques. The text table below shows the results based on the age readings of all readers reading all otoliths of all institutes:

Institute that prepared the otoliths	Percentage agreement to modal age	Precision CV (%)
RIVO	75.8	7.5
CEFAS	75.6	7.3
AZTI	66.7	14.8
IEO	66.6	10.2
IPIMAR	61.4	18.6
MARLAB	54.1	21.0

From the table above it is apparent that the otolith preparation method determines to a large extend the accuracy and precision of the age readings.

Therefore, the **Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy again recommends that institutes examine their otolith preparation technique for mackerel before a new mackerel otolith exchange be carried out to evaluate the otolith processing techniques of all institutes that are providing age data to this Working Group**.

Horse mackerel

The PGCCDS recommend that an otolith exchange be carried out next year. The Netherlands are to take the lead on this exchange.

Sardine

No new workshops on otolith exchange were carried out in 2003. Portugal and Spain are implementing the recommendations from the 2000 exchange programme.

Anchovy

During 2001 and 2002 and within the EU study project PELASSES (99/010) an exchange of otoliths and a workshop on age reading of anchovy otoliths from subareas VIII and IXa took place coordinated by AZTI.

The otoliths exchange programme took place during summer and Autumn 2001 based on which precision of current ageing procedures was assessed and served as starting point for analysis and discussions of the workshop.

The workshop was organised to standardise the age readings of anchovy and discuss the problems and difficulties for the age readings. The workshop took place in January 2002 in AZTI with participants from Portugal France and Spain (Uriarte *et al*. WD2002).

The major GOAL of the workshop was to identify major difficulties in age determination and standardise anchovy otolith ageing criteria for the Bay of Biscay and for division IXa. For the former case AZTI's methodology for age determination was discussed and adopted by the workshop. For the second area suggestions on age reading methodology and on further research were agreed.

After the workshop the general agreement achieved for the Bay of Biscay and Division IXa attained about 92 and 88 % respectively.

The next workshop will take place in 2005.

1.3.5 Biological data

The main problems in relation to other biological data, identified by the Working Group are listed by species.

Mackerel

The revision of the catch data by SGDRAMA (annexed to last years WG report) necessitated a revision of the maturity ogive for NEA mackerel. This was because the maturity ogive for NEA mackerel is based on a weighting by the SSB's from the three components. In addition the mean weights in the stock for NEA mackerel are based on average values over the past three years because of the lack of data from the spawning ground at spawning time.

Horse Mackerel

There is no new information on horse mackerel maturity. WGMEGS (2003) confirmed that it is highly unlikely that horsemackerel is a determinate spawner.

Sardine

Research on sardine maturity was carried out within the framework of the Study Group on the estimation of Spawning Stock Biomass of Sardine and Anchovy (SGSBSA) to revise the maturity key currently used for sardine and to standardise the definition of mature fish for SSB estimation, both for the DEPM method and the analytical stock assessment. The classification of female maturity stages was calibrated using microscopic and the definition of various terms related to reproductive state was clarified. Results from ongoing analysis and from the calibration of male maturity stages are still to be expected before a full revision of the macroscopic maturity key takes place. Regarding the definition of mature fish for the estimation of SSB, the SGSBSA agreed that stage II individuals are mature and will very probably spawn in the near future, hence, they should form part of the potential SSB that is estimated during analytical assessment. On the other hand, the DEPM aims to estimate SSB at the time of the survey, by dividing the observed total daily egg production over the fraction of the population biomass that has given rise to these eggs and therefore this population should only include stage III and above females. Nevertheless, the Group recommends that the issue is further discussed in the light of additional biological information on sardine reproduction and a final decision is only taken when a satisfactory maturity scale is introduced.

1.3.6 Quality Control and Data Archiving

Current methods of compiling fisheries assessment data. Information on official, area misreported, unallocated, discarded and sampled catches are currently recorded by the national laboratories on the WG-data exchange sheet (MS Excel; for definitions see text table below) and sent to the species co-ordinators. Co-ordinators collate data using the latest version of *sallocl* (Patterson, 1998) which produces a standard output file (*Sam.out*). However only sampled, official, WG and discards are available in this file.

There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches, but the following general process is implemented by the species co-ordinators. Searches are made for appropriate samples by gear (fleet), area, and quarter, if an exact match is not available the search will move to a neighbouring area, if the fishery extends to this area in the same quarter. More than one sample may be allocated to an unsampled catch, in this case a straight mean or weighted mean of the observations may be used. If there are no samples available the search will move to the closest non adjacent area by gear (fleet) and quarter, but not in all cases. For example in the case of NEA mackerel samples from the southern area are not allocated to unsampled catches in the western area. It would be very difficult to formulate an absolute definition of allocation of samples to unsampled catches which was generic to all stocks, however full documentation of any allocations made are stored each year in the data archives (see below). It was noted that when samples are allocated the quality of the samples may not be examined (i.e. numbers aged) and that allocations may be made notwithstanding this. The Working Group again encourages national data submitters to provide an indication of what data could be used as representative of their unsampled catches.

Definitions of the different catch categories as used by the MHMSA WG

Official Catch	Catches as reported by the official statistics to ICES
Unallocated Catch	Adjustments to the official catches made for any special knowledge about the fishery, such as under- or over-reporting for which there is firm external evidence. (can be negative)
Area misreported Catch	To be used only to adjust official catches which have been reported from the wrong area. (can be negative). For any country the sum of all the area misreported catches should be zero.
Discarded Catch	Catch which is discarded
WG Catch	The sum of the 4 categories above
Sampled Catch	The catch corresponding to the age distribution

Quality of the Input data. Primary responsibility for the accuracy of national biological data lies with the national laboratories that submit such data. Each species co-ordinator is responsible for combining, collating, and interpolating the national data where necessary to produce the input data for the assessments. A number of validation checks are already incorporated in the data submission spreadsheet currently in use, and these are checked by the co-ordinators who in the first instance report anomalies to the laboratory which provided the data.

The working group acknowledges the effort some members have made to provide “corrected” data, which in some cases differ significantly from the officially reported catches. Most of this valuable information is gathered on the basis of personal knowledge of the fishery and good relations between the responsible scientist and the fishermen. The WG is aware of the problem that this knowledge might be lost if the scientist resigns, and asks the national laboratories to ensure continuity in data provision. In addition the working group recognises and would like to highlight the inherent conflict of interest in obtaining details of unallocated catches by country and increasing the transparency of data handling by the Working Group. This issue will have to be carefully considered in light of any future development by ICES of a standard platform to store all fisheries aggregated data.

The quality and format of input data provided to the species co-ordinators is still highly variable. Table 1.3.6.1 gives an overview of possible problems by nation. From this and Figures 1.3.6.1-2 it can be seen that sampling deficiencies have overall been reduced, partly due to the implementation of the EU sampling regulation for commercial catch data. However, some nations have still not or inadequately aged samples, others have not even submitted any data. This is regarded to be problematic for France in the case of Mackerel; Denmark, England, France, Scotland and Sweden in the case of Horse Mackerel; and Portugal in the case of Anchovy. For Sardine, Ireland and England & Wales reported catches in the northern area (VIIIa, VII and VI) but did not sample their catch. However, under the EU directive for sampling of commercial catch the responsibility lies within the member state where the catch is landed. There are indications that France may also have significant catches in that area but does neither report nor sample these. This might become problematic if catches in this currently unregulated fishery continue to rise. This table will be updated again next year to continue to track improvements. For anchovy, a complex method of catch sampling based on stratifying by commercial size-categories is used. Although a documented programme such as *sallocl* is not used to combine these data it was felt that such a programme would not improve the quality of this data.

The Working Group documents sampling coverage of the catches in two ways. Sampling effort will be tabulated against official catches by species (as in this Section). Further, maps showing total catch in relation to numbers of aged and measured fish by area give a picture of the quality of the overall sampling programme in relation to where the fisheries are taking place (Figures 1.3.1.1 and 1.3.1.2).

Transparency of data handling by the Working Group and archiving past data. The current practice of data handling by the working group is unchanged since a number of years. Data received by the co-ordinators which is not reproduced in the report is available in a folder called “archives” under the working group and year directory structure. This archived data contains the disaggregated dataset, the allocations of samples to unsampled catches, the aggregated dataset and (in some cases) a document describing any problems with the data in that year.

Prior to 1997, most of the data was handled in multiple spreadsheet systems in different formats. These are now stored in the original format, separately for each stock and catch year. Table 1.3.6.2 gives an overview on data collected by Sept. 2003. It is the intention of the Working group that in the interim period until the proposed standard database is developed (see below) the previous years archived data will be copied over to the current year directory and updated at the working group. Thus the archive for each year will contain the complete dataset available. Further, it should be backed up on Compact Disk. The request by the WG for ICES to provide an archive folder was again not carried out, therefore the WG continues to create an archive by manually copying over all previously stored disaggregated and input data to the current WG folder. **The WG recommends again that archives folder should be given access only to designated members of the MHSA WG**, as it contains sensitive data.

The WG continues to ask members to provide any kind of national data reported to previous working groups (official catches, working group catches, catch-at-age and biological sampling data), to fill in missing historical disaggregated data. However, there was little response from the national institutes. **The WG recommends that national institutes increase national efforts to gain historic data, aiming to provide an overview which data are stored where, in which format and for what time frame.** The working Group still sees a need to raise funds (possibly in the framework of a EU-study) for completing the collection of historic data, for verification and transfer into digital format.

Review of recommended progress and future developments. During the last three years WGMHSA has pressed for the urgent need for a database-based input application for the handling of commercial catch and catch at age data. WGMHSA stated that this should preferably be developed under the auspices of ICES and meet the requirements of more than the pelagic groups in the ICES environment. It was the WG’s opinion that this database could solve not only the immediate data handling problems, but also most of the quality control issues at the data input level, as raised by ICES in the draft of a Quality Control handbook (see section 1.5 of last year’s report).

As ICES indicated its readiness to facilitate the development of this database already last year, the WG decided to put only little effort in further improvements of the input spreadsheet and *sallocl* program. Problems with the use of the spreadsheet/salloc-system and the urgent need for an input application have been discussed extensively in this section in last year’s report and will not be repeated here.

The group followed with interest a presentation on the status of the database development by Wim Panhorst, ICES secretariat’s computer systems manager. While funds are available for the development of the database, problems were encountered when trying to harmonise input formats between the proposed ICES database (which should *inter alia* contain confidential data on misreported and unallocated catch), and a database housed at the Commission of the European Union. The latter is also under development and will not hold any confidential data. The purpose of trying to agree on a common format is to avoid reformatting of the same data by national institutes. The WG appreciates this effort, however, the EU Commission's database was considered of being of little use for stock assessment purposes. Therefore, steps that might be needed to harmonize input formats should not lead to a delay in the development of the database. The ICES computer systems manager and the ICES fisheries advisor announced that the database should be functional for the first meeting off an assessment WG in 2004. The WG expressed its satisfaction with the progress and, as it regards this as being still a matter of highest priority, offers any possible support. It also stipulated that an early involvement of species coordinators from a variety of WGs would be mandatory to assure that the database can be sensibly used for assessment purposes.

1.4 Checklists for quality of assessments

As a step in the direction of systematic documentation of the assessment procedures and quality, checklists as suggested by the HAWG (ICES 2000) were made for some of the stocks since 2000 and updated again this year (Tables 1.4.1-1.4.5).

1.5 Review of reference points relevant for WG MHSA proposed by SGPRP and SGPA

The WG was asked to "comment on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management" (ToR h).

SGPRP and SGPA reviewed different reference points currently in place for a number of stocks in the ICES area, focussing on biomass reference points on the basis of stock-recruit relationships. For the stocks dealt with by WG MHSA, SGPRP concluded (ICES 2003/ACFM:15):

- **Southern Horse Mackerel** (VIIIc & IXa), **North Sea Horse Mackerel**, **Sardine** (VIIIc & IXa): $\mathbf{B_{lim}}$-estimation not possible due to a poor data situation. Reference points can only be revised when the quality of the assessment improves (Stock type 1 – data poor situation)
- **Anchovy (IXa)**: $\mathbf{B_{lim}}$-estimation not possible (Stock type 2 – short-lived species)
- **Anchovy (Bay of Biscay)**: $\mathbf{B_{lim}}$-estimation possible on basis of stock-specific method (Stock type 2 – short-lived species). The dynamic range in SSB and R has been relatively large but there is no clear signal in the S/R relationship. The assessment time series is relatively short. $\mathbf{B_{loss}}$ should be maintained as $\mathbf{B_{lim}}$.
- **Western Horse Mackerel**: $\mathbf{B_{lim}}$-estimation possible on basis of stock-specific method or judgement (Stock type 3- spasmodic stocks). Signal given by the S/R-plot is uninformative. The maximum likelihood given by SGPRP's method (segmented regression) is poorly defined. If a biomass reference point is to be re-established, $\mathbf{B_{loss}}$ is a candidate for $\mathbf{B_{lim}}$ - as this stock has shown a wide range of SSBs and was heavily exploited in recent years.
- **North-East Atlantic Mackerel**: $\mathbf{B_{lim}}$-estimation possible on basis of stock-specific method or judgement (Stock type 8- No S/R signal, no apparent plateau). The range of SSB to be used for the S/R relation is narrow, there is no evidence for impaired recruitment at lowest recorded SSBs. The maximum likelihood given by the segmented regression is poorly defined. Current basis for $\mathbf{B_{pa}}$ (2.3 Mill. t) is $\mathbf{B_{loss}}$ for the Western component raised by 15% to account for the Southern and North Sea components. The revision of the historic data in 2002 allowed a recalculation for the whole stock, and $\mathbf{B_{loss}}$ is now believed to be at around 2.4 Mill. t – which is higher than the currently accepted $\mathbf{B_{pa}}$. SGPRP recommends to maintain the basis for $\mathbf{B_{pa}}$ but to update the value to reflect data revisions. $\mathbf{B_{loss}}$ is taken as basis for $\mathbf{B_{pa}}$ as an exception for this stock, as this stock has shown a narrow range of SSBs with only moderate exploitation.

WG MHSA supports SGPRP's recommendations. The re-establishment of a biomass reference point for Western Horse Mackerel was repeatedly proposed by the group. WG MHSA also follows SGPRP's arguments to use $\mathbf{B_{loss}}$ as basis for setting $\mathbf{B_{lim}}$, while it has proposed to use $\mathbf{B_{loss}}$ as basis for $\mathbf{B_{pa}}$ before. While the WG considers that reference points should not be static but adapted if new information becomes available, it felt that the proposed increase (by SGPRP) of $\mathbf{B_{pa}}$ for NEA Mackerel from 2.3 Mill. t to 2.4 Mill. t would be within the range of uncertainty of the assessment. **The Working Group therefore recommends to ACFM to set $\mathbf{B_{lim}}$ for Western Horse Mackerel at 500,000 t, and to keep $\mathbf{B_{pa}}$ for NEA Mackerel at the well-established level of 2.3 mill. t.**

1.6 Proposal for benchmark and update assessments

In the light of ACFM's initiative to reduce the workload for the WGs by establishing a system of intermitting full/benchmark and update assessments, the working group was asked to define potential candidates for these categories. The WG MHSA expects to have spawning stock biomass estimates for NEA Mackerel and egg production estimates for Western Horse Mackerel from the 2004 egg survey available at next year's meeting. These stocks are therefore considered for a benchmark assessment in 2004. NEA Mackerel could in the future be dealt with as update assessment in any year without egg survey. At present, no other assessments conducted by WG MHSA are candidates for update assessments, as most of them still have an experimental character.

Table 1.3.6.1. Overview of the availability and format of data provided to the species co-ordinators and possible problems (e.g. inconsistencies, missing data) Grey fields in the last column indicate poor sampling level.

Catch year 2002.

A. Mackerel

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
Belgium	NO	-	-	NO
Denmark	YES	YES	YES	NO
England	YES	YES	YES	YES
Faroes	YES	YES	YES	YES
France	NO	-	-	YES
Germany	YES	YES	YES	NO
Ireland	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Norway	YES	YES	YES	NO
Portugal	YES	YES	YES	NO
Russia	YES	YES	YES	NO
Scotland	YES	YES	YES	NO
Spain	YES	YES	YES	NO
Sweden	YES	YES	NO	NO

B. Horse Mackerel

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
Belgium	NO	-	-	NO
Denmark	YES	YES	NO	YES
England	YES	YES	NO	YES
France	NO	-	-	YES
Germany	YES	YES	YES	YES
Ireland	YES	YES	YES	NO
Netherlands	YES	YES	YES	NO
Norway	YES	YES	YES	NO
Portugal	YES	YES	YES	NO
Russia	NO	-	-	NO
Scotland	YES	YES	NO	YES
Spain	YES	YES	YES	NO
Sweden	NO	-	-	YES

C. Sardine

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
France	NO	-	-	YES
England	YES	YES	NO	YES
Ireland	YES	YES	NO	YES
Germany	YES	YES	YES	NO
Portugal	YES	YES	YES	NO
Spain	YES	YES	YES	NO

C. Anchovy

Country	Data supplied	Data exchange sheet	Aged Samples	Problems
France	YES	-	YES	NO
Portugal	YES	-	NO	YES
Spain	YES	-	YES	NO

Table 1.3.6.2: Available disaggregated data for the WG MHSA per Sept. 2003
X: Multiple spreadsheets(usually xls); W: WG-data national input spreadsheets (xls);
D: Disfad and Alloc-outputs (ascii/txt)

Stock		Catchyear	Format			Comments
			X	W	D	
Horse Mackerel: Western and North Sea						
	HOM_NS+W	1991	X			Files from Svein Iversen, April 1999
		1992	X			Files from Svein Iversen, April 1999
		1993	X			Files from Svein Iversen, April 1999
		1994	X			Files from Svein Iversen, April 1999
		1995	X			Files from Svein Iversen, April 1999
		1996	X			Files from Svein Iversen, April 1999
		1997	X	W	D	Files from Svein Iversen, April 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Svein Iversen Sept 2000
		2000	X	W	D	Files provided by Svein Iversen Sept 2001
		2001	X	W	D	Files provided by Svein Iversen Sept 2002
		2002	X	W	D	Files provided by Svein Iversen Sept 2003
Horse Mackerel: Southern						
	HOM_S	1992	X			WG Files on ICES system [Database.92], March 1999
		1996	X			Source?
		1997		(W)	D	WG Files on ICES system [WGFILES\HOM_SOTH], March 1999
		1998		W	D	Files provided by Pablo Abaunza Sept 1999
		1999		W	D	Files provided by Pablo Abaunza Sept 2000
		2000	X	W		Files provided by Pablo Abaunza Sept 2001
		2001	X	W		Files provided by Pablo Abaunza Sept 2002
		2002	X	W		Files provided by Pablo Abaunza Sept 2003
North East Atlantic Mackerel						
	NEAM	1991	X			North Sea +Western WG Files on ICES system [Database.91], March 199
		1992	X			North Sea +Western WG Files on ICES system [Database.92], March 199
		1993	X			North Sea +Western WG Files on ICES system [Database.93], March 199
		1997		W	D	Files from Ciaran Kelly, April 1999
		1998		W	D	Files from Ciaran Kelly, Sept 1999
		1999		W	D	Files provided by Ciaran Kelly, Sept 2000
		2000		W	D	Files provided by Ciaran Kelly, Sept 2001
		2001		W	D	Files provided by Ciaran Kelly, Sept 2002
		2002		W	D	Files provided by Ciaran Kelly, Sept 2003
	Western Mackerel subset					
		1997		(W)	D	Files from Ciaran Kelly, April 1999; (W) contained in NEAM
		1998		(W)	D	Files from Ciaran Kelly, Sept 1999; (W) contained in NEAM
		1999		(W)	D	Files provided by Ciaran Kelly, Sept 2000; (W) contained in NEAM
		2000	X	(W)		Files provided by Guus Eltink, Sept 2001; (W) contained in NEAM
		2001	X	(W)		Files provided by Guus Eltink, Sept 2002; (W) contained in NEAM
	Southern Mackerel subset					
		1991	X			WG Files on ICES system [Database.91], March 1999
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1994	X			WG Files on ICES system [Database.94], March 1999
		1995	X			WG Files on ICES system [Database.95], March 1999
		1996	X			WG Files on ICES system [Database.96], March 1999
		1997	X	(W)		WG Files on ICES system [WGFILES\MAC_SOTH], March 1999
		1998	X	(W)		Files provided by Mane Martins; (W) contained in NEAM
		1999	X	(W)		Files provided by Begoña Villamor, Sept 2000; (W) contained in NEAM
		2000	X	(W)		Files provided by Begoña Villamor, Sept 2001; (W) contained in NEAM
		2001	X	(W)		Files provided by Guus Eltink, Sept 2002; (W) contained in NEAM
Sardine						
		1992	X			WG Files on ICES system [Database.92], March 1999
		1993	X			WG Files on ICES system [Database.93], March 1999
		1995	X			files provided by Pablo Carrera Sept 2001
		1996	X			files provided by Pablo Carrera Sept 2001
		1997		W	D	W for Portugal only, files provided by Pablo Carrera and Kenneth Patters
		1998		W	D	files provided by Pablo Carrera Sept 1999
		1999		W		files provided by Pablo Carrera Sept 2000
		2000		W	D	files provided by Pablo Carrera Sept 2001
		2001		W	D	files provided by Alexandra Silva, Sept. 2002
		2002		W	D	files provided by Alexandra Silva, Sept. 2003
Anchovy						
	Anchovy in VIII	1987-95	X			revised data, all in one spreadsheet, provided by Andres Uriarte Sept 199
		1996	X			file provided by Andres Uriarte Sept 1999
		1997	X	W	D	files provided by Andres Uriarte Sept 1999
		1998	X	W		files provided by Andres Uriarte Sept 1999
		1999	X	W		files provided by Andres Uriarte Sept 2000
		2000	X	W		files provided by Andres Uriarte Sept 2001
		2001	X	W		files provided by Andres Uriarte Sept 2002
		2002	X	W		files provided by Andres Uriarte Sept 2003
	Anchovy in IX					
		1992	X			files in WK3-format provided by Begoña Villamor Sept 1999
		1993	X			files in WK3-format provided by Begoña Villamor Sept 1999
		1994	X			files provided by Begoña Villamor Sept 1999
		1995	X			files provided by Begoña Villamor Sept 1999
		1996	X			files provided by Begoña Villamor Sept 1999
		1997	X	W		W for Spain only, files provided by Begoña Villamor Sept 1999
		1998	X	W		W for Spain only, files provided by Begoña Villamor Sept 1999
		1999	X	W		W for Spain only, files provided by Begoña Villamor Sept 2000
		2000	X	W		W for Spain only, files provided by Begoña Villamor Sept 2001
		2001	X	W		W for Spain only, files provided by Fernando Ramos Sept 2002
		2002	X	W		W for Spain only, files provided by Fernando Ramos Sept 2003

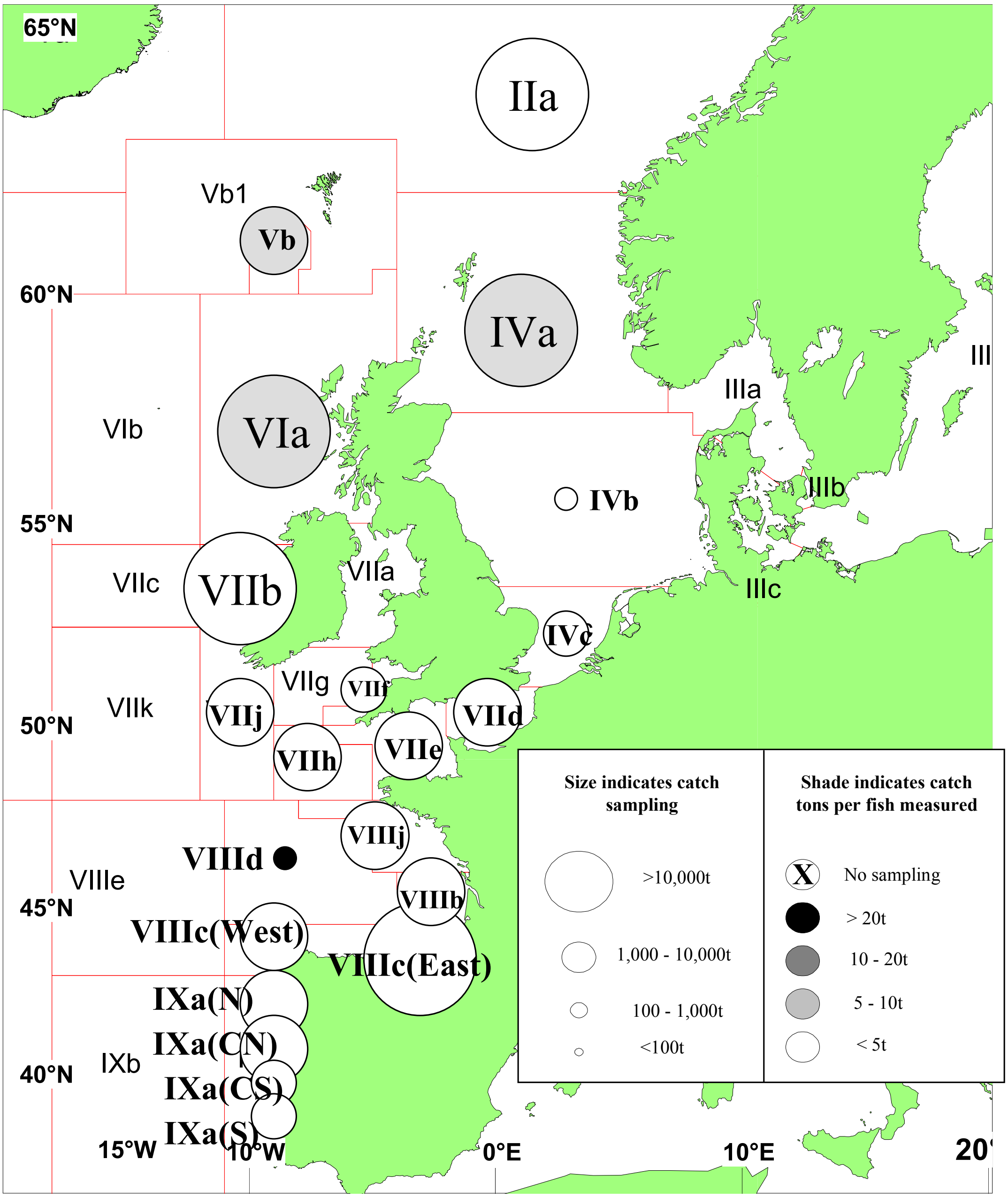

Figure 1.3.6.1 Sampling of mackerel for length in relation to tonnage landed by ICES sub-division. Circle size indicates catch tonnage and shading indicates sampling level

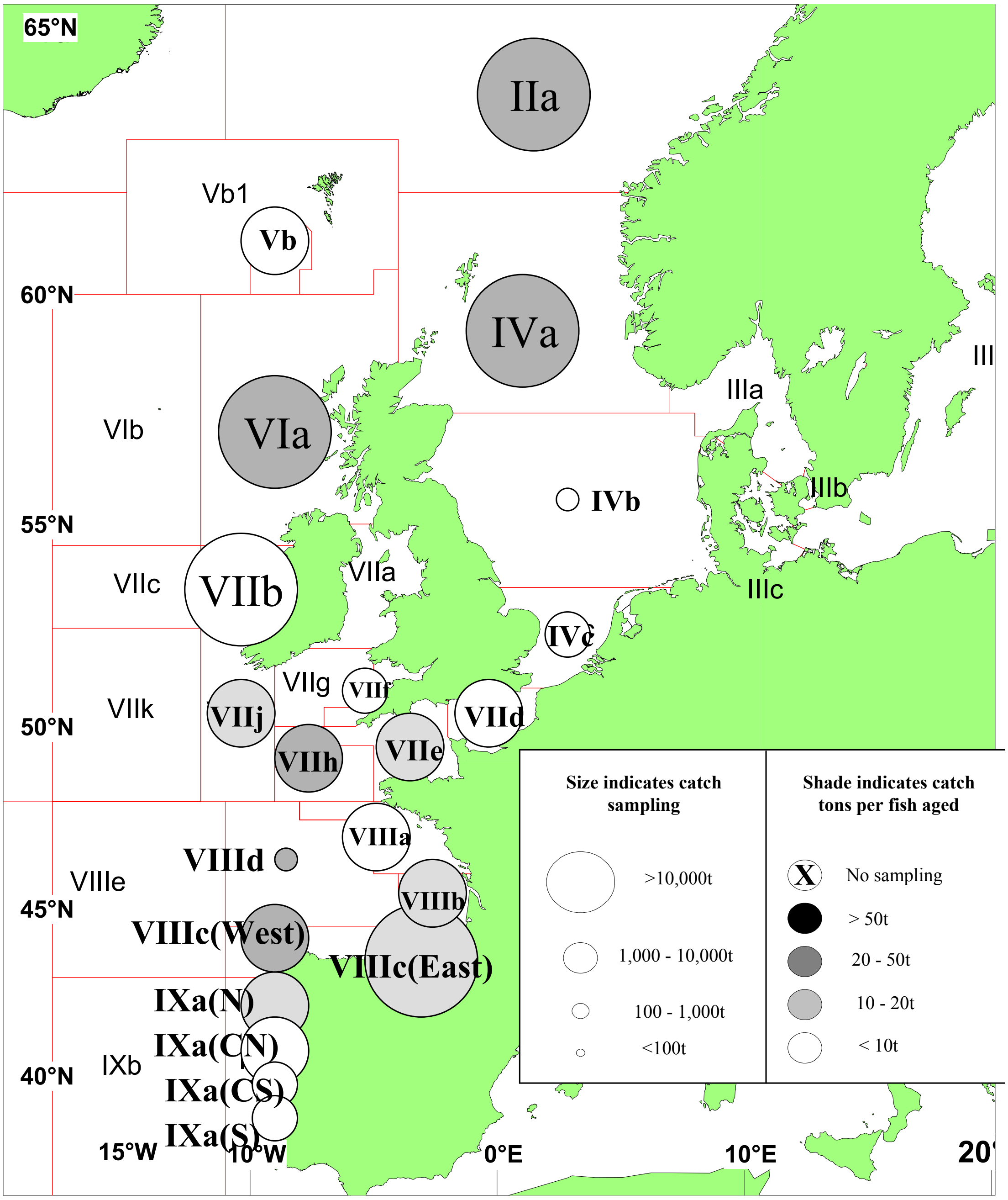

Figure 1.3.6.2 Sampling of mackerel for age in relation to tonnage landed by ICES sub-division. Circle size indicates catch tonnage and shading indicates sampling level

Table 1.4.1 Checklist for North-East Atlantic Mackerel assessments

1. General

step	*Item*	*Considerations*
1.1	Stock definition	Assessments are now performed for mackerel *(Scomber scombrus)* over the whole distribution area. Stock components are separated on the basis of catch distribution, which reflects management considerations and different historical information for the components rather than on any biological evidence: Western component: spawning in Sub-areas and Div. VI, VII, VIIIabde, distributed also in IIa, Vb, XII, XIV; North Sea component: spawning in IV and IIIa (but as the North Sea component is relatively small, most of the catches in IVa and IIIa are considered as belonging to the Western component); Southern component: spawning in VIIIc and IXa. Possible problems with species mixing *(S. japonicus)* in the Southern part of the area.
1.2	Stock structure	
1.3	Single/multi-species	Single species assessments

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, misreporting	Catch estimates are based on official landings statistics and are augmented by national information on misreporting and discarding.. In the 2002 data the age structure of the discards from one fleet (Scotland) was available for the first time. This age structure was not applied to other discarded catches. Discarding is considered as a problem in the fishery.. Separation of the different mackerel stock components is on the basis of the spatial and temporal distribution of catches (see above).
2.2	Indices of abundance	
	Catch per unit effort	CPUE (at age) information for the Southern area only
	Gear surveys (trawl, longline)	Trawl surveys for juvenile mackerel which give indications of recruit abundance and distribution. These are currently not used for the assessment, but did accurately predict the weak 2000 year class..
	Acoustic surveys	Experimental surveys in 1999 to 2002 by Norway, Scotland, Spain, Portugal and France. These are not currently used in the assessment.
	Egg surveys	The triennial egg survey for mackerel and horse mackerel currently provides the only fishery independent SSB estimate used in the assessment. The survey has been conducted in the western area since 1977, and in the southern area since 1992. In its present form the survey aims at covering the whole spawning time (January - July) and area (South of Portugal to West of Scotland) for both components since 1995. The next survey is planned for 2004. Applied method: Annual Egg Production Method. Similar egg surveys are also carried out on a roughly triennial basis in the North Sea, but these have only a partial spatio-temporal coverage and are not currently used in the assessment
	Larvae surveys	None
	Other surveys	Russian aerial surveys have been conducted annually in July since 1997 in international waters in the Norwegian Sea and in part of the Norwegian and Faroese waters (Div. IIa). This gives distribution and biomass estimates, not currently used in the assessment. The aerial surveys now include Norwegian & Faroese participation.

Table 1.4.1 (Cont'd)

2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Catch at age: derived from national sampling programmes. Sampling programmes differ largely by country and sometimes by fishery. Sampling procedures applied are either separate length and age sampling or representative age sampling. 87% of the catch was sampled for length and age in 2002. Total number of samples taken (2002): 1,450; total number of fish aged: 26,146; total number of fish measured: 184,101. Weight at age in the stock: Stock weights in the western area were not available from national sampling programmes in 2002. Therefore average weights over the period 1999 to 2001 were used to derive stock weights for the western area in 2002. Southern component: based on Spanish samples in the first half of the year in Div. VIIIc. North Sea components: constant value since 1984 (start of data series). The separate component stock weights were then weighted by the relative proportion of the egg production estimates of SSB for the respective components (Western / Southern / North Sea: 61-85% / 13-21% / 2-21%, in 2001 85% / 12% / 3%). Weight at age in the catch: derived from the total international catch at age data weighted by catch in numbers. In some countries, weight at age is derived from general length-weight relationships, others use direct measurements. Maturity at age: based on biological samples from commercial and research vessels; weighted maturity ogive according to the SSB biomass in the three components (see above). As there was no new data there was no change in the maturity ogive in 2002.
2.4	Tagging information	Used as indicator for the mixing of the Southern and Western components; used to estimate total mortality; for exploratory assessment runs (AMCI).
2.5	Environmental data	Not used
2.6	Fishery information	Several scientists involved in the assessment of this stock are familiar with the fishery. Most major mackerel fishing nations have placed observers aboard the fishing vessels. Anecdotal information on the fishery may be used in the judgement of the assessment.

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality: fixed parameter over years and ages (M=0.15) based on tagging data. Selection at age: Reference age 5 for which selection is set at 1. Selection at final age set to 1.2. One period of 11 years of separable constraint (including the egg survey biomass estimates from 1992 onwards). Population in final year: 13 parameters. Population at final age for separable years: 9 parameters. Recruitment for survivors year: Total number of parameters: 43 Total number of observations: 136 Number of observations per parameter: 3.2
	Recruitment	No recruitment relationship fitted.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Model is in the form of a weighted sum of squares. Terms are weighted by manually set weights. Index for biomass from egg surveys gets a weight of 5 and each catch at age observation in the separable period contributes a weight of 1 except 0-group, which is down-weighted to 0.01. The survey biomass estimate was treated as absolute up to 1998. From 1999 to 2001 it was treated as a relative index. In 2002 and 2003 it was again treated as absolute.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	Maximum likelihood estimates of parameters and 95% confidence limits are given. Total variance for the model and model components given, both weighted and unweighted. (weighted is currently incorrectly calculated in the model) Several test statistics given (skewness, kurtosis, partial chi-square). Historic uncertainty analysis based on Monte-Carlo evaluation of the parameter distributions.

Table 1.4.1 (Cont'd)

3.6	Retrospective evaluation	Currently no retrospective analysis is carried out. Two reasons: because it is not directly available within ICA and because the assumptions concerning the separable period have been very variable over recent years. It is recognised that the retrospective analysis would be useful. Historic realisations of assessments are routinely presented and form a direct overview on the changes in the perception of the state of the stock. These are presented for SSB, fishing mortality and recruitment.
3.7	Major deficiencies	• reference age not well determined • selection at final age not well determined • separable period changes often • weighting for catch data much higher than for survey data (41 to 5) • weighting for survey indices and catch data are not related to variability in the data • correlation structure of parameters not properly assessed and presented • catchability of surveys is assumed constant over the years • area misreporting of catch is a minor problem • relationship between number of parameters, number of data points and total SSQ not addressed • simpler assessment models currently not evaluated • Assessment is over sensitive to recent survey SSBs

4. Prediction model(s) – SHORT TERM

step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Age-structured model, by fleet and area fished.
4.2	Spatially explicit or not	Not
4.3	Key model (input) parameters	Stock weights at age: average from last 3 years Natural mortality at age: average from last 3 years Maturity at age: average from last 3 years Catch weights at age BY FLEET: average from last 3 years Proportion of M and F before spawning: 0.4 Fishing mortalities by age: From ICA Numbers at age: from ICA, final year in assessment; ages 2 to 12+ 0-group is GM recruitment whole period except last 3 years 1-group is GM recruitment applying mortality at age 0 Only in 2003 the ICA abundance at age 2 was modified to the 75 percentile in recognition of a strong year class (2001) in 2002. Fishing mortalities by area (and age): The exploitation pattern used in the prediction was the separable ICA F's for the final year and then re-scaled according the ratio status quo F (last 3 years) and reference F ($F_{4\text{-}8}$). This exploitation pattern is subdivided into partial F's for each fleet using the average ratio of the fleet catch at each age for the last 3 years.
4.4	Recruitment	Geometric mean over whole period except last 3 years.

Table 1.4.1 (Cont'd)

4.5	Evaluation of uncertainty	Uncertainty in model parameters is NOT incorporated, though sometimes a limited number of sensitivity analyses may be performed, usually with regard to recruitment level.
4.6	Evaluation of predictions	Predictions are not evaluated retrospectively (this is tricky to do in terms of catches, but some evaluation in terms of population numbers at age should be done).
4.7	Major Deficiencies	*SSB estimates from egg surveys are only available every 3 years.* *Assessment/Prediction mismatch: The prediction model contains more detail (by fleet) than the assessment model (not by fleet). In particular, stock estimates are based on a separable model which is then treated in a non-separable way in the short term predictions.* *Catch options: no unique solution for catches by fleet when management objectives are stated in terms of F_{adult} and $F_{juvenile}$. Need to impose further constraints (eg maintain proportions of catches between fleets), to find unique solution.* No stochasticity/uncertainty reflected in short term predictions. Intermediate year: general problem- whether to use status quo F or a TAC constraint for intermediate year Software: MFDP programme

5. Prediction model(s) – MEDIUM TERM

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	Age and fleet structured. *Software: STPR programme*
5.2	Spatially explicit or not	No
5.3	Key model parameters	*Model parameters as in short term predictions. Exploitation pattern and numbers at age taken from short-term prediction input; CVs taken from ICA estimates in the previous year assessment. Expected Recruitments are based on the arithmetic mean computed from the time-series of estimated recruitments and a CV of 0.25.*
5.4	Recruitment	An Ockham stock recruitment relationship is fitted, assuming recruitment independent of the SSB for SSB > 2 million t, and linearly decreasing with SSB below 2 million t.
5.5	Evaluation of uncertainty	Stochastic forward projections are based on the Baranov catch equation incorporating uncertainty in the starting population numbers and recruitment as noted in point 2, 5.3. Stochastic weights and maturities from historical data.
5.6	Evaluation of predictions	
5.7	Major Deficiencies	Intermediate year: general problem- whether to use status quo F or a TAC constraint for intermediate year

Table 1.4.2. Checklist Southern Horse Mackerel Assessment

1. General

step	*Item*	*Considerations*
1.1	Stock definition	The results of EU funded HOMSIR project suggest that the northern boundaries for the southern stock should be changed, moving to the west coast of the Iberian Peninsula. The HOMSIR project was unable to clarify the possible connection between fish from Divison Ixa and North African horse mackerel.
1.2	Stock structure	
1.3	Single/multi-species	A single species assessment is carried out

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Catches are included in the assessment. Catch reports are quite good and mis-reported catches and discards are negligible. During the assessment period the level of catches has never reached the TAC of 73 000 proposed for *Trachurus spp*. until 1999 (68 000 t in 2000 and 2001 and 2002, 57500 in 2003 and 55200 in 2004). The missing of target species for the purse seiners, like anchovy and sardine, can produce an increase in the fishing mortality of the horse mackerel, as it happened in 1997, 1998 and 1999.
2.2	Indices of abundance	The following series of age disaggregated indices are available: two series of bottom trawl surveys from 1985 onwards. Another series of bottom trawl surveys from 1989 onwards. The relationship between the indeces and abundance is considered to be linear. There also is a thre year series (1995, 1998, 2001) of SSB estimates based on egg surveys.
	Catch per unit effort	Three series of CPUE corresponding to three different bottom trawl fishing fleets are available. One from 1979 to 1990 and the other two from 1984 onwards. Data disaggregated by age are available from the two last ones.
	Gear surveys (trawl, longline)	Three series of Bottom trawl surveys are carried out in the distribution area (see Indices of abundance). Two of them cover the entire stock distribution area during the recruitment season (fourth quarter).
	Acoustic surveys	Information is available from acoustic surveys but not used in the assemment. Biomass estimates are considered to be underestimated, because the horse mackerel is also found close to the bottom blind area of the acoustic transducer.
	Egg surveys	Egg surveys are carried out on a triennual basis since 1995.
	Larvae surveys	Some information from the egg surveys but not used in the assessment.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches is considered to be good. Catch at age matrix is available from 1985. Age assignment is validated until age 12. There is no significative trends in the weight at age in the catch along the assessment period. Weight at age in the stock is considered to be constant over the assessment period, as it is also the case of the maturity ogive.
2.4	Tagging information	At the moment there is no available information from tagging
2.5	Environmental data	Enviromental information is available from acoustic surveys and bottom trawl surveys. Satellite images can provide useful information on the dynamics of the aquatic systems based mainly in the estimation of the sea surface temperature. Preliminar multivariate analysis have shown a good fit among the recruitment strength and some enviromental conditions.
2.6	Fishery information	Horse mackerel is mainly caught by purse seiners and bottom trawlers. The catches are relatively uniform over the year, although the second and third quarter show relatively higher catches.

Table 1.4.2 (cont'd). Checklist Southern Horse Mackerel Assessment

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	No assessment in 2002.
3.2	spatially explicit or not	
3.3	key model parameters: natural mortality, vulnerability, fishing mortality, catchability	
	recruitment	
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile - bootstrapping - bayes posteriors	
3.6	Retrospective evaluation	

4. Prediction model(s)

step	*Item*	*Considerations*
5.1	Age, size, sex or fleet-structured prediction model	
5.2	Spatially explicit or not	
5.3	Key model parameters	
5.4	Recruitment	
5.5	Evaluation of uncertainty	
5.6	Evaluation of predictions	

Table 1.4.3 Checklist for assessments of **Anchovy in Area VIII**

1. General

step	Item	*Considerations*
1.1	Stock definition	The stock is distributed in the Bay of Biscay. It is considered to be isolated from a small population in the English Channel and from the population(s) in the IXa.
1.2	Stock structure	No Subpopulations have been defined although morfometrics and meristic studies suggest some heterogeneity at least in morfotipes.
1.3	Single/multi-species	A single species assessment is carried out

2. Data

step	*Item*	*Considerations*
2.1	Removals: catch, discarding, fishery induced mortality	Discards are not included but considered not relevant for the two fleets. The fishing statistics are considered accurate and the fishery is well known
2.2	Indices of abundance	Series of surveys for DEPM and acoustic since 1987 (with a gap in 1993). Acoustic surveys since 1983 (although not covering all the years)
	Catch per unit effort	There exists series of catch per unit effort for the French trawlers and Spanish purse seine fleets (although not standardized) and not used in assessment
	Gear surveys (trawl, longline)	Surveys use Pelagic trawls to sample the population mainly during the spawning period and in some cases (opportunistically) purse seining.
	Acoustic surveys	There are French acoustic survey indexes available since 1989 (which are used in the assessment), some previous indexes are available since 1983 but before the period of the assessment. In 2003 a series of acoustic surveys are starting on juveniles.
	Egg surveys	Daily Egg Production Method applied to estimate the SSB. Series since 1987-2003 with a gap in 1993. estimates in 1996, 99 & 2003 are based on regression models of previous DEPM SSB on P0 and SA or Total Egg production.
	Larvae surveys	Some sampling exists to know the larvae condition. And there are some experimental surveys on Juveniles in 1999 and 2000 (JUVESU project CT97-3374). In 2003 a series of acoustic surveys are starting.
2.3	Age, size and sex-structure: catch-at-age, weight-at-age, Maturity-at-age, Size-at-age, age-specific reproductive information	Biological sampling of the catches has been generally sufficient, except for 2000 and 2001. An increase of the sampling effort seems useful to have a better knowledge of the age structure of the catches during the second semester in the North of the Bay of Biscay. Age reading is considered accurate and cross reading exchanges and workshops have taken place recently between Spain and France (Uriarte WD2002). Otoliths typology is made. Indirect validation with the fluctuation of the stock (2 years old validation) is being prepared
2.4	Tagging information	No tagging program
2.5	Environmental data	Much information exists, particularly on the temperature, water stratification, upwelling index, etc Motos et al. 1996, Borja et al. 1996, 98), (Allain et al. 2001). Currently a 3-Dymensional Hydrodynamic model is used to monitor the bay of Biscay environment affecting anchovy recruitment (Allain et al. 2001) .
2.6	Fishery information	Two main fisheries. A Spanish purse seine fishery operating mainly in Spring and a French one using mainly pelagic trawling and operating mainly in winter, summer and autumn. A small fleet of French purse seiners fishery operates in the South of the Bay of Biscay (Spring) and in the North (2^{nd} half of the year). See review in Uriarte *et al*. (1996).

Table 1.4.3 (Cont'd)

3. Assessment model

step	*Item*	*Considerations*
3.1	Age, size, length or sex-structured model	ICA is used with DEPM, Acoustic and age structure of the catches and the population. An alternative Biomass dynamic model was set up in 2002 and is being improved as to be adopted as the standard one in 2004.
3.2	Spatially explicit or not	No
3.3	Key model parameters: natural mortality, vulnerability, fishing mortality, catchability	Natural mortality is set fix at 1.2. It is considered variable. Catchability for the DEPM index is set to 1 because it is assumed to be an absolute indicator of Biomass. Catchability of the acoustic survey is estimated. Separability of the fishing mortality by ages is assumed and fishing pattern is estimated.
	Recruitment	No stock recruitment relationship is assumed. However, below 18,000 tonnes a link between recruitment and spawning abundance is assumed to exist and as such this level is used as Blim.
3.4	Statistical formulation: - what process errors - what observation errors - what likelihood distr.	Accuracy of the data are not taken into account (No observation error). Only, a weighted factor allows to translate the validity of the information used into the tuning of the assessment. Log normal errors assumed. Maximum likelihood estimates.
3.5	Evaluation of uncertainty: - asymptotic estimates of variance, - likelihood profile – bootstrapping - bayes posteriors	Asymptotic estimates of variances, by the inverse of the Hessian matrix. No explicit bootstrapping evaluation of the uncertainty
3.6	Retrospective evaluation	Not done so far (2002)

4. Prediction model(s)

Step	*Item*	*Considerations*
4.1	Age, size, sex or fleet-structured prediction model	Deterministic Age predictions models (too simplistic for this highly variable population) Based on CEFAS deterministic projections (MFDP).
4.2	Spatially explicit or not	No
4.3	Key model parameters	Recruitment at age 0 in the assessment year. Separable Fishing mortality, Catch constrain for the assessment year.
4.4	Recruitment	Geometric mean or more precautionary levels, according to the complementary information that might be available to the WG. Use of environmental indexes is on state of refinement for future use.
4.5	Evaluation of uncertainty	Short term sensitivity analysis was used in 1999.
4.6	Evaluation of predictions	Not properly.

2 NORTHEAST ATLANTIC MACKEREL

2.1 ICES advice applicable to 2002 and 2003

The internationally agreed TAC's have covered the total distribution area of the Northeast Atlantic mackerel stock since 2001. The advice for this stock includes the three stock components: Southern, Western and North Sea mackerel. In parts of the year these components mix in the distribution area. The advised TAC is split into a Northern (IIa, IIIa,b,d, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV) and a Southern (VIIIc, IXa) part on the basis of the catches the previous three years in the respective areas (Figure 2.1.1). The three components have overlapping distributions and parts of the Southern component is fished in the northern area.

The different agreements cover the total distribution area of Northeast Atlantic mackerel, while each agreement in some cases covers different parts of the same ICES Divisions and Subareas. The agreements also provide flexibility of where the catches can be taken.

The TACs agreed by the various management authorities and the advice given by ACFM for 2002 and 2003 are given in the text table below.

Agreement	Areas and Divisions	TACs in 2002	TACs in 2003
Coastal states agreement (EU, Faroes, Norway)	IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV	586,500	500,000
NEAFC agreement	International waters of IIa, IV, Vb, VI, VII, XII, XIV	53,900[1]	45,644[2]
EU-NO agreement[3]	IIIa, IVa,b	1,865	1,865
EU autonomous[4]	VIIIc, IXa	41,100	35,000
Total		683,365	582,509

Stock components	ACFM advice 2002	ACFM advice 2003	Areas used for allocations	Prediction basis	Catch in 2002
North Sea	Lowest possible level	Lowest possible level	IIa, IIIa, IV, Vb, VI, VII, VIIIa,b,d,e, XII, XIV	Northern	668,306
Western	Reduce F below **F_{pa}** = 0.17	Reduce F below **F_{pa}** = 0.17			
Southern			VIIIc, IXa	Southern[5]	49,576
					717,882

1) NEAFC agreement was 66,400 t including 12,500 t not fished by any party.
2) NEAFC agreement was 56,610 t including 10,966 t not fished by any party.
3) Quota to Sweden.
4) Includes 3,000 t of the Spanish quota that can be taken in Spanish waters VIIIb.
5) Does not include the 3,000 t of Spanish catches taken in Spanish waters of VIIIb under the southern TAC.

The TAC for the Southern area applies to Division VIIIc and IXa, although 3,000 t of this TAC could be taken from Division VIIIb (Spanish waters), which is included in the Northern area. These catches (3,000t) have always been included by the Working Group in the provision of catch options for the Northern area.

For the years 1999-2003 a fishing mortality not exceeding **F_{pa}** = 0.17 was recommended, which in 2004 corresponds to a catch around 550,000 t.

In addition to the TACs and the national quota the following are some of the more important additional management measures which have been in force since 1998. These measures are mainly designed to afford maximum protection to the North Sea component while it remains in it's present depleted state while at the same time allowing fishing on the western component while it is present in the North Sea, as well as to protect juvenile mackerel.

1. Prohibition of fishing in Division IVa from 15. February to 30. September, and of a directed mackerel fishery in Divisions IVb and IVc throughout the year;
2. Prohibition of a directed mackerel fishery in the “Mackerel Box”;
3. Minimum landing size of 30 cm for Subarea IV, Division IIIa and 20 cm for Divisions VIIIc and IXa.

Various national measures such as closed seasons and boat quotas are also in operations in most of the major mackerel catching countries.

2.2 The Fishery in 2002

2.2.1 Catch Estimates

The total estimated catch in 2002 was about 718,000t, which was about 40,000t higher than the catch taken in 2001. The combined TAC for 2002 amounted to 683,365 t, this was almost 15,000t higher than the 2001. The combined TAC for 2001 was 669,995t. The TAC set for 2002 covered all areas where mackerel is caught. The combined TAC as best ascertained by the Working Group (Section 2.1) agreed for 2003 amount to 582,509 t.

The total catch estimated by the Working Group to have been taken from the various areas is shown in Table 2.2.1.1. Revisions to the historical data series are shown in italics, these changes are further discussed in last years report (section 2.5). This table shows the development of the fisheries since 1969. The historical catches reported in this table were examined in 2002 and a report made in as an annex to the 2002 WG report.

The highest catches (about 363,000 t) were again taken in Division IVa, where the total has increased by about 60,000 t since 2001. The catches, taken from Div Vb and Sub area II (74,000 t), were a slightly higher than 2001 and 1999, but lower than in the mid to late nineties. The catch taken in the western area Subarea VI, VII and VIII (outside the southern area VIIIc) decreased by about 30,000 t to around 225,000 t which is similar the mid to late nineties. This represents a shift in the fishery with a greater proportion being taken in the 3rd and 4th quarters when the majority of the stock is in the northern area.

The catches taken in Divisions VIIIc and IXa increased again from about 43,000 to just less than 50,000 t which is the highest recorded catch taken in the southern area .

The total area misreported catch during 2002 as best ascertained by the WG was just less than 50,000t, this is similar to the situation last year.

The quarterly distributions of the catches since 1990 are shown in the text table below. The distribution of the catches in 2002 shows a greater proportion of catches in the 3rd & 4th quarters. The proportion of the catch taken in the 4th quarter was greater than the proportion of catch in the 1st quarter for the first time since 1993. Over 50% of the total catch was taken in Areas III and IV, this was predominantly from IVa in Q3 and Q4.

Percentage distribution of the total catches by quarter from 1990 - 2002

Year	Q1	Q2	Q3	Q4
1990	28	6	26	40
1991	38	5	25	32
1992	34	5	24	37
1993	29	7	25	39
1994	32	6	28	34
1995	37	8	27	28
1996	37	8	32	23
1997	34	11	33	22
1998	38	12	24	27
1999	34	9	30	27
2000	39	4	23	33
2001	38	7	25	30
2002	35	6	31	37

The catches per quarter by Subarea and Division are shown in Table 2.4.1.1. These catches are shown per statistical rectangle in Figs 2.7 1.1 to 2.7.1.4.and are discussed in more detail in Section 2.8. It should be noted that these figures are based on details submitted on the official log books and may not indicate the true location of the catches, it should also be noted that these data may not indicate the location of the stock. 35% of the total catch was taken during the 1st quarter as the shoals migrate from Division IVa through Subarea VI to the main spawning areas in Subarea VII. The proportion of the total catch taken in Quarter 2 was about the same at 7%. 31% of the total catch was taken during Quarter 3 this represents an increase the fishery in IVa. The main catches in the second quarter were taken in Area VII and in the southern area in VIIIc. During Quarter 4, 37% of the total catch was taken mainly from Division IVa. The main catches of southern mackerel are taken in VIIIc (78%) and these are mainly taken in the first and second quarter. Catches from IXa which comprise 22% of southern mackerel catches are mainly taken in the first and third quarters.

National catches

The national catches recorded by the various countries for the different areas are shown in Table 2.2.1.2 - 2.2.1.5. As has been stated in previous reports these figures should not be used to study trends in national figures. This is because of the high degree of misreporting and "unallocated" catches recorded in some years due to some countries exceeding their quota. The main mackerel catching countries in recent years continue to be Norway, Scotland, Ireland, Russia, Netherlands and Spain. Significant catches also taken by Denmark, Germany, France, England and Faroe Islands (combined catch 109,424t), of these only France do not sample their catches.

The total catch recorded from Sub area II and Vb (Table 2.2.1.2) in 2002 was about 74,000t which is similar to 2001. This slight increase in catches was due to small increases in both Norwegian and Russian. Again the WG was unaware of any misreporting of catches from IIa into IVa. The amount of misreporting into this area was very small in 2002.

The total catch recorded from the North Sea (Subarea IV and Division IIIa) (Table 2.2.1.3) in 2002 was about 369,000t which is about 55,000t more than in 2001.There has been a trend of increasing catches in this area since 1996. Misreporting of catches taken in this area into VIa appears to have increased again. The reason for this misreporting in not clear and does not appear to be caused by the early closure of the North Sea area (14th February). The increasing trend in catches in this area in the 3rd quarter, may be due to earlier targeting by the Norwegian fleet due to opportunities for blue whiting, and earlier targeting by the Scottish and Irish fleets, to avail of larger grade fish.

The main catches taken in IVa were recorded by Norway (161,121 t), while substantial catches were also recorded by the United Kingdom (58,876 t) and Denmark, (34,375 t), the Irish catch doubled to about 21,000 t. Discards were again reported this year and an age structure of the discarded catch was made available by Scotland (see section 1.3.3). The new information on discarding indicates that the increased quantities may be associated with the abundance of 1-year-old fish (2001 year class) in the area (see section 1.3.3 and 2.7.2 for further discussions).

The total catch estimated to have been taken from the Western areas (Table 2.2.1.4) was over 225,000t. This is 30,000 t less than the catch taken in 2001. The misreported catches from IVa appeared to have increased again slightly. The main catches continue to be taken by United Kingdom (131,599) and Ireland. (51,457 t). The Netherlands, (21,831 t) Germany (22,630 t) and France (19,276 t) continue to have important fisheries in this area. The amount of fish discarded in this area is significantly higher than that reported for the past 4 years. This may in part be due to increased sampling effort to monitor discarding in the area. The age structure of the discarded catch shows it to be dominated by 1 and 3 year old fish (1999 and 2001 year class).

The main catch taken in the southern area comes from VIIc. The total catch recorded from Divisions VIIIc and IXa (Table 2.2.1.5) in 2002 was 49,575 t this about 6,000t higher than the catch last year and continues a general increasing trend. Most of the increase in the southern mackerel catch in 2002 was due to increased Spanish catches in Division IXa north.

2.2.2 Species Mixing

Scomber sp.

As in previous years, there was both a Spanish and a Portuguese fishery for Spanish mackerel, *Scomber japonicus,* in the south of Division VIIIb, in Division VIIIc and Division IXa. Figure 2.2.2.1 shows the annual landings by ICES Divisions since 1982. The greatest catches came from Division IXa for the whole period. The distribution of catches in Division IXa is similar during the whole period with the highest catches in the IXa South (Table 2.2.2.1).

Table 2.2.2.1 shows the Spanish landings by subdivision in the period 1982-2002. The total Spanish landings of *S. japonicus* in 2002 was 3174 t, showing a decreasing trend since 1994 on. More than 95% of the catches were obtained by purse seiners and the main catches were taken in the second half of the year, mainly in autumn (80%) , when the *S. scombrus* catches were lowest. *S. japonicus* is not a target species to the Spanish purse seine fleet in these areas.

Data of monthly landings by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all Cantabrian and Galician ports. In the ports of Cantabria and Northern Galicia (Subdivision VIIIc West) catches of *S. scombrus* and *S. japonicus* are separated by species, since each of them is important in a certain season of the year. In the ports of Southern Galicia (Subdivision IXa North) the separation of the catch of the two species is not registered at all ports, for which reason the total separation of the catch is based on the monthly percentages of the ports in which they are separated and on the samplings carried out in the ports of this area. There is no problem in the mackerel species identification in the Spanish fishery in Divisions VIIIbc and Subdivision IXa North.

In Subdivision IXa South, the Gulf of Cadiz, there is a small Spanish fishery for mixed mackerel species which had a catch of 1512 t of *Scomber japonicus* in 2002. In the bottom trawl surveys carried out in the Gulf of Cadiz in 2002, catches of *S. japonicus* making up 98.18 % and *S. scombrus* 1.82 % of the total catch in weight of both species (M. Millán, pers. comm). From 1992 to 1997 the catch of *S. scombrus* in bottom trawl surveys was scarce or even non-existent (about 1% of the total catch of both species). Since 1998 to 2000, this proportion of the *S. scombrus* has progressively increased, accounting for 61 % in 2000. In 2002 the catch of *S. Scombrus* was very scarce, as in the period 1992-1997. Due to the uncertainties in to the proportion of *S. scombrus* in landings, these catches have never been included in the mackerel catches reported to this Working Group by Spain.

Portuguese landings of *S. japonicus* from Division IXa (CN, CS and S) were 5301 t, showing slight increase with respect to the 2001 (4228 t) catch level, but a strong decrease in comparison to the 1999 (13,877 t) and 2000 (10520 t) catch levels, the highest ones since 1982. The distribution of the catches is similar during the whole period, catches being higher in the southern areas than in the northern ones (Table 2.2.2.1). These species are landed by all fleets but the purse seiners accounted for 67 % of total weight. *S. japonicus* is not a main target species to the Portuguese fleet. Landing data are collected from the auction market system and sent to the General Directorate for Fisheries where they are compiled. This includes information on the landings per species by day and vessel. There is no probably no miss identification of mackerel species in the Portuguese fishery in Division IXa.

Unless stated otherwise, references to mackerel in this report refer to *Scomber scombrus* only. As stated in a paragraph above, the catches from the Gulf of Cadiz have never been included in this report.

2.3 Stock Components

2.3.1 Biological evidence for stock components

No new biological evidence has been presented to assist in stock component definition for mackerel.

2.3.2 Allocation of Catches to Component

Since 1987 all catches taken in the North Sea and Division IIIa have been assumed to belong to the Western stock. This assumption also applies to all the catches taken in the international waters. It has not been possible to calculate the total catch taken from the North Sea stock component separately but it has been assumed to be 10,000 t for a number of years. This is because of the very low stock size and because of the low catches taken from Divisions IVb,c. This figure was originally based on a comparison of the age compositions of the spawning stock calculated at the time of the North Sea egg surveys. This assumption has been continued for the catches taken in 2002. It should be pointed out that if the North Sea stock increases, this figure might need to be reviewed. An international egg survey carried out in the North Sea during June 1999 again provided a very low index of stock size in the area (<100,000t) (ICES 2002c). A new egg survey in the North Sea carried out during June 2002 and the SSB adopted at 210,000 t indicating an increase SSB from 70,000 t in 1999 (See Section 2.6.2).

Prior to 1995 catches from Divisions VIIIc and IXa were all considered belonging to the southern mackerel stock, although no separate assessment had been carried out on the stock. In 1995 a combined assessment was carried out in which all catches from all areas were combined, i.e. the catches from the southern stock were combined with those from the western stock. The same procedure was carried out by the 1997 - 2002 Working Groups and again by the present Working Group, - the new population unit again being called the Northeast Atlantic mackerel unit.

The TAC for the Southern area applies to Divisions VIIIc and IXa. Since 1990, 3,000t of this TAC, which has been around at 40,000 t, have been permitted to be taken from Division VIIIb in Spanish waters. This area is included in the "Western management area”. These catches (3,000t) have always been included by the Working Group in the western component and are therefore included in the provision of catch options for the Northern area.

2.4 Biological Data

2.4.1 Catch in numbers-at-age

The 2002 catches in numbers-at-age by quarter for NE Atlantic mackerel (Areas II, III, IV, V, VI, VII, VIII and IX) are shown in Table 2.4.1.1. These catch in numbers relate to a tonnage of 717 882 t, which is the best estimate of the WG of total catches from the stock in 2002.

The percentage catch by numbers-at-age is given in Table 2.4.1.2. The age structure of the 2002 catches of NE Atlantic mackerel is comprised mainly by 1-9 year old fish. These age groups constitute 91% of the total. Age 1 fish account for 11% of the catch numbers. Moreover 32% of age 1 fish were caught in IVa, with divisions VIIc and VIIIe accounting for 17% each.

In the northern North Sea (IVa) where most of the catches of mackerel are taken, ages 3 to 6 comprised 60% of numbers in catch but age 1 fish comprised 8%. In the southern North Sea and eastern English Channel (IVb,c and VIId) where mackerel are caught as a by-catch in fisheries for horse-mackerel the distribution is dominated by fish in the age range 1 to 6, with age 1 fish accounting for a large proportion. In the western English Channel and northern Biscay (VIIe,f and VIIIa,b) the catch is primarily composed of ages 2 to 5, following the trend from last year. In southern Biscayan waters (VIIIc) ages 2 to 6 predominate, and in IXa ages 0 to 2 dominate. Overall, the contribution of age 2 fish to the catches in 2002 is relatively low, reflecting the perception of poor recruitment in 2000.

Age distributions of catches were provided by Denmark, England, Ireland, Netherlands, Norway, Portugal, Russia, Faeroe Islands, Scotland, Spain and Germany. There are still gaps in the overall sampling for age from countries which take substantial catches notably France, and Sweden (combined catch of 27 110 t) and the UK (England & Wales) and the Faeroe Islands provide aged data for less than 15 % of their catches. In addition there was insufficient samples to cover VIIj and VIIIa (42 000 t total catch). There were minor catches from Divisions VIIa,e,g,k, and IIIa,c (total catch 2 500 t). As in 2001, catches for which there were no sampling data were converted into numbers-at-age using data from the most appropriate fleets. This is not ideal, especially when samples from different gear types are assigned.

A study of precision in estimates of mean numbers-at-age in sampling by the Netherlands (Dickey-Collas and Eltink, WD) showed low CVs for ages greater than 4, with lower precisions (CVs of 30%) for younger ages in most years and all quarters. Sampling data is further discussed in Section 1.3.1.

2.4.2 Length composition by fleet and country

Length distributions of some of the 2002 catches by some of the fleets were provided by England, Ireland, Netherlands, Norway, Portugal, Russia, Scotland, Spain and Germany. The length distributions were available from most of the fishing fleets and account for 86% of the catches. These distributions are only intended to give a very rough indication of the size of mackerel by the various fleets and do not reflect the seasonal variations, which occur in many of the landings. More detailed information on a quarterly basis is available for some fleets on the working group files. The length distributions by country and fleet for 2002 are shown in Table 2.4.2.1. These data may be useful for examination of the spatial distribution of fisheries.

2.4.3 Mean lengths-at-age and mean weights-at-age

Mean lengths

The mean lengths-at-age per quarter for 2002 for the NE Atlantic mackerel is shown in Table 2.4.3.1. These data continue the long time-series and may be useful in investigating changes in relation to stock size.

Mean weights

The mean weights-at-age in the catch per quarter and ICES Division for NE Atlantic mackerel in 2001 are shown in Table 2.4.3.2. A study of precision in estimates of mean weights-at-age from Dutch fisheries (Dickey-Collas and Eltink, WD) found precision to be high, (CVs of around 6%).

There were no samples available from the fishery at spawning time, therefore mean weights-at-age in the stock at spawning time for NE Atlantic mackerel are based on mean of the last three years of stock weights. The estimated stock weights for NE Atlantic mackerel and the Western, Southern and North Sea components are given in Table 2.10.1.3. In the period 1998-2001 the stock weights of NE Atlantic mackerel are based on a relative weighting of the North Sea, Western and Southern mackerel components based on the proportion of egg production in each area from the egg surveys. Due to the revision of the catch data by SGDRAMA (ICES 2003b) the stock weights for the period from 1972 to 1997 were revised. These revisions are further detailed in a WD by Eltink, Villamor and Uriarte (see ICES 2003a). For the Western component the stock weights were based on Dutch mean weights-at-age from commercial catch data from Division VIIj over the period March to May. From the 1997 WG onwards the stock weights for the Western component were based on mean weights-at-age in the catch from Irish and Dutch commercial catch data (from Division VIIb, & VIIj over the spawning period March to May) which is weighted by the number of observations from each country. For the southern component stock weights are based on samples taken in VIIIc in the first half of the year.

2.4.4 Maturity Ogive

The revision of the catch data by the SGDRAMA (ICES 2003b) necessitated a revision of the maturity ogive for NEA mackerel. This is because the maturity ogive for NEA mackerel is based on a weighting of the SSB's from the three components. For details of the changes in relative weighting and subsequent revision of the maturity ogive see the report of WGMHSA 2002 (ICES 2003a) and are given in Table 2.10.1.5. No further changes were made in 2003.

2.4.5 Natural Mortality and Proportion of F and M

The value for natural mortality used by the WG for all components of the NE Atlantic mackerel stock is 0.15. This estimate is based the value obtained from Norwegian tagging studies carried out in the North Sea (Hamre, 1978). The proportion of F and M before spawning for NE Atlantic mackerel is taken as 0.4.

2.4.6 Mortality estimates from tagging data

A working document (Skagen, WD 20) was presented giving calculations of total mortality from tag recaptures of the Norwegian tagging series. IMR has tagged mackerel on the spawning grounds from South-West of Ireland to West of Shetland most years since 1969. In the last decades, approximately 20 000 fish have been tagged each year, except in 2000, when fewer tags were released due to poor working conditions. Internal steel tags inserted in the belly are used. Recovery of tags was previously mostly from fish meal. In recent years, when most of the mackerel is used for human consumption, most tags are recovered using metal detectors at selected landing sites. Because the amount screened for tags is only known for a limited number of the tags, direct estimates of stock abundance were not considered. However, deriving mortalities does not depend on the amount screened.

Only tag releases from the period 1984-2002 were considered. Since estimating mortalities are done by comparing the recapture from subsequent releases, and recaptures from the release year should not be included, the last year for which mortality can be estimated is 2001. Data exist for years prior to 1984, but have so far not been edited for use by the present software.

The number included in the analysis is given in the text table below for each release year.

Release year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Released	13366	24620	17668		20299	20291	19833	22850	16551	22792	27328	24848	20001	34843	22375	12712	5755	21074	17460
Recaptured	257	489	372		424	409	558	644	489	520	670	504	451	662	375	203	78	148	43
Percent recaptured	1.9	2.0	2.1		2.1	2.0	2.8	2.8	3.0	2.3	2.5	2.0	2.3	1.9	1.7	1.6	1.4	0.7	0.2

Because all tagged fish was measured at release time, and good age-length keys were available from each tag release, the age distribution associated with each recaptured fish could be established. This was used to make mortality estimates by age. The same data set is used in the AMCI assessment method as an indicator of mortality, but in a slightly different way.

The mortality estimate is derived as follows:

Let $R(y_i,a_i)$ be the number of tags released in year y_i at age a_i, and let $r(y_i,a_i,y_k)$ be the number of those tags that are recaptured in year y_k.

Suppose that $R(y_j,a_j)$ fish from the same cohort were tagged in year y_j, now at he age $a_j = a_i+(y_j-y_i)$. In year y_j, the $R(y_i,a_i)$ are reduced to $R(y_i,a_i)*exp(-Z(y_i,y_j,a_i))$, where $Z(y_i,y_j,a_i)$ is the cumulated total mortality in the period from y_i to y_j of fish that had age a_i in year y_i.

The ratio between $R(y_j,a_j)$ and those remaining from the release in year y_i i.e.

$$R(y_i,a_i)/[R(y_i,ai)*exp(-Z(y_i,y_j,a_i)]. \quad (1)$$

is the mix of tags from the two releases in the sea. This ratio is assumed to persist in the following years, since these fish belong to the same cohort. The ratio can be estimated as the ratio between numbers of all tags subsequently recaptured from these two releases belonging to the cohort, i.e. as:

$$\Sigma r(y_i,y_k,a_i)/\Sigma r(y_j,y_k,a_j),$$

the sums being taken over all years $k > j$.

Thus, the estimate of the total mortality of the cohort between the two releases is

$$Z(y_i,y_j,a_i) = log\{\Sigma r(y_i,y_k,a_i)/\Sigma r(y_j,y_k,a_j)*R(y_j,a_j)/R(y_i,a_i)\} \quad (2)$$

where again $a_j = a_i+(y_j-y_i)$ and the sums are over $k>j$

Data for one year mortalities $(yj=yi+1)$ are presented here No tags were released in 1987, i.e. mortalities for 1986 and 1987 could not be estimated.

The raw mortalities obtained by using the equation (2) above directly pick up all the noise in the data and amplifies it by taking ratios. These mortality estimates are therefore not very informative. Therefore, mortalities for age 4-8 were calculated by lumping together all fish that was aged 4-8 when tagged.

An estimate of variance was made by bootstrapping. Bootstrap data sets were made by substituting each $r(y_i,y_k,a_i)$ value with a Poisson distributed random number, with Poisson parameter (which is both the expectation and the standard deviation in this distribution) equal to the measures $r(y_i,y_k,a_i)$ value. The Poisson distribution is used since it can be regarded as the limiting case of a binomial distribution with a very small success probability. This implies that the estimates, which basically are ratios between Poisson distributed random variables, will have an SD that increases as the number of observations decreases. The results are shown in Figure 2.4.6.1 indicate a slowly decreasing trend with Z-values from 0.5 to 0.35 until approximately 1997, and possibly an increase in the most recent years. The trend in the recent years is very noisy, but is supported by the apparently more rapid disappearance of the tags from recent releases, shown in figure 2.4.6.2.

As discussed in Section 2.9, the conclusions from ICA are substantiated by these independent estimates of the Z-values. The agreement between mortality estimates also indicate that the value 0.15 applied for the natural mortality is adequate. The apparently more rapid disappearance of the tags from recent releases may be taken as an indication that the mortality may have increased in recent years, which is in contrast to the perception that the fishing mortality has stabilised about 0.2. However, these trends have a very high variance.

2.5 Fishery Independent Information

2.5.1 Egg survey estimates of spawning biomass: Planning for the 2004 survey

WGMEGS met in Lisbon in April 2003 to plan the 2004 ICES Triennial Mackerel and Horse Mackerel Egg Survey. A detailed report is available on the ICES website. Only the major aspects relevant to this WG are presented here.

- Planning for the 2004 survey
- Responses to questions raised by WGMHSA
- Survey standardisation
- Possible joint meeting with SGSBSA on joint issues
- The “Year of the Mackerel”

2.5.1.1 Countries and vessels participating in the 2004 survey

Countries and vessels participating in the 2004 survey are detailed in table 2.5.1.1

As in previous years, the survey will be split into seven sampling periods, allowing full coverage of the expected spawning area in the south (periods 1-5) and in the western area (periods 3-7) (see Table 2.5.1.1). The widest area cover will be provided during the fourth sampling period (Cantabrian Sea to the North of Scotland). At this time the distribution of mackerel and horse mackerel spawning is at its most widespread in the southern and western area. The level of effort is slightly down from 2001. In 2001 there was additional support from the EC, which will not be available in 2004, however, the effort available is broadly similar to that in 1998.

2.5.1.2 Problems with the estimates raised by WGMHSA 2002

A number of problems and weaknesses in the conduct and analysis of the surveys were detailed by WGMHSA in 2002 for consideration by WGMEGS.

The three key areas were:

- Fecundity measurement
- Species ID and staging
- Variance estimation.

These problems and the response by WGMEGS are listed below.

Fecundity measurement.

Four major areas for development were identified for fecundity measurement:

- Temporal resolution/variability,
- Spatial resolution/variability
- Interaction of fecundity estimation with migration patterns
- Validation of recently observed changes in fecundity.

- **Temporal resolution and variability** – The basic proposal was that pre-spawning fecundity data should be collected on an annual rather than triennial basis. This was intended to avoid apparently sudden observed changes in fecundity such as was seen between 1995 and 1998. WGMEGS agreed this was desirable, but that until the Gilson free fixing protocol and Auto-diametric analysis methods were fully operational it would be logistically very difficult
- **Spatial resolution and variability –** The potential for different observed fecundity in different parts of the spawning area was recognized. The adult sampling protocols have been defined to maximise the spatial spread in 2004 to at least the same level as 2001.
- **Interaction of fecundity estimation with migration patterns** – The main problem here is the validity of using fecundity samples for the southern area collected mostly from young fish, when these may not be very representative of the actual spawners in that area. No action has been taken, but WGMEGS will consider this problem following the 2004 survey.
- **Validation of recently observed changes in fecundity** – It was proposed that studies be carried out to examine the samples taken in 1995 and 1998, and any other contemporaneous data for evidence of condition factor or any other differences which might explain the perceived drop in fecundity. Several studies have been carried out on data from the adult samples collected during the survey and in other areas. The results of these are reported in section 2.5.3.

Species ID and staging

Standardization of plankton sample sorting, species ID and egg staging will be addressed at a workshop to be held in Lowestoft in October 2003. WGMEGS strongly recommends that these be held routinely before every future survey.

Variance estimation

It was hoped that a full workshop on variance estimation methods, both traditional and new (e.g. geostatistics) could be held prior to the 2004 survey. This has not proved possible. Initial planning for such a workshop (hopefully in collaboration with SGSBSA) is underway.

2.5.1.3 Survey standardization

WGMEGS examined the question of standard methods and protocols for the conduct of the survey. This was based on a standard ToR on this matter handed to all survey WG. A detailed appraisal of the existing survey manual, and the degree to which it was complied with was carried out. Where there were inconsistencies, these were either corrected or substantiated. Outstanding problems on sampler deployment and use of $\mathbf{F}_{\text{low}}$ meters will be considered at the next meeting of WGMEGS.

2.5.1.4 Joint meeting with SGSBSA

A range of topics of joint interest to these two groups have been identified. Some of these are:

- Index and variance calculation
- Quality Control and Quality Assurance
- Survey methodology, particularly sampler performance and use of $\mathbf{F}_{\text{low}}$ meters
- Use of CUFES
- Survey design
- New DEPM methodologies

A provisional proposal would be for the two groups to meet at the same time and location. Each group would have a number of days to carry out their own work, and several more for joint issues.

2.5.1.5 The "Year of the Mackerel"

The next ICES Triennial survey takes place in 2004. This provides extensive data on mackerel distribution and abundance. During the same year, there are a wide range of other surveys which do produce, or could produce, abundance distribution data for this species. Examples would include the range of acoustic and bottom trawl surveys conducted throughout western European waters. Were these data assembled and collated in one place they would represent a valuable and comprehensive snap shot of this key species. The proposal has the support of two of the key groups, PGAAM and WGMEGS, and support from this WG and LRC at the ICES ASC is requested. Should there be broad agreement, coordination and collation would be undertaken by FRS Marine Lab Aberdeen.

2.5.2 Egg survey estimate in the North Sea 2002

During the period 3-24 June 2002 the Netherlands and Norway carried out egg surveys in the North Sea to estimate the spawning stock biomass (SSB) of mackerel (Iversen and Eltink WD 2002). This survey was reported both to ICES ICES 2003a and ICES 2003g.

SSB estimates based on egg surveys have been carried out in the North Sea since 1980. The estimates for the different years are given below and are based on a standard fecundity of 1401 eggs/g/female (Iversen and Adoff, 1983). This fecundity is similar to what has been observed in the western stock prior to 1998. Since then the fecundity has dropped by 30% in the western area. The surveys in the North Sea are assumed to cover main spawning. Based on earlier investigations the peak of spawning is in mid June, and the total spawning period is mid May to the end of July. There has over the later years been observed a shift in the main spawning area from the eastern central North Sea to the western central part. Since the surveys have been carried out during same period the later years a changes in temporal spawning might therefore not be detected. Therefore the egg production is considered uncertain and the Working Group decided to apply the conservative fecundity of 1401 eggs/g/female.

Year	1980	1981	1982	1983	1984	1986	1988	1990	1996	1999	2002
SSB Ktons	86	57	180	228	111	43	36	76	110	68	210

The increase in SSB since 1999 might be due to a relatively strong 1999 year class that dominated the trawl catches made during the egg survey.

2.5.3 Examination of fecundity changes in mackerel between the 1995 and 1998 surveys

One of the key elements in the production of a biomass estimate for mackerel (*Scomber scombrus*) from the Triennial mackerel and horse mackerel egg survey is the total fecundity estimate. From 1983 onwards the value was relatively constant between 1457 and 1608 egg g^{-1} female. In 1998 this dropped dramatically to 1206, and again in 2001 to 1097. The drop in 1998 coincided with a relatively low egg production of 1.49 * 10^{15} (cf. 1995 1.94 * 10^{15}). This resulted in a biomass estimate in 1995 of 2.47 million tonnes and in 1998 of 2.95 million tonnes. The combination of a drop in egg production but a rise in biomass caused some disquiet at the time and led to changes in the calculation of the SSB in the assessment – a switch from absolute to relative use of the survey index as a tuning factor. It also led to an intensified fecundity sampling programme in 2001, and the further drop from 1998 confirmed the validity of that estimate. The time-series of the potential fecundity (eggs g^{-1}) is presented in Figure 2.5.3.1.

WGMHSA and WGMEGS have asked for studies to identify what, if any, biological explanation could be found for this change.

Two studies were carried out on this question and were reported to the WG:

- Reid WD - "Investigation of correlates to observed mackerel fecundity changes 1995 to 1998". This WD concentrated on examining the additional biological data available from the adult samples collected during the survey and used for fecundity estimation.

- Slotte WD – "Historic changes in the condition of NEA mackerel – Possible effects on fecundity". This WD concentrated on changes in the condition of mackerel in the northern North Sea (ICES Area IVa) in the autumn *prior* to the surveys.

The key findings of the two studies are presented here, fuller versions can be found in the WDs.

2.5.3.1 Biological data from the fish sampled on the survey (Reid WD)

The data used in the study were the measurements made on the fish collected and used for the fecundity estimate in 1995 (n=93) and in 1998 (n=97). These data provided length, weight and annual potential fecundity (number of eggs per fish).

The samples taken in the two years were very similar (table 2.5.3.1.), as were the length to weight relationships (Figure 2.5.3.2.).

Figure 2.5.3.3. shows the plots of potential fecundity against female weight for the two years. Both show no relationship, and also show the fecundity differences between the survey years. Finally, the weight residuals were plotted against potential fecundity (Figure 2.5.3.4) and again there was no relationship in either year, suggesting that condition factor *during the spawning season* was not important in modulating potential fecundity. However, this does not disprove that the condition of these specimens at the onset of gonad development could have been higher prior to the 1995 than the 1998 spawning season (see below).

2.5.3.2 Condition factor prior to the spawning season (Slotte WD)

As mackerel is perceived to be a determinate spawner, the condition of the fish in the autumn prior to spawning may well be important in determining potential fecundity in the following year. This hypothesis was studied using a time-series of purse seine catches in the northern North Sea (ICES Area IVa), where the mackerel aggregates during the autumn. During August-December the weight at length appeared to decline steadily (figure 2.5.3.5.), and this can be related to a drop in *Calanus* copepod abundance (figure 2.5.3.6.). The weight at length of 35 and 36 cm fish in September varied considerably during the period 1987-2002, peaking in 1989 and 1994 (figure 2.5.3.7). Critically, the condition of these fish dropped from a high in 1994 (immediately prior to the 1995 survey) to a much lower value in 1997 (before the 1998 survey). This drop continued to 2000, before the 2001 survey. The observed trend is confirmed by the weight length relationships (figure 2.5.3.8), where 1994 was quite distinct from 1997 and 2000. The peaking of condition in 1989 and 1994, and the following decline, also correspond well with variations in *Calanus* copepod abundance (figure 2.5.3.9).

2.5.3.3 Synthesis

The overall conclusion of these studies would be that the condition factor in the autumn prior to spawning is critical for the understanding of potential fecundity in the following year. However, there is no evidence that condition at start of spawning is related to fecundity. If this is correct, then a second conclusion would be that the sampling for fecundity in the egg survey years was suitable for the intended purpose. The observed fecundity at the start of spawning would be the correct value to use.

The subject clearly requires further work. The second study demonstrated differences in condition between fish caught by commercial purse seine and RV trawl. The autumn data used for the condition studies were purely based on samples from purse seine catches, whereas the fecundity data were based on samples from potentially more selective gears such as trawl and hand line. Studies on the use of gonad weights as indicators for fecundity would be appreciated. This could be a time consuming way to measure reproductive potential on fish that are not sampled for fecundity. Further studies of food availability from CPR data, as well as studies on the effects of Atlantic water influx to the Norwegian Sea and North Sea, would also be useful for the understanding of fecundity changes in mackerel.

2.6 Effort and Catch per Unit Effort

The effort and catch-per-unit- effort from the commercial fleets is only provided for the southern area.

Table 2.6.1 and Figure 2.6.1 show the fishing effort data from Spanish and Portuguese commercial fleets. The table includes Spanish effort of the hand-line fleets from Santona and Santander (Subdivision VIIIc East) from 1989 to 2002 and from 1990 to 2002 respectively, for which mackerel is the target species from March to May. The Figure also shows the effort of the Aviles and A Coruna trawl fleets (Subdivision VIIIc East and VIIIc West) from 1983 to 2002. The Spanish trawl fleet effort corresponds to the total annual effort of the fleet for which demersal species is the main target. The Vigo purse-seine fleet (Subdivision IXa North) from 1983 to 2002 for which mackerel is a by catch is also presented. The effort of the hand-line fleet showed an increasing trend since 1994. The effort of the trawl fleets is rather stable during all period. The purse-seine fleet effort fluctuated during available period.

Portuguese Mackerel effort from the trawl fleet (Subdivision IXa Central-North, Central-South and South) during 1988 - 2001 is also included and as in Spain mackerel is a by catch. The effort for this fleet increased in 1998 with respect the previous years. Since 1999 to 2001, the effort decreased with respect 1998.

Figure 2.6.2 and Table 2.6.2 show the CPUE corresponding to the fleets referred to in table 2.6.1. The CPUE trend of the Spanish hand-line fleets shows an increasing trend since 1994. The CPUE for the Aviles trawl fleet has increased since 1994, in particular in 2000 and 2002, but this figure is not reliable because catches of this fleet are estimated since 1994 onwards (for more information see Section 7.5). For the A Coruña trawl fleet is rather stable during all period. The CPUE of the Portuguese trawl fleet shows a decrease from 1992 to 1998, increasing since 1999 to 2001. The CPUE of the purse-seine fleet shows fluctuations during the period 1983 to 1995 and since 1996 the CPUE of this fleet shows an increasing trend.

Catch-per-unit-effort, expressed as the numbers fish at each age group, for the hand-line and trawl fleets is shown in Table 2.6.3.

2.7 Distribution of mackerel in 2002 - 2003

2.7.1 Distribution of commercial catches in 2002

The distribution of the mackerel catches taken in 2002 is shown by quarter and rectangle in Figures 2.7.1.1 – 4. These data are based on catches reported by Portugal, Spain, Netherlands, Germany, Norway, Russia, Faroes, UK, Ireland, and Sweden. In these data the Spanish catches are not based on official data. Not all official catches are included in these data. The total catches reported by rectangle were approximately 592,200 tonnes including Spanish WG data, the total working group catches were 677,881 tonnes. The main data missing from these data are from France and Denmark, who do not report by rectangle.

First Quarter 2002

Catches reported by rectangle during this quarter totalled about 200,800 tonnes, down by about 10% from 2001. The perennial problem of mis-reporting between Divisions IVa and VIa, which gave large catches just west of 4^{o} W, seemed to remain at a high level. The relaxation of fishing regulations in IVa in the first quarter may still have reduced the pressure to misreport. Otherwise, the general distribution of catches was similar to 1995 to 2001, with the bulk of the catches along the western shelf edge between Shetland and the Celtic Sea, but mainly in the north of this area. Again, this suggests that the pattern and timing of the pre-spawning migration has remained relatively constant. However, see 2.7.3. for a more detailed appraisal of this question. The catch distribution is shown in Figure 2.7.1.1.

Second Quarter 2002

Catches reported by rectangle during this quarter totalled about 24,920 tonnes, down by 12,000 tonnes from 2001. Catches in this quarter have fluctuated considerably in the last five years. The general distribution of catches was broadly similar to 2001, with the main catch area being along the western shelf edge between the Hebrides and the Celtic Sea. The catches taken in international waters east and north of the Faroe Islands were less than in 2001, however, there were also catches immediately north of the Faroes that were not seen in 2001. Similar fishing patterns to 2000 & 2001 were apparent around the Iberian peninsula. There was a slight reduction in catches in the Bay of Biscay, south of 47°N. The catch distribution is shown in Figure 2.7.1.2.

Third Quarter 2002

Catches during this quarter totalled about 203,500 tonnes, up by around 50,000 tonnes from 2001. The general distribution of catches was similar to 2001, with the main catches being taken in international waters and off the Norwegian coast. As in 2001 the catch in international waters was mostly along the south eastern edge, suggesting that the distribution was continuous between there and the fishing area off Norway. Fishing off Norway appeared heavier with catches over 10,000 tonnes in six rectangles compared to three in 2001. The scattered catches on the western side of the British Isles were quite similar to 2001 and 2000. Catches in the Iberian area were also very similar to 2001 and 2000. The catch distribution is shown in Figure 2.7.1.3.

Fourth Quarter 2002

Catches during this quarter totalled about 162,500 tonnes, down by 15,000 tonnes from 2001, itself down by around 30,000 tonnes from 2000. This probably represents a trend for earlier fishing by the Norwegian fleet. The general distribution of catches was very similar to 2000. The main catches were taken in the area west of Norway across to the west of Shetland. There was little evidence of mis-reported catches west of 4°W, although there was more west of 8°W near the Faroes. Again, only small catches were taken west of Scotland, but catches west of Ireland were similar to those between 1999 and 2001. The pattern of catches seen in the English Channel were as in 2001 following the increase in 1999. The catch distribution is shown in Figure 2.7.1.4.

The catch totals by quarter represent only catches from those countries that provided data by ICES rectangle. They do not include those countries that provide catch by larger area units.

2.7.2 Distribution of juvenile mackerel

Surveys in winter 2002/2003

As the recruit database was fully completed at the 2000 and 2001 meetings of WGMHSA only the latest data are presented here. However comparisons with 2001/2002 are presented below.

Fourth Quarter 2002

Age 0 fish in quarter 4 2002 (Figure 2.7.2.1)

- Catch rates in NW Ireland were very low in 2000, they recovered to some extent in 2001and have recovered very strongly in 2002. In 2001, four rectangles in this area had catch rates over 100 per hour, one of these was over 1,000 per hour. In 2002, five rectangles in this area had catch rates over 100 per hour, and three of these were over 1,000 per hour.

- There were again good catch rates in Biscay, although further north and west than in 2001, and broadly of a similar scale.

- The hot spot in north Portugal which had been declining up to 2000 showed similar catch rates to 2001

- In the Celtic Sea there were good catches again in the inner part, but also very good catches SW of Cape Clear not seen in previous years.

- There were reasonable catches in the Hebrides and NW of Scotland as in 2001

- Survey data were also available this year for the northern North Sea from Norway. These showed no catch-at-age 0. It should be noted that these were carried out at the end of September and beginning of October and may be too early to catch young of the year spawned to the west in the spring and summer.

There was a very strong reduction in catch rates of age 0 fish in the 2000 surveys and this is now showing up in the commercial catches. Catch rates recovered in 2001 to close to normal levels, and appear to be even better in 2002. The major nursery areas in NW Ireland and Biscay were strong and the Portuguese area also remained as strong as in 2001, much better than most recent years. The Hebrides remained relatively weak. These data should be considered in conjunction with the first quarter data presented below.

Reasonable catches of age 1 fish (Figure 2.7.2.2.) were taken across most of the area, particularly in NW Ireland, Biscay and Portugal. This is broadly similar to the pattern in the years prior to the weak year class of 2000.

First quarter 2002

Age 1 fish in quarter 1 2003 (Figure 2.7.2.3)

- Extremely high catch rates were recorded in most rectangles off NW Ireland and the waters off the Hebrides. These were stronger and more widely spread than in any recent year. The highest catch rate was over 80,000 fish per hour, which is unprecedented.

- Unusually high and also well distributed catch rates were recorded in all parts of the Celtic Sea. Again this was much better than in any recent year. There was also at least one good catch in the area of the Cornish box.

- Fewer high catch rates in the north part of the North Sea than in either 2001 or 2002. Central North Sea data were not available prior to this meeting.

Age 2 fish in quarter 1 2003 (Fig 2.7.2.4)

- Good catch rates were recorded in NW Ireland/Hebrides area, quite different to 2002 when this age group was from the weak 2000 year class. These catch rates were similar to previous good years

- Extremely good catch rates in the Celtic Sea and in the Cornish box area. These were much better than in 2002 or in any previous year. Again, these data should be treated with some caution as the catches were split into age using length and not otolith readings.

As in previous years the data for the two quarters have also been merged to provide a picture over the entire area for which data were available. As the fish change age on the 1st of January, these fish are described as first and second winter fish. The picture from these distributions (figures 2.7.2.5 & 6) largely confirms that seen from the individual quarters.

It should be noted that not all these surveys use the same survey gears. Most surveys in the western area use an IBTS GOV trawl (although with various non-standard modifications). The Irish surveys use a smaller version of the GOV. The Portuguese gear is quite similar to the GOV. The Spanish surveys in the Cantabrian Sea use the *Baka* trawl. This is towed slower and has a much lower headline height, and has a very low catchabilty for young mackerel. The conversion factor calculated in the EU SESITS project for this gear, against the GOV was 8.45. This correction has not been applied to date for the data used here, but will be considered for future use.

The catch rates plotted here for the Biscay area in quarter 4 2002, and the Celtic Sea in quarter 1 2003 are length split and not age split, and so should be treated with more caution.

As noted in previous reports, the coverage of the western area in the fourth quarter remains reasonably good. The gaps in the area west of Ireland are now being surveyed. Most of the inner part of the Celtic Sea/Western Approaches is also being surveyed where the local conditions allow, it should be noted that fishing with GOV is very difficult in the western English Channel. This new data is available courtesy of the Irish Marine Institute and CEFAS. New data from Norwegian bottom trawl surveys in the northern North Sea in September/October were available for the first time this year. Although these are timed a little early for the purposes of mackerel recruit surveys, they should prove valuable. In 2002 they caught no age 0 fish, but were more successful with age 1 fish.

The surveys 1999-2003 have clearly shown a major dip in recruitment of the 2000 year class. This has now largely been confirmed by the landings and ICA recruitment output. ICA recruitment for 2000 was around $2*10^9$, which is the lowest value since 1983. The surveys have also indicated that 2001 was a reasonably good year. Current indications from the assessment are that 2001 may have been a very strong year. The surveys clearly suggest that 2002 will prove to be exceptional. The validity of this interpretation should become clear within the next two years.

2.7.3 Distribution and migration of adult mackerel

Acoustic surveys

Four relevant acoustic surveys were carried out on mackerel and reported to the Planning Group for Aerial and Acoustic Surveys for Mackerel (PGAAM – ICES 2003f) and to this WG. These were:

- An acoustic survey by the Institute of Marine Research, Bergen in October/November 2002. This mainly covered the area between the Viking and Tampen Banks but scouting surveys covered a wider area (approx 58-62°N and 5°E to 1°W).
- An acoustic survey by Fisheries Research Services, Aberdeen in October 2002. This was coordinated with the Norwegian survey. The survey mainly covered the area between the Viking and Tampen Banks but scouting surveys covered a wider area along the shelf break as far west as 6°W
- An acoustic survey by IEO in ICES Subdivisions VIIIc and IXa, in March and April 2002.
- Portuguese acoustic surveys by IPIMAR in March and November.

The IMR survey showed that there were substantial concentrations of mackerel spread across the platform up to 30 nm from the shelf break between the Viking and Tampen Banks (approx 60°N 3°E to 61°30N 2°E). The distribution of the acoustic NASC values are presented in Figure 2.7.3.1. As in previous years, most of the mackerel was found 30 – 50 nautical miles to the west of the edge of the Norwegian deep, with occasional registrations further to the west. The provisional biomass estimate was 535 000 tonnes for the whole survey. This is in line with the results from 2000 and 2001.

The FRS survey covered a similar area and found similar concentrations of mackerel. These data were analysed together with that part of the Norwegian survey which occurred at the same time. The combined cruise tracks and NASC values are presented in figure 2.7.3.2.

The IEO survey was primarily targeted on sardine and anchovy, however, substantial amounts of mackerel were observed and quantified. The survey took place in March in Subdivision IXa Central North, Subdivision IXa North and Division VIIIc. The TS/L relationship used was the same as in the North Sea and as recommended by PGAAM. Total biomass was estimated at 1,382,995 t. A large number of juvenile mackerel were observed.

The IPIMAR surveys have not been used to develop a biomass estimate for mackerel. This is due to the low mackerel abundance, the tendency to be mixed with other species, and the lack of targeted fishing. In the future attempts will be made to carry out more targeted hauls with the aim of producing a biomass estimate.

The IFREMER survey mentioned last year is targeted at all pelagic fish resources in the French Biscay area. However, at this time, the extraction of mackerel biomass data is not considered possible.

2.7.4 Aerial Surveys

A new Russian annual aerial survey for mackerel in the Norwegian Sea was carried out during 09 July – 04 August 2003. As usually the survey was targeted on the spatial distribution of mackerel aggregations, as well as the thermal and hydrodynamic status of the sea surface, distribution of locations of high bio-productivity and the availability and distribution of other marine organisms (sea mammals and birds).

The Russian aircraft were equipped with several different remote-sensing sensors like IR-radiometer and scanner, LIDAR, microwave radiometer, digital photo- and video cameras.

As a follow up of the recommendation of the Planning Group on Aerial and Acoustic Surveys for Mackerel (Anon. 2003) Russian research vessel and two Norwegian commercial purse seiners cooperated with Russian aircraft as well as Russian commercial vessels that fished in the Norwegian Sea to identify observations made by aircraft.

Russian and Norwegian research vessels followed special designed tracks and where CTD- and pelagic trawl stations were carried out at prefixed positions.

Russian commercial vessels collected biological samples and sea surface temperature when aircraft passed.

All vessels of both countries collected biological samples and investigated the distribution and abundance of mackerel by sonars, echo sounders and surface trawling.

Three “intercalibrations" between aircraft and research vessels were carried out: 14 and 16 of July with Russian and 23 of July with Norwegian research vessels.

The areas of the summer survey are shown in Figure 2.7.4.1.

Due to the technical reasons it was not possible to provide a results at this WGMHSA meeting and it will reported to the PGAAM meeting in 2004.

Both Russia and Norway plan aerial surveys for the summer (July and August) 2004.

2.7.5 Inferences on migration from commercial data

A working document was presented updating the picture of the pre-spawning migration of mackerel (Reid, Eltink & Kelly WD). The study was based on information on catch locations, times and tonnes derived direct from the commercial fleet and not based on official landings. This information was made available from Scotland, Ireland and the Netherlands from 1997-2002. For the purpose of an analysis of the pre-spawning migration the data was partitioned to provide aggregate catches for 16 sea regions (fig 2.7.5.1) and 27 time periods (table 2.7.5.3.)

These are presented as surface plots of the proportion caught by period and region. Proportions were calculated from the total catches between the start of September and the end of the following May. Plots for five winters 1997/98 to 2001/02 are presented in figure 2.7.5.2. a-e. The main conclusions from these plots are that the commercial catches clearly show a migrations starting from region 1 (NE North Sea) around period 13-14 (early and mid January) in the recent three winters and later – around periods 16 & 17 (early and mid February) in 1997/98 & 1998/99. Other differences included the prolonged fishing in the North Sea from September in the recent three years, and the strong fishery in area 10 (NW Ireland) in October and November in the earlier two years.

Historical data on the mackerel pre-spawning migration was also available:

1. Data on Scottish commercial catches in ICES Division VIa 1976 to 1984 – Based on a study by Walsh & Martin (1986). These data were available as monthly totals.

2. Data on Scottish commercial catches in ICES Division VIa and the North Sea – 1985 to 1994 - Based on a study by Walsh & Reid and included in the SEFOS final report (1997). These data were also available as monthly totals

These data and the most recent set were used to calculate two migration indicators:

- The mid point period of fishing in ICES Division Via, calculated as a weighted mean based on the tonnages caught.

- The last period of fishing in the North Sea.

The ensemble of these indicators is presented in fig 2.7.5.3. The well known shift in the migration through the 1970s and 1980s can be clearly seen. During this period the main fishing in VIa shifted from September to the start of February. After 1989, the timing appeared to stabilise. The most recent data suggest that the migration through Via occurred as late as early March by 1998, but since then has moved back to the end of January/early February. The same general picture appears for the time of the last fishing in the North Sea. During the 1990s it was around the beginning of February. By the late 1990s it was as late as the end of March. Again this has moved back and in recent years the fishery ended in early February.

In conclusion there is some evidence that the migration which stabilised in the 1990s may now be occurring earlier than has been the case since the late 1980s. It is probably too early to be definite about this, however, and the data collection programme will continue to allow the tracking of any further change.

2.8 Data exploration and Preliminary Modelling

ISVPA trial runs

The version of ISVPA was basically the same as last year and reviewed by the methods working group (ICES 2003e). The options taken in the trial runs were also similar: with the age range from 0 to 12+; year range from 1980 to 2003; two selection patterns were estimated for periods with equal lengths (1980-1990 and 1991-2002) to supply maximum information support for the estimation of selection. As the time period was extended to 1980, the year of change in selection was chosen to be closer to the year of expected change in the NEA mackerel selection pattern (1989) when compared to the previous (2002 WG) assessment, when the first year of the second selection pattern was chosen as 1993. The overall loss function of the model was composed of the sum of squared errors (SSE) in logarithmic catch-at-age and the sum of squared errors between logarithms of model-derived and observed SSB values from egg surveys.

The ISVPA model settings allow the application of different assumptions about the origin of the residuals in the model approximation of catch-at-age data and this year, most attention was paid to the sensitivity of this choice of assumptions.

Figure 2.8.1 represents the profiles of the ISVPA loss function with respect to the terminal effort factor when:

- the model was fitted on catch-at-age data only,
- the model was fitted only on SSB estimates from egg surveys,
- the catch-at-age- and SSB-derived terms were included with equal weights.

For all the tested versions of the model, separate signals from catch-at-age and from egg surveys were very close to each other. For effort-controlled version, with the separability assumption considered as true and attributing residuals to noise in catch-at-age data, the positions of the minima from the two sources of information almost ideally coincide. However the level of SSE from catch-at-age is higher (Figure 2.8.1 b) in comparison to the catch-controlled version of the model, in which it is assumed that the catch-at-age data are true and the residuals are attributed on account of violations in stability of the selection pattern (Figure 2.8.1 a). To use the merits of these two versions (the better fit to catch-at-age of the catch-controlled version and the more coherent signals from the catch-at-age and from the egg surveys of the effort-controlled one), the so called mixed version was also applied. In the mixed version for each point (age, year) the abundance estimates calculated by catch-controlled and effort-controlled versions are weighted by reciprocal squared residuals, calculated using catch-controlled and effort controlled versions accordingly. As intended, this version revealed the “compromise” result: a lower SSE with respect to the effort-controlled version, and more coherent signals from the catch-at-age and egg surveys with respect to the catch-controlled version (Figure 2.8.1 c).

In the model versions shown, which are represented in Figures 2.8.1 a-c, an addition restriction on the possible solutions was applied - condition of year- and age- sums of residuals of the model approximation of logarithmic catch-at-age. This means that the intentional search for an “unbiased” solution and for noisy data often helps to get a more reasonable catch-at-age -derived minimum. But the solution for noisy data in this case may not correspond to the solution in the pure sense of maximum likelihood. In order to test the role of this additional restriction for NEA Mackerel data, the mixed version ISVPA free from any condition on bias in the residuals was also applied. For this version of the model (Figure 2.8.1 d) the positions of the minima were still the same, as for the mixed “conditioned” version (Figure 2.8.1 d) and SSE of catch-at-age model approximation became only slightly lower.

As it can be seen in Figure 2.8.2, application of the condition of “unbiased” residuals in logarithmic catch-at-age does not cause any substantial changes in structure of residuals.

The year- and age- sums of residuals for the “unconditioned” version of the model are represented on Figure 2.8.3. For the “conditioned” ISVPA version they are zero by definition. Presence of some bias in the residuals of the “unconditioned” version and no substantial merits in the structure of residuals, might serve as a reason to prefer the ISVPA version with constraint of unbiased residuals.

As mentioned above, the ISVPA loss function profiles suggest that the mixed ISVPA version is preferable. This version of the model also showed intermediate retrospective patterns when compared to the catch-controlled and effort-controlled versions (Figure 2.8.4). The catch-controlled version gave more stable results for SSB and F(4-8), but in the effort-controlled version the recruitment was more stable.

Figure 2.8.5 represents comparison of the ISVPA-derived estimates of SSB, R(0) and F(4-8) for the ISVPA versions tested. The results are similarly independent of model assumptions and parameter estimation procedures, while the procedure of parameter estimation, free from restriction on bias in residuals, gives sharper changes in fishing mortality.

Abundance estimates and estimates of SSB, B(0+), R(0) and F(4-8) for the "mixed" version of the ISVPA are given in tables 2.8.1. and 2.8.2. Residuals in logarithmic catch-at-age are given in table 2.8.3.

Results of a bootstrap (conditional parametric with respect to catch-at-age and unconditional parametric with respect to egg surveys) indicates rather high uncertainty of the model parameter estimates (Figure 2.8.6) perhaps, because of the lack of strong signals in the data due to the small amount of changes in the dynamics of the stock.

In general, the ISVPA results are in broad agreement with the other methods used (ICA and AMCI).

Trial runs with AMCI

AMCI was used to explore the data and support the interpretation of the data with ICA. The AMCI software was described in previous reports of this and other working groups (e.g. ICES 2003a, ICES 2003e). It fits a modelled population to the data by optimising an objective function. The fishing mortality in the population model is a product of a year factor and an age factor, where the age factor (selection at age) is allowed to vary slowly over time. The data included catches-at-age, SSB estimates from egg surveys in 1992, 1995, 1998 and 2001, and tag return data by release year and age from 1984 onwards. The objective function used here was a sum of squares of log catch residuals and of log SSB residuals, and a Poisson likelihood function for the number of tags returned from each release. The version used was Version 2.3. Compared to the Version 2.2 which was used previously, it has added some more diagnostics and printout options, and a few errors corrected. Nothing in basic algorithms have been changed. Version 2.3 is still under development, but the only parts left to make are more printing routines. Data from 1980 onwards were used, since the age structure in the catch data earlier is incomplete.

In all runs, the selection was allowed to vary slowly, except in the first 4 years, where it was assumed to be constant, and in 2002, where it was assumed equal to 2001. The SSB values from the egg survey were taken as absolute measures of the SSB. In the key run, the whole series of SSB observations was given the same weight as 10 years of catch data. An alternative run was made where the SSB series was given the same weight as one year of catch data. An alternative run was also made where the tag recapture data were not used.

The main results of these 3 runs are shown in Figure 2.8.7, together with the ICA assessment run. The results of the key run are largely in line with the ICA estimates. If a low weight is given to the SSB data, AMCI tends towards lower fishing mortalities and higher SSBs in recent years. This indicates that there is a signal in the catches themselves that 'prefers' a low F in recent years. This influence of the catch data is probably not real, but relates to the fact that the model assumptions applied here are so weak that the stock estimated by fitting to the catches alone are dominated by a fit to the noise in the data. Unless the supplementary data are given sufficiently weight, this effect will still be present. It also shows that the final solution is heavily dependent on the SSB data, as it is for the ICA model.

When taking away the tag data, the results deviate in the early period, and also deviate from the ICA assessment. The way AMCI is conditioned here, it probably is over-parameterised in this early period without supporting data. ICA has strong assumptions about the relation between F at oldest age and the selection in the separable period, which can cause problems if the selection has varied over time, but probably is adequate for the mackerel, where the selection at age has been relatively stable. The selection at age estimated by AMCI is shown in Figure 2.8.8. Hence, the finding that ICA and AMCI give quite similar results in the early period when AMCI uses the information from the tag return data can be taken as a confirmation that the results by ICA are in accordance with the independent mortality estimates by the tag return data.

To estimate the uncertainty due to the noise in the data, a bootstrap run was made with specifications as in the key run. For the catch data at age, bootstrap data were generated by using the residuals in the key run. For egg survey SSB data, a lognormal distribution with a c.v. of 20% was used. The results are shown in Figure 2.8.9. and indicate that the estimates for the most recent years are very sensitive to noise in the data. It also is in line with the finding by Simmonds *& al* (WD) that the variability in the final assessment is larger than the variability in the input data. The cases are not quite comparable, however, since noise also is included in the catch data here, and a somewhat higher variance is included in the SSB data than assumed by Simmonds & al.

Exploration of assumption about the tuning index

To provide information for discussion and to try to provide a basis for selection of the appropriate method for using the Egg Survey in the ICA model, two retrospective analyses of the 2002 NEA mackerel assessment were carried out with the Egg Survey used as relative or absolute indices (Simmonds *et al.* WD). Historically there are known to be errors in the total catch and there is current uncertainty of the extent of unreported fishing mortality for North Eastern Atlantic (NEA) mackerel. Thus it might be expected that there are indeed differences in the catch and the Egg Survey. Thus for management purposes it might be supposed that fitting the Egg Survey as a relative index is the safer option. The settings for the ICA assessment model were held constant for all terminal years. The data and the assessment settings used were taken from the 2002 assessment (ICES 2003a).

Two measures of retrospective performance (discussed in ICES 2003d) were used to compare assessments. In all cases values of the metrics closer to zero indicate less revision in the assessment and thus probably a more useful assessment. The assessments are illustrated in Figures 2.8.10. and 2.8.11. They showed that the use of the Egg Survey as a relative index reduced the bias in the assessment but at the expense of increased variability (Table 2.8.4). The Ab metric for bias in both SSB and F estimation (Jonsson & Hjorleifsson 2000) for a relative index use is around half the value for the absolute index use. Conversely, the Asd metric of variability (Jonsson & Hjorleifsson 2000) for a relative index use gives twice the value of the absolute index use in both SSB and F estimation. Comparison of the values of all the metrics for SSB and F showed a considerable decrease in both bias and variability when only Egg Survey years were used (Table 2.8.5). The values of Ab and Asd are very similar whether the index is used as relative or absolute. These results support the view that the most reliable assessments are those with an Egg Survey in the terminal year.

Although there is little to choose between terminal year assessments in terms of bias and variability, the assessment results give a very different perception of the stock. When the Egg Survey is used as absolute, the effect is to drag the final SSB trajectory up to the Egg Survey level, the use of the index as relative gives a much flatter trajectory (Figure 2.8.12). The implications are that there is a distinct possibility that using the Egg Survey as absolute will cause ICA to overestimate the stock, however, a use of the survey as a relative index will add noise to the assessment and the magnitude of the noise is thought to be greater than this bias. There is a need for a combination method which minimises the overall mean square error providing a balance between noise and bias. Currently no such method has been developed (though ad hoc solutions are available).

Despite this new analysis, the working group felt that there was little extra information compared to last year with which to decide between the tuning index as absolute and as relative. On this basis, the working group decided to maintain the assumptions about the tuning index used in last year's assessment.

ICA trial runs

Table 2.8.6 shows for comparison the different input parameters of the final ICA assessment on NEA mackerel for the years 1997-2002.

A run was made with a period of separable constraint of 11 years covering all available SSB's from the 1992, 1995, 1998 and 2001 egg surveys, while using this SSB index as an relative index. In the diagnostic output of ICA this resulted in a catchability of 1.299 (run2), which is similar to last years trial run which resulted in a catchability of 1.272. In earlier years a catchability was achieved closely to 1. In last years WG report the arguments are given why the WG changed from using the SSB values from egg surveys from relative to absolute (catchability =1). The arguments for using the SSB values from egg surveys as absolute have remained the same as reported at last years WG. The WG felt again that relative tuning to the short NEA mackerel SSB time-series (1992, 1995,1998 and 2001) was inappropriate. This was due substantially to the low signal contrast in these data, and that the bulk of the observed variability could be attributed to variance in the surveys, rather than major shifts in the SSB. SSB's from egg surveys prior to 1992 were not used in the assessment because they were carried out in the western area only. They were then raised to a NEA value using a 15% ratio -based on surveys in 1992 and 1995. The validity of this ratio is suspect, as the 1998 survey gave a ratio closer to 25%, thus only complete NEA mackerel survey indices have been used.

The sensitivity of the ICA model was tested with preliminary data files by applying different weightings to the relative index of SSB's from egg surveys. ICA did not appear to be very sensitive to changes in weighting between 1 and 10 compared to the standard value of 5 for weighting (Figure 2.8.13). ICA did not appear to be sensitive to changes in the periods of separable constraint ranging from 3 to 11 years. Splitting the period of separable constraint into two periods had little effect on the perception of the exploitation patterns, as they both appeared similar.

AMCI, ISVPA and ICA showed similar flat F-patterns in the recent years and all indicated 2000 as a weak year class and 2001 as a strong one. The WG decided to use ICA in the assessment, to use the SSB values from the egg surveys as an absolute index with a weighting of 5 and with a period of separable constraint of 11 years.

2.9 State of the stock

2.9.1 Stock Assessment

Tables 2.9.1.1-6 show the catches in number, the mean weights-at-age in the catch, the mean weights-at-age in the stock, the natural mortality, the proportion of fish spawning and the SSB index values used in the assessment.

ICA fits to the catch-at-age data and the egg production estimates were used to examine the relationship between the indices and the catch-at-age data as estimated by a separable VPA. The WG decided to use a weighting of 5 for the SSB index and used the index series as a absolute index of abundance as was last year. The argumentation for this is given in section 2.8. The WG decided to use the 4 most recent SSB estimates from the egg surveys in the analysis. This is because the egg surveys prior to 1992 were only carried out in the western area and were raised to give retrospective SSB for the NEA stock assuming that the proportion of the NEA stock in the western area was 0.85. This proportion was estimated as 0.75 from the 1998 egg survey and this cast doubt on the validity on using a fixed value to raise the western SSB estimates for years prior to 1992. In this years assessment the separable constraint was changed to one period of 11 years to include the SSB index time-series over the period 1992-2002. A terminal selection of 1.2 was used for the period of separable constraint. The selection pattern was calculated relative to the reference fishing mortality-at-age 5. The changes in the inputs used in ICA this year relative to other years is given in Table 2.8.6.

The model was fitted by a non-linear minimisation of:

$$\sum_{a=0}^{a=11}\sum_{y=1992}^{y=2002}\lambda_a\left(\ln(C_{a,y}) - \ln(F_y.S_a\cdot\overline{N}_{a,y})\right)^2 +$$
$$\lambda_b\sum_{y=1992}^{y=2002}\Sigma\left(\ln(EPB_y) - \ln(Q\sum_a N_{a,y}\cdot O_{a,y}\cdot W_{a,y}.\exp(-PF.F_y.S_a - PM.M)\right)^2$$

subject to the constraints

$S_5 = 1.0$
$S_{11} = 1.2$

where

$\overline{N}$ - mean exploited population abundance over the year.
N - population abundance on 1 January.
O - percentage maturity.
M - natural mortality.
F - fishing mortality-at-age 5.
S - selection at age over the time period 1992–2002, referenced to age 5.
λ_a - weighting factor set to 0.01 for age 0, 1.0 for all other ages.
λ_b - weighting factor for Egg production estimates.
a,y - age and year subscripts.
PF, PM - proportion of fishing and natural mortality occurring before spawning.
EPB - Egg production estimates of mackerel spawning biomass.
C - Catches in number-at-age and year.
Q - the ratio between egg estimates of biomass and the assessment model of biomass.

Tables 2.9.1.7 and 2.9.1.8 present the estimated fishing mortalities, and population numbers-at-age. Tables 2.9.1.9 and Figures 2.9.1.1–2.9.1.4 present the ICA diagnostic output. The stock summary is presented in Table 2.9.1.10. Figure 2.9.1.5 shows the catches, F, recruitment and SSB for the extended period 1972-2001.

2.9.2 Reliability of the Assessment and Uncertainty estimation

Assessment

It is recognised that poor sampling of some parts of the fishery, may lead to unknown errors in the catch-at-age data. In 2002 the proportion of the total catch sampled was the highest ever, at 87% of the total catch (see Section 1.3). In addition the numbers of fish sampled and aged increased in 2002 to the highest ever level. This was due in part to the increased landings from sampled areas but also due to more intensive sampling programmes carried out by Russia, and countries such as the Faroes who sampled their catch for the first time. This said however catches in the southern Celtic Sea and north Biscay area, which have increased in recent years, continue to be poorly sampled.

The problem of assessing the stock with very little supplementary data remains serious, as has been pointed out previously. Five years ago, the WG found that the main problem was obtaining stability in stock estimates when the last independent information was far back in time. In the two to four years prior to this WG meeting the problem related more to the over-dependence of the estimate on the last data point (the egg survey biomass in 1998). In the last and this years assessment the 1998 and 2001 egg survey biomass estimates did not fit to the SSB estimates from ICA. The WG considers the egg survey estimates of SSB to be quite reliable information. In recent years the coverage in area and time of the egg surveys as well as the collection of biological data has improved.

At the 2001 WG meeting the most serious concern was that an increase in SSB following from the high egg survey SSB estimate measured in 1998 could only be explained by recent strong year classes coming into the spawning stock. There was no clear evidence from landings or other sources that this was the case. The inclusion of the 2001 egg survey SSB in last year’s assessment then reduced the modelled recent recruitment to around the average level.

Data exploration in 2002 and 2003 using different weighting factors for the SSB of 1, 5 and 10 as an absolute index appeared to have no significant effect on the predicted SSB in the last year.

The AMCI model is able to use the large data set of Norwegian tag material as an additional source of information about mortality. It is reassuring that the AMCI model gives results that are in line with the ICA assessment, although the trends in SSB and F differ. Similar results were also obtained using the ISVPA model. In each case these models were set up to use the same SSB estimates, and as absolute values. The AMCI and ISVPA models were also run with and without the biomass estimates from the egg surveys and again this had no substantial effect on the stock trajectories. In summary, these results suggest that the ICA estimate as presented here is relatively robust and provides a valid perception of the stock situation (see section 2.8).

Uncertainty

The variances estimated by ICA express how well the parameters, including the present population numbers, can be estimated with the present data and model assumptions. The CV's of the stock number estimates for age 2-11 are in the range of 8-14% in the 2002 assessment. The 2001 and 2002 year classes, for which there is little information in the data, have higher CV's. In the 2001 WG meeting this CV range was similar (7-13%). Both recent years are better than in the assessment carried out in 2001 (14 - 19%). The numbers-at-age 0, 1 and 2 in this assessment particularly uncertain, as the are based on very few catch estimates, e.g. the 2002 year class on 1 data point and the 2001 on 2 data points in the catch matrix.

The SSB, F and recruitment estimates as obtained by previous Working Groups (1995 - 2002), are shown in Figure 2.9.2.1. Although the long-term trend in biomass is consistent, the levels of variability reflect switches between the use of SSB as a relative or an absolute index. The SSB estimates calculated at last years Working Group differed considerably from the three earlier Working Groups, because the lower SSB estimate from the 2001 egg survey was included in this year’s assessment. From 1994 until data from the next egg survey in 1998 became available, the model tried to fit to the relatively low SSB estimate from the 1995 egg survey, leading to the low SSB assessments in those years. From then onwards the model appeared to be trying to fit an increasing trend driven by the low 1995 and high 1998 SSB estimates based on the egg surveys. The inclusion of the 2001 estimate then changed the perception again, suggesting a more median stock trajectory. The two recent WG's treated the egg survey biomass estimates as absolute indices, while before it was the standard practice to treat them as relative indices, since 1999. Until the 2002 WG, the catchability coefficient for the SSB estimates was found to be close to 1 in the Western mackerel assessment suggesting that an absolute biomass figure should be acceptable. When tuning the ICA to the egg survey SSB as a relative index at the 2002 WG meeting the catchability plots showed too little range and contrast for the model to be able to estimate q. Therefore, the western mackerel and NEA mackerel assessments of the past years of assessment were used as a prior for q. In the past q was estimated as being close to 1 both for western and NEA mackerel and therefore it was decided last year to return to the use of the SSB as an absolute index. This WG decided again to use the egg survey SSB's as an absolute index based on the same arguments as last year.

The WG feels strongly that the current use of the ICA model appears to be too sensitive to variability in the SSB estimates from egg surveys. The variability in the survey SSB estimates at around 30% is not exceptional for surveys in general and once incorporated in the assessment, uncertainty in the assessment from the egg surveys is 20%. A problem appears to lie mainly in the three year interval between survey estimates becoming available. The model attempts to fit to the last survey estimate, which has the greatest influence. Large corrections in the modelled SSB then have to be made when a new estimate becomes available that differs to any substantial degree from the previous one, as happened with the 1995 and 1998 survey estimates and again for the 2001 estimates. It could be suggested that the model is actually attempting to fit to the noise in the survey data rather than the signal. Examination of the full egg survey time-series in the western area suggests that the stock is relatively stable. (Figure 2.9.1.5 shows that the SSB of the NEA mackerel remained rather constant from 1980 onwards).

Bootstrap estimates of AMCI suggest that that the variability in the final assessment is larger than the variability in the input data (section 2.8), and that the uncertainty in the final few years of the assessment is very large.

In summary the fundamental problem is the sparcity of fishery independent data, specifically the three year cycle in the availability of egg survey SSB estimates, which, additionally is not age disaggregated. Possible ways to emeliorate this situation are:

– More fishery independent data - e.g. more frequent egg surveys, or some other index
– Improved assessment modelling methodology -
– Design a management regime adapted to the uncertainty in the assessment process

Fishery independent data - There is currently ongoing work on the development of acoustic surveys for provision of a stock estimate for mackerel. Bottom trawl surveys in both the western area and the North Sea have the potential to provide information on year classes prior to their appearance in the fishery. More extensive tagging programmes, e.g. in the juvenile areas, would provide additional supporting data. It should be recognized that none of these approaches will provide an instant fix and will require varying degrees of development and validation work.

Modelling - Although there is scope for improvement in the models it must be recognized that models cannot compensate for lack of real data, and so model developments can only partly address the problem.

Management - Therefore the management regime needs to take into account these problems in providing an accurate assessment of the state of the stock. This implies a moderate fishing mortality allowing a buffer stock, which is sufficiently large to sustain year-to-year variations in recruitment and extraction. In a strategy like this, the long-term yield would be nearly independent of the fishing mortality over a wide range of fishing mortalities. So such moderate fishing mortalities can be applied without any significant loss in long-term yield. The current management regime is appropriate to this approach and should be continued. However, managers should understand that fluctuations in SSB estimates are likely and that any management regime should be robust to such fluctuations on at least a three-year cycle. As such it could be suggested that the NEA mackerel stock would be an ideal candidate for a multi-annual management regime.

2.10 Catch predictions

Table 2.10.1 presents the calculations for the input values for the catch forecasts and Table 2.10.2 lists the input data for the predictions.

Traditionally the ICA-estimated abundances of ages 2 to 12+ are used as the starting populations in the prediction. The recruitments of age 0 and the abundance at age 1 are routinely revised. However, at this meeting the estimated abundance of age group 2 (2001 year class) was revised in addition.

The following assumptions were made regarding recruitment at age 0 and the abundance at age 1 and 2 in 2003:

Age 0 No recruitment indices are available for the 2003 year class.
Figure 2.10.1 shows the recruitment estimates of year classes 1972-2001 as obtained from this years assessment. The value of 4115 million fish is calculated from the geometric mean of the North East Atlantic mackerel recruitments for the period 1972-1999, which value is used for the recruitment at age 0 for 2003 in de predictions. Figure 2.10.2 shows the GM recruitment estimates as estimated at the various WG meetings

from 1995 -2003. The GM recruitment estimate of this years WG meeting is just above the average of the GM recruitments as annually estimated during the WG meetings of 1995-2003.

Age 1 The abundance at age 1 is taken to be the geometric mean recruitment (4115 million fish) brought forward 1 year by the total mortality-at-age 0 in that year (see Table 2.10.1).

Age 2 ICA indicated a recruitment of the 2001 year class at age 0 of 11080 million, which has only been based on the catches as 0- and 1-group. The WG regarded the 2001 year class to be strong, but not as strong as indicated by ICA (Figure 2.10.1), because ICA tends to overestimate recent recruitments. This year class was abundant in the catches in 2002 in almost all areas. The surveys did not indicate such an extremely year class (see Section 2.7.2). The WG decided to assume strength of the 2001 year class at age 0 to correspond to the 75percentile of the recruitments over the period 1972-1999 in order to represent a strong year class. This corresponds to 5210 million fish at age 0. The recruitment of this year class at age 1 is taken to be this recruitment of 5210 million fish brought forward 1 year by the total mortality-at-age 0 and also brought forward by the total mortality-at-age 1 (see Table 2.10.1).

Recruitment at age 0 in 2004 and 2005 was also assumed to be 4115 million fish.

Catch forecasts have been calculated for the provision of area based TACs. Two "fleets" have been defined:

1. "Northern" area corresponding to the exploitation of the western area, including the North Sea and Division I, IIa and IIIa; "Northern" area reflects all areas except Divisions VIIIc and IXa;

2. "Southern" area including Div. VIIIc and IXa.

The exploitation pattern used in the prediction was the mean of the separable ICA F's over the last three years 2000-2002. This exploitation pattern was subdivided into partial F's for each fleet using the average ratio of the fleet catch at each age for the years 2000–2002.

Maturity-at-age was taken as an average of the values for the period 2000–2002. Weight-at-age in the catch was taken as an average of the values for the period 2000–2002 for each area. Weight-at-age in the stock was calculated from an average (2000–2002) of weights-at-age for the NEA mackerel stock.

The catch for 2003 is assumed to be 603 kt, which corresponds to the TAC of 583 kt in 2002 (see Section 2.1) plus an assumed amount of discards of 20 kt (see Section 1.3.3).

Predictions were calculated by the MFDP program.

The single option summary tables are presented and summarised in the text tables below. In addition Table 2.10.3 and 2.10.4 refer to 5 options with *status quo* fishing mortality ($\mathbf{F}_{sq}$ = 0.20) in 2003 and to 5 options with a catch constraint of 603 kt in 2003. Each of these two options for 2003 are then followed by:

F2004 = F2005 = 0.15 lower level of F of the F-range 0.15-0.20 as agreed by EU, Norway and Faroese in 1999;
F2004 = F2005 = 0.17 corresponding to $\mathbf{F}_{pa}$;
F2004 = F2005 = 0.18 intermediate step;
F2004 = F2005 = 0.19 corresponding to $\mathbf{F}_{0.1}$;
F2004 = F2005 = 0.20 upper level of F of the F-range 0.15-0.20 as agreed by EU, Norway and Faroese in 1999 and equal to $\mathbf{F}_{sq}$ (2000–2002);

A detailed multifleet prediction table is presented in Table 2.10.5 for the $F_{status\ quo}$ = 0.20 in 2003 and F=$\mathbf{F}_{pa}$=0.17 in 2004-2005.

UNITS: '000 t

	Catch 2003 = 603 kt F=0.15 2004,2005			Catch 2003 = 603 kt **F**$_{pa}$=0.17 2004,2005			Catch 2003 = 603 kt F=0.18 2004,2005			Catch 2003 = 603 kt F=0.19 2004,2005			Catch 2003 = 603 kt **F**$_{sq}$=0.20 2004,2005		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
2003	0.186	603	3107	0.186	603	3107	0.186	603	3107	0.186	603	3107	0.186	603	3107
2004	0.15	490	3144	0.17	551	3123	0.18	581	3112	0.19	610	3101	0.20	640	3091
2005	0.15	509	3258	0.17	562	3190	0.18	588	3157	0.19	614	3124	0.20	638	3091

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	Status quo (F2000-2002=0.20) F=0.15 2004,2005			*Status quo* (F2000-2002=0.20) **F**$_{pa}$=0.17 2004,2005			*Status quo* (F2000-2002=0.20) F=0.18 2004,2005			*Status quo* (F2000-2002=0.20) F=0.19 2004,2005			*Status quo* (F2000-2002=0.20) **F**$_{sq}$=0.20 2004,2005		
Year	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB	Ref F	Catch	SSB
2003	0.20	646	3091	0.20	646	3091	0.20	646	3091	0.20	646	3091	0.20	646	3091
2004	0.15	485	3111	0.17	545	3090	0.18	573	3080	0.19	603	3069	0.20	632	3059
2005	0.15	504	3231	0.17	557	3164	0.18	583	3131	0.19	608	3098	0.20	632	3066

For option F = 0.15 the forecasts for 2004 and 2005 predict that SSB will increase compared to 2003.

For option F = 0.17 = F_{pa} the forecasts predict that SSB in 2004 will remain at the same level as in 2003 and will slightly increase in 2005.

For options F = 0.18 to F = 0.20 the forecasts for 2004 and 2005 predict that SSB will remain rather stable compared to 2003.

The MFDP programme could not produce a two fleet management option table for the options *status quo* F or a catch constraint of 603kt for 2004. Therefore, this was carried out by a spreadsheet, which was again checked at this WG meeting by comparing its results to the MFDP results. The results of both were in agreement. Table 2.10.6 presents the two fleet management option table for the option of *status quo* F in 2003 and a range of F's for 2004. Table 2.10.7 presents the two fleet management option table for the option of 683kt in 2002 for a range of F's for 2004.

This years assessment appears to be consistent with last years (see Figure 2.9.2.1). The 2000 year class appears to be weak and will be 4 years old in the catches of 2004. The 2001 year class is indicated to be strong and will be 3 years old in the catches of 2004.

The catch predictions are carried out for two options: a) a catch corresponding **F**$_{sq}$ and b) a catch constraint. The actual catch and actual F obtained one year later for the same year can be compared to the catch and F of both prediction options to check, which of the two options fits best to the actual values. Figures 2.10. 3 and 2.10.4 show these comparisons for respectively catch and fishing mortality. The catch constraint option fits best to the actual catches, when predicted catches are compared actual catches (Figure 2.10.3). However, when the predicted fishing mortalities are compared to the actual fishing mortalities (Figure 2.10.4), it is not evident anymore whether the **F**$_{sq}$ option or the catch constraint option has a better fit. The predicted fishing mortalities from both options are closely related in most years. However, in a year of a strong TAC change (e.g. 1995 to 1996 from 645kt to 452kt) there is a large difference in the predicted catch and F between the **F**$_{sq}$ and the catch constraint options. Especially in such case it would be preferable to use a catch constraint option for the predictions. In most years the actual observed fishing mortalities are fluctuating more than the predicted fishing mortalities from both options. These fluctuations are likely to be due to up- and downward revisions once every three years when new SSB values from egg surveys become available for tuning the assessment. Predictions with a **F**$_{sq}$ option should be carried out in the case of consistent year to year underestimations of the fishing mortality (actual F values lower than predicted F values). This is, however, not the case.

The Working Group recommends that the MFDP program be improved in order to be able at next years meeting to produce a suitable multi-management option table for two fleets.

2.11 Special Requests

2.11.1 The Request from Norway

Norway has asked the Working Group to:

Comment on the biological rationale for setting TACs by areas

Identify the implications for the TAC advice for the remaining part of the distribution area, considering a range of TAC options for the Southern area

ICES is assessing the NEA mackerel stock which is combined of three spawning components: North Sea , Western and Southern mackerel. It is possible to distinguish the spawning area in the North Sea from the other areas. However the border between the western and southern components is not clear when looking at the egg distributions. Tagging experiments have shown that mackerel from the different spawning areas are mixing during the year in different parts of the distribution area. Since it is impossible to allocate catches to the different spawning components ICES has decided to assess the combined NEA stock as one unit.

There rationale for setting regional TACs is to protect smaller stock components from being over exploited. This is especially the case for the rather depleted North Sea component. ICES is advising a TAC for the NEA mackerel stock and in addition advice on temporal and spatial closures to restrict catches of juvenile mackerel.

Predictions were made for different options of the partial fishing mortalities for the Southern (Divisions VIIc, IXa) and the Northern areas (the rest of the distribution area) for 2004 (Table 2.11.1). The predictions were based on a total F_{2003}=0.20 and F_{2004}=0.17=$\mathbf{F}_{pa}$ for all areas. The impact on catches from the two areas is considerable when changing the partial fishing mortalities by area. At current practice the southern versus the northern catches are 6.4% : 93.6% in 2004. If the partial fishing mortality in the southern area is increased by 100%, the catch proportion changes to 12.8% : 87.2%. A long-term analysis based on the different options given in Table 2.11.1 indicates that the impact on SSB of NEA mackerel is negligible (less than l%).

2.12 Medium-term predictions

The NEA mackerel stock has been considered as a candidate for triennial assessment for some time (ICES 1999b and section 2.15). Medium-term predictions can be used to assess the stability of the stock relative to certain levels of exploitation to determine if given management constraints give desirable results over a given period.

Medium-term predictions in the 2002 WG using the ICP software showed that the upper ranges of recruitment were higher than any observed in the historical record, which led to over-optimistic trajectories of both SSB and catches in the medium-term. This arises because of the distribution of future recruitments assumed by ICA and ICP. In 2002, therefore, the WG decided not to present results of medium-term predictions until these problems had been solved. (see ICES 2003a, Figure 2.12.1).

In 2003 it was possible to use a function within the medium-term prediction software STPR (Skagen, 1997, Patterson & al, 1997, Patterson & al, 2000) to tune the predicted probability of recruitment numbers, to find a pattern of recruitment that more closely recreated the pattern of historical recruitment of this stock. The stock-recruit relationship was the 'Ockhams razor', assuming recruitment independent of the SSB for SSB > 2 million tonnes, and linearly decreasing with SSB below 2 million tonnes. A normally distributed noise function was added to the recruitments from this stock-recruit relationship, with a CV of 0.25, to give a distribution of future recruitments (at high levels of SSB) comparable with the historic recruitments (Figure 2.12.1). The probability of drawing very low recruitment was lower than observed by this choice of parameters, but the occurrence of large year classes was similar to the historical series.

Considering that this has overcome the problems encountered last year the WG decided to explore the possibilities of using medium-term predictions to investigate the behaviour of the stock under fixed constraints. This was done by illustrating the risk for SSB (in 2007) associated with a fixed TAC for the 3 years 2004-2006. This effectively shows the state of the stock in the year after a theoretical triennial management regime and enables an exploration to determine what level of fixed TAC over a three-year period carries a low risk of the stock falling below $\mathbf{B}_{pa}$.

STPR performs a medium-term simulation with stochastic values for the initial stock numbers, future recruitments, weights and maturities; it also allows one to simulate a range of harvest control rules. Input values used were the same as for the short-term prediction input (section 2.10). A fixed catch regime was simulated, using catch constraints of 400

– 800 kt, in increments of 100 kt. However, to avoid depletion of the stock in extreme cases, within the model it was assumed that F = 0.05 would be applied if SSB < 1.5 million tonnes. Catch options that resulted in the above situation too often were not considered.

Figure 2.12.2 shows the cumulative probability of SSB and F for 1000 bootstrap realizations, with both $\mathbf{B}_{pa}$ and $\mathbf{F}_{pa}$ provided for illustration. In this simulation SSB remains above $\mathbf{B}_{pa}$ over all catch constraints, except at the lower bounds (around 20% for an 800 kt constraint and around 5% for a 700 kt constraint.). F remains below $\mathbf{F}_{pa}$ most of the time when constraints of 400 and 500 kt are used.

This exercise was carried out to simulate the effects of a triennial management regime using the current perception of the state of the stock. If triennial management is to be introduced then it should not be attempted this year as these results are only indicative. However, it is anticipated that this WG will be in a stronger position to provide advice from this model at the 2004 WGMHSA when a new assessment of the stock will be possible with results of the 2004 egg survey.

2.13 Long-term Yield

Table 2.13.1 presents the yield-per-recruit forecasts for the combined North East Atlantic Mackerel stock. The multi-fleet yield-per-recruit programme (MFYPR) was not able to carry out the yield-per-recruit forecasts for both the Northern and Southern area as was done at earlier yield-per-recruit programmes. Therefore, yield-per-recruit forecast was carried out for the combined areas. The input values for $\mathbf{F}_{low}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ were obtained from the PA run in next section (2.14).

$\mathbf{F}_{max}$ is poorly defined at a combined reference F of about 0.66. However, for pelagic species $\mathbf{F}_{max}$ is generally estimated to be at levels of F well beyond sustainable levels and should not be used as a fishing mortality target. $\mathbf{F}_{0.1}$ was estimated to be 0.19.

2.14 Reference Points for Management Purposes

In the 1997 Working Group Report (ICES 1998) an extensive and detailed analysis on potential candidates for reference points for the precautionary approach were given. The reference points suggested by SGPAFM were largely based on this analysis and are in line with the suggestions from the 1997 Working Group, and were consequently adopted in the 1998 Working Group Report (ICES 1998). These values have been used by ACFM since 1998.

The WG ran the PA programme to calculate various precautionary reference points of spawning stock biomass and fishing mortality.

The input to the PA is the .sum and the .sen files from ICA. However, these need extensive modifications before any use. The stock numbers in the .sen file are from the last years with data, and not the stock sizes at the end of the current year (i.e. 2003, where stock size at age 0 is replaced with appropriate (GM) estimates of recruitment, and stock sizes of age 1 and 2 are replaced by corrected estimates of recruitment, respectively, see sec. 2.10.1). Furthermore the selection-pattern from the ICA output has to be changed to the mean F at age for the last three years, as well as three year averages of stock and catch weights (same as used for prediction, Table 2.10.1). At the end of the new input file, some additional values have to be added manually (Human consumption multipliers, recruitments and natural mortality multipliers, all set to 1). In addition the CV for age 0 (2003 year class) was taken from the GM estimate while the CVs for older ages were the same as for the stock size number from 2002 (ICA output). The .sum file also need changes, the recruitment at age 0 in 2002 was replaced with the GM estimate, and recruitment at age 0 from ICA in 2001, which was only based on catches as 0- and 1-groups, was replaced by the 75percentile estimate of the recruitments over the period 1972-1999 (sec. 2.10). The analysis is limited to cover the years 1977-2002 due to incomplete average F(2-8) values in the beginning of the period (1972-1976). Table 2.14.1 give a list of input parameters to the PA run.

The WG do not consider themselves as experts in this PA software, and do not have a complete understanding of the calculations and parameter setting. However, the analysis is required by ACFM and is accordingly presented here.

The results are shown in Table 2.14.2 and Figs 2.14.1-5. The stock-recruitment plot is shown in Fig. 2.14.6. $\mathbf{F}_{0.1}$ was estimated to be 0.19 in the present assessment, the same as in the previous four years.

The Working Group noted that recent updates have not significantly changed the basis for the present references points. The WG also noted that the lowest observed SSB was 2.39 million tonnes, slightly higher than the current $\mathbf{B}_{pa}$ (Table 2.14.1).

2.15 Case for a three year management cycle

The following appraisal is explicitly for a three year management cycle as opposed to a three year assessment cycle. It is envisaged that some form of assessment would be carried out in the intervening years to monitor the state of the stock. This would not be used to alter management advice unless major changes in the stock or fishery came to light.

Short-term assessment instability despite long-term stock stability

The NEA mackerel assessment has only two sources of input data, the catch-at-age data from the fishery and an SSB index derived from the triennial egg surveys. This index is not age disaggregated. The survey has been used as both an absolute and a relative tuning index. It is currently used as absolute. In common with most surveys this has a variability of between 20 and 30%. WGMHSA has commented on many occasions that the combination of the three year gap between surveys and this intrinsic variation leads to a situation where a high survey estimate tends to drive the stock up and vice versa. An examination of the full time-series of the western as opposed to NEA surveys suggests that the stock is relatively stable, with a possible slight increase over the last 20 years. Much of the variation in the perception of SSB and hence F could be argued to be the result of the noise in the SSB index signal rather than real information about changes in the stock. This can be expressed in terms of the assessment being more variable than the stock.

This conundrum is illustrated by the following extract from the 2002 report of WGMHSA:

"The SSB estimates calculated at this years Working Group differ considerably from the three earlier Working Groups, because the lower SSB estimate from the 2001 egg survey was included in this years assessment. From 1994 until data from the next egg survey in 1998 became available, the model tried to fit to the relatively low SSB estimate from the 1995 egg survey, leading to the low SSB assessments in those years. From then onwards the model appeared to be trying to fit an increasing trend driven by the low 1995 and high 1998 SSB estimates based on the egg surveys. The inclusion of the 2001 estimate then changes the perception again, suggesting a more median stock trajectory. "

Two WDs by John Simmonds and co-workers presented at this years meeting have relevance to this discussion.

In the first Simmonds (WD 18) examined the impact of using the egg survey SSB estimate as an absolute or a relative index. The study was based on the use of a series of retrospective assessments and then applying Bob Mohn's metric for retrospective discrepancies (Rho) (Mohn 1999) and Jonsson & Hjorleifsson's metrics for bias (Ab) and variation (Asd) (Jonsson & Hjorleifsson 2000). The conclusion from the study was that, in the years where a new egg survey estimate was available, the bias and variance in the assessment were broadly similar in either case. However, in the intervening years, an absolute index led to an increase in bias, and a relative to an increase in variance. One conclusion from this study would be that assessments carried out in the years when a new egg survey was available would be more reliable, regardless of the use of the SSB index. A second conclusion would be that the survey should be used as relative if the main aim is to reduce bias. Variance in the estimate can be taken into account when providing advice for management, however, bias can lead to incorrect advice.

In the second, Simmonds *et al* (2003) examined the variability in the assessment caused by the egg surveys. The study is based on boostrap resampling to generate multiple realisations of the survey which were then entered into the assessment with all other information as usual. The protocols used were identical to those developed for the EU EVARES project to evaluate survey based sources of variability in assessments. It should be noted that this analysis was based on the western mackerel spawning component rather than the entire NEA mackerel. This was to allow the use of the full time-series of egg surveys from 1977 and was considered viable as the western component is taken to represent approximately 85% of the NEA stock. Again the conclusion was that the surveys introduced a variability of between 15 and 30% into the assessment of SSB and F. However, the study also concluded that performance was much better for terminal years which included an egg survey. The authors went on to suggest that the additional landings data in terminal years after an egg survey generally added variance to the estimate. Once again, the suggestion was for a 3 year management cycle.

Medium-term projections

Medium-term projections for the NEA mackerel have proved problematic in the past due to overly optimistic estimates of recruitment. Stable, and robust medium-term projections would a vital tool for any three year management cycle. However, other studies have been carried out to examine the feasibility of a three year assessment cycle. A study by Kolody and Paterson presented at the final meeting of the Study Group on Multiannual Assessment Procedures in Vigo, Spain in 1999 (ICES 1999b) examined 3 year assessment in this stock. The study concluded the following:

"Preliminary results indicate that triennial assessments perform essentially the same as annual assessments if the initial conditions are known perfectly, P(F > $\boldsymbol{F}_{lim}$ = 0.26) < 0.01 (i.e. probability of limit exceeded at least once over a 20 year period). The admission of uncertainty in the initial state of the model (which is considered more appropriate) results in a much higher frequency of limit violations, with triennial assessments somewhat more risky (P(F>$\boldsymbol{F}_{lim}$)=0.52) than annual assessments (P(F>$\boldsymbol{F}_{lim}$)=0.35) In all cases, the total yield was similar (<3% difference) across scenarios, while the mean change in TAC between consecutive years was substantially lower in the triennial assessment case.".

Given that initial conditions may not be known perfectly this may argue against a three year cycle.

At the 2003 meeting of WGMHSA medium-term stochastic projections for this stock were carried out using the STPR software (see section 2.12). This allowed a much more realistic, though possibly still slightly optimistic view of recruitment. The conclusion from the projections was that given a fixed TAC of around 600 k tonnes the risk of the SSB dropping below $\mathbf{B}_{pa}$ was minimal. Again this would argue for a three year cycle.

Additional data required for a three year assessment cycle

The WG considered two other matters important for such a three year approach;

- Availability of the egg survey biomass estimate in the year of the survey
- Availability of a useable predictor for recruitment.

Egg survey biomass estimate

Currently, the procedure for the analysis of an egg survey takes too long for the estimate to be available to WGMHSA in the same year as the survey. It is critical that this should be faster and that the new egg survey estimate should be made available **IN** the year of the survey. To date this delay has been inavoidable as while the egg production estimate is relatively quick to produce after the survey, the fecundity estimate was not. New methodology now available should speed this process considerably and allow a reasonably robust SSB estimate in time for the WGMHSA meeting

Recruitment predictor

The second key factor would the availability of a useable early indication of likely recruitment. The only source of such information would be from the western bottom trawl surveys. These were used historically to provide a recruit index, but this was abandoned in the mid 1990s due to perceived trends between ICA and survey estimates of recruitment. Since that time no index has been calculated. In 2000/01 the surveys showed a dramatic fall in catch rates between the 1999 and 2000 year classes. Since then the 2000 year class has appeared as very weak in the landings and assessment. In the winter of 2001/02 the surveys indicated a good recruitment and this has begun to appear in the catches. In the winter of 2002/03 the surveys indicated an exceptionally high catch rate in many areas. Whether this will translate into the catches remains to be seen. However, the potential for these surveys to provide at least a prediction of bad recruitment is encouraging. If they could also predict good recruitment, this might allow the use of, say a 3 stage recruitment scale (low, mid and high). This would allow a much more sensitive projection and could allow more rapid response between putative triennial assessments should recruitment collapse.

Conclusion

WGMHSA feels that for the above reasons NEA mackerel would be a suitable candidate for a three year management cycle. Indeed, it could be argued that management would be improved by the stability introduced by this measure. The proposal would be to set a single TAC based on medium-term projection, such as the STPR used by WGMHSA. This should be set in the year of each triennial egg survey, assuming the survey index is available in year. WGMHSA would then continue to carry out assessments on the stock in the following two years, using new catch and recruit survey data. These would generally be used for monitoring purposes only, and should not lead to any change in the management advice. The role of WGMHSA would then be to carry out this monitoring and advice if the situation of the stock or fishery had changed substantially. What represents a "substantial change" would have to be determined in advance, and would be critical in the process. Ideally a "substantial change" should be beyond the range of the known variability in the assessment process. The next suitable year for introducing such a measure would be in 2004 for management starting in 2005.

2.16 Management Measures and Considerations

The perception of the NEA mackerel stock has not changed from the previous assessment. The mackerel stock is still in a healthy state.

The assessment model is considered as unreliable at estimating the most recent year classes prior to their appearance in the fishery. Given this, and the over-sensitivity of the model to the most recent SSB estimate leading to fluctuations in the stock assessment, a management regime is needed which is capable of incorporating this uncertainty in their advice. Specifically the regime should consider the possibility that poor year classes are not recognised until several years later, and that the recent perceptions of the stock is subject to variability and allow for this uncertainty in the advice. See Section 2.9.2 for a detailed discussion of the reliability of the assessment and its implications for management.

In 1999 Norway, Faroese and EU have agreed on: "For 1999 and subsequent years, the parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality in the range of 0.15 – 0.20 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of the fishing mortality rate." The Working Group sees no reason to deviate from the strategy to maintain a fishing mortality of 0.17. Medium and long-term predictions made in previous Working Groups have indicated that a long-term harvesting strategy with a fixed F near $\mathbf{F}_{0.1}$ would be optimal with respect to long-term yield and low risk. ACFM has recommended F=0.17 as $\mathbf{F}_{pa}$.

The North Sea spawning component still needs the maximum possible protection although the indications from the egg survey in the 2002 stock show some signs of recovery.

Even though information on discards has improved in 2002, still, little is known about discards in the mackerel fishery.

The Working Group would again put forward the possibility of introducting a Harvest Control Rule (HCR) for the period between the results from the egg surveys. An appraisal of the potential for a multi-annual management scheme is discussed in Section 2.15.

Table 2.2.1.1 Catches of MACKEREL by area. Discards not estimated prior to 1978. (Data submitted by Working Group members.)

Year	Sub-area VI			Sub-area VII and Divisions VIIIa,b,d,e			Sub-area IV and III			Sub-area I,II & Divs.Vb[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Landings	Landings	Discards	Catch
1969	4,800		4,800	*47,404*		47,404	*739,175*		739,175	7	*42,526*	833,912	0	833,912
1970	3,900		3,900	*72,822*		72,822	322,451		322,451	163	*70,172*	469,508	0	469,508
1971	10,200		10,200	*89,745*		89,745	243,673		243,673	358	*32,942*	376,918	0	376,918
1972	*13,000*		13,000	*130,280*		130,280	188,599		188,599	88	*29,262*	361,229	0	361,229
1973	52,200		52,200	*144,807*		144,807	326,519		326,519	21,600	*25,967*	571,093	0	571,093
1974	64,100		64,100	*207,665*		207,665	298,391		298,391	6,800	*30,630*	607,586	0	607,586
1975	64,800		64,800	*395,995*		395,995	263,062		263,062	34,700	*25,457*	784,014	0	784,014
1976	67,800		67,800	*420,920*		420,920	*305,709*		305,709	10,500	*23,306*	828,235	0	828,235
1977	74,800		74,800	259,100		259,100	*259,531*		259,531	1,400	*25,416*	620,247	0	620,247
1978	151,700	15,100	166,800	355,500	35,500	391,000	148,817		148,817	4,200	*25,909*	686,126	50600	736,726
1979	203,300	20,300	223,600	398,000	39,800	437,800	152,323	500	152,823	7,000	*21,932*	782,555	60600	843,155
1980	218,700	6,000	224,700	386,100	15,600	401,700	*87,931*		87,931	8,300	*12,280*	713,311	21600	734,911
1981	335,100	2,500	337,600	274,300	39,800	314,100	64,172	3,216	67,388	18,700	*16,688*	708,960	45516	754,476
1982	340,400	4,100	344,500	257,800	20,800	278,600	35,033	450	35,483	37,600	*21,076*	691,909	25350	717,259
1983	*320,500*	*2,300*	322,800	*235,000*	9,000	244,000	40,889	96	40,985	49,000	*14,853*	660,242	11396	671,638
1984	306,100	1,600	307,700	*161,400*	10,500	171,900	*43,696*	202	43,898	*98,222*	20,208	629,626	12302	641,928
1985	388,140	2,735	390,875	75,043	1,800	76,843	46,790	3,656	50,446	78,000	18,111	606,084	8191	614,275
1986	104,100		104,100	128,499		128,499	236,309	7,431	243,740	101,000	24,789	594,697	7431	602,128
1987	183,700		183,700	100,300		100,300	290,829	10,789	301,618	47,000	22,187	644,016	10789	654,805
1988	115,600	3,100	118,700	75,600	2,700	78,300	308,550	29,766	338,316	*120,404*	24,772	644,926	35566	680,492
1989	121,300	2,600	123,900	72,900	2,300	75,200	279,410	2,190	281,600	*90,488*	18,321	582,419	7090	589,509
1990	114,800	5,800	120,600	56,300	5,500	61,800	300,800	4,300	305,100	*118,700*	21,311	611,911	15600	627,511
1991	109,500	10,700	120,200	50,500	12,800	63,300	358,700	7,200	365,900	97,800	20,683	637,183	30700	667,883
1992	141,906	9,620	151,526	72,153	12,400	84,553	364,184	2,980	367,164	139,062	18,046	735,351	25000	760,351
1993	133,497	2,670	136,167	99,828	12,790	112,618	387,838	2,720	390,558	165,973	19,720	806,856	18180	825,036
1994	134,338	1,390	135,728	113,088	2,830	115,918	471,247	1,150	472,397	*72,309*	25,043	816,025	5370	821,395
1995	145,626	74	145,700	117,883	6,917	124,800	321,474	730	322,204	*135,496*	27,600	748,079	7721	755,800
1996	129,895	255	130,150	73,351	9,773	83,124	211,451	1,387	212,838	103,376	34,123	552,196	11415	563,611
1997	65,044	2,240	67,284	114,719	13,817	128,536	*226,680*	2,807	229,487	*103,598*	40,708	550,749	18864	569,613
1998	110141	71	110,212	105,181	3,206	108,387	264,947	4,735	*269,682*	134,219	44,164	658,652	8012	666,664
1999§	98,666		98,666	93,821		93,821	299,798		299,798	72,848	43,796	608,929	0	608,929
2000*	150,927	1	150,928	113,520	1,918	115,438	271,997	165	272,162	92,557	36,074	665,075	2084	667,159
2001*	113,234	83	113,317	141,012	1,081	142,093	311,979	24	312,003	67,097	43,198	676,520	1,188	677,708
2002*	109,170	12,931	122,101	101,028	2,260	103,288	360,405	8,583	368,988	73,929	49,576	694,108	23,774	717,882

*Preliminary.

[1]For 1976–1985 only Division IIa. Sub-area I, and Division IIb included in 2000 only

§ Discards reported as part of unallocated catches

NB Figures in italics are revised, the revisions are documented in the SGDRAMA annex to 2002 WG report

Table 2.2.1.2 Catches (t) of MACKEREL in the Norwegian Sea (Division IIa) and off the Faroes (Division Vb). (Data submitted by Working Group members.)

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Denmark	11,787	7,610	1,653	3,133	4,265	6,433	6,800	1,098	251		
Estonia									216		3,302
Faroe Islands	137				22	1,247	3,100	5,793	3,347	1,167	6,258
France		16				11		23	6	6	5
Germany, Fed. Rep.			99		380						
German Dem. Rep.			16	292		2,409					
Iceland											
Ireland											
Latvia									100	4,700	1,508
Lithuania											
Netherlands											
Norway	82,005	61,065	85,400	25,000	86,400	68,300	77,200	76,760	91,900	110,500	141,114
Russia									42,440	49,600	28,041
United Kingdom			2,131	157	1,413		400	514	802		1,706
USSR	4,293	9,405	11,813	18,604	27,924	12,088	28,900	13,631[2]			
Poland											
Sweden											
Misreported (IVa)											-109,625
Misreported (VIa)											
Discards							2,300				
Total	98,222	78,096	101,112	47,186	120,404	90,488	118,700	97,819	139,062	165,973	72,309

Country	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	4,746	3,198	37	2,090	106	1,375	7	1
Estonia	1,925	3,741	4,422	7,356	3,595	2,673	219	
Faroe Islands	9,032	2,965	5,777**	2,716	3,011	5,546	3,272	4,730
France	5	0	270					
Germany		1						
Iceland		92	925	357				53
Ireland					100			
Latvia	389	233						
Lithuania						2,085		
Netherlands		561			661			569
Norway	93,315	47,992	41,000	54,477	53,821	31,778	21,971	22,670
Russia	44,537	44,545	50,207	67,201	51,003	49,100*	41,566	45,811
United Kingdom	194	48	938	199	662		54	665
USSR[2]								
Poland			22					
Sweden							8	
Misreported (IVa)	-18,647			-177	-40,011			
Misreported (VIa)					-100			
Misreported (unknown)								-570
Discards								
Total	135,496	103,376	103,598	134,219	72,848	92,557	67,097	73,929

[2]Russia.
*Includes small bycatches in Sub area I & IIb
** Faroese catch revised from previously reported 7,628

Table 2.2.1.3 Catch (t) of MACKEREL in the North Sea, Skagerrak, and Kattegat (Sub-area IV and III). (Data submitted by Working Group members).

Country	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	14	20	37		125	102	191	351
Denmark	28,217	32,588	26,831	29,000	38,834	41,719	42,502	47,852
Estonia						400		
Faroe Islands			2,685	5,900	5,338		11,408	11,027
France	2,146	1,806	2,200	1,600	2,362	956	1,480	1,570
Germany, Fed. Rep.	474	177	6,312	3,500	4,173	4,610	4,940	1,479
Iceland								
Ireland			8,880	12,800	13,000	13,136	13,206	9,032
Latvia						211		
Netherlands	2,761	2,564	7,343	13,700	4,591	6,547	7,770	3,637
Norway	108,250	59,750	81,400	74,500	102,350	115,700	112,700	114,428
Sweden	3,162	1,003	6,601	6,400	4,227	5,100	5,934	7,099
United Kingdom	19857	1,002	38,660	30,800	36,917	35,137	41,010	27,479
USSR (Russia from 1990)								
Romania								2,903
Misreported (IIa)								109,625
Misreported (VIa)	117,000	180,000	92,000	126,000	130,000	127,000	146,697	134,765
Unallocated	8,948	29,630	6,461	-3,400	16,758	13,566	-	-
Discards	10,789	29,776	2,190	4,300	7,200	2,980	2,720	1,150
Total	301,618	338,316	281,600	305,100	365,875	367,164	390,558	472,397

Country	1995	1996	1997	1998	1999	2000[1]	2001	2002
Belgium	106	62	114	125	177	146	97	22
Denmark	30,891	24,057	21,934	25,326	29,353	27,720	21,680	34,375
Estonia			-	-				
Faroe Islands	17,883	13,886	3,288[2]	4,832	4,370	10,614	18,571	12,548
France	1,599	1,316	1,532	1,908	2,056	1,588	1,981	2,152
Germany, Fed. Rep.	712	542	213	423	473	78	4,514	3,902
Iceland					357			
Ireland	5,607	5,280	280	145	11,293	9,956	10,284	20,715
Latvia			-	-				
Netherlands	1,275	1,996	951	1,373	2,819	2,262	2,441	11,044
Norway	108,890	88,444	96,300	103,700	106,917	142,320	158,401	161,621
Sweden	6,285	5,307	4,714	5,146	5,233	4,994	5,090	5,232
United Kingdom	21,609	18,545	19,204	19,755	31,578	57,110	50,165	58,876
Russia			3,525	635	345	1,672	2	
Romania			-	-				
Misreported (IIa)	18,647	-	-	-	40,000			
Misreported (VIa)	106,987	51,781	73,523	98,432	59,882	8,591	39,024	49,918
Unallocated	983	236	1,102	3,147	4,946	3,197	-272	
Discards	730	1,387	2,807	4,753		1,912	24	8,583
Total	322,204	212,839	229,487	269,700	299,799	272,160	312,004	368,988

[1]Includes small catches in IIIb & IIId

[2]Faroese catches revised from previously reported 1,367

Table 2.2.1.4 Catch (t) of MACKEREL in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e). (Data submitted by Working Group members).

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993
Denmark	400	300	100		1,000		1,573	194	
Faroe Islands	9,900	1,400	7,100	2,600	1,100	1,000			
France	7,400	11,200	11,100	8,900	12,700	17,400	4,095		2,350
Germany	11,800	7,700	13,300	15,900	16,200	18,100	10,364	9,109	8,296
Ireland	91,400	74,500	89,500	85,800	61,100	61,500	17,138	21,952	23,776
Netherlands	37,000	58,900	31,700	26,100	24,000	24,500	64,827	76,313	81,773
Norway	24,300	21,000	21,600	17,300	700		29,156	32,365	44,600
Poland									600
Spain				1,500	1,400	400	4,020	2,764	3,162
United Kingdom	205,900	156,300	200,700	208,400	149,100	162,700	162,588	196,890	215,265
USSR									
Unallocated	75100	49299	26000	4700	18900	11,500	-3,802	1,472	0
Misreported (Iva)		-148,000	-117,000	-180,000	-92,000	-126,000	-130,000	-127,000	-146,697
Discards	4,500			5,800	4,900	11,300	23,550	22,020	15,660
Grand Total	467,700	232,599	284,100	197,000	199,100	182,400	183,509	236,079	248,785

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	2,239	1,443	1,271	-	-	552	82	835	
Estonia		361		-	-				
Faroe Islands	4,283	4,248	-	2,448[1]	3,681	4,239	4,863	2,161	2,490
France	9,998	10,178	14,347	19,114	15,927	14,311	17,857	18,975	19,726
Germany	25,011	23,703	15,685	15,161	20,989	19,476	22,901	20,793	22,630
Ireland	79,996	72,927	49,033	52,849	66,505	48,282	61,277	60,168	51,457
Netherlands	40,698	34,514	34,203	22,749	28,790	25,141	30,123	33,654	21,831
Norway	2,552			-	-			223	
Spain	4,126	4,509	2,271	7,842	3,340	4,120	4,500	4,063	3,483
United Kingdom	208,656	190,344	127,612	128,836	165,994	127,094	126,620	139,589	131,599
USSR									
Unallocated	4,632	28,245	10,603	4,577	8,351	9,254	0	12,807	
Misreported (IVa)	-134,765	-106,987	-51,781	-73,523	-98,255	-59,982	-3,775	-39,024	-43,339
Discards	4,220	6,991	10,028	16,057	3,277		1,920	1,164	15,191
Grand Total	251,646	270,476	213,272	196,110	218,599	192,486	266,367	255,408	225,389

[1]Faroese catches revised from 2,158

Table 2.2.1.5 Landings (tonnes) of mackerel in Divisions VIIIc and IXa, 1977–2001. Data submitted by Working Group members.

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Spain[1]	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810	16,533	15,982	16,844	13,446
Portugal[2]	1,743	1,555	1,071	1,929	3,108	3,018	2,239	2,250	4,178	6,419	5,714	4,388	3,112
Spain[2]	2,935	6,221	6,280	2,719	2,111	2,437	2,224	4,206	2,123	1,837	491	3,540	1,763
Poland[2]	8	-	-	-	-	-	-	-	-	-	-	-	-
USSR[2]	2,879	189	111	-	-	-	-	-	-	-	-	-	-
Total[2]	7,565	7,965	7,462	4,648	5,219	5,455	4,463	6,456	6,301	8,256	6,205	7,928	4,875
TOTAL	27,417	26,508	22,475	15,964	18,053	21,076	14,853	20,308	18,111	24,789	22,187	24,772	18,321

[1]Division VIIIc.[2]Division IXa.

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Spain[1]	16,086	16,940	12,043	16,675	21,146	23,631	28,386	35,015	36,174	37,631	30,061	38,205	38,703
Portugal[2]	3,819	2,789	3,576	2,015	2,158	2,893	3,023	2,080	2,897	2,002	2,253	3,119	2,934
Spain[2]	1,406	1,051	2,427	1,027	1,741	1,025	2,714	3,613	5,093	4,164	3,760	1,874	7,938
Total[2]	5,225	3,840	6,003	3,042	3,899	3,918	6,737	5,693	7,990	6,165	6,013	4,993	10,873
TOTAL	21,311	20,780	18,046	19,719	25,045	27,549	34,123	40,708	44,164	43,796	36,074	43,198	49,575

[1]Division VIIIc. [2]Division IXa.

Table 2.4.1.1 Catch in numbers at age (000's) for NE Atlantic mackerel

For Quarters 1 to 4

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
				502.6	0.0			266.3		10.3						4001.0	223.4		13.2	4.7		3236.9			893.8	38.4	61187.3	3.7	70381.4
1	591.5	19.8	0.0	67201.9	582.5	5729.9		38798.7	4.2	74.2	0.9	931.0	5411.3	300.0	295.4	36097.9	2041.5	0.0	34711.9	360.7	928.5	3519.2	15.2	0.2	5568.0	1436.4	3413.4	2232.9	210266.9
2	2209.6	79.8	0.1	20057.8	115.2	780.3	84.6	8157.6	2.4	1621.4	46.2	1626.9	3150.7	152.5	78.6	646.4	589.4	0.0	11567.3	338.4	4611.8	5635.1	5.2	0.2	1289.0	616.6	2758.3	508.0	66729.2
3	27781.2	530.4	0.3	137815.7	516.1	1096.7	1146.1	87292.7	2.5	18536.1	184.4	2590.5	6719.5	268.6	132.1	3592.2	12736.4	9.2	13158.5	786.3	9922.0	10578.6	5.8	57.9	194.7	135.3	4007.4	108.6	339905.5
4	33470.4	854.7	0.4	140001.9	745.5	433.4	2187.8	65212.0	1.7	30100.2	365.9	1123.1	5228.7	83.8	55.6	1866.2	13868.1	7.2	4711.4	1544.6	12956.9	7150.1	3.9	45.4	130.8	109.1	3303.9	74.7	325637.5
5	21749.1	754.0	0.3	113654.5	636.5	299.6	2063.4	44568.0	1.2	13879.2	132.4	939.6	3180.2	57.5	44.0	1604.5	11115.1	4.4	1679.6	2037.9	16469.7	4489.8	102.4	27.4	97.7	116.0	2935.2	61.9	242700.8
6	19198.4	748.0	0.3	110796.0	615.4	277.8	2068.6	40075.8	0.5	13643.4	113.3	580.1	1040.6	17.7	11.5	1514.8	11614.6	4.7	1483.2	1387.5	10857.0	916.4	127.3	29.7	77.5	118.8	1169.5	56.2	218544.6
7	12697.5	453.6	0.2	64720.7	379.3	41.3	1393.2	24003.0	0.3	9359.9	48.8	209.6	761.0	13.5	12.3	1049.3	7658.2	1.1	2667.1	1461.1	11693.4	680.9	7.7	7.1	39.7	132.0	892.9	419.7	140804.4
8	8674.0	276.0	0.1	51269.3	230.4	111.4	1404.5	24687.4	0.1	5387.3	17.4	368.7	205.7	4.1	0.1	492.2	6438.8	2.0	1352.4	910.2	6729.0	328.2	126.5	12.4	15.9	45.9	363.8	17.1	109470.8
9	7162.1	217.8	0.1	35837.4	174.7	54.1	940.4	12185.4		7205.9	86.8	99.8	100.9	1.9	1.7	590.9	3057.1	1.1	521.7	625.0	4754.0	244.1	76.1	6.7	11.0	29.6	175.5	3.9	74165.4
10	1981.6	132.3	0.1	20076.8	118.0	11.1	185.5	8377.4		2692.6	5.9	211.9	50.4	0.8	0.8	147.9	2615.7	0.9	173.7	316.6	2162.8	110.7	193.8	5.7	441.3	6.6	61.6	0.9	40083.2
11	946.5	65.0	0.0	10747.5	53.0	4.4	58.2	4581.4		1338.6	7.0	13.4		0.2	0.0	97.9	481.1	0.2	130.1	145.3	1031.9	55.9	0.8	1.4	1.2	2.1	28.5	0.2	19791.9
12	828.1	21.7	0.0	9977.3	15.6	2.2	68.2	3328.8		1257.9	6.3	99.1	0.1			49.6	401.0	0.5	327.2	47.6	285.6	10.6	0.6	3.2	0.8	2.4	2.1	0.1	16736.4
13	388.7	3.9		3487.4	0.1		62.1	1638.2		808.9	2.7	13.4				49.6	177.1	0.2		53.7	269.3	14.2		1.2	0.1	1.1	2.3	0.1	6974.1
14	326.7	2.8		2964.9	0.1		28.8	1358.8		364.2							531.9	0.4		24.2	137.5	2.7		2.6	0.1	0.2	0.2	0.0	5745.9
15	96.5	28.1	0.0	3328.8	27.9	4.4	10.8	2035.3		663.6	7.0	2.4				49.6	981.2	0.6	87.2	2.1	81.9	0.8	0.6	3.6			0.0		7412.2
SOP	68056.5	2076.6	1.0	363748.6	1902.3	2182.8	5872.4	122977.7	3.1	37093.2	294.0	3101.1	7388.6	198.3	117.2	8755.7	26353.4	10.0	15804.6	3841.7	30466.3	8242.2	295.6	63.0	1442.5	673.4	7941.0	818.6	719724.1
Catch	68058.0	2077.0	1.0	362826.6	1902.5	2180.5	5871.5	122101.1	3.2	37187.8	294.0	3102.2	7388.3	198.3	117.2	8754.8	26505.2	10.0	15525.9	3843.1	30467.8	8235.5	294.8	63.0	1442.4	673.3	7938.3	818.6	717881.8
SOP%	100%	100%	100%	100%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	101%	100%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Quarter 1

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
										10.3																			10.3
1	0.4							33081.8	3.1	45.3	0.8				247.5		19.3	0.0		17.1	410.4	222.5		0.2	3149.5	139.0	584.4	178.9	38100.5
2	12.0	11.3		678.4	6.1	0.2	7.6	3292.7	1.7	143.0	38.5	100.2	150.6	1.8	64.6	1.1	528.7	0.0	483.3	176.7	3574.3	3554.0		0.2	743.8	371.5	1842.1	49.7	15834.4
3	134.3	87.6		18990.1	47.3	1.9	537.5	71368.8	1.3	12628.6	153.7	150.3	2048.7	24.5	113.0	521.6	10638.1	9.2	723.3	458.8	7090.3	6808.8		57.9	67.7	48.7	3436.5	16.3	136164.6
4	379.1	229.9		26170.0	124.0	4.9	1256.8	60723.6	1.1	18378.9	304.9	136.9	2277.1	27.2	51.7	661.5	12130.9	7.2	1450.0	936.8	7722.0	4500.4		45.4	34.4	18.8	2581.0	17.3	140171.8
5	245.4	203.1		25923.7	109.5	4.4	1045.5	42494.7	0.9	9639.2	110.3	86.8	1789.0	21.4	41.1	658.0	7051.9	4.4	723.3	1342.2	9259.9	2732.2	23.7	27.4	27.4	26.5	2064.1	9.7	105665.3
6	197.4	208.2		28287.8	112.3	4.5	1077.2	38993.8	0.4	10015.5	94.4	63.5	367.3	4.4	10.4	694.2	8471.7	4.7	483.3	1024.3	6033.1	445.0	29.7	29.7	26.8	20.8	738.2	5.6	97444.2
7	151.4	109.3		16430.1	58.9	2.4	660.3	23273.9	0.3	7796.5	40.7	23.4	530.2	6.3	11.6	741.9	4521.3	1.1	1450.0	1141.1	6634.7	272.3		7.1	9.0	16.2	531.1	2.2	64423.0
8	174.3	60.8		10264.0	32.8	1.3	680.7	23362.9		4828.9	14.5	23.4				461.4	2544.2	2.0	483.3	741.1	3842.7	104.5	29.7	12.4	3.1	7.4	200.9	2.0	47878.3
9	163.8	65.9		8128.2	35.6	1.4	324.4	11909.2		4426.0	72.3		100.0	1.2	1.6	553.9	1555.4	1.1		529.6	2775.1	73.3	17.9	6.7	2.6	10.8	92.0	1.0	30848.9
10	34.5	33.0		3666.2	17.8	0.7	47.6	8302.1		2505.1	4.9	13.4	49.8	0.6	0.8	138.7	847.2	0.9		271.0	1275.7	29.4	47.4	5.7	2.0	1.3	30.1		17325.5
11	16.1	16.5		1437.1	8.9	0.4	17.4	4518.2		1114.3	5.8	13.4				91.8	439.0	0.2		126.7	604.4	17.2		1.4	0.3	0.7	15.2		8444.6
12	21.2			3297.1			39.4	3251.2		1055.9	5.3					46.5	314.0	0.5	240.0	41.1	164.4	2.2		3.2	0.4	0.3	0.9		8483.4
13	5.2			640.1			10.0	1623.5		722.3	2.3	13.4				46.5	144.3	0.2		46.2	173.5	5.4		1.2	0.1	0.4	0.8		3435.4
14	10.4			953.5			14.4	1327.9		364.2							464.6	0.4		20.9	98.1	0.2		2.6		0.1	0.1		3257.4
15	20.4	5.2		778.1	2.8	0.1	10.8	1997.1		440.2	5.8					46.5	239.0	0.6		1.5	60.4	0.1		3.6					3612.0
SOP	784.0	418.5		57980.3	225.7	9.0	2851.5	111911.8	2.0	27676.3	245.0	232.7	2203.6	26.3	102.0	1961.5	17091.6	10.0	2065.8	2805.7	17904.7	4564.0	68.2	63.0	475.2	154.8	3165.8	55.3	255042.5
Catch	784.0	419.0		57969.6	226.0	9.0	2850.5	110855.0	2.0	27769.3	245.0	233.7	2203.6	26.3	102.0	1961.7	17184.4	10.0	2066.5	2807.1	17908.6	4564.6	68.0	63.0	475.3	154.8	3165.6	55.3	254180.0
SOP%	100%	100%	0%	100%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	101%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 2.4.1.1 (continued.)

Quarter 2

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
1	0.7	2.0		3.5	95.4	105.6		564.4		21.1	0.2			196.2	45.0		6.4		2390.7	30.2	335.2	3129.4	15.2		1170.2	143.5	187.6	642.7	9085.2
2	20.1	7.5		1.7	16.3	8.5		2436.5		1083.3	7.7	1.1	1.2	49.3	11.3		8.0		825.5	85.1	457.1	1753.5	5.2		360.0	89.1	80.4	311.3	7619.7
3	224.4	65.2		26.0	82.5	11.0	65.7	5606.4		4328.7	30.7	14.4	15.8	63.0	14.5	33.9	1797.3		912.7	266.3	2033.7	3314.7	5.8		69.5	14.3	235.9	37.8	19270.2
4	633.4	151.7		33.4	177.3	5.3	120.5	1699.5		8588.9	61.0	16.0	17.6	11.5	2.6	43.1	1475.6		608.2	543.6	4796.2	2276.6	3.9		50.7	16.4	584.2	18.3	21935.3
5	410.1	130.6		23.9	147.6	2.0	327.2	805.2		3106.9	22.1	12.6	13.8	9.4	2.2	43.1	3315.7		956.3	650.9	6984.3	1504.8	78.8		39.5	22.2	800.1	22.8	19431.6
6	329.8	135.0		26.4	150.2	2.0	322.2	530.0		2658.4	18.9	2.6	2.8	3.5	0.8	46.2	2604.5		999.9	355.3	4775.6	406.7	97.6		27.2	13.1	417.2	15.3	13941.4
7	253.0	72.2		16.2	78.8	1.6	209.7	429.0		1145.6	8.1	3.7	4.1	2.3	0.5	49.3	2520.4		1217.1	316.2	5029.4	362.6	7.7		15.0	14.4	354.6	13.3	12125.1
8	291.2	42.1		12.4	44.5	0.3	301.6	1044.5		409.2	2.9					30.8	3174.1		869.1	168.3	2874.0	204.0	96.8		9.1	14.2	160.6	6.2	9755.7
9	273.8	42.7		8.3	46.8	0.3	262.8	155.5		2037.0	14.5	0.7	0.8			37.0	1210.9		521.7	95.1	1970.9	159.2	58.2		3.5	2.5	82.2	2.5	6986.8
10	57.7	21.7		4.7	24.6	0.2	65.7	61.4		137.4	1.0	0.4	0.4			9.2	1441.9		173.7	45.6	883.9	76.6	146.5		0.6	3.0	31.0	0.2	3187.2
11	26.9	10.9		2.5	11.7	0.1		33.5		164.4	1.2					6.1	39.6		130.1	18.6	425.9	36.4	0.8		0.9	0.5	13.1	0.0	923.3
12	35.4	1.3		2.4	0.1			47.9		148.0	1.1					3.1	84.7		87.2	6.5	120.9	7.9	0.6		0.4	1.2	1.2		549.7
13	8.8	0.7		1.2	0.0		32.9	14.7		63.4	0.5					3.1	31.8			7.4	95.5	8.4				0.4	1.5		270.0
14	17.4	0.5		0.9	0.0			16.1									67.3			3.4	39.3	2.4			0.1		0.1		147.3
15	34.2	3.3		0.6	3.7	0.0		38.1		163.7	1.2					3.1	610.0		87.2	0.6	21.5	0.7	0.6				0.0		968.3
SOP	1310.0	289.7		85.2	335.1	28.8	773.0	4159.1		6900.6	49.0	15.5	17.0	52.3	12.0	130.0	7359.3		2838.2	930.7	11993.4	3033.2	227.4		273.2	77.5	985.2	205.1	42080.3
Catch	1310.0	290.0		85.2	335.4	28.7	773.0	4321.3		6901.4	49.0	15.5	17.0	52.3	12.0	130.0	7366.0		2833.3	930.8	11994.8	3033.2	227.2		273.1	77.5	985.3	205.0	42247.0
SOP%	100%	100%	0%	100%	100%	100%	100%	104%	0%	100%	100%	100%	100%	100%	100%	100%	100%	0%	100%	100%	100%	100%	100%	0%	100%	100%	100%	100%	100%

Quarter 3

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
				0.3	0.0																	1242.6			149.3	21.6	45009.7	2.5	46426.1
1	565.2	13.7	0.0	5724.7	331.8	1380.3		303.5	1.1			35.8	255.2	87.2	2.4		0.3		88.6	112.2	81.4	68.9			236.9	831.7	2112.9	1072.3	13306.2
2	2128.7	44.2	0.1	3774.4	66.0	110.8	77.0	290.3	0.7	0.2		25.7	140.2	81.6	2.1		16.6		3.6	4.4	196.5	155.0			48.9	134.5	825.5	125.8	8252.7
3	26635.8	284.6	0.3	46458.3	272.4	140.0	486.1	697.1	1.1	0.6		26.4	109.7	127.8	3.2		131.4			1.9	275.2	234.6			21.7	65.3	321.7	51.5	76346.5
4	31659.7	377.1	0.4	57665.1	320.1	57.5	640.1	230.0	0.6	1.2		15.8	88.0	29.5	0.8		196.8			0.4	93.9	202.3			14.3	69.1	128.9	38.3	91829.8
5	20664.9	328.9	0.3	41546.4	262.7	15.9	548.7	90.7	0.3	0.5		13.5	71.0	17.6	0.5		697.1			0.3	47.5	133.8			7.8	63.7	65.8	29.1	64606.8
6	18278.4	320.7	0.3	45018.1	244.9	15.8	534.2	100.3	0.1	0.4		7.0	32.8	5.9	0.2		495.1			0.1	16.8	30.0			6.2	82.1	12.8	34.9	65237.1
7	12077.3	214.1	0.2	28193.3	165.0	15.1	438.0	47.9	0.1	0.2		3.7	21.3	3.0	0.1		602.1			0.0	15.2	18.4			3.1	96.9	6.6	39.3	41960.6
8	8059.8	126.4	0.1	20930.5	92.5	0.8	336.9	94.3	0.1	0.1		2.0		2.9	0.1		720.6			0.0	8.4	6.9			0.6	21.9	2.1	8.6	30415.2
9	6621.1	80.1	0.1	13707.0	55.2	0.5	317.6	32.9		0.3		0.6		0.7	0.0		290.9			0.0	6.0	3.8			0.4	13.9	1.1		21132.0
10	1853.2	51.8	0.1	7919.6	41.3	0.3	72.2	7.9		0.0		1.2		0.2			326.6				2.6	1.4			437.7	0.8	0.4	0.5	10717.7
11	886.5	27.1	0.0	4253.5	19.3	0.2	33.7			0.0				0.2	0.0		2.5				1.2	0.7					0.2	0.0	5225.2
12	756.6	14.8	0.0	3717.1	8.3	0.1	28.9			0.0		0.6					2.3				0.2	0.1					0.0		4529.0
13	367.5	3.1		1824.6	0.0		19.3			0.0							1.0				0.2	0.2					0.0		2215.8
14	293.1	2.2		1322.3	0.0		14.4														0.1	0.0					0.0		1632.3
15	40.0	8.8	0.0	1025.0	6.8	0.1				0.0		0.0					132.3				0.0	0.0					0.0		1213.1
SOP	64527.3	1060.4	1.0	149662.4	911.2	357.4	1848.0	601.8	1.1	1.0		35.6	163.8	84.0	2.2		1531.4		10.0	11.1	177.9	300.8			374.4	366.5	2740.4	305.0	225073.2
Catch	64527.0	1060.0	1.0	149644.8	911.1	356.0	1848.0	618.0	1.1	1.0		35.6	163.8	84.0	2.2		1533.0		10.0	10.9	175.6	299.5			374.5	366.5	2738.5	305.0	225067.1
SOP%	100%	100%	100%	100%	100%	100%	100%	103%	101%	100%	0%	100%	100%	100%	100%	0%	100%	0%	100%	99%	99%	100%	0%	0%	100%	100%	100%	100%	100%

Table 2.4.1.1 (continued.)

Quarter 4

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
				502.3				266.3								4001.0	223.4		13.2	4.7		1994.3			744.6	16.7	16177.5	1.1	23945.1
1	25.1	4.1		61473.7	155.3	4244.0		4848.9		7.7		895.1	5156.0	16.5	0.5	36097.9	2015.4		32232.6	201.2	101.5	98.4			1011.3	322.2	528.5	339.1	149775.0
2	48.7	16.8		15603.4	26.8	660.8		2138.0		394.9		1500.0	2858.7	19.8	0.6	645.3	36.0		10254.9	72.3	383.9	172.6			136.2	21.5	10.2	21.3	35022.5
3	786.7	93.0		72341.2	114.0	943.9	56.8	9620.5		1578.1		2399.4	4545.4	53.3	1.5	3036.8	169.6		11522.5	59.3	522.9	220.5			35.8	6.9	13.2	2.9	108124.1
4	798.2	96.1		56133.5	124.1	365.7	170.4	2558.9		3131.2		954.5	2846.0	15.5	0.4	1161.5	64.9		2653.2	63.8	344.8	170.9			31.5	4.8	9.8	0.8	71700.5
5	428.6	91.5		46160.5	116.8	277.3	142.0	1177.4		1132.7		826.7	1306.4	9.2	0.3	903.5	50.4			44.5	178.0	119.0			23.1	3.6	5.3	0.4	52997.1
6	392.7	84.1		37463.6	108.0	255.5	134.9	451.7		969.2		507.1	637.6	4.0	0.1	774.4	43.2			7.8	31.5	34.6			17.3	2.8	1.3	0.4	41921.9
7	215.7	58.1		20081.2	76.6	22.2	85.2	252.3		417.7		178.8	205.5	1.9	0.1	258.2	14.4			3.8	14.1	27.6			12.5	4.6	0.7	364.9	22295.8
8	148.7	46.8		20062.5	60.6	109.0	85.2	185.7		149.2		343.4	205.7	1.2	0.0					0.7	3.9	12.8			3.1	2.6	0.3	0.3	21421.6
9	103.4	29.1		13994.0	37.2	51.9	35.5	87.8		742.6		98.5	0.1							0.3	2.1	7.9			4.4	2.5	0.2	0.3	15197.8
10	36.2	25.9		8486.4	34.3	9.9		6.0		50.1		197.0	0.2							0.1	0.6	3.4			1.0	1.6	0.1	0.2	8852.9
11	17.1	10.5		5054.5	13.1	3.8	7.1	29.7		59.9										0.0	0.3	1.6				0.9	0.0	0.1	5198.8
12	14.9	5.6		2960.7	7.3	2.1		29.7		54.0		98.5	0.1								0.1	0.4				0.9	0.0	0.1	3174.3
13	7.2	0.2		1021.6						23.1											0.1	0.3				0.4	0.0	0.1	1052.8
14	5.8	0.1		688.2				14.8													0.0	0.1				0.1		0.0	709.1
15	1.9	10.7		1525.2	14.6	4.2				59.7		2.4										0.1							1618.8
SOP	1434.4	308.1		156012.1	430.3	1787.8	400.0	6312.0		2515.7		2817.4	5003.7	35.6	1.0	6664.3	372.1		10888.0	94.4	389.3	343.6			319.4	74.5	1048.3	253.3	197514.4
Catch	1437.00	308.00		155126.99	430.31	1786.72	400.00	6306.30		2516.00		2817.27		35.61	1.10	6662.80			10615.35	94.22	388.85	388.86			319.44	74.51	1048.82	253.27	191011.41
SOP%	100%	100%	0%	99%	100%	100%	100%	100%	0%	100%	0%	100%	0%	100%	109%	100%	0%	0%	97%	100%	100%	113%	0%	0%	100%	100%	100%	100%	97%

Table 2.4.1.2 Percentage catch numbers-at-age for NE Atlantic mackerel

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	VIa	Vb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	xa-Central nort	Ixa-Central south	north-Ixa	south-Ixa	Total
0				0%	0%		0%			0%						8%	0%		0%	0%		9%			10%	1%	76%	0%	4%
1	0%	0%	1%	8%	14%	65%	11%		33%	0%	0%	11%	21%	33%	47%	70%	3%	0%	48%	4%	1%	10%	2%	0%	64%	51%	4%	64%	11%
2	2%	2%	3%	3%	3%	9%	2%	1%	19%	2%	5%	18%	12%	17%	12%	1%	1%	0%	16%	3%	6%	15%	1%	0%	15%	22%	3%	15%	4%
3	20%	13%	15%	17%	12%	12%	24%	10%	19%	17%	18%	29%	26%	30%	21%	7%	17%	28%	18%	8%	12%	29%	1%	28%	2%	5%	5%	3%	18%
4	24%	20%	20%	18%	18%	5%	18%	19%	13%	28%	36%	13%	20%	9%	9%	4%	19%	22%	6%	15%	16%	19%	1%	22%	1%	4%	4%	2%	17%
5	16%	18%	18%	14%	15%	3%	12%	18%	9%	13%	13%	11%	12%	6%	7%	3%	15%	13%	2%	20%	20%	12%	15%	13%	1%	4%	4%	2%	13%
6	14%	18%	17%	14%	15%	3%	11%	18%	4%	13%	11%	7%	4%	2%	2%	3%	16%	15%	2%	14%	13%	2%	19%	15%	1%	4%	1%	2%	12%
7	9%	11%	12%	8%	9%	0%	7%	12%	2%	9%	5%	2%	3%	2%	2%	2%	10%	3%	4%	15%	14%	2%	1%	3%	0%	5%	1%	12%	7%
8	6%	7%	6%	6%	5%	1%	7%	12%	1%	5%	2%	4%	1%	0%	0%	1%	9%	6%	2%	9%	8%	1%	19%	6%	0%	2%	0%	0%	6%
9	5%	5%	4%	5%	4%	1%	3%	8%		7%	8%	1%	0%	0%	0%	1%	4%	3%	1%	6%	6%	1%	11%	3%	0%	1%	0%	0%	4%
10	1%	3%	3%	3%	3%	0%	2%	2%		3%	1%	2%	0%	0%	0%	0%	4%	3%	0%	3%	3%	0%	29%	3%	5%	0%	0%	0%	2%
11	1%	2%	1%	1%	1%	0%	1%	0%		1%	1%	0%		0%	0%	0%	1%	1%	0%	1%	1%	0%	0%	1%	0%	0%	0%	0%	1%
12	1%	1%	1%	1%	0%	0%	1%	1%		1%	1%	1%	0%			0%	1%	2%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	1%
13	0%	0%		0%	0%		0%	1%		1%	0%	0%				0%	0%	1%		1%	0%	0%		1%	0%	0%	0%	0%	0%
14	0%	0%		0%	0%		0%	0%		0%							1%	1%		0%	0%	0%		1%	0%	0%	0%	0%	0%
15	0%	1%	1%	0%	1%	0%	1%	0%		1%	1%	0%				0%	1%	2%	0%	0%	0%	0%	0%	2%			0%		0%

Table 2.4.2.1. Percentage length compositon in catches by country and gear in 2002. Zeros represent values <1%.

Length	Portugal	Spain			Netherlands	Ireland	Norway	Scotland	England			Russia	Denmark	Germany
		seine	trawl	artisanal	pel. trawl	pel. trawl	purse seine	pel. Trawl	lines	otter trawl	pel. trawl	pel trawl	pel trawl	all gears
5														
6														
7														0
8														1
9														0
10														0
11														0
12														0
13														
14														
15			0											
16	0													
17	0	4	0	0	0									0
18	0	19	0	0	1									0
19	1	19	0	0	1	0								0
20	7	15	1	0	0	0								0
21	7	8	1	0	0	0		0						0
22	6	3	0	0	0	0		1			0			0
23	3	1	0	0	0	0		1	1		0		0	0
24	2	1	0		3	0		1	1		0		0	1
25	1	2	0	0	9	1	0	0	3		2			2
26	3	1	0		5	1	0	0	3		3	0		3
27	8	1	0	0	5	1	0	0	3		5	0		4
28	10	1	1	0	3	2	1	1	6	3	8	0		4
29	9	0	5	1	2	3	1	3	10	11	12	0		4
30	6	1	13	1	3	4	1	5	15	27	12	1	0	6
31	5	1	17	1	6	5	1	7	16	16	11	2	1	7
32	4	2	17	3	6	8	2	9	12	14	11	5	1	8
33	3	2	11	5	7	10	4	10	13	12	10	9	4	8
34	2	1	9	6	7	11	7	10	8	12	10	13	6	8
35	2	2	7	9	7	11	10	10	4	5	6	14	9	8
36	1	2	5	12	6	10	12	10	2	1	3	13	12	8
37	1	2	4	15	6	9	13	9	1		3	12	13	7
38	6	3	3	14	6	7	14	8	1	1	2	10	16	6
39	0	3	2	13	6	5	12	6	0		1	8	12	5
40	0	3	2	11	4	4	10	4	0		0	6	10	3
41	10	2	1	5	3	3	6	3	0		0	4	8	2
42	0	1	0	3	2	1	4	1	0		0	2	4	1
43	0	0	0	1	1	1	2	1	0		0	1	2	0
44	0	0	0	0	0	0	1	0				0	0	0
45	0	0	0	0	0	0	0	0				0	0	0
46		0		0		0	0		0				0	0
47		0		0	0	0	0					0	0	0
48		0	0	0		0	0							
49		0		0										
50												0		
51														
52														
53														
54														
55														
56														
57														
58														
59														
60														
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 2.4.3.1 Mean Length (cm) at age by area for NE Atlantic mackerel

Quarters 1-4

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
				24.4	24.5			22.0		24.0						19.2	19.2		22.5	20.6		19.5			21.3	24.8	19.7	25.3	19.7
1	31.0	30.0	31.0	29.8	29.0	28.3		24.3	27.5	25.9	28.5	28.4	28.1	26.3	25.3	26.2	26.3	28.5	27.4	26.3	26.5	25.9	22.6	28.5	24.2	28.5	24.1	28.3	27.3
2	32.2	32.1	33.8	32.3	32.4	32.3	31.5	31.3	30.8	30.5	30.7	33.1	32.0	30.4	29.5	31.3	30.7	28.5	31.4	30.9	30.9	31.1	29.0	28.5	31.1	31.1	30.4	31.3	31.6
3	33.9	34.3	35.6	34.1	34.3	34.6	33.4	32.0	32.2	32.3	32.6	34.4	32.5	31.9	31.3	32.3	32.2	31.8	32.2	33.3	32.6	31.9	31.3	31.8	33.6	33.9	31.9	33.8	33.1
4	34.9	35.7	37.2	35.7	35.8	36.2	34.9	33.6	34.2	34.0	33.7	36.1	35.2	33.8	34.1	33.7	34.0	33.7	34.6	35.5	35.2	33.4	34.1	33.7	34.7	34.9	34.2	34.8	34.9
5	36.1	37.1	38.2	37.1	37.2	37.3	36.5	35.3	34.4	35.8	35.9	36.3	35.0	34.9	34.9	35.1	35.6	35.2	36.4	36.6	36.6	34.3	36.3	35.2	35.5	35.7	35.6	35.7	36.4
6	37.0	33.7	39.2	37.3	34.0	36.4	37.2	36.2	35.8	36.4	35.4	37.3	38.3	35.7	36.1	35.0	37.0	36.1	38.1	38.1	38.1	36.2	38.7	36.1	36.6	36.9	37.1	36.8	37.0
7	38.1	38.9	40.0	38.9	39.0	39.0	38.4	38.0	33.8	37.7	36.8	38.6	34.7	35.7	35.2	38.6	39.0	37.8	38.8	39.1	39.1	37.8	39.6	37.8	37.8	38.1	38.0	38.4	38.6
8	39.0	39.7	40.6	39.3	39.9	38.8	39.5	38.2	34.9	38.7	39.1	39.9	32.5	34.1	34.2	39.8	39.1	37.5	40.8	40.0	39.9	39.8	40.1	37.5	38.7	39.0	38.7	39.0	39.1
9	40.1	40.6	41.1	40.2	40.6	38.2	40.2	39.8	35.5	38.9	37.8	43.5	37.5	36.4	37.5	40.4	39.8	38.1	40.7	41.1	40.8	40.7	41.5	38.1	39.9	40.1	39.4	39.6	40.0
10	41.1	41.0	41.3	40.8	41.1	41.5	40.7	39.9		39.5	40.5	39.8	37.5	37.3	37.5	40.5	40.1	37.9	41.3	41.2	41.1	41.4	41.6	37.9	41.5	40.9	40.1	41.3	40.5
11	41.0	42.4	42.2	41.2	42.4	41.7	40.8	41.1		38.7	39.5	40.5		38.6	38.6	42.0	39.2	38.6	42.2	41.7	41.4	41.4	42.2	38.6	41.7	41.9	39.6	42.3	41.0
12	41.8	41.9	41.8	41.5	41.8	41.9	40.7	41.2		40.8	41.9	44.5	44.5			40.5	40.2	40.4	42.5	43.5	43.8	42.7	42.5	40.4	42.5	42.9	41.4	43.5	41.5
13	43.0	43.0		42.4	42.7		42.1	41.5		41.9	42.5	43.5				43.5	40.5	40.2		43.2	43.6	42.0		40.2	43.5	43.8	41.1	44.5	42.2
14	41.7	42.2		41.7	41.5		41.2	42.5		41.9							41.9	37.5		44.2	45.7	44.0		37.5	44.5	45.5	43.8	45.5	42.0
15	43.3	42.5	42.5	43.0	42.5	42.9	42.3	43.5		40.8	39.9	44.5	44.5			44.5	42.8	39.9	41.5	47.2	47.1	45.1	41.5	39.9			45.8		43.0

Quarter 1

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
										24.0																			24.0
1	28.0							23.4	27.3	24.3	28.5				25.3		26.3	28.5		27.7	28.5	28.7		28.5	22.2	28.6	23.8	27.4	23.4
2	31.8	27.5		30.1	27.5	27.5	31.1	31.0	30.3	27.9	30.7	30.6	31.5	31.5	29.5	31.5	30.7	28.5	29.5	30.9	30.9	31.2		28.5	30.9	30.7	31.1	31.3	30.9
3	32.9	31.4		32.3	31.4	31.4	33.6	31.8	31.8	32.2	32.6	32.9	32.2	32.2	31.4	32.2	32.2	31.8	33.2	33.3	32.2	31.9		31.8	33.4	33.5	31.9	33.5	32.0
4	35.1	34.1		34.0	34.1	34.1	35.2	33.6	33.4	34.2	33.7	34.1	34.6	34.6	34.2	34.4	34.0	33.7	35.3	35.8	35.0	33.4		33.7	34.5	34.4	33.9	34.5	33.9
5	36.4	35.9		35.5	35.9	35.9	36.8	35.3	34.1	35.7	35.9	37.6	35.0	35.0	34.9	35.8	35.4	35.2	36.2	36.9	36.5	34.2	36.3	35.2	35.4	35.5	35.4	35.4	35.5
6	37.2	27.1		34.7	27.1	27.1	37.2	36.2	34.8	36.7	35.4	38.5	37.5	37.5	36.2	35.4	36.9	36.1	37.0	38.3	38.2	35.6	38.7	36.1	36.5	36.5	36.9	36.5	36.0
7	38.6	37.6		37.8	37.6	37.6	38.6	38.0	33.9	37.9	36.8	37.0	35.6	35.6	35.2	39.2	38.6	37.8	38.2	39.3	39.2	36.7		37.8	37.5	37.5	37.8	37.5	38.1
8	39.6	38.4		37.6	38.4	38.4	39.6	38.2		38.7	39.1	41.5				39.8	38.7	37.5	41.0	40.1	39.9	39.3	40.1	37.5	38.5	38.5	38.5	38.5	38.4
9	40.8	40.4		39.3	40.4	40.4	40.0	39.8		39.6	37.8		37.5	37.5	37.5	40.4	39.5	38.1		41.2	40.8	40.2	41.5	38.1	39.5	39.5	39.1	39.5	39.8
10	41.0	40.5		39.7	40.5	40.5	39.6	39.9		39.4	40.5	37.5	37.5	37.5	37.5	40.5	39.1	37.9		41.3	41.2	41.3	41.6	37.9	40.5	40.5	39.8		39.9
11	40.1	43.2		40.7	43.2	43.2	40.1	41.0		38.5	39.5	40.5				42.0	39.2	38.6		41.8	41.4	41.1		38.6	41.5	41.5	39.1		40.6
12	41.6			40.7	39.8		39.8	41.2		40.6	41.9					40.5	40.1	40.4	42.5	43.4	43.6	42.0		40.4	42.5	42.5	40.7		41.0
13	41.0			40.9	40.9		40.9	41.4		41.8	42.5	43.5				43.5	40.6	40.2		43.2	44.1	41.6		40.2	43.5	43.5	40.5		41.6
14	42.0			40.7	40.7		40.7	42.5		41.9							42.5	37.5		44.2	46.0	44.0		37.5		45.5	43.5		42.0
15	42.8	41.5		42.2	41.5	41.5	42.3	43.5		41.2	39.9					44.5	40.9	39.9		47.5	47.6	44.9		39.9			44.9		42.8

Table 2.4.3.1 continued.

Quarter 2

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
1	28.0	29.5		29.5	28.7	27.9		28.7		28.5	28.5			25.3	25.3		28.5		22.6	27.0	23.2	25.7	22.6		24.3	27.2	25.2	27.6	25.0
2	31.8	28.0		31.6	30.0	31.7		30.9		30.7	30.7	31.5	31.5	29.4	29.4		29.1		29.0	31.1	31.8	31.1	29.0		31.0	30.9	31.1	30.9	30.8
3	32.9	32.1		34.4	31.8	33.0	33.5	32.6		32.6	32.6	32.2	32.2	31.0	31.0	32.2	32.0		31.3	33.4	34.0	31.9	31.3		33.4	33.5	33.6	33.4	32.6
4	35.1	34.3		35.9	34.2	35.8	34.5	33.9		33.7	33.7	34.6	34.6	33.0	33.0	34.4	34.0		34.1	35.2	35.7	33.5	34.1		34.5	34.5	35.6	34.4	34.3
5	36.4	36.1		37.5	35.9	37.8	36.8	35.5		35.9	35.9	35.0	35.0	34.6	34.6	35.9	36.1		36.6	36.2	36.8	34.6	36.3		35.4	35.4	36.4	35.4	36.2
6	37.2	28.3		37.9	27.3	31.9	37.3	36.9		35.4	35.4	37.5	37.5	34.5	34.5	35.4	37.2		38.6	37.6	38.1	36.9	38.7		36.5	36.5	37.6	36.5	37.1
7	38.6	37.8		39.2	37.6	38.2	38.1	37.5		36.8	36.8	35.6	35.6	34.0	34.0	39.3	39.5		39.6	38.7	39.1	38.6	39.6		37.5	37.5	38.3	37.5	38.8
8	39.6	38.6		39.6	38.5	38.4	39.4	37.7		39.1	39.1					39.8	39.4		40.7	39.5	39.8	40.1	40.1		38.5	38.5	39.0	38.5	39.5
9	40.8	40.4		40.3	40.4	40.4	40.6	37.4		37.8	37.8	37.5	37.5			40.4	40.1		40.7	40.3	40.7	41.0	41.5		39.5	39.5	39.6	39.5	39.7
10	41.0	40.5		40.8	40.6	40.5	40.5	40.2		40.5	40.5	37.5	37.5			40.5	40.6		41.3	40.8	41.0	41.5	41.6		40.5	40.5	40.4	40.5	40.8
11	40.1	43.0		41.3	43.2	43.2		41.3		39.5	39.5					42.0	38.7		42.2	41.2	41.3	41.5	42.2		41.8	41.5	40.2	41.5	41.0
12	41.6	42.0		41.9	41.6			40.2		41.9	41.9					40.5	40.4		42.5	44.1	44.0	42.9	42.5		42.5	42.5	41.8		42.1
13	41.0	43.0		42.9	42.8		42.0	41.5		42.5	42.5					43.5	40.2			43.7	42.7	42.2				43.5	41.4		42.2
14	42.0	42.2		42.1	41.9			42.8									37.5			44.6	44.8	43.9			44.5		43.9		40.9
15	42.8	41.7		43.8	41.5	41.5		42.9		39.9	39.9					44.5	43.4		41.5	46.5	45.8	45.0	41.5				46.1		42.6

Quarter 3

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
				24.5	24.5																	19.4			22.2	24.8	19.3	25.5	19.3
1	31.1	30.0	31.0	29.5	28.8	27.9		29.6	28.1	28.5		27.4	27.3	27.8	27.7		28.5		24.4	23.4	28.0	27.0			29.2	28.8	24.4	28.6	28.3
2	32.2	33.6	33.8	32.1	33.2	31.8	31.6	31.4	31.9	30.7		31.3	30.3	30.5	30.5		30.7		31.5	28.6	30.6	30.6			32.4	32.4	28.6	32.3	31.6
3	33.9	35.3	35.6	34.5	35.0	33.1	33.1	33.0	32.6	32.6		33.2	31.8	31.8	31.8		33.0			30.2	31.2	32.2			34.1	34.3	30.9	34.1	34.2
4	34.9	36.9	37.2	36.1	36.9	36.3	34.3	34.2	35.6	33.7		34.3	33.4	33.1	33.1		34.3			32.9	32.9	33.7			34.9	35.1	33.1	35.0	35.7
5	36.0	38.1	38.2	37.7	38.1	39.3	35.7	36.8	35.0	35.9		34.9	34.1	35.1	34.9		36.3			33.6	34.6	34.4			35.9	35.9	34.2	35.9	37.1
6	37.0	39.0	39.2	38.3	39.1	36.9	36.8	37.8	38.8	35.4		35.7	34.8	35.0	35.0		37.5			35.9	37.5	36.0			36.9	37.1	35.6	37.1	37.9
7	38.1	39.9	40.0	39.4	40.0	38.6	38.1	38.6	33.4	36.8		35.4	33.9	36.4	35.8		39.5			38.0	39.0	37.3			38.1	38.3	36.9	38.3	39.0
8	38.9	40.4	40.6	39.8	40.6	40.6	39.0	38.5	34.9	39.1		40.1		33.8	33.8		39.6			39.2	39.8	39.0			39.5	39.5	38.5	39.5	39.5
9	40.0	40.9	41.1	40.5	41.1	41.1	40.1	40.1	35.5	37.8		43.5		34.5	34.5		40.2			40.3	40.7	39.7			40.5	40.5	39.5		40.3
10	41.1	41.2	41.3	40.9	41.3	41.3	41.5	36.5		40.5		40.0		36.5	36.5		40.9			41.2	41.0	40.7			41.5	41.5	40.9	41.5	41.0
11	41.0	42.0	42.2	41.4	42.2	42.2	40.7			39.5				38.6	38.6		39.5			40.7	41.4	40.7					40.5	42.5	41.3
12	41.8	41.9	41.8	42.0	41.8	41.8	42.0			41.9		44.5					41.9			42.2	43.0	43.1					43.7		42.0
13	43.1	43.0		43.0	42.6		43.0			42.5							42.5			41.5	42.1	42.0					42.7		43.0
14	41.6	42.2		42.2	41.2		41.7														43.9	44.5					44.5		42.1
15	43.9	42.7	42.5	43.7	42.5	42.5				39.9		44.5					43.9				45.7	45.7					45.7		43.7

Table 2.4.3.1 continued.

Quarter 4

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central north	Ixa-Central south	north-Ixa	south-Ixa	Total
				24.4	24.5			22.0								19.2	19.2		22.5	20.6		19.5			21.1	24.8	20.7	24.7	20.4
1	30.2	30.5		29.8	29.6	28.5		29.9		28.5		28.4	28.1	30.3	30.2	26.2	26.2		27.8	27.7	28.0	26.7			29.0	28.0	22.7	29.1	28.3
2	32.5	33.3		32.5	33.2	32.4		32.1		30.7		33.3	32.1	32.0	32.0	31.3	31.3		31.7	30.6	30.6	30.3			32.0	32.1	30.3	31.2	32.2
3	34.0	35.4		34.3	35.5	34.9	35.2	33.4		32.6		34.5	32.6	32.9	32.9	32.3	32.3		32.3	32.9	31.9	32.0			34.2	34.0	31.9	33.8	33.8
4	35.2	36.7		36.1	36.7	36.2	35.4	34.5		33.7		36.5	35.8	34.1	34.1	33.3	33.3		34.3	33.8	33.1	33.7			35.1	35.1	33.4	34.8	35.8
5	36.6	37.8		37.5	37.8	37.2	37.4	35.2		35.9		36.2	35.0	34.5	34.5	34.5	34.5			34.2	33.8	34.7			35.8	35.7	34.1	36.0	37.2
6	37.3	38.8		38.1	38.9	36.6	38.6	36.8		35.4		37.2	39.0	35.6	35.6	34.7	34.7			35.0	35.1	36.8			37.0	37.1	35.4	37.0	37.9
7	38.4	39.4		39.2	39.4	39.4	38.8	38.9		36.8		38.9	32.5	36.9	36.9	36.5	36.5			35.8	36.4	38.2			38.2	38.5	37.8	38.5	39.0
8	38.7	40.5		39.8	40.6	38.8	40.1	38.2		39.1		39.8	32.5	34.9	34.9	32.5				36.8	38.2	39.4			39.5	39.5	39.7	39.5	39.7
9	39.6	40.3		40.3	40.3	38.1	40.0	39.6		37.8		43.5	43.5							36.9	38.9	40.3			40.5	40.5	40.6	40.5	40.2
10	40.6	41.6		41.1	41.6	41.6		36.5		40.5		40.0	40.0							40.6	40.9	40.9			41.5	41.5	41.1	41.5	41.1
11	40.9	41.4		41.2	41.5	41.5	43.2	42.0		39.5										38.7	40.6	41.0				42.5	41.3	42.5	41.2
12	41.9	41.9		41.8	41.9	41.9		42.0		41.9		44.5	44.5							42.9	42.8	43.6				43.5	43.7	43.5	41.9
13	43.1	42.9		42.2	42.6					42.5										43.4	41.9	42.6				44.5	42.8	44.5	42.2
14	41.9	43.7		42.0	41.2			44.5												43.9	44.4	44.5				45.5	44.5	45.5	42.0
15	43.9	42.9		43.0	42.9	42.9				39.9		44.5	44.5							44.5	45.7	45.7					45.7		42.9

Table 2.4.3.2. Mean weight (kg) at age for NEA mackerel.

Table 2.4.3.2. Mean weight (kg) at age for NEA mackerel.

Mean Weight at Age by Area (Kg)

Quarters 1-4

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-Central	north-Ixa	south-Ixa	Total
				0.117	0.113			0.072		0.081						0.038	0.038		0.077	0.063		0.051			0.062	0.106	0.053	0.112	0.052
1	0.258	0.228	0.262	0.223	0.199	0.179		0.111	0.156	0.113	0.147	0.180	0.172	0.132	0.113	0.124	0.124	0.144	0.139	0.129	0.132	0.117	0.087	0.144	0.110	0.174	0.101	0.169	0.159
2	0.341	0.302	0.361	0.298	0.297	0.280	0.321	0.246	0.231	0.186	0.189	0.293	0.267	0.214	0.185	0.253	0.204	0.144	0.232	0.208	0.208	0.208	0.169	0.144	0.226	0.229	0.198	0.233	0.255
3	0.385	0.372	0.438	0.357	0.369	0.349	0.374	0.262	0.268	0.240	0.232	0.330	0.272	0.253	0.226	0.256	0.234	0.218	0.255	0.266	0.246	0.225	0.227	0.218	0.292	0.307	0.228	0.301	0.308
4	0.439	0.414	0.509	0.424	0.417	0.406	0.432	0.304	0.331	0.286	0.258	0.382	0.356	0.302	0.296	0.306	0.286	0.270	0.306	0.326	0.314	0.262	0.278	0.270	0.323	0.343	0.282	0.333	0.369
5	0.497	0.479	0.561	0.481	0.482	0.443	0.479	0.361	0.334	0.349	0.319	0.381	0.337	0.333	0.317	0.343	0.337	0.318	0.335	0.358	0.353	0.286	0.352	0.318	0.349	0.367	0.321	0.360	0.426
6	0.524	0.525	0.601	0.508	0.527	0.439	0.503	0.397	0.388	0.374	0.306	0.426	0.472	0.363	0.357	0.396	0.384	0.352	0.382	0.406	0.401	0.342	0.408	0.352	0.384	0.416	0.364	0.410	0.464
7	0.585	0.570	0.658	0.563	0.573	0.572	0.555	0.462	0.313	0.430	0.347	0.484	0.323	0.361	0.330	0.488	0.467	0.414	0.406	0.442	0.436	0.393	0.423	0.414	0.431	0.469	0.392	0.495	0.514
8	0.615	0.610	0.688	0.589	0.614	0.515	0.595	0.472	0.345	0.476	0.427	0.559	0.279	0.324	0.325	0.504	0.459	0.403	0.484	0.473	0.463	0.459	0.468	0.403	0.456	0.492	0.417	0.491	0.539
9	0.671	0.641	0.717	0.623	0.643	0.509	0.614	0.545	0.367	0.472	0.379	0.715	0.398	0.374	0.397	0.521	0.506	0.430	0.455	0.514	0.495	0.491	0.507	0.430	0.523	0.538	0.439	0.474	0.583
10	0.726	0.665	0.717	0.655	0.663	0.693	0.591	0.549		0.513	0.476	0.458	0.398	0.400	0.398	0.563	0.497	0.420	0.525	0.519	0.510	0.516	0.521	0.420	0.651	0.555	0.465	0.616	0.604
11	0.740	0.721	0.770	0.679	0.725	0.719	0.680	0.595		0.467	0.438	0.720		0.493	0.493	0.600	0.475	0.446	0.499	0.541	0.521	0.516	0.499	0.446	0.551	0.614	0.448	0.672	0.632
12	0.713	0.728	0.729	0.675	0.724	0.719	0.615	0.596		0.565	0.534	0.693	0.693			0.560	0.519	0.526	0.580	0.616	0.623	0.573	0.544	0.526	0.582	0.652	0.516	0.771	0.646
13	0.775	0.813		0.747	0.761		0.669	0.611		0.600	0.558	0.826				0.672	0.533	0.518		0.605	0.621	0.541		0.518	0.626	0.694	0.503	0.835	0.686
14	0.677	0.765		0.690	0.680		0.619	0.662		0.626							0.631	0.412		0.649	0.717	0.627		0.412	0.671	0.806	0.628	0.904	0.673
15	0.753	0.730	0.737	0.762	0.734	0.769	0.681	0.708		0.539	0.439	0.678	0.678			0.762	0.600	0.489	0.510	0.797	0.792	0.683	0.510	0.489			0.761		0.702

Quarter 1

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-Central	north-Ixa	south-Ixa	Total
										0.081																			0.081
1	0.211							0.094	0.150	0.091	0.147				0.112		0.120	0.144		0.147	0.157	0.162		0.144	0.082	0.173	0.092	0.150	0.095
2	0.345	0.150		0.219	0.150	0.150	0.244	0.230	0.217	0.158	0.189	0.219	0.227	0.227	0.184	0.227	0.202	0.144	0.149	0.209	0.204	0.208		0.144	0.219	0.213	0.206	0.227	0.210
3	0.354	0.233		0.270	0.233	0.233	0.368	0.254	0.254	0.244	0.232	0.297	0.247	0.247	0.225	0.229	0.234	0.218	0.234	0.267	0.237	0.223		0.218	0.277	0.278	0.225	0.278	0.251
4	0.408	0.310		0.326	0.310	0.310	0.434	0.302	0.298	0.304	0.258	0.327	0.309	0.309	0.298	0.291	0.287	0.270	0.307	0.335	0.308	0.258		0.270	0.304	0.304	0.273	0.305	0.306
5	0.467	0.387		0.381	0.387	0.387	0.485	0.360	0.325	0.361	0.319	0.435	0.320	0.320	0.317	0.338	0.336	0.318	0.325	0.367	0.350	0.279	0.353	0.318	0.331	0.332	0.313	0.330	0.360
6	0.514	0.447		0.402	0.447	0.447	0.501	0.396	0.346	0.399	0.306	0.489	0.400	0.400	0.361	0.451	0.385	0.352	0.379	0.412	0.403	0.318	0.409	0.352	0.364	0.364	0.356	0.364	0.399
7	0.547	0.457		0.465	0.457	0.457	0.556	0.462	0.314	0.446	0.347	0.455	0.341	0.341	0.331	0.495	0.473	0.414	0.391	0.447	0.438	0.354		0.414	0.395	0.395	0.386	0.395	0.456
8	0.612	0.501		0.460	0.501	0.501	0.609	0.474		0.481	0.427	0.615				0.504	0.466	0.403	0.521	0.478	0.465	0.438	0.468	0.403	0.429	0.429	0.409	0.429	0.474
9	0.622	0.585		0.531	0.585	0.585	0.614	0.547		0.530	0.379		0.398	0.398	0.398	0.521	0.497	0.430		0.519	0.499	0.471	0.509	0.430	0.464	0.464	0.431	0.464	0.532
10	0.674	0.601		0.551	0.601	0.601	0.542	0.550		0.516	0.476	0.518	0.398	0.398	0.398	0.563	0.470	0.420		0.522	0.513	0.507	0.521	0.420	0.502	0.502	0.454		0.538
11	0.639	0.686		0.589	0.686	0.686	0.566	0.595		0.473	0.438	0.720				0.600	0.478	0.446		0.543	0.523	0.503		0.446	0.541	0.541	0.429		0.566
12	0.621			0.589	0.553		0.553	0.596		0.571	0.534					0.560	0.517	0.526	0.593	0.612	0.619	0.537		0.526	0.582	0.582	0.485		0.587
13	0.530			0.604	0.604		0.604	0.611		0.605	0.558	0.826				0.672	0.536	0.518		0.602	0.647	0.520		0.518	0.626	0.626	0.479		0.608
14	0.625			0.591	0.591		0.591	0.661		0.626							0.663	0.412		0.647	0.740	0.621		0.412		0.719	0.602		0.638
15	0.688	0.644		0.676	0.644	0.644	0.681	0.709		0.590	0.439					0.762	0.539	0.489		0.812	0.821	0.663		0.489			0.665		0.677

Table 2.4.3.2 (Cont'd)

Quarter 2

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-Central	north-Ixa	south-Ixa	Total
1	0.211	0.214		0.214	0.193	0.171		0.206		0.147	0.147			0.112	0.112		0.144		0.087	0.136	0.084	0.112	0.087		0.105	0.148	0.106	0.154	0.115
2	0.345	0.168		0.293	0.218	0.252		0.249		0.189	0.189	0.227	0.227	0.182	0.182		0.163		0.169	0.213	0.227	0.206	0.169		0.222	0.219	0.208	0.218	0.216
3	0.354	0.267		0.384	0.255	0.297	0.310	0.284		0.232	0.232	0.247	0.247	0.216	0.216	0.228	0.226		0.227	0.268	0.282	0.224	0.227		0.277	0.278	0.267	0.277	0.254
4	0.408	0.328		0.452	0.318	0.408	0.343	0.312		0.258	0.258	0.309	0.309	0.268	0.268	0.291	0.278		0.278	0.316	0.328	0.263	0.278		0.305	0.305	0.319	0.304	0.289
5	0.467	0.401		0.523	0.389	0.496	0.402	0.355		0.319	0.319	0.320	0.320	0.309	0.309	0.338	0.338		0.342	0.345	0.358	0.292	0.352		0.331	0.332	0.341	0.332	0.345
6	0.514	0.459		0.551	0.447	0.435	0.429	0.400		0.306	0.306	0.400	0.400	0.307	0.307	0.451	0.380		0.384	0.389	0.400	0.360	0.407		0.364	0.364	0.377	0.364	0.380
7	0.547	0.476		0.604	0.458	0.506	0.463	0.419		0.347	0.347	0.341	0.341	0.301	0.301	0.496	0.458		0.423	0.426	0.433	0.415	0.423		0.395	0.395	0.400	0.395	0.431
8	0.612	0.524		0.633	0.503	0.501	0.511	0.426		0.427	0.427					0.504	0.452		0.464	0.456	0.460	0.465	0.468		0.429	0.429	0.425	0.429	0.459
9	0.622	0.594		0.662	0.585	0.585	0.529	0.430		0.379	0.379	0.398	0.398			0.521	0.516		0.455	0.486	0.491	0.497	0.506		0.464	0.464	0.447	0.464	0.466
10	0.674	0.612		0.685	0.598	0.601	0.466	0.528		0.476	0.476	0.398	0.398			0.563	0.508		0.525	0.502	0.505	0.516	0.521		0.502	0.502	0.474	0.502	0.511
11	0.639	0.690		0.712	0.686	0.686		0.582		0.438	0.438					0.600	0.449		0.499	0.522	0.518	0.519	0.499		0.554	0.541	0.468	0.541	0.509
12	0.621	0.733		0.722	0.701			0.534		0.534	0.534					0.560	0.526		0.544	0.642	0.629	0.576	0.544		0.582	0.582	0.530		0.564
13	0.530	0.814		0.807	0.793		0.630	0.593		0.558	0.558					0.672	0.519			0.625	0.572	0.548				0.626	0.511		0.573
14	0.625	0.764		0.753	0.734			0.661									0.412			0.667	0.661	0.620			0.671		0.620		0.543
15	0.688	0.662		0.821	0.645	0.644		0.669		0.439	0.439					0.762	0.616		0.510	0.759	0.708	0.670	0.510				0.723		0.584

Quarter 3

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-Central	north-Ixa	south-Ixa	Total
				0.113	0.113																	0.050			0.071	0.106	0.049	0.116	0.050
1	0.258	0.229	0.262	0.215	0.194	0.171		0.214	0.174	0.147		0.153	0.150	0.161	0.160		0.147		0.102	0.087	0.156	0.150			0.190	0.182	0.108	0.176	0.185
2	0.341	0.355	0.361	0.308	0.327	0.253	0.328	0.264	0.269	0.189		0.243	0.217	0.220	0.220		0.189		0.257	0.162	0.206	0.223			0.274	0.273	0.178	0.271	0.294
3	0.385	0.426	0.438	0.390	0.407	0.301	0.379	0.301	0.285	0.232		0.295	0.254	0.255	0.255		0.253			0.195	0.220	0.264			0.325	0.332	0.231	0.326	0.385
4	0.440	0.497	0.509	0.462	0.492	0.437	0.437	0.334	0.389	0.258		0.325	0.298	0.291	0.292		0.276			0.255	0.268	0.304			0.354	0.362	0.287	0.358	0.453
5	0.498	0.556	0.561	0.536	0.556	0.592	0.496	0.422	0.362	0.319		0.342	0.325	0.356	0.351		0.342			0.274	0.322	0.328			0.389	0.392	0.320	0.391	0.520
6	0.524	0.593	0.601	0.566	0.595	0.447	0.527	0.457	0.509	0.306		0.371	0.346	0.355	0.353		0.385			0.337	0.413	0.382			0.431	0.437	0.368	0.437	0.552
7	0.586	0.649	0.658	0.617	0.654	0.543	0.589	0.487	0.305	0.347		0.366	0.314	0.405	0.382		0.459			0.404	0.464	0.430			0.481	0.491	0.415	0.490	0.605
8	0.616	0.676	0.688	0.645	0.681	0.688	0.623	0.471	0.345	0.427		0.568		0.310	0.310		0.458			0.446	0.494	0.492			0.548	0.548	0.476	0.548	0.632
9	0.674	0.705	0.717	0.674	0.716	0.717	0.681	0.571	0.367	0.379		0.717		0.334	0.334		0.515			0.488	0.528	0.525			0.598	0.598	0.519		0.672
10	0.730	0.711	0.717	0.695	0.698	0.717	0.739	0.414		0.476		0.454		0.406	0.406		0.518			0.519	0.543	0.564			0.652	0.652	0.575	0.652	0.694
11	0.745	0.757	0.770	0.722	0.769	0.770	0.708			0.438				0.493	0.493		0.438			0.500	0.557	0.566					0.559	0.710	0.726
12	0.719	0.731	0.729	0.733	0.729	0.729	0.700			0.534		0.693					0.534			0.556	0.649	0.684					0.714		0.731
13	0.784	0.814		0.814	0.729		0.770			0.558							0.558			0.529	0.598	0.630					0.667		0.808
14	0.682	0.764		0.764	0.644		0.648														0.676	0.755					0.755		0.748
15	0.837	0.753	0.737	0.820	0.737	0.737				0.439		0.678					0.635				0.825	0.825					0.825		0.799

Table 2.4.3.2 (cont'd)

Quarter 4

Ages	IIa	IIIa	IIIc	IVa	IVb	IVc	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc-east	VIIIc-west	VIIId	VIIIe	Ixa-Central	Ixa-Central	north-Ixa	south-Ixa	Total
				0.117	0.113			0.072								0.038	0.038		0.077	0.063		0.051			0.060	0.105	0.061	0.104	0.058
1	0.244	0.228		0.224	0.211	0.182		0.208		0.147		0.181	0.173	0.220	0.219	0.124	0.124		0.143	0.149	0.165	0.145			0.186	0.163	0.083	0.187	0.176
2	0.332	0.325		0.299	0.307	0.285		0.266		0.189		0.299	0.272	0.267	0.267	0.253	0.253		0.241	0.202	0.213	0.216			0.262	0.266	0.216	0.242	0.274
3	0.384	0.412		0.358	0.418	0.357	0.455	0.303		0.232		0.333	0.284	0.292	0.292	0.261	0.261		0.259	0.253	0.242	0.259			0.329	0.323	0.255	0.314	0.334
4	0.438	0.468		0.430	0.470	0.403	0.463	0.338		0.258		0.392	0.395	0.334	0.335	0.314	0.314		0.311	0.276	0.270	0.306			0.360	0.362	0.297	0.350	0.410
5	0.502	0.520		0.488	0.522	0.435	0.541	0.365		0.319		0.377	0.362	0.341	0.341	0.347	0.347			0.288	0.292	0.338			0.388	0.384	0.318	0.394	0.473
6	0.523	0.566		0.517	0.570	0.438	0.598	0.422		0.306		0.419	0.520	0.385	0.387	0.344	0.344			0.311	0.333	0.410			0.433	0.439	0.363	0.433	0.507
7	0.579	0.607		0.567	0.609	0.609	0.606	0.512		0.347		0.493	0.278	0.435	0.434	0.467	0.467			0.334	0.377	0.464			0.487	0.499	0.451	0.500	0.557
8	0.599	0.651		0.598	0.654	0.514	0.667	0.485		0.427		0.555	0.279	0.355	0.354	0.278				0.364	0.440	0.511			0.548	0.548	0.522	0.548	0.592
9	0.636	0.661		0.627	0.663	0.505	0.660	0.546		0.379		0.717	0.717							0.371	0.465	0.551			0.598	0.598	0.563	0.598	0.614
10	0.688	0.699		0.663	0.700	0.700		0.414		0.476		0.454	0.454							0.500	0.537	0.576			0.652	0.652	0.586	0.652	0.657
11	0.713	0.715		0.670	0.720	0.720	0.820	0.663		0.438										0.430	0.526	0.581				0.710	0.594	0.710	0.667
12	0.724	0.721		0.697	0.719	0.719		0.667		0.534		0.693	0.693							0.589	0.631	0.711				0.771	0.716	0.771	0.695
13	0.807	0.791		0.718	0.729					0.558										0.614	0.575	0.661				0.835	0.671	0.835	0.715
14	0.720	0.785		0.688	0.644			0.810												0.634	0.750	0.755				0.904	0.755	0.904	0.691
15	0.834	0.774		0.766	0.773	0.773				0.439		0.678	0.678							0.660	0.825	0.825					0.825		0.754

Table 2.5.1.1 **Countries, vessels, areas assigned, dates and sampling periods for the 2004 survey.**

Country	Vessel	Areas	Dates	Period
Portugal	Capricorn	Cadiz, Portugal and Galicia	6-21 Jan	1
			3-18 Feb	2
			2-24 Mar	3
Spain (IEO)	Cornide de Saavedra	Cantabrian Sea	15 Mar - 5 Apr	3
			9-30 Apr	3/4
Germany	W. Herwig III	Biscay (N), Celtic Sea & NW Ireland	16 Mar - 23 Apr	3/4
Netherlands	Tridens	Biscay and Celtic Sea	10 – 27 May	5
			8 – 28 June	6
Spain (AZTI)	Investigador	Cantabrian Sea & Biscay	20 Mar - 10 Apr	3
			15-31 May	5
UK (CEFAS)	CEFAS Endeavour	N. Biscay and Celtic Sea	22 Apr - 19 May	4/5
Norway	GO Sars	North west Ireland & West of Scotland	23 May - 15 June	5
Ireland	Celtic Explorer	Celtic Sea	13 Apr - 3 May	4
	Celtic Voyager	Biscay, Celtic Sea, North west Ireland & West of Scotland	6-20 July	7
Scotland	Scotia	North west Ireland & West of Scotland	6 –26 Apr	4
		Celtic Sea, North west Ireland & West of Scotland	15 Jun - 5 July	6

Table 2.5.3.1 Summary statistics for weights and lengths from the 1995 and 1998 fecundity samples.

	Length 1995	Length 1998	Weight 1995	Weight 1998
N	93	97	93	97
Mean	36.0	36.6	359	382
Standard Deviation	2.8	4.2	109	151
Standard Error	0.3	0.4	11	15
95% CI on the mean	0.6	0.8	22	30

Table 2.6.1 SOUTHERN MACKEREL. Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Av. HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) (Nº fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Nº fishing trips)	VIGO (Subdiv.IXa North) (Nº fishing trips)	(Subdiv.IXa CN,CS &S) (Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	12568	33999	-	-	20	-
1984	10815	32427	-	-	700	-
1985	9856	30255	-	-	215	-
1986	10845	26540	-	-	157	-
1987	8309	23122	-	-	92	-
1988	9047	28119	-	-	374	55178
1989	8063	29628	-	605	153	52514
1990	8492	29578	322	509	161	49968
1991	7677	26959	209	724	66	44061
1992	12693	26199	70	698	286	74666
1993	7635	29670	151	1216	-	47822
1994	9620	39590	130	1926	392	38719
1995	6146	41452	217	1696	677	42090
1996	4525	35728	560	2007	777	43633
1997	4699	35211	736	2095	304	42043
1998	5929	-	754	3022	631	86020
1999	6829	30232	739	2602	546	55311
2000	4453	30073	719	1709	413	67112
2001	2385	29923	700	2479	88	74684
2002	2748	21823	1282	2672	541	-

\- Not available

Table 2.6.2 SOUTHERN MACKEREL. CPUE series in commercial fisheries.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Kg/HP*fishing days*10^-2)	LA CORUÑA (Subdiv.VIIIc West) (Kg/Av. HP*fishing days*10^-2)	SANTANDER (Subdiv.VIIIc East) (Kg/Nº fishing trips)	SANTOÑA (Subdiv.VIIIc East) (Kg/Nº fishing trips)	VIGO (Subdiv.IXa North) (t/Nº fishing trips)	(Subdiv.IXa CN,CS &S) (Kg/Fishing hours)
YEAR	ANUAL	ANUAL	MARCH to MAY	MARCH to MAY	ANUAL	ANUAL
1983	14.2	34.2	-	-	1.3	-
1984	24.1	40.1	-	-	5.6	-
1985	17.6	38.1	-	-	4.2	-
1986	41.1	34.2	-	-	5.0	-
1987	13.0	36.5	-	-	2.1	-
1988	15.9	48.0	-	-	3.7	36.4
1989	19.0	43.0	-	1427.5	2.1	26.8
1990	82.7	59.0	739.6	1924.4	2.7	39.2
1991	68.2	54.6	632.9	1394.4	2.0	39.9
1992	35.1	19.7	905.6	856.4	3.9	21.2
1993	12.8	19.2	613.3	1790.9	-	16.9
1994	57.2	41.4	2388.5	1590.6	1.1	20.9
1995	94.9	34.0	3136.1	1987.9	0.3	24.5
1996	124.5	29.1	1165.7	1508.9	0.8	23.8
1997	133.2	35.7	2137.9	1867.8	1.7	18.5
1998	142.1	-	2361.5	2128.0	3.3	15.4
1999	136.4	42.9	2438.0	2084.7	3.6	23.9
2000	311.6	65.1	1795.5	1879.7	3.8	25.7
2001	222.9	61.1	2323.2	2401.0	3.8	26.4
2002	342.5	58.3	2062.3	1871.2	5.0	-

\- Not available

Table 2.6.3. SOUTHERN MACKEREL. CPUE at age from fleets.

VIIIc East handline fleet (Spain:Santoña) (Catch thousands)

		Catch															
Year	Effort	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	age 11	age 12	age 13	age 14	age 15+
1989	605	0	0	3	74	142	299	197	309	441	134	67	27	23	19	7	27
1990	509	0	0	0	17	71	210	465	177	384	378	127	40	51	2	7	5
1991	724	0	0	52	435	785	473	309	323	100	98	150	29	3	7	7	18
1992	698	0	0	35	568	442	477	139	69	77	20	15	17	4	4	0	1
1993	1216	0	0	40	65	1043	621	1487	771	345	339	215	126	59	66	30	52
1994	1926	0	23	168	526	1060	2005	1443	1003	406	360	176	98	54	24	24	9
1995	1696	0	41	83	793	1001	789	1092	998	928	519	339	300	159	83	81	63
1996	2007	0	0	28	401	1234	865	701	1361	802	773	330	288	105	13	28	18
1997	2095	0	7	255	709	3475	2591	894	880	693	471	248	146	98	24	11	11
1998	3022	0	1	100	1580	2017	4456	3461	1496	1015	1006	594	428	443	155	114	296
1999	2602	0	1	230	1435	3151	2900	3697	1956	758	424	317	233	131	75	21	18
2000	1709	0	1	34	619	877	2098	1297	1822	913	282	125	122	62	42	26	9
2001	2479	0	8	208	1230	2978	2859	3030	1654	1477	783	177	196	157	75	74	74
2002	2672	0	4	167	692	1587	2517	1938	2291	1355	990	465	213	64	48	24	11

VIIIc East handline fleet (Spain:Santander) (Catch thousands)

		Catch															
Year	Effort	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	age 11	age 12	age 13	age 14	age 15+
1990	322	0	0	0	6	25	66	132	41	86	83	28	8	11	0	2	2
1991	209	0	0	5	45	96	60	39	43	14	14	23	4	1	1	1	4
1992	70	0	0	4	60	47	51	15	7	8	2	2	2	0	0	0	0
1993	151	0	0	1	2	43	26	63	33	15	15	9	5	3	3	1	2
1994	130	0	2	18	56	110	205	146	101	40	36	18	10	5	2	2	1
1995	217	0	3	33	171	168	144	225	227	222	107	70	56	22	9	11	9
1996	560	0	0	6	89	276	191	152	293	171	164	70	60	22	3	6	4
1997	736	0	0	22	170	963	754	368	472	398	328	170	100	74	18	8	10
1998	754	0	391	86	486	644	1419	1035	403	250	232	127	96	82	19	9	9
1999	739	0	24	211	668	1541	1006	1174	496	183	83	65	44	23	13	4	1
2000	719	0	0	2	110	285	781	534	777	388	133	62	58	35	21	13	3
2001	700	0	133	97	283	857	945	966	438	342	151	35	24	17	8	3	3
2002	1282	0	33	130	518	1254	1912	1194	1063	530	311	130	64	9	11	4	0

VIIIc East trawl fleet (Spain:Aviles) (Catch thousands)

		Catch															
Year	Effort	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8	age 9	age 10	age 11	age 12	age 13	age 14	age 15+
1988	9047	0	333	25	78	126	28	34	31	15	6	1	0	1	2	0	1
1989	8063	0	535	201	66	38	53	17	23	29	7	3	2	2	2	0	4
1990	8492	1834	6690	145	123	147	158	181	21	24	17	6	1	2	3	5	24
1991	7677	95	2419	592	205	108	99	57	55	16	14	26	4	3	2	1	13
1992	12693	236	1495	329	122	65	115	56	38	52	16	19	27	13	4	0	2
1993	7635	3	31	48	8	49	20	37	20	11	13	7	6	9	5	3	9
1994	9620	0	83	317	299	180	302	204	144	56	45	21	12	7	3	4	1
1995	6146	0	9	139	261	168	125	177	156	147	74	50	44	20	10	11	9
1996	4525	0	327	126	274	527	149	81	134	70	63	27	21	8	1	2	3
1997	4699	368	786	934	183	391	167	48	49	43	37	22	14	13	3	2	5
1998	5929	0	537	1442	868	237	341	221	74	34	29	15	10	9	1	0	1
1999	6829	2	601	746	685	730	262	284	117	41	15	10	6	2	2	0	0
2000	4453	1	380	594	1889	629	878	268	297	128	41	16	12	10	4	2	0
2001	2385	0	139	475	573	536	166	131	45	24	10	2	1	1	0	0	0
2002	2748	0	76	371	604	457	486	313	299	162	103	43	25	13	6	4	3

Table 2.6.3. (Cont'd)

VIIIc West trawl fleet (Spain:La Coruña) (Catch thousands)

									Catch								
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	28119	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	29628	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	29578	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	26959	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	26199	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	29670	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39590	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41452	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35728	54	5865	104	562	695	148	77	127	65	59	27	20	8	1	2	2
1997	35211	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6
1998	-	3	6745	2965	2547	641	678	451	144	80	72	49	36	38	13	8	18
1999	30232	4461	444	292	409	512	314	399	220	112	85	74	59	34	20	6	17
2000	30073	40	9283	902	1932	642	781	170	158	79	24	12	11	9	5	4	3
2001	29923	0	184	886	1615	1799	814	648	201	128	48	11	7	9	4	4	7
2002	21823	12	52	993	1900	1263	762	120	69	25	17	7	4	0	1	0	0

IXa trawl fleet (Portugal) (Catch thousands)

									Catch								
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10**	**age 11**	**age 12**	**age 13**	**age 14**	**age 15+**
1988	55178	8076	4510	536	457	76	14	3	0	1	5	0	0	0	0	0	0
1989	52514	6092	6468	1080	572	185	51	15	4	7	4	3	0	0	0	0	0
1990	49968	2840	5729	1967	137	36	11	4	4	0	0	0	0	0	0	0	0
1991	44061	1695	2397	1904	1090	138	85	65	24	3	5	0	0	0	0	0	0
1992	74666	498	2211	1015	664	263	100	45	22	17	10	70	0	0	0	0	0
1993	47822	1010	2365	442	172	155	32	8	5	1	0	1	0	0	0	0	0
1994	38719	650	1128	1447	342	125	94	65	21	4	1	2	0	1	0	0	0
1995	42090	1001	2690	983	295	99	59	46	40	25	17	16	8	5	0	0	1
1996	43633	423	1293	778	490	269	86	88	129	98	109	66	34	17	6	0	1
1997	42043	318	885	1763	181	98	125	95	59	47	20	20	6	10	0	0	0
1998	86020	1873	3950	1265	171	47	39	40	56	23	14	19	51	32	13	0	5
1999	55311	2311	3615	1384	316	94	55	32	13	2	2	1	1	1	0	0	0
2000	67112	2730	6318	1328	424	226	135	71	40	20	9	13	4	11	0	0	0
2001*	74684	3030	5539	1665	382	195	149	65	42	24	3	2	0	0	0	0	0
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(-) Not available

* preliminary

Table 2.7.5.1 Time periods used in the analysis.

Period Number	Description
1,2,3	Early, Mid and Late September
4,5,6	Early, Mid and Late October
7,8,9	Early, Mid and Late November
10,11,12	Early, Mid and Late December
13,14,15	Early, Mid and Late January
16,17,18	Early, Mid and Late February
19,20,21	Early, Mid and Late March
22,23,24	Early, Mid and Late April
25,26,27	Early, Mid and Late May

Table 2.8.1 **NEA Mackerel**. Abundance estimates (ISVPA)

	0	1	2	3	4	5	6	7	8	9	10	11	12
1980	4896	3752	1866	686	1786	1278	951	756	335	982	213	250	467
1981	6190	4174	2969	1335	519	1251	874	671	513	230	690	143	903
1982	2319	5271	3390	2186	957	396	890	596	463	331	157	456	776
1983	1875	1980	4352	2578	1533	673	300	633	411	315	212	108	720
1984	6738	1602	1653	3270	1881	1048	474	229	455	286	223	141	325
1985	3496	5634	1337	1314	2294	1304	699	322	168	321	198	153	554
1986	3495	2958	4644	1096	1042	1630	917	475	224	122	229	136	482
1987	4788	2971	2479	3643	876	805	1127	630	315	156	90	164	403
1988	3627	4101	2502	1984	2660	684	605	784	429	207	107	62	268
1989	4137	3078	3389	1985	1503	1847	502	431	510	269	132	72	185
1990	3468	3513	2572	2640	1505	1122	1286	373	310	342	175	86	145
1991	3755	2959	2904	2018	1937	1104	813	891	273	217	224	120	214
1992	4620	3218	2491	2335	1555	1363	777	573	586	184	143	133	221
1993	5470	3943	2693	2002	1720	1089	898	517	373	368	109	86	203
1994	5170	4681	3283	2138	1485	1140	710	550	306	225	204	59	166
1995	4660	4421	3898	2620	1571	1020	715	442	307	169	121	118	123
1996	5674	3990	3712	3082	1953	1092	690	444	256	169	87	66	110
1997	4841	4851	3335	3024	2352	1410	764	487	276	166	95	52	93
1998	5606	4138	4057	2703	2356	1681	981	526	330	177	104	58	80
1999	7168	4781	3469	3280	2073	1702	1126	652	338	212	107	65	126
2000	2210	6122	4036	2849	2592	1537	1213	769	429	219	137	67	120
2001	13438	1880	5162	3322	2214	1900	1081	841	513	281	143	90	180
2002	15712	11527	1584	4276	2642	1657	1380	754	571	347	184	91	169

Table 2.8.2 **NEA mackerel**. Results of stock assessment by means of ISVPA

Year	Catch	R(0)	B (th.t.)	SSB(th.t.) at sp. Time	F(4-8)
1980	735	4896	3630	2606	0.229
1981	754	6190	3665	2576	0.225
1982	717	2319	3470	2409	0.202
1983	672	1875	3470	2554	0.182
1984	638	6738	3163	2425	0.215
1985	614	3496	3401	2452	0.175
1986	602	3495	3380	2444	0.166
1987	655	4788	3272	2475	0.154
1988	680	3627	3328	2439	0.217
1989	590	4137	3376	2474	0.194
1990	628	3468	3135	2325	0.193
1991	668	3755	3418	2558	0.221
1992	760	4620	3552	2562	0.284
1993	825	5470	3492	2448	0.315
1994	821	5170	3366	2275	0.327
1995	756	4660	3614	2487	0.300
1996	564	5674	3484	2499	0.253
1997	570	4841	3758	2652	0.243
1998	667	5606	3765	2690	0.262
1999	609	7168	4207	3014	0.217
2000	667	2210	4423	3125	0.225
2001	678	13438	4806	3708	0.182
2002	718	15712	5206	3606	0.192

Table 2.8.3 **NEA mackerel.** ISVPA residuals in lnC(a,y) and lnSSB(y)

	0	1	2	3	4	5	6	7	8	9	10	11	12	**AgeSUM**	**Residuals in LnSSB**
1980	-0.467	1.043	0.778	-0.364	0.144	0.101	-0.225	-0.042	-0.295	-0.492	-0.181	0.000	0.000	**0.000**	
1981	-0.148	0.555	0.575	0.265	-0.906	-0.180	0.067	-0.131	0.126	-0.182	-0.043	0.000	0.000	**0.000**	
1982	-0.695	0.160	0.388	0.579	0.303	-0.875	-0.077	0.048	-0.014	0.317	-0.135	0.000	0.000	**0.000**	
1983	-0.811	-0.264	0.667	0.421	0.630	0.249	-0.827	-0.139	-0.021	-0.140	0.235	0.000	0.000	**0.000**	
1984	1.429	-0.608	-0.565	0.487	0.313	0.344	0.149	-0.678	-0.425	-0.210	-0.235	0.000	0.000	**0.000**	
1985	1.017	0.455	-1.580	-0.872	0.442	0.317	0.470	0.206	-0.388	-0.144	0.077	0.000	0.000	**0.000**	
1986	0.570	-0.388	0.231	-1.064	-0.485	0.505	0.474	0.569	0.142	-0.390	-0.164	0.000	0.000	**0.000**	
1987	-1.581	-0.689	-0.064	0.658	-0.538	-0.125	0.503	0.537	0.580	0.384	0.334	0.000	0.000	**0.000**	
1988	0.436	0.011	-0.516	-0.296	0.289	-0.474	-0.219	0.292	0.312	0.263	-0.099	0.000	0.000	**0.000**	
1989	0.531	-0.466	0.102	-0.109	-0.207	0.236	-0.516	-0.250	0.144	0.301	0.235	0.000	0.000	**0.000**	
1990	-0.280	0.189	-0.016	0.293	0.014	-0.098	0.201	-0.413	-0.161	0.292	-0.023	0.000	0.000	**0.000**	
1991	-0.649	-0.050	0.422	0.122	0.323	0.024	-0.127	0.044	-0.154	-0.199	0.245	0.000	0.000	**0.000**	
1992	0.393	0.005	0.050	0.303	-0.019	0.079	-0.111	-0.285	-0.140	-0.086	-0.187	0.000	0.000	**0.000**	**-0.2740**
1993	-0.672	0.142	0.182	0.080	0.195	-0.010	0.150	0.006	-0.122	-0.003	0.054	0.000	0.000	**0.000**	
1994	-0.376	0.078	0.004	0.124	-0.088	0.123	0.030	0.147	0.126	0.040	-0.207	0.000	0.000	**0.000**	
1995	-0.742	-0.384	0.336	0.096	-0.044	-0.171	0.162	0.151	0.261	0.251	0.084	0.000	0.000	**0.000**	**-0.1329**
1996	0.154	0.252	-0.170	0.061	-0.099	-0.142	-0.374	0.122	-0.117	0.256	0.058	0.000	0.000	**0.000**	
1997	0.294	0.277	0.070	-0.221	0.054	-0.035	-0.103	-0.288	0.014	-0.105	0.043	0.000	0.000	**0.000**	
1998	0.610	-0.005	0.016	-0.072	-0.173	0.105	0.010	-0.093	-0.139	-0.054	-0.207	0.000	0.000	**0.000**	**-0.3324**
1999	0.625	-0.281	-0.217	-0.315	-0.133	-0.042	0.138	0.092	0.117	-0.075	0.091	0.000	0.000	**0.000**	
2000	1.157	-0.233	-0.385	-0.029	-0.066	0.008	-0.029	-0.059	0.005	-0.152	-0.218	0.000	0.000	**0.000**	
2001	-0.793	0.201	-0.308	-0.150	0.050	0.063	0.254	0.163	0.150	0.127	0.243	0.000	0.000	**0.000**	**0.2456**
2002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	
YearSUM	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**		

Table 2.8.4 **NEA mackerel.** Retrospective bias and variability in the assessment of NEA mackerel with the Egg Survey used as relative or absolute indices in an ICA assessment. Rho is Bob Mohn's metric for retrospective discrepancies Mohn, R. (1999). Ab is the retrospective bias and Asd is the retrospective variability in assessments (Jonsson, S. T. and E. Hjorleifsson 2000).

	Relative			Absolute		
	SSB	F4-8	Recruits	SSB	F4-9	Recruits
Rho	-0.017	-1.299	0.854	0.681	-1.668	1.275
Ab	0.036	-0.093	0.677	0.078	-0.145	0.755
Asd	0.261	0.239	1.034	0.115	0.101	0.945

Table 2.8.5 **NEA mackerel.** Retrospective bias and variability in the assessment of NEA mackerel with the Egg Survey used as relative or absolute indices in an ICA assessment with Egg Surveys in the terminal year (1995, 1998 and 2001). Rho is Bob Mohn's metric for retrospective discrepancies Mohn, R. (1999). Ab is the retrospective bias and Asd is the retrospective variability in assessments (Jonsson, S. T. and E. Hjorleifsson 2000).

	Relative			Absolute		
	SSB	F4-8	Recruits	SSB	F4-9	Recruits
Rho	0.274	-0.561	-0.818	0.213	-0.518	-1.038
Ab	0.030	-0.049	0.054	0.023	-0.046	0.043
Asd	0.019	0.029	0.176	0.017	0.028	0.178

Table 2.8.6 Input parameters of the final ICA assessments of NEA-Mackerel for the years 1999-2003.

Assessment year	**2003**	**2002**	**2001**	**2000**	**1999**
First data year	1972	1972	1984	1984	1984
Final data year	2002	2001	2000	1999	1998
No of years for separable constraint ?	11	10	9	8	7
Selection pattern model choice	S1 (1992-2002)	S1 (1992-2001)	S1 (1992-2000)	S1 (1992-1999)	S1 (1992-1998)
S to be fixed on last age	1.2	1.2	1.2	1.2	1.2
Reference age for separable constraint	5	5	5	5	5
First age for calculation of reference F	4	4	4	4	4
Last age for calculation of reference F	8	8	8	8	8
Shrink the final populations	No	No	No	No	No
Tuning indices					
SSB from egg surveys Years	1992+1995 +1998+2001	1992+1995 +1998+2001	1992+1995 +1998	1992+1995 +1998	1992+1995 +1998
Abundance index	absolute	absolute	relative: linear	relative: linear	relative: linear
Model weighting					
Relative weights in catch-at-age matrix	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01	all 1, except 0-gr 0.01
Survey indices weighting — Egg surveys	5.0	5.0	5.0	5.0	5.0
Stock recruitment relationship fitted?	No	No	No	No	No
Parameters to be estimated	43	41	40	38	36
Number of observations	136	124	111	99	87

Table 2.9.1.1 North East Atlantic Mackerel. Catch in numbers at age

Output Generated by ICA Version 1.4

Mackerel NE Atlantic WG2003

Catch in Number

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	10.71	17.00	29.28	36.17	62.51	6.08	34.62	114.53	33.10	56.68	11.18	7.33	287.29	81.80	49.98
1	34.98	46.27	108.08	62.91	282.82	175.22	34.51	360.70	411.33	276.23	213.94	47.91	31.90	268.96	58.13
2	51.65	74.54	47.41	92.39	249.29	328.73	560.74	62.91	393.02	502.37	432.87	668.91	86.06	20.89	424.56
3	194.46	109.02	155.39	84.51	374.25	226.56	449.34	609.52	64.55	231.81	472.46	433.74	682.49	58.35	38.39
4	650.98	415.01	148.54	265.13	176.79	236.12	279.24	385.58	328.21	32.81	184.58	373.26	387.58	445.36	76.55
5	0.00	814.52	424.46	164.67	314.26	67.76	282.16	250.75	254.17	184.87	26.54	126.53	251.50	252.22	364.12
6	0.00	0.00	673.32	251.42	133.82	186.62	78.88	248.10	142.98	173.35	138.97	20.18	98.06	165.22	208.02
7	0.00	0.00	0.00	991.63	379.79	105.00	172.21	92.66	145.38	116.33	112.48	90.15	22.09	62.36	126.17
8	0.00	0.00	0.00	0.00	478.93	229.80	73.93	169.60	54.78	125.55	89.67	72.03	61.81	19.56	42.57
9	0.00	0.00	0.00	0.00	0.00	236.97	127.97	73.90	130.77	41.19	88.73	48.67	47.92	47.56	13.53
10	0.00	0.00	0.00	0.00	0.00	0.00	243.33	102.36	39.92	146.19	27.55	49.25	37.48	37.61	32.79
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	204.29	56.21	31.64	91.74	19.75	30.11	26.96	22.97
12+	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	104.93	199.62	156.12	132.04	69.18	97.65	81.15

x 10 ^ 6

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	7.40	57.64	65.40	24.25	10.01	43.45	19.35	25.37	14.76	37.96	36.01	61.13	67.00	36.34	26.03
1	40.13	152.66	64.26	140.53	58.46	83.58	128.14	147.31	81.53	119.85	144.39	99.35	73.52	102.15	40.09
2	156.67	137.63	312.74	209.85	212.52	156.29	210.32	221.49	340.90	168.88	186.48	229.77	131.32	133.59	152.69
3	663.38	190.40	207.69	410.75	206.42	356.21	266.68	306.98	340.21	333.37	238.43	264.57	212.65	254.13	217.27
4	56.68	538.39	167.59	208.15	375.45	266.59	398.24	267.42	275.03	279.18	378.88	323.19	249.96	345.21	274.28
5	89.00	72.91	362.47	156.74	188.62	306.14	244.28	301.35	186.85	177.67	246.78	361.94	267.01	262.17	283.47
6	244.57	87.32	48.70	254.01	129.15	156.07	255.47	184.93	197.86	96.30	135.06	207.62	228.68	215.42	210.89
7	150.59	201.02	58.12	42.55	197.89	113.90	149.93	189.85	142.34	119.83	84.38	118.39	149.11	156.34	176.62
8	85.86	122.50	111.25	49.70	51.08	138.46	97.75	106.11	113.41	55.81	66.50	72.75	81.45	95.29	109.29
9	34.80	55.91	68.24	85.45	43.41	51.21	121.40	80.05	69.19	59.80	39.45	47.35	47.00	46.55	65.17
10	19.66	20.71	32.23	33.04	70.84	36.61	38.79	57.62	42.44	25.80	26.73	24.39	28.50	27.79	37.81
11	25.75	13.18	13.90	16.59	29.74	40.96	29.07	20.41	37.96	18.35	13.95	16.55	15.79	16.75	18.70
12+	63.15	57.49	35.81	27.91	52.99	68.20	68.22	57.55	39.75	30.65	24.97	22.93	30.59	30.09	37.48

Table 2.9.1.1 (Cont'd

Catch in Number

AGE	2002
0	70.38
1	210.27
2	66.73
3	339.90
4	325.64
5	242.70
6	218.54
7	140.80
8	109.47
9	74.17
10	40.08
11	19.79
12+	36.87

x 10 ^ 6

Table 2.9.1.2 North East Atlantic Mackerel. Catch weights at age

Weights at age in the catches (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.05200	0.05000	0.05100	0.05000	0.05900	0.05600	0.03600	0.01600	0.05700	0.06000	0.05300	0.05000	0.03100	0.05500	0.03900
1	0.13500	0.14500	0.13600	0.14800	0.13700	0.13600	0.13500	0.13700	0.13100	0.13200	0.13100	0.16800	0.10200	0.14400	0.14600
2	0.27700	0.19400	0.22900	0.17700	0.20700	0.16900	0.16100	0.16100	0.24900	0.24800	0.24900	0.21900	0.18400	0.26200	0.24500
3	0.34100	0.28500	0.26100	0.25900	0.26300	0.27500	0.25000	0.24300	0.28500	0.28700	0.28500	0.27600	0.29500	0.35700	0.33500
4	0.42300	0.36800	0.33400	0.32300	0.32000	0.33300	0.32500	0.31800	0.34500	0.34400	0.34500	0.31000	0.32600	0.41800	0.42300
5	0.00000	0.44800	0.39200	0.34800	0.34600	0.35200	0.34500	0.34800	0.37800	0.37700	0.37800	0.38600	0.34400	0.41700	0.47100
6	0.00000	0.00000	0.48100	0.43000	0.40600	0.40700	0.40300	0.40100	0.45400	0.45400	0.45400	0.42500	0.43100	0.43600	0.44400
7	0.00000	0.00000	0.00000	0.48800	0.44300	0.44600	0.42100	0.41600	0.49800	0.49900	0.49600	0.43500	0.54200	0.52100	0.45700
8	0.00000	0.00000	0.00000	0.00000	0.51800	0.54600	0.51800	0.50600	0.52000	0.51300	0.51300	0.49800	0.48000	0.55500	0.54300
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.53700	0.53600	0.51300	0.54200	0.54300	0.54100	0.54500	0.56900	0.56400	0.59100
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.52900	0.53700	0.57400	0.57300	0.57400	0.60600	0.62800	0.62900	0.55200
11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.52200	0.59000	0.57600	0.57400	0.60800	0.63600	0.67900	0.69400
12+	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.58000	0.58400	0.58200	0.61400	0.66300	0.71000	0.68800

Table 2.9.1.2 (Cont'd)

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.07600	0.05500	0.04900	0.08500	0.06800	0.05100	0.06100	0.04600	0.07200	0.05800	0.07600	0.06500	0.06200	0.06300	0.06900
1	0.17900	0.13300	0.13600	0.15600	0.15600	0.16700	0.13400	0.13600	0.14300	0.14300	0.14300	0.15700	0.17600	0.13500	0.17100
2	0.22300	0.25900	0.23700	0.23300	0.25300	0.23900	0.24000	0.25500	0.23400	0.22600	0.23000	0.22700	0.23600	0.22900	0.22300
3	0.31800	0.32300	0.32000	0.33600	0.32700	0.33300	0.31700	0.33900	0.33300	0.31300	0.29500	0.31000	0.30700	0.30800	0.30700
4	0.39900	0.38800	0.37700	0.37900	0.39400	0.39700	0.37600	0.39000	0.39000	0.37700	0.35900	0.35400	0.36100	0.36700	0.37800
5	0.47400	0.45600	0.43300	0.42300	0.42300	0.46000	0.43600	0.44800	0.45200	0.42500	0.41500	0.40800	0.40600	0.42900	0.42600
6	0.51200	0.52400	0.45600	0.46700	0.46900	0.49500	0.48300	0.51200	0.50100	0.48400	0.45300	0.45200	0.45400	0.46700	0.47700
7	0.49300	0.55500	0.54300	0.52800	0.50600	0.53200	0.52700	0.54300	0.53900	0.51800	0.48100	0.46200	0.50100	0.50400	0.49900
8	0.49800	0.55500	0.59200	0.55200	0.55400	0.55500	0.54800	0.59000	0.57700	0.55100	0.52400	0.51800	0.53700	0.53700	0.54300
9	0.58000	0.56200	0.57800	0.60600	0.60900	0.59700	0.58300	0.58300	0.59400	0.57600	0.55300	0.55000	0.56900	0.57000	0.58000
10	0.63400	0.61300	0.58100	0.60600	0.63000	0.65100	0.59500	0.62700	0.60600	0.59600	0.57700	0.57300	0.58700	0.58800	0.60800
11	0.63500	0.62400	0.64800	0.59100	0.64900	0.66300	0.64700	0.67800	0.63100	0.60300	0.59100	0.59100	0.60900	0.59700	0.61200
12+	0.71800	0.69700	0.73900	0.71300	0.70800	0.66900	0.67900	0.71300	0.67200	0.67000	0.63600	0.63100	0.68800	0.64900	0.66700

Weights at age in the catches (Kg)

AGE	2002
0	0.05200
1	0.15900
2	0.25500
3	0.30700
4	0.36900
5	0.42600
6	0.46400
7	0.51400
8	0.53900
9	0.58300
10	0.60400
11	0.63200
12+	0.66900

Table 2.9.1.3 North East Atlantic Mackerel. Stock weights at age

Weights at age in the stock (Kg)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00800	0.00000	0.00000	0.00000
1	0.13200	0.13200	0.13000	0.12900	0.12800	0.12700	0.11100	0.11000	0.10900	0.08700	0.08600	0.08600	0.08100	0.08500	0.07700
2	0.17800	0.17700	0.17300	0.17100	0.17000	0.16700	0.17500	0.17400	0.17300	0.18600	0.13500	0.17200	0.19400	0.16500	0.17900
3	0.24300	0.24200	0.23800	0.23600	0.23600	0.23300	0.23800	0.23700	0.23600	0.25200	0.22100	0.23500	0.25300	0.29300	0.26700
4	0.41100	0.30100	0.29600	0.29400	0.29300	0.28900	0.30000	0.29900	0.29700	0.31300	0.28000	0.28000	0.29500	0.30600	0.30400
5	0.00000	0.43800	0.32200	0.31800	0.31800	0.31300	0.34600	0.34500	0.34300	0.32300	0.38500	0.33900	0.32400	0.34100	0.35600
6	0.00000	0.00000	0.46900	0.36500	0.36500	0.36100	0.38200	0.38000	0.37900	0.37800	0.35300	0.37700	0.39300	0.38400	0.35100
7	0.00000	0.00000	0.00000	0.49700	0.41900	0.41600	0.41000	0.40800	0.40700	0.41900	0.40800	0.40400	0.43600	0.43000	0.41600
8	0.00000	0.00000	0.00000	0.00000	0.51200	0.44600	0.43200	0.43000	0.42900	0.43400	0.43700	0.43900	0.44100	0.45900	0.47300
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.53000	0.45100	0.44900	0.44800	0.44900	0.44600	0.50300	0.47900	0.46800	0.44300
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.51400	0.50400	0.50300	0.44300	0.47900	0.47300	0.52000	0.55900	0.46800
11	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.51600	0.50800	0.52300	0.52600	0.55500	0.51000	0.57900	0.49700
12+	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.51800	0.53100	0.53400	0.56300	0.55000	0.60700	0.57500

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.07800	0.07200	0.07600	0.07400	0.07500	0.07800	0.07800	0.07900	0.08100	0.07600	0.07600	0.07700	0.08100	0.07400	0.07800
2	0.14800	0.15600	0.17700	0.13800	0.15500	0.21200	0.19700	0.17800	0.16400	0.13300	0.18600	0.14900	0.19400	0.18500	0.16400
3	0.24000	0.23700	0.24400	0.22200	0.23000	0.25900	0.26800	0.23700	0.26700	0.25100	0.22800	0.22300	0.24200	0.23500	0.24100
4	0.28600	0.30100	0.30600	0.28700	0.30700	0.31000	0.31500	0.30100	0.32600	0.31700	0.29600	0.28500	0.30100	0.28900	0.34200
5	0.37400	0.32900	0.35200	0.33900	0.35700	0.36200	0.36000	0.36100	0.39800	0.36600	0.36100	0.34200	0.35300	0.35000	0.39000
6	0.38600	0.42300	0.38000	0.37300	0.40900	0.40200	0.41600	0.41300	0.44800	0.44400	0.40200	0.40000	0.39600	0.39000	0.44600
7	0.41100	0.44500	0.42900	0.41400	0.43200	0.42400	0.45400	0.46600	0.49100	0.46200	0.44500	0.42600	0.42300	0.42600	0.45900
8	0.42900	0.43200	0.47400	0.40900	0.50200	0.46200	0.46500	0.47000	0.50800	0.50100	0.47800	0.46600	0.44000	0.44700	0.49900
9	0.48200	0.45500	0.45700	0.43700	0.54100	0.48700	0.48400	0.48300	0.54600	0.56500	0.51900	0.50200	0.48500	0.48500	0.52900
10	0.49900	0.52200	0.46600	0.51400	0.56600	0.52200	0.51100	0.55000	0.51400	0.57300	0.53700	0.54900	0.49800	0.49200	0.57600
11	0.47000	0.58900	0.51000	0.52300	0.56600	0.55200	0.58500	0.60800	0.61900	0.61100	0.53200	0.52400	0.46500	0.53200	0.60300
12+	0.54900	0.63200	0.59500	0.52900	0.59400	0.58300	0.57700	0.58400	0.63900	0.63200	0.58500	0.58000	0.56500	0.54400	0.58600

Table 2.9.1.3 (Cont'd)

Weights at age in the stock (Kg)

AGE	2002
0	0.00000
1	0.07800
2	0.18100
3	0.23900
4	0.31100
5	0.36400
6	0.41100
7	0.43600
8	0.46200
9	0.50000
10	0.52200
11	0.53300
12+	0.56500

Table 2.9.1.4 North East Atlantic Mackerel. Natural mortality at age

Natural Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12+	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

Table 2.9.1.4 (Cont'd)

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
1	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
2	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
3	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
4	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
5	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
6	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
7	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
8	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
9	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
10	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
11	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000
12+	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000	0.15000

Natural Mortality (per year)

AGE	2002
0	0.15000
1	0.15000
2	0.15000
3	0.15000
4	0.15000
5	0.15000
6	0.15000
7	0.15000
8	0.15000
9	0.15000
10	0.15000
11	0.15000
12+	0.15000

Table 2.9.1.5 North East Atlantic Mackerel. Proportion of fish spawning

Proportion of fish spawning

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0500	0.0500	0.0500	0.0600	0.0600	0.0600	0.0600	0.0600	0.0600	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700
2	0.5300	0.5400	0.5400	0.5500	0.5500	0.5500	0.5600	0.5600	0.5700	0.5700	0.5700	0.5800	0.5800	0.5800	0.5800
3	0.9000	0.9000	0.9000	0.8900	0.8900	0.8900	0.8900	0.8900	0.8900	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800
4	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9700	0.9700	0.9700
5	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9800	0.9700	0.9700	0.9700
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12+	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700	0.0700
2	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5800	0.5900
3	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8800	0.8600	0.8600	0.8600	0.8800
4	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9800	0.9800	0.9800	0.9700
5	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9700	0.9800	0.9800	0.9800	0.9700
6	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12+	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.9.1.5 (cont'd)

Proportion of fish spawning

AGE	2002
0	0.0000
1	0.0700
2	0.5900
3	0.8800
4	0.9700
5	0.9700
6	0.9900
7	1.0000
8	1.0000
9	1.0000
10	1.0000
11	1.0000
12+	1.0000

Table 2.9.1.6 North East Atlantic Mackerel. Biomass estimates from egg surveys

INDICES OF SPAWNING BIOMASS

INDEX1

x 10 ^ 3

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	*******	*******	*******	3370.0	*******	*******	2840.0	*******	*******	3750.0	*******	*******	2900.0

INDEX1

	2002
1	*******

Table 2.9.1.7 North East Atlantic Mackerel. Fishing mortality at age

Fishing Mortality (per year)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	0.00515	0.00369	0.00752	0.00768	0.01324	0.00621	0.01124	0.02299	0.00620	0.00814	0.00555	0.00468	0.04154	0.02542	0.01501
1	0.00666	0.02627	0.02768	0.01902	0.07251	0.04436	0.04196	0.14679	0.10198	0.06210	0.03649	0.02809	0.02400	0.04723	0.02148
2	0.02526	0.01668	0.03220	0.02827	0.09248	0.10705	0.18433	0.09506	0.22311	0.16514	0.12393	0.14480	0.06126	0.01866	0.09283
3	0.04961	0.06474	0.04158	0.07014	0.14476	0.10791	0.19753	0.29474	0.12652	0.18797	0.21824	0.16666	0.20403	0.05105	0.04102
4	0.08833	0.13465	0.11186	0.08786	0.19399	0.12128	0.17796	0.24538	0.24155	0.08306	0.21227	0.25331	0.20847	0.18830	0.08317
5	0.00000	0.14404	0.18773	0.16527	0.13513	0.10031	0.19705	0.22701	0.23954	0.19711	0.08489	0.20869	0.25576	0.19272	0.21907
6	0.00000	0.16290	0.16107	0.15336	0.18589	0.10521	0.15386	0.25148	0.18502	0.24140	0.21104	0.08148	0.23432	0.25161	0.22763
7	0.00000	0.18662	0.24322	0.35429	0.34278	0.20603	0.12660	0.25710	0.21661	0.21326	0.23048	0.19495	0.11420	0.21708	0.29264
8	0.00000	0.18900	0.24633	0.21685	0.27288	0.33890	0.20722	0.16765	0.22496	0.27770	0.23930	0.21431	0.18812	0.13292	0.21355
9	0.00000	0.20103	0.26201	0.23066	0.18859	0.19909	0.30262	0.31067	0.17850	0.24886	0.30480	0.18704	0.20429	0.20455	0.12135
10	0.00000	0.18120	0.23616	0.20790	0.16999	0.12618	0.30446	0.39755	0.25982	0.29231	0.24797	0.26130	0.20334	0.23140	0.20065
11	0.00000	0.17285	0.22528	0.19832	0.16216	0.12037	0.23646	0.42561	0.37331	0.31884	0.28446	0.26692	0.23842	0.20883	0.20436
12+	0.00000	0.17285	0.22528	0.19832	0.16216	0.12037	0.23646	0.42561	0.37331	0.31884	0.28446	0.26692	0.23842	0.20883	0.20436

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.00151	0.01669	0.01556	0.00758	0.00275	0.00753	0.00942	0.00940	0.00910	0.00683	0.00637	0.00685	0.00614	0.00628	0.00642
1	0.01421	0.03682	0.02204	0.03992	0.02153	0.02852	0.03566	0.03558	0.03444	0.02585	0.02413	0.02593	0.02325	0.02377	0.02432
2	0.07038	0.05868	0.09344	0.08825	0.07422	0.06314	0.07893	0.07876	0.07624	0.05722	0.05340	0.05740	0.05146	0.05261	0.05382
3	0.19403	0.10860	0.11193	0.16173	0.11139	0.12458	0.15574	0.15541	0.15043	0.11290	0.10537	0.11325	0.10153	0.10381	0.10620
4	0.07451	0.22544	0.12476	0.14832	0.20619	0.19045	0.23809	0.23758	0.22996	0.17259	0.16108	0.17313	0.15521	0.15870	0.16235
5	0.12454	0.12279	0.22041	0.15587	0.18423	0.21662	0.27080	0.27022	0.26156	0.19631	0.18322	0.19692	0.17654	0.18051	0.18466
6	0.21214	0.16382	0.10691	0.22410	0.17606	0.24498	0.30626	0.30561	0.29581	0.22201	0.20721	0.22271	0.19966	0.20414	0.20884
7	0.24201	0.25561	0.14811	0.12163	0.25782	0.28064	0.35084	0.35009	0.33887	0.25433	0.23737	0.25512	0.22872	0.23386	0.23924
8	0.31296	0.29920	0.20749	0.17265	0.19870	0.28423	0.35533	0.35457	0.34320	0.25758	0.24040	0.25838	0.23164	0.23685	0.24230
9	0.25613	0.32569	0.25601	0.23030	0.21216	0.30232	0.37795	0.37714	0.36505	0.27398	0.25571	0.27483	0.24639	0.25193	0.25773
10	0.24515	0.22558	0.29827	0.17947	0.28672	0.27250	0.34066	0.33993	0.32903	0.24695	0.23048	0.24772	0.22208	0.22707	0.23230
11	0.22648	0.24382	0.21989	0.23317	0.23000	0.25994	0.32496	0.32427	0.31387	0.23557	0.21986	0.23631	0.21185	0.21661	0.22160
12+	0.22648	0.24382	0.21989	0.23317	0.23000	0.25994	0.32496	0.32427	0.31387	0.23557	0.21986	0.23631	0.21185	0.21661	0.22160

Table 2.9.1.7 (cont'd)

Fishing Mortality (per year)

AGE	2002
0	0.00633
1	0.02395
2	0.05301
3	0.10461
4	0.15991
5	0.18189
6	0.20570
7	0.23565
8	0.23866
9	0.25385
10	0.22881
11	0.21827
12+	0.21827

Table 2.9.1.8 North East Atlantic Mackerel. Population numbers at age

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	2243.	4969.	4208.	5093.	5117.	1057.	3337.	5424.	5771.	7529.	2176.	1690.	7599.	3509.	3612.
1	5674.	1921.	4261.	3595.	4350.	4347.	904.	2840.	4563.	4937.	6427.	1862.	1448.	6274.	2944.
2	2229.	4852.	1611.	3567.	3036.	3482.	3579.	746.	2111.	3546.	3993.	5334.	1558.	1217.	5151.
3	4324.	1871.	4107.	1342.	2985.	2382.	2693.	2562.	584.	1453.	2588.	3036.	3972.	1262.	1028.
4	8283.	3542.	1509.	3391.	1077.	2223.	1840.	1902.	1642.	443.	1037.	1791.	2212.	2788.	1032.
5	0.	6527.	2664.	1162.	2673.	764.	1695.	1326.	1281.	1110.	351.	722.	1196.	1546.	1988.
6	0.	0.	4864.	1901.	848.	2010.	594.	1198.	909.	868.	785.	277.	504.	797.	1097.
7	0.	0.	0.	3564.	1403.	606.	1557.	439.	802.	651.	587.	547.	220.	343.	534.
8	0.	0.	0.	0.	2152.	857.	424.	1181.	292.	556.	452.	401.	387.	169.	238.
9	0.	0.	0.	0.	0.	1410.	526.	297.	859.	201.	362.	307.	279.	276.	127.
10	0.	0.	0.	0.	0.	0.	995.	334.	187.	619.	135.	230.	219.	195.	194.
11	0.	0.	0.	0.	0.	0.	0.	631.	193.	124.	398.	90.	152.	154.	133.
12+	0.	0.	0.	0.	0.	0.	0.	0.	361.	784.	677.	605.	350.	557.	472.

x 10 ^ 6

Table 2.9.1.8 (cont'd)

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	5289.	3750.	4561.	3458.	3924.	4828.	5916.	4814.	4987.	5588.	4385.	4132.	5184.	2026.	11081.
1	3062.	4545.	3174.	3865.	2954.	3368.	4125.	5045.	4105.	4254.	4777.	3750.	3532.	4434.	1733.
2	2480.	2599.	3771.	2672.	3196.	2489.	2817.	3426.	4190.	3413.	3568.	4014.	3145.	2970.	3727.
3	4041.	1990.	2109.	2956.	2106.	2554.	2011.	2241.	2725.	3342.	2775.	2911.	3262.	2571.	2426.
4	849.	2864.	1536.	1623.	2164.	1621.	1941.	1481.	1651.	2018.	2569.	2149.	2237.	2537.	1995.
5	817.	679.	1968.	1167.	1204.	1516.	1154.	1317.	1005.	1129.	1462.	1882.	1556.	1649.	1863.
6	1374.	621.	517.	1359.	860.	862.	1051.	757.	865.	666.	799.	1047.	1331.	1122.	1185.
7	752.	957.	454.	399.	935.	620.	581.	666.	480.	554.	459.	559.	722.	938.	788.
8	343.	508.	638.	337.	304.	622.	403.	352.	404.	295.	370.	312.	373.	494.	639.
9	165.	216.	324.	446.	244.	215.	403.	243.	213.	247.	196.	250.	207.	254.	336.
10	97.	110.	134.	216.	305.	170.	137.	238.	144.	127.	161.	131.	164.	139.	170.
11	136.	65.	76.	86.	155.	197.	111.	84.	146.	89.	85.	110.	88.	113.	96.
12+	335.	285.	195.	144.	277.	320.	264.	223.	158.	157.	136.	117.	172.	166.	203.

x 10 ^ 6

Population Abundance (1 January)

AGE	2002	2003
0	(12019.)	4236.
1	9476.	10279.
2	1455.	7963.
3	3040.	1188.
4	1877.	2357.
5	1460.	1377.
6	1333.	1047.
7	828.	934.
8	534.	563.
9	432.	362.
10	223.	288.
11	116.	153.
12+	202.	220.

x 10 ^ 6

Table 2.9.1.9 North East Atlantic Mackerel. Diagnostic output

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1992	0.2166	7	0.1885	0.2490	0.2018	0.2326	0.2172
2	1993	0.2708	6	0.2361	0.3106	0.2525	0.2904	0.2715
3	1994	0.2702	6	0.2357	0.3098	0.2520	0.2897	0.2709
4	1995	0.2616	7	0.2278	0.3003	0.2437	0.2807	0.2622
5	1996	0.1963	7	0.1705	0.2261	0.1827	0.2110	0.1968
6	1997	0.1832	7	0.1591	0.2110	0.1705	0.1969	0.1837
7	1998	0.1969	7	0.1705	0.2275	0.1830	0.2120	0.1975
8	1999	0.1765	7	0.1522	0.2048	0.1637	0.1904	0.1770
9	2000	0.1805	7	0.1548	0.2105	0.1669	0.1952	0.1811
10	2001	0.1847	8	0.1561	0.2185	0.1695	0.2012	0.1853
11	2002	0.1819	9	0.1500	0.2205	0.1649	0.2007	0.1828
Separable Model: Selection (S) by age								
12	0	0.0348	50	0.0130	0.0930	0.0210	0.0575	0.0394
13	1	0.1317	7	0.1128	0.1537	0.1217	0.1425	0.1321
14	2	0.2915	7	0.2520	0.3371	0.2706	0.3139	0.2923
15	3	0.5751	7	0.5006	0.6606	0.5358	0.6173	0.5765
16	4	0.8792	6	0.7695	1.0045	0.8214	0.9410	0.8812
	5	1.0000	Fixed : Reference Age					
17	6	1.1309	6	0.9975	1.2822	1.0608	1.2057	1.1333
18	7	1.2956	6	1.1484	1.4615	1.2183	1.3777	1.2980
19	8	1.3121	5	1.1684	1.4735	1.2367	1.3921	1.3144
20	9	1.3956	5	1.2462	1.5630	1.3173	1.4786	1.3980
21	10	1.2580	5	1.1185	1.4148	1.1848	1.3357	1.2602
	11	1.2000	Fixed : Last true age					
Separable model: Populations in year 2002								
22	0	12018824	165	465099	310583009	2287140	63158414	47603196
23	1	9476245	19	6420000	13987417	7768911	11558791	9665092
24	2	1455437	14	1087955	1947044	1254621	1688395	1471567
25	3	3039823	11	2410814	3832949	2700714	3421512	3061163
26	4	1877396	10	1532367	2300111	1692620	2082343	1887499
27	5	1459783	9	1213859	1755529	1328650	1603857	1466263
28	6	1332985	8	1123550	1581461	1221663	1454452	1338064
29	7	827575	8	699146	979596	759347	901934	830644
30	8	533679	8	449731	633296	489055	582374	535717
31	9	431612	8	363780	512091	395556	470953	433257
32	10	223199	9	186669	266877	203746	244508	224129
33	11	116125	9	96349	139961	105575	127731	116653
Separable model: Populations at age								
34	1992	197031	16	141564	274231	166448	233234	199854
35	1993	111291	12	86451	143269	97835	126598	112219
36	1994	83669	11	66916	104616	74655	93772	84215
37	1995	145509	10	118345	178909	130949	161688	146320
38	1996	88968	10	72908	108565	80375	98479	89428
39	1997	85382	9	70770	103011	77585	93963	85775
40	1998	110283	9	91848	132418	100456	121071	110764
41	1999	87738	9	73316	104996	80057	96156	88107
42	2000	112754	8	94642	134333	103117	123292	113205
43	2001	95601	9	80045	114179	87320	104667	95994

SSB Index catchabilities
INDEX1
Absolute estimator. No fitted catchability.

Table 2.9.1.9 (cont'd)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.255	-0.979	-0.500	-1.044	0.072	0.331	0.848	0.821	1.127	-0.928	0.000
1	-0.051	-0.046	-0.106	-0.460	0.173	0.311	0.108	-0.025	0.054	0.036	0.009
2	0.099	0.057	-0.085	0.176	-0.044	0.079	0.099	-0.110	-0.057	-0.173	-0.045
3	0.247	-0.012	0.023	-0.040	0.005	-0.079	-0.091	-0.320	0.075	-0.045	0.191
4	0.018	0.039	-0.087	-0.138	-0.064	0.063	0.016	-0.180	-0.003	-0.014	0.232
5	0.108	-0.043	0.037	-0.143	-0.053	0.080	0.145	0.131	0.034	-0.031	0.072
6	-0.112	-0.011	-0.005	-0.042	-0.249	-0.030	0.064	0.020	0.110	0.014	-0.054
7	-0.217	-0.067	0.035	0.101	0.034	-0.069	0.010	0.082	-0.153	0.124	-0.139
8	-0.035	-0.141	0.079	0.036	-0.110	-0.101	0.095	0.127	-0.018	-0.158	0.037
9	-0.020	0.026	0.115	0.132	0.083	-0.043	-0.168	0.109	-0.126	-0.086	-0.195
10	-0.030	0.053	-0.102	0.122	-0.003	-0.146	-0.090	-0.062	0.052	0.140	-0.059
11	-0.026	0.010	-0.057	0.038	0.054	-0.118	-0.267	0.012	-0.200	0.055	-0.069

Table 2.9.1.9 (cont'd)

SPAWNING BIOMASS INDEX RESIDUALS

INDEX1

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******	*******

INDEX1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	*******	*******	*******	0.1594	*******	*******	0.0400	*******	*******	0.2657	*******	*******	-0.1673

INDEX1

	2002
1	*******

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1992 to 2002	
Variance	0.0190
Skewness test stat.	-3.3992
Kurtosis test statistic	3.8419
Partial chi-square	0.1459
Significance in fit	0.0000
Degrees of freedom	89

Table 2.9.1.9 (cont'd)

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR INDEX1

Index used as absolute measure of abundance

Variance	0.1570
Skewness test stat.	0.6673
Kurtosis test statistic	-0.5606
Partial chi-square	0.0421
Significance in fit	0.0002
Number of observations	4
Degrees of freedom	4
Weight in the analysis	5.0000

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	7.7597	136	43	93	0.0834
Catches at age	7.6341	132	43	89	0.0858
SSB Indices					
INDEX1	0.1256	4	0	4	0.0314

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.8288	136	43	93	0.0519
Catches at age	1.6896	132	43	89	0.0190
SSB Indices					
INDEX1	3.1392	4	0	4	0.7848

Table 2.9.1.10 North East Atlantic Mackerel. Stock summary table

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 4- 8	SoP (%)
1972	2243420	5618946	4137315	361204	0.0873	------	99
1973	4969000	5529561	4242519	571011	0.1346	------	100
1974	4207860	5429528	4103425	607632	0.1481	------	100
1975	5093080	5262422	3859914	784070	0.2031	------	99
1976	5117350	4983096	3539099	828239	0.2340	------	99
1977	1056910	4685649	3372999	620276	0.1839	0.1743	100
1978	3336780	4329925	3337159	736832	0.2208	0.1725	100
1979	5424490	3888507	2884318	843227	0.2923	0.2297	100
1980	5771190	3534326	2430235	734951	0.3024	0.2215	100
1981	7528510	3700244	2492482	754438	0.3027	0.2025	100
1982	2175600	3617041	2393484	717267	0.2997	0.1956	100
1983	1690460	3705854	2659113	671588	0.2526	0.1905	99
1984	7598990	3447126	2654157	637606	0.2402	0.2002	99
1985	3508710	3680558	2642568	614371	0.2325	0.1965	100
1986	3611680	3648720	2626595	602200	0.2293	0.2072	99
1987	5289000	3486774	2598311	654991	0.2521	0.1932	99
1988	3749830	3572062	2617938	680492	0.2599	0.2134	100
1989	4560880	3644497	2684291	589509	0.2196	0.1615	100
1990	3458360	3409480	2533449	627511	0.2477	0.1645	100
1991	3923590	3761023	2842339	667886	0.2350	0.2046	98
1992	4828330	3888592	2873492	760351	0.2646	0.2434	99
1993	5916410	3812642	2706936	825036	0.3048	0.3043	100
1994	4813990	3678159	2521890	821395	0.3257	0.3036	100
1995	4987370	3895093	2728648	755776	0.2770	0.2939	99
1996	5588240	3733701	2728807	563612	0.2065	0.2206	100
1997	4385090	3962707	2850721	569613	0.1998	0.2059	99
1998	4132130	3917456	2875096	666682	0.2319	0.2213	100
1999	5183760	4224354	3147483	608930	0.1935	0.1984	100
2000	2025670	4192456	3117099	667159	0.2140	0.2028	100
2001	(11080760)	4400410	3428068	677708	0.1977	0.2075	99
2002	(12018820)	4507873	3147035	717882	0.2281	0.2044	99

No of years for separable analysis : 11
Age range in the analysis : 0 . . . 12
Year range in the analysis : 1972 . . . 2002
Number of indices of SSB : 1
Number of age-structured indices : 0

Parameters to estimate : 43
Number of observations : 136

Conventional single selection vector model to be fitted.

Table 2.10.1 CALCULATION OF INPUTS FOR SHORT-TERM PREDICTIONS FOR NEA MACKEREL

UNIT: millions

Year class	AGE	Stock in numbers at 1st January 2003	
2003	0	4115	<--- GM over period 1972-1999
2002	1	3519	<--- corrected 1-year olds
2001	2	3744	<--- corrected 2-year olds
2000	3	1188	<-- from ICA
1999	4	2357	<-- from ICA
1998	5	1377	<-- from ICA
1997	6	1047	<-- from ICA
1996	7	934	<-- from ICA
1995	8	563	<-- from ICA
1994	9	362	<-- from ICA
1993	10	288	<-- from ICA
1992	11	153	<-- from ICA
	12+	220	<-- from ICA

GM recruitment 1972-1999 (ICA) = 4115

CALCULATION OF RECRUITMENT AT AGE 1	
Numbers at age **1** in 2003	10279
Numberst age **0** in 2002	12019
CORRECTED **1**-YEAR OLDS	3519

(N_age_1_in_2003 / N_age_0_in 2002) x GM recruitment

75percentile recruitment 1972-1999 (ICA) = 5210

CALCULATION OF RECRUITMENT AT AGE 2	
Numbers at age **1** in 2002	9476
Numbers at age **0** in 2001	11081
CORRECTED **1**-YEAR OLDS	4455
Numbers at age **2**	7963
At age **1** one year earlier	9476
CORRECTED **2**-YEAR OLDS	3744

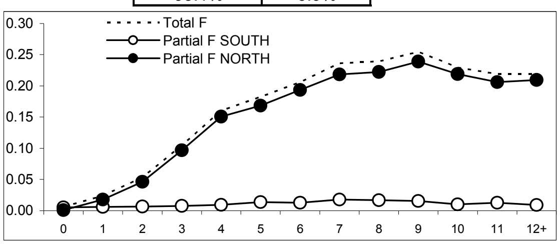
(N_age_1_in_2002 / N_age_0_in 2001)*(N_age_2_in_2003 / N_age_1_in 2002) x 75percentile recr. 1972-1999

Calculation of status quo F and fishery pattern by fleet

AGE	MAC-south catch at age			MAC-northern catch at age			MAC-northern fraction		
	2000	2001	2002	2000	2001	2002	2000	2001	2002
0	29314	21070	65360	7032	4963	5021	0.1935	0.1906	0.0713
1	36657	12369	17098	65496	27725	193169	0.6412	0.6915	0.9187
2	10186	12053	15419	123401	140642	51310	0.9237	0.9211	0.7689
3	20928	14432	24946	233205	202836	314959	0.9176	0.9336	0.9266
4	9629	21560	23726	335582	252717	301912	0.9721	0.9214	0.9271
5	17322	17167	24170	244852	266300	218531	0.9339	0.9394	0.9004
6	8773	17688	13195	206646	193200	205349	0.9593	0.9161	0.9396
7	11973	9577	13859	144366	167046	126946	0.9234	0.9458	0.9016
8	6237	8510	7500	89049	100782	101971	0.9345	0.9221	0.9315
9	2018	4438	5218	44528	60732	68947	0.9566	0.9319	0.9296
10	1076	986	2784	26711	36821	37299	0.9613	0.9739	0.9305
11	1014	1108	1120	15733	17594	18672	0.9394	0.9408	0.9434
12	636	884	302	28694	35333	36057	0.9535	0.9426	0.9779
13	394	444	287						
14	269	411	141						
15+	100	413	83						

Rescaling factor mean over three years: 1.0000

AGE	F's of WG2003 (from ICA)			Mean F(4-8)	AGE	Rescaled	Rescaled fishery pattern partial fishing mortalities		Mean fractions last 3 years	
	2000	2001	2002	2000-2002		F-values	NORTH	SOUTH	NORTH	SOUTH
0	0.00628	0.00642	0.00633	0.00634	0	0.00634	**0.0010**	**0.0054**	0.1518	0.8482
1	0.02377	0.02432	0.02395	0.02401	1	0.02401	**0.0180**	**0.0060**	0.7504	0.2496
2	0.05261	0.05382	0.05301	0.05315	2	0.05315	**0.0463**	**0.0068**	0.8712	0.1288
3	0.10381	0.1062	0.10461	0.10487	3	0.10487	**0.0971**	**0.0078**	0.9259	0.0741
4	0.1587	0.16235	0.15991	0.16032	4	0.16032	**0.1507**	**0.0096**	0.9402	0.0598
5	0.18051	0.18466	0.18189	0.18235	5	0.18235	**0.1686**	**0.0138**	0.9246	0.0754
6	0.20414	0.20884	0.20570	0.20623	6	0.20623	**0.1935**	**0.0127**	0.9383	0.0617
7	0.23386	0.23924	0.23565	0.23625	7	0.23625	**0.2182**	**0.0181**	0.9236	0.0764
8	0.23685	0.2423	0.23866	0.23927	8	0.23927	**0.2224**	**0.0169**	0.9294	0.0706
9	0.25193	0.25773	0.25385	0.25450	9	0.25450	**0.2391**	**0.0154**	0.9394	0.0606
10	0.22707	0.2323	0.22881	0.22939	10	0.22939	**0.2191**	**0.0103**	0.9552	0.0448
11	0.21661	0.2216	0.21827	0.21883	11	0.21883	**0.2060**	**0.0129**	0.9412	0.0588
12+	0.21661	0.2216	0.21827	0.21883	12+	0.21883	**0.2096**	**0.0092**	0.9580	0.0420
	0.2028	**0.2075**	**0.2044**	**0.2049**	Mean F(4-8)	**0.2049**	**0.1907**	**0.0142**		
							93.1%	6.9%		



Proportion of F and M before spawing

F	M
0.4	0.4

Table 2.10.1 (Continued)

AGE	Proportion MATURE		2000	2001	2002
0	0.00		0.00	0.00	0.00
1	0.07	NEA	0.07	0.07	0.07
2	0.59		0.58	0.59	0.59
3	0.87		0.86	0.88	0.88
4	0.98		0.98	0.97	0.97
5	0.98		0.98	0.97	0.97
6	0.99		0.99	0.99	0.99
7	1.00		1.00	1.00	1.00
8	1.00		1.00	1.00	1.00
9	1.00		1.00	1.00	1.00
10	1.00		1.00	1.00	1.00
11	1.00		1.00	1.00	1.00
12+	1.00		1.00	1.00	1.00

AGE	NEA Mean weight at age in the STOCK		2000	2001	2002
0	0.000		0.000	0.000	0.000
1	0.077	NEA	0.074	0.078	0.078
2	0.176		0.185	0.164	0.181
3	0.239		0.235	0.241	0.240
4	0.314		0.289	0.342	0.310
5	0.368		0.350	0.390	0.364
6	0.415		0.390	0.446	0.410
7	0.440		0.426	0.459	0.436
8	0.469		0.447	0.499	0.462
9	0.505		0.485	0.529	0.500
10	0.530		0.492	0.576	0.522
11	0.556		0.532	0.603	0.533
12+	0.565		0.544	0.586	0.565

AGE	NORTHERN Mean weight at age in the CATCH		2000	2001	2002
0	0.058		0.056	0.070	0.048
1	0.161	NORTHERN	0.150	0.171	0.163
2	0.241		0.231	0.224	0.268
3	0.312		0.314	0.310	0.313
4	0.375		0.368	0.383	0.375
5	0.433		0.435	0.429	0.436
6	0.474		0.470	0.483	0.469
7	0.512		0.511	0.502	0.523
8	0.546		0.543	0.549	0.545
9	0.583		0.575	0.586	0.589
10	0.604		0.591	0.611	0.609
11	0.619		0.602	0.616	0.639
12+	0.665		0.653	0.673	0.669

AGE	SOUTHERN Mean weight at age in the CATCH		2000	2001	2002
0	0.062		0.064	0.069	0.053
1	0.136	SOUTHERN	0.110	0.174	0.124
2	0.204		0.196	0.208	0.209
3	0.242		0.233	0.257	0.235
4	0.308		0.311	0.318	0.294
5	0.355		0.348	0.380	0.337
6	0.402		0.408	0.404	0.394
7	0.436		0.429	0.446	0.433
8	0.460		0.447	0.472	0.461
9	0.482		0.459	0.493	0.494
10	0.515		0.509	0.504	0.532
11	0.527		0.516	0.547	0.519
12+	0.581	weighted mean weight!	0.536	0.557	0.621
			0.543	0.564	0.616
			0.571	0.594	0.715
			0.614	0.595	0.791

AGE	NEA Mean weight at age in the CATCH		2000	2001	2002
0	0.061		0.063	0.069	0.052
1	0.155	NEA	0.135	0.171	0.159
2	0.236		0.229	0.223	0.255
3	0.307		0.308	0.307	0.307
4	0.371		0.367	0.378	0.369
5	0.427		0.429	0.426	0.426
6	0.469		0.467	0.477	0.464
7	0.506		0.504	0.499	0.514
8	0.540		0.537	0.543	0.539
9	0.578		0.570	0.580	0.583
10	0.600		0.588	0.608	0.604
11	0.614		0.597	0.612	0.632
12+	0.662		0.649	0.667	0.669

TAC 2003 :	582,509	tonnes (see section 2.1)
Discards 2003:	20,000	tonnes (see section ????)
Assumed CATCH in 2003 :	**603,000**	tonnes

Table 2.10.2 North East Atlantic Mackerel. Multifleet prediction: INPUT DATA

2003

	NORTHERN		SOUTHERN							
Age	**Exploit. pattern**	**Weight in catch**	**Exploit. pattern**	**Weight in catch**	**Stock size**	**Natural mortality**	**Maturity ogive**	**Prop. of F bef. spaw.**	**Prop. of M bef. spaw.**	**Weight in the stock**
0	0.0009	0.058	0.0053	0.062	**4115**	0.15	0.00	0.4	0.4	0.000
1	0.0180	0.161	0.0059	0.136	**3519**	0.15	0.07	0.4	0.4	0.076
2	0.0463	0.241	0.0068	0.204	**3744**	0.15	0.58	0.4	0.4	0.176
3	0.0971	0.312	0.0077	0.241	1188	0.15	0.87	0.4	0.4	0.238
4	0.1507	0.375	0.0096	0.307	2357	0.15	0.97	0.4	0.4	0.314
5	0.1686	0.433	0.0137	0.355	1377	0.15	0.97	0.4	0.4	0.368
6	0.1934	0.474	0.0127	0.402	1047	0.15	0.99	0.4	0.4	0.415
7	0.2182	0.512	0.0180	0.436	934	0.15	1.00	0.4	0.4	0.440
8	0.2223	0.545	0.0169	0.460	563	0.15	1.00	0.4	0.4	0.469
9	0.2390	0.583	0.0154	0.482	362	0.15	1.00	0.4	0.4	0.504
10	0.2191	0.604	0.0102	0.515	288	0.15	1.00	0.4	0.4	0.530
11	0.2059	0.619	0.0128	0.527	153	0.15	1.00	0.4	0.4	0.556
12+	0.2096	0.665	0.0092	0.592	220	0.15	1.00	0.4	0.4	0.565
UNIT:		(kg)		(kg)	(millions)					(kg)

2004

	NORTHERN		SOUTHERN							
Age	**Exploit. pattern**	**Weight in catch**	**Exploit. pattern**	**Weight in catch**	**Recruit-ment**	**Natural mortality**	**Maturity ogive**	**Prop. of F bef. spaw.**	**Prop. of M bef. spaw.**	**Weight in the stock**
0	0.0009	0.058	0.0053	0.062	4115.0	0.15	0.00	0.4	0.4	0.000
1	0.0180	0.161	0.0059	0.136	-	0.15	0.07	0.4	0.4	0.076
2	0.0463	0.241	0.0068	0.204	-	0.15	0.58	0.4	0.4	0.176
3	0.0971	0.312	0.0077	0.241	-	0.15	0.87	0.4	0.4	0.238
4	0.1507	0.375	0.0096	0.307	-	0.15	0.97	0.4	0.4	0.314
5	0.1686	0.433	0.0137	0.355	-	0.15	0.97	0.4	0.4	0.368
6	0.1934	0.474	0.0127	0.402	-	0.15	0.99	0.4	0.4	0.415
7	0.2182	0.512	0.0180	0.436	-	0.15	1.00	0.4	0.4	0.440
8	0.2223	0.545	0.0169	0.460	-	0.15	1.00	0.4	0.4	0.469
9	0.2390	0.583	0.0154	0.482	-	0.15	1.00	0.4	0.4	0.504
10	0.2191	0.604	0.0102	0.515	-	0.15	1.00	0.4	0.4	0.530
11	0.2059	0.619	0.0128	0.527	-	0.15	1.00	0.4	0.4	0.556
12+	0.2096	0.665	0.0092	0.592	-	0.15	1.00	0.4	0.4	0.565
UNIT:		(kg)		(kg)	(millions)					(kg)

2005

	NORTHERN		SOUTHERN							
Age	**Exploit. pattern**	**Weight in catch**	**Exploit. pattern**	**Weight in catch**	**Recruit-ment**	**Natural mortality**	**Maturity ogive**	**Prop. of F bef. spaw.**	**Prop. of M bef. spaw.**	**Weight in the stock**
0	0.0009	0.058	0.0053	0.062	4115.0	0.15	0.00	0.4	0.4	0.000
1	0.0180	0.161	0.0059	0.136	-	0.15	0.07	0.4	0.4	0.076
2	0.0463	0.241	0.0068	0.204	-	0.15	0.58	0.4	0.4	0.176
3	0.0971	0.312	0.0077	0.241	-	0.15	0.87	0.4	0.4	0.238
4	0.1507	0.375	0.0096	0.307	-	0.15	0.97	0.4	0.4	0.314
5	0.1686	0.433	0.0137	0.355	-	0.15	0.97	0.4	0.4	0.368
6	0.1934	0.474	0.0127	0.402	-	0.15	0.99	0.4	0.4	0.415
7	0.2182	0.512	0.0180	0.436	-	0.15	1.00	0.4	0.4	0.440
8	0.2223	0.545	0.0169	0.460	-	0.15	1.00	0.4	0.4	0.469
9	0.2390	0.583	0.0154	0.482	-	0.15	1.00	0.4	0.4	0.504
10	0.2191	0.604	0.0102	0.515	-	0.15	1.00	0.4	0.4	0.530
11	0.2059	0.619	0.0128	0.527	-	0.15	1.00	0.4	0.4	0.556
12+	0.2096	0.665	0.0092	0.592	-	0.15	1.00	0.4	0.4	0.565
UNIT:		(kg)		(kg)	(millions)					(kg)

Table 2.10.3 NORTH EAST ATLANTIC MACKEREL. Two area prediction summary table with Fsq option for 2003

(Data obtained from the MFDP programm)

Fsq=0.20 in 2003 and F=0.15 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9761	0.19	1423	605	0.01	147	41	0.20	1570	646	19867	4117	10671	3519	9464	3091
2004	0.7321	0.14	1068	454	0.01	111	31	0.15	1179	485	19762	4065	10683	3477	9627	3111
2005	0.7321	0.14	1113	473	0.01	111	31	0.15	1224	504	20034	4188	11002	3613	9908	3231
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.20 in 2003 and F=0.17 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9761	0.19	1423	605	0.01	147	41	0.20	1570	646	19867	4117	10671	3519	9464	3091
2004	0.7321	0.16	1201	510	0.01	125	35	0.17	1326	545	19762	4065	10683	3477	9571	3090
2005	0.7321	0.16	1234	523	0.01	123	34	0.17	1357	557	19898	4135	10874	3561	9736	3164
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.20 in 2003 and F=0.18 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9761	0.19	1423	605	0.01	147	41	0.20	1570	646	19867	4117	10671	3519	9464	3091
2004	0.7321	0.17	1267	537	0.01	132	36	0.18	1399	573	19762	4065	10683	3477	9543	3080
2005	0.7321	0.17	1293	547	0.01	130	36	0.18	1423	583	19831	4109	10811	3536	9652	3131
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.20 in 2003 and F=0.19 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9761	0.19	1423	605	0.01	147	41	0.20	1570	646	19867	4117	10671	3519	9464	3091
2004	0.7321	0.18	1332	565	0.01	138	38	0.19	1470	603	19762	4065	10683	3477	9515	3069
2005	0.7321	0.18	1350	571	0.01	136	37	0.19	1486	608	19764	4083	10748	3510	9568	3098
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Fsq=0.20 in 2003 and F=0.20 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9761	0.19	1423	605	0.01	147	41	0.20	1570	646	19867	4117	10671	3519	9464	3091
2004	0.7321	0.19	1397	592	0.01	145	40	0.20	1542	632	19762	4065	10683	3477	9488	3059
2005	0.7321	0.19	1407	593	0.01	142	39	0.20	1549	632	19698	4057	10686	3485	9486	3066
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.10.4 NORTH EAST ATLANTIC MACKEREL. Two area prediction summary table with catch constraint option for 2003.

(Data obtained from the MFDP programm)

Catch constraint of 603 kt in 2003 and F=0.15 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9058	0.1727	1328	565	0.0129	137	38	0.1856	1465	603	19867	4117	10671	3519	9504	3107
2004	0.7321	0.1396	1079	459	0.0104	111	31	0.1500	1190	490	19859	4103	10774	3514	9708	3144
2005	0.7321	0.1396	1122	478	0.0104	111	31	0.1500	1233	509	20106	4219	11074	3644	9971	3258
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 603 kt in 2003 and F=0.17 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9058	0.1727	1328	565	0.0129	137	38	0.1856	1465	603	19867	4117	10671	3519	9504	3107
2004	0.8297	0.1582	1213	516	0.0118	125	35	0.1700	1338	551	19859	4103	10774	3514	9652	3123
2005	0.8297	0.1582	1244	528	0.0118	124	34	0.1700	1368	562	19969	4166	10944	3591	9798	3190
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 603 kt in 2003 and F=0.18 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9058	0.1727	1328	565	0.0129	137	38	0.1856	1465	603	19867	4117	10671	3519	9504	3107
2004	0.8785	0.1675	1280	544	0.0125	132	37	0.1800	1412	581	19859	4103	10774	3514	9623	3112
2005	0.8785	0.1675	1303	552	0.0125	130	36	0.1800	1433	588	19902	4139	10880	3566	9712	3157
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 603 kt in 2003 and F=0.19 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9058	0.1727	1328	565	0.0129	137	38	0.1856	1465	603	19867	4117	10671	3519	9504	3107
2004	0.9273	0.1768	1346	571	0.0132	139	39	0.1900	1485	610	19859	4103	10774	3514	9595	3101
2005	0.9273	0.1768	1361	576	0.0132	137	38	0.1900	1498	614	19834	4113	10817	3540	9628	3124
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Catch constraint of 603 kt in 2003 and Fsq=0.20 in 2004-2005

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		1st of January		Spawning time	
Year	F Factor	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	Stock size	Stock biomass	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
2003	0.9058	0.1727	1328	565	0.0129	137	38	0.1856	1465	603	19867	4117	10671	3519	9504	3107
2004	0.9761	0.1861	1411	599	0.0139	146	41	0.2000	1557	640	19859	4103	10774	3514	9567	3091
2005	0.9761	0.1861	1417	599	0.0139	143	39	0.2000	1560	638	19768	4087	10754	3515	9545	3091
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.10.5 NORTH EAST ATLANTIC MACKEREL. Two area prediction detailed table.

data obtained from MFDP output

Rundate :12/09/2003

Fsq = 0.20 constraint for each fleet in 2003 and F=0.17 (2004-2005)

YEAR 2003 F-factor **0.9761**

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		Spawning time	
Year class	**Age**	**F**	**Catch in numbers**	**Catch in weight**	**F**	**Catch in numbers**	**Catch in weight**	**F**	**Catch in numbers**	**Catch in weight**	**Stock size**	**Stock biomass**	**SP. ST. size**	**SP. ST. biomass**
2003	**0**	0.00	4	0	0.01	20	1	0.01	24	1	4115	0	0	0
2002	**1**	0.02	57	9	0.01	19	3	0.02	76	12	3519	270	230	18
2001	**2**	0.05	153	37	0.01	23	5	0.05	176	42	3744	661	2026	358
2000	**3**	0.09	100	31	0.01	8	2	0.10	108	33	1188	283	938	224
1999	**4**	0.15	299	112	0.01	19	6	0.16	318	118	2357	740	2029	637
1998	**5**	0.16	193	84	0.01	16	6	0.18	209	90	1377	507	1175	433
1997	**6**	0.19	167	79	0.01	11	4	0.20	178	83	1047	435	901	374
1996	**7**	0.21	165	85	0.02	14	6	0.23	179	91	934	411	802	353
1995	**8**	0.22	101	55	0.02	8	4	0.23	109	59	563	264	483	227
1994	**9**	0.23	70	41	0.02	5	2	0.25	75	43	362	183	309	156
1993	**10**	0.21	51	31	0.01	2	1	0.22	53	32	288	153	248	131
1992	**11**	0.20	26	16	0.01	2	1	0.21	28	17	153	85	132	74
1991	**12+**	0.20	38	25	0.01	2	1	0.21	40	26	220	124	190	107
		0.19	1423	605	0.01	147	41	**0.20**	1573	**646**	19867	4117	9464	**3091**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

YEAR 2004 F-factor: **1.0000**

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		Spawning time	
Year class	**Age**	**F**	**Catch in numbers**	**Catch in weight**	**F**	**Catch in numbers**	**Catch in weight**	**F**	**Catch in numbers**	**Catch in weight**	**Stock size**	**Stock biomass**	**SP. ST. size**	**SP. ST. biomass**
2004	**0**	0.00	3	0	0.00	17	1	0.01	20	1	4115	0	0	0
2003	**1**	0.02	48	8	0.01	16	2	0.02	64	10	3520	270	230	18
2002	**2**	0.04	103	25	0.01	15	3	0.04	118	28	2959	523	1606	284
2001	**3**	0.08	219	69	0.01	18	4	0.09	237	73	3060	729	2430	579
2000	**4**	0.13	101	38	0.01	6	2	0.13	107	40	923	290	802	252
1999	**5**	0.14	210	91	0.01	17	6	0.15	227	97	1735	638	1497	551
1998	**6**	0.16	136	65	0.01	9	4	0.17	145	69	992	412	864	359
1997	**7**	0.18	113	58	0.02	9	4	0.20	122	62	737	324	642	283
1996	**8**	0.18	99	54	0.01	8	3	0.20	107	57	638	300	555	261
1995	**9**	0.20	64	37	0.01	4	2	0.21	68	39	384	194	332	168
1994	**10**	0.18	37	23	0.01	2	1	0.19	39	24	243	129	212	112
1993	**11**	0.17	29	18	0.01	2	1	0.18	31	19	198	110	174	96
1992	**12+**	0.17	38	26	0.01	2	1	0.18	40	27	259	147	227	128
		0.16	1201	510	0.01	125	35	**0.17**	1325	**545**	19762	4065	9571	**3090**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

YEAR 2005 F-factor: **1.0000**

		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			1st of January		Spawning time	
Year class	**Age**	**F**	**Catch in numbers**	**Catch in weight**	**F**	**Catch in numbers**	**Catch in weight**	**F**	**Catch in numbers**	**Catch in weight**	**Stock size**	**Stock biomass**	**SP. ST. size**	**SP. ST. biomass**
2005	**0**	0.00	3	0	0.00	17	1	0.01	20	1	4115	0	0	0
2004	**1**	0.02	48	8	0.01	16	2	0.02	64	10	3523	270	230	18
2003	**2**	0.04	104	25	0.01	15	3	0.04	119	28	2970	525	1612	285
2002	**3**	0.08	175	55	0.01	14	3	0.09	189	58	2437	581	1936	461
2001	**4**	0.13	263	99	0.01	17	5	0.13	280	104	2414	758	2098	659
2000	**5**	0.14	84	36	0.01	7	2	0.15	91	38	696	256	600	221
1999	**6**	0.16	176	84	0.01	12	5	0.17	188	89	1284	534	1118	465
1998	**7**	0.18	110	56	0.02	9	4	0.20	119	60	720	317	627	276
1997	**8**	0.18	81	44	0.01	6	3	0.20	87	47	521	245	453	213
1996	**9**	0.20	75	44	0.01	5	2	0.21	80	46	451	227	390	197
1995	**10**	0.18	41	25	0.01	2	1	0.19	43	26	267	142	233	124
1994	**11**	0.17	25	16	0.01	2	1	0.18	27	17	173	96	151	84
1993	**12+**	0.17	49	32	0.01	2	1	0.18	51	33	328	186	288	162
		0.19	1234	523	0.01	123	34	**0.17**	1358	**557**	19898	4135	9736	**3164**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.10.6 NORTH EAST ATLANTIC MACKEREL. Two area management option table.

Fsq = 0.20 in 2003

Data from: MAC Predictions 2003-2008.xls

		YEAR 2003										
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass
0.97609	**0.2000**	0.1861	1423.3	605.1	0.0139	146.8	40.9	**0.2000**	1570	**646**	9462	**3091**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)

		YEAR 2004											2005	
		NORTHERN AREA			SOUTHERN AREA			TOTAL AREA			Spawning time		Spawning time	
F factor	Reference F	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	F	Catch in numbers	Catch in weight	SP. ST. size	SP. ST. biomass	SP. ST. size	SP. ST. biomass
0.00	**0.0000**	0.0000	0	0	0.0000	0	0	**0.0000**	0	**0**	10055	**3275**	11332	3797
0.05	**0.0100**	0.0093	75	32	0.0007	8	2	**0.0100**	83	**34**	10026	**3264**	11228	3756
0.10	**0.0200**	0.0186	150	64	0.0014	15	4	**0.0200**	165	**68**	9996	**3253**	11126	3715
0.15	**0.0300**	0.0279	224	96	0.0021	23	6	**0.0300**	247	**102**	9967	**3242**	11026	3675
0.20	**0.0400**	0.0372	298	127	0.0028	30	9	**0.0400**	328	**136**	9938	**3231**	10926	3635
0.25	**0.0500**	0.0465	370	158	0.0035	38	11	**0.0500**	408	**169**	9908	**3220**	10828	3596
0.30	**0.0600**	0.0558	443	189	0.0042	45	13	**0.0600**	488	**202**	9879	**3209**	10730	3558
0.35	**0.0700**	0.0651	514	219	0.0049	53	15	**0.0700**	567	**234**	9850	**3198**	10634	3519
0.40	**0.0800**	0.0744	586	250	0.0055	60	17	**0.0800**	646	**266**	9821	**3187**	10539	3482
0.45	**0.0900**	0.0838	656	279	0.0062	68	19	**0.0900**	724	**298**	9793	**3176**	10446	3445
0.50	**0.1000**	0.0931	726	309	0.0069	75	21	**0.1000**	801	**330**	9764	**3165**	10353	3408
0.55	**0.1100**	0.1024	796	339	0.0076	82	23	**0.1100**	878	**362**	9735	**3155**	10261	3372
0.60	**0.1200**	0.1117	865	368	0.0083	89	25	**0.1200**	954	**393**	9707	**3144**	10171	3336
0.65	**0.1300**	0.1210	933	397	0.0090	96	27	**0.1300**	1029	**424**	9678	**3133**	10081	3301
0.70	**0.1400**	0.1303	1001	425	0.0097	104	29	**0.1400**	1104	**454**	9650	**3123**	9992	3266
0.75	**0.1500**	0.1396	1068	454	0.0104	111	31	**0.1500**	1179	**485**	9622	**3112**	9905	3231
0.80	**0.1600**	0.1489	1135	482	0.0111	118	33	**0.1600**	1253	**515**	9594	**3101**	9819	3197
0.85	**0.1700**	0.1582	1201	510	0.0118	125	35	**0.1700**	1326	**544**	9566	**3091**	9733	3164
0.90	**0.1800**	0.1675	1267	537	0.0125	132	36	**0.1800**	1399	**574**	9538	**3080**	9649	3131
0.95	**0.1900**	0.1768	1332	565	0.0132	138	38	**0.1900**	1471	**603**	9510	**3070**	9565	3098
1.00	**0.2000**	0.1861	1397	592	0.0139	145	40	**0.2000**	1542	**632**	9482	**3060**	9483	3066
1.05	**0.2100**	0.1954	1461	619	0.0146	152	42	**0.2100**	1613	**661**	9455	**3049**	9401	3034
1.10	**0.2200**	0.2047	1525	646	0.0152	159	44	**0.2200**	1684	**690**	9427	**3039**	9320	3002
1.15	**0.2300**	0.2140	1588	672	0.0159	166	46	**0.2300**	1754	**718**	9400	**3029**	9241	2971
1.20	**0.2400**	0.2233	1651	698	0.0166	172	48	**0.2400**	1823	**746**	9373	**3018**	9162	2941
1.25	**0.2500**	0.2327	1713	724	0.0173	179	49	**0.2500**	1892	**774**	9345	**3008**	9084	2910
1.30	**0.2600**	0.2420	1775	750	0.0180	186	51	**0.2600**	1960	**801**	9318	**2998**	9007	2880
1.35	**0.2700**	0.2513	1836	776	0.0187	192	53	**0.2700**	2028	**829**	9291	**2988**	8931	2851
1.40	**0.2800**	0.2606	1897	801	0.0194	199	55	**0.2800**	2096	**856**	9264	**2978**	8855	2821
1.45	**0.2900**	0.2699	1957	826	0.0201	206	56	**0.2900**	2162	**883**	9238	**2968**	8781	2793
1.50	**0.3000**	0.2792	2017	851	0.0208	212	58	**0.3000**	2229	**909**	9211	**2958**	8707	2764
1.55	**0.3100**	0.2885	2076	876	0.0215	218	60	**0.3100**	2295	**936**	9184	**2948**	8634	2736
1.60	**0.3200**	0.2978	2135	900	0.0222	225	62	**0.3200**	2360	**962**	9158	**2938**	8562	2708
1.65	**0.3300**	0.3071	2193	925	0.0229	231	63	**0.3300**	2425	**988**	9131	**2928**	8491	2681
1.70	**0.3400**	0.3164	2252	949	0.0236	238	65	**0.3400**	2489	**1014**	9105	**2918**	8421	2654
1.75	**0.3500**	0.3257	2309	972	0.0243	244	67	**0.3500**	2553	**1039**	9079	**2908**	8351	2627
1.80	**0.3600**	0.3350	2366	996	0.0249	250	68	**0.3600**	2617	**1064**	9052	**2898**	8283	2601
1.85	**0.3700**	0.3443	2423	1020	0.0256	257	70	**0.3700**	2679	**1089**	9026	**2889**	8215	2575
1.90	**0.3800**	0.3536	2479	1043	0.0263	263	71	**0.3800**	2742	**1114**	9000	**2879**	8147	2549
1.95	**0.3900**	0.3629	2535	1066	0.0270	269	73	**0.3900**	2804	**1139**	8974	**2869**	8081	2523
2.00	**0.4000**	0.3722	2590	1089	0.0277	275	75	**0.4000**	2866	**1163**	8949	**2860**	8015	2498
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.10.7 NORTH EAST ATLANTIC MACKEREL. Two area management option table.

Catch constraint 603kt in 2003

data from: MAC Predictions 2003-2008.xls

YEAR 2003

F factor	Reference F	NORTHERN AREA F	NORTHERN AREA Catch in numbers	NORTHERN AREA Catch in weight	SOUTHERN AREA F	SOUTHERN AREA Catch in numbers	SOUTHERN AREA Catch in weight	TOTAL AREA F	TOTAL AREA Catch in numbers	TOTAL AREA Catch in weight	Spawning time SP. ST. size	Spawning time SP. ST. biomass
0.9053	**0.1855**	0.1726	1327.8	564.8	0.0129	136.7	38.2	**0.1855**	1464	**603**	9503	**3107**
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)

YEAR 2004 / 2005

F factor	Reference F	2004 NORTHERN AREA F	2004 NORTHERN AREA Catch in numbers	2004 NORTHERN AREA Catch in weight	2004 SOUTHERN AREA F	2004 SOUTHERN AREA Catch in numbers	2004 SOUTHERN AREA Catch in weight	2004 TOTAL AREA F	2004 TOTAL AREA Catch in numbers	2004 TOTAL AREA Catch in weight	2004 Spawning time SP. ST. size	2004 Spawning time SP. ST. biomass	2005 Spawning time SP. ST. size	2005 Spawning time SP. ST. biomass
0.00	**0.0000**	0.0000	0	0	0.0000	0	0	0.0000	0	0	10142	3310	11409	3831
0.05	**0.0100**	0.0093	76	33	0.0007	8	2	**0.0100**	84	**35**	10112	**3299**	11305	3789
0.10	**0.0200**	0.0186	152	65	0.0014	15	4	**0.0200**	167	**69**	10082	**3288**	11202	3748
0.15	**0.0300**	0.0279	226	97	0.0021	23	7	**0.0300**	249	**103**	10052	**3276**	11100	3707
0.20	**0.0400**	0.0372	301	128	0.0028	31	9	**0.0400**	331	**137**	10023	**3265**	11000	3667
0.25	**0.0500**	0.0465	374	160	0.0035	38	11	**0.0500**	412	**171**	9993	**3254**	10900	3628
0.30	**0.0600**	0.0558	447	191	0.0042	46	13	**0.0600**	493	**204**	9964	**3243**	10802	3589
0.35	**0.0700**	0.0651	520	222	0.0049	53	15	**0.0700**	573	**237**	9934	**3232**	10705	3550
0.40	**0.0800**	0.0744	592	252	0.0055	61	17	**0.0800**	652	**269**	9905	**3221**	10609	3512
0.45	**0.0900**	0.0838	663	283	0.0062	68	19	**0.0900**	731	**302**	9876	**3210**	10514	3474
0.50	**0.1000**	0.0931	734	313	0.0069	75	21	**0.1000**	809	**334**	9847	**3199**	10421	3437
0.55	**0.1100**	0.1024	804	343	0.0076	83	23	**0.1100**	886	**366**	9818	**3188**	10328	3401
0.60	**0.1200**	0.1117	873	372	0.0083	90	25	**0.1200**	963	**397**	9789	**3177**	10237	3364
0.65	**0.1300**	0.1210	943	401	0.0090	97	27	**0.1300**	1040	**428**	9761	**3166**	10146	3329
0.70	**0.1400**	0.1303	1011	430	0.0097	104	29	**0.1400**	1115	**459**	9732	**3156**	10057	3294
0.75	**0.1500**	0.1396	1079	459	0.0104	111	31	**0.1500**	1190	**490**	9704	**3145**	9968	3259
0.80	**0.1600**	0.1489	1146	488	0.0111	118	33	**0.1600**	1265	**521**	9675	**3134**	9881	3224
0.85	**0.1700**	0.1582	1213	516	0.0118	125	35	**0.1700**	1339	**551**	9647	**3123**	9795	3190
0.90	**0.1800**	0.1675	1280	544	0.0125	132	37	**0.1800**	1412	**581**	9619	**3113**	9710	3157
0.95	**0.1900**	0.1768	1346	571	0.0132	139	39	**0.1900**	1485	**610**	9591	**3102**	9625	3124
1.00	**0.2000**	0.1861	1411	599	0.0139	146	41	**0.2000**	1557	**640**	9563	**3092**	9542	3091
1.05	**0.2100**	0.1954	1476	626	0.0146	153	43	**0.2100**	1629	**669**	9535	**3081**	9460	3059
1.10	**0.2200**	0.2047	1540	653	0.0152	160	44	**0.2200**	1700	**698**	9507	**3071**	9378	3027
1.15	**0.2300**	0.2140	1604	680	0.0159	167	46	**0.2300**	1771	**726**	9479	**3060**	9298	2996
1.20	**0.2400**	0.2233	1667	707	0.0166	174	48	**0.2400**	1841	**755**	9452	**3050**	9218	2965
1.25	**0.2500**	0.2327	1730	733	0.0173	180	50	**0.2500**	1910	**783**	9424	**3040**	9139	2934
1.30	**0.2600**	0.2420	1792	759	0.0180	187	52	**0.2600**	1979	**811**	9397	**3029**	9062	2904
1.35	**0.2700**	0.2513	1854	785	0.0187	194	53	**0.2700**	2048	**838**	9369	**3019**	8985	2874
1.40	**0.2800**	0.2606	1916	810	0.0194	200	55	**0.2800**	2116	**866**	9342	**3009**	8909	2844
1.45	**0.2900**	0.2699	1976	836	0.0201	207	57	**0.2900**	2183	**893**	9315	**2999**	8834	2815
1.50	**0.3000**	0.2792	2037	861	0.0208	213	59	**0.3000**	2250	**920**	9288	**2989**	8759	2786
1.55	**0.3100**	0.2885	2097	886	0.0215	220	60	**0.3100**	2317	**946**	9261	**2978**	8686	2758
1.60	**0.3200**	0.2978	2156	911	0.0222	226	62	**0.3200**	2383	**973**	9234	**2968**	8613	2730
1.65	**0.3300**	0.3071	2215	935	0.0229	233	64	**0.3300**	2448	**999**	9207	**2958**	8542	2702
1.70	**0.3400**	0.3164	2274	960	0.0236	239	66	**0.3400**	2513	**1025**	9181	**2948**	8471	2675
1.75	**0.3500**	0.3257	2332	984	0.0243	246	67	**0.3500**	2578	**1051**	9154	**2938**	8400	2648
1.80	**0.3600**	0.3350	2390	1008	0.0249	252	69	**0.3600**	2642	**1077**	9128	**2929**	8331	2621
1.85	**0.3700**	0.3443	2447	1031	0.0256	258	71	**0.3700**	2705	**1102**	9101	**2919**	8262	2595
1.90	**0.3800**	0.3536	2504	1055	0.0263	265	72	**0.3800**	2768	**1127**	9075	**2909**	8195	2569
1.95	**0.3900**	0.3629	2560	1078	0.0270	271	74	**0.3900**	2831	**1152**	9049	**2899**	8127	2543
2.00	**0.4000**	0.3722	2616	1101	0.0277	277	75	**0.4000**	2893	**1177**	9023	**2889**	8061	2518
	UNIT:	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	F(4-8)	(millions)	(kt)	(millions)	(kt)	(millions)	(kt)

Table 2.11.1 NEA MACKEREL. Two area prediction table regarding Norwegian request.

For 2003 an Fsq = 0.20 constraint was assumed.

For 2004 the $F_{(4-8)}$ of 0.17 is divided over the Northern and Southern areas in 7 different ways.

		NORTHERN area				SOUTHERN area				TOTAL			Mean	Mean	Percentage
													age	weight	immatures
Year	Option	F(4-8)	F in %	Catch	% Catch	F(4-8)	F in %	Catch	% Catch	F(4-8)	Catch	SSB	in catch	in catch	in catch
2003		0.186	93.1%	605	93.7%	0.014	6.9%	41	6.3%	0.200	646	3092	5.2	0.411	12%
2004	100% reduction of F in South	0.170	100.0%	548	100%	0.000	0.0%	0	0%	0.170	548	3091	5.4	0.424	11%
2004	50% reduction of F in South	0.164	96.6%	529	96.9%	0.006	3.4%	17	3.1%	0.170	546	3091	5.3	0.417	12%
2004	25% reduction of F in South	0.161	94.8%	519	95.2%	0.009	5.2%	26	4.8%	0.170	545	3091	5.3	0.414	12%
2004	Current practice: partial F's according catch	0.158	93.1%	510	93.6%	0.012	6.9%	35	6.4%	0.170	545	3091	5.3	0.411	13%
2004	25% increase in F in South	0.155	91.4%	501	92.1%	0.015	8.6%	43	7.9%	0.170	544	3091	5.2	0.407	13%
2004	50% increase in F in South	0.152	89.6%	491	90.4%	0.018	10.4%	52	9.6%	0.170	543	3091	5.2	0.404	14%
2004	100% increase in F in South	0.146	86.1%	472	87.2%	0.024	13.9%	69	12.8%	0.170	541	3091	5.1	0.398	15%
	UNIT:	F(4-8)	%	(kt)	%	F(4-8)	%	(kt)	%	F(4-8)	(kt)	(kt)	(years)	(kg)	%

Table 2.13.1 NEA Atlantic mackerel yield per recruit analysis

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	7.1792	2.1858	4.9604	2.0402	4.6716	1.9214
0.1	0.0205	0.0783	0.0386	6.6583	1.9122	4.4426	1.7672	4.154	1.6512
0.2	0.041	0.1391	0.0667	6.2539	1.7031	4.0412	1.5589	3.7529	1.4453
0.3	0.0615	0.1878	0.0877	5.9302	1.5386	3.7204	1.395	3.4325	1.2838
0.4	0.082	0.2278	0.1038	5.6648	1.406	3.4579	1.2631	3.1704	1.154
0.5	0.1024	0.2612	0.1164	5.4427	1.297	3.2387	1.1547	2.9516	1.0477
0.6	0.1229	0.2897	0.1263	5.2539	1.2059	3.0527	1.0643	2.766	0.9591
0.7	0.1434	0.3143	0.1343	5.0909	1.1287	2.8926	0.9877	2.6063	0.8842
0.8	0.1639	0.3358	0.1408	4.9487	1.0624	2.7531	0.922	2.4673	0.8202
0.9	0.1844	0.3547	0.1461	4.8231	1.0049	2.6302	0.8651	2.3449	0.7648
1	0.2049	0.3716	0.1504	4.7113	0.9545	2.5211	0.8153	2.2363	0.7165
1.1	0.2254	0.3868	0.154	4.6109	0.9101	2.4234	0.7714	2.1391	0.674
1.2	0.2459	0.4006	0.1571	4.52	0.8705	2.3352	0.7324	2.0514	0.6363
1.3	0.2663	0.4131	0.1596	4.4374	0.835	2.2552	0.6975	1.9719	0.6026
1.4	0.2868	0.4245	0.1617	4.3617	0.803	2.1821	0.666	1.8994	0.5724
1.5	0.3073	0.4351	0.1635	4.2921	0.774	2.115	0.6376	1.8329	0.545
1.6	0.3278	0.4448	0.1651	4.2277	0.7476	2.0532	0.6117	1.7716	0.5202
1.7	0.3483	0.4539	0.1664	4.1679	0.7234	1.9959	0.588	1.715	0.4976
1.8	0.3688	0.4624	0.1675	4.1122	0.7011	1.9427	0.5663	1.6623	0.4769
1.9	0.3893	0.4703	0.1684	4.0601	0.6806	1.8931	0.5463	1.6133	0.4578
2	0.4098	0.4777	0.1692	4.0112	0.6616	1.8466	0.5277	1.5675	0.4402

Reference poi	F multiplier	Absolute F
Fbar(4-8)	1	0.2049
FMax	3.23	0.6623
F0.1	0.93	0.19
F35%SPR	1.10	0.2261
F low	0.29	0.06
F med	0.38	0.25
F high	2.00	0.41

Table 2.14.1. NEA mackerel: Input variables to the PA software.

Age	N	M	CWt	SWt	Mat	F	FPreSpwn	MPreSpwn	NCV
0	4115000	0.15	0.06147	0	0	0.00634	0.4	0.4	0.432
1	3519268	0.15	0.15517	0.07693	0.07	0.02401			0.199
2	3743997	0.15	0.23574	0.17649	0.5867	0.05315			0.148
3	1188000	0.15	0.3072	0.23879	0.8733	0.10487			0.118
4	2357000	0.15	0.37123	0.31355	0.9733	0.16032			0.104
5	1377000	0.15	0.42715	0.36824	0.9733	0.18235			0.094
6	1047000	0.15	0.46921	0.41526	0.99	0.20623			0.087
7	934000	0.15	0.50565	0.43996	1	0.23625			0.086
8	563000	0.15	0.53956	0.4693	1	0.23927			0.087
9	362000	0.15	0.57756	0.50464	1	0.2545			0.087
10	288000	0.15	0.60008	0.53002	1	0.22939			0.091
11	153000	0.15	0.61364	0.55602	1	0.21883			0.095
12	220000	0.15	0.66174	0.5649	1	0.21883			0.095

FbarMinAge	4
FbarMaxAge	8
M year CV	0.1

Table 2.14.2. Calculated references points for NEA mackerel based on the full 1972-1999 recruitment time series.

Reference point	Deterministic	Median	75th percentile	95th percentile	Hist SSB < ref pt %
MedianRecruits	4473000	4473000	4814000	4999350	
MBAL	2300000				0.00
Bloss	2393000				
SSB90%R90%Surv	2567177	2639373	2738745	2903925	19.23
SPR%ofVirgin	37.29	37.74	38.90	40.35	
VirginSPR	1.92	1.86	2.14	2.60	
SPRloss	0.50	0.51	0.54	0.62	

	Deterministic	Median	25th percentile	5th percentile	Hist F > ref pt %
FBar	0.20	0.20	0.20	0.20	46.15
Fmax	0.66	0.68	0.60	0.50	0.00
F0.1	0.19	0.19	0.18	0.16	84.62
Flow	0.06	0.06	0.03	0.01	100.00
Fmed	0.24	0.25	0.22	0.19	15.38
Fhigh	0.41	0.41	0.38	0.34	0.00
F35%SPR	0.23	0.23	0.21	0.18	19.23
Floss	0.35	0.35	0.30	0.24	0.00

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.

NEA Mackerel Mackerel NEA (sen file)

Steady state selection provided as input
FBar averaged from age 4 to 8

FishLab DLL used
FLVB32.DLL built on Jun 14 1999 at 11:53:37
PASoft 4 October 1999
17-09-2003 16:28:35

Number of iterations = 100
Random number seed = -99
Stock recruitment data Monte Carloed using residuals from the equilibrium LOWESS fit

Data source:
M:\2003\Personal\Jan Arge\PA\NEA-Mac-ica.sen
M:\2003\Personal\Jan Arge\PA\NEA-Mac-ica.sum

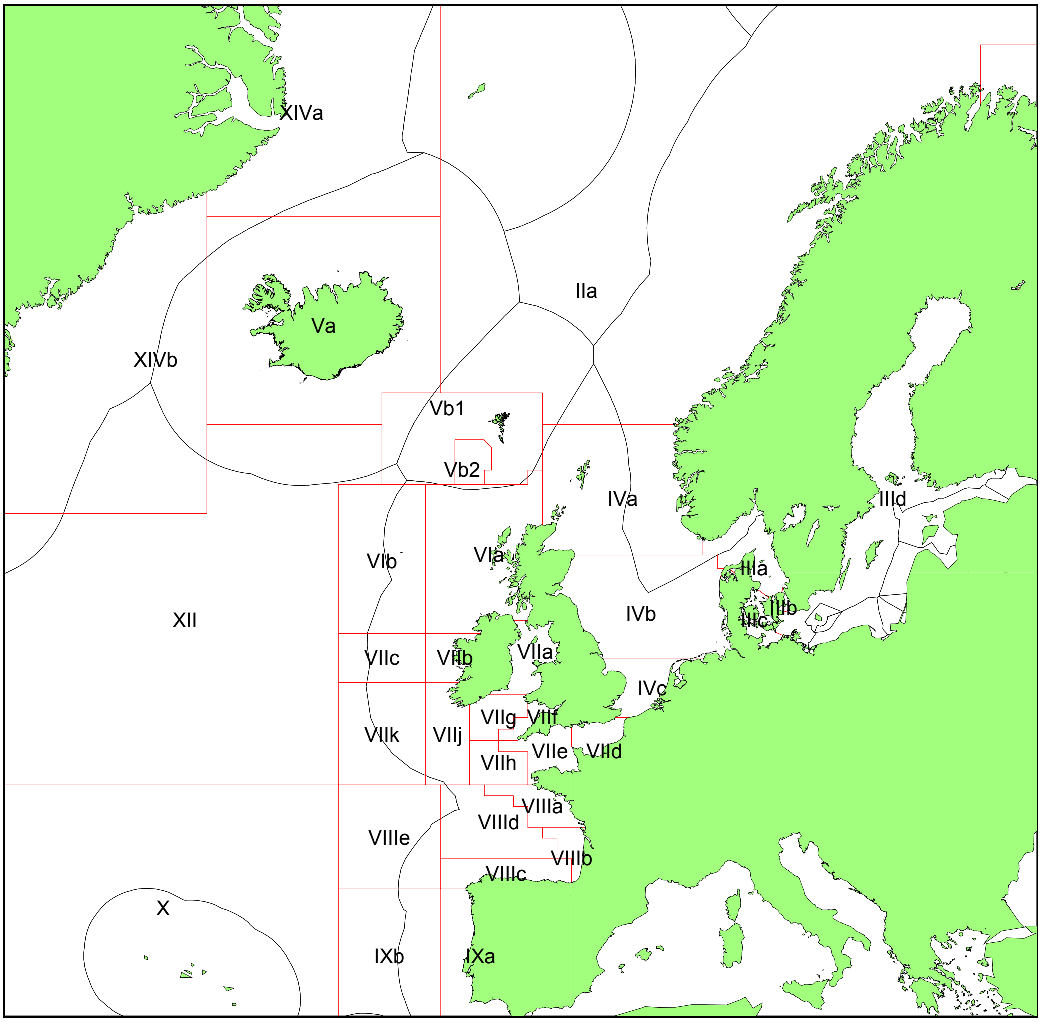


Figure 2.1.1. Map of approximate national zones and ICES Divisions and Subareas. Note that EU region is considered as one zone in this map.

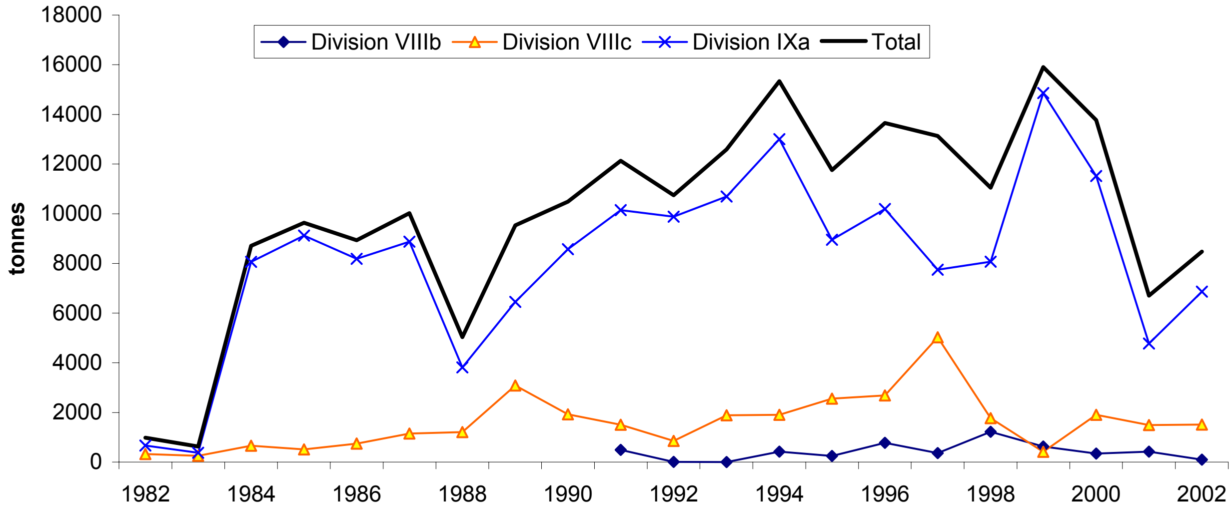


Figure 2.2.2.1: Annual landings of Scomber japonicus by ICES divisions since 1982 to 2002.

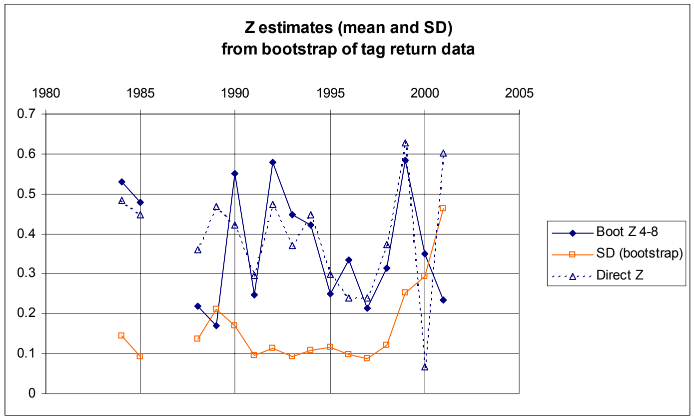


Figure 2.4.6.1 Mortality estimates (mean and SD) from bootstapped tag return data, assuming Poisson distribution of number of tags at age by year and release.

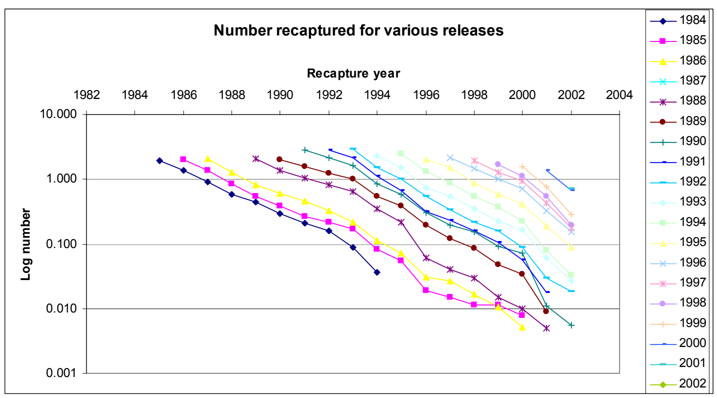


Figure 2.4.6.2 Number recaptured for each release, by recapture year. Logarithmic scale. Recaptures in 2003 are not included.

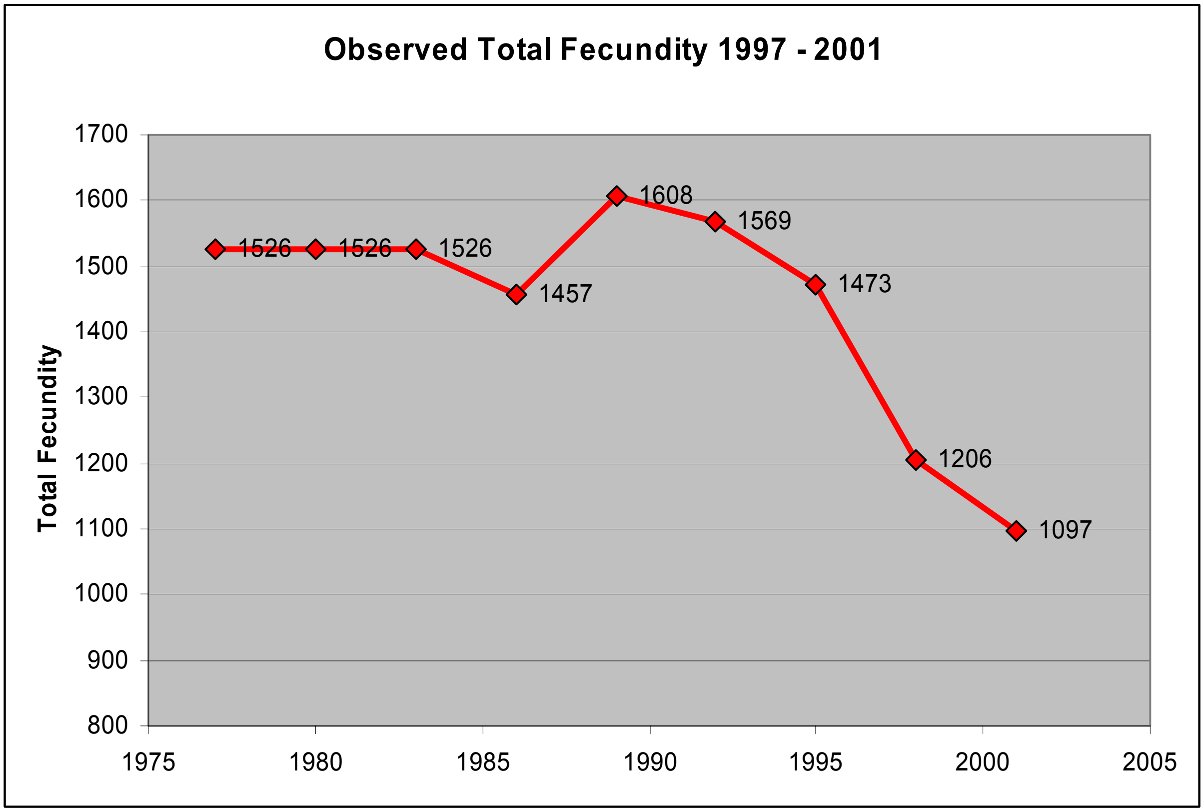


Figure 2.5.3.1. Observed total potential fecundity (eggs per gram female) in the egg survey used.

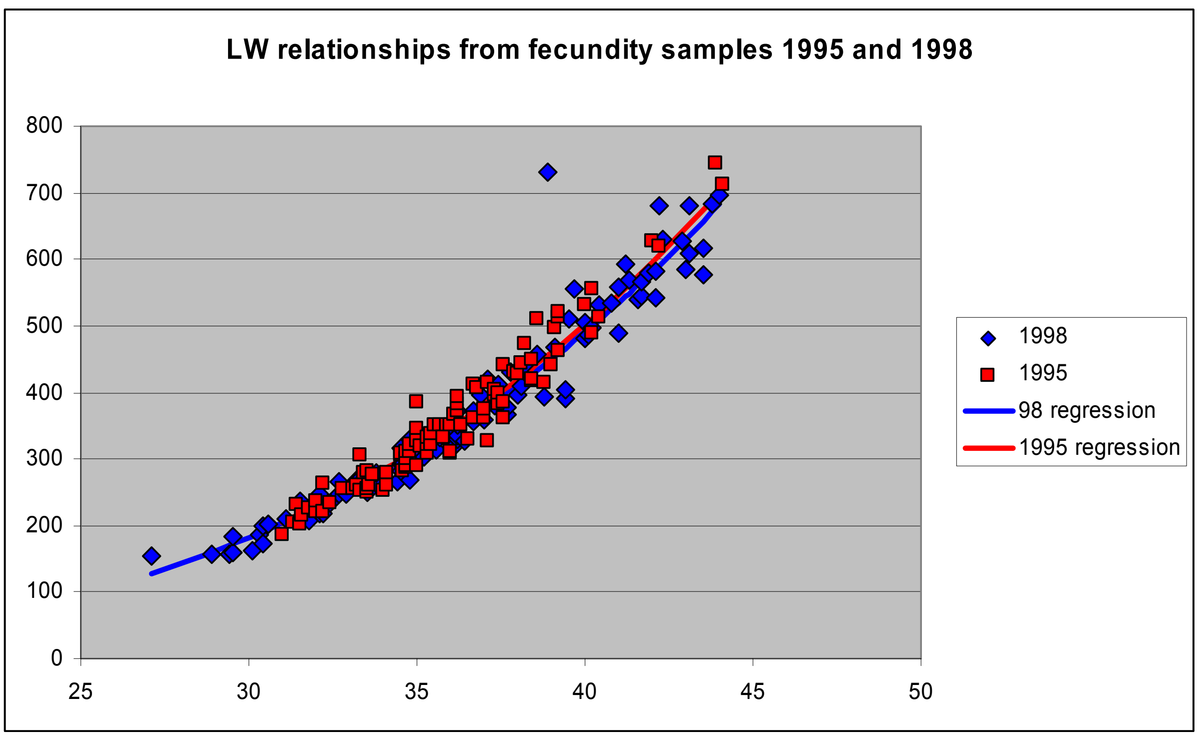


Figure 2.5.3.2. Length weight relationships from the fish sampled in the surveys 1995 and 1998.

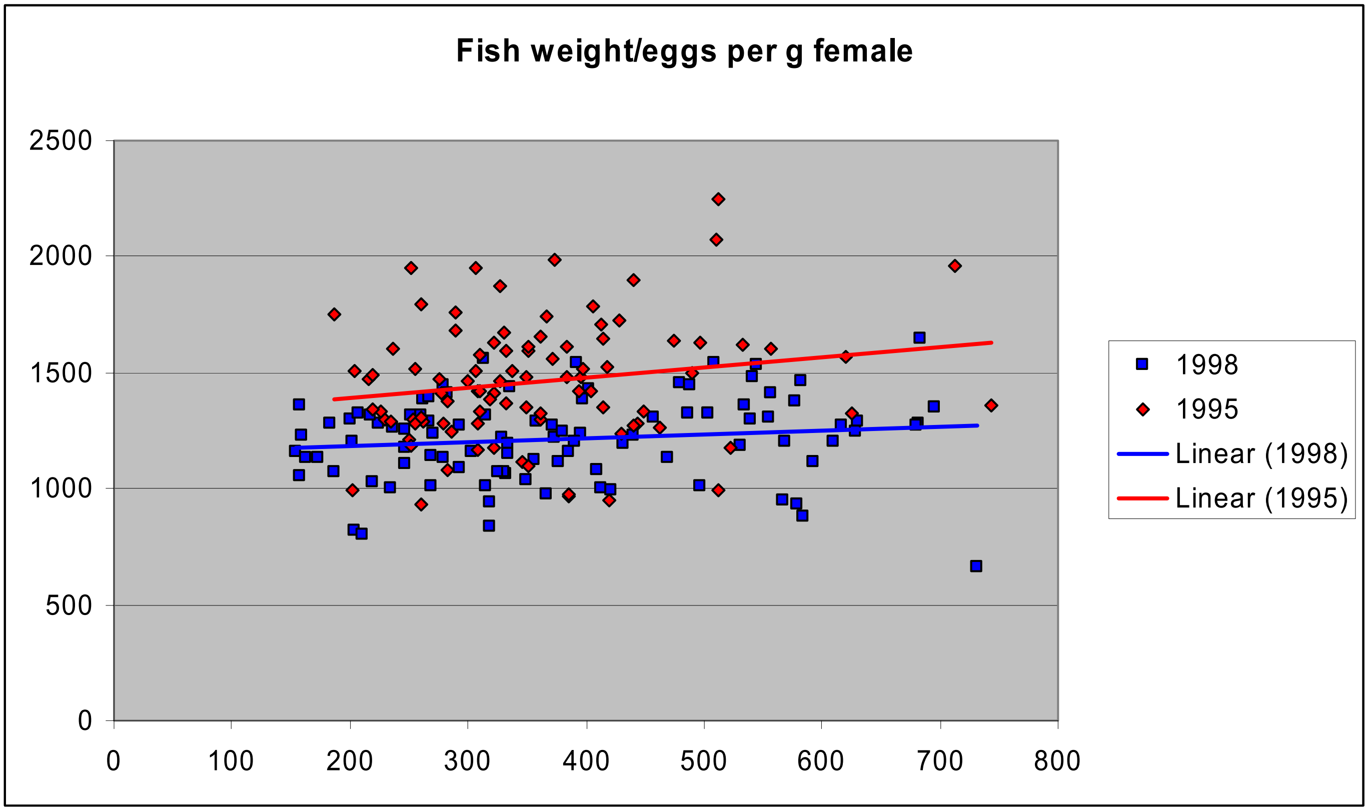
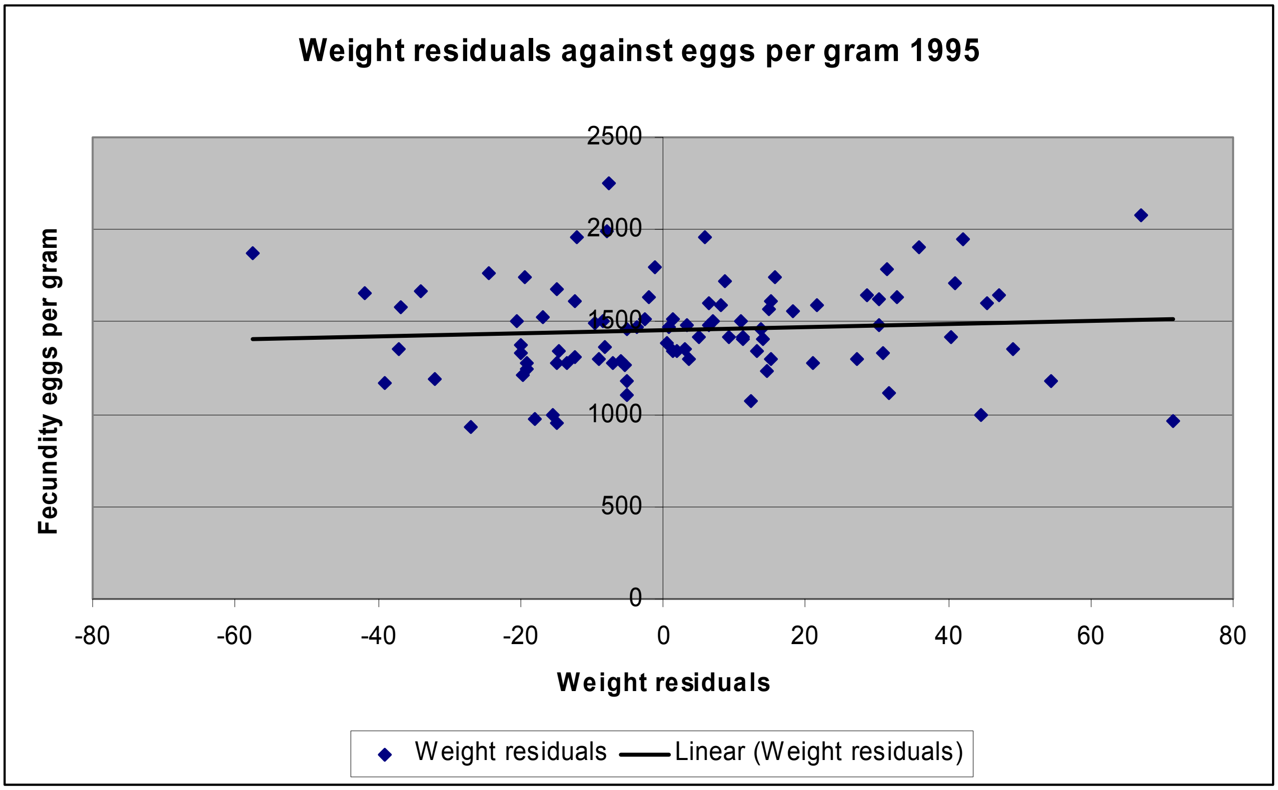


Figure 2.5.3.3. Potential fecundity (eggs per gram female) against female weight for the surveys in 1995 and 1998



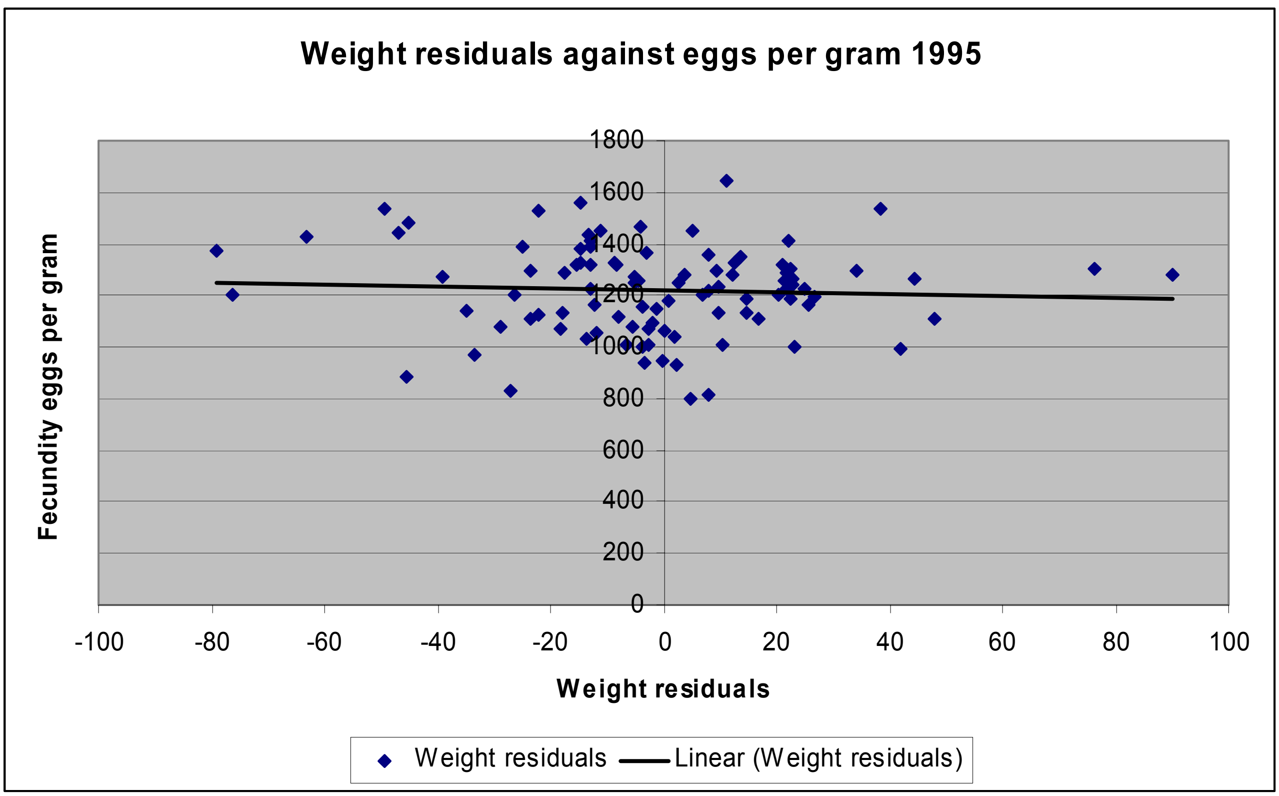


Figure 2.5.3.4. Residuals around the length weight relationship plotted against potential fecundity (eggs per gram female) for the surveys in 1995 (top) and 1998 (bottom)

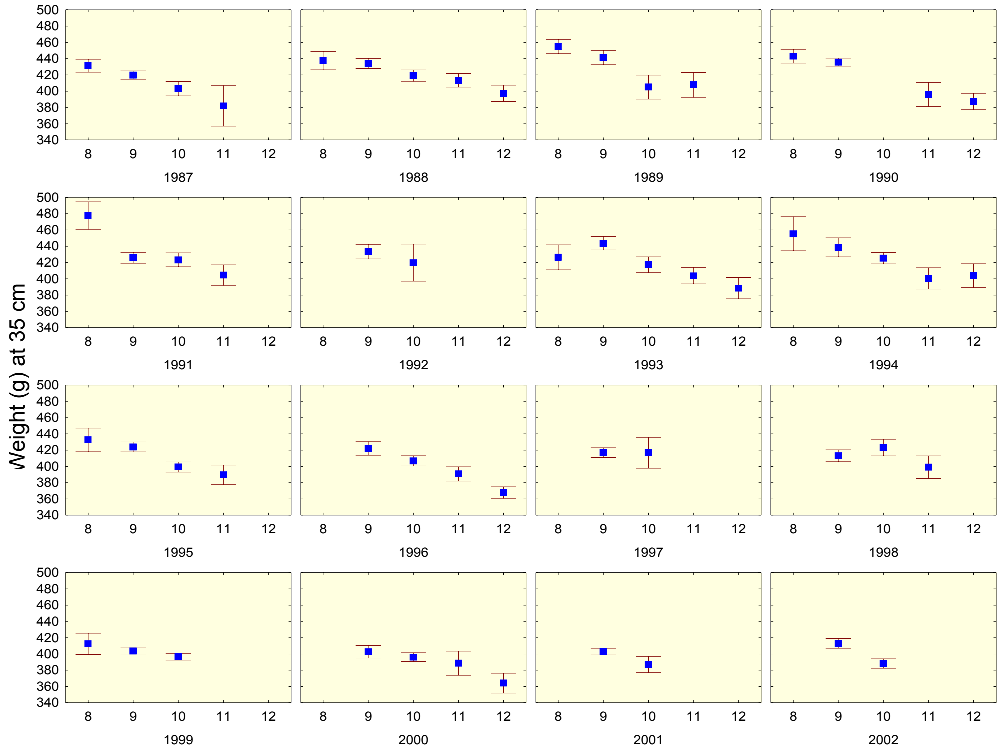
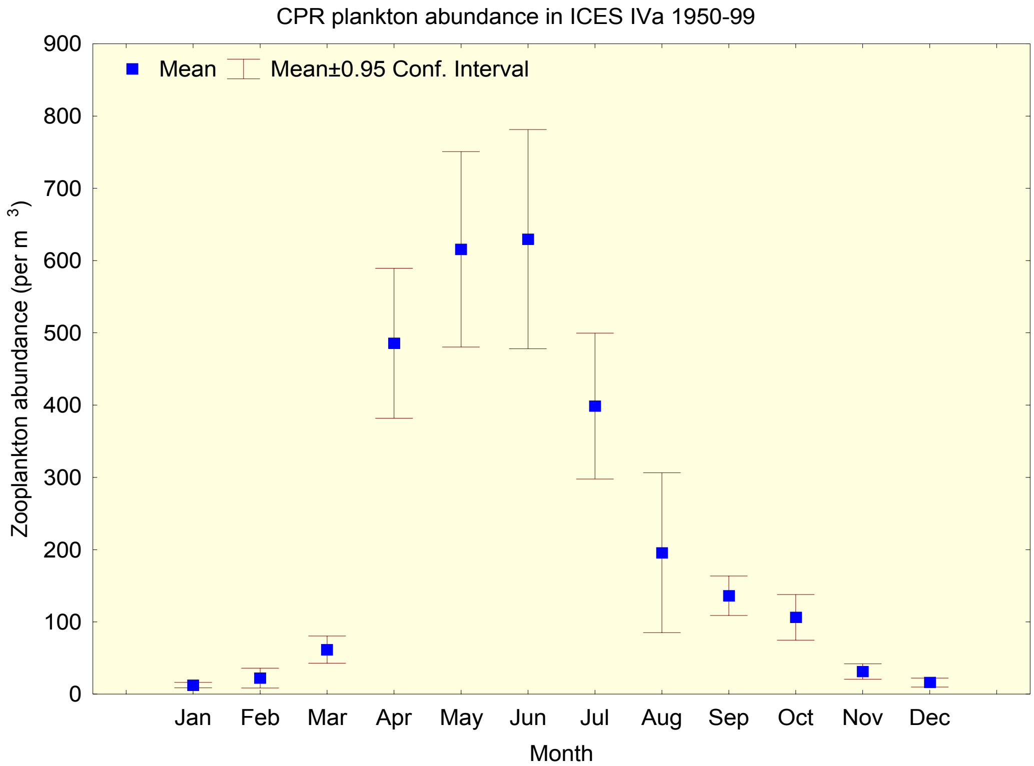


Figure 2.5.3.5. Weight of 35 cm purse seine mackerel related to month in ICES Area IVa for the years 1987-2002



(mean ± 0.95% conf.int).

Figure 2.5.3.6. Seasonal variations in abundance of calanus copepods in ICES Area IVa. Data from CPR database SAFHOS CPR data survey, http://192.171.163.165/data.htm.

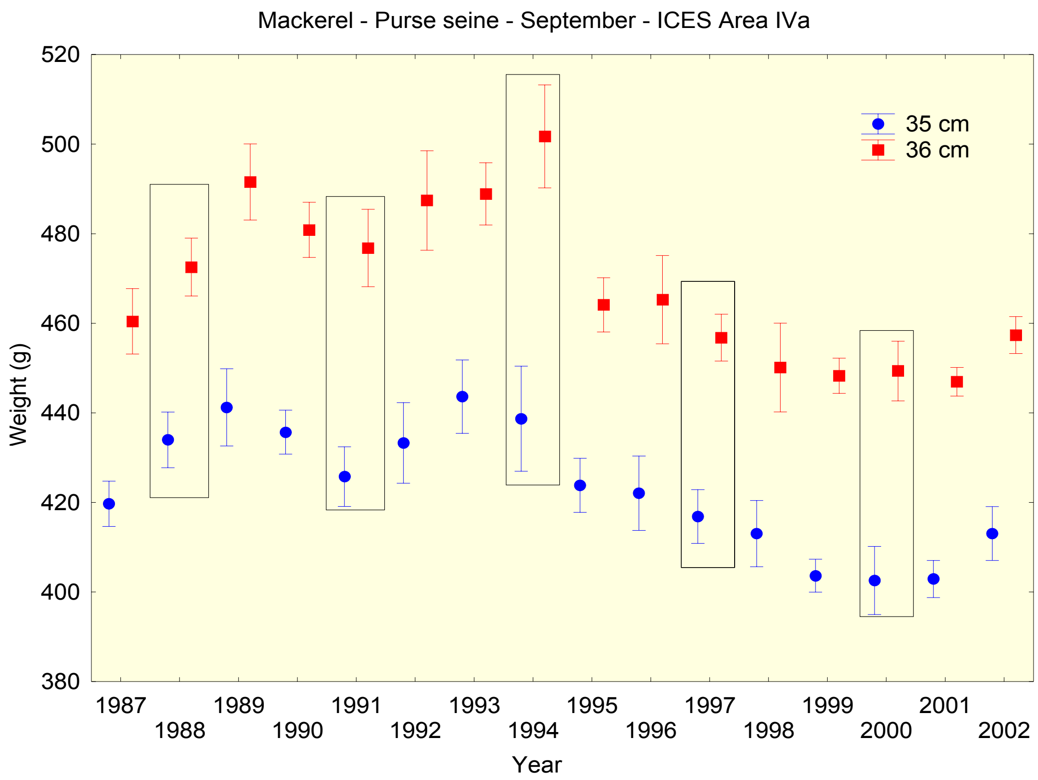


Figure 2.5.3.7. September weights of 35-36 cm herring 1987-2002. Years prior to egg surveys are marked

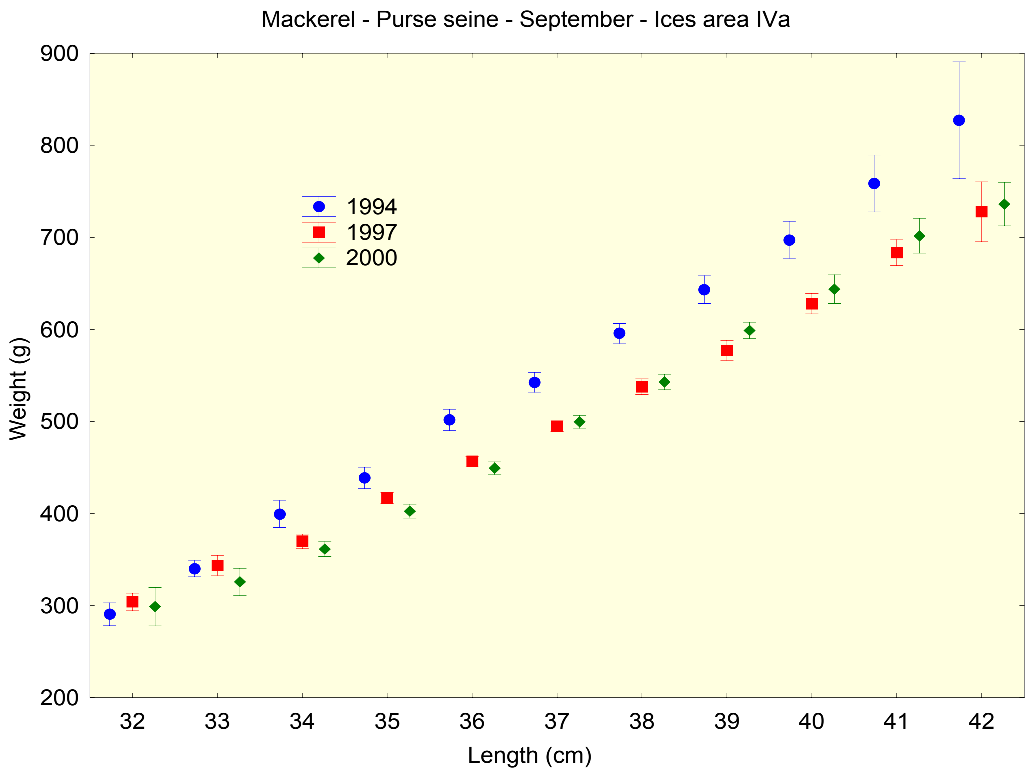


Figure 2.5.3.8. Weight-length relationships in September. Comparison between the years 1994. 1997 and 2000.

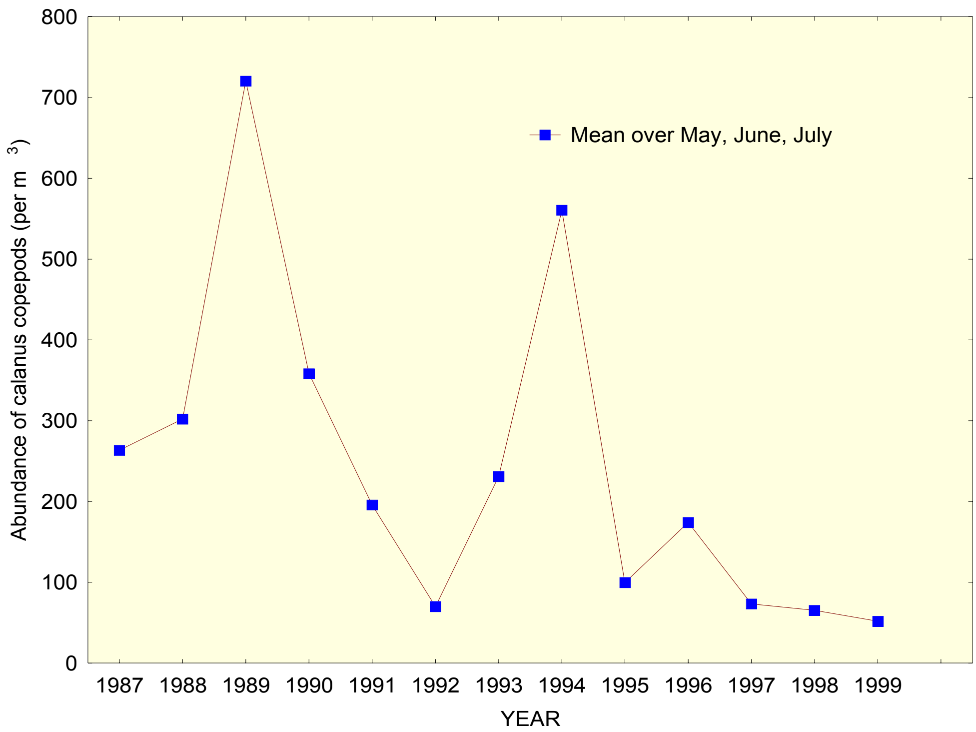
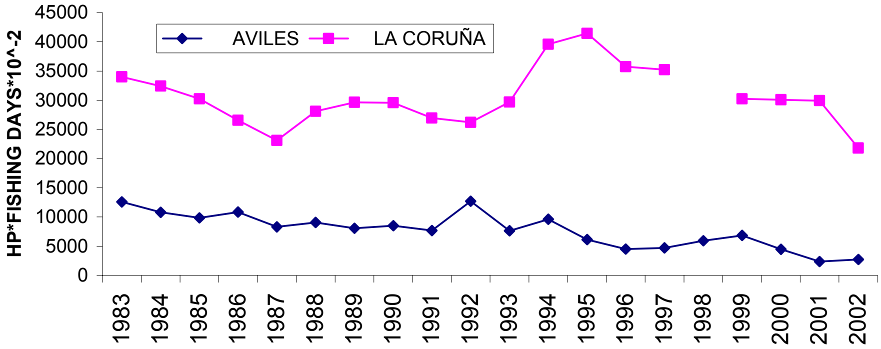
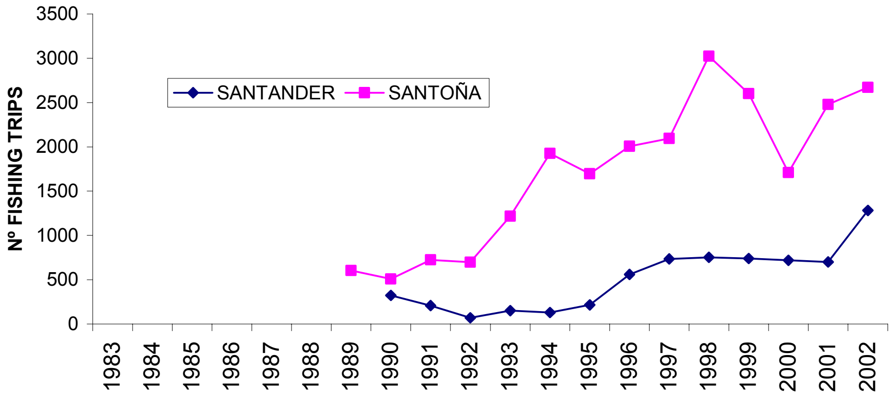


Figure 2.5.3.9. Historic variations in calanus copepod abundance in ICES Area IVa (mean over May, June and July). Data from SAFHOS CPR data survey, http://192.171.163.165/data.htm)

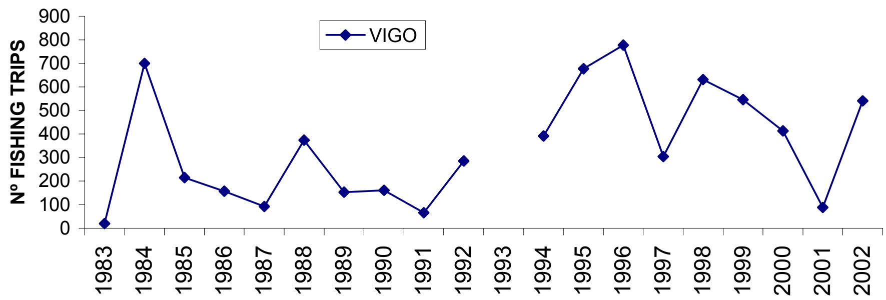
TRAWL EFFORT FROM DIVISION VIIIc



HAND-LINE EFFORT FROM DIVISION VIIIc



PURSE-SEINE EFFORT FROM SUB-DIVISION IXa NORTH



TRAWL EFFORT FROM DIVISION IXa CN, CS & S

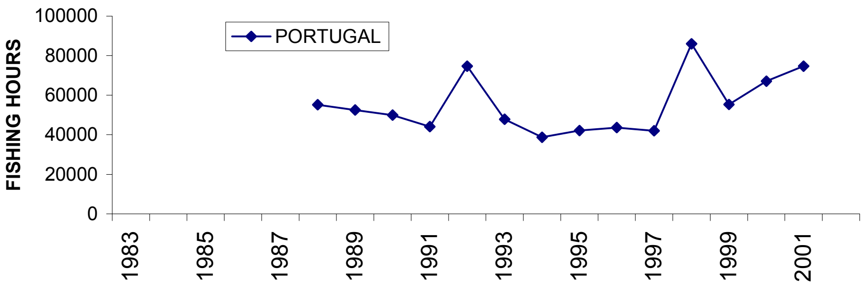
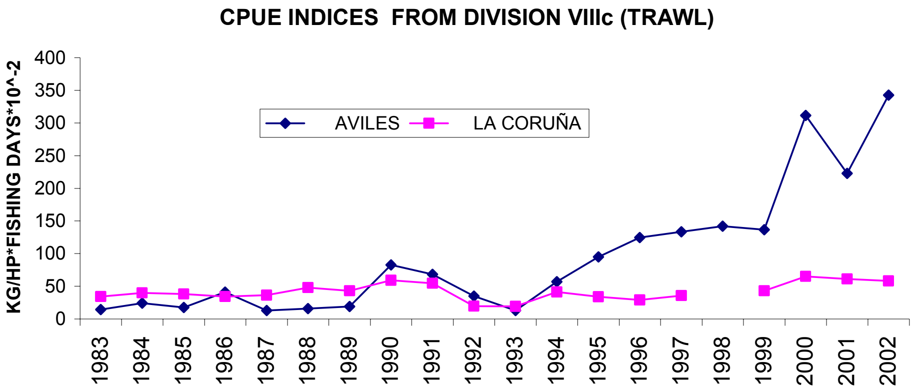
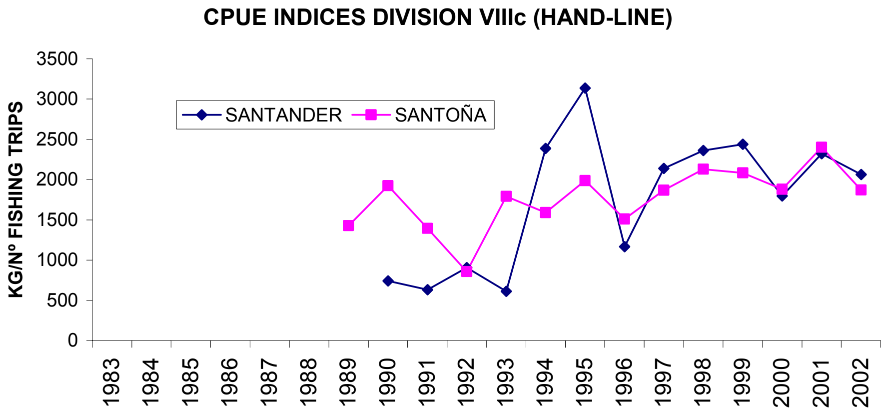
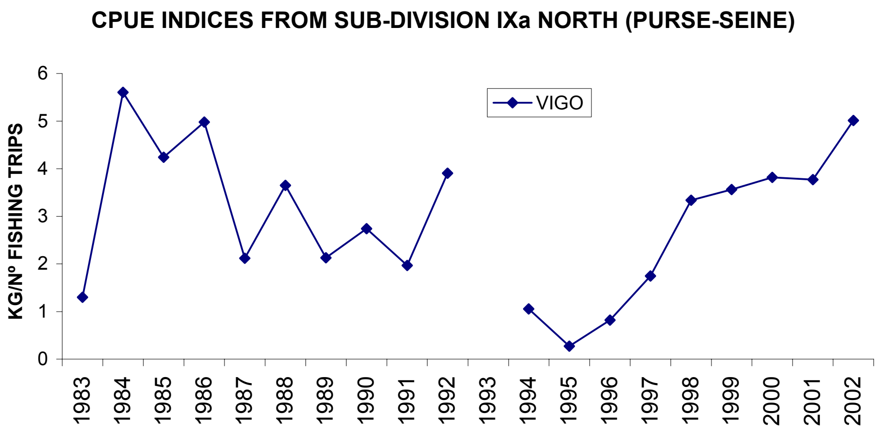


Figure 2.6.1 : SOUTHERN MACKEREL. Effort data by fleets and area







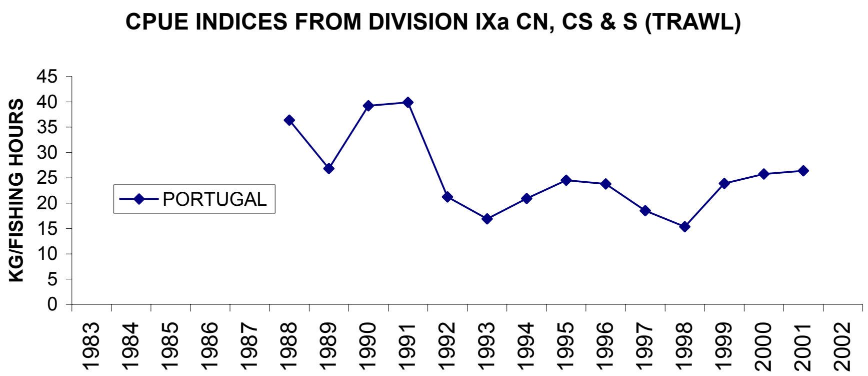


Figure 2.6.2 : SOUTHERN MACKEREL. CPUE indices by fleets and area

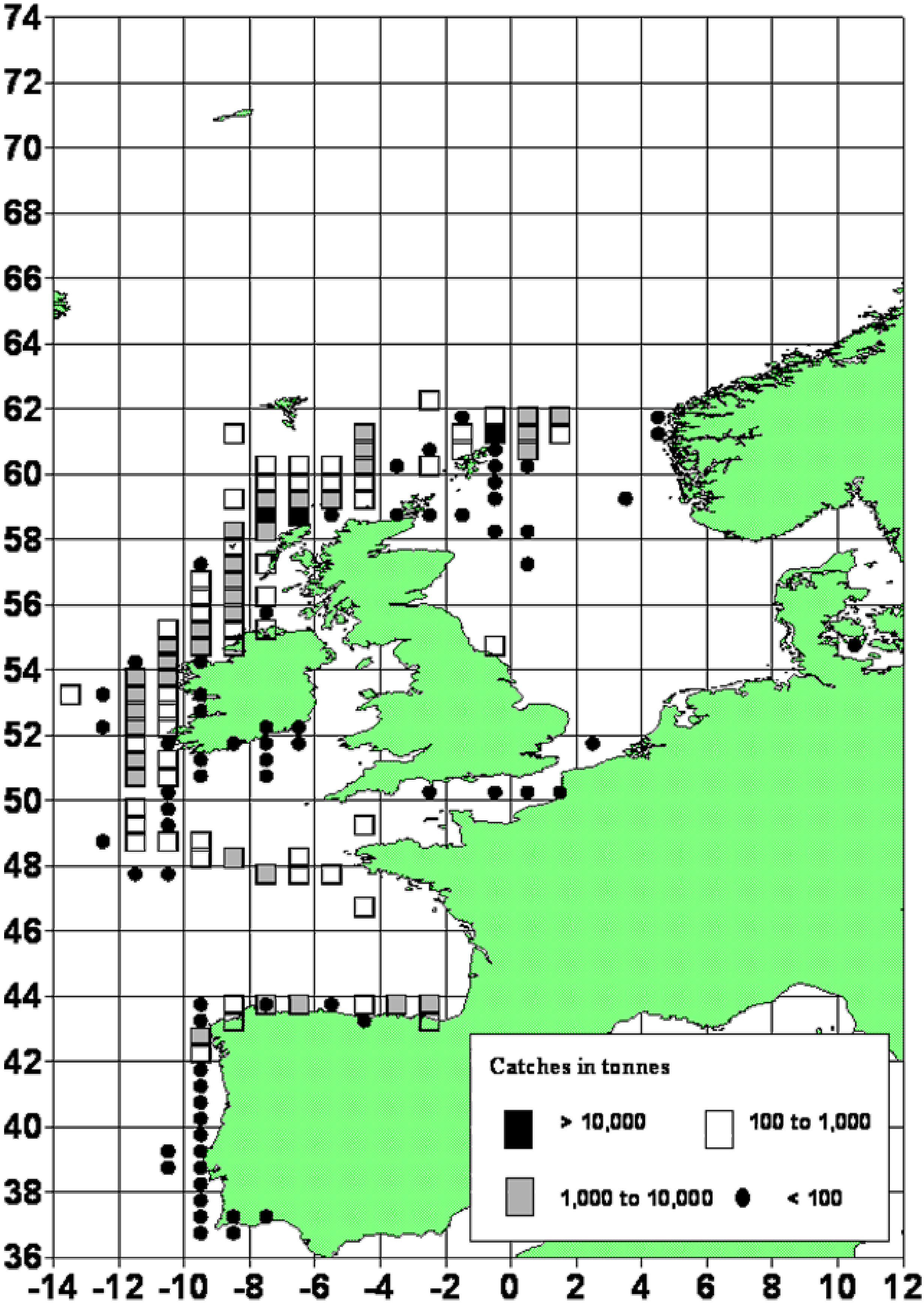


Figure 2.7.1.1. Mackerel commercial catches in quarter 1 2002.

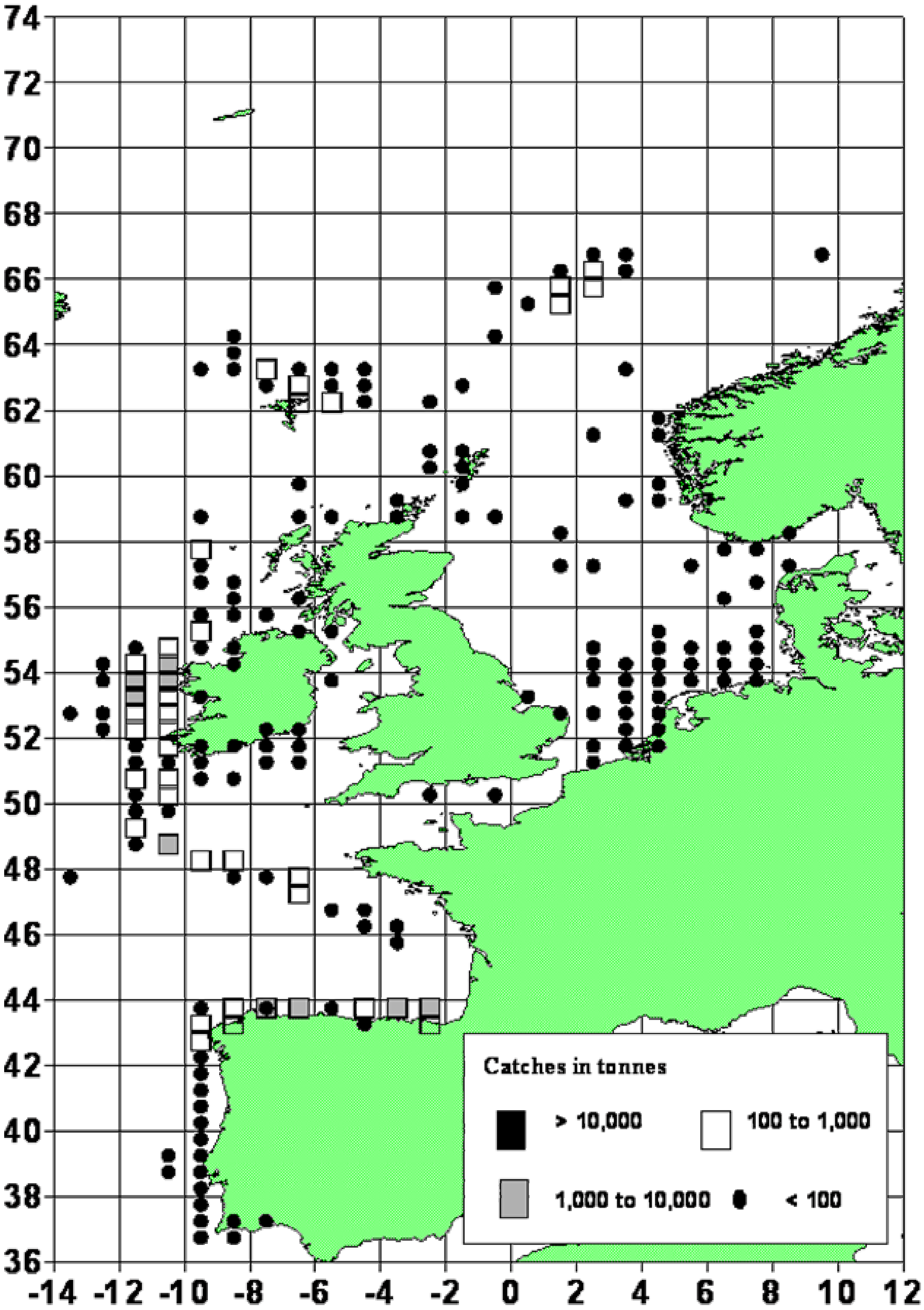


Figure 2.7.1.2. Mackerel commercial catches in quarter 2 2002.

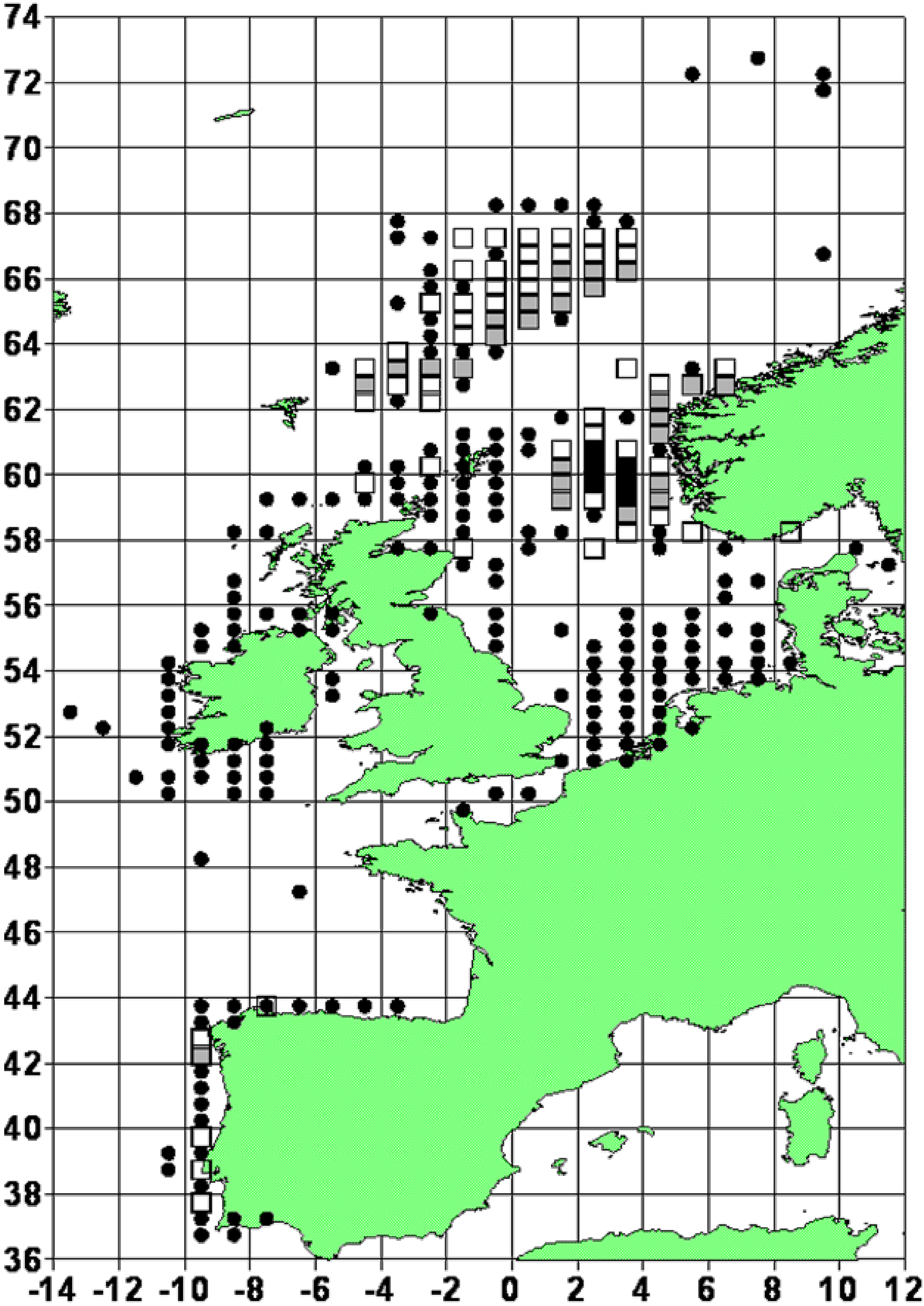


Figure 2.7.1.3. Mackerel commercial catches in quarter 3 2002.

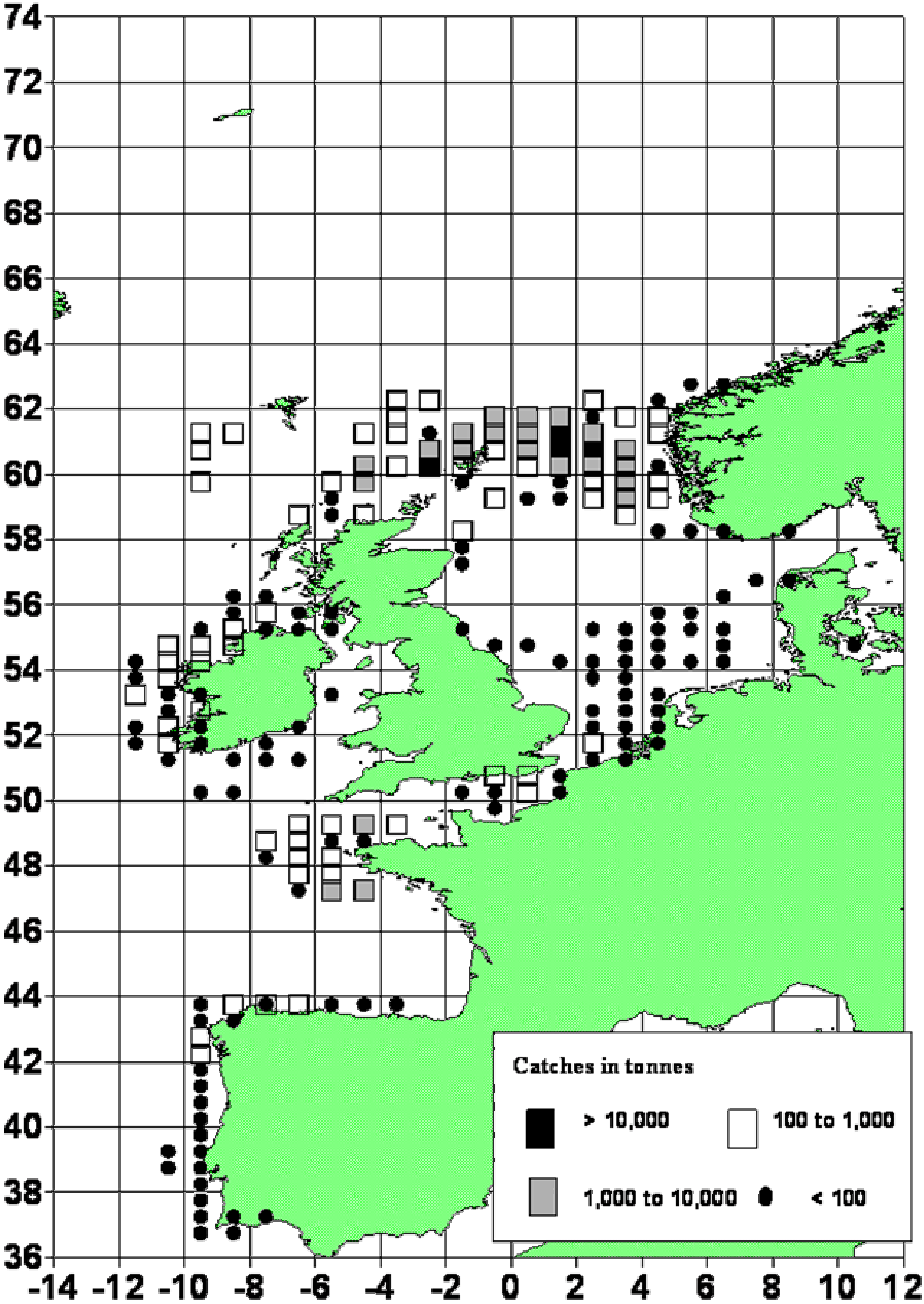


Figure 2.7.1.4. Mackerel commercial catches in quarter 4 2002.

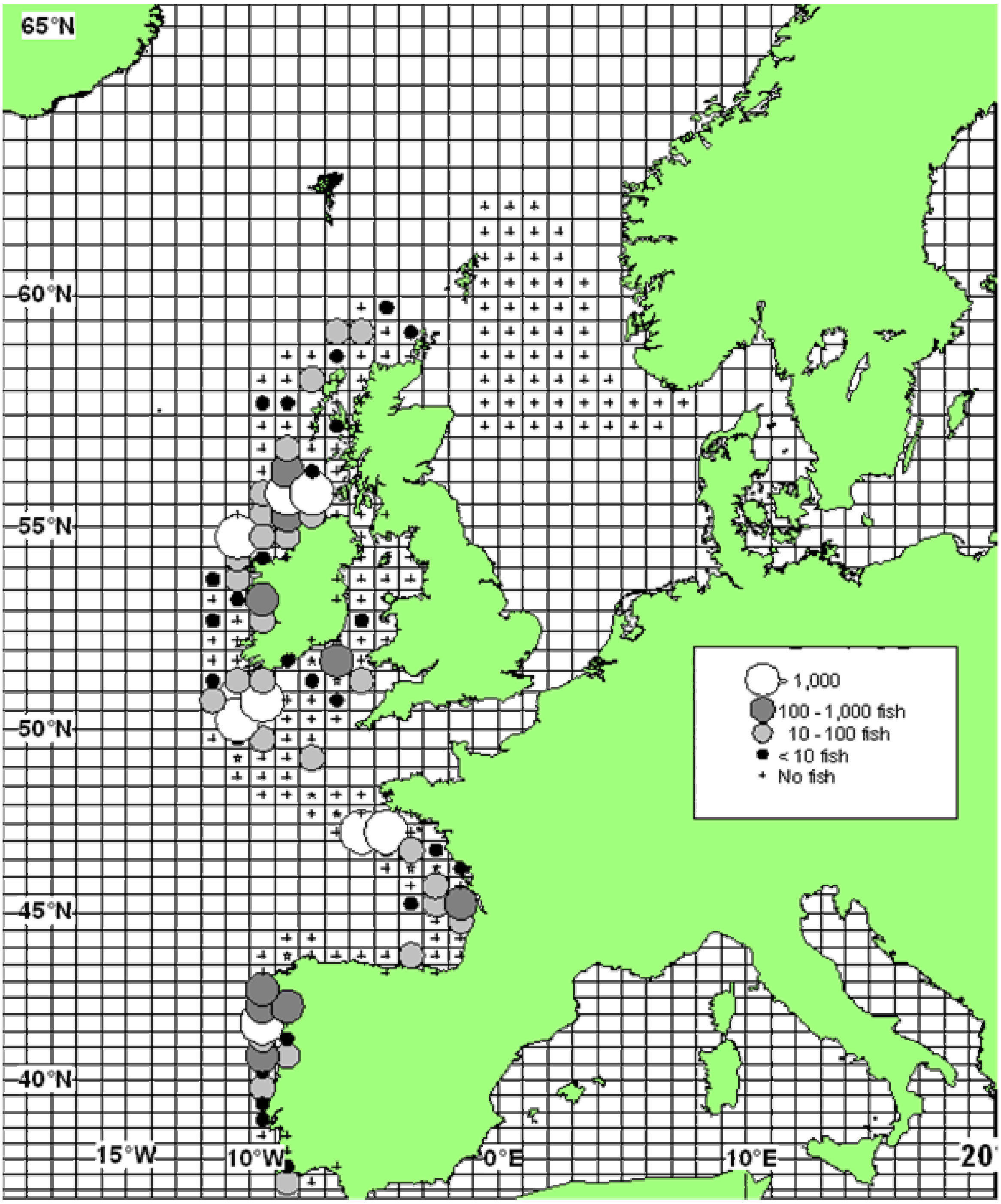


Figure 2.7.2.1. Distribution of mackerel recruits, 2002 year class age 0 in quarter 4, 2002.

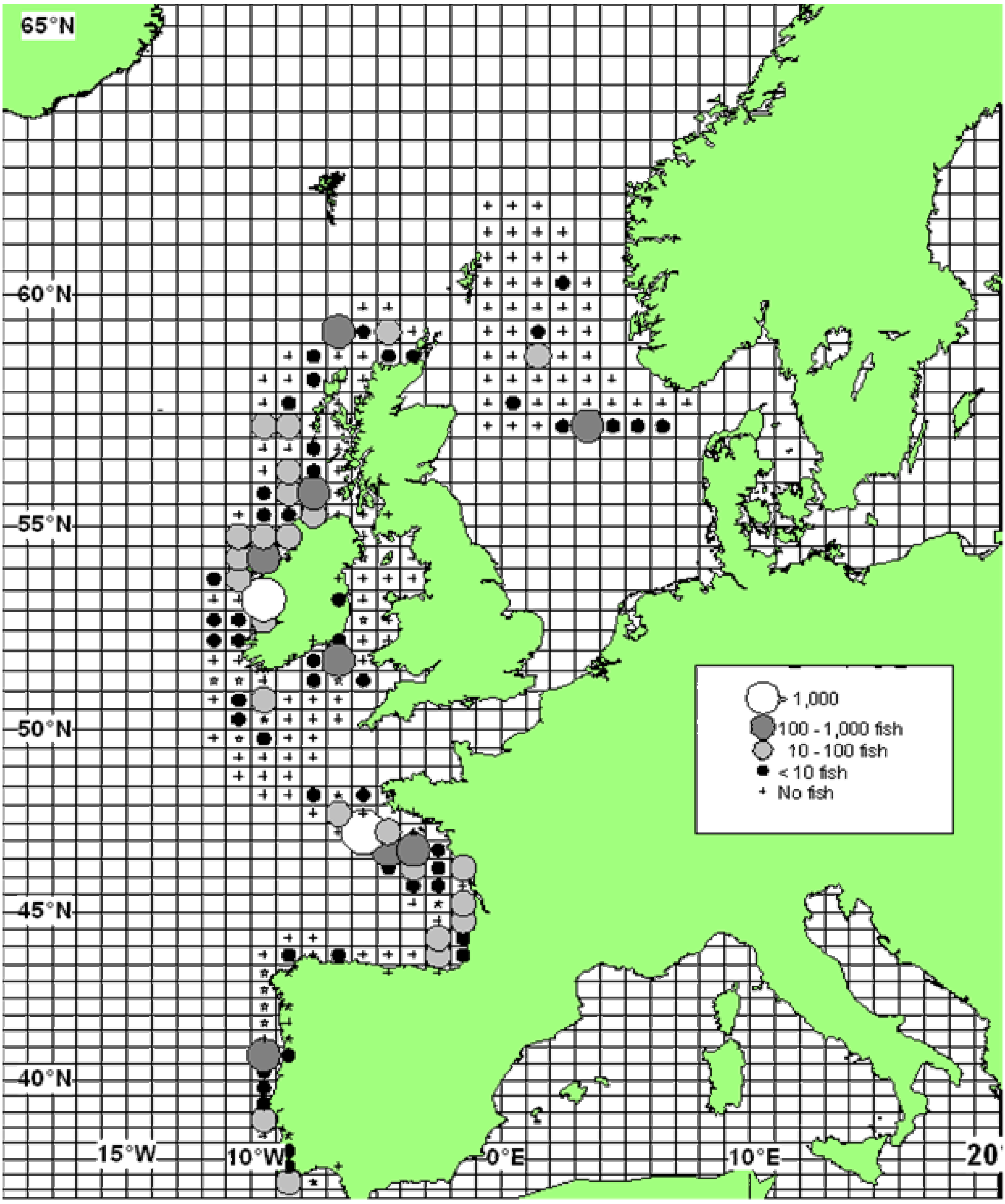


Figure 2.7.2.2. Distribution of mackerel recruits, 2001 year class age 1 in quarter 4, 2002.

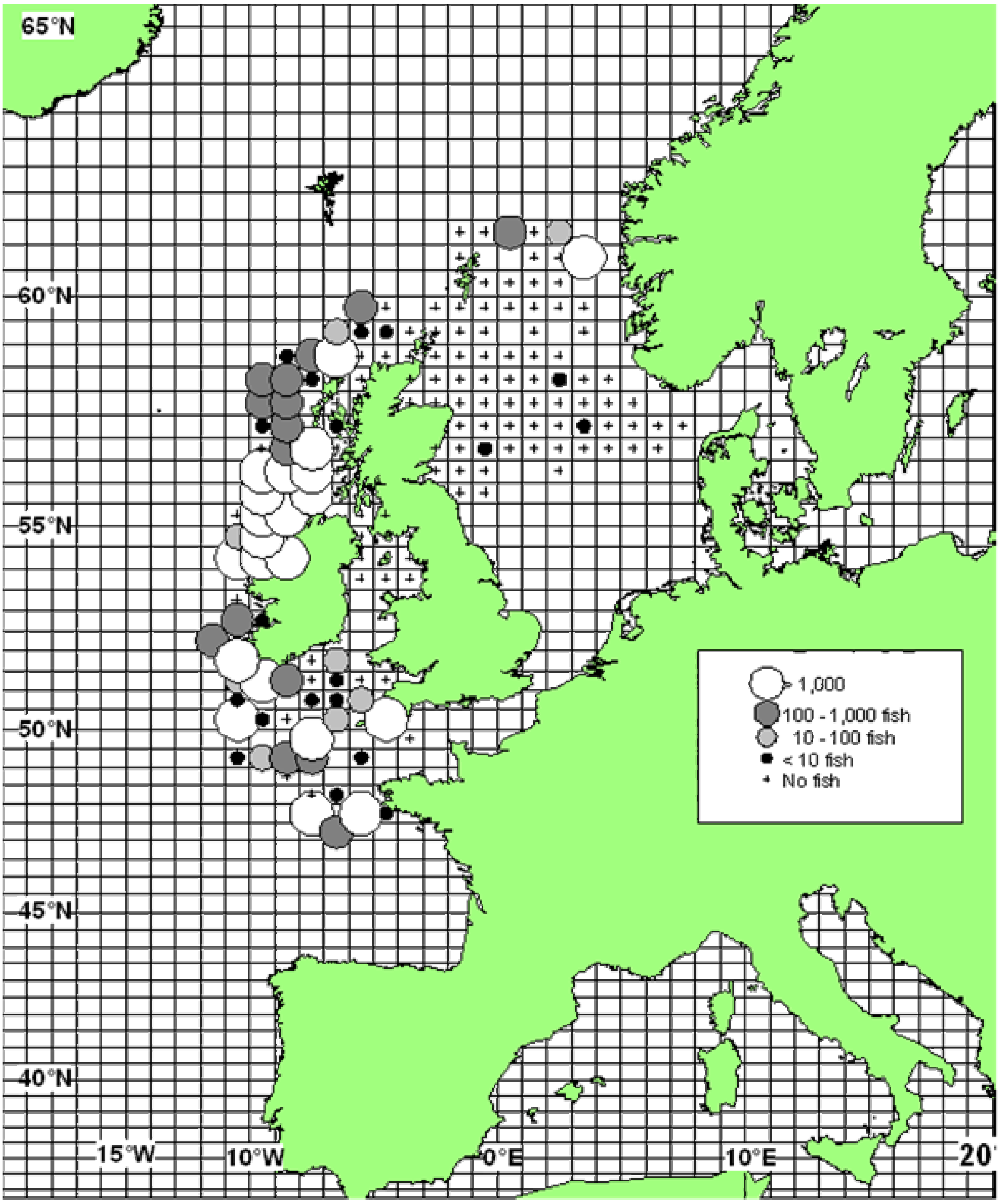


Figure 2.7.2.3. Distribution of mackerel recruits, 2002 year class age 1 in quarter 1, 2003.

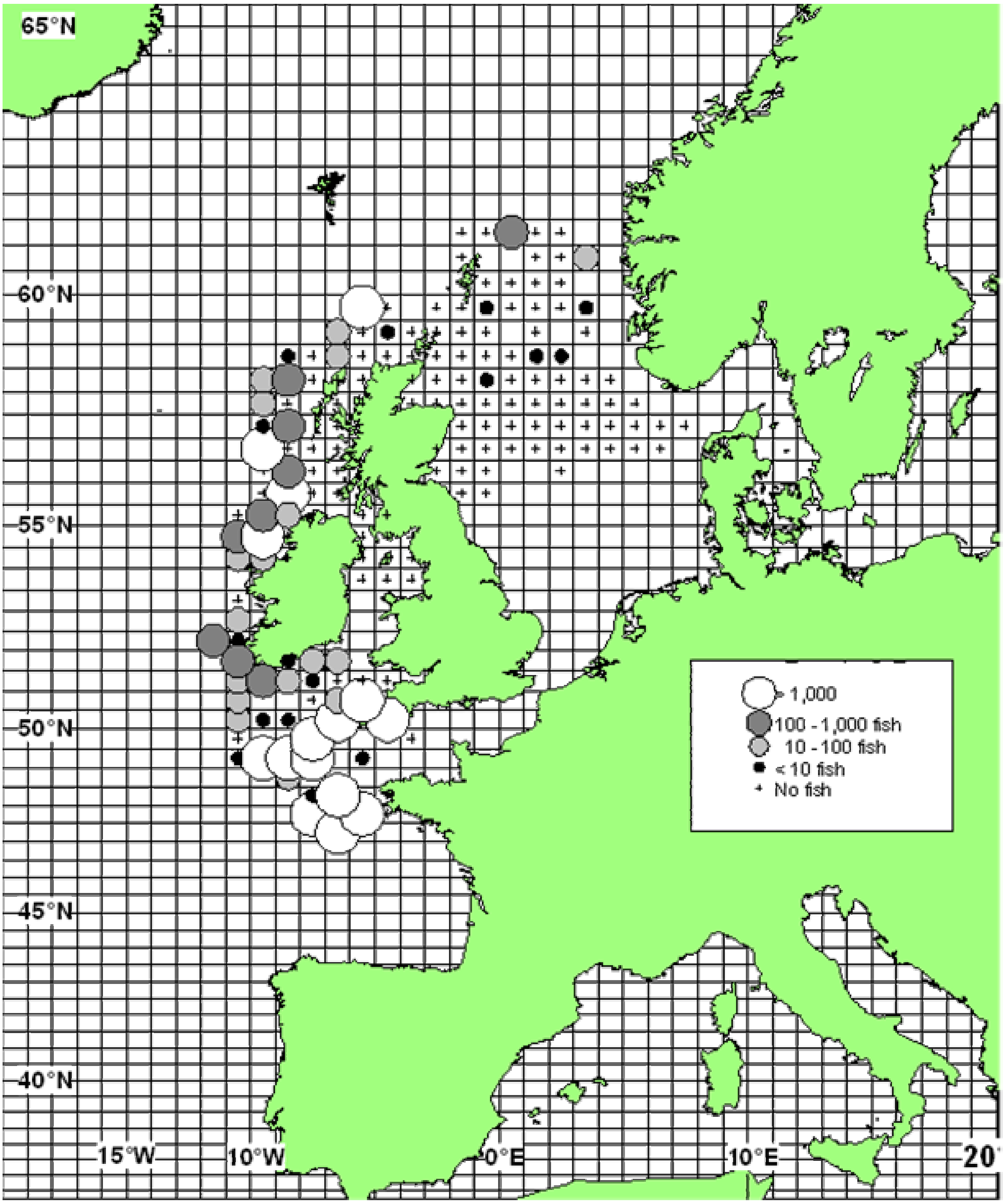


Figure 2.7.2.4. Distribution of mackerel recruits, 2001 year class age 2 in quarter 1, 2003.

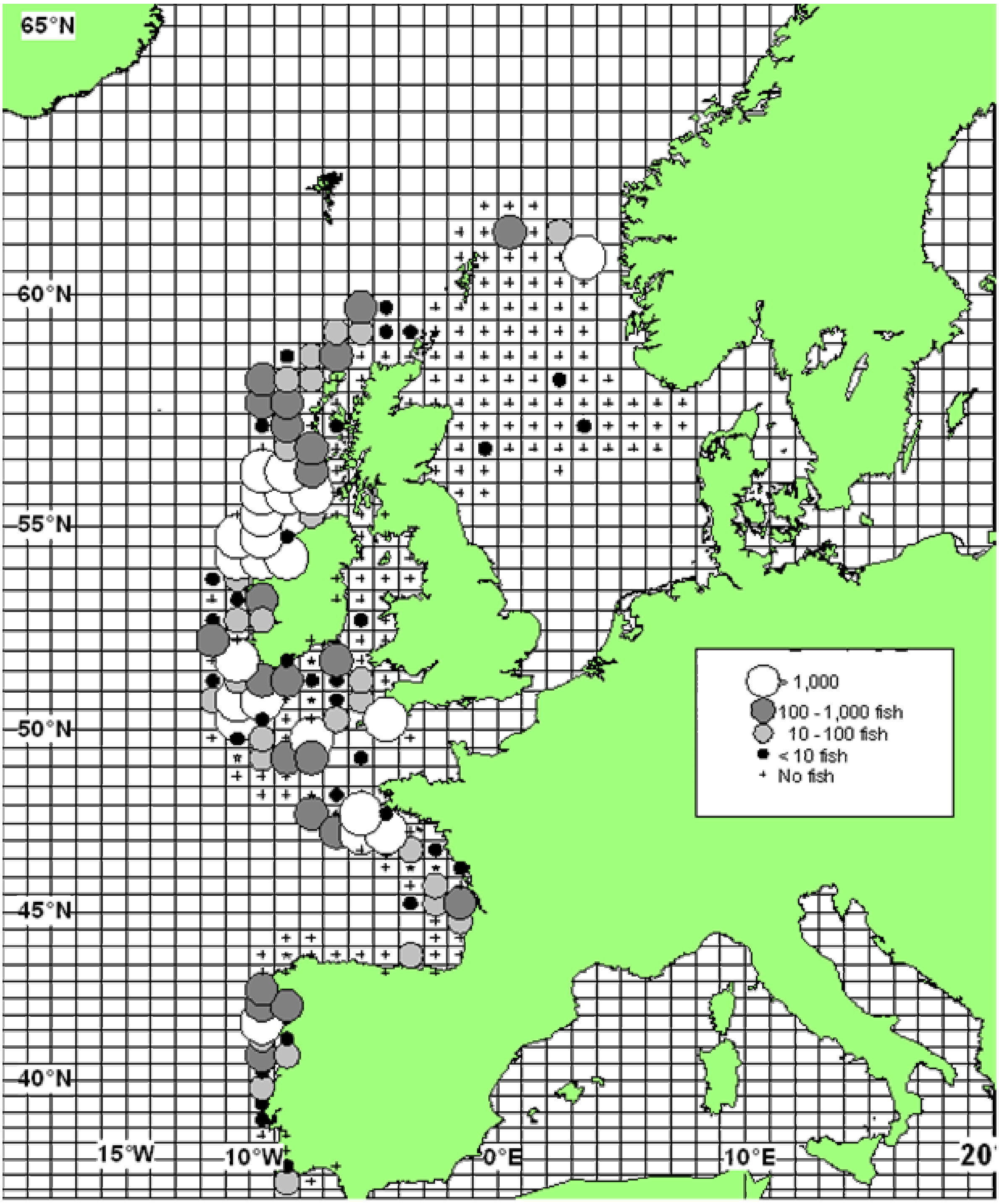


Figure 2.7.2.5. Distribution of mackerel recruits. 2002 year class in 1st winter (2002/2003).

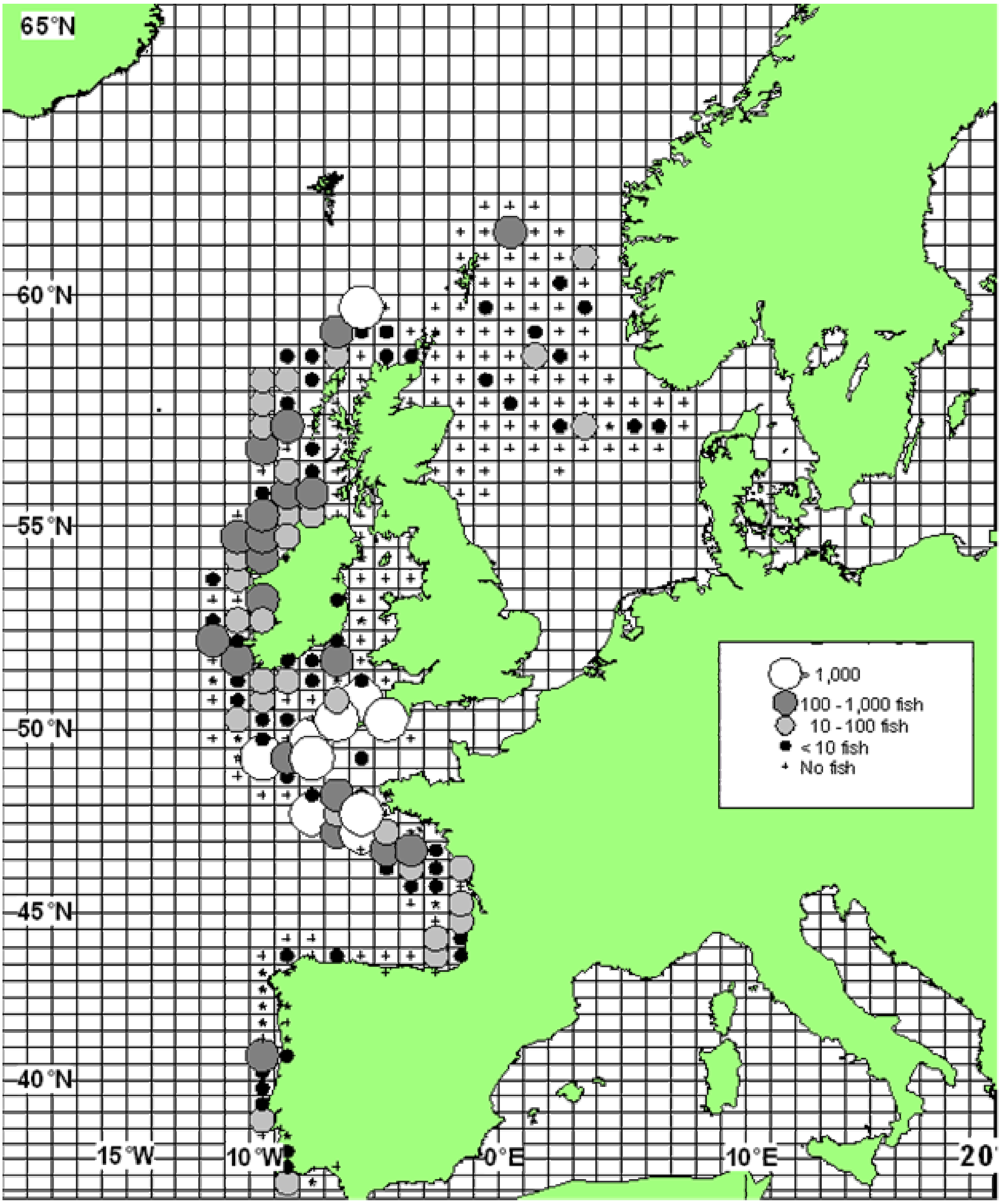


Figure 2.7.2.6. Distribution of mackerel recruits. 2001 year class in 2nd winter (2002/2003).

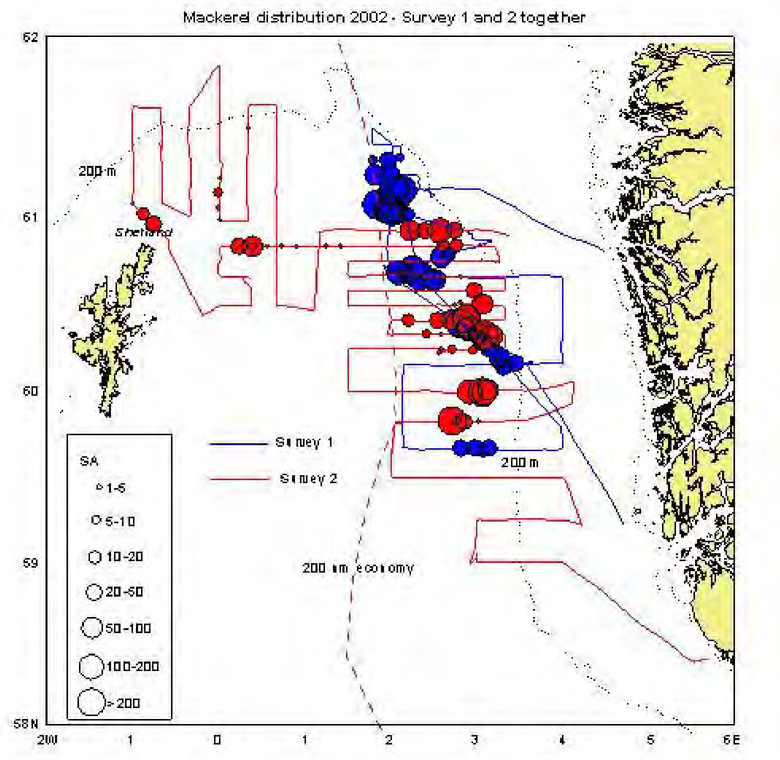


Figure 2.7.3.1 Cruise track and NASC values for the IMR 2002 survey

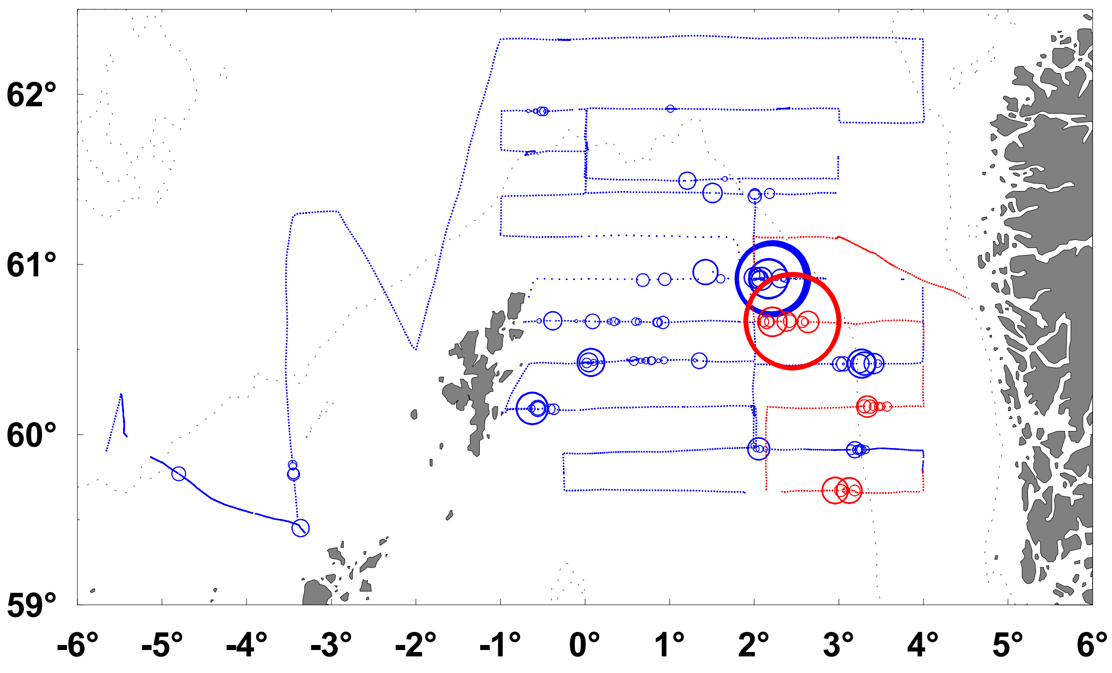


Figure 2.7.3.2 Map of the northern North Sea and a post plot of the distribution of mackerel. Circle size proportional to NASC attributed to mackerel, from the combined acoustic survey in October 2002: red circles = G.O. Sars; blue circles = Scotia; on a square root scale relative to a maximum value of 971 $m^2.nmi.^{-2}$.

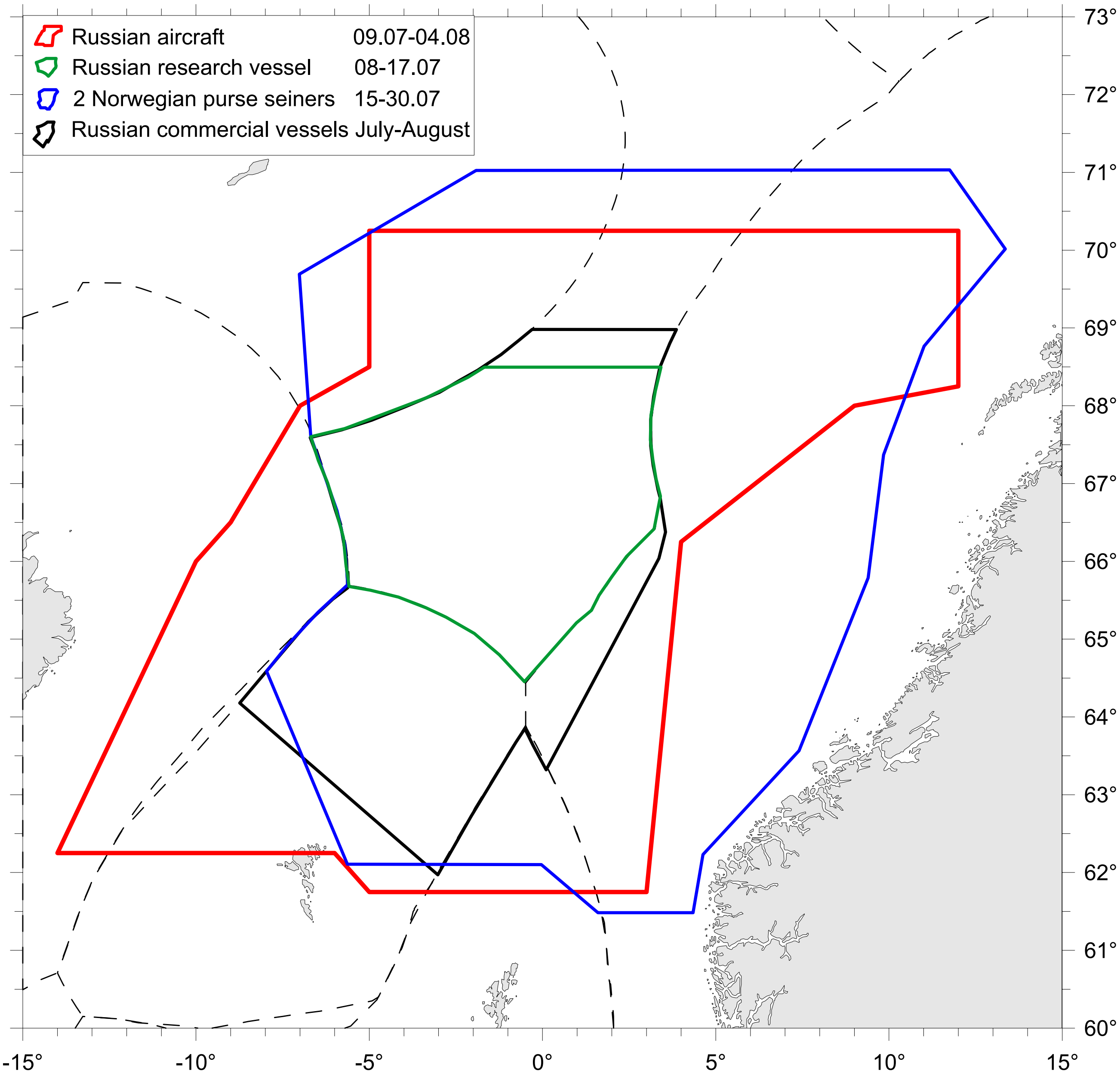


Figure 2.7.4.1 Areas covered by the Russian airplane, research and commercial vessels and by the Norwegian purse seiners during July – early August 2003

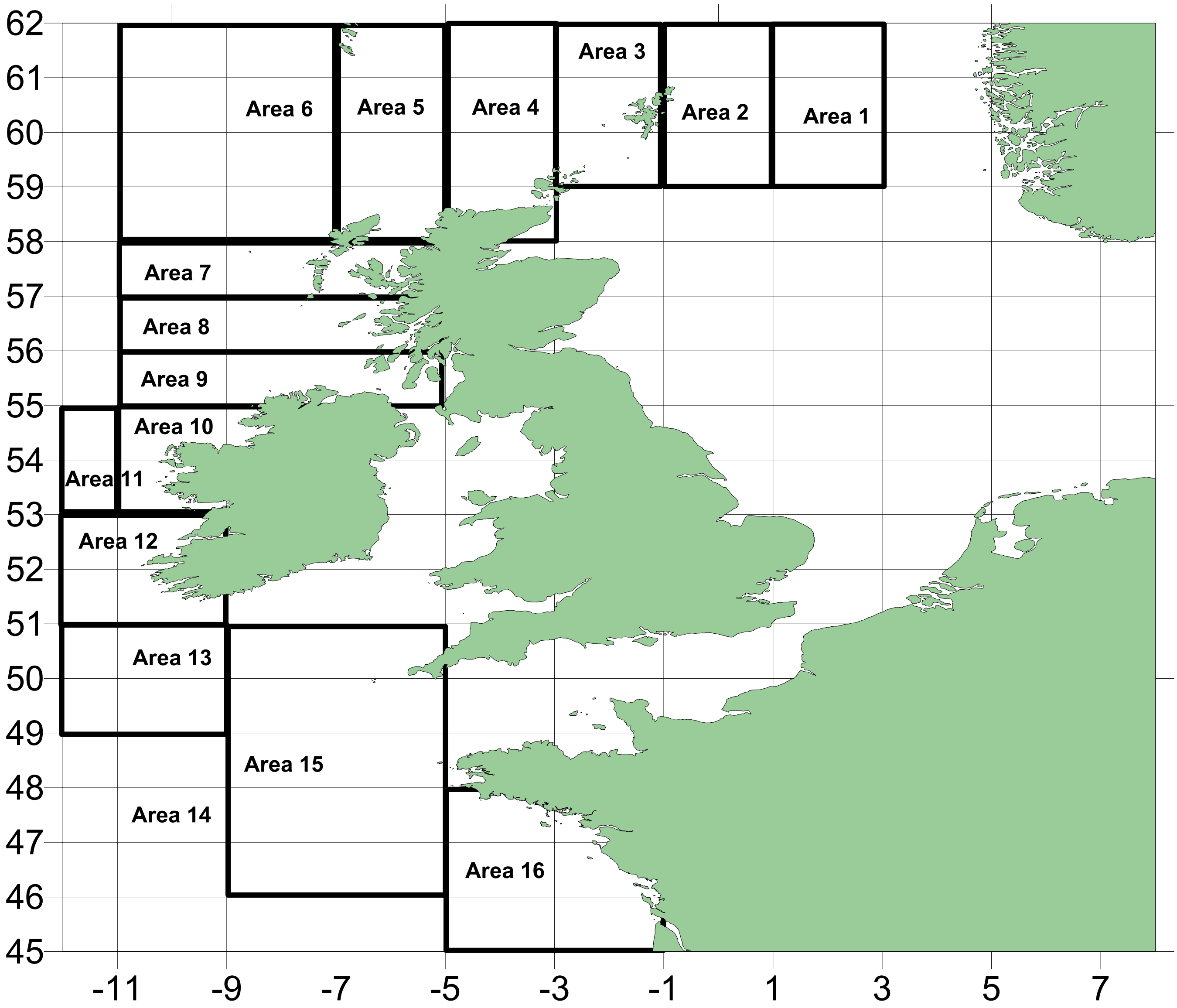


Figure 2.7.5.1 Map showing sea areas used in the migrations analysis.

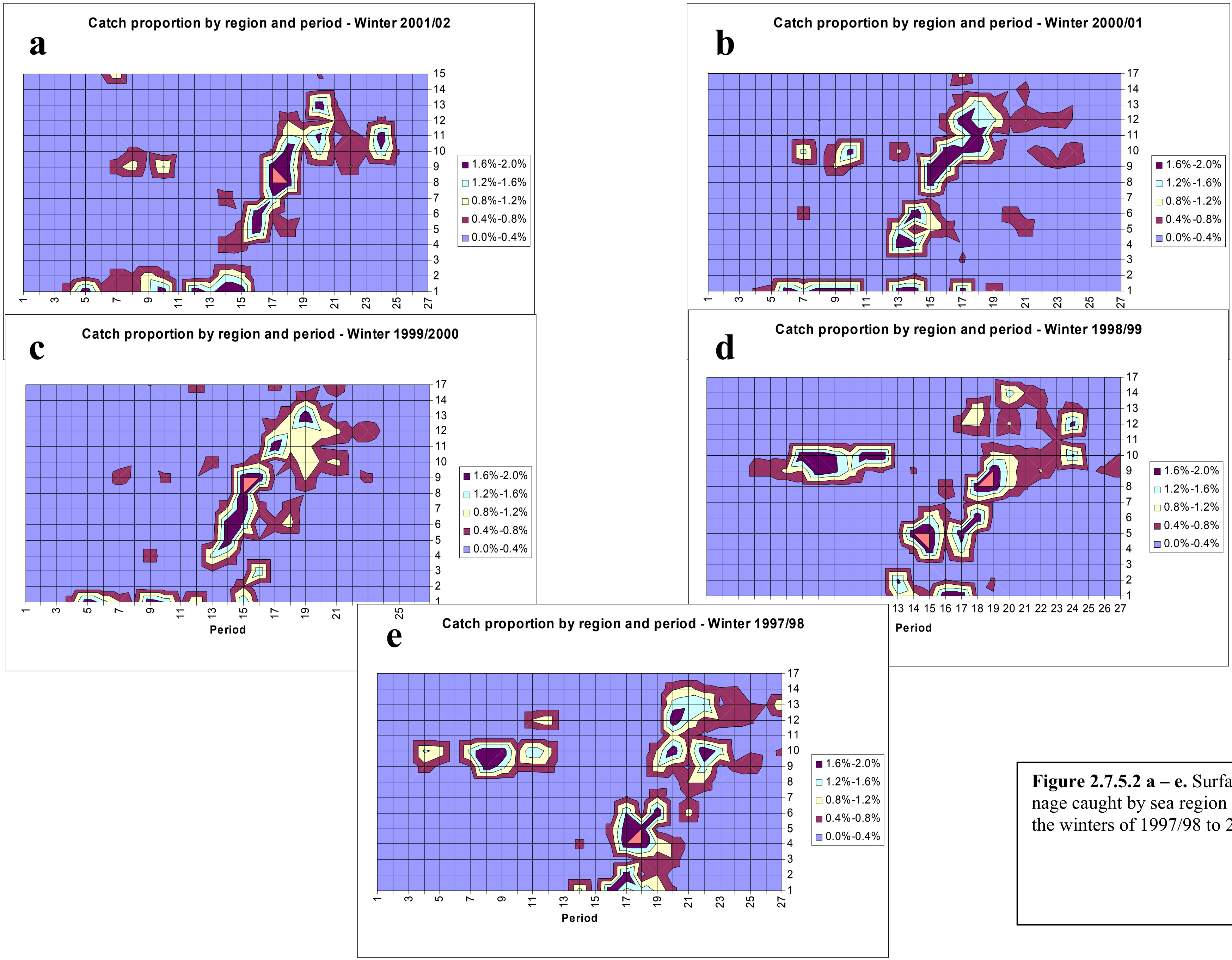


Figure 2.7.5.2 a – e. Surface plots of tonnage caught by sea region and period for the winters of 1997/98 to 2001/02

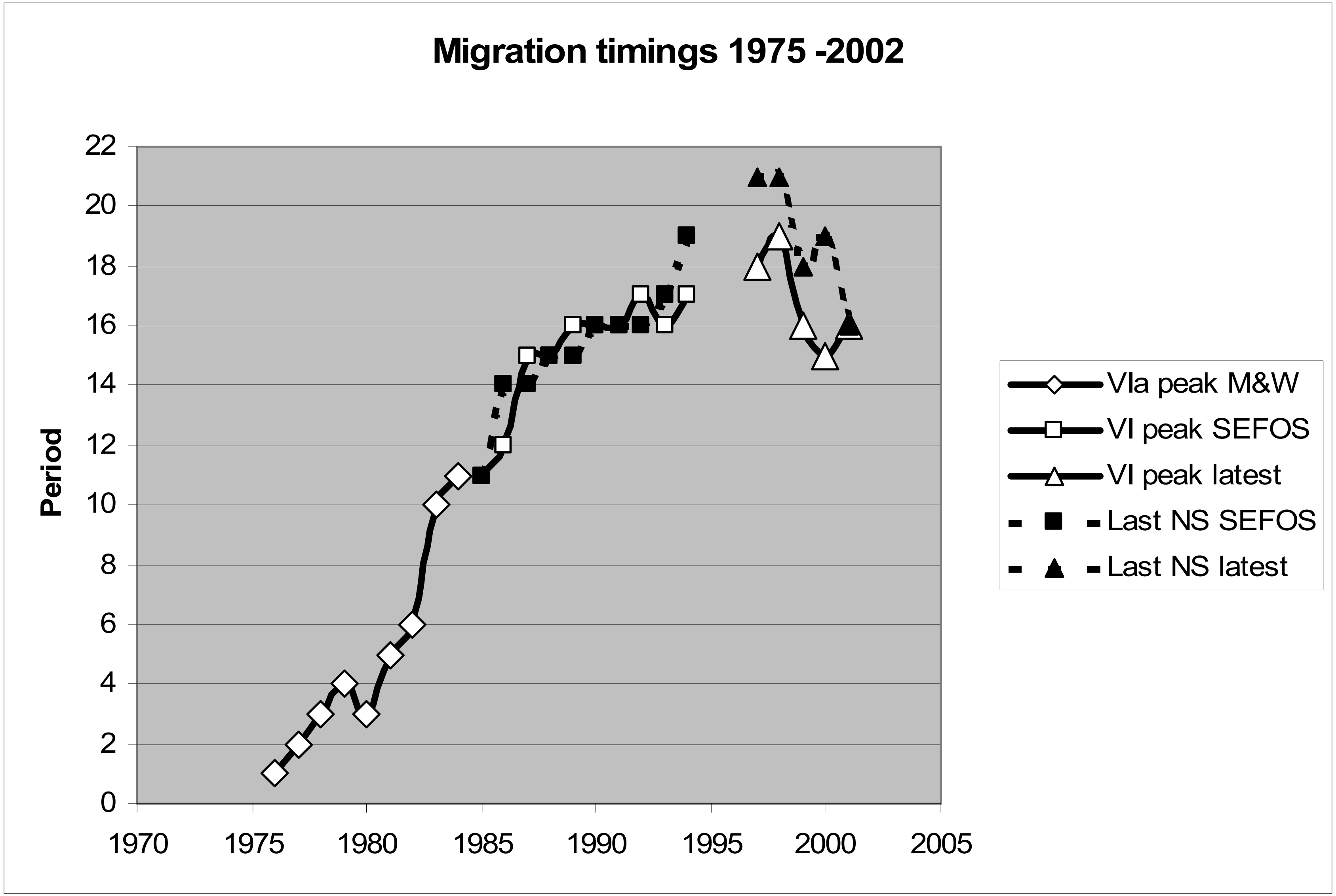
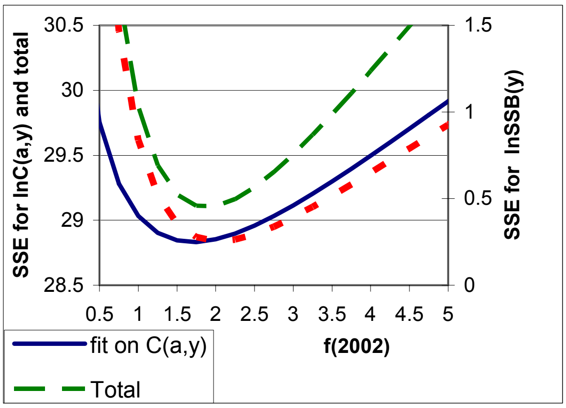
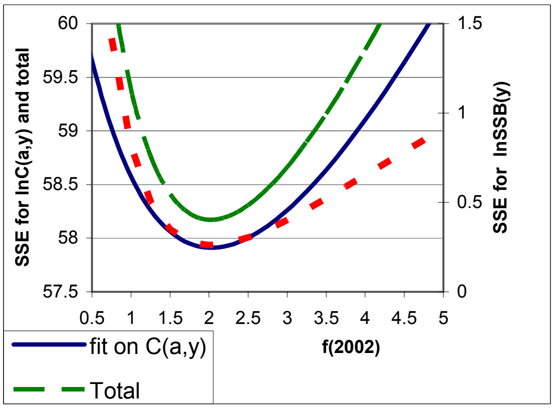


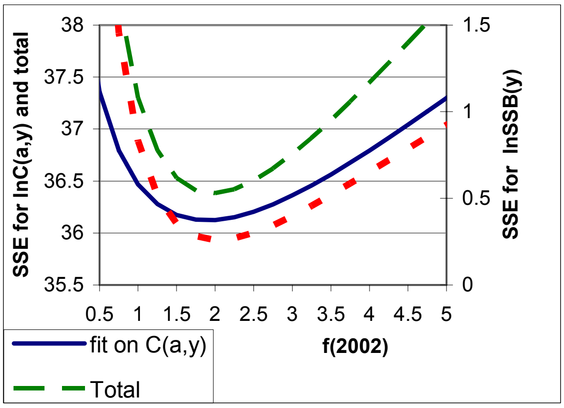
Figure 2.7.5.3. Plot of period of peak fishing in VIa and period of last fishing in the North Sea from historic data and present study



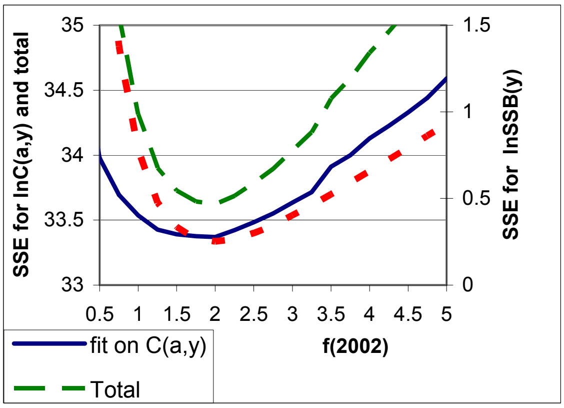
a. ISVPA catch-controlled version,
unbiased residuals in LnC(a,y)



b. ISVPA effort-controlled version,
unbiased residuals in LnC(a,y)

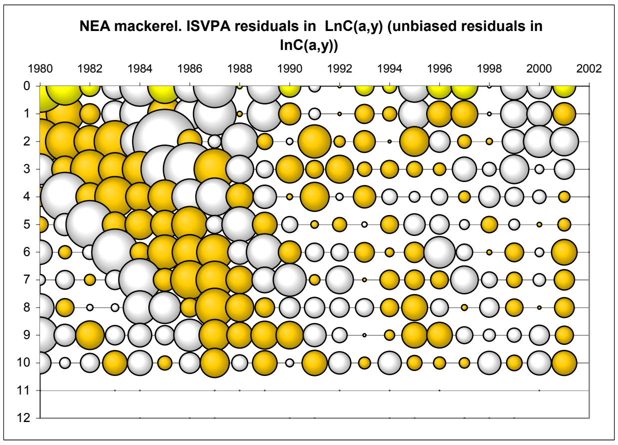


c. ISVPA mixed version,
unbiased residuals in LnC(a,y)



d. ISVPA mixed version,
free from conditions on bias

Figure 2.8.1 Profiles of different ISVPA versions applied to NEA mackerel data.



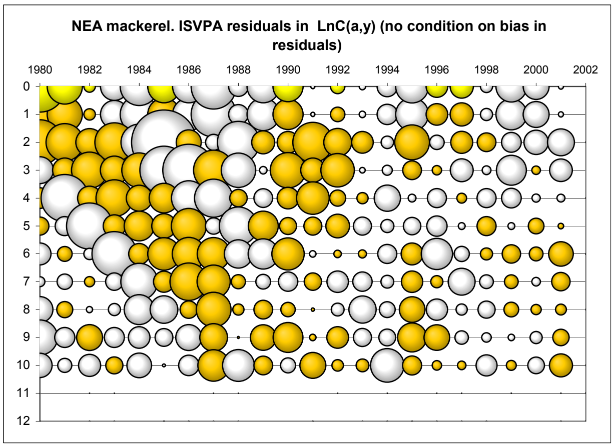


Figure 2.8.2 **NEA mackerel.** Patterns of residuals in logarithmic catch-at-age for mixed version of ISVPA, restricted by condition of unbiasedness and without this restriction.

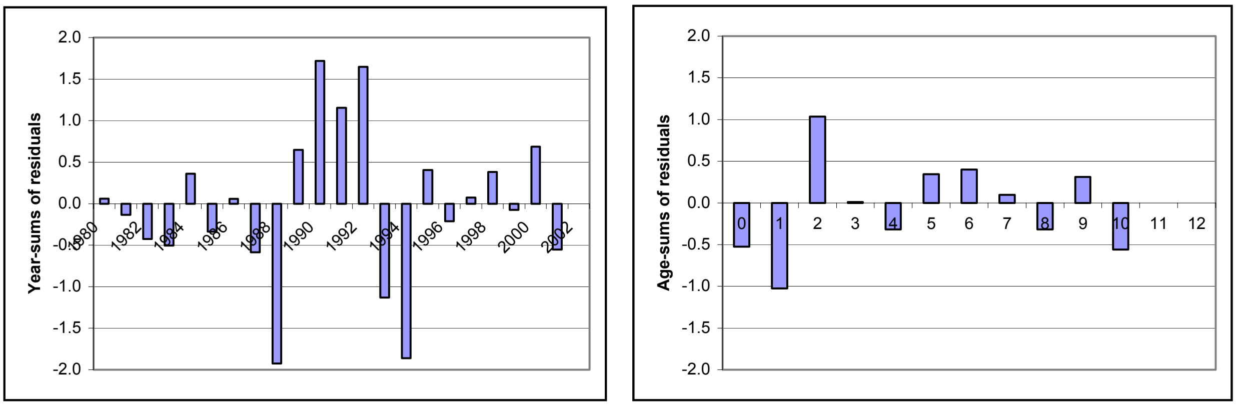


Figure 2.8.3 **NEA mackerel.** Sums of residuals in logarithmic catches for the ISVPA, mixed version, no conditions on bias applied. (For the «conditioned" version they are zero by definition).

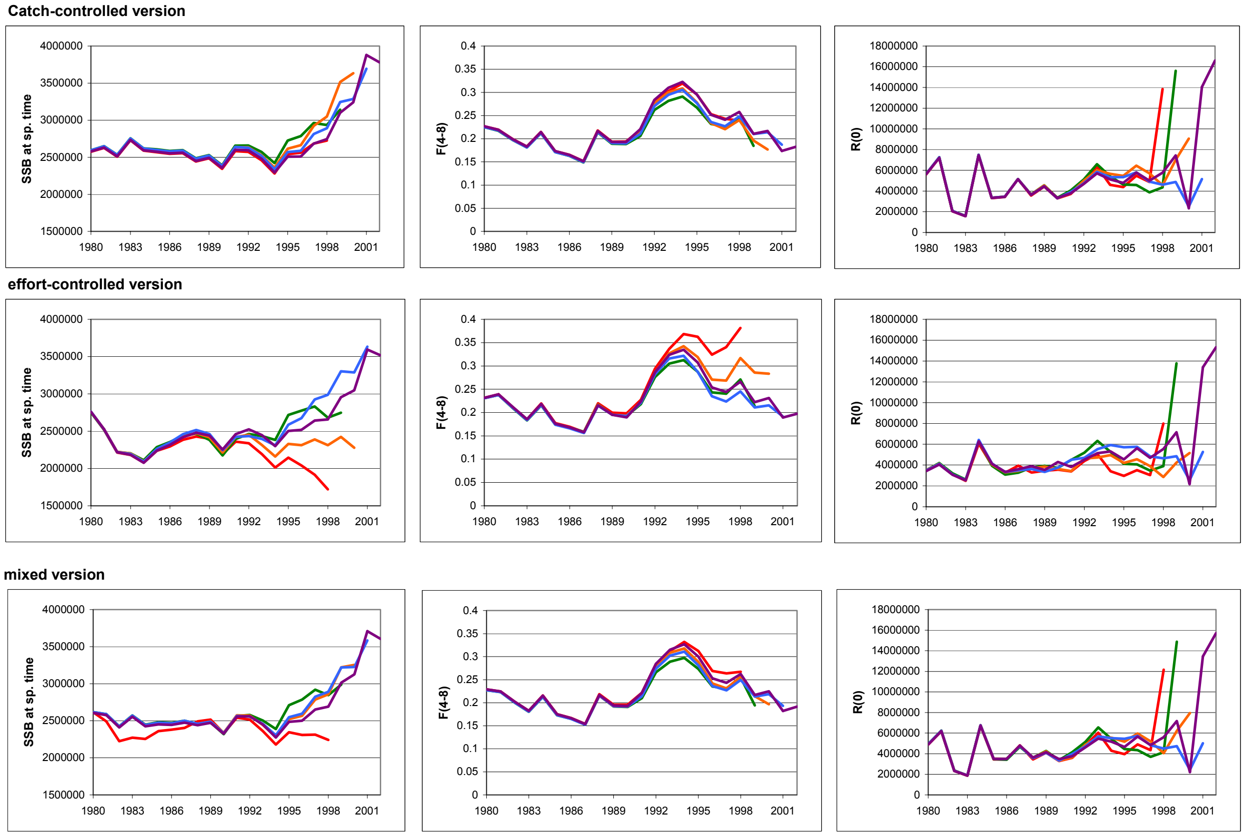
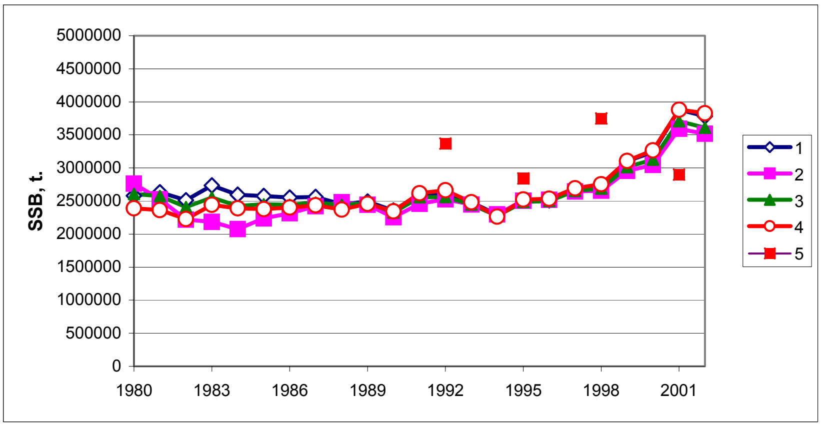
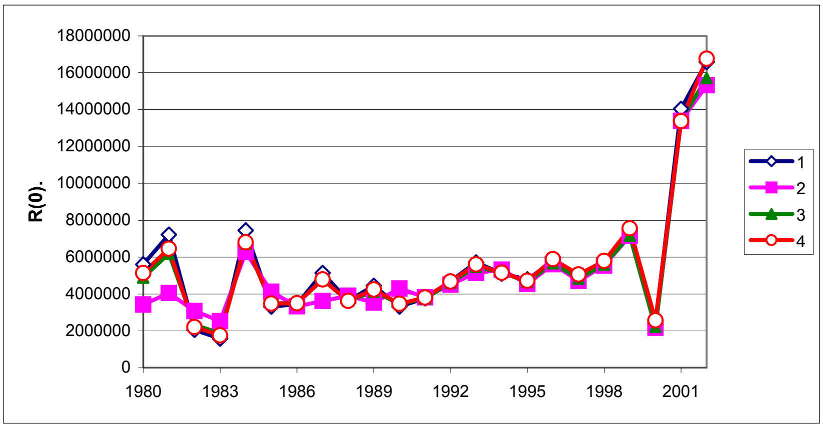


Figure 2.8.4 **NEA mackerel.** Retrospective runs with different ISVPA versions.





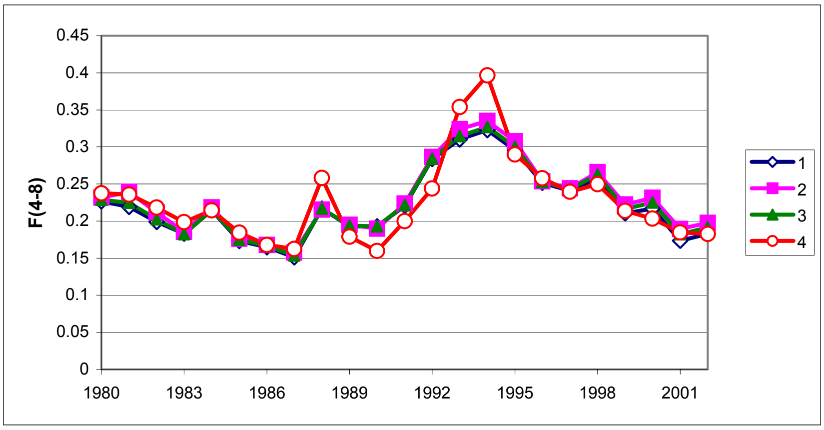
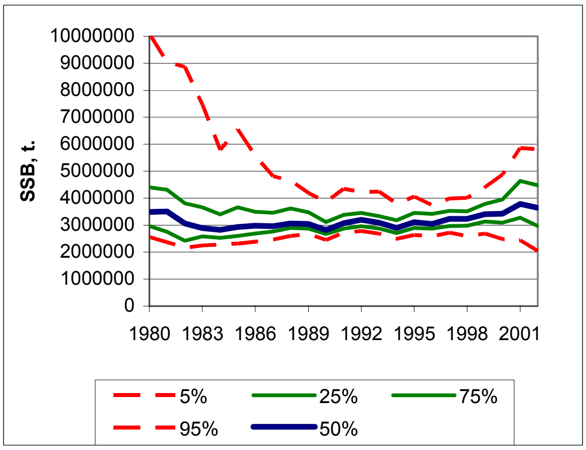


Figure 2.8.5 **NEA Mackerel.** Comparison of different ISVPA versions:

1- catch-controlled, "unbiased" residuals in lnC(a,y)
2- effort-controlled, "unbiased" residuals in lnC(a,y)
3- mixed, "unbiased" residuals in lnC(a,y)
4- mixed, no restriction on residuals
5 - egg surveys



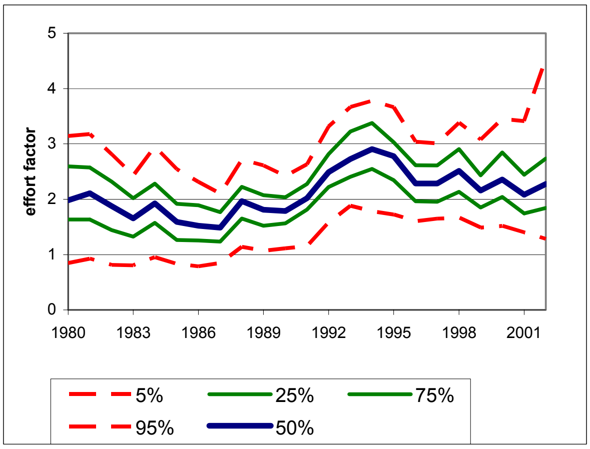


Figure 2.8.6 **NEA Mackerel.** ISVPA, results of bootstrap

Figure 2.8.7
AMCI assessment runs for NEA mackerel
Key: Fitting to tag recapture data and SSB as well as to catches. Weighting 10 on SSB data
Notags: As key run, but without using the tag recapture data
Low w. SSB: As key run, but weighting of SSB data set to 1.
ICA: Taken from the adopted ICA assessment for comparison

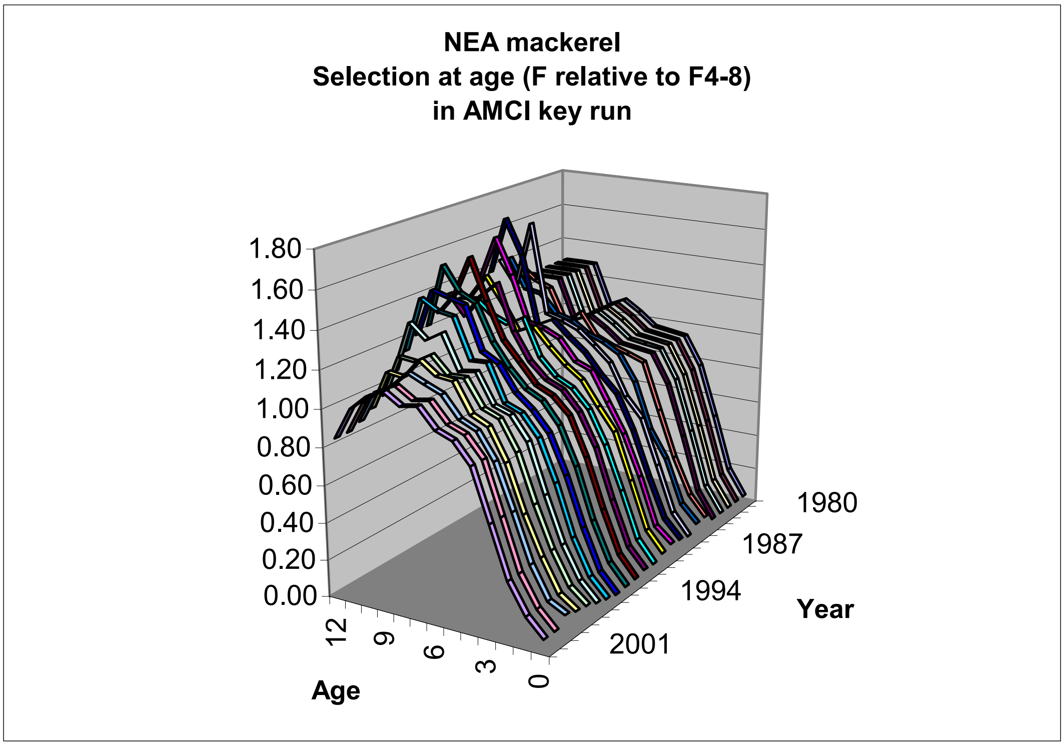
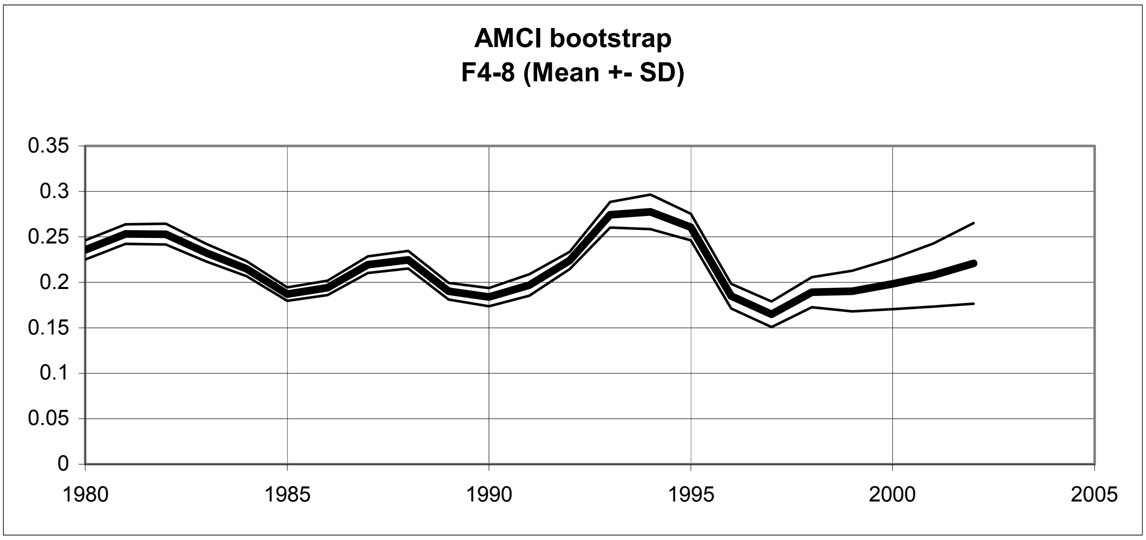
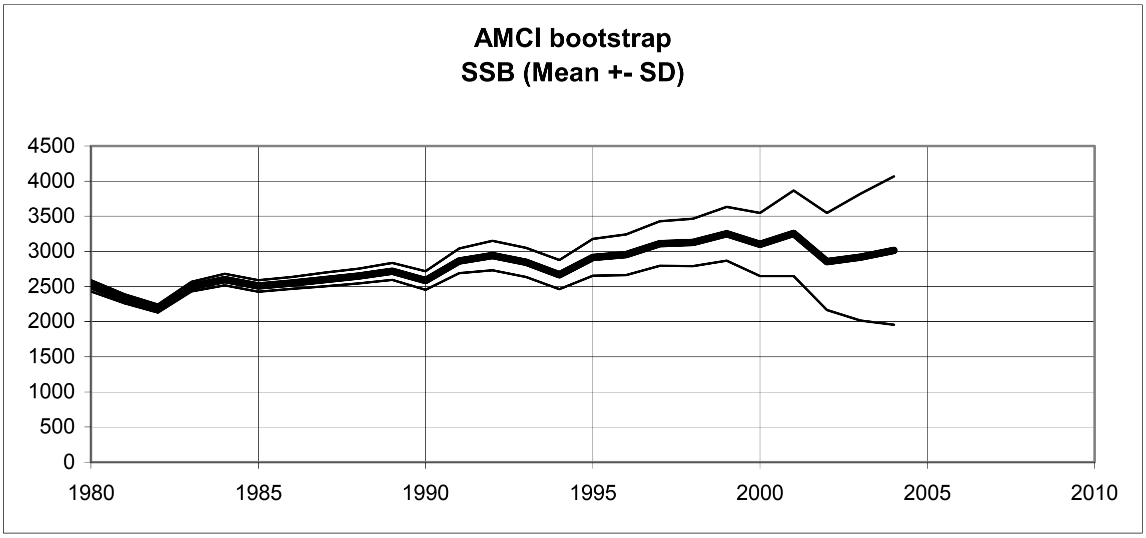


Figure 2.8.8 NEA mackerel
Selection at age (F at age relative to F4-8)





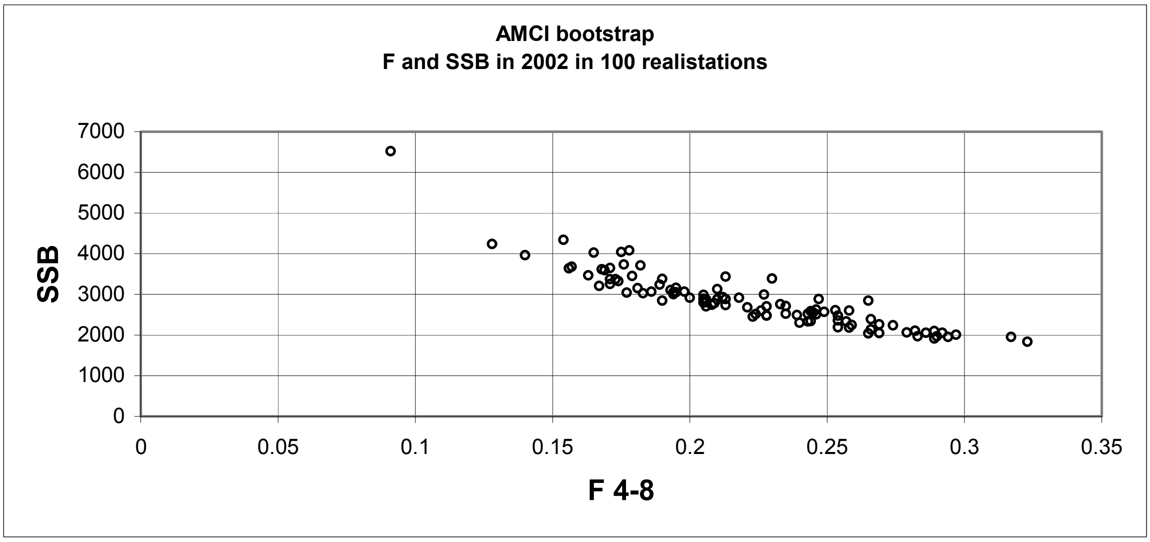


Figure 2.8.9 NEA mackerel
Uncertainty estimates by bootstrap of AMCI key run for NEA mackerel

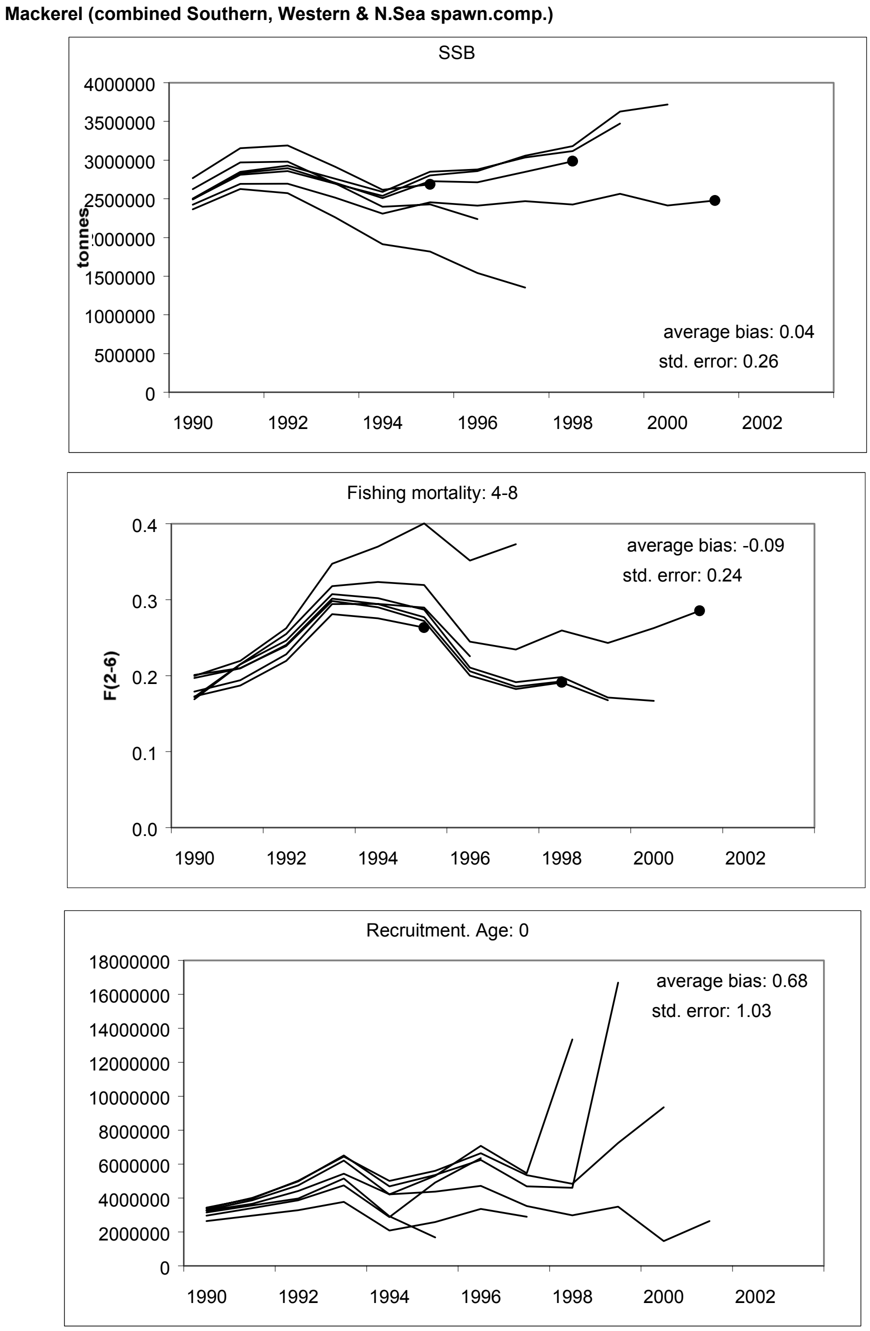


Figure 2.8.10 **NEA mackerel.** Retrospective performance of ICA assessment with Egg Survey used as a relative index, Assessments with Egg Surveys in the terminal year are shown with *. Bias and Std error are calculated following the method of Jonsson, S. T. and E. Hjorleifsson (2000).

Mackerel (combined Southern, Western & N.Sea spawn.comp.)

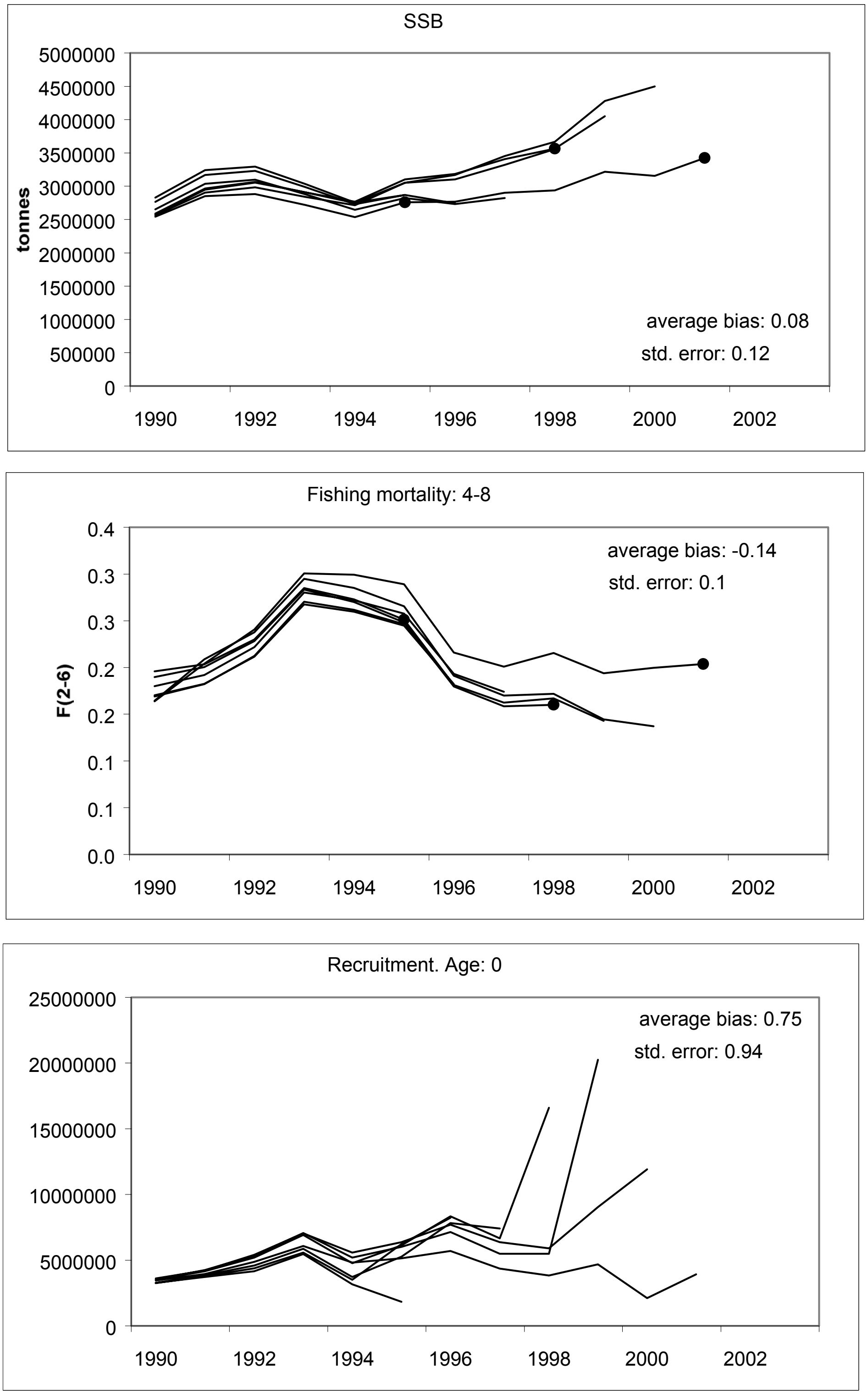


Figure 2.8.11 **NEA mackerel.** Retrospective performance of ICA assessment with Egg Survey used as an absolute index, Assessments with Egg Surveys in the terminal year are shown with *. Bias and Std error are calculated following the method of Jonsson, S. T. and E. Hjorleifsson (2000).

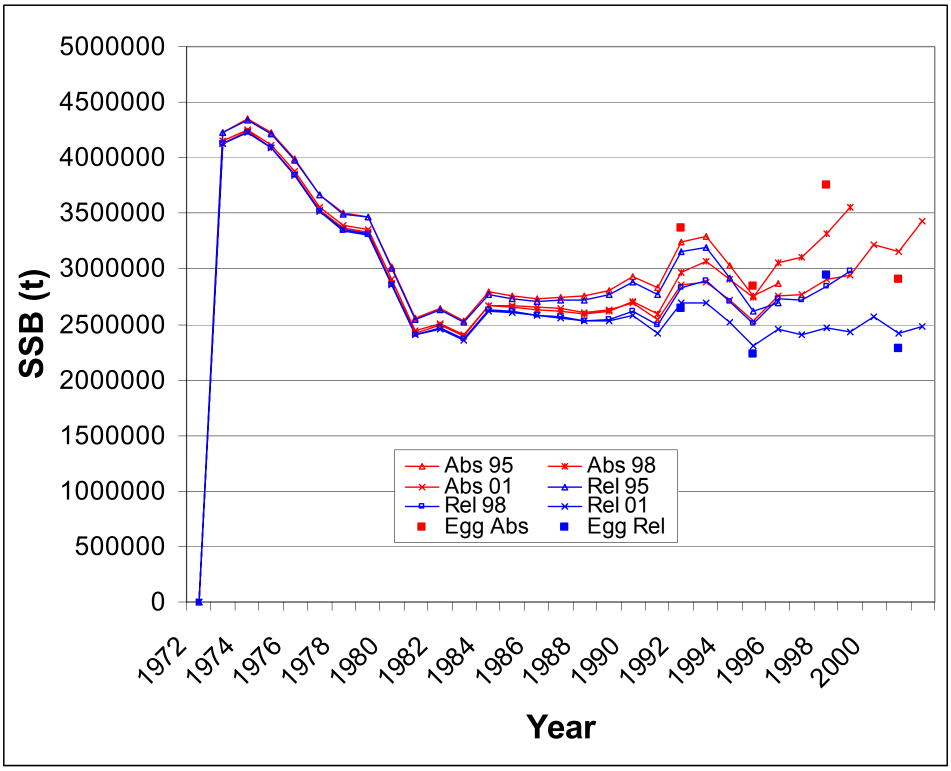


Figure 2.8.12 **NEA mackerel.** Comparision of SSB from assessments with an Egg Survey in the terminal year using the survey as absolute (grey) and relative (black). Egg Suvey values are shown for four years as absolute (grey squares) and as relative moved by the fitted value from the assessment (black squares).

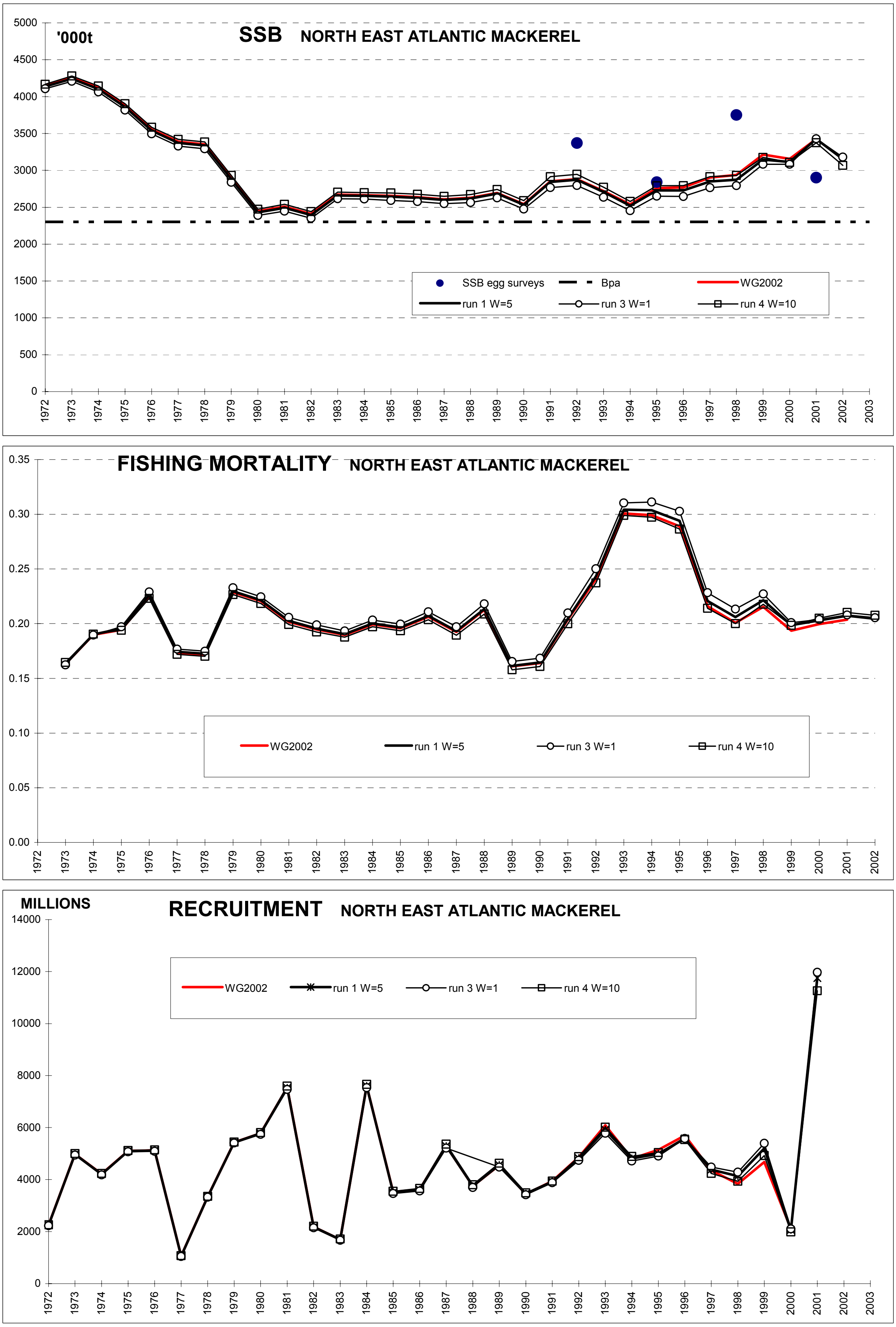


Figure 2.8.13 NEA mackerel
SSB, F and recruitment estimates (ICA) obtained from three test runs in comparison to last years assessment (WG2002). Assessment input parameters the same as last year (tuning to absolute SSB) except period of separable constraint was extended to 11 years to cover the period 1992-2002 and variable survey weighting of 1, 10 compared to traditional weighting of 5.

Run 1: Survey weighting = 5
Run 3: Survey weighting = 1
Run 4: Survey weighting = 10

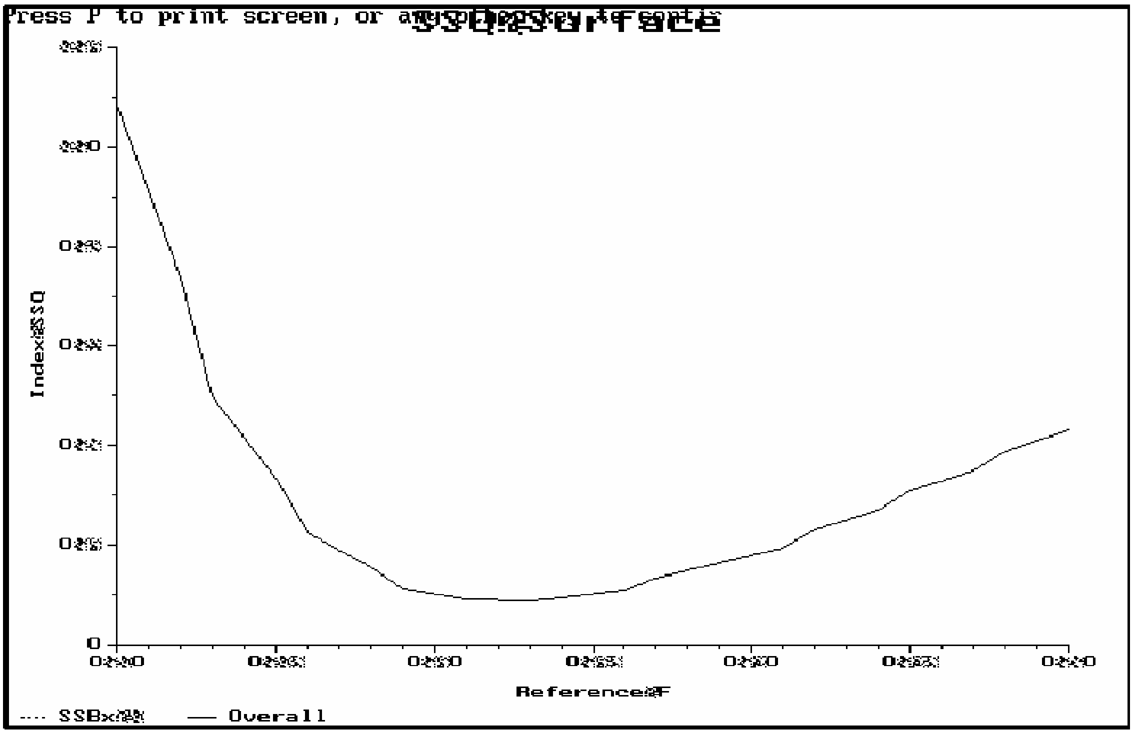


Figure 2.9.1.1 The sum of squares surface for the ICA separable VPA fit to the North East Atlantic mackerel egg survey biomass estimates (period of separable constraint 1992-2002).

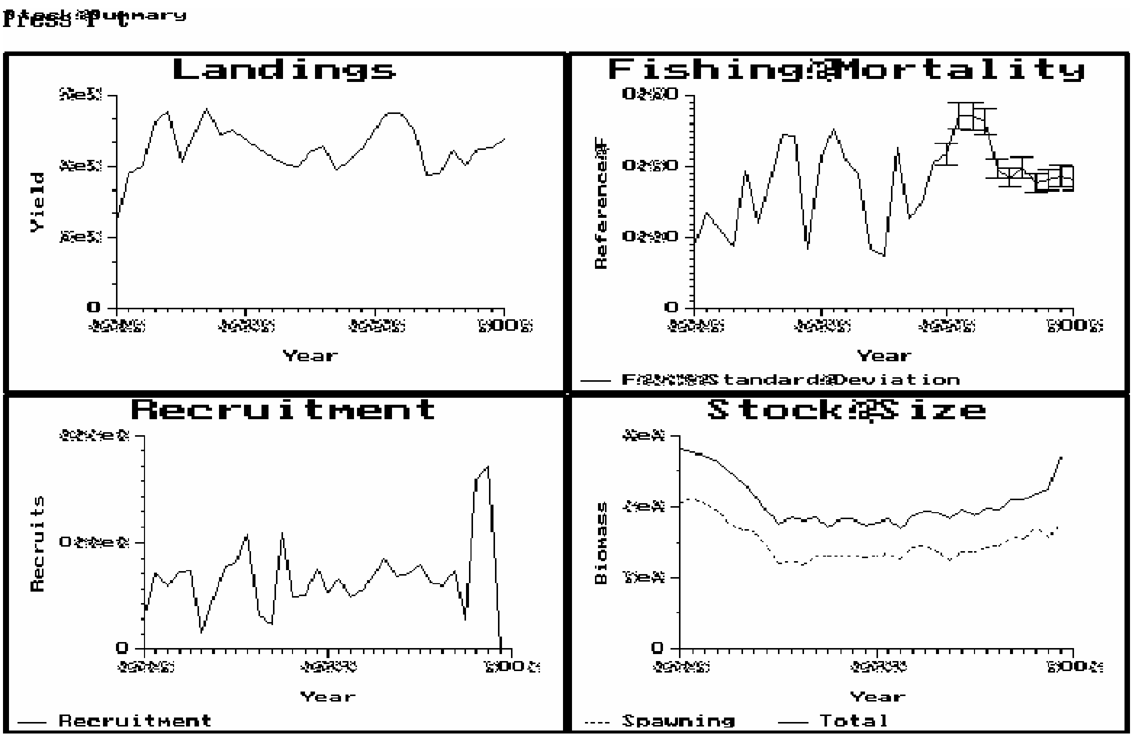


Figure 2.9.1.2 The long term trends in stock parameters for North East Atlantic mackerel. Only SSB estimates from egg surveys covering the range 1992-2001 are used in the biomass index.

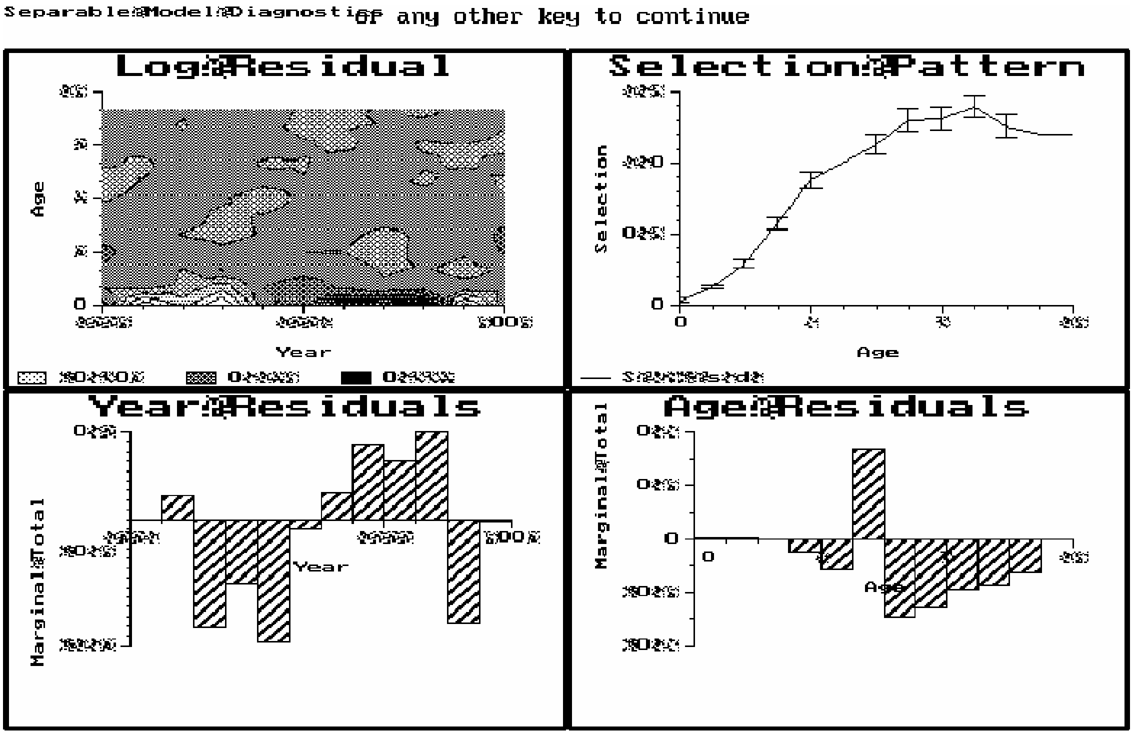


Figure 2.9.1.3 The catch at age residuals and ages fitted by ICA to the North East Atlantic Mackerel data. Only SSB estimates from egg surveys covering the range 1992-2002 are used in the biomass index and there is only one period of separable constraint (1992-2002).

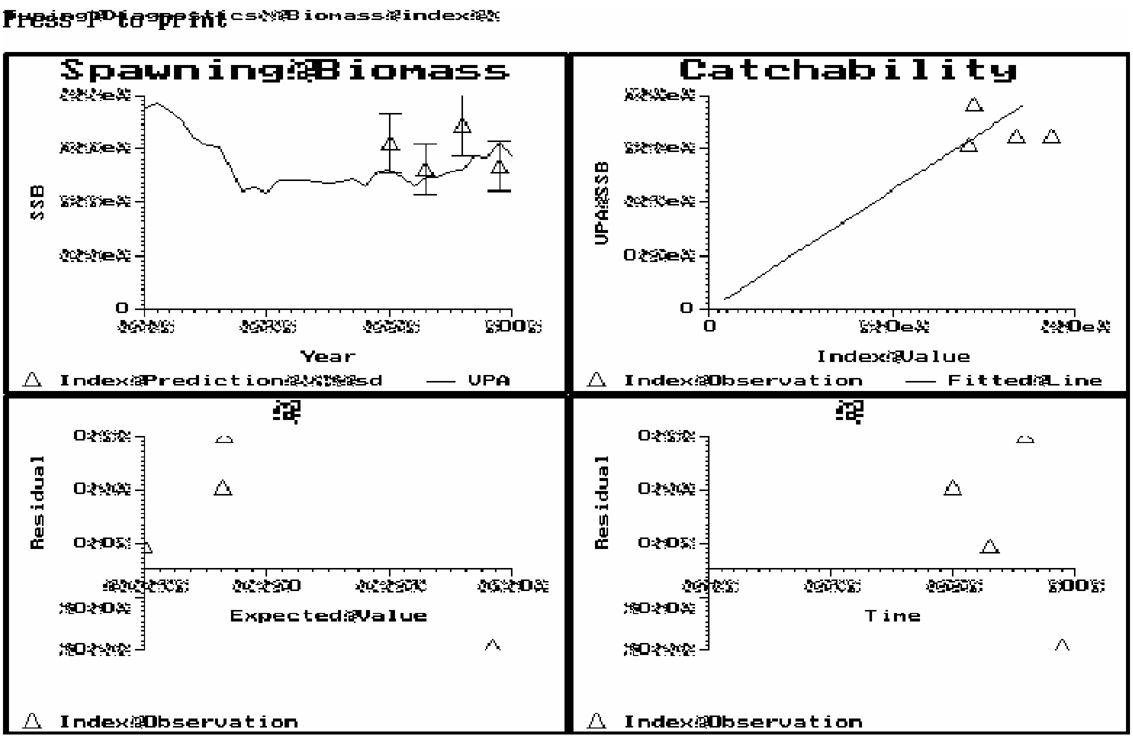


Figure 2.9.1.4 The diagnostics for the egg production index as fitted by ICA to the North East Atlantic Mackerel. Only SSB estimates from egg surveys covering the range 1992-2001 in the biomass index and there is only one period of separable constraint (1992-2002).

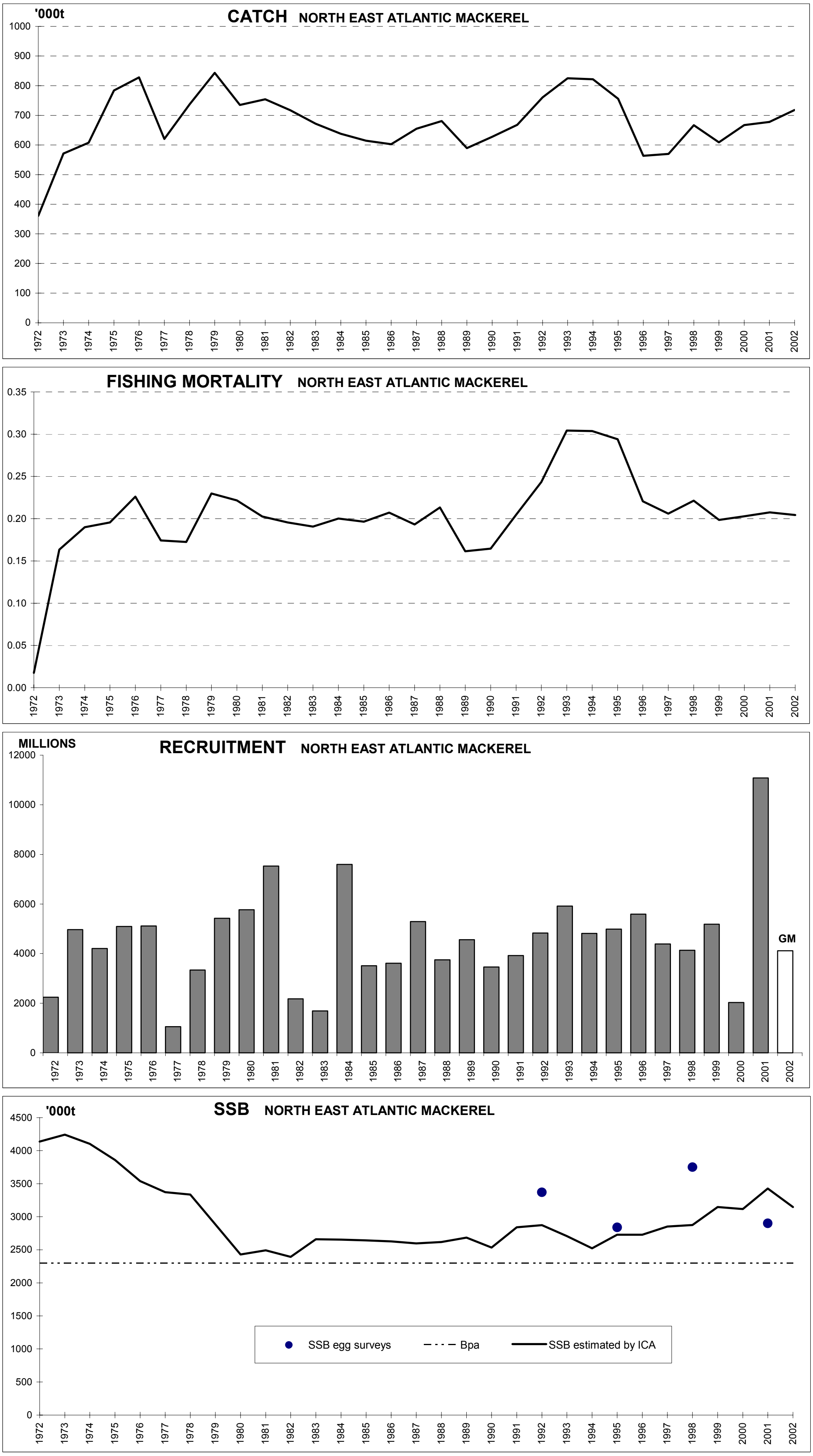


Figure 2.9.1.5 **Catch, SSB, F and recruitment for North East Atlantic Mackerel (ICA) for the period 1972-2002. Biomass estimates from egg surveys in 1992, 1995, 1998 and 2001 are used for the assessment.**

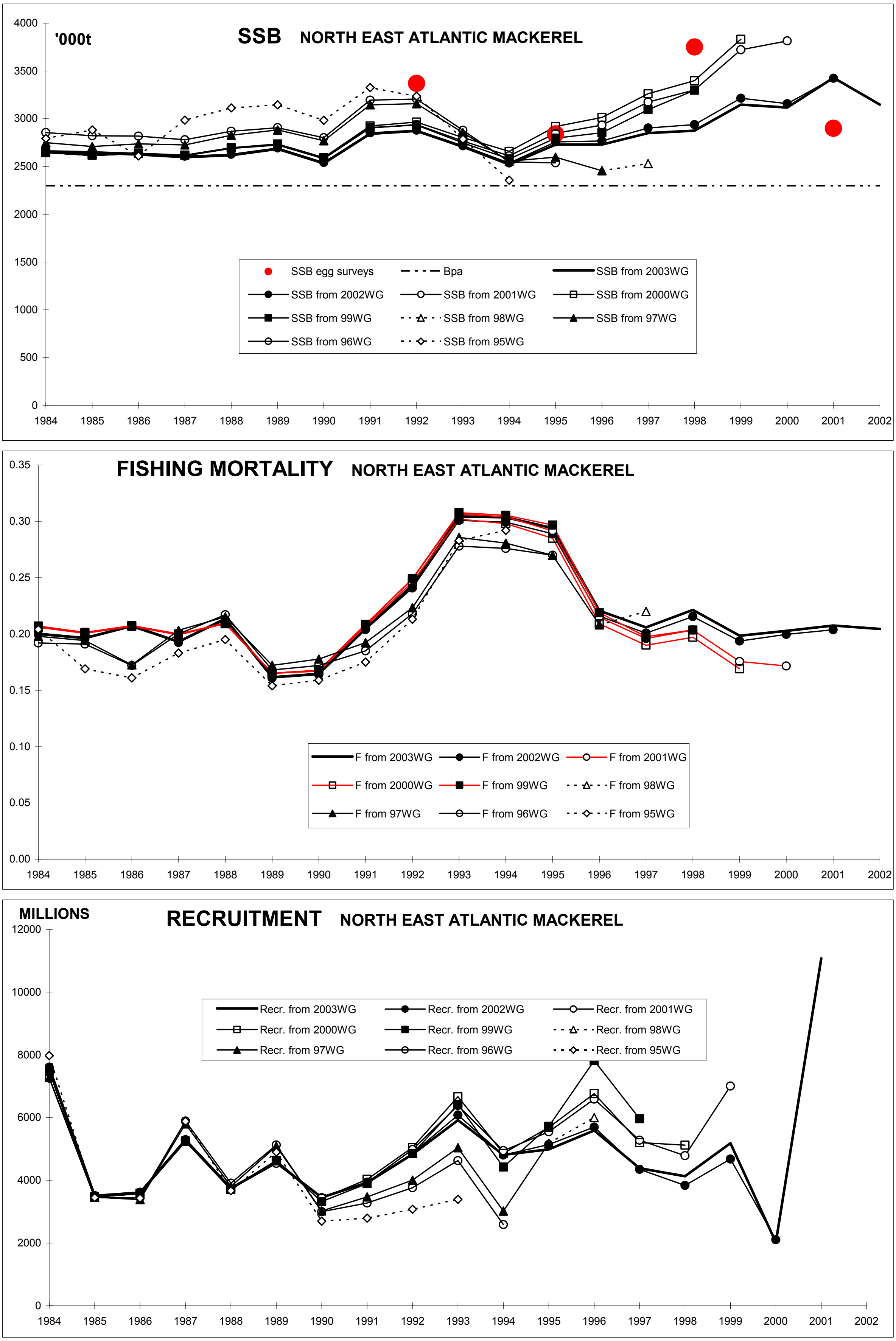


Figure 2.9.2.1 **Comparison of SSB, F and recruitment estimates (ICA) obtained at various assessment working group meetings. Biomass estimates from egg surveys in 1992, 1995, 1998 and 2001 are also shown. At the 1999 - 2001 working groups the 1992, 1995 and 1998 egg survey SSB's and at the 2002 and 2003 WG meetings the 1992, 1995, 1998 and 2001 egg survey SSB's were used. At the 1998 working group meeting the new assessment was rejected and in stead the 1997 assessment was projected one year forward.**

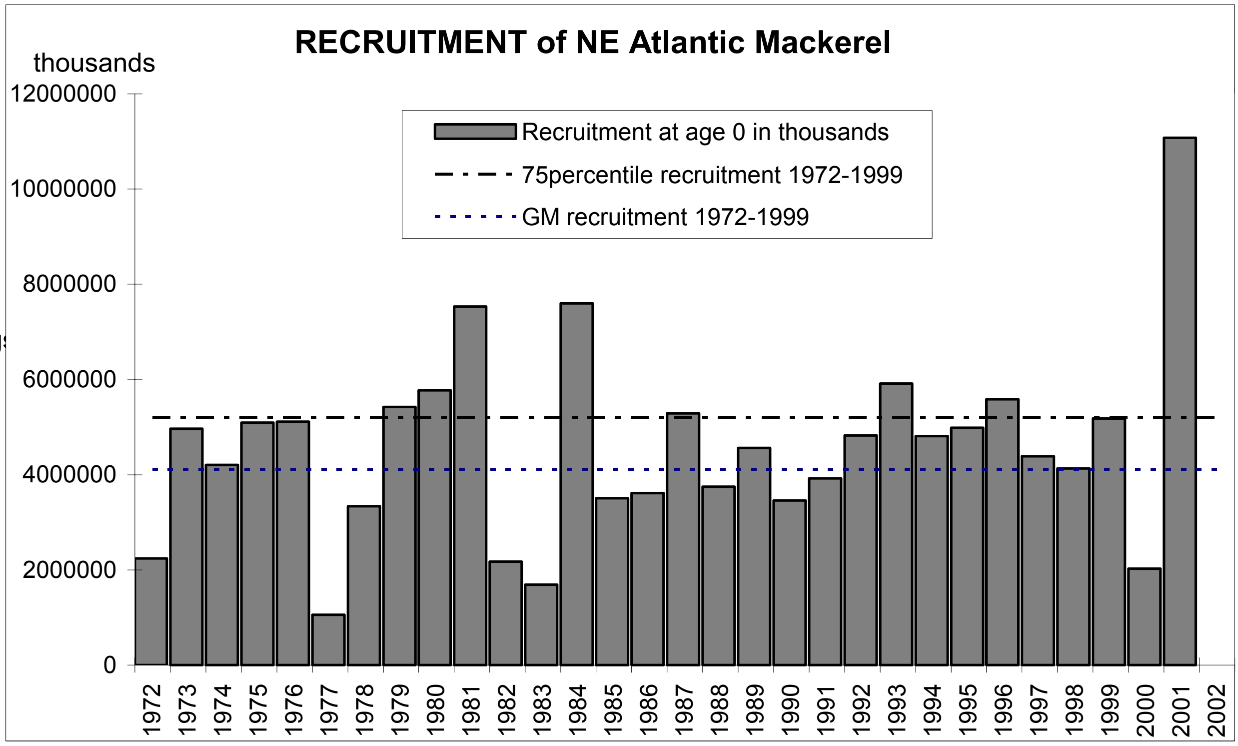


Figure 2.10.1 Recruitment estimates of NEA mackerel from ICA.

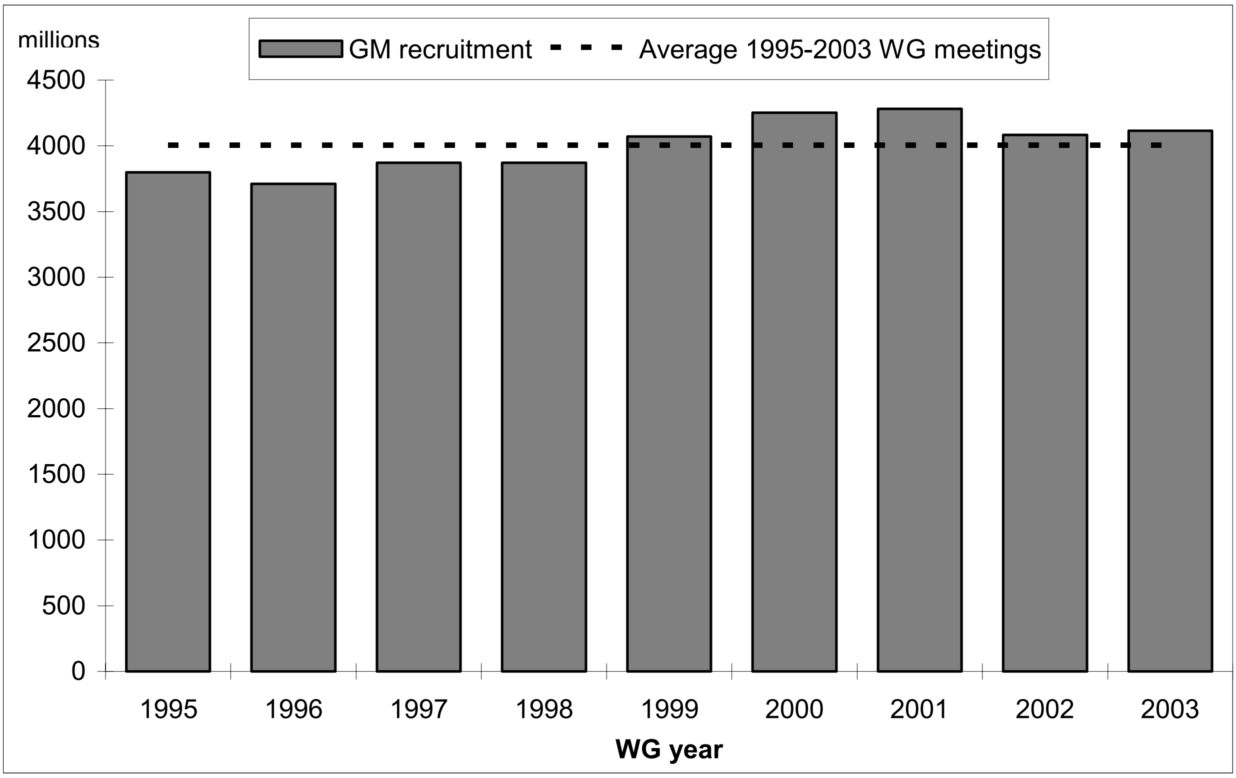


Figure 2.10.2 Annual GM recruitment estimates of NEA mackerel as estimated at the various WG meetings from 1995 -2003. Broken line is the average 1995-2003.

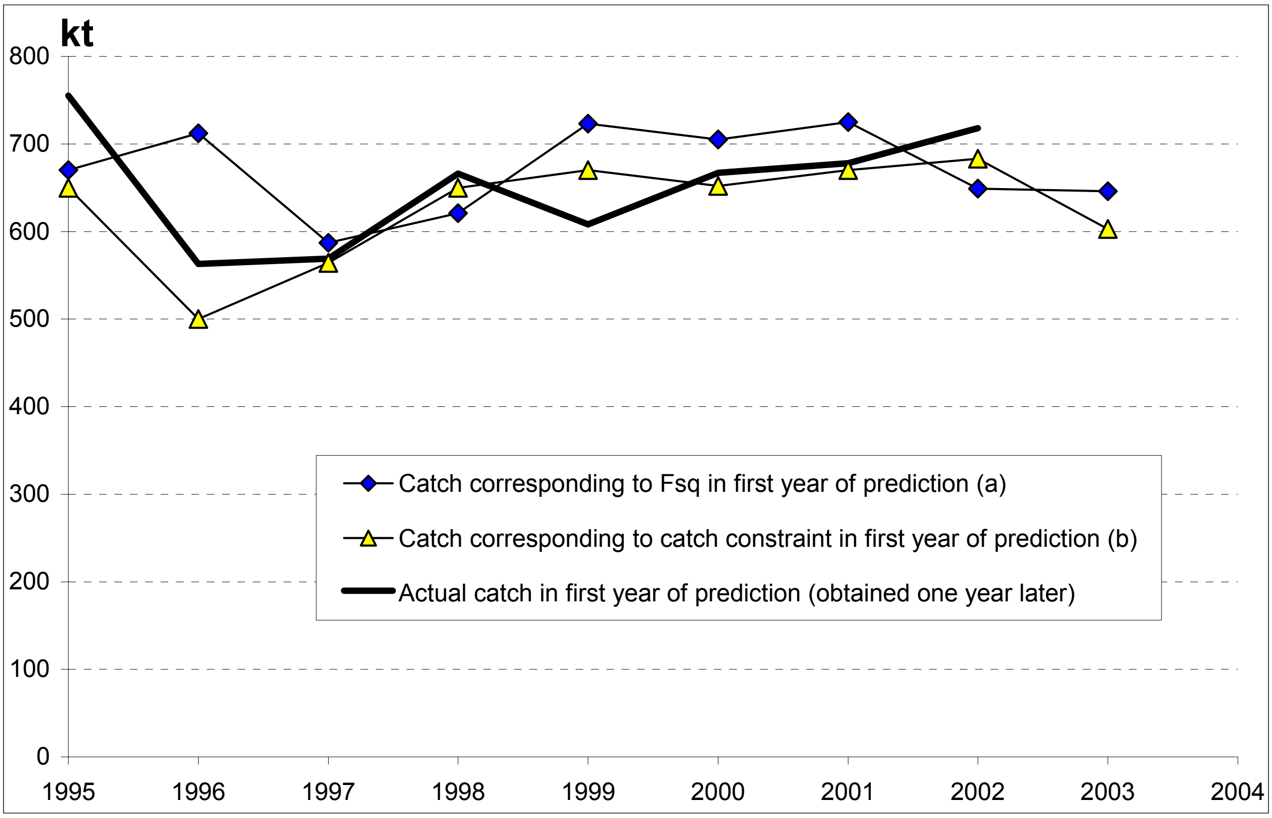


Figure 2.10.3 The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) a catch contstraint. The actual catch obtained one year after the predictions can be compared to catches of both options to check which of the two options fits best to it.

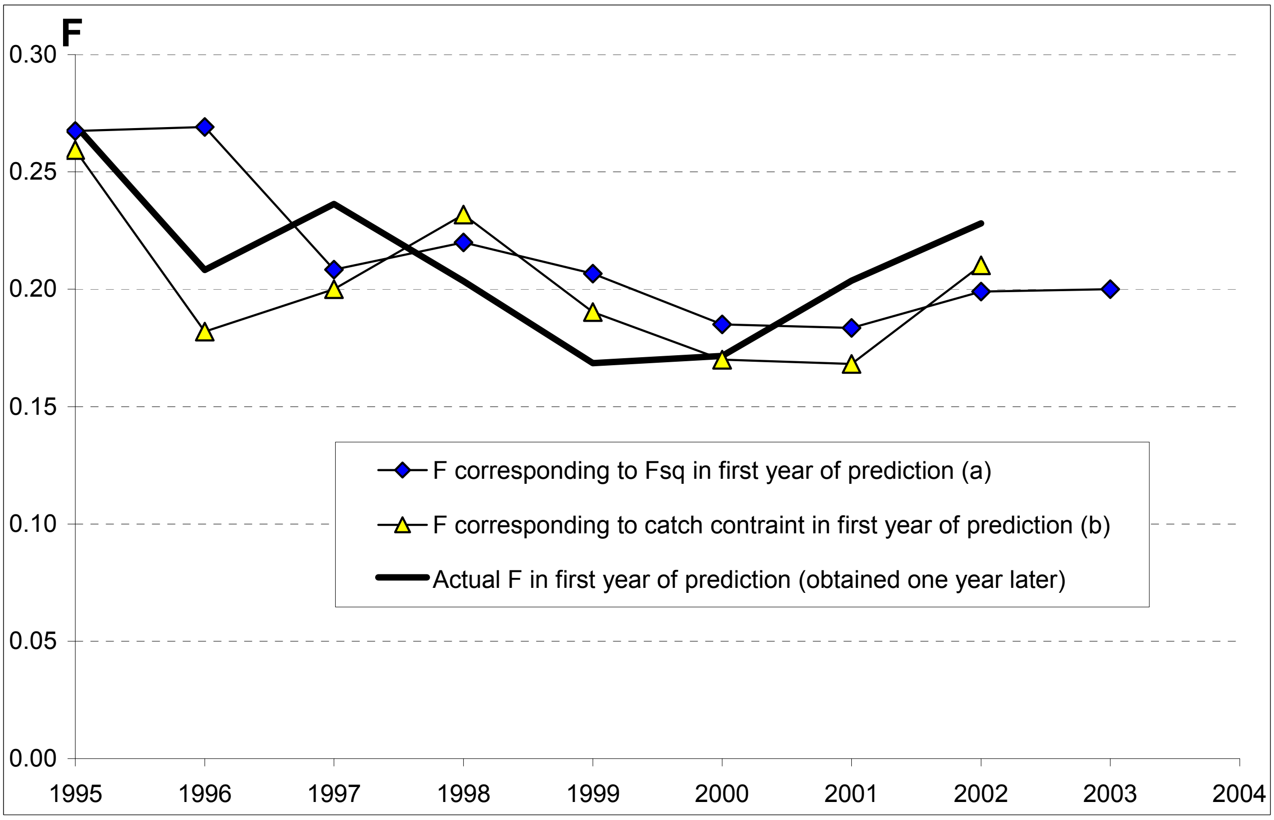


Figure 2.10.4 The catch predictions are carried out for two options: a) a catch corresponding Fsq and b) a catch contstraint. The actual F obtained one year after the predictions can be compared to F's of both options to check which of the options fits best to it.

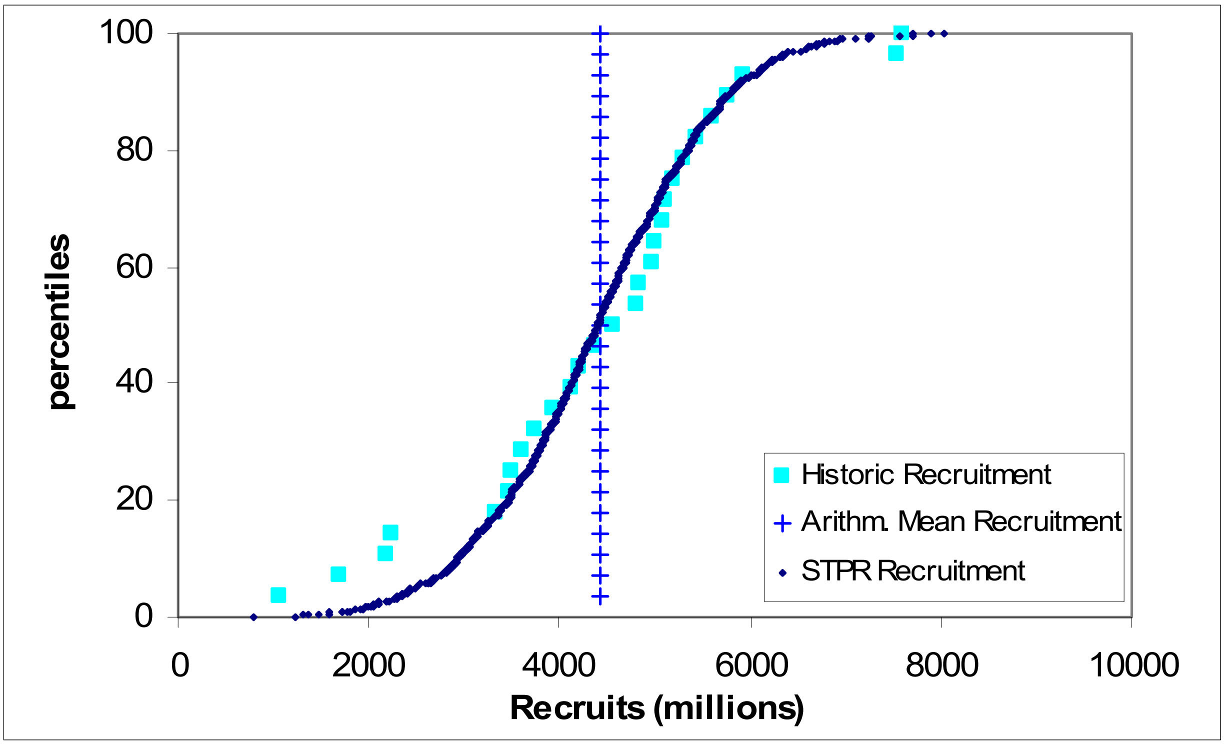


Figure 2.12.1 NEA mackerel. Cumulative probability of recruitment numbers comparing output from the ICA assessment (historical recruitment and arithmetic mean) and the distribution of recruitments, in the tenth year, produced by the medium term projection by STPR

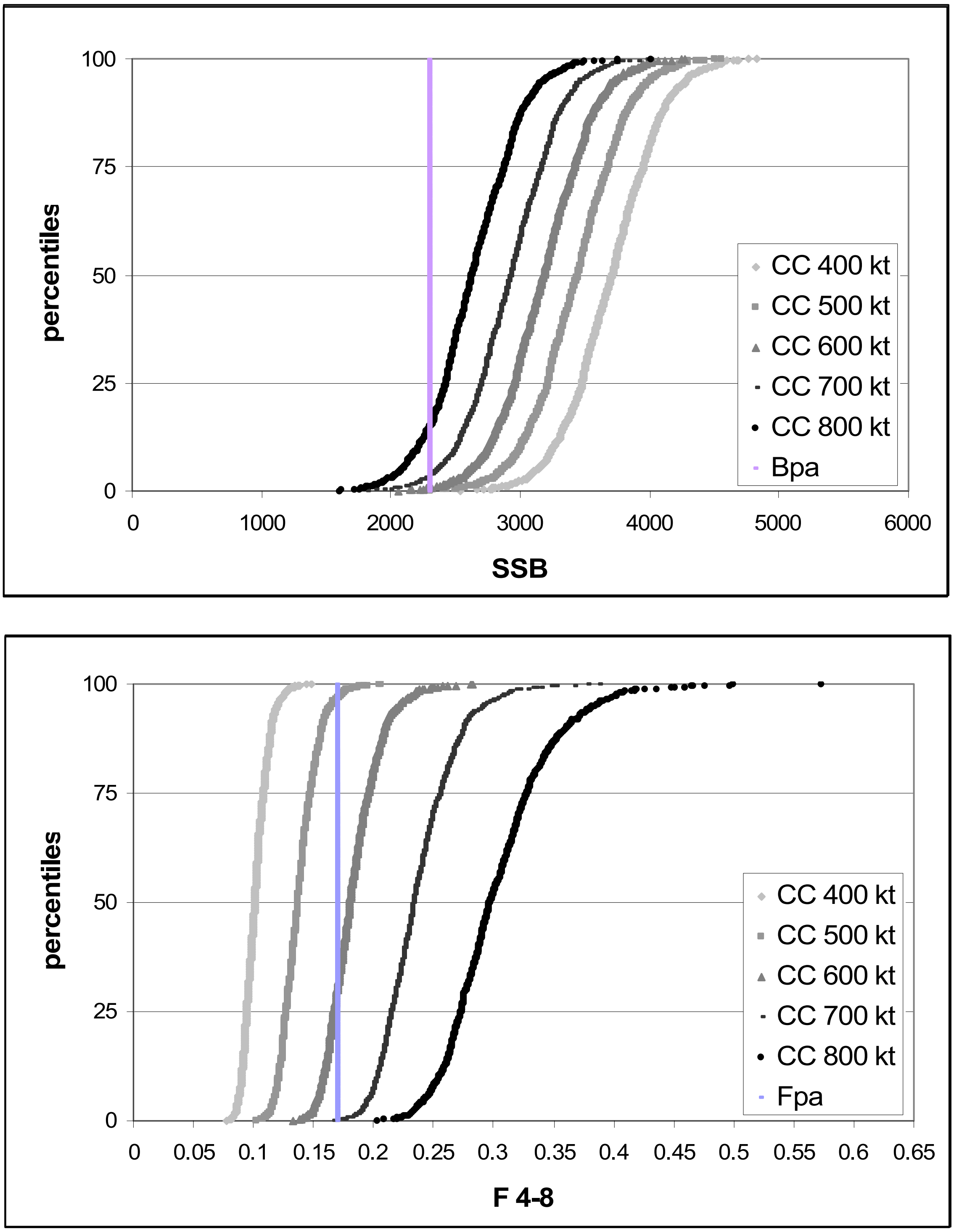


Figure 2.12.2 NEA mackerel. Cumulative probability of SSB and F in year 2007, for various levels of triennial (2004 - 2006) catch constraint (400 – 800 kt) produced by the medium term projection using STPR.

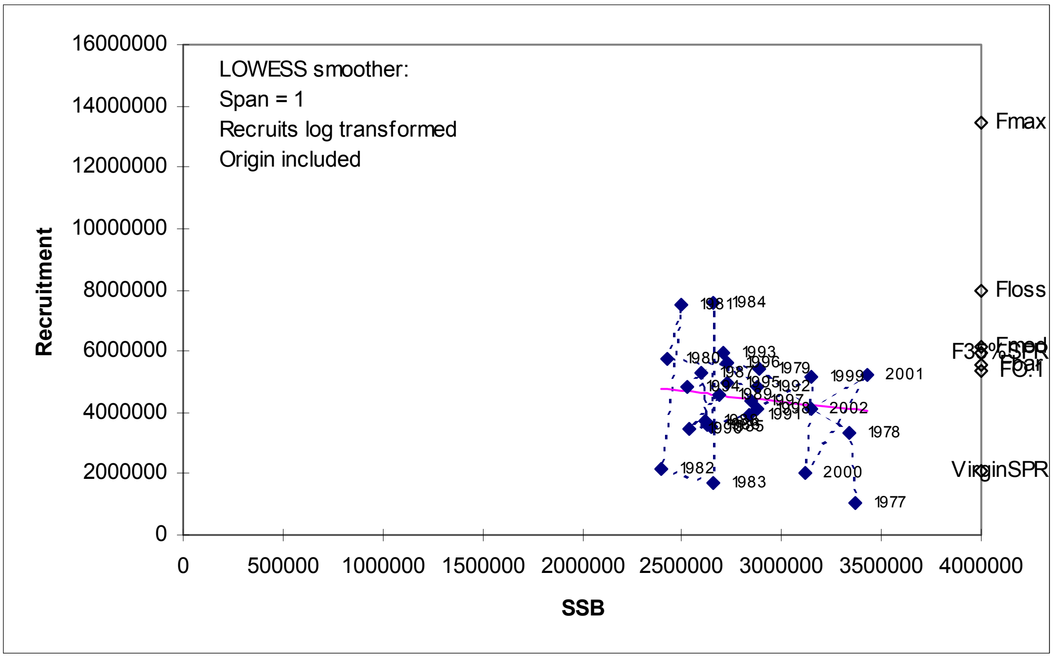


Figure 2.14.1 NEA mackerel. Stock-recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated (PA output).

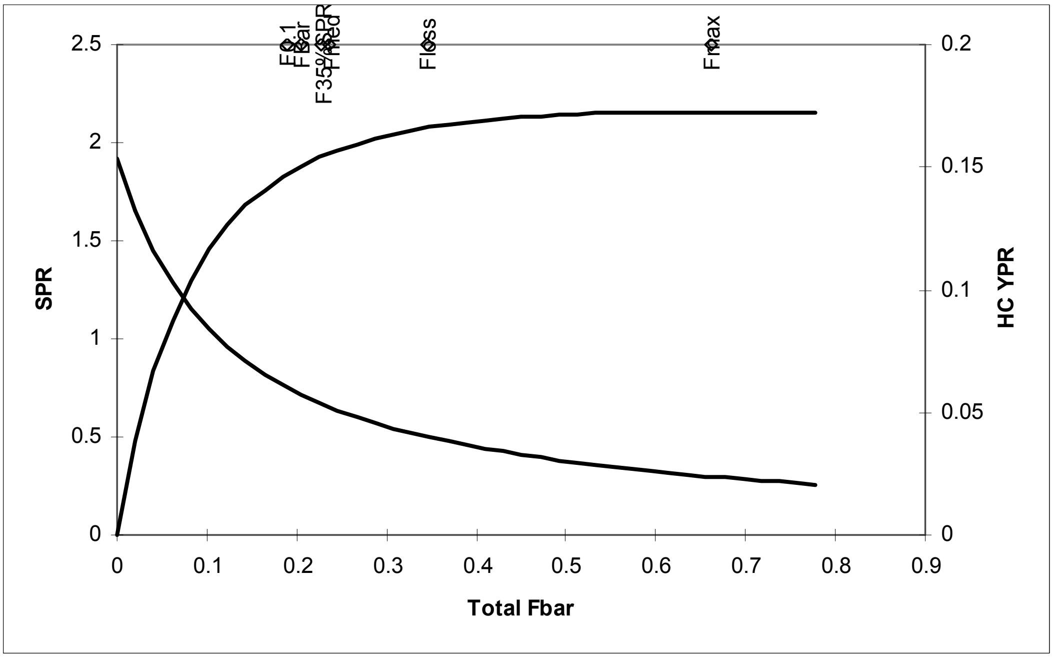


Figure 2.14.2 NEA mackerel. Plot of YPR and SPR curves with some reference points indicated.

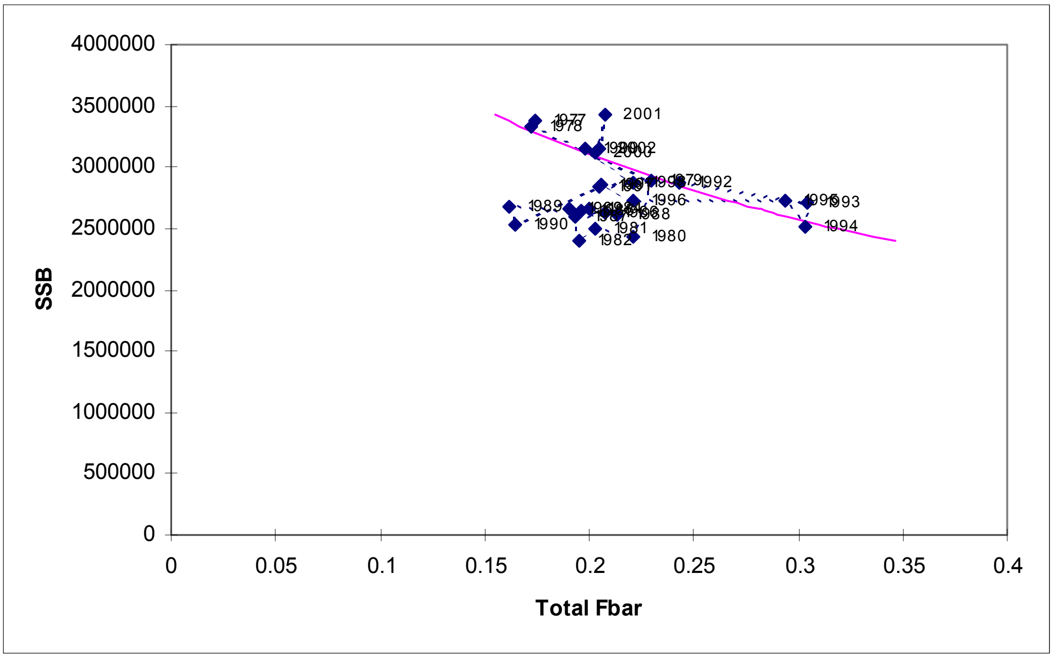


Figure 2.14.3 NEA mackerel. Plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

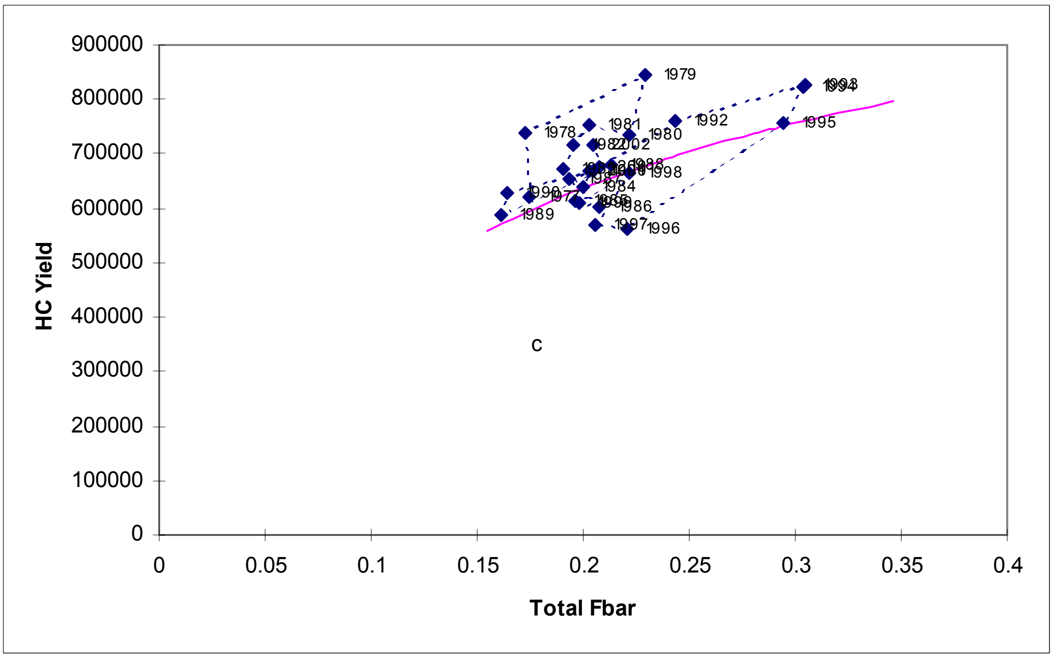


Figure 2.14.4 NEA mackerel. Plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.

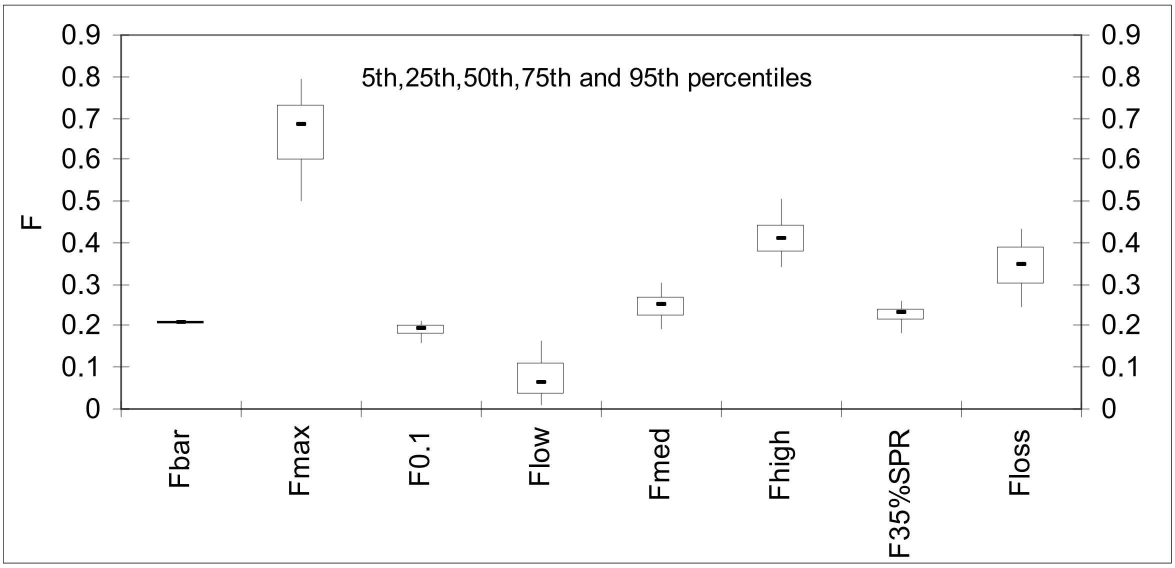


Figure 2.14.5 NEA mackerel. Various Reference points and their uncertainties calculated.

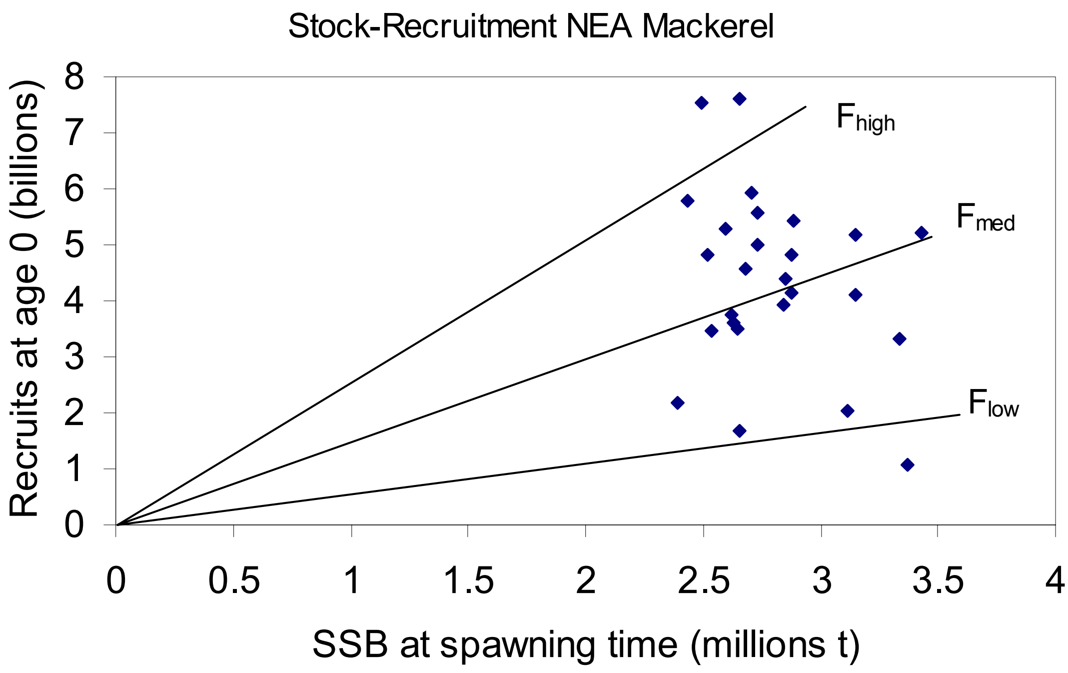


Figure 2.14.6 NEA mackerel. Stock-recruitment plot, indicating F_{high}, F_{med} and F_{low} (drawn by hand).

3 Mackerel Stock components: North Sea, Western and Southern Areas

3.1 North Sea Mackerel Component

3.1.1 Fishery independent information

The last egg survey was carried out in 2002 and there is no new information of the stock. It is recommended to carry out a new egg survey in the North Sea in 2005.

3.1.2 State of the stock

Based on the egg survey in 2002 the SSB was estimated at 210,000 tons, which is considered an uncertain estimate (Section 2.5.2). The increase in SSB since 1999 might be due to a relatively strong 1999 year class. However, the stock is still considered to be at a low level compared to a stock size of about 3.5 mill tons in the early 1960s.

3.2 Western Mackerel Component

3.2.1 Biological Data

The Western mackerel component is regarded as a subset of the NEA Mackerel, which is considered in Section 2. In previous years, a separate calculation of the historic stock abundance was made for the Western component, in order to get a longer time-series of stock-recruitment data. Last year, data for the whole NEA stock became available back to 1972. Since then, no separate assessment has been made of the Western component.

For the previous assessments on the Western component catches from Divisions VIIIa and b, Subareas VII, VI, V, IV, III and II were allocated to that component. These data can be found in Tables 2.2.1.1 (landings), 2.4.1.1 (catch in numbers), 2.4.3.1 (lengths-at-age) and 2.4.3.3 (weights-at-age). According to the present perception of migrations (Section 2.3), it is likely that some of these catches come from fish spawning in other areas than the Western spawning area.

3.2.2 Fishery independent information

Egg surveys

Egg surveys were performed only in the Western area prior to 1992. The text table below shows the time-series of egg survey estimates for the Western area.

	1977	1980	1983	1986	1989	1992	1995	1998	2001
Egg production $*10^{-15}$	1.98	1.48	1.53	1.24	1.52	1.94	1.49	1.37	1.21
SSB (million tonnes)	3.25	2.43	2.51	2.15	2.56	2.93	2.47	2.95	2.53

3.3 Southern Mackerel Component

3.3.1 Biological Data

Catch in numbers-at-age

The 2002 catches in numbers-at-age for Divisions VIIIc and IXa are discussed in Section 2.4.1 (Table 2.4.1.1 and 2.4.1.2 NEA mackerel).

Mean lengths-at-age and mean weigths at age

The mean lengths-at-age and mean weigths at age for Divisions VIIIc and IXa are discussed in Section 2.4.3 (Tables 2.4.3.1 and 2.4.3.2 - NEA mackerel).

The mean weights-at-age in the stock for the Southern mackerel are presented in Section 2.4.3 (Table 2.4.3.3- NEA Mackerel). For the Southern component the stock weights were based on Spanish sampling during the first half of the year in Division VIIIc.

Maturity ogive

No new information became available on maturity ogive since the 1999 meeting of this Working Group (ICES, 2000). In 1999 the WG changed the southern maturity ogive used in the assessment by the maturity ogive based on histological analysis and this ogive was also used for the subsequent years. In the present WG, this ogive had been used in the assessment for the period 1972-recent.

Natural Mortality

The value for natural mortality used by the WG for the Southern component as well as for all the others of the NE Atlantic mackerel stock is 0.15. (see section 2.4.5).

3.3.2 Fishery- independent information

Egg Surveys

The SSB estimated in 2001 was 371 279 t with a CV of 20.7%. This estimation is 53% lower than the SSB estimated in 1998 (800 000 t). With the increase of the fecundity, the total annual egg production in 2001 (34% lower than in 1998) resulted in a sharp reduction in SSB. However, the SSB estimated in 2001 is similar to the one in 1995 (378 450 t).

Further information is given in Section 2.5.1- NEA Mackerel.

Bottom trawl surveys

There are two surveys series: The Spanish September-October survey and the Portuguese October survey. The two sets of Autumn surveys covered Subdivisions VIIIc East, VIIIc West and IXa North (Spain) from 20-500 m depth, using Baka 44/60 gear and Subdivisions IXa Central North, Central South and South (Portugal), from 20-750 m depth, using a Norwegian Campell Trawl (NCT), that is a trawl net having a 14 m horizontal opening, rollers on the ground-roper and has been fitted with a 20 mm mesh size cod end. The same sampling methodology is used in both surveys but there were differences in the gear design. The Spanish survey used a bottom trawl gear called "Baka" (similar to the gear normally used in these waters by the commercial trawl fleet) aimed at benthic and demersal species, therefore the scope of the survey must be borne in mind, regarding the validity of the abundance indices obtained for pelagic species. In addition, no work is carried out at less than 80 m depth, which results in an imcomplete coverage of the whole area of mackerel juvenile distribution. Comparative data analysis of Baka and GOV gears are described in Section 2.7.2.

Table 3.3.2.1 shows the numbers-at-age per half hour trawl from the Spanish bottom trawl surveys from 1984 to 2002 in September-October and the numbers-at-age per hour trawl from the Portuguese bottom trawl Autumn surveys from 1986 to 2002. Both are carried out during the fourth quarter when the recruits have entered the area and the adults are very scarce in this area. The historical series of abundance indices from the Spanish trawl surveys indicates that 1992, the period from 1996 to 2000 and 2002 were those with the highest values of juvenile presence (0 and 1). The series of the Portuguese October survey shows a very high values of recruitment (age 0) in 1988, 1992, the period 1995 to 1999, 2001 and 2002.

Acoustic surveys

Since 1999, an Spanish acoustic survey was carried out in spring to estimate the stock abundance of mackerel off the Galician and Cantabrian Sea (Subdivision IXa North and Division VIIIc). The mackerel biomass was estimated to be 320,000 t in 1999, 706,000 t in 2000 and 399,000 t in 2001. In 2002 and 2003, the acoustic survey took place in March-April in Subdivision IXa Central North (Portuguese waters), Subdivision IXa North (Spanish waters) and Division VIIIc. In 2002 the total biomass was estimated to be 1,382,995 t (55,000 t in Division IXa and 1,327,497 t in Division

VIIIc) in 2002. In 2003 the total biomass was estimated to be 1,167,548 t (30,265 t in Division IXa Central North, 273,354 t in Division IXa North and 863,930 t in Division VIIIc). In the 2002 and 2003 surveys the target strength changed for mackerel (TS from –82 to –88) as recommended by the Planning Group on Aerial and Acoustic Surveys for Mackerel (ICES CM 2002/G:03). The surveys since 1999 to 2001 used the old target strength for mackerel (-82), and the mackerel acoustic data was not revised with the new target strength (-88).

The biomass assessed in 2000 is considered to be an overestimated due to high plankton abundance in the area (Carrera, WD 2000). In comparison with the previous years, the number of juvenile fish estimated in 2001 was lower than that observed last year, most of the fish found (90%) were higher than 33 cm. During 2001 the number of adult mackerel estimated in the Spanish area remain quite stable. There were no indication of a strong 2000 year class, and therefore the total biomass estimated in 2001 was lower than that estimated in 2000 (Carrera, WD 2001). In 2001 the biomass estimated for mackerel (399,000 t) was very similar to the value estimated by means of the egg production method (371,279 t SSB). The total number of juvenile fish estimated in 2003 (68%) was higher than in 2002 (40%). In 2003, fish measuring less than 25 cm accounted for more than 80% in IXa, about 40% in the west of Cantabrian Sea, and a low proportion in the east of Cantabrian Sea (Figure 3.3.2.1). This contributions of juveniles by area were similar to those found in 2002 (ICES 2003).

In 1999 another Spanish acoustic survey was carried out in August only in Division IXa North within the JUVESU Project (FAIR CT 97 3374), mackerel was the most fished species in this area and most of the mackerel fish belonged to age 0 (80%) (Carrera WD, 1999).

Further information is given in Section 2.8.3.- NEA Mackerel.

Table 3.3.2.1 SOUTHERN MACKEREL. CPUE at age from surveys.

October Spain Survey, Bottom trawl survey (Catch: numbers)

		Catch										
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10+**
1984	1	1.47	0.20	0.11	0.37	0.15	0.21	0.04	0.01	0.03	0.02	0.07
1985	1	2.65	1.60	0.02	0.06	0.37	0.14	0.09	0.03	0.02	0.03	0.08
1986	1	0.03	0.17	0.14	0.02	0.03	0.06	0.03	0.00	0.00	0.00	0.03
1987												
1988	1	0.29	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.00
1989	1	0.51	0.00	0.02	0.00	0.04	0.02	0.00	0.01	0.00	0.00	0.00
1990	1	0.40	0.94	0.04	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00
1991	1	0.13	0.27	0.22	0.27	0.34	0.07	0.03	0.01	0.03	0.00	0.01
1992	1	19.90	0.48	0.16	0.15	0.09	0.03	0.01	0.00	0.00	0.00	0.00
1993	1	0.07	1.26	0.79	0.03	0.06	0.02	0.01	0.00	0.00	0.00	0.01
1994	1	0.47	0.11	0.12	0.15	0.04	0.04	0.01	0.01	0.00	0.00	0.00
1995	1	0.92	0.03	0.19	0.16	0.05	0.01	0.01	0.00	0.00	0.00	0.00
1996	1	46.09	6.40	1.32	0.07	0.10	0.02	0.00	0.01	0.01	0.00	0.00
1997	1	5.73	27.11	6.28	0.67	0.39	0.00	0.00	0.00	0.00	0.00	0.00
1998	1	0.46	3.82	0.97	0.24	0.05	0.09	0.06	0.02	0.02	0.00	0.01
1999	1	3.93	0.98	2.42	0.53	0.12	0.01	0.00	0.00	0.00	0.00	0.00
2000	1	26.78	1.90	0.87	0.20	0.10	0.02	0.03	0.00	0.00	0.00	0.00
2001	1	0.31	1.21	1.07	0.32	0.15	0.08	0.00	0.00	0.00	0.00	0.00
2002	1	14.46	0.34	0.61	0.32	0.10	0.05	0.03	0.00	0.00	0.00	0.00

October Portugal Survey, Bottom trawl survey (Catch: numbers)

		Catch										
Year	**Effort**	**age 0**	**age 1**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7**	**age 8**	**age 9**	**age 10+**
1986	1	0.52	2.76	1.00	0.51	0.04	0.01	0.01	0.00	0.00	0.00	0.00
1987	1	1.03	23.28	14.79	2.94	0.55	0.00	0.00	0.00	0.00	0.00	0.00
1988	1	86.47	24.55	0.35	0.33	0.04	0.01	0.00	0.00	0.00	0.00	0.00
1989	1	11.64	28.43	4.71	3.45	0.02	0.01	0.00	0.00	0.00	0.00	0.00
1990	1	1.34	2.99	1.75	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1991	1	0.31	0.37	0.29	0.19	0.03	0.02	0.02	0.01	0.00	0.00	0.00
1992	1	123.55	2.74	0.66	0.30	0.06	0.01	0.01	0.00	0.00	0.00	0.00
1993	1	52.32	0.39	0.12	0.05	0.08	0.00	0.00	0.00	0.00	0.00	0.00
1994	1	12.21	0.77	0.30	0.11	0.04	0.05	0.02	0.01	0.00	0.00	0.00
1995	1	318.60	9.08	0.28	0.11	0.03	0.01	0.01	0.00	0.00	0.00	0.00
1996*	1	235.26	2.16	0.22	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1997	1	772.03	39.40	7.66	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	1	226.59	11.58	0.31	0.00	0.04	0.02	0.00	0.00	0.02	0.00	0.00
1999*	1	209.11	2.62	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2000	1	23.23	2.26	0.03	0.04	0.14	0.07	0.00	0.02	0.00	0.00	0.00
2001	1	299.04	12.19	3.89	1.70	0.19	0.05	0.02	0.00	0.01	0.01	0.01
2002	1	116.57	18.54	0.21	0.27	0.00	0.02	0.00	0.00	0.00	0.00	0.00

* DIFFERENT SHIP

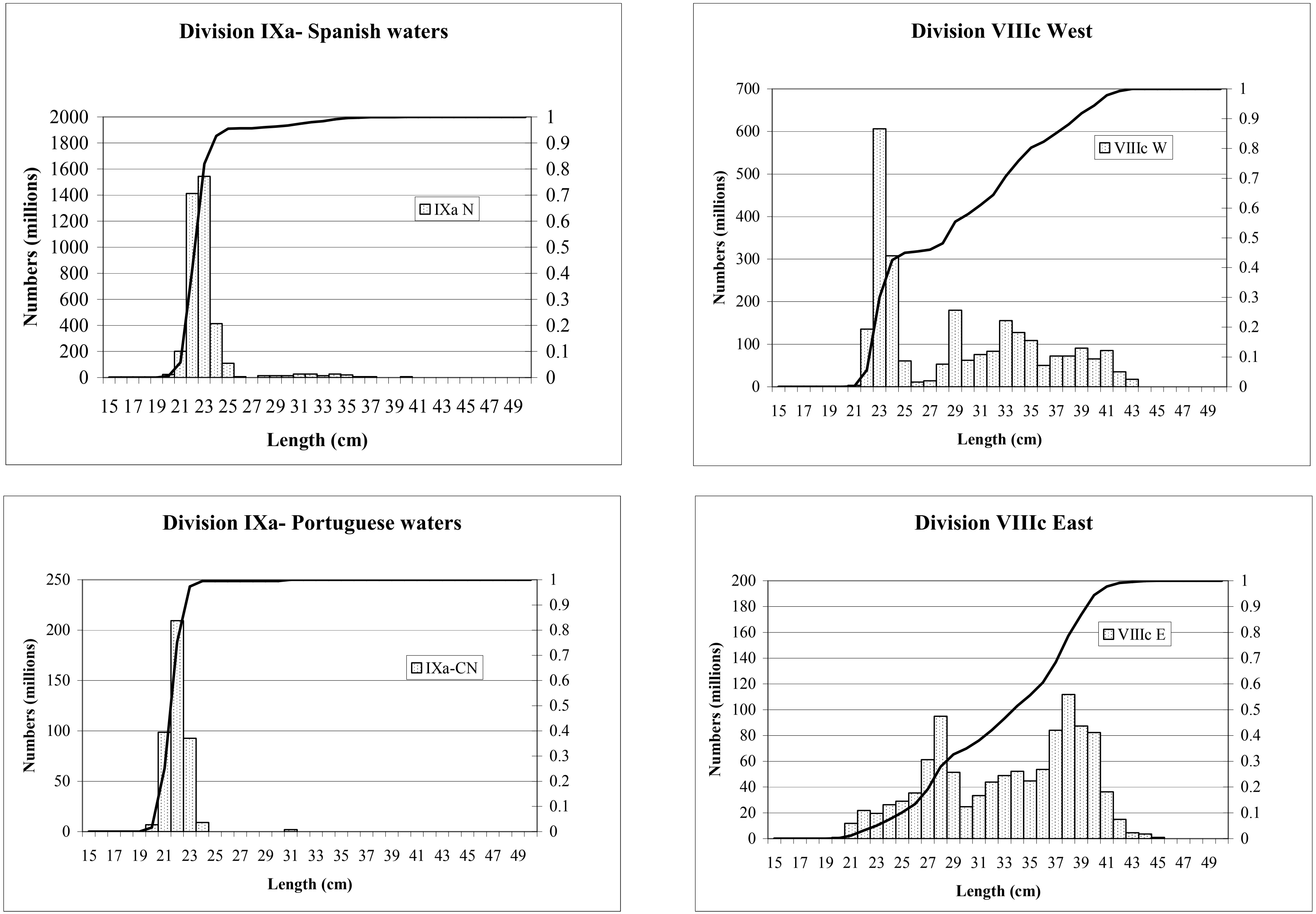


Figure 3.3.2.1: Mackerel length distribution by area for the Spanish acoustic survey during 2003. The line denotes the cumulative frecuency

4 HORSE MACKEREL

4.1 Fisheries in 2002

The total international catches of horse mackerel in the North East Atlantic are shown in Table 4.1.1 and Figure 4.3.1. The total catch from all areas in 2002 was 241,300 tons which is 42,000 tons less than in 2001. Ireland, Denmark, Scotland, England and Wales, Germany and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have directed trawl and purse seine fisheries.

The quarterly catches of horse mackerel by Division and Subdivision in 2002 are given in Table 4.1.2 and the distribution of the fisheries are given in Figure 4.1.1.a–d. The figures are based on data provided by Denmark, England and Wales, Scotland, Ireland, Northern Ireland, Germany, Netherlands, Norway, Portugal and Spain representing 91 % of the total catches.

First quarter: 49,900 tons. This is 39,600 tons less than in 2001. The catches this quarter (Figure 4.1.1.a) are mainly distributed in the western and southern areas as in previous years.

Second quarter: 38,900 tons. This is 4,600 tons less than in 2001. As usual, rather low catches were taken during the second quarter and the catches are distributed as in previous years (Figure 4.1.1.b). Most of the catches were taken in the southern part of the western area and in the southern area.

Third quarter: 28,400 tons. This is 3,200 tons less than in 2001. As in previous years the catches were spread over large parts of the distribution (Figure 4.1.1.c).

Fourth quarter: 124,200 tons. This is 4,500 tons less than in 2001 and the distribution of the catches were mainly as in previous years (Figure 4.1.1.d). The Norwegian fishery in the North Sea have since 1987 mainly been carried out during this quarter and the catches have varied between 2,000 and 128,000 tons. In 2002 Norway increased the catches from 8,000 tons in 2001 to about 35,400 tons.

During this quarter a record high numbers of juvenile horse mackerel (particularly the 2001 year class) were caught in the juvenile distribution area (Divisions VIIa,e,f,g,h and VIIIa,b,d).

4.2 Stock Units

For many years the Working Group has considered the horse mackerel in the north east Atlantic as separated into three management stocks: the North Sea, The Southern and the Western stocks (ICES 1990, ICES 1991a). Since little information from research has been available until recently (HOMSIR project), this separation was based on the observed egg distributions and the temporal and spatial distribution of the fishery. Western horse mackerel are thought to have broadly similar migration patterns as Western mackerel. The egg surveys have demonstrated that it is difficult to determine a realistic border between a western and southern spawning area.

A study of stock structures of horse mackerel within the western, the southern, the North Sea and the Mediterranean areas has just been carried out in a EU funded project (HOMSIR). The project finished in June 2003 and the main results are summarised in section 4.2.1. The results from this project in many ways support the Working Group's perception of stock units.

4.2.1 Results and main conclusions from the EU funded HOMSIR project

The concept of stock separation can be considered under two complemented points of view: the genetic approach and the operational approach (Tyler & Gallucci, 1980; Booke, 1981; Carvalho & Hauser, 1994). In essence, the stock concept describes the characteristics of the units assumed homogenous for a particular management purpose (Begg and Waldman, 1999). Fish stocks are identified on the basis of differences in characteristics between stocks. Investigation of a single characteristic will not necessarily reveal stock differences even when "true" stock differences exist (known as "type I error" in statistics). To overcome this difficulty, a holistic approach of fish stock identification, involving a broad spectrum of techniques, appears to be pertinent (Begg & Waldman, 1999). The EU-funded HOMSIR project (**A**

multidisciplinary approach using genetic markers and biological tags in horse mackerel (*Trachurus trachurus*) stock structure analysis), was conducted according this approach. The project was carried out during January 2000 - June 2003, and the final report will soon be sent to Brussels for review. However some main results and findings of the project was presented to this Working Group (Abaunza et al WD 2003):

In the HOMSIR project, horse mackerel samples from 21 (figure 4.2.1.1) sites representing almost the entire distribution area (north east Atlantic Ocean and the Mediterranean Sea) were analysed. From each of the sites 200 specimens were caught and analysed. All the different techniques used were applied on the same fish:

Genetics: multilocus allozyme electrophoresis (MAE), microsatellite DNA (msDNA), mitochondrial DNA sequencing (mtDNA) on control region and two enzymatic regions and single-strand conformation polymorphism (SSCP) on nuclear DNA.

Parasites: The use of parasites as biological tags requires the identification of the species by applying morphological criteria and molecular techniques (i.e. MAE analysis). The latter is especially necessary to identify anisakid nematods to the species level.

Morphometry: Horse mackerel specimens from each location were analysed to find body and otolith shape differences among areas or samples.

Tagging: It was explored the possibility of using artificial tags for migratory studies. Unfortunately, the observed mortality in tagged fish was so high, that the application of the method at larger scale was discarded. New methods for catching and handling fish with little damage should be explored, since they were identified as the critical processes in the survivorship of tagged fish.

Life history traits: Changes in growth, reproduction and distribution in space and time give information on the population dynamics. The analysis of these factors allows the identification of management units or stocks.

Finally, all the data was integrated to assess the structure of horse mackerel stocks.

Based on the analysis of the parasitical fauna it was possible to distinguish a North Sea population (area 5 in the map). However there is evidence of small-scale mixing between the areas in the so called "Western stock" and that in the "North Sea stock". Horse mackerel from the west Iberian Atlantic coast (areas 8, 9 and 10) showed to be infected with some parasite species that are very rare in the other areas. Regarding just the parasites of the genus *Anisakis*, areas 7, 8, 9, 10 and 11 are clearly different from all the other areas in the Atlantic.

The results from body morphometrics , which only includes fish in pre-spawning and spawning conditions demonstrated distinctions between the Atlantic areas and area 17 in the Mediterranean (Alboran Sea). The analyses demonstareted also that horse mackerel the Atlantic areas, 2 and 21 ("western stock"), were similar to horse mackerel from the northern Galicia area(7), and clearly distinct from the North Sea area (5) and from the areas along the Portuguese coast. Area 3 appears as an outlier in the analysis. Based on the otolith shape analysis, sampled areas can be divided in 4 groups:

1) the eastern and central Mediterranean areas,
2) the northern Atlantic areas, including North Sea (area 5) and North Galicia (area 7),
3) the areas in the Portuguese coast (8, 9 and 10) and Mauritania (11),
4) the western Mediterranean (areas 17 and 20).

In the Northeast Atlantic, differences in lengths-at-age between sampling areas were evident (Figure 4.2.1.2)

Several genetic techniques were applied in this project. Multilocus Allozyme Electrophoresis and the sequence analysis of mitochondrial and micro-sattelite DNA did not yield significant genetic differences between sampling sites. These results would suggest that horse mackerel is a quite homogeneus population along its entire area of distribution. However, lack of genetic differences does not necessarily mean population homogeneity, because gene flow rates of 1% between two populations can be enough to mask their genetic differences (Ward, 2000) but not enough to treat them as a single stock unit. Given the genetic homogeneity among samples, genetic markers still can be used as biological tags if they are able to show lack of population inter-breeding. The SSCP (Single-Strand Conformation Polymorphism) technique on nuclear DNA was successful in finding such a genetic marker, demonstrating a significant differences between the horse mackerel from the Atlantic Ocean and the Mediterranean Sea, and some sub-structuring within the two areas that confirms generally the patterns obatined with the other techniques.

The summarised main conclusions significant for this working group are:

The North Sea population seems to be different from most areas belonging to the "western stock", and more similar to fish in the Bay of Biscay.

The current boundaries of the "southern stock" may need to be revised. Most results pointed out differences between area 7 (North Galicia) and the areas along the Portuguese coast, which suggest that North Galicia may correspond to a transition area between two possible stock units (sections 7.5 and 7.7).

It seems there are no significant connections between the southern stock and the Mediterranean stock, but the southern boundary of this stock may be placed further south than it is now. Given that the only area sampled in the African coast (area 11) is very far south (coast of Mauritania).Data from the Moroccan coast is needed to allow a definitive delimitation of the southern boundary of this stock.

According to the results from most techniques, the Mediterranean population of horse mackerel at least can be divided into three management units: a western, a central and a eastern one.

4.3 Allocation of Catches to Stocks

Based on spatial and temporal distribution of the horse mackerel fishery the catches were as in previous years allocated to the three management stocks as follows:

Western stock: Divisions IIa, IIIa (western part), Vb, IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. It seems strange that only catches from western part of Division IIIa are allocated to this stock. The reason for this is that the catches in the western part of this Division taken in the fourth quarter usually are taken in neighbouring area of catches of western fish in Division IVa. In 2002 there were no information about where and when the Swedish catches were taken in Division IIIa . The Working Group is not sure if catches in Divisions IIIa and IVa the first two quarters are of western or North Sea origin. Usually this is a minor problem because the catches here during this period are zero or close to zero. In 2002 these catches were low and are either 3% of the North Sea stock or 0.4% of the western stock. The Working Group allocated these catches to the western stock

At present there is only set a TAC for the western stock in EU waters. The present management area for this stock is therefore restricted to Divisions VIa, VIIa–c,e–k and VIIIa,b,d,e and western part of Division IVa, which do not cover the total distribution area. If TACs are set by stocks, they should apply to all areas where the different stocks are distributed.

North Sea stock: Divisions IIIa (eastern part), IVb,c and VIId.

Southern stock: Divisions VIIIc and IXa. All catches from these areas are allocated to the southern stock.

The catches by stock are given in Table 4.3.1 and Figure 4.3.1. Over the years only one country have provided data about discard and the amount of discards given in Table 4.3.1 are therefore not representative for the total fishery. No data about discard were provided during 1998-2001.

4.4 Estimates of discards

Germany and the Netherlands reported data of minor discards (Section 1.3.3) but it was not possible to estimate total amount of discards for horse mackerel.

4.5 Species Mixing

Trachurus spp.

Three species of *Trachurus* genus, *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together and are commercially exploited in the NE Atlantic waters. Studies on genetic differentiation showed three clear groups corresponding to each species of *Trachurus* with no intermediate principal component scores, excluding the possibility of hybrids between species (Soriano, M. and Sanjuan, WD 1997).

Following the Working Group recommendation (ICES 2002a), special care was again taken to ensure that catch and length distributions and numbers-at-age of *T. trachurus* supplied to the Working Group did not include *T. mediterraneus* and *T. picturatus*. Spain provided data on *T. mediterraneus* and Portugal on *T. picturatus*.

Table 4.5.1 shows the catch of *T. mediterraneus* by Subdivisions since 1989. In Divisions VIIIab and Subdivision VIIIc East , the total catch of *T. mediterraneus* was 1724 t in 2002, being the lowest catches since 1989. In Subdivision VIIIc West and Division IXa North there are no catches of this species. Since 2000 there were a small catches of *T.mediterraneus* in Subarea VII.

As in previous years in both areas, more than 95% of the catches were obtained by purse seiners and the main catches were taken in the second half of the year, mainly in autumn, when the *T. trachurus* catches were lowest. *T. mediterraneus* catches were lowest in spring.

Catches and length distributions of *T. mediterraneus* in the Spanish fishery in Divisions VIIIa,b and c were reported separately from the catches and length distributions of *T. Trachurus*. Data of monthly landings by gear and area were obtained from fishing vessel owner's associations and fishermen's associations through the existing information network of the IEO and AZTI (Advisory Organisations to Fisheries and Oceanography Administration) in all ports of the Cantabrian and Galician ports. *T. mediterraneus* is only landed in ports of the Basque country, Cantabria and Asturias. In ports of the Basque country the catches of *T. mediterraneus* and *T. trachurus* appear separately, except some small categories, in which the separation is made on the basis of samplings carried out in ports and information reported by fishermen. In the ports of Cantabria and Asturias the separation of the catch of the two species is not registered in all the ports, for which reason the total separation of the catch is made based on the monthly percentages of the ports in which these catches are separated and based on samplings made in the ports of this area.

A fishery for *T. picturatus* only occurred in the southern part of Division IXa, as in previous years. Data on *T. picturatus* in the Portuguese fishery for the period 1986-2002 are also given in Table 4.5.1 . Catches and length distributions of *T. trachurus* for the Portuguese fishery in Division IXa do not include data for *T. picturatus*. Landings data are collected from the auction market system and sent to the General Directorate for Fisheries to be compiled. This includes information on landings per species by day and vessel.

As information is available on the amounts and distribution of catches of T. *mediterraneus* and *T. picturatus* for at least 14 years (ICES 1990, ICES 1991a, ICES 1992a, ICES 1993a, ICES 1995, ICES 1996a, ICES 1997, ICES 1998a, ICES 1999a, ICES 2000a; ICES 2001a; ICES 2002a; ICES 2003a/), and as the evaluations and assessments are only made for *T. trachurus*, the Working Group recommends that the TACs and any other management regulations which might be established in the future should be related only to *T. trachurus* and not to *Trachurus spp*. in general, as is the case at present . It would then be appropriate to set TACs for the other species as well.

4.6 Length Distribution by Fleet and by Country:

As usual England and Wales, Netherlands, Norway, Germany, Ireland, Denmark, Portugal and Spain provided length distribution data for parts or for the total of their catches in 2002. These length distributions cover 60 % of the total landings and are shown in Table 4.6.1.

4.7 Relevant aspects of the report of WGMEGS 2003

At the 2002 meeting of WGMEGS (ICES 2002c) it was suggested that there was some doubt about whether horse mackerel was a determinate or an indeterminate spawner. In consequence WGMEGS held a two day workshop to specifically address this question and chart a way forward.

The workshop agreed on the following:

- Horse mackerel is an indeterminate spawner
- Mesocosm studies to be carried out in Norway to confirm this interpretation
- While, this might indicate that a switch to DEPM rather than AEPM, it was recognized that this was impractical. Pilot work on horse mackerel DEPM in 1989 and 1992 indicated major problems in adult parameter determination, resulting in a very high variance. Additionally, an AEPM for mackerel and a DEPM for horse mackerel would be difficult to carry out effectively at the same time.

- In the absence of any useable fecundity measure, that TAEP should be used alone for the foreseeable future
- Recognising that fecundity could change over time (ref: mackerel) a suitable proxy for fecundity should be sought – identified candidates were:

  a) The energy indicated by lipid content and dry weight fraction prior to the onset of spawning
  b) The energy taken in as food during spawning.

- Based on work presented at this meeting of WGMHSA (De Oliveira *et al,* 2003) it was recognized that these proxies are unlikely to be suitable as indices of fecundity. However, WGMEGS feels that an understanding of realised fecundity and how it interacts with condition and feeding will usefully underpin the use of TAEP in the assessment

- Fecundity samples should continue to be taken in the 2004 survey and should be collected throughout the survey period.

- Institutes should attempt to locate any historical data on horse mackerel lipid content or dry weights.

- The WG will continue to examine this issue and report any developments

Table 4.1.1 Landings (t) of HORSE MACKEREL by Subarea. Data as submitted by Working Group members.

Subarea	1979	1980	1981	1982	1983	1984
II	2	-	+	-	412	23
IV + IIIa	1,412	2,151	7,245	2,788	4,420	25,987
VI	7,791	8,724	11,134	6,283	24,881	31,716
VII	43,525	45,697	34,749	33,478	40,526	42,952
VIII	47,155	37,495	40,073	22,683	28,223	25,629
IX	37,619	36,903	35,873	39,726	48,733	23,178
Total	137,504	130,970	129,074	104,958	147,195	149,485

Subarea	1985	1986	1987	1988	1989	1990
II	79	214	3,311	6,818	4,809	11,414
IV + IIIa	24,238	20,746	20,895	62,892	112,047	145,062
VI	33,025	20,455	35,157	45,842	34,870	20,904
VII	39,034	77,628	100,734	90,253	138,890	192,196
VIII	27,740	43,405	37,703	34,177	38,686	46,302
IX	20,237	31,159	24,540	29,763	29,231	24,023
Total	144,353	193,607	222,340	269,745	358,533	439,901

Subarea	1991	1992	1993	1994	1995	1996	1997
II + Vb	4,487	13,457	3,168	759	13,133	3,366	2,617
IV + IIIa	77,994	113,141	140,383	112,580	98,745	27,782	81,198
VI	34,455	40,921	53,822	69,616	83,595	81,259	40,145
VII	201,326	188,135	221,120	200,256	330,705	279,109	326,415
VIII	49,426	54,186	53,753	35,500	28,709	48,269	40,806
IX	21,778	26,713	31,944	28,442	25,147	20,400	27,642
Total	389,466	436,553	504,190	447,153	580,034	460,185	518,882

Subarea	1998	1999	2000	2001	2002[1]
II + Vb	2,538	2,557	1,169	60	1,324
IV + IIIa	31,295	58,746	31,583	19,839	49,691
VI	35,073	40,381	20,657	24,636	14,190
VII	250,656	186,604	137,716	138,790	97,906
VIII	38,562	47,012	54,211	75,120	54,560
IX	41,574	27,733	27,160	24,912	23,665
Total	399,698	363,033	272,496	283,357	241,335

[1]Preliminary.

4.1.2 Quarterly catches of HORSE MACKEREL by Division and Subdivision in 2002.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	0	8	39	1,277	1,324
IIIa	4	1	8	166	179
IVa	103	531	302	35,919	36,855
IVbc	218	170	2,335	9,934	12,656
VIId	5,732	22	266	4,702	10,723
VIa,b	2,387	128	5,245	6,430	14,189
VIIa–c,e–k	30,991	3,824	1,565	50,804	87,184
VIIIa,b,d,e	782	21,213	3,788	6,667	32,450
VIIIc	4,481	6,976	6,920	3,733	22,110
IXa	5,170	6,045	7,895	4,555	23,665
Sum	49,867	38,918	28,364	124,187	241,335

Table 4.3.1 Landings and discards of HORSE MACKEREL (t) by year and division, for the North Sea, Western and Southern horse mackerel. (Data submitted by Working Group members.)

Year	North Sea horse mackerel					Western horse mackerel							Southern horse mackerel			Total
	IIIa	IVb,c	Discards	VIId	Total	IIa	IVa	VIa,b	VIIa-c,e-k	VIIIa,b,d,e	Discards	Total	VIIIc	IXa	Total	All stocks
1982	- 2,788[3]	-		1,247	4,035	-	-	6,283	32,231	3,073	-	41,587	19,610	39,726	59,336	104,958
1983	- 4,420[3]	-		3,600	8,020	412	-	24,881	36,926	2,643	-	64,862	25,580	48,733	74,313	147,195
1984	- 25,893[3]	-		3,585	29,478	23	94	31,716	38,782	2,510	500	73,625	23,119	23,178	46,297	149,400
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	150,830
1986	396	19,496		4,756	24,648	214	776	20,343	72,761	3,071	8,500	105,665	40,334	31,159	71,493	201,806
1987	436	9,477		1,721	11,634	3,311	11,185	35,197	99,942	7,605	-	157,240	30,098	24,540	54,638	223,512
1988	2,261	18,290		3,120	23,671	6,818	42,174	45,842	81,978	7,548	3,740	188,100	26,629	29,763	56,392	268,163
1989	913	25,830		6,522	33,265	4,809	85,304[2]	34,870	131,218	11,516	1,150	268,867	27,170	29,231	56,401	358,533
1990	14,872[1]	17,437		1,325	18,762	11,414	112,753[2]	20,794	182,580	21,120	9,930	373,463	25,182	24,023	49,205	441,430
1991	2,725[1]	11,400		600	12,000	4,487	63,869[2]	34,415	196,926	25,693	5,440	333,555	23,733	21,778	45,511	391,066
1992	2,374[1]	13,955	400	688	15,043	13,457	101,752	40,881	180,937	29,329	1,820	370,550	24,243	26,713	50,955	436,548
1993	850[1]	3,895	930	8,792	13,617	3,168	134,908	53,782	204,318	27,519	8,600	433,145	25,483	31,945	57,428	504,190
1994	2,492[1]	2,496	630	2,503	5,689	759	106,911	69,546	194,188	11,044	3,935	388,875	24,147	28,442	52,589	447,153
1995	240	7,948	30	8,666	16,756	13,133	90,527	83,486	320,102	1,175	2,046	510,597	27,534	25,147	52,681	580,034
1996	1,657	7,558	212	9,416	18,843	3,366	18,356	81,259	252,823	23,978	16,870	396,652	24,290	20,400	44,690	460,185
1997	2,037[4]	15,504[5]	10	5,452	19,540	2,617	63,647	40,145	318,101	11,677	2,921	442,571	29,129	27,642	56,771	518,882
1998	3,693	10,530	83	16,194	30,500	2,540[6]	17,011	35,043	232,451	15,662	830	303,543	22,906	41,574	64,480	398,523
1999	2,095[4]	9,335		27,889	37,224	2,557[7]	47,316	40,381	158,715	22,824		273,888	24,188	27,733	51,921	363,033
2000	1,105[4]	25,954		22,471	48,425	1,169[8]	4,524	20,657	115,245	32,227		174,927	21,984	27,160	49,144	272,496
2001	157[9]	8,157		38,114	46,425	60	11,525[10]	24,636	100,676	54,293		191,193	20,828	24,911	45,739	283,357
2002	179[4]	12,636	20	10,723	23,379	1,324	36,855	14,190	86,878	32,450	305	172,182	22,110	23,665	45,775	241,336

[1]Norwegian and Danish catches are included in the Western horse mackerel.
[2]Norwegian catches in Division IVb included in the Western horse mackerel
[3]Divisions IIIa and IVb,c combined.
[4]Included in Western horse mackerel
[5]Norwegian catches in IVb (1,426 t) included in Western horse mackerel.
[6]Includes 1937 t from Vb
[7]Includes 132 t from Vb
[8]Includes 250 t from Vb
[9]Includes 72 t allocated to western horse mackerel
[10]Includes 69 t allocated to North Sea horse mackerel

Table 4.5.1 Catches (t) of Trachurus mediterraneus in Divisions VIIIab, VIIIc and IXa and Sub-area VII in the period 1989-2002 and Trachurus picturatus in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-2002.

	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
T. mediterraneus	**VII**		-	-	-	0	0	0	0	0	0	0	0	0	0	0	59	1	1
	VIIIab		-	-	-	23	298	2122	1123	649	1573	2271	1175	557	740	1100	988	525	525
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198
		VIIIc west	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198
	IXa	IXa North	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		IXa C, N & S	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL		-	-	-	**3926**	**3241**	**7142**	**5927**	**6225**	**4917**	**6856**	**4618**	**3821**	**4495**	**2692**	**1854**	**1820**	**1724**
T. picturatus	**IXa**		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526	320	464	420	663
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473	690	563	1089	5000
	34.1.1 Madeira's area		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657	344	646	385	358
	TOTAL		**5704**	**4734**	**7136**	**6824**	**6385**	**4135**	**3082**	**3290**	**3120**	**2756**	**3117**	**3516**	**2657**	**1354**	**1672**	**1894**	**6021**

(-) Not available

Table 4.6.1 Length distributions (%) of HORSE MACKEREL catches by fleet and country in 2002 (0.0=<0.05%)

	E&W	Neth	Germany			Norway	Spain				Portugal			Denmark
	P. trawl	**P.trawl**	**vessels<30m**	**Trawl**	**Trawl**	**P.seine**	**P.seine**	**D.trawl**	**Gill net**	**Hook**	**Trawl**	**P. Seine**	**Artisanal**	**Bycatch[1]**
cm	Div. VIIe		Div IVb	Div VIIe	Div VIIh	Divs IIa, IVa								Divs IVbc, VIId
5														5.1
6														16.4
7							0.1					0.1		2.3
8							0.9					0.3		
9							1.8					0.1		
10							0.1				0.0	0.1	0.2	1.7
11							2.0				0.0	0.4	1.5	10.2
12							9.6				0.3	3.1	8.8	19.8
13		0.0					15.9	0.1	0.0		4.7	3.6	14.1	13.6
14		0.1		0.0	0.0		13.4	1.1	0.4		15.1	8.9	7.2	1.7
15		0.3		0.5	0.5		12.6	2.9	0.6		20.7	12.5	2.2	
16		2.1		1.8	3.6		9.2	4.1	0.3		14.6	9.8	0.7	
17		4.5		8.5	12.1		6.2	2.3	0.1		11.2	11.7	0.6	1.1
18		6.8		15.3	15.1		3.6	0.9	0.1		8.9	9.4	1.0	1.1
19		6.3		7.7	6.0		1.9	0.6	0.1		4.6	8.1	0.9	2.3
20		5.7		3.8	3.0		1.3	0.9	0.2		2.8	7.7	1.5	2.8
21	0.4	7.1		1.7	0.8		0.9	1.4	0.3		1.6	6.7	2.6	5.6
22	1.5	6.6		4.1	1.1		0.6	1.0	0.5		1.6	5.0	1.6	8.5
23	4.5	6.5		13.4	3.5		0.7	1.3	2.3	0.2	1.5	3.5	1.3	5.6
24	6.8	9.1		18.1	9.4		1.5	3.3	5.8	0.6	1.4	3.3	2.6	
25	22.1	11.5	1.7	16.6	18.3		2.8	4.2	5.6	1.0	1.5	3.0	5.3	0.6
26	16.3	8.8	1.7	5.6	14.7	0.1	3.8	2.8	7.2	3.2	2.1	1.7	6.7	1.1
27	15.6	5.8	4.4	2.4	8.5	0.1	3.1	4.0	9.1	4.4	2.4	0.7	9.4	0.6
28	9.0	4.9	6.9	0.4	2.9	0.1	2.4	5.0	8.0	9.2	1.8	0.3	8.9	
29	6.5	4.4	14.9		0.4	0.5	1.9	7.3	8.8	14.1	1.1	0.0	6.0	
30	4.8	3.6	15.0		0.1	1.8	1.7	9.5	9.1	13.7	0.8	0.0	5.4	
31	3.4	2.0	16.3		0.0	6.7	1.1	11.6	9.9	10.4	0.5	0.0	3.1	
32	2.3	1.1	16.5			12.9	0.6	11.1	7.9	9.4	0.3	0.0	2.2	
33	1.7	0.9	10.7			17.3	0.2	8.0	7.3	9.5	0.2		1.5	
34	1.1	0.6	5.0			21.6	0.1	6.7	6.2	10.2	0.1		1.3	
35		0.4	2.8			19.0	0.0	3.7	5.0	6.7	0.1		1.0	
36	2.8	0.2	2.7			12.0	0.0	2.2	2.3	3.8	0.0		0.8	
37	1.1	0.2	0.7			5.3	0.0	1.3	1.1	1.8	0.0		0.5	
38		0.1	0.6			1.7	0.0	1.0	0.6	0.2	0.0		0.2	
39		0.1				0.7	0.0	0.6	0.4	0.5	0.0		0.2	
40		0.1	0.1			0.3	0.0	0.5	0.4	1.2			0.0	
41		0.0	0.1					0.3	0.1				0.1	
42+		0.0						0.4	0.0		0.0		0.4	
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.0

[1]Bycatch taken in the industrila trawl fishery

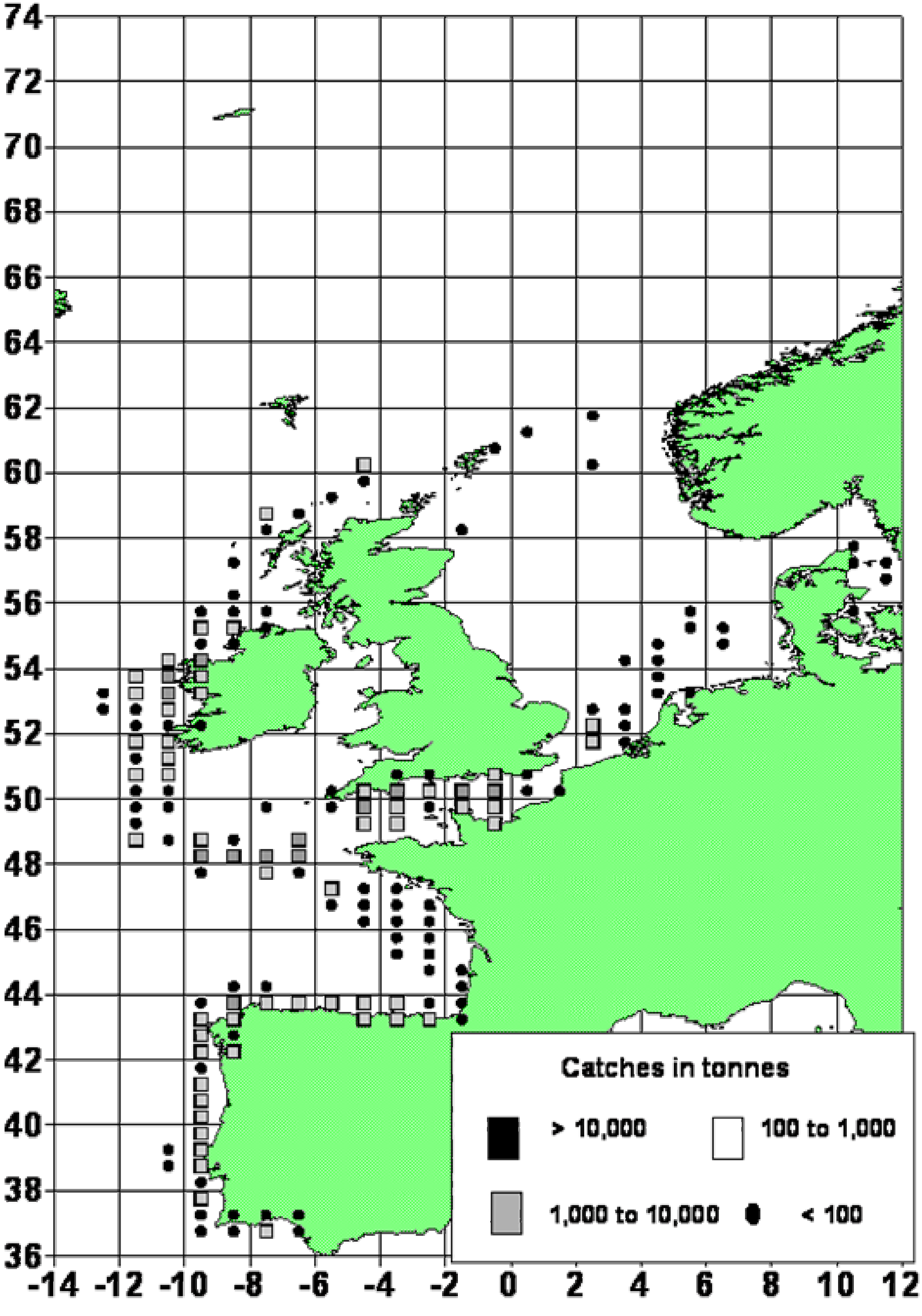


Figure 4.1.1.a Horse Mackerel commercial catches in quarter 1 2002.

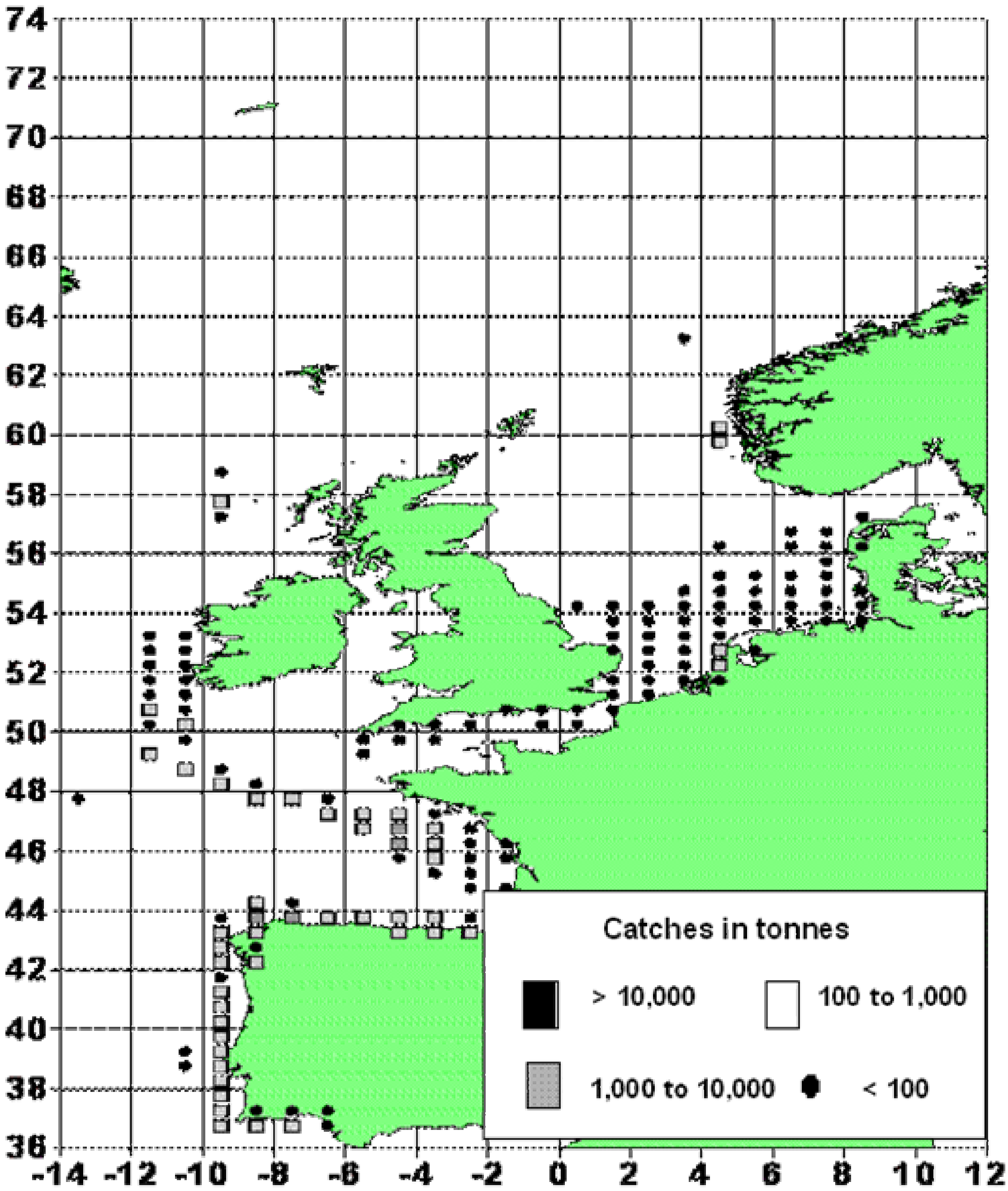


Figure 4.1.1.b Horse Mackerel commercial catches in quarter 2 2002

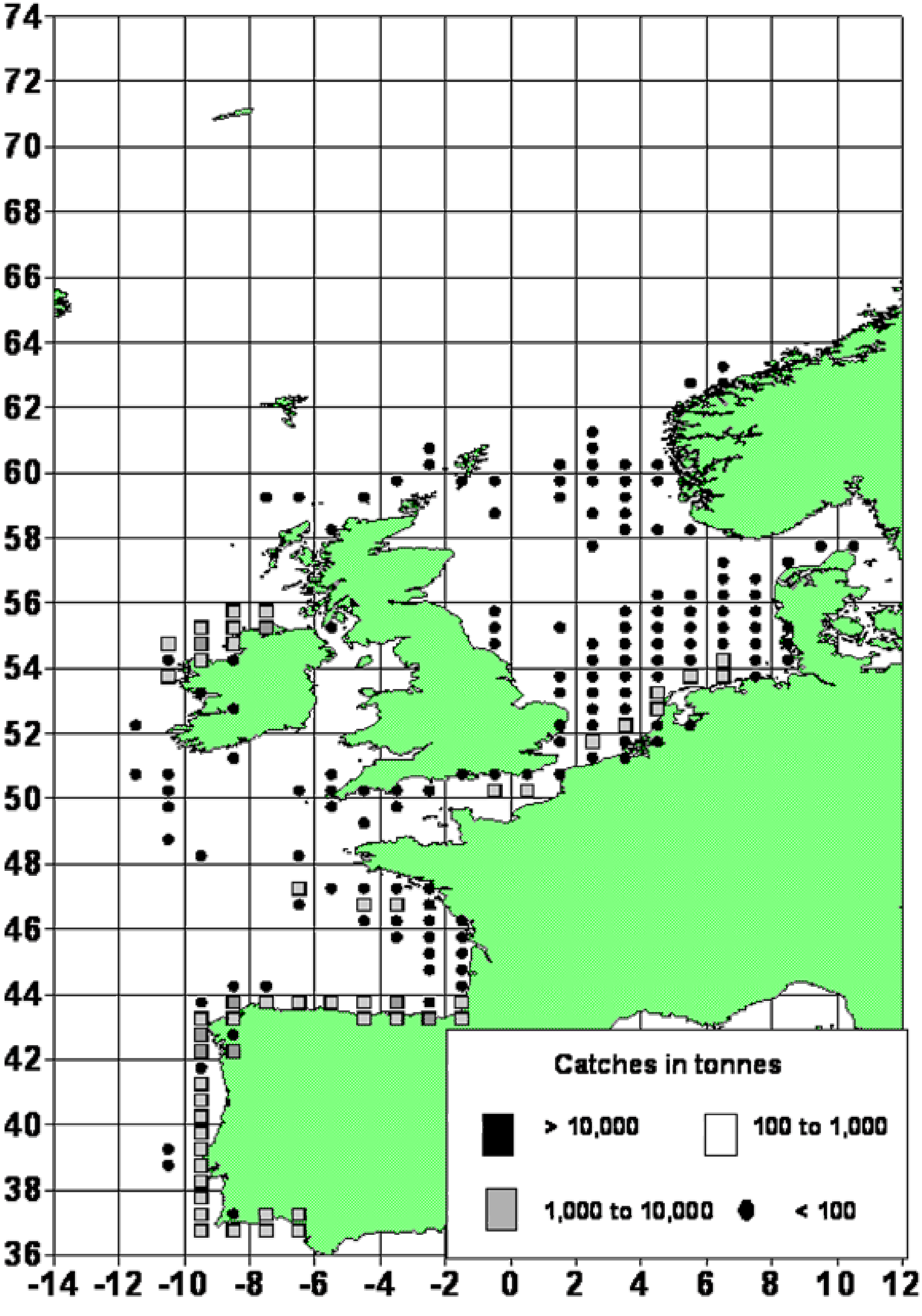


Figure 4.1.1.c Horse Mackerel commercial catches in quarter 3 2002.

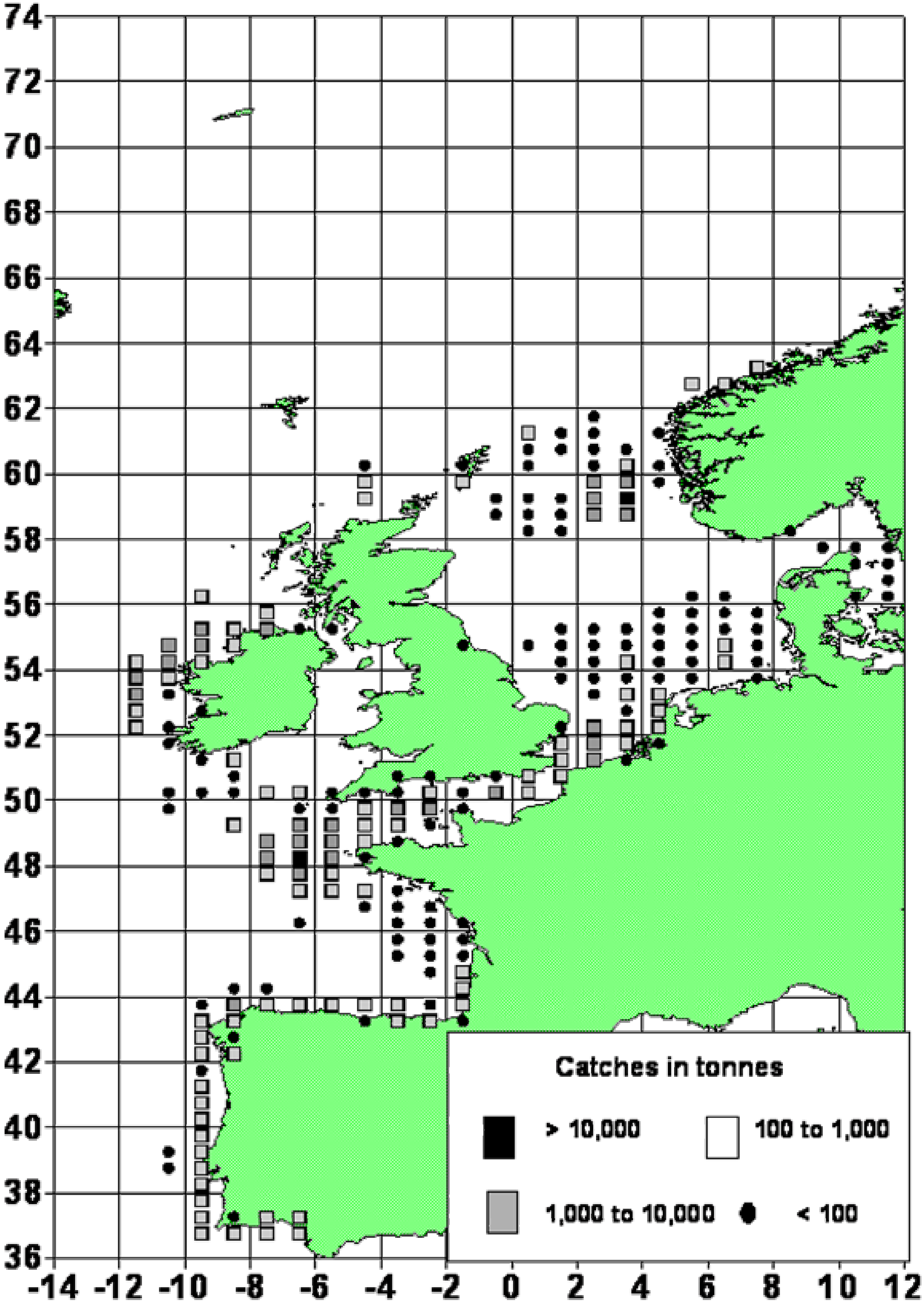


Figure 4.1.1.d Horse Mackerel commercial catches in quarter 4 2002.

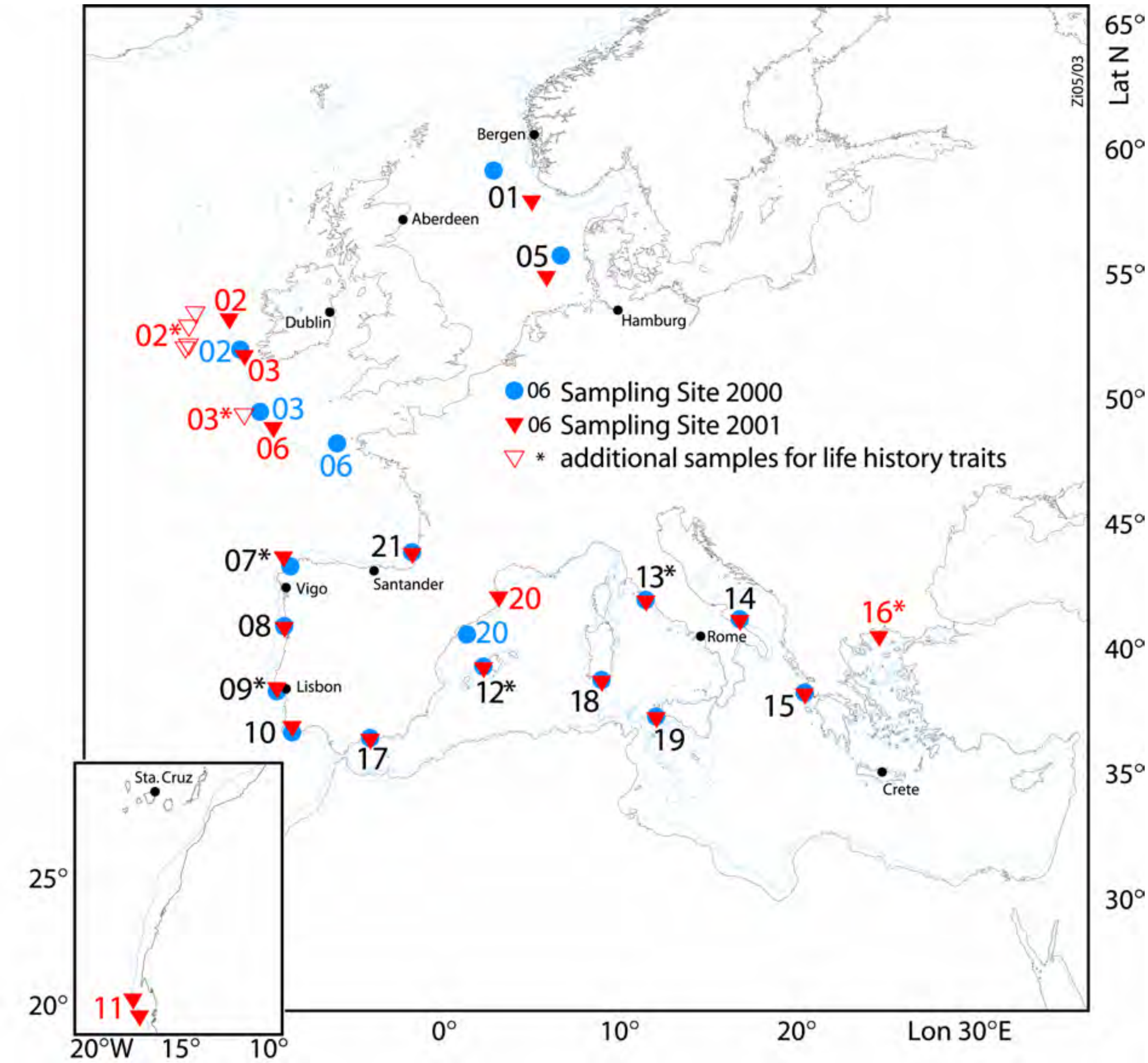


Figure 4.2.1.1 Realised sampling site positions for the EU-project HOMSIR in 2000 (circles) and 2001 (triangles). Map source: GEBCO, 200m depth contour drawn. Kartesian projection, inset in same scale.

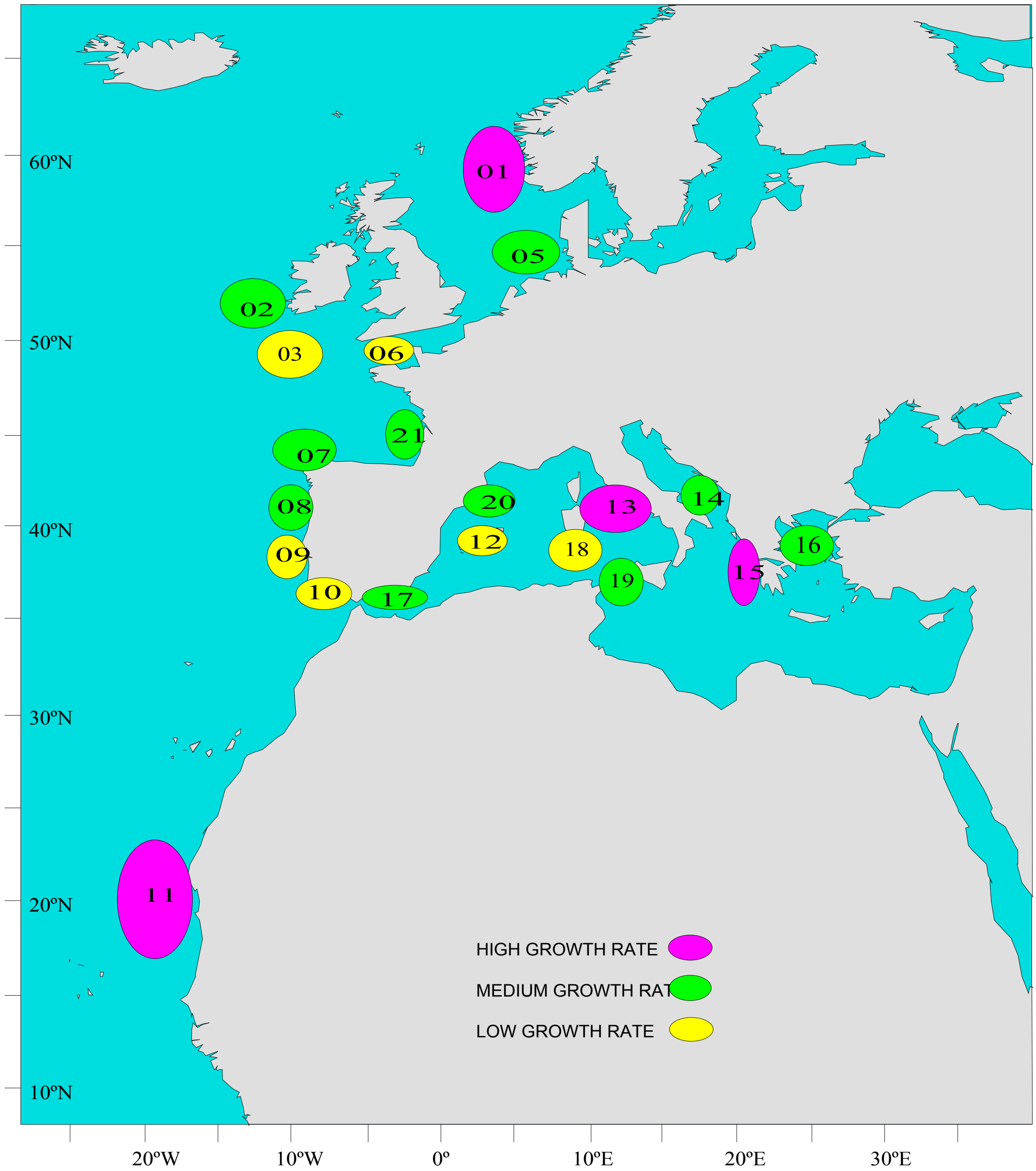


Figure 4.2.1.2 Study area with the characterization of zones with respect to horse mackerel growth during the sampling period. Red = high values in length-at-age; orange: medium values of length-at-age; yellow = low values of length-at-age.

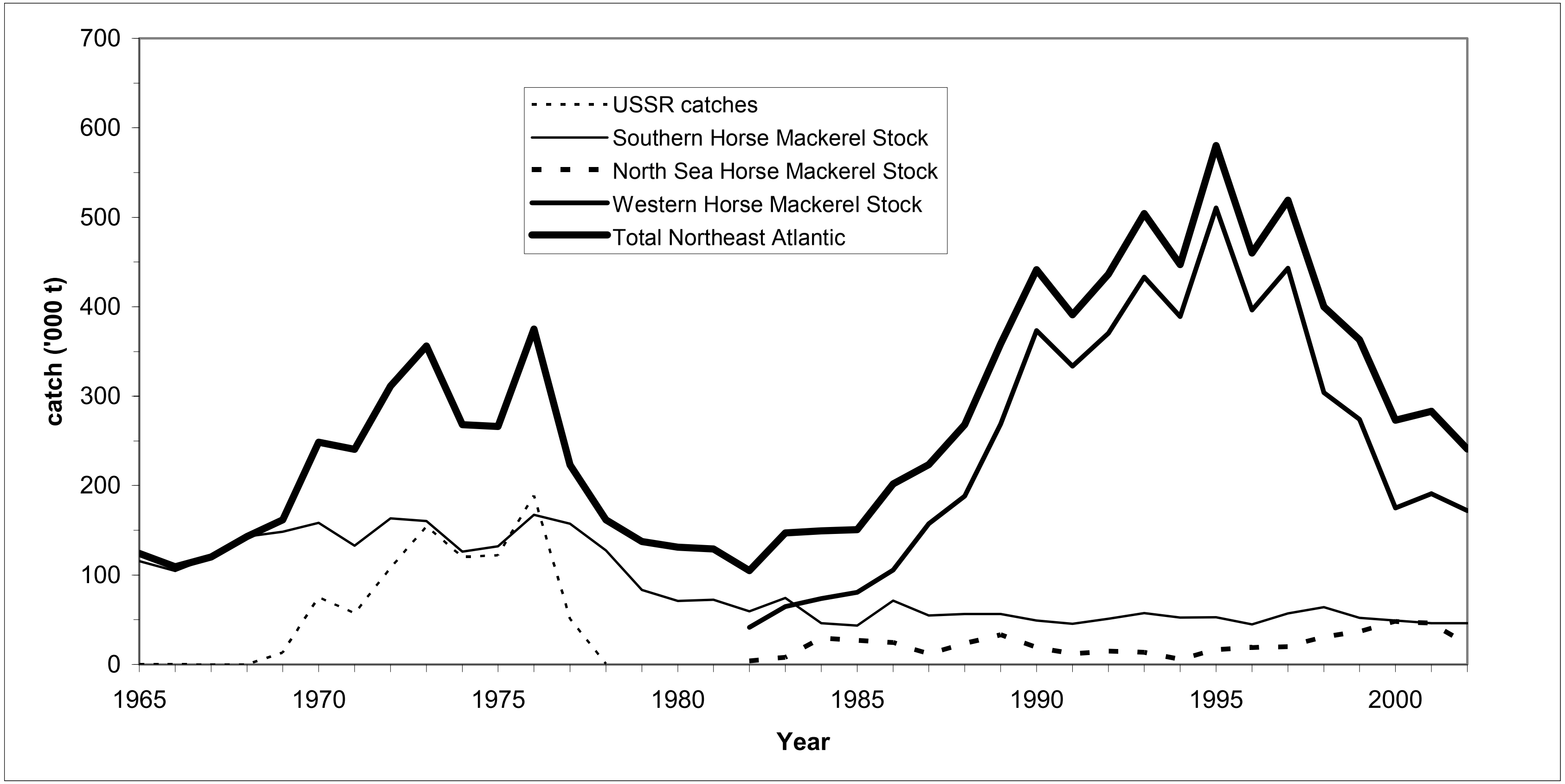


Figure 4.3.1 Total catches of horse mackerel in the northeast Atlantic during the period 1965 - 2002. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic.

5 NORTH SEA HORSE MACKEREL (DIVISIONS IIIA (EXCLUDING WESTERN SKAGERRAK), IVBC AND VIID

5.1 ACFM advice Applicable to 2001 and 2002

The ACFM stated in 2002 that no assessment is possible because of insufficient data. Also fishery independent information is lacking. It was noted that the increase in juvenile fish in the catch in recent years may be caused by a relative strong year class 1998. Also the relative large catch numbers of the year classes around the 1998 year class may indicate that there are ageing problems.

The ACFM (in 2002) recommended a precautionary TAC not above the long-term average of 18.000 tonnes in 2002.

EU has since 1987 set a TAC for EU waters in Division IIa and Subarea IV, which is a wider area than the North Sea stock is distributed in. This TAC has been fixed at 60,000 t for 1993-1999. In 2000 the TAC was reduced to 51 000 a value which was kept for 2001.

5.2 The Fishery in 2002 on the North Sea stock

Catches taken in Divisions IVb, c and VIId are regarded as belonging to the North Sea horse mackerel and in some years also catches from Division IIIa - except the western part of Skagerrak (see Sections 4.2 and 4.3). Table 4.3.1 shows the catches of this stock from 1982–2001. The total catch taken from this stock in 2002 is 23380 (about half the catch of 46,425 tonnes in year 2001, which was the largest catch on record). In previous years most of the catches from the North Sea stock were taken as a by-catch in the small mesh industrial fisheries in the fourth quarter carried out mainly in Divisions IVb and VIId, but in recent years a large part of the catch was taken in a directed horse mackerel fishery for human consumption.

5.3 Fishery-independent Information

5.3.1 Egg Surveys

No egg surveys for horse mackerel have been carried out in the North Sea since 1991. Such surveys were carried out during the period 1988-1991. SSB estimates are available historically. However, they were calculated assuming horse mackerel to be a determinate spawner. New information has cast doubt on this, so the SSB information is currently not used in assessment.

5.3.2 Bottom trawl surveys

This year, the WG investigated the IBTS data on horse mackerel 1995-2001.

IBTS data for North Sea Horse Mackerel are given only as catch rates by length group. Therefore length distributions were converted into an index of biomass, by use of a length-weight relationship.

The length-weight relationship, log(Weight) = a + b*log(Length), with b = 2.96, b = 0.0000116. (based on data in Dickey-Collas and Eltink, WD 2003). Weight and length-at-age by are shown in Table 5.3.2.a+b. The index of biomass was defined as:

$$BiomassIndex = \sum_{Length} CPUE(Length) * \exp(a) * Length^{b}$$

Indices for quarters 3 are shown in Figure 5.3.2. There appear to be little correlation between the IBTS index based on quarter 1 (as demonstrated by the WG in 2001) and the index based on quarter 3. Because the stock migrates outside the area covered by the IBTS in the first quarter, this index is not representative for the stock, and consequently, it has not been used. Thus, only the IBTS index of third quarter is considered representative for the stock.

5.4 Biological Data

5.4.1 Catch in Numbers-at-age

Catch in numbers-at-age by quarter and annual values were calculated according to Dutch samples collected in Divisions IVb and IVc from the third and fourth quarter, and in VIId from the first, third and fourth quarter. Annual catch numbers-at-age are given in Table 5.4.1.1 and by area for 2002 in Table 5.4.1.2. Table 5.4.1.3 shows catch number by quarter and by area in 2001. The allocations of samples to calculate catch in numbers by age for the different Divisions are available in the Working Group archive. For the earlier years age compositions were presented based on samples taken from smaller Dutch commercial catches and research vessel catches. These are available for the period 1987–1995, and cover only a small proportion of the total catch, but give a rough indication of the age composition of the stock (Figure 5.4.1.1).

At present the sampling intensity is rather low and the quality of the catch-at-age data may be questionable. If a dependable analytical assessment is to be done in the future the sampling needs to be improved. In year 2001, and this year, however, a preliminary assessment was made based on available data. From 1995 the proportion of the catch taken for human consumption has been high (around 70% in 1995 and 96). The Dutch samples after 1996 covered all their catches, and as this catch is the largest part, the coverage has been around 70 % in recent years The coverage for 1995-6 is not known. In 2002 the coverage was 60 % as shown in the text table below.

The number-at-age are based on Dutch age sampling. The precision of numbers-at-age of North Sea mackerel from Dutch market sampling was estimated and was relatively low compared to precision of estimates of the western horse mackerel stock (Dickey-Collas and Eltink, WD 2003)

	1995	1996	1997	1998	1999	2000	2001	2002
% of landings covered	62	55	57	66	77	71	50	60
Samples from	RV	RV+FV	FV	FV	FV	FV	FV	FV

(RV = Research Vessel, FV = Commercial fishing Vessels)

5.4.2 Mean weight-at-age and mean length-at-age

Table 5.4.1.3 shows weight and length by quarter and by area in 2002. The annual average values are shown in Table 5.3.2.

5.4.3 Maturity-at-age

No data have been made available for this Working Group. Maturity ogive was not used in the preliminary analysis.

5.4.4 Natural mortality

There is no specific information available about natural mortality of this stock. The value M = 0.15 for all ages (as used for other mackerel stocks) was used in the preliminary assessment (Section 5.5.1) .

5.5 State of the Stock

Estimates of total age composition are available since 1995 based on Dutch samples (Table 5.4.1.1). Estimates of age composition prior to 1995 are considered unreliable, that is, not representative for the entire fishery, and should not be used for analytical assessment. During the period the catches were relatively low with an average of 18,000 t. The catch, however, has gone up considerably in recent years, and the state of the stock is unknown. In 2000 the catch level increased to the highest on record and remained at the high level in 2001, but decreased in 2002. The egg surveys in later years for mackerel in the North Sea do not cover the spawning area of horse mackerel. The present stock level is uncertain since the last SSB estimate was made in 1991. Since allocation of catches to the stock is based on the temporal and spatial distribution of the fishery it is important that catches are reported by ICES rectangle and quarters. Since there is no information of the SSB since 1991 it is not known if this stock is still exploited moderately. In year 2001, however, it was attempted to make a first preliminary analytical assessment based on data from 1995 to 2000. It was attempted to analyse the IBTS data to obtain an index of biomass. Two preliminary assessments were made in 2001 for the North Sea Horse Mackerel: (1) ISVPA (2) Ad Hoc Spread Sheet – (a method, with a smaller number of parameters). This year, a similar attempt was made using the R-language.

The catch-at-age appears to have changed during the period from 1995 to 2000, with a large reduction in mean age, mean length and mean weight. This coinside with the disappearance of the large 1982-year class, but may also be caused by biased samples. In years 1995 and 1996 a certain number of commercial catches were converted into age distributions by research vessel samples, which may not be representative for the commercial fishery. In recent years, however, a fishery for human consumption fishery has developed. This fishery targets at small size horse mackerel for the Japanese market (Eltink, pers. Com.). It appears that fishing mortality has shown a pronounced increasing trend during the period 1995-2000. More younger age groups appear in the catch in recent, as demonstrated by Figures 5.4.11 and 5.4.1.3.

5.5.1 Ad Hoc Stochastic – assessment method

This method is essentially like all the other single-species assessment methods used by ICES WGs. It is a model with a small number of parameters matching the short time-series of data and a single length based biomass index available for North Sea horse mackerel. It is a model assuming a separable fishing mortality, which uses catch-at-age, and biomass index as input. Parameters are fitted by the Chi-squared method. It deviates from other methods in that the number of parameters is smaller, which is made possible by the introduction of a number of assumptions.

1) The selection ogive has an ascending (left hand side) and a descending (right hand side). Here this is modelled by the product of two logistic curves (that requires 4 parameters per year).
2) The parameters in the selection ogive are assumed to remain constant within preselected sequences of years.

In the actual application of the model, selection was assumed to remain constant during the two periods (9995-1998) and (1999-2002). This should reflect the observation that more young fish appear in the catches in recent years (see Table 5.4.1.1 and Figure 5.4.1.3)

The left hand side gear selection ogive in year "y" of age group "a" is.

$$\mathrm{SEL}_{\mathrm{LEFT}}(\mathrm{y,a}) = \frac{1}{1+\exp(\mathrm{Sel1}_{\mathrm{Left}}(y)+\mathrm{Sel2}_{\mathrm{Left}}(\mathrm{y})*\mathrm{Lgt}\ \ (a))}$$

where $\mathrm{Sel2}_{Left}(y) = \ln(3)* L_{Left50\%}(y)/(L_{Left75\%}(y) - L_{Left50\%}(y))$ and $\mathrm{Sel2}_{Left}(y) = \ln(3)/(L_{Left75\%}(y) - L_{Left50\%}(y))$
$L_{Left50\%}(y)$ = Body Length at which 50% of the fish entering the gear are retained (ignoring the right hand side selection)
$L_{left75\%}(y)$ = Body Length at which 75 % of the fish entering the gear are retained

The right hand side of the selection is modelled by:

$$\mathrm{SEL}_{\mathrm{RIGHT}}(\mathrm{y,a}) = 1 - \frac{1}{1+\exp(\mathrm{Sel1}_{\mathrm{Right}}(y)+\mathrm{Sel2}_{\mathrm{Right}}(\mathrm{y})*\mathrm{Lgt}\ \ (a))}$$

and with the parameters defined as for the left-hand side selection.

The combined selection ogive thus becomes: $\mathrm{SEL(y,a)} = \mathrm{SEL}_{\mathrm{LEFT}}(y,a)*SEL_{RIGHT}(y,a)$
The selection ogive is normalized so that the maximum value is 1.0.

Thus the selection part of the separable VPA is replaced by only 4 parameters: A_{Left} , $B_{Left,}$ A_{Right} and B_{Right} for each sequence of years with constant selection.

The stock numbers in the first year were fitted to the catch numbers by N=n1*C*Z/F/(1-exp(-Z)), where the parameter "n1" allows for the level of all Ns in the first year to vary.

The object function to be minimized is the "modified χ^2 –criterion":

$$\chi^2 = W_C \sum_y \sum_a \frac{(C_{Observed}(y,a) - C_{\Pr edicted}(y,a))^2}{C_{\Pr edicted}(y,a)} +$$

$$W_B \sum_y \frac{(\mathrm{Re}l.Bionass(y) - \mathrm{Re}l.IBTSIndex(y))^2}{\mathrm{Re}l.Biomass(y)}$$

where W_C and W_B are the weight allocated to the catch-at-age data and the IBTS-data, respectively.

(the χ^2-criterion is a most often used to test "model goodness of fit", see e.g. Sokal & Rohlf, 1995)

The "relative biomass" is the biomass predicted by the model, and the relative index is the length based IBTS index for quarter 3.

The model was implemented in R-language, and is available in the WG-archive.

5.5.2 Results of the Ad Hoc assessment method.

Several exploratory runs were made. The only important option war the weight given to the IBTS relative to the catch-at-age data, when evaluating the object function. Giving zero weight to the IBTS-index gave a fair reproduction of the observed catches, as shown in Tables 5.4.2.4.a-d. Parameter estimates have relative standard deviations from 10% to 100% except for the parameters for the left hand side selection, where the values are millions of %. The large uncertainty about the right hand side selection is, however, not very important, as the parameters hardly have any influence on the fishing mortality (See Table 5.52.4.a).

Giving equal weights to IBTS and catch-at-age data, however, produces unrealistic results for all outputs. The total biomass is now in accordance with the IBTS index but anything else is unexpected (See Tables 5.5.2.5.a-c.). This is not surprising when one compares the relative biomasses of the IBTS and that estimated from catch-at-age data (Compare Figures 5.3.2.2 and 5.5.2.1). The conclusion is that that the two sources of data are in conflict. The catch-at-age data produces reasonable results.

The working group stresses that the results of this exercise are to be considered "data-exploration" rather than an assessment, due to the uncertainties of data, the short time-series and the experimental nature of the model.

The results are inconclusive, which may be due to errors in data allocation and stock identification. The problems with the IBTS data, may be that they are not interpreted in accordance the biology of the stock.

5.6 Reference Points for Management Purposes

At present there is not sufficient information to estimate appropriate reference points.

5.7 Harvest Control Rules

No harvest control rules were considered since no assessment was carried out.

5.8 Management Measures and Considerations

EU has since 1987 set a TAC for EU waters in Division IIa and Subarea IV. This TAC has been 60,000 t from 1993 to 1999 and 51000 in 2000. However, this TAC includes Divisions IIa and IVa and does not include Division VIId compared to the areas where the North Sea horse mackerel is distributed in. The Working Group recommends that if a TAC is set for this stock, it should apply to those areas where the North Sea horse mackerel are fished, i.e. Divisions IVb,c, VIId and eastern part of Division IIIa.

No forecast for the North Sea stock has been made for 2003.

The data were insufficient to define a management plan for this stock.

5.9 Recommendation

The Working Group recommends that the IBTS collects age composition samples from horse mackerel in third quarter in the area of the North Sea horse mackerel (IVbc, VIId and IIIa), to improve the fishery independent abundance indices. It is also recommended that more age composition samples be collected, covering all major components of the North Sea horse mackerel fisheries.

ICES in 2002 recommended that catches in 2003 be no more than the 1982-1997 average of 18,000t in order to avoid an expansion of the fishery until there is more information about the structure of horse mackerel stocks and there is sufficient information to facilitate an adequate assessment. Despite this advice the North Sea horse mackerel catches increased considerably, from about 37 000 t in 1999, to 48 000 t in 2000, 46 000 t in 2001 and 23500 t in 2002.

According to ICES the North Sea horse mackerel is distributed in Divisions IIIa (eastern part), IVbc and VIId. However, the management area for the North Sea horse mackerel does not cover Division VIId. Therefore, the catches from Division VIId are taken from the North Sea horse mackerel population, but have to be counted against the western horse mackerel TAC. This implies that catches of the North Sea horse mackerel population can be taken during overwintering in the 1st and 4th quarter in the eastern Channel (VIId) area in addition to the TAC of North Sea horse mackerel. During the period 1982 to 1997 the catches in Division VIId remained rather low (below 10 thousand tonnes). However, from 1998 onwards they increased rapidly up to about 40 thousand tonnes in 2001 and decreased to 11 000 t in 2002. There is no protection against over-fishing of the North Sea stock, if the much higher TAC of western horse mackerel is used to fish for North Sea horse mackerel in Division VIId.

Therefore, the TAC for this stock should apply to all areas in which North Sea horse mackerel are fished, i.e., Divisions IIIa, (eastern part), IVbc, and VIId.

Table 5.3.2.1.a Weight-at-age (kg), 1995-2002, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	0.076	0.107	0.063	0.063	0.063	0.075	0.055	0.066
2	0.126	0.123	0.102	0.102	0.102	0.101	0.072	0.095
3	0.125	0.143	0.126	0.126	0.126	0.136	0.071	0.129
4	0.133	0.156	0.142	0.142	0.142	0.152	0.082	0.154
5	0.146	0.177	0.16	0.16	0.16	0.166	0.12	0.172
6	0.164	0.187	0.175	0.175	0.175	0.194	0.183	0.195
7	0.161	0.203	0.199	0.199	0.199	0.198	0.197	0.216
8	0.178	0.195	0.231	0.231	0.231	0.213	0.201	0.227
9	0.165	0.218	0.25	0.25	0.25	0.247	0.235	0.228
10	0.173	0.241	0.259	0.259	0.259	0.28	0.246	0.251
11	0.317	0.307	0.3	0.3	0.3	0.279	0.26	0.302
12	0.233	0.211	0.329	0.329	0.329	0.342	0.286	0.292
13	0.241	0.258	0.367	0.367	0.367	0.318	0.287	0.318
14	0.348	0.277	0.299	0.299	0.299	0.325	0.295	0.319
15+	0.348	0.277	0.36	0.36	0.36	0.332	0.336	0.390

Table 5.3.2.1.b Length-at-age (cm) 1995-2002, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	19.2	19.2	19.2	19.2	19.2	19	18.7	17.1
2	22	22	22	22	22	21.5	20.4	21.4
3	23.5	23.5	23.5	23.5	23.5	23.9	20.6	22.9
4	24.8	24.8	24.8	24.8	24.8	24.9	21.3	24.9
5	25.5	25.5	25.5	25.5	25.5	26	25	26.2
6	26.4	26.4	26.4	26.4	26.4	27.8	27.4	26.6
7	27.2	27.2	27.2	27.2	27.2	28.3	28	27.4
8	29.2	29.2	29.2	29.2	29.2	28.6	28.4	28.2
9	29.5	29.5	29.5	29.5	29.5	30	29.7	29.2
10	29.5	29.5	29.5	29.5	29.5	31.3	30.2	30.8
11	30.6	30.6	30.6	30.6	30.6	31.4	30.7	32.5
12	32.1	32.1	32.1	32.1	32.1	33.7	32	33.8
13	33.3	33.3	33.3	33.3	33.3	33.5	31.7	33.8
14	31.1	31.1	31.1	31.1	31.1	33.4	32.1	32.4
15+	32.5	32.5	32.5	32.5	32.5	33.4	33.4	34.4

Table 5.4.1.1 Catch in numbers (millions), 1995-2002, for the North Sea horse mackerel stock

Age	1995	1996	1997	1998	1999	2000	2001	2002
1	1.76	4.58	12.56	2.3	12.42	70.23	12.81	60.42
2	3.12	13.78	27.24	22.13	31.45	77.98	36.36	16.82
3	7.19	11.04	14.07	36.69	23.13	28.41	174.34	19.27
4	10.32	11.87	14.93	38.82	17.59	21.42	87.81	11.90
5	12.08	9.64	14.58	20.79	23.12	31.27	18.51	5.61
6	13.16	12.49	12.38	12.1	26.19	19.64	11.49	5.83
7	11.43	7.96	10.12	13.99	20.64	19.47	18.25	5.54
8	12.64	6.6	8.64	10.79	21.75	9	14.7	10.48
9	7.25	1.48	2.45	8.26	12.91	11.5	10.22	6.33
10	5.87	5.31	0.75	4.01	8.21	8.96	9.98	6.75
11	0.01	0.29	0.34	2.72	2.14	6.98	9.58	5.12
12	8.84	1.28	0.25	0.71	0.43	3.07	5.35	3.02
13	0.2	8.92	0	1.81	1.4	1.61	3.73	2.17
14	4.37	8.01	1.38	0.31	3.78	0	1.95	1.29
15+	0	0	0	5.11	4.03	12.22	5.81	2.71

Table 5.4.1.2 Catch number, annual mean length and annual mean weight North Sea horse mackerel stock by area in 2002.

Catch number (Total 2002)

Ages	IVb	IVc	IVbc	VIId	Total
0	0.0	0.0	0.0	0.0	0
1	4161.4	35047.4	136.8	21073.4	60419.0
2	2792.6	11069.9	47.7	2906.5	16816.8
3	3252.4	13189.1	56.5	2772.2	19270.3
4	952.8	5978.7	23.8	4947.7	11903.0
5	589.2	3325.4	13.4	1684.2	5612.0
6	218.9	2051.3	7.7	3549.9	5827.8
7	214.3	2006.2	7.5	3315.8	5543.8
8	242.4	2326.0	8.5	7906.0	10483.0
9	165.6	1572.7	5.8	4589.2	6333.3
10	444.4	1698.4	7.0	4597.0	6746.7
11	428.0	1522.8	6.4	3159.4	5116.7
12	92.8	881.9	3.2	2046.7	3024.6
13	65.1	617.5	2.3	1482.5	2167.5
14	26.1	255.8	0.9	1004.1	1287.0
15	133.1	1240.9	4.7	1333.6	2712.3

Mean Weight-at-age (kg)

Ages	IVb	IVc	IVbc	VIId	Total
0	0	0	0	0	0
1	0.073	0.072	0.072	0.056	0.066
2	0.101	0.094	0.095	0.095	0.095
3	0.130	0.129	0.129	0.128	0.129
4	0.166	0.156	0.157	0.150	0.154
5	0.173	0.179	0.177	0.159	0.172
6	0.210	0.210	0.210	0.186	0.195
7	0.245	0.244	0.245	0.196	0.216
8	0.262	0.260	0.263	0.216	0.227
9	0.273	0.271	0.274	0.211	0.228
10	0.313	0.286	0.292	0.232	0.251
11	0.343	0.320	0.325	0.287	0.302
12	0.325	0.323	0.325	0.278	0.292
13	0.301	0.302	0.301	0.325	0.318
14	0.406	0.399	0.407	0.297	0.319
15	0.371	0.372	0.371	0.409	0.390

Mean Length-at-age (cm)

Ages	IVb	IVc	IVbc	VIId	Total
0	0	0	0	0	0
1	19.853	19.759	19.783	18.814	19.436
2	21.804	21.489	21.545	22.003	21.630
3	23.870	23.764	23.773	24.348	23.866
4	25.747	25.449	25.490	25.228	25.381
5	26.428	26.394	26.335	26.146	26.323
6	27.418	27.415	27.418	27.406	27.410
7	29.089	29.079	29.089	28.284	28.604
8	29.994	29.951	29.998	29.033	29.260
9	30.233	30.196	30.236	29.091	29.396
10	31.393	30.472	30.652	30.049	30.244
11	31.812	31.505	31.561	31.262	31.380
12	32.169	32.140	32.172	31.284	31.561
13	31.107	31.180	31.100	33.006	32.427
14	34.483	34.316	34.500	31.870	32.411
15	33.440	33.469	33.437	35.227	34.332

Table 5.4.2.2 Catch, weight and Length-at-age of North Sea horse mackerel stock by quarter and by area in 2002.

	Q1Catch					Q2 Catch					Q3 Catch					Q4 Catch				
Ages	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total
0	0	0	0	0	**0**	0	0	0	0	**0**	0	0	0	0	**0**	0	0	0	0	**0**
1	0.30	185.38	0.00	296.88	**482.56**	177.58	73.84	0.00	1.16	**252.58**	1038.54	7671.77	33.56	1114.02	**9857.89**	2944.95	27116.41	103.24	19661.34	**49825.94**
2	0.60	316.86	0.00	1039.16	**1356.62**	295.98	39.07	0.00	4.05	**339.10**	1730.96	3669.06	20.89	99.92	**5520.83**	765.11	7044.91	26.82	1763.43	**9600.27**
3	0.62	354.96	0.00	890.77	**1246.35**	335.44	41.61	0.00	3.47	**380.52**	1961.76	4002.67	23.08	100.70	**6088.21**	954.62	8789.87	33.47	1777.27	**11555.23**
4	0.29	77.55	0.00	1187.66	**1265.50**	59.18	13.02	0.00	4.62	**76.82**	346.13	849.92	4.62	201.38	**1402.05**	547.17	5038.20	19.18	3554.08	**9158.63**
5	0.18	50.99	0.00	742.27	**793.44**	39.47	6.26	0.00	2.89	**48.62**	230.80	333.62	2.19	50.35	**616.96**	318.70	2934.48	11.17	888.64	**4152.99**
6	0.36	30.10	0.00	2078.43	**2108.89**	0.00	8.70	0.00	8.09	**16.79**	0.00	0.00	0.00	78.47	**78.47**	218.57	2012.53	7.66	1384.87	**3623.63**
7	0.34	27.94	0.00	1929.93	**1958.21**	0.00	8.08	0.00	7.51	**15.59**	0.00	0.00	0.00	73.91	**73.91**	213.97	1970.20	7.50	1304.42	**3496.09**
8	0.96	79.54	0.00	5492.91	**5573.41**	0.00	23.00	0.00	21.38	**44.38**	0.00	0.00	0.00	128.25	**128.25**	241.48	2223.48	8.47	2263.50	**4736.93**
9	0.49	40.84	0.00	2820.70	**2862.03**	0.00	11.81	0.00	10.98	**22.79**	0.00	0.00	0.00	94.24	**94.24**	165.09	1520.07	5.79	1663.29	**3354.24**
10	0.62	87.54	0.00	3266.09	**3354.25**	39.47	13.67	0.00	12.71	**65.85**	230.80	0.00	0.91	70.68	**302.39**	173.46	1597.15	6.08	1247.50	**3024.19**
11	0.37	66.04	0.00	1781.43	**1847.84**	39.47	7.46	0.00	6.93	**53.86**	230.80	0.00	0.91	73.52	**305.23**	157.40	1449.34	5.52	1297.50	**2909.76**
12	0.28	23.65	0.00	1633.05	**1656.98**	0.00	6.84	0.00	6.36	**13.20**	0.00	0.00	0.00	21.84	**21.84**	92.47	851.40	3.24	385.48	**1332.59**
13	0.18	15.05	0.00	1039.16	**1054.39**	0.00	4.35	0.00	4.05	**8.40**	0.00	0.00	0.00	23.56	**23.56**	64.96	598.11	2.28	415.78	**1081.13**
14	0.16	12.90	0.00	890.77	**903.83**	0.00	3.73	0.00	3.47	**7.20**	0.00	0.00	0.00	5.89	**5.89**	25.98	239.18	0.91	103.98	**370.05**
15	0.16	12.90	0.00	890.77	**903.83**	0.00	3.73	0.00	3.47	**7.20**	0.00	0.00	0.00	23.56	**23.56**	132.96	1224.27	4.66	415.78	**1777.67**

	Q1 Weight					Q2 Weight					Q3 Weight					Q4 Weight				
Ages	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total
0	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
1	0.0717	0.0720	0.0000	0.0700	**0.0708**	0.0720	0.0680	0.0000	0.0700	**0.0708**	0.072	0.068	0.069	0.056	**0.067**	0.0728	0.0728	0.0728	0.0555	**0.0660**
2	0.1034	0.1039	0.0000	0.1020	**0.1024**	0.1040	0.0993	0.0000	0.1020	**0.1034**	0.104	0.099	0.101	0.092	**0.100**	0.0913	0.0913	0.0913	0.0915	**0.0913**
3	0.1270	0.1287	0.0000	0.1210	**0.1232**	0.1290	0.1246	0.0000	0.1210	**0.1284**	0.129	0.125	0.126	0.131	**0.126**	0.1309	0.1309	0.1309	0.1312	**0.1309**
4	0.1421	0.1682	0.0000	0.1270	**0.1295**	0.1800	0.1468	0.0000	0.1270	**0.1712**	0.180	0.159	0.166	0.158	**0.164**	0.1550	0.1550	0.1550	0.1575	**0.1560**
5	0.1482	0.1550	0.0000	0.1440	**0.1447**	0.1580	0.1314	0.0000	0.1440	**0.1537**	0.158	0.119	0.132	0.170	**0.138**	0.1863	0.1863	0.1863	0.1700	**0.1828**
6	0.1780	0.1780	0.0000	0.1780	**0.1780**	0.0000	0.1780	0.0000	0.1780	**0.1780**	0.000	0.000	0.000	0.196	**0.196**	0.2101	0.2101	0.2101	0.1962	**0.2048**
7	0.1920	0.1920	0.0000	0.1920	**0.1920**	0.0000	0.1920	0.0000	0.1920	**0.1920**	0.000	0.000	0.000	0.203	**0.203**	0.2449	0.2449	0.2449	0.2026	**0.2291**
8	0.2130	0.2130	0.0000	0.2130	**0.2130**	0.0000	0.2130	0.0000	0.2130	**0.2130**	0.000	0.000	0.000	0.223	**0.223**	0.2626	0.2626	0.2626	0.2232	**0.2438**
9	0.2070	0.2070	0.0000	0.2070	**0.2070**	0.0000	0.2070	0.0000	0.2070	**0.2070**	0.000	0.000	0.000	0.218	**0.218**	0.2735	0.2735	0.2735	0.2180	**0.2460**
10	0.2562	0.2862	0.0000	0.2490	**0.2500**	0.3300	0.2490	0.0000	0.2490	**0.2976**	0.330	0.000	0.330	0.189	**0.297**	0.2863	0.2863	0.2863	0.1890	**0.2462**
11	0.2991	0.3298	0.0000	0.2890	**0.2905**	0.3560	0.2890	0.0000	0.2890	**0.3381**	0.356	0.000	0.356	0.284	**0.339**	0.3200	0.3200	0.3200	0.2843	**0.3041**
12	0.2680	0.2680	0.0000	0.2680	**0.2680**	0.0000	0.2680	0.0000	0.2680	**0.2680**	0.000	0.000	0.000	0.316	**0.316**	0.3251	0.3251	0.3251	0.3160	**0.3225**
13	0.3360	0.3360	0.0000	0.3360	**0.3360**	0.0000	0.3360	0.0000	0.3360	**0.3360**	0.000	0.000	0.000	0.298	**0.298**	0.3010	0.3010	0.3010	0.2980	**0.2998**
14	0.2900	0.2900	0.0000	0.2900	**0.2900**	0.0000	0.2900	0.0000	0.2900	**0.2900**	0.000	0.000	0.000	0.349	**0.349**	0.4070	0.4070	0.4070	0.3490	**0.3907**
15	0.4340	0.4340	0.0000	0.4340	**0.4340**	0.0000	0.4340	0.0000	0.4340	**0.4340**	0.000	0.000	0.000	0.357	**0.357**	0.3712	0.3712	0.3712	0.3570	**0.3679**

	Q1 Length					Q2 Length					Q3 Length					Q4 Length				
Ages	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total	IVb	IVc	IVbc	VIId	Total
0	0	0	0	0		0	0	0	0		0	0	0	0		0	0	0	0	
1	19.855	19.738	0.000	20.500	**20.207**	19.72	19.2612	0	20.5	**19.589**	19.72	19.24	19.4	18.7893	**19.240**	0.0728	0.0728	0.0728	0.0555	**0.066**
2	22.174	22.002	0.000	22.640	**22.491**	21.97	21.7869	0	22.64	**21.957**	21.97	21.68	21.777	21.6463	**21.771**	0.0913	0.0913	0.0913	0.0915	**0.091**
3	23.969	23.867	0.000	24.330	**24.198**	23.85	23.5016	0	24.33	**23.816**	23.85	23.42	23.563	24.3566	**23.575**	0.1309	0.1309	0.1309	0.1312	**0.131**
4	25.155	25.855	0.000	24.750	**24.818**	26.17	25.2135	0	24.75	**25.922**	26.17	25.5	25.723	25.38	**25.649**	0.155	0.155	0.155	0.1575	**0.156**
5	25.790	25.937	0.000	25.700	**25.715**	26	24.3394	0	25.7	**25.768**	26	23	24	26.5	**24.411**	0.1863	0.1863	0.1863	0.17	**0.183**
6	27.290	27.290	0.000	27.290	**27.290**	0	27.29	0	27.29	**27.290**	0	0	0	27.5721	**27.572**	0.2101	0.2101	0.2101	0.1962	**0.205**
7	28.500	28.500	0.000	28.500	**28.500**	0	28.5	0	28.5	**28.500**	0	0	0	27.9805	**27.981**	0.2449	0.2449	0.2449	0.2026	**0.229**
8	28.930	28.930	0.000	28.930	**28.930**	0	28.93	0	28.93	**28.930**	0	0	0	29.2704	**29.270**	0.2626	0.2626	0.2626	0.2232	**0.244**
9	29.030	29.030	0.000	29.030	**29.030**	0	29.03	0	29.03	**29.030**	0	0	0	29.19	**29.190**	0.2735	0.2735	0.2735	0.218	**0.246**
10	30.177	30.920	0.000	30.000	**30.024**	32	30	0	30	**31.199**	32	0	32	30.17	**31.572**	0.2863	0.2863	0.2863	0.189	**0.246**
11	31.643	31.836	0.000	31.580	**31.589**	32	31.58	0	31.58	**31.888**	32	0	32	30.8463	**31.722**	0.32	0.32	0.32	0.2843	**0.304**
12	31.230	31.230	0.000	31.230	**31.230**	0	31.23	0	31.23	**31.230**	0	0	0	31.5	**31.500**	0.3251	0.3251	0.3251	0.316	**0.322**
13	33.640	33.640	0.000	33.640	**33.640**	0	33.64	0	33.64	**33.640**	0	0	0	31.5	**31.500**	0.301	0.301	0.301	0.298	**0.300**
14	31.670	31.670	0.000	31.670	**31.670**	0	31.67	0	31.67	**31.670**	0	0	0	33.5	**33.500**	0.407	0.407	0.407	0.349	**0.391**
15	35.830	35.830	0.000	35.830	**35.830**	0	35.83	0	35.83	**35.830**	0	0	0	34	**34.000**	0.3712	0.3712	0.3712	0.357	**0.368**

Table 5.5.2.1 Input to Ad hoc method: Catch-at-age.

Observed catch-at-age

	1995	1996	1997	1998	1999	2000	2001	2002
1	0.000	0.0	0.0	2.3	12.4	70.2	12.8	60.4
2	1.760	4.6	12.6	22.1	31.5	78.0	36.4	16.8
3	3.117	13.8	27.2	36.7	23.1	28.4	174.3	19.3
4	7.190	11.0	14.1	38.8	17.6	21.4	87.8	11.9
5	10.321	11.9	14.9	20.8	23.1	31.3	18.5	5.6
6	12.082	9.6	14.6	12.1	26.2	19.6	11.5	5.8
7	13.161	12.5	12.4	14.0	20.6	19.5	18.3	5.5
8	11.426	8.0	10.1	10.8	21.8	9.0	14.7	10.5
9	12.644	6.6	8.6	8.3	12.9	11.5	10.2	6.3
10	7.247	1.5	2.4	4.0	8.2	9.0	10.0	6.7
11	5.872	5.3	0.8	2.7	2.1	7.0	9.6	5.1
12	0.010	0.3	0.3	0.7	0.4	3.1	5.3	3.0
13	8.843	1.3	0.2	1.8	1.4	1.6	3.7	2.2
14	0.202	8.9	0.0	0.3	3.8	0.0	2.0	1.3
15	4.369	8.0	1.4	5.1	4.0	12.2	5.8	2.7

Table 5.5.2.2 Input to Ad hoc method: Weight-at-age.

Weight-at-age (Input)

	1995	1996	1997	1998	1999	2000	2001	2002
1	0.064	0.064	0.063	0.063	0.063	0.075	0.055	0.066
2	0.076	0.107	0.102	0.102	0.102	0.101	0.072	0.095
3	0.126	0.123	0.126	0.126	0.126	0.136	0.071	0.129
4	0.125	0.143	0.142	0.142	0.142	0.152	0.082	0.154
5	0.133	0.156	0.160	0.160	0.160	0.166	0.120	0.172
6	0.146	0.177	0.175	0.175	0.175	0.194	0.183	0.195
7	0.164	0.187	0.199	0.199	0.199	0.198	0.197	0.216
8	0.161	0.203	0.231	0.231	0.231	0.213	0.201	0.227
9	0.178	0.195	0.250	0.250	0.250	0.247	0.235	0.228
10	0.165	0.218	0.259	0.259	0.259	0.280	0.246	0.251
11	0.173	0.241	0.300	0.300	0.300	0.279	0.260	0.302
12	0.317	0.307	0.329	0.329	0.329	0.342	0.286	0.292
13	0.233	0.211	0.367	0.367	0.367	0.318	0.287	0.318
14	0.241	0.258	0.299	0.299	0.299	0.325	0.295	0.319
15	0.348	0.277	0.360	0.360	0.360	0.332	0.336	0.390

Table 5.5.2.3 Input to Ad hoc method: Relative index of total biomass from length distributions of IBTS, quarter 3 (from Areas IVb+c).

INPUT:	BIOMASS-INDEX
1995	0.049161
1996	0.142526
1997	0.214397
1998	0.056242
1999	0.081966
2000	0.151331
2001	0.304377

Length weight relationship, Weight = a*Length^b: b=2.964, a= 0.0000116

Table 5.5.2.4.a Output: F at age, when giving zero weight to survey (corresponding relative biomass is shown in Figure 5.5.2.1**)**

$"Fishing mortality"

	1995	1996	1997	1998	1999	2000	2001	2002
[1,]	0.00525857	0.01088592	0.009263247	0.01481561	0.0864946	0.1249571	0.2377207	0.1006061
[2,]	0.01204026	0.02492489	0.021209555	0.03392249	0.1715463	0.2478297	0.4714756	0.1995338
[3,]	0.02588798	0.05359144	0.045603026	0.07293733	0.2103315	0.3038620	0.5780724	0.2446468
[4,]	0.04950245	0.10247643	0.087201150	0.13946923	0.2195560	0.3171885	0.6034251	0.2553763
[5,]	0.07963027	0.16484490	0.140272888	0.22435198	0.2212605	0.3196510	0.6081097	0.2573589
[6,]	0.10651961	0.22050929	0.187639868	0.30011057	0.2214510	0.3199261	0.6086332	0.2575804
[7,]	0.12386853	0.25642379	0.218200896	0.34898978	0.2213401	0.3197659	0.6083283	0.2574514
[8,]	0.13284260	0.27500128	0.234009199	0.37427353	0.2211571	0.3195016	0.6078255	0.2572386
[9,]	0.13695813	0.28352096	0.241258924	0.38586871	0.2209438	0.3191934	0.6072392	0.2569905
[10,]	0.13874093	0.28721158	0.244399420	0.39089161	0.2207061	0.3188500	0.6065860	0.2567140
[11,]	0.13949408	0.28877069	0.245726128	0.39301354	0.2204434	0.3184705	0.6058639	0.2564085
[12,]	0.13980887	0.28942235	0.246280645	0.39390043	0.2201534	0.3180515	0.6050669	0.2560711
[13,]	0.13993985	0.28969350	0.246511377	0.39426947	0.2198335	0.3175893	0.6041875	0.2556990
[14,]	0.13999425	0.28980611	0.246607205	0.39442273	0.2194806	0.3170795	0.6032177	0.2552885
[15,]	0.14001683	0.28985284	0.246646973	0.39448634	0.2190915	0.3165174	0.6021484	0.2548360

Table 5.5.2.4.b Output: Catch-at-age, when giving zero weight to survey (corresponding relative biomass is shown in Figure 5.5.2.1)

```
Calculated catch-at-age
          1995        1996        1997        1998       1999       2000       2001       2002
 [1,]  2.07448568  3.52802369  2.307746226  4.699836 47.476110 36.337601  23.316309 56.728798
 [2,]  2.09592206  8.33863775  5.822995078  7.121046 42.806556 99.482402  88.714786 13.520981
 [3,]  3.71192560  7.77523307 12.680456541 16.456804 33.768521 51.674877 134.208089 27.433172
 [4,]  8.56231796 11.87682095 10.155262747 30.486714 36.970240 33.793027  56.960012 33.133792
 [5,] 12.29091568 22.10158415 12.404069660 19.311548 34.836671 35.503159  35.631138 13.372104
 [6,] 14.38802860 25.30124053 18.165878472 18.417721 13.127338 33.190857  37.120083  8.284865
 [7,] 15.67297173 24.96712644 17.303413362 22.361841  8.984032 12.489797  34.654738  8.617308
 [8,] 13.60682129 24.64192722 15.334974905 19.106361  9.129341  8.546474  13.040405  8.044543
 [9,] 15.05729462 20.38905051 14.357462205 16.056817  7.168055  8.685582   8.925569  3.027909
[10,]  8.63019726 22.08381503 11.602376267 14.680856  5.800616  6.820725   9.073939  2.073188
[11,]  6.99275815 12.54188054 12.440272099 11.743815  5.215517  5.520574   7.128450  2.108483
[12,]  0.01190865 10.12314896  7.035104266 12.538271  4.139894  4.964752   5.772112  1.657142
[13,] 10.53081749  0.01721199  5.668297277  7.077907  4.402125  3.941748   5.193419  1.342485
[14,]  0.24055469 15.21038971  0.009630472  5.698563  2.478619  4.192488   4.125449  1.208537
[15,]  1.30982206  2.23836778  9.759724054  9.816709  5.421433  7.536175  12.298734  3.831056
```

Table 5.5.2.4.c Output: Stock numbers-at-age, when giving zero weight to survey (corresponding relative biomass is shown in Figure 5.5.2.1)

Stock numbers

```
           1995         1996         1997       1998      1999      2000       2001       2002
 [1,] 425.91272734 350.86021107 269.49424309 344.08134 616.35179 332.60911 118.322796 637.473131
 [2,] 188.56048978 364.66382056 298.71859255 229.81710 291.79820 486.54202 252.651435  80.294069
 [3,] 156.36338963 160.35315354 306.14259655 251.71372 191.20789 211.56160 326.847464 135.712031
 [4,] 190.79461412 131.14384086 130.81539768 251.75288 201.41251 133.35701 134.377670 157.814647
 [5,] 172.74913115 156.28716008 101.88230882 103.19145 188.47752 139.18432  83.583098  63.258482
 [6,] 153.13842429 137.30574630 114.07432215  76.21402  70.96835 130.02389  87.020879  39.162969
 [7,] 144.64511649 118.48929718  94.79350284  81.38657  48.59083  48.94920  81.271229  40.752407
 [8,] 117.59561112 109.99278167  78.91717239  65.59503  49.41335  33.51841  30.600524  38.071417
 [9,] 126.46845783  88.62456814  71.90986555  53.75247  38.83129  34.09202  20.959525  14.341990
[10,]  71.61562664  94.92003472  57.44845759  48.62581  31.45384  26.79680  21.324785   9.829165
[11,]  57.73512219  53.65487677  61.30265883  38.72513  28.31135  21.71091  16.767335  10.006992
[12,]   0.09811607  43.22295025  34.59820049  41.26840  22.49910  19.54696  13.590137   7.874020
[13,]  86.68823637   0.07343072  27.85323908  23.27829  23.95547  15.53852  12.240719   6.387082
[14,]   1.97949478  64.86955061   0.04730655  18.73583  13.50759  16.54962   9.735047   5.757944
[15,]  10.77674160   9.54489976  47.93462214  32.27128  29.59194  29.79375  29.059926  18.281216
$"Absolute Total Biomass"
[1]      241.9016     276.6914      268.0781  250.7696  242.1798  237.1673   141.6065   149.5294
```

Table 5.5.2.4.d Output: Model parameters and their relative standard deviations, when giving zero weight to survey (corresponding relative biomass is shown in Figure 5.5.2.1)

Parameter estimates (F:Maximum F over ages, by yrear, R: Relative recruitment by year) :

Sel1	Sel1	Sel2	Sel2	Rig1	Rig1	Rig2	Rig2	n1	F1	F2	F3	F4	F5	F6
4.123	2.122	-0.880	-1.672	5.499	5.489	-0.000001	-0.1010125	1.191	0.1406	0.2911	0.248	0.396	0.223	0.3224

F7	F8	R1	R2	R3	R4	R5	R6	R7	R3
0.613	0.259	1.0119	0.833	0.640	0.817	1.464	0.790	0.281	1.514

Parameter relative standard deviation (Std.Dev/Mean):

Sel1	Sel1	Sel2	Sel2	Rig1	Rig1	Rig2	Rig2	n1	F1	F2	F3
1.1e-01	3.4e-01	-1.9e-01	-4.0e-01	6.2e+00	1.6e+00	-3.2e+06	-5.8e+00	2.5e-01	3.5e-01	3.3e-01	3.5e-01

F4	F5	F6	F7	F8	R1	R2	R3	R4	R5	R6	R7	R3
3.5e-01	4.0e-01	4.9e-01	7.7e-01	1.1e+00	3.3e-01	3.5e-01	4.1e-01	3.8e-01	4.2e-01	5.1e-01	9.6e-01	1.1e+00

Table 5.5.2.5.a Output: F at age, when giving equal weight to survey and catch-at-age data

Fishing mortality

	1995	1996	1997	1998	1999	2000	2001	2002
[1,]	0.00532509	0.009277868	0.1135608	0.03454783	0.02460954	0.02602971	0.04036743	0.01837227
[2,]	0.00955604	0.016649425	0.2037884	0.06199717	0.06074201	0.06424731	0.09963610	0.04534700
[3,]	0.01640605	0.028584143	0.3498689	0.10643827	0.13293119	0.14060240	0.21804919	0.09923990
[4,]	0.02632102	0.045858932	0.5613118	0.17076410	0.23718635	0.25087392	0.38906062	0.17707169
[5,]	0.03857054	0.067201197	0.8225404	0.25023591	0.33407006	0.35334861	0.54798055	0.24940031
[6,]	0.05105733	0.088956835	1.0888287	0.33124700	0.39346792	0.41617421	0.64541183	0.29374384
[7,]	0.06152419	0.107193184	1.3120410	0.39915337	0.42109376	0.44539428	0.69072694	0.31436793
[8,]	0.06895240	0.120135294	1.4704520	0.44734568	0.43224020	0.45718397	0.70901063	0.32268932
[9,]	0.07362363	0.128273942	1.5700687	0.47765142	0.43642711	0.46161250	0.71587849	0.32581506
[10,]	0.07634143	0.133009151	1.6280275	0.49528383	0.43790440	0.46317504	0.71830172	0.32691794
[11,]	0.07785166	0.135640422	1.6602342	0.50508185	0.43835660	0.46365333	0.71904346	0.32725552
[12,]	0.07866950	0.137065333	1.6776751	0.51038777	0.43842255	0.46372309	0.71915165	0.32730476
[13,]	0.07910620	0.137826195	1.6869880	0.51322097	0.43834050	0.46363631	0.71901706	0.32724351
[14,]	0.07933764	0.138229426	1.6919235	0.51472248	0.43819860	0.46348622	0.71878429	0.32713757
[15,]	0.07945980	0.138442273	1.6945288	0.51551505	0.43802924	0.46330709	0.71850649	0.32701114

Table 5.5.2.5.b Output: Predicted Catch-at-age when giving equal weight to survey and catch-at-age data

Calculated catch-at-age

	1995	1996	1997	1998	1999	2000	2001	2002
[1,]	1.058463292	5.312267068	19.13006999	6.496496	15.7176468	47.868983	166.727553	17.3812486
[2,]	0.971480060	2.817722202	90.65752960	8.225279	9.3777500	33.804815	148.298235	154.4552926
[3,]	1.720513265	2.454546296	42.82342696	34.812876	13.7901162	16.922340	86.070070	115.0992383
[4,]	3.968716834	4.014266125	31.50302447	13.782325	56.4274653	18.550972	31.192091	49.3161106
[5,]	5.696957781	8.328428964	41.67862385	7.941557	18.1287430	54.086977	23.710419	12.4387613
[6,]	6.668989818	10.619881500	69.26979544	7.878118	7.8339242	13.406051	52.422520	7.0957394
[7,]	7.264573332	11.146188780	72.86214631	9.873877	5.9407254	5.030119	11.188144	13.3680374
[8,]	6.306892705	11.162311056	66.37528745	8.249574	6.0823008	3.584735	3.931352	2.6567542
[9,]	6.979201065	9.161495630	60.64461191	6.398593	4.4505581	3.581041	2.730022	0.9074532
[10,]	4.000179541	9.799410861	47.13467838	5.288466	3.1880799	2.596180	2.700783	0.6234561
[11,]	3.241210744	5.509112840	48.89402696	3.878502	2.5185972	1.853467	1.951121	0.6143859
[12,]	0.005519773	4.416775441	27.03162597	3.895855	1.8016947	1.462548	1.391287	0.4432602
[13,]	4.881135322	0.007478995	21.47833455	2.116705	1.7854131	1.045893	1.097498	0.3159586
[14,]	0.111499416	6.593646855	0.03619676	1.666308	0.9629344	1.036416	0.784848	0.2492369
[15,]	0.494465127	0.816183287	35.76535089	2.755005	2.0007237	1.721098	2.070180	0.6487039

Table 5.5.2.5.c Output: Stock numbers-at-age when giving equal weight to survey and catch-at-age data

Absolute Stock numbers

	1995	1996	1997	1998	1999	2000	2001	2002
[1,]	214.6054	619.3833	191.62994	205.928422	696.062853	2005.620089	4535.847908	1027.9376
[2,]	109.9873	183.7316	528.18491	147.231380	171.225399	584.543045	1681.899106	3749.5829
[3,]	113.8381	93.7665	155.52816	370.798219	119.105325	138.689664	471.813183	1310.3410
[4,]	164.4646	96.3870	78.43141	94.344961	286.924685	89.754396	103.713927	326.5339
[5,]	162.0658	137.8787	79.24248	38.509800	68.456176	194.811693	60.111615	60.4959
[6,]	144.1882	134.2135	110.96041	29.963265	25.807802	42.187489	117.764257	29.9108
[7,]	131.0046	117.9265	105.68631	32.147828	18.517665	14.987386	23.949549	53.1582
[8,]	101.8459	106.0285	91.18304	24.494153	18.563393	10.460763	8.263222	10.3317
[9,]	105.7896	81.8189	80.92909	18.036853	13.478405	10.370356	5.699893	3.5001
[10,]	58.5520	84.5911	61.94427	14.490665	9.628867	7.498190	5.625663	2.3978
[11,]	46.5562	46.6920	63.74049	10.466793	7.600552	5.348741	4.061233	2.3608
[12,]	0.0784	37.0700	35.09062	10.428952	5.436447	4.220123	2.895645	1.7030
[13,]	69.0415	0.0624	27.81967	5.642114	5.388128	3.018329	2.284486	1.2141
[14,]	1.5726	54.9049	0.046877	4.431577	2.906757	2.991747	1.634059	0.9580
[15,]	6.9640	6.7865	46.24216	7.318304	6.041347	4.969690	4.311281	2.49434

$"Absolute Total Biomass"

19.29436	24.65448	26.46869	13.24331	15.54637	29.88622	45.49086	67.77146

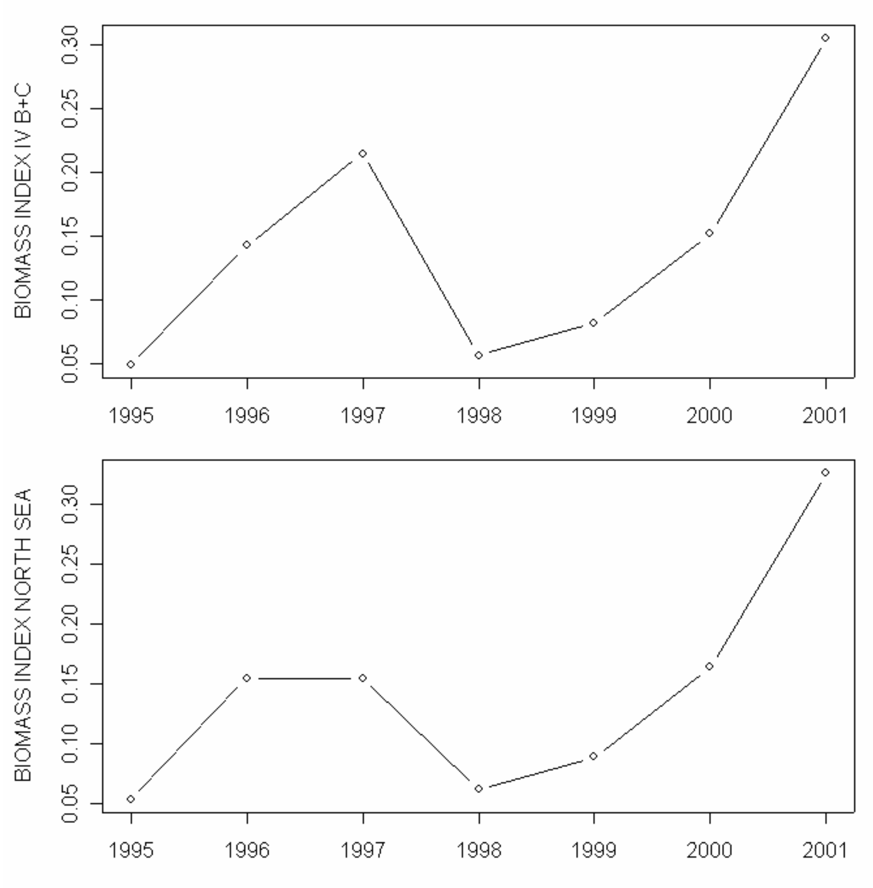


Figure 5.3.2.2 Biomass index for Horse Mackerel, based on length distributions from third quarter. Upper figure shows the index based on hauls made in areas IVb and c, and the lower figure shows the index based on all hauls.

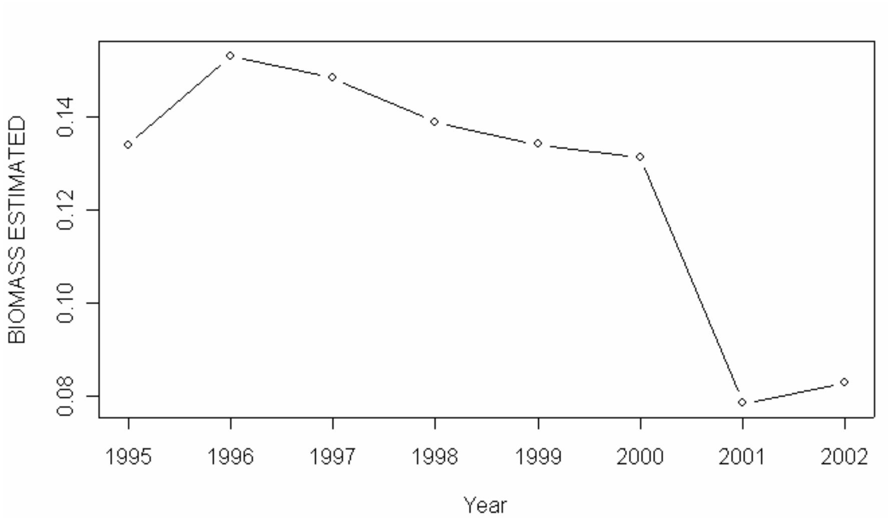


Figure 5.5.2.1 Biomass index for Horse Mackerel, estimated from catch-at-age.

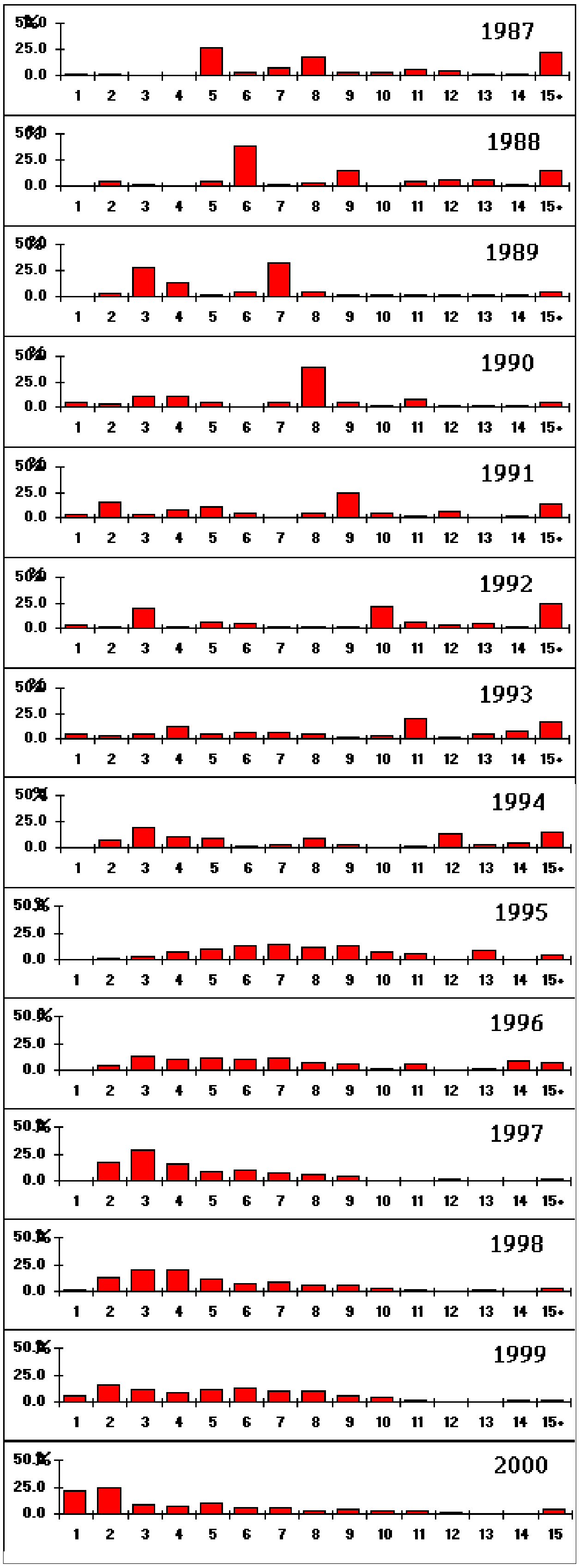


Figure 5.4.1.1 Age composition North Sea horse mackerel stock from commercial and research vessel samples, 1987-2000 (Survey data not yet processed for 2001).

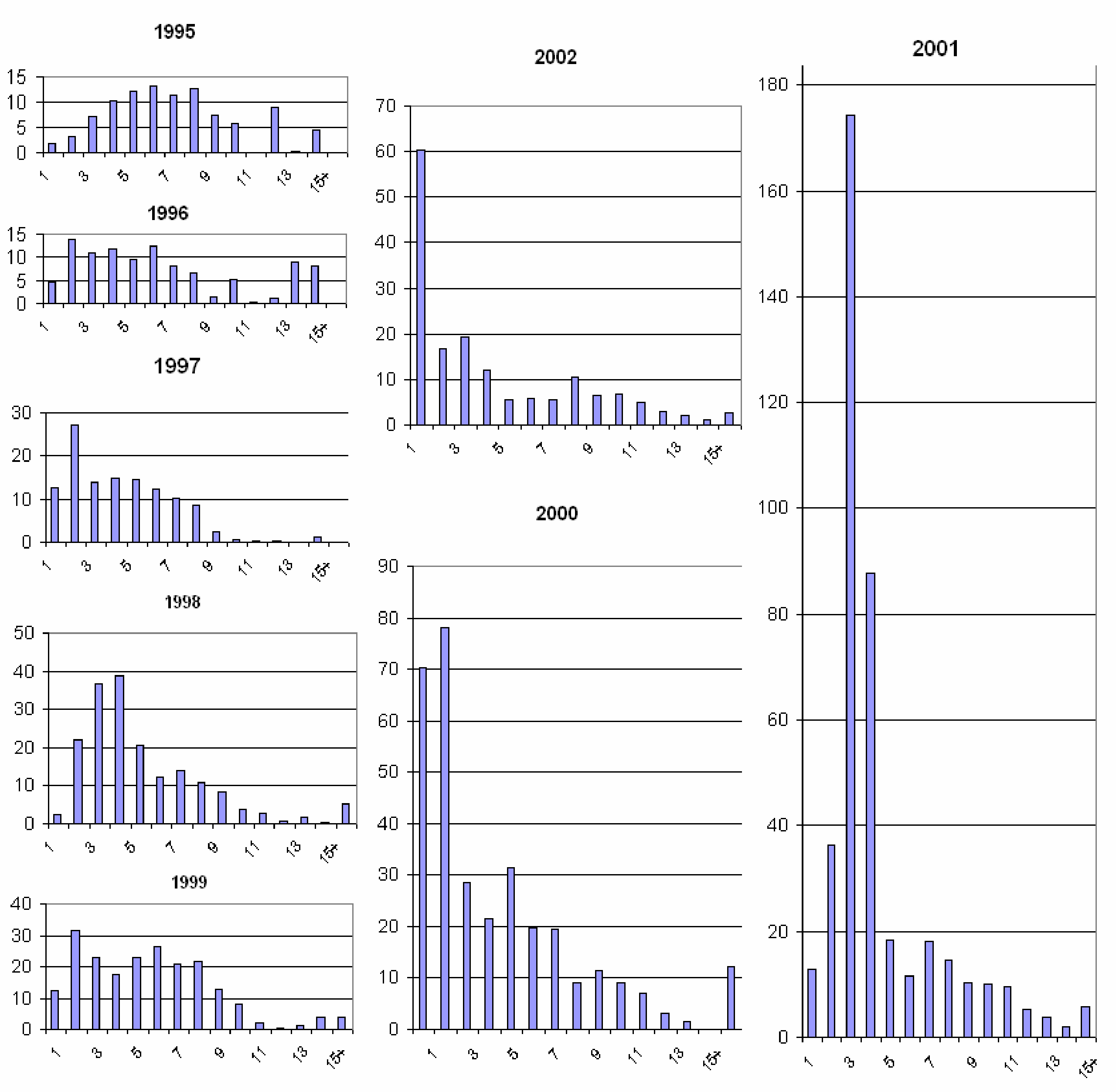


Figure 5.4.1.3 North Sea horse mackerel. Catch-at-age (000'), 1995-2002.

6 WESTERN HORSE MACKEREL (DIVISIONS IIa, IIIa (WESTERN PART), IVa, Vb, VIa, VIIa–c, VIIe–k, AND VIIIa,b,d,e

6.1 ACFM Advice Applicable to 2002 and 2003

For 2002 ICES advised that the catches should be limited to less than 98,000 tons. As for the two previous years ICES also for 2002 advised to close the directed trawl fishery for horse mackerel and the industrial fisheries in Divisions VIIe,f due to relatively large catches of juvenile horse mackerel.

For 2003 ICES adviced to limit the catches to less than 113,000 tons which corresponds to F=0.15. The advice about restricting the directed horse mackerel fisheries and industrial fisheries in which juvenile horse mackerel are abundant was repeated.

EU has set TACs for horse mackerel since 1987 covering Division Vb (EU waters only), Sub areas VI and VII, Divisions VIIIa,b,d,e. These areas do not correspond to the total distribution area of western horse mackerel. The TAC for this stock should apply to those areas in which western horse mackerel are fished i.e. Divisions IIa, IIIa (western part), IVa, Vb, VIa, VIIa-c, VIIe-k, and VIIIa,b,d,e. The TAC set by EU has been reduced every year since 1998 when the TAC was 320,000 tons to TACs of 150,000 tons and 137.000 tons for 2002 and 2003 respectively. This TAC also includes Division VIId which is part of the distribution area of the North Sea horse mackerel. The TAC for the North Sea stock should apply to those areas where North Sea horse mackerel are fished i.e. Divisions IVb,c, IIIa(eastern part) and Division VIId.

The catches of western horse mackerel in 2002 were 172,200 tons which is about 75% more than recommended by ICES.

6.2 The Fishery in 2002 of the Western Stock

The fishery for western horse mackerel is carried out in Divisions IIa, IIIa (western part) IVa, VIa, VIIa–c,e–k and VIIIa,b,d,e. The national catches taken by the countries fishing in these areas are shown in Tables 6.2.1–6.2.5, while information on the development of the fisheries by quarter and division is shown in Table 4.1.2 and in Figures 4.1.1.a–d.

The total catch allocated to western horse mackerel in 2002 was 172,200 t (Table 4.3.1) which is 19,000 tons less than in 2001.

Divisions IIa and Vb

The national catches in this area are shown in Table 6.2.1. The catches in this area have varied from year to year. The catches dropped from the record high catch of 14,000 tons in 1995 to 60 tons in 2001. In 2002 the catches increased due to the Norwegian catch of 1,321 tons.

Subarea IV and Division IIIa

As mentioned in section 4.3 all catches from Divisions IVa and IIIa in 2002 were allocated to the western stock. The catches of the western stock in Division IVa has fluctuated between 4,500 -135,000 tons during the period 1987-2002. These fluctuations are mainly due to the availability of western horse mackerel for the Norwegian fleet in October –November (section 6.3.2). Mainly due to the Norwegian catches the catches of the western horse mackerel in Division IV a increased from 11,500 tons in 2001 to 36.900 tons in 2002 (table 4.3.1).

The total catches of horse mackerel in Sub area IV and Division IIIa are shown in Table 6.2.2.

Subarea VI

The catches in this area increased from 21,000 tons in 1990 to a historical high level of 84,000 tons in 1995 and 81,000 tons in 1996 (Table 6.2.3). After a reduction in the catches of more than 50% in 1997 and 1998 the catches increased to 65,300 tons in 1999. The catches in 2002 dropped to 14,000 tons.

The main part of the catches in this area is taken in a directed Irish trawl fishery for horse mackerel.

Subarea VII

All catches from Sub area VII except Division VIId were allocated to the western stock. The main catches are taken in directed Dutch and Irish trawl fisheries in Divisions VIIb,e,h,j. The catches of western horse mackerel in Subarea VII (Table 4.3.1) increased from below 100,000 tons prior 1989 to about 320,000 tons in 1995 and 1997 and were 87,000 tons in 2002. This was the lowest catch since 1989 (Table 4.3.1).

The total catches of horse mackerel in Sub area VII are shown in Table 6.2.4.

Subarea VIII

All catches from this Sub area except Division VIIIc are allocated to the western stock. The catches of western horse mackerel in these areas were less than 10,000 t in the period 1982-1988. Since then, except for a very low catch in 1995 (1,175 tons) the catches have usually fluctuated between 10,000 and 32,000 tons (Table 4.3.1) In 2001 the catches were 54,200 tons which is the highest on record. In 2002 the catches dropped to the same level as in 2000 (32,500 tons).

The total catches of horse mackerel in Subarea VIII are given in Table 6.2.5.

6.3 Fishery Independent information

6.3.1 Egg survey estimates of spawning biomass

The last egg survey was carried out in 2001. Since horse mackerel now is considered an indeterminate spawner the egg production was not converted to SSB (See section 4.7).

6.3.2 Environmental Effects

Since the strong 1982 year class of the western stock started to appear in the North Sea in 1987 there were good correlations until 2000 between the modeled influx of Atlantic water to the North Sea the first quarter and the horse mackerel catches taken in the Norwegian EEZ (NEZ) later the same year (Iversen *et al.* 2002). However, there was no obvious correlation for 2000, but for 2001 and 2002 the predicted and actual catches were similar. The modelled influx for 2003 indicates a similar availability/catch level of horse mackerel in NEZ as in 2002 (Iversen et al WD 2003).

6.4 Biological Data

6.4.1 Catch in numbers

Since 1998 there has been an increase in age readings compared with previous years. This has improved the quality of the catch-at-age matrix of the western horse mackerel. In 2002 the Netherlands (Division VIa, Subareas IV, VII and VIII) and Norway (Division IVa), Ireland (Divisions VIa and VIIb) and Germany (Divisions VIIe,h) and Spain (Sub area VIII) provided catch in numbers-at-age. The catch sampled for age readings in 2000 provided 70% of the total catch. This is an improvement since 2001 but still the number of age readings for parts of the fishing area are considered too low to be satisfactory.

Catches from other countries were converted to numbers-at-age using adequate data provided by the countries quoted above. Catch-at-age data from the juvenile areas, (Divisions VIIa,e,f,g,h and VIIIa,b,d) were only applied when converting catches from these divisions into catch in numbers-at-age. The procedure has been carried out using the specific software for calculating international catch-at-age (Patterson, 1999).

The total annual and quarterly catches in numbers for western horse mackerel in 2002 are shown in Table 6.4.1.1. The sampling intensity is discussed in Section 1.3. The catch-at-age matrix shows the predominance and the dominance of the 1982 year class in the catches since 1984 (see Figure 6.4.1.1). Currently this cohort has been included in the plus group since 1996. In 2002 the catches of 1 year old horse mackerel was far larger than in previous years. This catch might either indicate a strong incoming year class or might demonstrate an increase in fishing effort in the juvenile areas. These catches were mainly taken in Divisions VIIe and VIIh.

6.4.2 Mean length-at-age and mean weight-at-age

Mean length-at-age and mean weight-at-age in the catches

The same countries providing data for catch in numbers by age also provide data for mean weight and length in catches by quarter and area. These data were applied to the catches from other countries using the specific software for calculating international catch-at-age, mean weight and mean length-at-age in the catches (Patterson, 1999). The mean weight and mean length-at-age in the catches by year and quarters of 2002 are shown in Tables 6.4.2.1 and 6.4.2.2.

Mean weight-at-age in the stock

As for previous years the mean weight-at-age for the two years old was given a constant weight while the weight for the older ages is based on all mature fish sampled from Dutch freezer trawlers the first and second quarter in Divisions VIIj,k (Table 6.5.1.2b). Both the mean weight by age groups in the stock and in the catches were lower than usual in 2001, but returned to normal in 2002..

6.4.3 Maturity ogive

There are no new data on maturity for the western horse mackerel since 1988. In 1999 the working group applied a maturity ogive based on the estimated maturity ogive from the Cantabrian Sea (southern area), which is close to the western area for assessment purposes of the western horse mackerel (ICES, 2000a). The difference between the maturity ogive as used for the years 1987-1997 and the new maturity ogive applied since 1998 is shown in Table 6.5.1.1b.

6.4.4 Natural mortality

The natural mortalities applied in previous assessments of western horse mackerel are summarised and discussed in ICES (1998/Assess:6) and the Working Group admitted uncertainties in M in the range of 0.05 to 0.15. The Working Group applied M=0.15.

6.5 State of the Stock

6.5.1 Data exploration and preliminary modelling

The SAD assessment method combines a Separable VPA with an "ADAPT" model structure, and has been used by the working group since the 2000 meeting. At the time, three assessment methods were compared (ICES CM2001), and the Working Group and ACFM considered the SAD model to provide the most realistic representation of the dynamics of the western horse mackerel stock. The state of the stock is currently based on estimates derived from the SAD assessment method.

At this year's meeting, two separable periods were considered: a 4-year (1999-2002) and 5-year period (1998-2002). This was done in order to investigate the sensitivity of the SAD model to the choice of separable period. The SAD assessment in 2002 considered only a 4-year period (1998-2001).

A Separable VPA /ADAPT (SAD) assessment of the Western Horse mackerel

A detailed description of the SAD assessment model and rationale for its use is provided in last year's report (ICES 2003a). The main features of western horse mackerel that require the use of a uniquely-developed assessment tool are the dominance of a very strong 1982 year class in the catches for many years, a change in the selection pattern towards increasing exploitation of younger fish in recent years, and the lack of age-disaggregated information for model callibration. A further problem is that horse mackerel appears to be an indeterminate spawner (section 4.7) so that the time-series of egg production estimates is treated as an index of spawner biomass with a constant but unknown fecundity, estimated within the SAD assessment.

Figure 6.5.1.1 presents an illustration of the model structure and the parameters estimated within the non-linear minimisation, and Table 6.5.1.1 summarises its main features. The age structure of the assessment, 1 to 11+, aggregates the 1982 year class within the plus group for the years 1993 - 2002, removing its influence on the selection pattern estimated for the cohorts currently dominating the catches. The separable model is fitted to the catch data for the years 1999 - 2002 for the 4-year separable run, and for 1998-2002 for the 5-year run. The separable model estimates of the 1999 (1998 for the 5-year run) population abundance at age initiate a historic VPA for the cohorts exploited in that year. Apart from 1992, population abundance at the oldest age for the years 1998 (1997 for the 5-year run) and earlier is derived from the catch-at-age data at the oldest age and the average (un-weighted) fishing mortality-at-ages 7 - 9, in the same year, scaled by a ratio multiplier. The ratio is estimated within the model as a parameter. Fishing mortality on the plus group is taken to be equal to that on the oldest age. The ratio parameter allows the model to increase selection at the oldest age and for the plus group, compared to the mid range ages, allowing for directed fishing of older, larger fish. In order to model the directed fishing of the dominant 1982 year class, fishing mortality on this year class at age 10 in 1992 was also estimated as a parameter within the model.

The sum of squares objective function for the model is:

$$SSQ = \lambda * \sum_{\substack{y=1983,1989,\ 1992,\\ 1995,1998,\ 2001}} \left[\ln(q\ EP_y) - \ln\left(\sum_a N_{a,y} . O_{a,y} . W_{a,y} .\exp(-PF.\ F_y . S_a - PM.M)\right)\right]^2$$

$$+ \sum_{y=1999 \text{ or } 1998}^{2002} \left[\ln(C_{(y,a)}) - \ln(N_{y,a} F_y S_a (1 - e^{-Z_{y,a}})/Z_{y,a})\right]^2$$

Where : N - represents the population abundance estimated by a separable VPA for the years 1999/8 - 2002 and from the VPA transformation for the years 1982 - 1998/7;

F - the separable model annual fishing mortality factor;
S - the separable model selection at age factor;
M - natural mortality;
Z - total fishing mortality (F + M);
W - weights-at-age;
O - maturity-at-age;
EP - the egg production estimates from surveys;
q - the catchability parameter linking egg production to SSB;
PF - the proportion of fishing mortality exerted before spawning;
PM - the proportion of natural mortality exerted before spawning;
a,y - denote age and year respectively.
l - a weighting factor allows the components of the objective function to be given different relative weights.

The 1986 egg production estimate is excluded from the objective function for the reasons given in last year's report (ICES CM 2003/ACFM:07). The parameters, estimated by a non-linear minimisation of the sum of squares, are:

1) Fishing mortality on the reference age for the separable model (age 7) in 2002.

2) The selection at the oldest age relative to that at the reference age in 2002.

3) The scaling of the fishing mortality for age 10 and the plus group relative to the average of ages 7 - 9.

4) Fishing mortality on the 1982 year class at age 10 and the corresponding plus group in 1992.

5) Catchability linking the egg production estimates and the SSB estimates from the model.

Input data for the model were as presented in Tables 6.5.1.2 and 6.5.1.3. Natural mortality (constant at age and by year at 0.15), maturity-at-age and stock weights-at-age and the proportions of F and M before spawning (0.45), are assumed to be known precisely. Table 6.5.1.4 presents the Egg production estimates taken from ICES (2002:G06).

As noted in last year's report, during the initial fitting of the SAD model to the catch-at-age and survey data it was established that there appeared to be insufficient information in the model to determine the magnitude of the catchability parameter. A reduction in the number of estimated parameters by the introduction of additional model constraints or an increase in the amount of available data are required in order to estimate the parameters. The latter approach was taken by fitting a linear regression model to the last four egg production estimates ($R^2 = 0.99$) and using this regression model to provide pseudo data for the intermediate years. A detailed motivation for this approach is provided in last year's report (ICES CM 2003a).

In order to investigate the precision of the parameter estimates derived from the fitted model, the profile of the sum of squares (SSQ) surface was examined. This was carried out by constraining the parameter for which the profile was required at a range of values covering the value estimated at the optimum solution and then searching for the constrained minimum with the remaining four parameters. Plots of the objective function value at the constrained minima against the range of parameter values are presented in Figure 6.5.1.2; they illustrate the curvature of the five dimensional sum of squares surface in the direction of each parameter. A comparison is provided in this Figure for the 4-year and 5-year separable period runs.

Comparisons of SSB, recruitment and F trajectories for the 4- and 5-year separable runs are also provided in Figure 6.5.1.3. Figure 6.5.1.4 compares the log-catch residuals for the two separable periods as well as the estimates of selectivity at age. In each of these two Figures, the estimates from the 2002 assessment are included for comparison.

Figures 6.5.1.2 - 6.5.1.4 illustrate the sensitivity of the SAD model to the separable period. The SSQ profiles for the 4-year separable period show smoother curves and a better-behaved SSQ surface compared to the 5-year separable period. A comparison of the 2003 log-catchability residuals with those from the 2002 assessment (Figure 6.5.1.4) shows a greater similarity between the residuals from 2003 5-year run and the 2002 assessment compared to the 2003 4-year run, with the latter showing better-behaved residuals than the former two. This may indicate conflicting information in the 1998 catch-at-age data compared to the 1999-2002 period.

Although neither option is entirely satisfactory, the 4-year run showing greater sensitivity to year-to-year changes in selectivity, and the 5-year run being more assumption driven with a greater risk that the assumption of constant selectivity within the separable period will be violated, the Working Group selected the 4-year run. This was partly because it showed better behaviour than the 5-year run, and partly because the SAD model was originally constructed to have a separable period as short as possible, and thus minimise the assumptions required to obtain a unique solution for the data at hand. Furthermore, there are indications in the catch-at-age data that the selectivity at age may have changed in recent years, which would make the choice of a shorter separable period more appropriate. The remaining results are for the 4-year separable run.

Table 6.5.1.5 presents the log catchability residuals from the fit of the 4-year separable model to the catch-at-age data for ages 1 - 10. Table 6.5.1.6 presents the log catchability residuals from the fit of the SAD model to the time-series of egg production estimates scaled by the catchability estimate. Figures 6.5.1.5 and 6.5.1.6 plot the SSB residuals against time and expected value.

In an analysis of the consistency of assessments carried out with the SAD model methodology, the time-series of estimates from the last three assessment Working groups were compared. The results for the SSB time-series are presented in Figures 6.5.1.7, recruits in Figure 6.5.1.8 and for fishing mortality in Figure 6.5.1.9 and 6.5.1.10. The model fits have consistent trends, showing a robust solution for the estimates of the stock dynamics.

6.5.2 Stock assessment

The sensitivity analyses carried out in Section 6.5.1 have shown that solution space for parameter estimates from the SAD model is relatively well defined. The SAD assessment model with a 4-year separable period was therefore adopted as the final assessment for this stock. It was fitted to the catch-at-age and egg production data sets with the structure described previously. The assessment results for fishing mortality, population abundance at age and the stock summary time-series are presented in Tables 6.5.2.1. - 6.5.2.3. The stock summary plots are presented in Figures 6.5.2.1.

The SAD estimates of SSB increased to a peak value of 2.9 million tonnes in 1988 following the recruitment of the 1982 year class. With the lack of recruitments of equivalent magnitude and given the catch history, SSB has generally declined until 2002 (Figure 6.5.2.1). The 2002 estimate of SSB, at 900 thousand tonnes, is estimated to be above the historic low that gave rise to the 1982 year class.

Average fishing mortality (Fbar 1-10) is estimated by the model to have fluctuated within the range 0.06 - 0.25 throughout the history of the fishery. An increase in fishing mortality at the youngest ages (Fbar 1-3) has occurred progressively since the early 1990s indicating a shift in the selection pattern towards younger fish (Figure 6.4.1.1), but has declined again in recent years (Figure 6.5.2.1). Because of this, the Working Group decided to change to the reference age range for the fishing mortality to ages 1-10, and simultaneously, provide estimates of the fishing mortality for the young ones (ages 1-3) and the old ones (ages 4-10)

Apart from the strong 1982 year class, recruitment to the stock showed an increasing trend between 1991 and 1994 and is then estimated to have declined, followed by another increase. However, the age of full recruitment to the fishery is 5 and catch-at-age data at the youngest ages is subject to higher relative errors so that the level of the most recent recruitment is uncertain. The very high estimate of abundance of the 2001 year class results from the very high catches of fish at age 1 in 2002. This estimate relies on only a single observation in the catch-at-age matrix, and is therefore highly uncertain. It is yet too early to verify whether there has indeed been good recruitment in 2001.

6.5.3 Reliability of the Assessment

The SAD model has been adapted to the changing situation in the understanding of the reproductive biology of the Western horse mackerel stock. The model structure was modified at the Working Group due to the uncertainty in the estimates of fecundity in order to allow the estimation of catchability. The inclusion of the assumption of a linear decline in egg production was necessary in order to stabilise the assessment. The effect on the assessment of the uncertainty associated with this assumption has not been tested; furthermore, ancillary data sources that could be used to avoid reliance on this assumption should be investigated. The trends in SSB estimates show a consistent retrospective pattern when compared with assessment carried out during the last three working groups.

Figure 6.5.3.1 illustrates the consistency in the trends SAD estimates of SSB, and compares them with the estimates from the historic egg survey estimates and the previously applied Adapt and Bayesian models.

New information about the stock identity of horse mackerel adds further uncertainty to the assessment. (see section 4.2.1). If more detailed analyses of the data from the HOMSIR project confirm the impression that the southern boundary of the western stock has to be moved south, then catch data and the available assessment tuning data must be revised.

6.6 Catch Prediction

A calculation of the consequences of different short-term catch options was made from the results of the SAD assessment.

Table 6.6.1 presents the calculations for the input values for the catch forecasts and Table 6.6.2 lists the input data for the predictions.

The SAD-estimated abundances of ages 3 to 11+ are used as the starting populations in the prediction for 2003. The following assumptions were made regarding recruitment at age 0, the abundance at age 1 and the abundance at age 2 in 2003:

Age 0 No recruitment indices are available for the 2003 year class. Recruitment in 2002 and the following years was taken as the geometric mean (2663.3 million fish) of the weak recruitment over the years 1983 – 2000 (excluding the strong 1982 year class).

Age 1 The abundance at age 1 is taken to be the geometric mean recruitment (2663.3 million fish) brought forward 1 year by the total mortality-at-age 0 in that year (see Table 6.6.1).

Age 2 SAD indicated a recruitment of the 2001 year class at age 0 of 41227 million, which has only been based on the catches as 0- and 1-group. The WG was very uncertain about the strength of the 2001 year class and was unable to revise it in a mean of recruitments of strong year classes, because only the 1982 year class is known as an extremely strong year class, while recruitment from 1983 to 2000 has been relatively week. The WG decided to assume both a strength of the 2001 year class at age 0 directly taken as abundance at age 2 from SAD as well as the geometric mean of the weak recruitments over the period 1983-2000. In the latter case the recruitment of this year class at age 1 is taken to be this recruitment of 2663.3 million fish brought forward 1 year by the total mortality-at-age 0 and also brought forward by the total mortality-at-age 1 (see Table 6.6.1).

Recruitment at age 0 in 2004 and 2005 was also assumed to be 2663.3 million fish.

Maturity-at-age was taken as an average of the values for the period 2000–2002.

In last years WG report (ICES CM 2003/ACFM:08) a biological evaluation of the fisheries on juvenile and adult horse mackerel was presented. In order to provide the possibility of managing the fisheries that exploit juvenile and adult horse mackerel in different areas the catch forecast have been calculated for the provision of area based TACs. Therefore, two "fleets" have been defined:

1. "Adult area" corresponding to the exploitation of adult fish, being Divisions IIa, IIIa(west), IVa,VIab,VIIbcjk;
2. "Juvenile area" corresponding to the exploitation of juvenile fish, being Divisions VIIefgh, VIIIabd.

The exploitation pattern used in the prediction was the mean of the separable SAD F's over the last three years 2000-2002. This exploitation pattern was subdivided into partial F's for each fleet using the average ratio of the fleet catch at each age for the years 2000–2002.

Weight-at-age in the stock was taken as an average of the values for the period 2000–2002. Weight-at-age in the catch was taken as an average of the values for the period 2000–2002 for each area.

Two deterministic forecasts were made for the Western horse mackerel. Two options for the forecasts are made assuming:

1) 2001 year class is geometric mean weak recruitment;
2) 2001 is a strong years class.

Each of these options is then followed by 6 exploitation scenario's in which the mean $\mathbf{F}_{sq}$=0.14 is divided over the juvenile and the adult areas. These scenario's are:

1) No fishery in the juvenile area and 100% of F(1-10) in adult area;
2) 20% of F(1-10) in the juvenile area and 80% of F(1-10) in adult area;
3) 40% of F(1-10) in the juvenile area and 60% of F(1-10) in adult area;
4) 60% of F(1-10) in the juvenile area and 40% of F(1-10) in adult area (corresponds to the current situation);
5) 80% of F(1-10) in the juvenile area and 20% of F(1-10) in adult area;
6) 100% of F(1-10) in juvenile area and no fishery in the adult areas.

The F(1-10) for 2003 is assumed to be $F_{status\ quo}$ = 0.14, which approximately corresponds to the $\mathbf{F}_{0.1}$. A mean F over age 1-10 was chosen, because it represents both the exploited juveniles (ages 1-3) as well as the adults (ages 4-10).

The F(1-10) for 2004 and following years corresponds also to $F_{status\ quo}$ = 0.14.

The results of the deterministic catch predictions are presented in Table 6.6.3 for the assumption that 2001 year class corresponds to GM weak recruitment. For all exploitation scenario's it shows that SSB increases slightly in 2004, but decreases again in 2005. Catch levels in 2004 and 2005 differ considerably dependent on the exploitation scenario. Catches in 2004 and 2005 are higher if the exploitation increases in adult areas and catches are lower if exploitation increases in juvenile area. The effects of the different exploitation scenario's in the long-term on SSB and catch are shown in Figure 6.6.1.

The results of the deterministic catch predictions are presented in Table 6.6.4 for the assumption that the 2001 year class is strong. For all exploitation scenario's it shows that SSB increases considerably in 2004 and 2005. However, catch levels in 2004 and 2005 differ considerably dependent on the exploitation scenarios. Catches in 2004 and 2005 are lower if the exploitation increases in adult areas and catches are higher if exploitation increases in juvenile area. The effects of the different exploitation scenario's in the long-term on SSB and catch are shown in Figure 6.6.2.

Detailed predictions for both assumptions on the strength of the 2001 year class are given in Tables 6.6.5 and 6.6.6. There were limitations to the production of multifleet option tables, as all the scenarios could not be constructed with the current approved software (MFDP).

6.7 Medium-term analysis

The assessment of this stock is currently under development. At this stage in the analysis estimates of the uncertainty associated with parameters has not been fully tested and therefore short and medium-term risks have not been evaluated. The deterministic medium-term predictions are detailed in section 6.6.

6.8 Long-term Yield

Table 6.8.1 presents the yield-per-recruit forecasts for the combined western horse mackerel stock. The multifleet yield-per-recruit programme (MFYPR) was not able to carry out the yield-per-recruit forecasts for both the adult and juvenile areas, as possible on older software. Therefore, yield-per-recruit forecast was carried out for the combined areas.

$\mathbf{F}_{max}$ is poorly defined at a combined reference F of about 0.65. However, for pelagic species $\mathbf{F}_{max}$ is generally estimated to be at levels of F well beyond sustainable levels and should not be used as a fishing mortality target. $\mathbf{F}_{0.1}$ was estimated to be 0.13. It should be noted that care should be taken when comparing these results with last year's assessment as the ages of F bar have changed (see section 6.6).

6.9 Reference Points for Management Purposes

Biomass reference points

At it's meeting in autumn 2001, ACFM rejected the $\mathbf{B}_{pa}$ established by this working group and declared the status of the stock uncertain. $\mathbf{B}_{pa}$ was not re-established during the autumn 2003 meeting of ACFM as the review of all reference points by SGPRP was pending. SGPRP recommended later to re-establish 500,000 t as $\mathbf{B}_{lim}$ (see Section 1.5).

The rationale for the working groups proposal of a Biomass reference point at 500kt was: This stock is characterised by infrequent, extremely large recruitments ("spasmodic stock" as phrased by SGPRP). As only a short time-series of data is available, it is not possible to quantify stock-recruit relationships, but one may make the precautionary assumption that the likelihood of a strong year class appearing would decline if stock size were to fall below the stock size at which the only such event has been observed. The basis for the level of $\mathbf{B}_{lim}$ is the stock size in 1983 (as estimated by an egg survey and the assessment), which is used as a proxy for the stock size present in 1982, which produced the strong 1982 year class. The egg survey biomass estimate for 1983 based on the old fecundity estimate was 530,000 t. A time-series of egg survey production estimates is available from 1977, which shows a stable stock up to 1986, when the 1982 year class became mature and increased SSB. There is therefore a series of egg production estimates, which agree with the 1982 observation showing the stock was stable at around 500kt based on either the previous estimate of fecundity or the SAD estimate of catchability. The current SAD assessment estimate for 1982 was 641,000 (assessment 2002) and 571,000 (assessment 2003). $\mathbf{B}_{lim}$ has not been changed, because it was close to these observed SSB estimates. A 35% SPR of 485kt was established from an equilibrium prediction based on an average mean weak recruitment to the stock from 1983 onwards (Eltink 2002 WD).

The WG therefore recommends to ACFM to re-establish a biomass reference point $\mathbf{B}_{lim}$ at 500,000 t as proposed by SGPRP.

Fishing mortality reference points

Model development for the assessment of this stock is incomplete. Two fishing mortality reference points have been calculated from the current implementation, they are $\mathbf{F}_{0.1}$ = 0.134 and $F_{35\%SPR}$ = 0.137. Both are different to the previous years estimates, because the age range for mean F is changed from F(4-10) to F(1-10) to include both the exploited age groups of the juveniles as the adults. The current estimate of F(1-10) for 2002 at 0.116 is below $F_{35\%SPR}$. The rather high uncertainty of the assessment (see Section 6.5) has to be taken into account when judging the current estimate of F in relation to potential fishing mortality reference points.

ACFM has not defined any fishing mortality reference points for this stock but in its advice it has used $\mathbf{F}_{0.1}$ as the highest F that is consistent with the Precautionary Approach.

6.10 Harvest control rules

The age distribution is no longer dominated by a single strong year class and younger year classes have become relatively more abundant. Up to last year's WG meeting there has been a change from a harvesting strategy on a single strong year class towards a protection strategy to maitain SSB above $\mathbf{B}_{lim}$. Further development work for the estimation of uncertainty and on the sensitivity of the model to the imposed structural constraints, will allow an evaluation of Harvest control rules in the near future.

6.11 Management considerations

This SSB has been dominated by the strong 1982 year class for many years and no equivalent year classes of this magnitude have been estimated at earlier WG meetings. The SAD model indicated that 2001 is a strong year class, but it is only based on the catches as 0- and 1- group. At this year's meeting the WG was very uncertain about the strength of the 2001 year class. At next years WG meeting the strength of the 2001 year class will be more reliable, because it then will be based on one more year catch data. Because of this uncertainty two catch forecasts are presented assuming the 2001 year class to be average weak or as strong as indicated by the SAD model.

At last years WG meeting an evaluation was presented on the fishery on juvenile and adult western horse mackerel based on biological criteria by means of long-term equilibrium predictions of catch and stock and by studying the effect of area/period closures. Effort reductions in 5 steps in the juvenile areas/periods up to a total closure and effort reductions in 5 steps in the adult areas/periods were evaluated. The Working Group then recommended that a management strategy similar to that for North Sea Herring, in which both adult and juvenile mortality are independently restricted, be explored for this stock.

At this years WG meeting the catch predictions are for the first time carried out for two areas being the areas where juveniles and where the adults are exploited. This provides the possibility of managing the fisheries that exploit juvenile and adult horse mackerel in different areas to enable the provision of area based TACs. Therefore, two "fleets" have been defined:

1) "Adult area" corresponding to the exploitation of adult fish, being Divisions IIa, IIIa(west), IVa,VIab,VIIbcjk;
2) "Juvenile area" corresponding to the exploitation of juvenile fish, being Divisions VIIefgh, VIIIabd.

From about 1994 onwards the fishery shifted from a fishery on adults towards a fishery on juveniles. This may be due to the lack of older fish (decline of 1982 year class) and the development of a market for juveniles. The percentage of catch (in weight) in the juvenile areas increased gradually from 1997 to 2001 respectively from 36%, 48%, 43%, 49% to 60%. In 2002 it was slightly reduced to 55%.

The proportion at age of 4-10 in the catch in 2002 has been higher in the "juvenile" areas than in the "adult" areas, because of the greater proportion of the total catch in the juvenile area. In 2002 especially Divisions VIIIabd contributed to the high proportion of juveniles in the catches: respectively 100%, 60% and 50% of respectively the 1-, 2- and 3-year olds. Management strategies may have to change if strong year classes appear, particularly if the fishery is targeted at the juvenile areas.

Each of the above options on 2001 year class strength have been carried out for 6 exploitation scenario's in which the mean $\mathbf{F}_{sq}$=0.14 is divided over the juvenile and the adult areas. These scenario's are:

1) No fishery in the juvenile area and 100% of F(1-10) in adult area;
2) 20% of F(1-10) in the juvenile area and 80% of F(1-10) in adult area;
3) 40% of F(1-10) in the juvenile area and 60% of F(1-10) in adult area;
4) 60% of F(1-10) in the juvenile area and 40% of F(1-10) in adult area (corresponds to the current situation);
5) 80% of F(1-10) in the juvenile area and 20% of F(1-10) in adult area;
6) 100% of F(1-10) in juvenile area and no fishery in the adult areas.

The catch forecasts from the short-term prediction differ considerably depending on the assumption of the strength of the 2001 year class and the choice of the exploitation scenario.

The TAC has only been given for parts of the distribution and fishing areas (EU waters). The Working Group advises that if a TAC is set for this stock, it should apply to all areas where western horse mackerel are caught, i.e. Divisions IIa, IIIa (western part), IVa, Vb, VIa, VIIa–c, VIIe–k and VIIIa,b,d,e.

The TAC had been overshot considerably between 1988 and 1997 (Figure 6.11.1). Since 1998 the total catches have been close to or below the TAC.

Table 6.2.1 Landings (t) of HORSE MACKEREL in Subarea II. (Data as submitted by Working Group members.)

Country	1980	1981	1982	1983	1984	1985	1986	1987
Denmark	-	-	-	-	-	-	-	39
France	-	-	-	-	1	1	-[2]	-[2]
Germany, Fed.Rep	-	+	-	-	-	-	-	-
Norway	-	-	-	412	22	78	214	3,272
USSR	-	-	-	-	-	-	-	-
Total	-	+	-	412	23	79	214	3,311

	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	-	-	964[3]	1,115	9,157[3]	1,068	-	950
Denmark	-	-	-	-	-	-	-	200
France	-[2]	-	-	-	-	-	55	-
Germany, Fed. Rep.	64	12	+	-	-	-	-	-
Norway	6,285	4,770	9,135	3,200	4,300	2,100	4	11,300
USSR / Russia (1992 -)	469	27	1,298	172	-	-	700	1,633
UK (England + Wales)	-	-	17		-	-	-	-
Total	6,818	4,809	11,414	4,487	13,457	3,168	759	14,083

	1996	1997	1998	1999	2000	2001	2002[1]
Faroe Islands	1,598	799[3]	188[3]	132[3]	250[3]	-	
Denmark	-	-	1,755[3]			-	
France	-	-	-			-	
Germany	-	-	-			-	
Norway	887	1,170	234	2304	841	44	1,321
Russia	881	648	345	121	84[3]	16	3
UK (England + Wales)	-	-	-			-	
Estonia	-	-	22				
Total	3,366	2,617	2,544	2557	1175	60	1,324

[1]Preliminary.
[2]Included in Subarea IV.
[3]Includes catches in Division Vb.

Table 6.2.2 Landings (t) of HORSE MACKEREL in Subarea IV and Division IIIa by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	8	34	7	55	20	13	13	9	10
Denmark	199	3,576	1,612	1,590	23,730	22,495	18,652	7,290	20,323
Faroe Islands	260	-	-	-	-	-	-	-	-
France	292	421	567	366	827	298	231[2]	189[2]	784[2]
Germany, Fed.Rep.	+	139	30	52	+	+	-	3	153
Ireland	1,161	412	-	-	-	-	-	-	-
Netherlands	101	355	559	2,029[3]	824	160[3]	600[3]	850[4]	1,060[3]
Norway[2]	119	2,292	7	322	[3]	203	776	11,728[4]	34,425[4]
Poland	-	-	-	2	94	-	-	-	-
Sweden	-	-	-	-	-	-	2	-	-
UK (Engl. + Wales)	11	15	6	4	-	71	3	339	373
UK (Scotland)	-	-	-	-	3	998	531	487	5,749
USSR	-	-	-	-	489	-	-	-	-
Total	2,151	7,253	2,788	4,420	25,987	24,238	20,808	20,895	62,877

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	10	13	-	+	74	57	51	28	-
Denmark	23,329	20,605	6,982	7,755	6,120	3,921	2,432	1,433	648
Estonia	-	-	-	293	-		17	-	-
Faroe Islands	-	942	340	-	360	275	-	-	296
France	248	220	174	162	302		-	-	-
Germany, Fed.Rep.	506	2,469[5]	5,995	2,801	1,570	1,014	1,600	7	7,603
Ireland	-	687	2,657	2,600	4,086	415	220	1,100	8,152
Netherlands	14,172	1,970	3,852	3,000	2,470	1,329	5,285	6,205	37,778
Norway	84,161	117,903	50,000	96,000	126,800	94,000	84,747	14,639	45,314
Poland	-	-	-	-	-	-	-	-	-
Sweden	-	102	953	800	697	2,087	-	95	232
UK (Engl. + Wales)	10	10	132	4	115	389	478	40	242
UK (N. Ireland)	-	-	350	-	-		-	-	-
UK (Scotland)	2,093	458	7,309	996	1,059	7,582	3,650	2,442	10,511
USSR / Russia (1992 -)	-	-	-						
Unallocated + discards	12,482[4]	-317[4]	-750[4]	-278[6]	-3,270	1,511	-28	136	-31,615
Total	112,047	145,062	77,904	114,133	140,383	112,580	98,452	26,125	79,161

Country	1998	1999	2000	2001	2002[1]
Belgium	19	21	19	19	1,004
Denmark	2,048	8,006	4,409	2,288	1,393
Estonia	22	-	-		
Faroe Islands	28	908	24	-	699
France	379	60	49	48	-
Germany	4,620	4,071	3,115	230	2,671
Ireland	-	404	103	375	72
Netherlands	3,811	3,610	3,382	4,685	6,612
Norway	13,129	44,344	1,246	7,948	35,368
Russia	-	-	2	-	-
Sweden	3,411	1,957	1,141	119	575
UK (Engl. + Wales)	2	11	15	317	1,191
UK (Scotland)	3,041	1,658	3,465	3,161	255
Unallocated + discards	737	-325	14613	649	-149
Total	31,247	64,725	31583	19,839	49,691

[1]-Preliminary. [2] Includes Division IIa. [3] Estimated from biological sampling. [4] Assumed to be misreported. [5] Includes 13 t from the German Democratic Republic. [6] Includes a negative unallocated catch of -4,000 t.

Table 6.2.3 Landings (t) of HORSE MACKEREL in Subarea VI by country. (Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	734	341	2,785	7	-	-	-	769	1,655
Faroe Islands	-	-	1,248	-	-	4,014	1,992	4,450[3]	4,000[3]
France	45	454	4	10	14	13	12	20	10
Germany, Fed. Rep.	5,550	10,212	2,113	4,146	130	191	354	174	615
Ireland	-	-	-	15,086	13,858	27,102	28,125	29,743	27,872
Netherlands	2,385	100	50	94	17,500	18,450	3,450	5,750	3,340
Norway	-	5	-	-	-		83	75	41
Spain	-	-	-	-	-		-[2]	-[2]	-[2]
UK (Engl. + Wales)	9	5	+	38	+	996	198	404	475
UK (N. Ireland)						-	-	-	-
UK (Scotland)	1	17	83	-	214	1,427	138	1,027	7,834
USSR	-	-	-		-	-	-	-	-
Unallocated + disc.						-19,168	-13,897	-7,255	-
Total	8,724	11,134	6,283	19,381	31,716	33,025	20,455	35,157	45,842

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	973	615	-	42	-	294	106	114	780
Faroe Islands	3,059	628	255	-	820	80	-	-	-
France	2	17	4	3	+	-	-	-	52
Germany, Fed. Rep.	1,162	2,474	2,500	6,281	10,023	1,430	1,368	943	229
Ireland	19,493	15,911	24,766	32,994	44,802	65,564	120,124	87,872	22,474
Netherlands	1,907	660	3,369	2,150	590	341	2,326	572	498
Norway	-	-	-	-	-	-	-	-	-
Spain	-[2]	-[2]	1	3	-	-	-	-	-
UK (Engl. + Wales)	44	145	1,229	577	144	109	208	612	56
UK (N.Ireland)	-	-	1,970	273	-	-	-	-	767
UK (Scotland)	1,737	267	1,640	86	4,523	1,760	789	2,669	14,452
USSR / Russia (1992 -)	-	44	-	-	-	-	-	-	-
Unallocated + disc.	6,493	143	-1,278	-1,940	-6,960[4]	-51	-41,326	-11,523	837
Total	34,870	20,904	34,456	40,469	53,942	69,527	83,595	81,259	40,145

Country	1998	1999	2000	2001	2002[1]
Denmark	-	-	-	-	-
Faroe Islands	-	-	-	-	-
France	221	25,007	-	428	55
Germany	414	1,031	209	265	149
Ireland	21,608	31,736	15,843	20,162	12,341
Netherlands	885	1,139	687	600	450
Spain	-	-	-	-	-
UK (Engl. + Wales)	10	344	41	91	-
UK (N.Ireland)	1,132	-	-		
UK (Scotland)	10,447	4,544	1,839	3,111	1,192
Unallocated +disc.	98	1,507	2,038	-21	3
Total	34,815	65,308	20,657	24,636	14,190

[1]Preliminary.
[2]Included in Subarea VII.
[3]Includes Divisions IIIa, IVa,b and VIb.
[4]Includes a negative unallocated catch of -7,000 t.

Table 6.2.4 Landings (t) of HORSE MACKEREL in Subarea VII by country. Data submitted by the Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium	-	1	1	-	-	+	+	2	-
Denmark	5,045	3,099	877	993	732	1,477[2]	30,408[2]	27,368	33,202
France	1,983	2,800	2,314	1,834	2,387	1,881	3,801	2,197	1,523
Germany, Fed.Rep.	2,289	1,079	12	1,977	228	-	5	374	4,705
Ireland	-	16	-	-	65	100	703	15	481
Netherlands	23,002	25,000	27,500[2]	34,350	38,700	33,550	40,750	69,400	43,560
Norway	394	-	-	-	-	-	-	-	-
Spain	50	234	104	142	560	275	137	148	150
UK (Engl. + Wales)	12,933	2,520	2,670	1,230	279	1,630	1,824	1,228	3,759
UK (Scotland)	1	-	-	-	1	1	+	2	2,873
USSR	-	-	-	-	-	120	-	-	-
Total	45,697	34,749	33,478	40,526	42,952	39,034	77,628	100,734	90,253

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Faroe Islands	-	28	-	-	-	-	-	-	-
Belgium	-	+	-	-	-	1	-	-	18
Denmark	34,474	30,594	28,888	18,984	16,978	41,605	28,300	43,330	60,412
France	4,576	2,538	1,230	1,198	1,001	-	-	-	27,201
Germany, Fed.Rep.	7,743	8,109	12,919	12,951	15,684	14,828	17,436	15,949	28,549
Ireland	12,645	17,887	19,074	15,568	16,363	15,281	58,011	38,455	43,624
Netherlands	43,582	111,900	104,107	109,197	157,110	92,903	116,126	114,692	81,464
Norway	-	-	-	-	-	-	-	-	-
Spain	14	16	113	106	54	29	25	33	-
UK (Engl. + Wales)	4,488	13,371	6,436	7,870	6,090	12,418	31,641	28,605	17,464
UK (N.Ireland)	-	-	2,026	1,690	587	119	-	-	1,093
UK (Scotland)	+	139	1,992	5,008	3,123	9,015	10,522	11,241	7,931
USSR / Russia (1992-)	-	-	-	-	-	-	-	-	-
Unallocated + discards	28,368	7,614	24,541	15,563	4,0103	14,057	68,644	26,795	58,718
Total	135,890	192,196	201,326	188,135	221,000	200,256	330,705	279,100	326,474

Country	1998	1999	2000	2001	2002[1]
Faroe Islands	-	-	550	-	-
Belgium	18	-	-	-	1
Denmark	25,492	19,223	13,946	20,574	10,094
France	24,223	-	20,401	11,049	6,466
Germany	25,414	15,247	9,692	8,320	10,812
Ireland	51,720	25,843	32,999	30,192	23,366
Netherlands	91,946	56,223	50,120	46,196	37,605
Spain	-	-	50	7	0
UK (Engl. + Wales)	12,832	8,885	2,972	8,901	5,525
UK (N.Ireland)	-	-	-	-	-
UK (Scotland)	5,095	4,994	5,152	1,757	1,461
Unallocated + discards	12,706	31,239	1,884	11,046	2,576
Total	249,446	161,654	137,766	138,042	97,906

[1]Provisional.
[2]Includes Subarea VI.

Table 6.2.5 Landings (t) of HORSE MACKEREL in Subarea VIII by country.
(Data submitted by Working Group members).

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988
Denmark	-	-	-	-	-	-	446	3,283	2,793
France	3,361	3,711	3.073	2,643	2,489	4,305	3,534	3,983	4,502
Netherlands	-	-	-	-	-[2]	-[2]	-[2]	-[2]	-
Spain	34,134	36,362	19,610	25,580	23,119	23,292	40,334	30,098	26,629
UK (Engl. + Wales)	-	+	1	-	1	143	392	339	253
USSR	-	-	-	-	20	-	656	-	-
Total	37,495	40,073	22,684	28,223	25,629	27,740	45,362	37,703	34,177

Country	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	6,729	5,726	1,349	5,778	1,955	-	340	140	729
France	4,719	5,082	6,164	6,220	4,010	28	-	7	8,690
Germany, Fed. Rep.	-	-	80	62	-		-	-	-
Netherlands	-	6,000	12,437	9,339	19,000	7,272	-	14,187	2,944
Spain	27,170	25,182	23,733	27,688	27,921	25,409	28,349	29,428	31,081
UK (Engl. + Wales)	68	6	70	88	123	753	20	924	430
USSR/Russia (1992 -)	-	-	-	-	-	-	-	-	-
Unallocated + discards	-	1,500	2,563	5,011	700	2,038	-	3,583	-2,944
Total	38,686	43,496	46,396	54,186	53,709	35,500	28,709	48,269	40,930

Country	1998	1999	2000	2001	2002[1]
Denmark	1,728	4,818	2,584	582	-
France	1,844	74	7	5,316	13,676
Germany	3,268	3,197	3,760	3,645	2,249
Ireland	-	-	6,485	1,483	704
Netherlands	6,604	22,479	11,768	36,106	12,538
Russia	-	-	-	-	-
Spain	23,599	24,190	24,154	23,531	22,110
UK (Engl. + Wales)	9	29	112	1,092	157
UK (Scotland)	-	-	249	-	-
Unallocated + discards	1,884	-8658	5,093	4,365	1,705
Total	38,936	46,129	54,212	76,120	54,560

[1]Preliminary.
[2]Included in Subarea VII.

Table 6.4.1.1 Western horse mackerel catch in numbers (1000) at age by quarter and area in 2002

Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
1Q															
0															
1		0	5												6
2		1	19				294	0							313
3		1	16				4412	1				989	75	1	5495
4		1	21		272	0	5000	1		3394	737	1484	113	2	11025
5		1	13	87	742	1	1177	0		5651	2456	1980	150	3	12261
6		1	37	87	1651	3	884	0		7917	1228	1238	94	2	13142
7		1	35	87	4202	7	1765	0		9045	2456	247	19	1	17865
8		4	98	1128	7988	13	4706	1		16962	4912	247	19	3	36081
9		2	51	260	6567	11	6177	1		6788	6386			2	26244
10		2	59	607	4779	8	4412	1		0	2947			1	12816
11		1	32	678	1655	3	1765	0		1129	982				6245
12		1	29	418	269	0	2647	0		1129	491				4986
13		1	19	678	942	2	883	0		0	1228				3751
14		1	16	749	820	1	294	0		1129	1474				4483
15+		1	16	2614	7125	12	2353	0		3394	5404				20920
2Q															
Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0															
1		0	28									8492	253		8773
2		0	96				1					50951	1519		52567
3	1	0	83	14	71		8					88692	2713	2152	93735
4	10	0	110	156	152		9			67		28306	930	2690	32431
5	4	0	69	56	103		2			112	484	1887	211	4842	7769
6	6	0	193	101	25		2			157	484	3774	353	7533	12627
7	6	0	179	96	63		3			180	1111	2831	273	5918	10661
8	8	1	509	128	82		8			337	2851		120	3766	7812
9	5	0	261	80	63		11			135	1738	943	28		3265
10	3	1	303	56	12		8			0	1495				1877
11	0	0	165	4	4		3			22	2075	943	28		3246
12		0	151	0	0		5			22	289				468
13		0	96	0	2		2				433	943	28		1504
14		0	83	0	0		1			22	675				780
15+		0	83	0	0		4			67	2845	943	28		3971
3Q															
Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												4	63	71	139
1		33					116		4			375	5382	6184	12093
2		3					28		0			11	152	213	406
3	0	3	2	574	794		58		1		111	3684	37	311	5576
4	0	6	1	6408	1686		29		1		662	7364	13	180	16351
5	0	2	1	2295	1139		11		0		221	1841	1	167	5678
6	0	2	1	4137	278		23		1		442	2762	4	206	7856
7	1	2	9	3950	705		17		1		662	4603	6	352	10307
8	9	4	71	5238	915		12		1		331	921	8	267	7778
9	8	3	61	3295	697		17		0		111	921	4	128	5245
10	12	2	96	2287	130		8		0		0	0	1	52	2588
11	10	2	76	177	44		5		0		221	921	1	77	1533
12	15	1	120				6		0			0	0	34	177
13	2	1	19		17				0			0	0	14	53
14	3	0	27						0			0	0	49	80
15+	38	1	298	12			4		0			0	4	92	449
4Q															
Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0															
1		71					16198		32	119721		156805	5654	10212	308693
2		6					3737		3	12034		12005	433	782	29000
3	10	8	285	1097	645		7880		12	39130	95	3910	141	255	53467
4	4	13	112	6423	3924		3981		11	44271	569	691	25	45	60068
5	5	4	150	3175	1259		1567		4	28065	189	35	1	2	34458
6	4	5	105	4308	4663		3222		5	19258	379	30	1	2	31983
7	37	9	1045	5631	8922		2400		6	27446	569	38	1	3	46108
8	301	43	8468	6003	8816		1749		7	32682	284	29	1	2	58384
9	260	36	7305	5021	3037		2503		4	18935	95	3	0	0	37198
10	405	52	11395	1725	1315		1174		1	5270	0	0			21337
11	321	42	9012	109	414		783		0	1613	189	0			12483
12	506	61	14249	81	114		979		0	1267	0	0			17258
13	80	11	2257	248	114										2711
14	114	14	3221						0	1780					5130
15+	1258	148	35385	33	75		587		0	1613					39099
2002															
Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												4	63	71	139
1		105	33				16314		36	119721		165671	11289	16396	329564
2		10	115				4060	0	4	12034		62966	2104	995	82287
3	11	11	386	1685	1510		12358	1	13	39130	205	97276	2967	2720	158272
4	14	20	244	12987	6033	0	9019	1	12	47732	1968	37846	1081	2917	119875
5	9	6	233	5612	3243	1	2757	0	5	33829	3350	5743	364	5015	60167
6	10	10	336	8633	6618	3	4131	0	6	27332	2533	7803	452	7743	65608
7	44	13	1267	9764	13892	7	4185	0	7	36671	4798	7719	299	6275	84941
8	318	52	9146	12497	17802	13	6475	1	8	49982	8379	1196	148	4038	110055
9	273	42	7678	8657	10364	11	8708	1	4	25858	8329	1867	32	130	71953
10	421	57	11852	4675	6236	8	5602	1	2	5270	4443	0	1	53	38618
11	331	46	9285	968	2117	3	2556	0	0	2764	3467	1864	29	77	23507
12	522	63	14550	499	383	0	3637	0	0	2419	781	0	0	34	22888
13	83	12	2391	926	1074	2	884	0			1661	943	28	14	8019
14	118	15	3347	749	820	1	295	0	0	2931	2148	0	0	49	10473
15+	1296	150	35781	2660	7201	12	2949	0	0	5074	8249	944	32	92	64440

Table 6.4.2.1 Western horse mackerel mean weight (Kg) at age in catch by quarter and area in 2002

1Q

Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0															
1		0.070	0.070												0.070
2		0.102	0.102				0.039	0.039							0.043
3		0.121	0.121				0.057	0.057				0.101	0.101	0.101	0.066
4		0.127	0.127		0.169	0.169	0.098	0.098		0.104	0.109	0.110	0.110	0.110	0.104
5		0.144	0.144	0.125	0.162	0.158	0.126	0.126		0.130	0.131	0.120	0.120	0.120	0.130
6		0.178	0.178	0.150	0.176	0.180	0.169	0.169		0.124	0.137	0.130	0.130	0.130	0.136
7		0.192	0.192	0.149	0.184	0.181	0.212	0.212		0.140	0.143	0.114	0.114	0.146	0.158
8		0.213	0.213	0.167	0.202	0.199	0.207	0.207		0.146	0.163	0.149	0.149	0.144	0.170
9		0.207	0.207	0.165	0.219	0.214	0.231	0.231		0.150	0.194			0.148	0.197
10		0.249	0.249	0.258	0.256	0.253	0.233	0.233			0.172			0.142	0.229
11		0.289	0.289	0.362	0.292	0.295	0.295	0.295		0.152	0.225				0.265
12		0.268	0.268	0.342	0.314	0.314	0.332	0.332		0.234	0.329				0.309
13		0.336	0.336	0.365	0.260	0.268	0.391	0.391			0.275				0.315
14		0.290	0.290	0.357	0.315	0.309	0.443	0.443		0.154	0.239				0.265
15+		0.434	0.434	0.404	0.345	0.345	0.502	0.502		0.193	0.261			0.201	0.324

2Q

Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0															
1		0.070	0.070									0.060	0.060		0.060
2		0.102	0.102				0.039					0.073	0.073		0.073
3	0.157	0.121	0.121	0.157	0.160		0.057					0.084	0.089	0.110	0.085
4	0.164	0.127	0.127	0.164	0.161		0.098			0.104		0.106	0.110	0.125	0.108
5	0.165	0.144	0.144	0.165	0.169		0.126			0.130	0.155	0.147	0.143	0.127	0.135
6	0.184	0.178	0.178	0.184	0.180		0.169			0.124	0.159	0.132	0.132	0.131	0.134
7	0.189	0.192	0.192	0.189	0.182		0.212			0.140	0.169	0.169	0.163	0.135	0.150
8	0.195	0.213	0.213	0.195	0.182		0.207			0.146	0.191	0.000	0.150	0.150	0.170
9	0.199	0.207	0.207	0.199	0.178		0.231			0.150	0.218	0.218	0.218		0.213
10	0.209	0.249	0.249	0.209	0.213		0.233			0.000	0.284				0.276
11	0.218	0.289	0.289	0.218	0.193		0.295			0.152	0.282	0.345	0.345		0.300
12	0.000	0.268	0.268	0.000	0.000		0.332			0.234	0.212				0.232
13	0.000	0.336	0.336	0.000	0.267		0.391			0.000	0.295	0.244	0.244		0.265
14	0.000	0.290	0.290	0.000	0.000		0.443			0.154	0.313				0.306
15+	0.220	0.434	0.434	0.220	0.000		0.502			0.193	0.308	0.377	0.377		0.326

3Q

Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												0.017	0.017	0.017	0.017
1		0.056					0.048		0.050			0.033	0.033	0.033	0.033
2		0.092					0.100		0.092			0.071	0.071	0.074	0.075
3	0.220	0.131	0.220	0.157	0.160		0.116		0.120		0.109	0.109	0.093	0.100	0.121
4	0.243	0.158	0.243	0.164	0.161		0.141		0.128		0.126	0.120	0.095	0.109	0.142
5	0.249	0.170	0.249	0.165	0.169		0.137		0.142		0.138	0.130	0.163	0.136	0.153
6	0.253	0.196	0.253	0.184	0.180		0.162		0.147		0.150	0.136	0.179	0.147	0.164
7	0.320	0.203	0.320	0.189	0.182		0.170		0.158		0.152	0.143	0.190	0.153	0.164
8	0.319	0.223	0.319	0.195	0.182		0.170		0.164		0.171	0.200	0.206	0.171	0.193
9	0.328	0.218	0.328	0.199	0.178		0.174		0.174		0.181	0.184	0.225	0.201	0.195
10	0.359	0.189	0.359	0.209	0.213		0.236		0.164			0.238	0.238	0.214	0.216
11	0.374	0.284	0.374	0.218	0.193		0.257		0.242		0.246	0.228	0.246	0.214	0.236
12	0.399	0.316	0.399		0.000		0.301		0.309			0.230	0.230	0.225	0.362
13	0.425	0.298	0.425		0.267							0.250	0.250	0.247	0.326
14	0.378	0.349	0.378						0.244			0.267	0.267	0.247	0.297
15+	0.424	0.357	0.424	0.220			0.395		0.232			0.379	0.379	0.276	0.387

4Q

Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												0.018	0.018	0.018	0.000
1		0.056					0.048		0.050	0.049		0.036	0.036	0.036	0.042
2		0.092					0.099		0.092	0.083		0.074	0.074	0.074	0.081
3	0.220	0.145	0.220	0.161	0.163		0.116		0.120	0.118	0.109	0.089	0.089	0.089	0.117
4	0.243	0.161	0.243	0.169	0.175		0.141		0.128	0.124	0.126	0.086	0.086	0.086	0.133
5	0.249	0.183	0.249	0.182	0.182		0.138		0.142	0.143	0.138	0.142	0.142	0.142	0.148
6	0.253	0.201	0.253	0.182	0.187		0.161		0.147	0.147	0.150	0.150	0.150	0.150	0.159
7	0.320	0.259	0.320	0.190	0.192		0.171		0.158	0.158	0.152	0.153	0.153	0.153	0.173
8	0.319	0.301	0.319	0.195	0.192		0.175		0.164	0.161	0.171	0.158	0.158	0.158	0.193
9	0.328	0.310	0.328	0.196	0.199		0.180		0.174	0.200	0.181	0.168	0.168	0.168	0.224
10	0.359	0.344	0.359	0.219	0.197		0.236		0.164	0.173	0.000	0.273	0.273	0.273	0.285
11	0.374	0.364	0.374	0.301	0.207		0.257		0.242	0.239	0.246	0.238	0.238	0.238	0.341
12	0.399	0.397	0.399	0.258	0.222		0.301		0.309	0.310		0.203	0.203	0.203	0.385
13	0.425	0.408	0.425	0.236	0.222				0.000	0.000		0.267	0.267	0.267	0.399
14	0.378	0.377	0.378						0.244	0.310		0.267	0.267	0.267	0.354
15+	0.424	0.424	0.424	0.259	0.209		0.395		0.232	0.201		0.203	0.203	0.203	0.414

2002

Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												0.017	0.017	0.017	0.017
1		0.056	0.070				0.048		0.050	0.049		0.038	0.035	0.035	0.042
2		0.092	0.102				0.095	0.039	0.092	0.083		0.073	0.073	0.074	0.076
3	0.215	0.140	0.194	0.160	0.161		0.095	0.057	0.120	0.118	0.109	0.085	0.089	0.107	0.096
4	0.188	0.158	0.181	0.167	0.171	0.169	0.117	0.098	0.128	0.122	0.120	0.109	0.109	0.123	0.125
5	0.215	0.175	0.212	0.174	0.173	0.158	0.133	0.126	0.142	0.141	0.135	0.132	0.134	0.127	0.143
6	0.211	0.195	0.202	0.183	0.184	0.180	0.163	0.169	0.147	0.140	0.145	0.133	0.132	0.131	0.150
7	0.302	0.240	0.298	0.189	0.189	0.181	0.189	0.212	0.158	0.153	0.151	0.152	0.160	0.136	0.166
8	0.316	0.287	0.312	0.193	0.196	0.199	0.198	0.207	0.164	0.156	0.173	0.189	0.153	0.151	0.184
9	0.326	0.298	0.323	0.196	0.210	0.214	0.216	0.231	0.174	0.186	0.199	0.201	0.219	0.200	0.212
10	0.358	0.334	0.356	0.219	0.242	0.253	0.234	0.233	0.164	0.173	0.210	0.248	0.238	0.212	0.261
11	0.374	0.357	0.372	0.328	0.273	0.295	0.283	0.295	0.242	0.203	0.262	0.287	0.341	0.214	0.308
12	0.399	0.394	0.398	0.329	0.287	0.314	0.324	0.332	0.309	0.274	0.286	0.223	0.230	0.225	0.365
13	0.425	0.396	0.421	0.330	0.256	0.268	0.391	0.391	0.000	0.000	0.280	0.244	0.244	0.247	0.334
14	0.378	0.372	0.375	0.357	0.315	0.309	0.443	0.443	0.244	0.249	0.262	0.267	0.267	0.247	0.312
15+	0.424	0.423	0.424	0.402	0.343	0.345	0.481	0.502	0.232	0.196	0.277	0.377	0.377	0.275	0.379

Table 6.4.2.2 Western horse mackerel mean length (cm) at age in catch by quarter and area in 2002

1Q Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0															
1		20.5	20.5	0.0	0.0	0.0	0.0	0.0							20.5
2		22.6	22.6	0.0	0.0	0.0	17.5	17.5							17.8
3		24.3	24.3	0.0	0.0	0.0	19.1	19.1				24.0	24.0	24.0	20.1
4		24.8	24.8	0.0	27.9	27.9	23.0	23.0	0.0	24.5	25.2	25.2	25.2	25.2	24.1
5		25.7	25.7	26.5	27.7	27.5	25.5	25.5	0.0	26.5	26.4	25.4	25.4	25.4	26.3
6		27.3	27.3	27.5	28.2	28.4	26.8	26.8	0.0	26.4	26.7	25.9	25.9	25.9	26.6
7		28.5	28.5	26.5	28.7	28.6	29.2	29.2	0.0	27.3	27.4	25.5	25.5	27.2	27.8
8		28.9	28.9	27.7	29.5	29.4	28.9	28.9	0.0	27.2	28.1	27.5	27.5	26.7	28.1
9		29.0	29.0	28.2	30.1	29.9	29.8	29.8	0.0	27.5	29.4	0.0	0.0	27.3	29.2
10		30.0	30.0	31.4	31.8	31.7	29.9	29.9	0.0	0.0	28.9	0.0	0.0	27.3	30.4
11		31.6	31.6	35.0	32.9	33.0	32.0	32.0	0.0	28.5	31.0	0.0	0.0	0.0	31.8
12		31.2	31.2	34.2	33.9	33.9	32.8	32.8	0.0	31.5	34.0	0.0	0.0	0.0	32.8
13		33.6	33.6	35.1	32.1	32.4	34.5	34.5	0.0	0.0	32.3	0.0	0.0	0.0	33.3
14		31.7	31.7	35.0	34.0	33.9	36.5	36.5	0.0	28.5	31.7	0.0	0.0	0.0	32.2
15+		35.8	35.8	36.2	34.8	34.8	37.5	37.5	0.0	30.5	32.2	0.0	0.0	30.5	33.9

2Q Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0															
1		20.5	20.5									19.8	19.8		19.8
2		22.6	22.6				17.5					21.4	21.4		21.4
3	26.3	24.3	24.3	26.3	26.4		19.1					22.2	22.5	23.8	22.2
4	26.8	24.8	24.8	26.8	26.5		23.0			24.5		23.9	24.0	24.5	24.0
5	26.8	25.7	25.7	26.8	27.0		25.5			26.5	27.5	27.0	26.7	25.3	25.9
6	28.0	27.3	27.3	28.0	27.7		26.8			26.4	27.0	25.5	25.5	25.6	25.7
7	28.3	28.5	28.5	28.3	27.8		29.2			27.3	28.2	27.2	27.0	26.1	26.7
8	28.6	28.9	28.9	28.6	27.8		28.9			27.2	29.1		26.8	26.8	27.8
9	28.9	29.0	29.0	28.9	27.5		29.8			27.5	30.3	29.5	29.5		29.8
10	29.4	30.0	30.0	29.4	29.6		29.9				32.2				31.7
11	30.0	31.6	31.6	30.0	28.5		32.0			28.5	32.8	37.5	37.5		34.1
12		31.2	31.2				32.8			31.5	30.2				30.6
13		33.6	33.6		32.5		34.5				33.7	33.5	33.5		33.6
14		31.7	31.7				36.5			28.5	33.6				33.3
15+	30.2	35.8	35.8	30.2			37.5			30.5	34.0	34.5	34.5		34.1

3Q Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												12.4	12.4	12.4	12.4
1		18.8	0.0	0.0	0.0		17.8		18.3			15.5	15.5	15.6	15.6
2		21.6	0.0	0.0	0.0		22.8		22.6			20.4	20.4	20.5	20.6
3	28.0	24.4	28.0	26.3	26.4		24.0		24.6		23.5	23.2	22.4	22.5	24.0
4	28.6	25.4	28.6	26.8	26.5		25.3		25.1		24.5	24.0	22.5	23.4	25.4
5	29.4	26.5	29.4	26.8	27.0		25.3		26.1		25.0	24.5	27.2	24.9	26.0
6	30.0	27.6	30.0	28.0	27.7		26.6		26.3		26.3	24.8	28.2	26.0	26.7
7	31.1	28.0	31.1	28.3	27.8		26.8		26.8		26.3	25.9	28.8	26.4	27.0
8	32.2	29.3	32.2	28.6	27.8		26.9		27.3		27.2	27.5	29.5	27.3	28.3
9	32.2	29.2	32.2	28.9	27.5		27.5		27.5		28.5	27.5	30.5	28.9	28.5
10	33.2	30.2	33.2	29.4	29.6		29.7		27.0			31.2	31.2	30.4	29.6
11	33.4	30.8	33.4	30.0	28.5		30.5		32.0		31.0	28.5	31.4	29.5	29.4
12	34.6	31.5	34.6	0.0	0.0		31.7		32.4			30.8	30.8	30.7	33.7
13	35.1	31.5	35.1	0.0	32.5							31.8	31.8	31.1	33.2
14	33.6	33.5	33.6	0.0	0.0				29.4			32.5	32.5	30.5	31.7
15+	35.0	34.0	35.0	30.2	0.0		36.2		30.1			36.6	36.6	32.2	34.3

4Q Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0							0.0					12.5	12.5	12.5	0.0
1		18.8					17.8		18.3	18.4		16.1	16.1	16.1	17.1
2		21.6					22.8		22.6	21.8		20.6	20.6	20.6	21.4
3	28.0	24.9	28.0	26.8	26.5		24.0		24.6	24.5	23.5	22.1	22.1	22.1	24.3
4	28.6	25.5	28.6	27.3	27.4		25.3		25.1	25.0	24.5	21.7	21.7	21.7	25.4
5	29.4	27.0	29.4	28.0	27.8		25.4		26.1	26.1	25.0	26.0	26.0	26.0	26.3
6	30.0	27.8	30.0	28.1	28.2		26.6		26.3	26.4	26.3	26.5	26.5	26.5	26.9
7	31.1	29.5	31.1	28.5	28.5		26.9		26.8	26.8	26.3	26.7	26.7	26.7	27.4
8	32.2	31.6	32.2	28.8	28.5		27.1		27.3	27.3	27.2	27.0	27.0	27.0	28.4
9	32.2	31.7	32.2	28.8	29.0		27.8		27.5	28.4	28.5	27.6	27.6	27.6	29.3
10	33.2	32.9	33.2	30.0	28.8		29.7		27.0	27.6		32.7	32.7	32.7	31.1
11	33.4	33.1	33.4	33.7	29.5		30.5		32.0	32.3	31.0	31.1	31.1	31.1	32.9
12	34.6	34.5	34.6	31.8	30.5		31.7		32.4	32.5		29.5	29.5	29.5	34.2
13	35.1	34.6	35.1	31.0	30.5							32.5	32.5	32.5	34.5
14	33.6	33.6	33.6						29.4	30.4		32.5	32.5	32.5	32.5
15+	35.0	35.0	35.0	31.2	29.0		36.2		30.1	28.9		29.5	29.5	29.5	34.8

2002 Ages	IIa	IIIa	IVa	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIIa	VIIIb	VIIId	Total
0												12.4	12.4	12.4	12.4
1		18.8	20.5				17.8		18.3	18.4		16.3	15.9	15.9	17.1
2		21.7	22.6				22.4	17.5	22.6	21.8		21.2	21.2	20.6	21.4
3	27.9	24.7	27.1	26.6	26.4		22.3	19.1	24.6	24.5	23.5	22.2	22.5	23.4	22.9
4	27.3	25.4	26.5	27.0	27.1	27.9	24.1	23.0	25.1	25.0	24.8	24.0	24.1	24.4	24.9
5	28.3	26.7	28.1	27.5	27.5	27.5	25.4	25.5	26.1	26.2	26.4	25.6	26.1	25.3	26.2
6	28.8	27.6	28.1	28.0	28.2	28.4	26.6	26.8	26.3	26.4	26.6	25.3	25.6	25.6	26.6
7	30.7	29.1	30.7	28.4	28.5	28.6	27.8	29.2	26.8	26.9	27.3	26.4	26.9	26.1	27.4
8	32.1	31.2	32.0	28.6	28.9	29.4	28.4	28.9	27.3	27.3	28.3	27.5	27.0	26.8	28.2
9	32.1	31.4	32.1	28.8	29.6	29.9	29.2	29.8	27.5	28.2	29.6	28.5	29.6	28.9	29.2
10	33.2	32.7	33.1	29.9	31.1	31.7	29.9	29.9	27.0	27.6	30.0	31.6	31.2	30.3	30.8
11	33.4	33.0	33.4	33.9	32.2	33.0	31.5	32.0	32.0	30.7	32.1	33.1	37.3	29.5	32.5
12	34.6	34.4	34.6	33.8	32.9	33.9	32.5	32.8	32.4	32.0	32.6	30.5	30.8	30.7	33.8
13	35.1	34.4	35.0	34.0	31.9	32.4	34.5	34.5			32.7	33.5	33.5	31.1	33.8
14	33.6	33.5	33.5	35.0	34.0	33.9	36.5	36.5	29.4	29.7	32.3	32.5	32.5	30.5	32.4
15+	35.0	35.0	35.0	36.1	34.7	34.8	37.2	37.5	30.1	30.0	32.8	34.5	34.7	32.1	34.4

Table 6.5.1.1 A summary of the main features of the SAD model used for the assessment of western horse mackerel.

Model	SAD
Version	2002 Working Group (WGMHSA)
Model type	A linked separable VPA and ADAPT VPA model, so that different structural models are applied to the recent and historic periods. The separable component is short (currently 4 years) and applies to the most recent period, while the ADAPT VPA component applies to the historic period. Model estimates from the separable period initiate a historic VPA for the cohorts in the first year of the separable period. Fishing mortality at the oldest true age (age 10) in the historic VPA is calculated as the average of the three preceding ages (7-9), scaled by a ratio multiplier that is estimated in the model. In order to model the directed fishing of the dominant 1982 year class, fishing mortality on this year class at age 10 in 1992 is estimated as a parameter in the model.
Data used	Egg production estimates, used as relative indices of abundance; catch-at-age data; weight-at-age in the catches and in the stock. Natural mortality, maturity-at-age, and the proportions of fishing and natural mortality before spawning are fixed and assumed to be known precisely.
Selection	The separable period assumes constant selection at age, and requires specification of a reference age (for which selection is normalised to 1) and estimates for fishing mortality on the reference age and selection at the oldest true age relative to the reference age.
Estimated parameters	There are five estimable parameters: (1) Fishing mortality on the reference age for the separable period; (2) selection at the oldest true age relative to the reference age in the terminal year; (3) scaling factor of fishing mortality-at-age 10 relative to the average for ages 7-9; (4) fishing mortality on the 1982 year class at age 10 in 1992; (5) catchability linking the egg production estimates and the SSB estimates from the model.
Catchabilities	The catchability parameter links the egg production estimates and the SSB estimates from the model.
Plus group	The fishing mortality on the plus group is set equal to that on the oldest true age, and population abundance in the plus group is derived from this fishing mortality estimate and catches in the plus group.
Objective function	Described in Section 6.5.1. The objective function directly incorporates catch-at-age data for the separable period and egg survey indices for the years for which these are available. "Pseudo" egg indices are derived from a linear regression to real egg indices to support the assumption of a linear decline in the time-series of egg indices since the early 1990s, necessary in order to estimate catchability and thus stabilise the assessment.
Variance estimates / uncertainty	Currently not provided. Marginal SSQ profiles and residual plots give some idea of the quality of the model fit.
Program language	EXCEL-based program in its current form
References	Description in Working Group reports.

Table 6.5.1.2 Western Horse Mackerel: Input to SAD

a. Catch in numbers (thousands)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0	0	0	0	0	767	0	0	3230	12420	0	2315	0	0	0	123	0	181	186	139
1	2523	5668	0	1267	0	83	23975	0	19117	19570	83830	94250	15324	50843	4036	3726	71802	11551	57665	36767	329564
2	14320	1627	183682	3802	0	414	5354	0	42191	47240	24040	49520	796606	411412	615759	417131	153811	51232	113043	222178	82287
3	91566	23595	3378	467741	1120	0	1839	18860	130153	13980	66180	7700	104631	382838	841304	703245	464537	166912	41346	142694	158272
4	7825	38374	27621	3462	489397	2476	3856	16604	57561	187410	50210	52870	49463	198181	157053	390131	340241	221663	62114	90475	119875
5	8968	11005	114001	32441	6316	748405	16616	4821	31195	126310	243720	83770	40466	52812	67924	231570	206255	233540	132496	93623	60167
6	7979	31942	17009	77862	47149	1730	824940	13169	9883	68330	110620	307370	26961	85565	45939	112433	141961	198856	140014	108360	65608
7	6013	37775	29105	9808	79428	34886	10613	1159554	19305	19000	42840	124050	205842	26425	48597	120131	111607	175297	153776	211022	84941
8	1122	12854	25890	12545	18609	76224	34963	10940	1297370	21090	14202	65790	87767	230028	49091	122121	74827	136735	119389	189691	110055
9	281	2360	11230	4809	15328	9854	59452	53909	34673	1173940	17930	25250	37045	107838	44193	103944	64746	72017	54766	96110	71953
10	1122	3948	3121	7155	11052	8015	8531	75496	66058	21140	1063910	3250	40453	95799	48439	95516	47935	33058	15337	29408	38618
11+	55306	92614	44421	31785	41126	52690	66659	71705	211999	132370	149030	1285690	992582	1354115	718074	585684	378334	247613	157285	123525	129328

b. Proportion of fish mature at start of year

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05
3	0.8	0.7	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.25	0.25	0.25	0.25	0.25
4	1	1	0.85	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
5	1	1	1	0.95	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.95	0.95	0.95	0.95	0.95
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 6.5.1.3 Western Horse Mackerel: Input to SAD

a. Mean weight at age in the catch (kg)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.012	0.015	0.012	0.008	0.010	0.021	0.015	0.015	0.017	0.014	0.000	0.023	0.041	0.017
1	0.054	0.039	0.034	0.029	0.029	0.068	0.031	0.050	0.032	0.031	0.014	0.033	0.037	0.038	0.059	0.039	0.041	0.057	0.059	0.045	0.042
2	0.090	0.113	0.073	0.045	0.045	0.067	0.075	0.075	0.031	0.046	0.092	0.083	0.052	0.052	0.078	0.075	0.087	0.094	0.083	0.065	0.076
3	0.142	0.124	0.089	0.087	0.110	0.110	0.114	0.149	0.090	0.113	0.117	0.120	0.106	0.073	0.090	0.093	0.102	0.110	0.097	0.103	0.096
4	0.178	0.168	0.130	0.150	0.107	0.155	0.132	0.142	0.124	0.125	0.139	0.126	0.124	0.089	0.125	0.109	0.113	0.122	0.128	0.114	0.125
5	0.227	0.229	0.176	0.156	0.171	0.143	0.147	0.142	0.126	0.148	0.143	0.142	0.158	0.126	0.141	0.142	0.140	0.142	0.141	0.132	0.143
6	0.273	0.247	0.216	0.199	0.196	0.174	0.157	0.220	0.129	0.141	0.157	0.154	0.153	0.130	0.155	0.179	0.162	0.164	0.157	0.143	0.150
7	0.276	0.282	0.245	0.243	0.223	0.198	0.240	0.166	0.202	0.144	0.163	0.163	0.167	0.170	0.166	0.189	0.172	0.188	0.161	0.152	0.166
8	0.292	0.281	0.278	0.256	0.251	0.249	0.304	0.258	0.183	0.187	0.172	0.183	0.194	0.176	0.177	0.199	0.183	0.207	0.195	0.171	0.184
9	0.305	0.254	0.262	0.294	0.296	0.264	0.335	0.327	0.227	0.185	0.235	0.199	0.199	0.200	0.191	0.209	0.192	0.216	0.212	0.196	0.212
10	0.369	0.260	0.259	0.257	0.280	0.321	0.386	0.330	0.320	0.215	0.222	0.177	0.280	0.204	0.206	0.234	0.213	0.225	0.243	0.228	0.261
11+	0.352	0.319	0.306	0.319	0.356	0.342	0.413	0.432	0.358	0.329	0.357	0.250	0.249	0.249	0.277	0.270	0.250	0.316	0.295	0.285	0.356

b. Mean weight at age in the stock (kg)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
2	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.070	0.050
3	0.080	0.080	0.077	0.081	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.066	0.095	0.080	0.090	0.110	0.087	0.074	0.109
4	0.207	0.171	0.122	0.148	0.105	0.105	0.105	0.105	0.105	0.121	0.105	0.105	0.105	0.119	0.118	0.112	0.108	0.120	0.108	0.082	0.120
5	0.232	0.227	0.155	0.140	0.134	0.126	0.126	0.103	0.127	0.137	0.133	0.153	0.147	0.096	0.129	0.124	0.129	0.130	0.148	0.100	0.135
6	0.269	0.257	0.201	0.193	0.169	0.150	0.141	0.131	0.135	0.143	0.151	0.166	0.185	0.152	0.148	0.162	0.142	0.160	0.170	0.121	0.146
7	0.280	0.276	0.223	0.236	0.195	0.171	0.143	0.159	0.124	0.144	0.150	0.173	0.169	0.166	0.172	0.169	0.151	0.170	0.173	0.131	0.153
8	0.292	0.270	0.253	0.242	0.242	0.218	0.217	0.127	0.154	0.150	0.158	0.172	0.191	0.178	0.183	0.184	0.162	0.180	0.193	0.142	0.177
9	0.305	0.243	0.246	0.289	0.292	0.254	0.274	0.210	0.174	0.182	0.160	0.170	0.191	0.187	0.185	0.188	0.174	0.190	0.202	0.161	0.206
10	0.369	0.390	0.338	0.247	0.262	0.281	0.305	0.252	0.282	0.189	0.182	0.206	0.190	0.197	0.202	0.208	0.191	0.210	0.257	0.187	0.216
11+	0.352	0.311	0.287	0.306	0.342	0.317	0.366	0.336	0.345	0.333	0.287	0.222	0.235	0.233	0.238	0.238	0.215	0.222	0.260	0.268	0.275

Table 6.5.1.4 The time-series of egg production estimates for the western horse mackerel as reported in ICES (2002/G:06).

Year	Egg Produc-tion
1977	5.33E+14
1980	6.35E+14
1983	3.81E+14
1986	5.08E+14
1989	1.63E+15
1992	1.58E+15
1995	1.23E+15
1998	1.00E+15
2001	6.84E+14

Table 6.5.1.5 The Log catch ratio residuals from the fit of the SAD model (4-year separable period) to the catch-at-age data for ages 1 – 10 and years 1999 – 2002.

Ln(C/Cest)	1999	2000	2001	2002
1	-0.33	0.16	0.10	0.00
2	-0.13	0.10	-0.08	-0.10
3	0.16	-0.10	0.07	-0.08
4	0.11	-0.13	0.12	0.15
5	0.00	0.04	-0.06	0.11
6	0.00	0.01	-0.07	0.04
7	-0.08	-0.01	0.03	-0.07
8	0.01	-0.04	0.02	-0.04
9	0.07	0.00	-0.01	-0.01
10	0.00	-0.07	-0.01	0.13

Table 6.5.1.6 The time-series of log residuals from the SAD model fit to the western horse mackerel egg production estimates. A true value of 1 indicates real data a 0 value indicates interpolated estimates of data points.

	1983	1989	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
True data	1	1	1	0	0	1	0	0	1	0	0	1
Log Resid	-0.01	0.10	-0.07	0.03	-0.03	-0.03	0.07	-0.08	-0.06	0.04	0.08	-0.04

Table 6.5.2.1 The fishing mortality-at-age estimated by the SAD assessment model for the western horse mackerel

F	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
1	0.006	0.000	0.000	0.002	0.000	0.000	0.007	0.000	0.010	0.013	0.035
2	0.013	0.004	0.007	0.015	0.000	0.000	0.003	0.000	0.035	0.031	0.019
3	0.049	0.024	0.010	0.020	0.005	0.000	0.002	0.011	0.049	0.014	0.052
4	0.032	0.025	0.034	0.012	0.025	0.014	0.008	0.017	0.039	0.088	0.059
5	0.040	0.054	0.090	0.049	0.026	0.045	0.115	0.012	0.038	0.106	0.149
6	0.048	0.184	0.105	0.078	0.088	0.009	0.061	0.119	0.028	0.103	0.120
7	0.059	0.314	0.241	0.077	0.101	0.082	0.063	0.108	0.243	0.066	0.082
8	0.074	0.163	0.348	0.147	0.194	0.126	0.105	0.081	0.161	0.429	0.061
9	0.019	0.208	0.198	0.094	0.255	0.141	0.130	0.221	0.375	0.203	0.754
10	0.084	0.378	0.435	0.176	0.304	0.193	0.165	0.227	0.431	0.386	0.269
+gp	0.084	0.378	0.435	0.176	0.304	0.193	0.165	0.227	0.431	0.386	0.269

F	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.021	0.003	0.010	0.001	0.002	0.061	0.012	0.008	0.011	0.007
2	0.025	0.230	0.097	0.153	0.153	0.100	0.073	0.052	0.067	0.046
3	0.007	0.063	0.156	0.277	0.248	0.242	0.096	0.068	0.087	0.060
4	0.051	0.054	0.155	0.084	0.189	0.172	0.126	0.089	0.115	0.078
5	0.125	0.047	0.071	0.069	0.162	0.137	0.163	0.115	0.148	0.101
6	0.269	0.051	0.127	0.078	0.149	0.134	0.178	0.126	0.162	0.110
7	0.182	0.275	0.062	0.093	0.282	0.204	0.282	0.200	0.257	0.175
8	0.166	0.180	0.530	0.147	0.336	0.269	0.381	0.270	0.346	0.236
9	0.138	0.126	0.330	0.170	0.496	0.283	0.347	0.246	0.316	0.215
10	0.269	0.321	0.509	0.227	0.616	0.418	0.214	0.152	0.195	0.133
+gp	0.269	0.321	0.509	0.227	0.616	0.418	0.214	0.152	0.195	0.133

Table 6.5.2.2 The population numbers-at-age estimated by the SAD assessment model for the western horse mackerel

N	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	40712852	360885	968938	1961131	3027187	4624728	1809988	2307907	1917176	3061117	5773845
1	490811	35041876	310617	833973	1687961	2605524	3980540	1557159	1986434	1650128	2631731
2	1242403	420104	30155564	267350	716632	1452841	2242518	3403840	1340259	1692004	1402123
3	2071783	1056061	360078	25784725	226583	616811	1250088	1925186	2929712	1114429	1412495
4	271097	1698250	887070	306788	21759174	193983	530894	1074255	1639526	2400878	946228
5	247202	226076	1426096	737883	260843	18274260	164666	453367	909215	1357751	1892587
6	184211	204449	184375	1121689	605005	218650	15034474	126314	385744	753628	1051444
7	113730	151149	146337	142913	893211	476990	186589	12174959	96502	322844	585261
8	16959	92309	95050	98951	113907	695105	378184	150752	9403315	65150	260247
9	15905	13556	67526	57791	73529	80777	527566	293069	119604	6889882	36509
10	14980	13429	9478	47702	45280	49067	60383	398924	202233	70777	4841061
+gp	738396	315026	134898	211908	168492	322562	471818	378892	649025	443174	678124

N	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	6494413	6374187	4271787	2363797	1518248	2583392	5991076	3406094	56062651	2663339	2663339
1	4958072	5589793	5484166	3676761	2034539	1306768	2223432	5156567	2931485	48253398	2292357
2	2187379	4180012	4796963	4673096	3160873	1747687	1058132	1891083	4400981	2495989	41226648
3	1184515	1836753	2858724	3747099	3450905	2333598	1361551	846276	1545070	3543319	2052700
4	1154348	1012378	1483837	2105351	2444644	2317790	1577576	1064450	680362	1218493	2873196
5	767844	944506	825473	1093289	1666388	1742183	1679284	1196907	837753	522124	969846
6	1402855	583173	775402	661495	877987	1219436	1308159	1228462	917951	621944	406289
7	802359	922288	476929	588012	526735	651381	917874	942310	931890	671982	479352
8	463994	575510	602852	385981	461021	341914	457106	595783	663913	620544	485526
9	210821	338327	413921	305472	286673	283508	224868	268838	391400	404174	421759
10	14789	158030	256833	256219	221923	150308	183950	136791	180893	245701	280511
+gp	5850450	3877528	3630320	3798269	1360784	1186329	1377832	1197938	748951	1116538	1026484

Table 6.5.2.3 The population summary time-series age estimated by the SAD assessment model for the Western Horse mackerel

YEAR	RECRUITS Age 0	Biomass (tonnes)	SSB (tonnes)	TOTAL INT. LANDINGS (tonnes)	Fbar (4 - 10)	Fbar (1 - 3)	Fbar (1 - 10)
1982	40712852	698269	571183	41587	0.05	0.02	0.04
1983	360885	672741	560584	64862	0.19	0.01	0.14
1984	968938	2017097	565178	73625	0.21	0.01	0.15
1985	1961131	2618041	1226616	80551	0.09	0.01	0.07
1986	3027187	2768520	1652036	105665	0.14	0.00	0.10
1987	4624728	2847462	2079162	157240	0.09	0.00	0.06
1988	1809988	2852700	2412175	188100	0.09	0.00	0.07
1989	2307907	2744668	2170446	268867	0.11	0.00	0.08
1990	1917176	2402593	1821278	373463	0.19	0.03	0.14
1991	3061117	2229083	1672263	333555	0.20	0.02	0.14
1992	5773845	1903522	1429926	370550	0.21	0.04	0.16
1993	6494413	2234332	1688049	433145	0.17	0.02	0.13
1994	6374187	1981400	1372068	388875	0.15	0.10	0.14
1995	4271787	1962912	1220959	510597	0.25	0.09	0.20
1996	2363797	2262545	1471939	396652	0.12	0.14	0.13
1997	1518248	1654413	958927	442571	0.32	0.13	0.26
1998	2583392	1432835	929942	303543	0.23	0.13	0.20
1999	5991076	1444461	1032929	273888	0.24	0.06	0.19
2000	3406094	1348661	1009939	174927	0.17	0.04	0.13
2001	56062651	1186436	669807	191193	0.22	0.06	0.17
2002		1474973	895619	172181	0.15	0.04	0.12

Table 6.6.1 CALCULATION OF INPUTS FOR SHORT-TERM PREDICTIONS FOR WESTERN HORSE MACKEREL

UNIT: millions

Version: 01.okt.2003 13:10

Year class	AGE	Stock in numbers at 1st January 2003		
2003	0	2663.3	2663.3	<--- geometric mean over period 1983-2000
2002	1	2292.4	2292.4	<--- corrected 1-year olds ------------------>
2001	2	41226.6	1958.5	<-- from SAD and calculated abundance at age 2
2000	3	2052.7	2052.7	<-- from SAD
1999	4	2873.2	2873.2	<-- from SAD
1998	5	969.8	969.8	<-- from SAD
1997	6	406.3	406.3	<-- from SAD
1996	7	479.4	479.4	<-- from SAD
1995	8	485.5	485.5	<-- from SAD
1994	9	421.8	421.8	<-- from SAD
1993	10	280.5	280.5	<-- from SAD
	11+	1026.5	1026.5	<-- from SAD
	OPTION:	strong 2001	GM recr 2001	

CALCULATION OF RECRUITMENT AT AGE 1

Numbers at age **1**	2292.4
At age **0** one year earlier	2663.3
CORRECTED **1**-YEAR OLDS	2292.4

(N_age_1_in_2002 / N_age_0_in 2001) x GM recruitment

CALCULATION OF RECRUITMENT AT AGE 2

Numbers at age **1** in 2002	48253.4
Numbers at age **0** in 2001	56062.7
CORRECTED **1**-YEAR OLDS	2292.3
Numbers at age **2**	41226.6
At age **1** one year earlier	48253.4
CORRECTED **2**-YEAR OLDS	1958.5

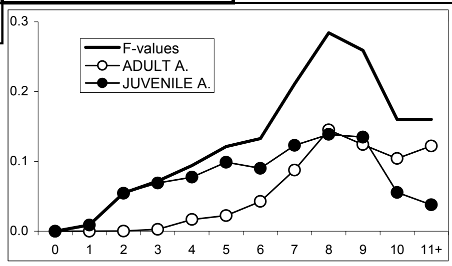
(N_age_1_in_2002 / N_age_0_in 2001)*(N_age_2_in_2003 / N_age_1_in 2002) x GM recruitment

Calculation of status quo F and fishery pattern by fleet

AGE	Catch at age from ADULT AREA FLEET 2000	2001	2002	Catch at age from JUVENILE AREA FLEET 2000	2001	2002	Fraction JUVENILE AREA FLEET 2000	2001	2002
0	0	0	0	181	186	139	1.0000	1.0000	1.0000
1	322	0	33	57342	36767	329427	0.9944	1.0000	0.9999
2	806	887	115	112237	221291	82162	0.9929	0.9960	0.9986
3	3763	303	3797	37583	142391	154463	0.9090	0.9979	0.9760
4	19714	3445	21247	42400	87030	98608	0.6826	0.9619	0.8227
5	30476	10980	12449	102021	82643	47712	0.7700	0.8827	0.7931
6	53496	33164	18132	86518	75196	47466	0.6179	0.6939	0.7236
7	88671	67812	29772	65105	143210	55156	0.4234	0.6787	0.6494
8	79551	81606	48155	39838	108085	61848	0.3337	0.5698	0.5622
9	23597	49598	35312	31169	46512	36599	0.5691	0.4839	0.5090
10	9565	18098	27634	5771	11311	10928	0.3763	0.3846	0.2834
11+	121047	90553	101425	36237	32972	27617	0.2304	0.2669	0.2140

Rescaling factor mean over three years: 1.0000

AGE	F's of WG2003 (from SAD) 2000	2001	2002	Mean F(1-10) 2000-2003	AGE	Rescaled F-values	Rescaled fishery pattern for the prediction ADULT A.	JUVENILE A.	Mean fractions last 3 years ADULT A.	JUVENILE A.
0	0.000	0.000	0.000	0.000	0	0.00000	**0.0000**	**0.0000**	0.0000	1.0000
1	0.008	0.011	0.007	0.009	1	0.00888	**0.0000**	**0.0089**	0.0019	0.9981
2	0.052	0.067	0.046	0.055	2	0.05479	**0.0002**	**0.0546**	0.0042	0.9958
3	0.068	0.087	0.060	0.072	3	0.07177	**0.0028**	**0.0690**	0.0390	0.9610
4	0.089	0.115	0.078	0.094	4	0.09415	**0.0167**	**0.0774**	0.1776	0.8224
5	0.115	0.148	0.101	0.121	5	0.12136	**0.0224**	**0.0989**	0.1847	0.8153
6	0.126	0.162	0.110	0.133	6	0.13288	**0.0427**	**0.0902**	0.3215	0.6785
7	0.200	0.257	0.175	0.211	7	0.21060	**0.0876**	**0.1230**	0.4162	0.5838
8	0.270	0.346	0.236	0.284	8	0.28421	**0.1454**	**0.1389**	0.5114	0.4886
9	0.246	0.316	0.215	0.259	9	0.25902	**0.1242**	**0.1349**	0.4793	0.5207
10	0.152	0.195	0.133	0.160	10	0.16004	**0.1043**	**0.0557**	0.6519	0.3481
11+	0.152	0.195	0.133	0.160	11+	0.16004	**0.1221**	**0.0379**	0.7629	0.2371
	0.1329	**0.1703**	**0.1161**	**0.1398**		**0.1398**				
	Mean F(1-10)	Mean F(1-10)	Mean F(1-10)	Mean F(1-10)		Mean F(1-10)				



Proportion of F and M before spawing

F	M
0.45	0.45

Table 6.6.1 (Continued)

AGE	Proportion MATURE		2000	2001	2002
0	0.00		0.00	0.00	0.00
1	0.00	ADULT and JUVENILE area	0.00	0.00	0.00
2	0.05		0.05	0.05	0.05
3	0.25		0.25	0.25	0.25
4	0.70		0.70	0.70	0.70
5	0.95		0.95	0.95	0.95
6	1.00		1.00	1.00	1.00
7	1.00		1.00	1.00	1.00
8	1.00		1.00	1.00	1.00
9	1.00		1.00	1.00	1.00
10	1.00		1.00	1.00	1.00
11+	1.00		1.00	1.00	1.00

AGE	Mean weight at age in the STOCK		2000	2001	2002
0	0.000		0.000	0.000	0.000
1	0.000	ADULT and JUVENILE area	0.000	0.000	0.000
2	0.057		0.050	0.070	0.050
3	0.090		0.087	0.074	0.109
4	0.103		0.108	0.082	0.120
5	0.128		0.148	0.100	0.135
6	0.146		0.170	0.121	0.146
7	0.152		0.173	0.131	0.153
8	0.171		0.193	0.142	0.177
9	0.190		0.202	0.161	0.206
10	0.220		0.257	0.187	0.216
11+	0.268		0.260	0.268	0.275

AGE	ADULT AREA - Mean weight at age in the CATCH		2000	2001	2002
0	0.000		0.000	0.000	
1	0.071	ADULT area	0.069	0.074	0.070
2	0.084		0.085	0.065	0.102
3	0.137		0.092	0.157	0.161
4	0.148		0.122	0.160	0.163
5	0.155		0.141	0.162	0.164
6	0.168		0.165	0.161	0.178
7	0.178		0.173	0.174	0.188
8	0.202		0.196	0.195	0.214
9	0.220		0.213	0.217	0.229
10	0.268		0.265	0.256	0.284
11+	0.323		0.292	0.304	0.374

AGE	JUVENILE AREA - Mean weight at age in the CATCH		2000	2001	2002
0	0.027		0.023	0.041	0.017
1	0.049	JUVENILE area	0.059	0.045	0.042
2	0.074		0.083	0.065	0.076
3	0.098		0.098	0.102	0.095
4	0.120		0.131	0.112	0.116
5	0.135		0.141	0.128	0.138
6	0.142		0.152	0.135	0.139
7	0.147		0.145	0.142	0.154
8	0.168		0.192	0.152	0.160
9	0.193		0.210	0.173	0.194
10	0.199		0.207	0.184	0.204
11+	0.279		0.309	0.245	0.283

AGE	TOTAL AREA - Mean weight at age in the CATCH		2000	2001	2002
0	0.027		0.023	0.041	0.017
1	0.049	ADULT and JUVENILE area	0.059	0.045	0.042
2	0.074		0.083	0.065	0.076
3	0.099		0.097	0.102	0.096
4	0.122		0.128	0.114	0.125
5	0.139		0.141	0.132	0.143
6	0.150		0.157	0.143	0.150
7	0.160		0.161	0.152	0.166
8	0.183		0.195	0.171	0.184
9	0.206		0.212	0.196	0.212
10	0.244		0.243	0.228	0.261
11+	0.312		0.295	0.285	0.356

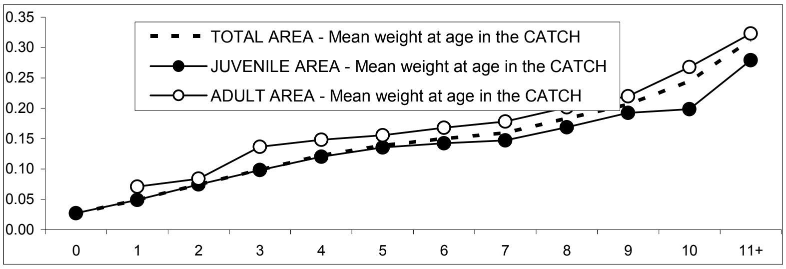


Table 6.6.2 Western Horse Mackerel. Multifleet prediction: INPUT DATA

Rundate: 17 Sep 2003 20:00

2003

	ADULT area		JUVENILE area		2 OPTIONS						
					GM 2001yc	Strong 2001yc					
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Stock size	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0000	0.000	0.0000	0.027	**2663.3**	**2663.3**	0.15	0.00	0.45	0.45	0.000
1	0.0000	0.071	0.0089	0.049	**2292.4**	**2292.4**	0.15	0.00	0.45	0.45	0.000
2	0.0002	0.084	0.0546	0.074	**1958.5**	**41226.6**	0.15	0.05	0.45	0.45	0.057
3	0.0028	0.137	0.0690	0.098	2052.7	2052.7	0.15	0.25	0.45	0.45	0.090
4	0.0167	0.148	0.0774	0.120	2873.2	2873.2	0.15	0.70	0.45	0.45	0.103
5	0.0224	0.155	0.0989	0.135	969.8	969.8	0.15	0.95	0.45	0.45	0.128
6	0.0427	0.168	0.0902	0.142	406.3	406.3	0.15	1.00	0.45	0.45	0.146
7	0.0876	0.178	0.1230	0.147	479.4	479.4	0.15	1.00	0.45	0.45	0.152
8	0.1454	0.202	0.1389	0.168	485.5	485.5	0.15	1.00	0.45	0.45	0.171
9	0.1242	0.220	0.1349	0.193	421.8	421.8	0.15	1.00	0.45	0.45	0.190
10	0.1043	0.268	0.0557	0.199	280.5	280.5	0.15	1.00	0.45	0.45	0.220
11+	0.1221	0.323	0.0379	0.279	1026.5	1026.5	0.15	1.00	0.45	0.45	0.268
UNIT:		(kg)		(kg)	(millions)	(millions)					(kg)

2004 and following years

	ADULT area		JUVENILE area							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0000	0.000	0.0000	0.027	2663.3	0.15	0.00	0.45	0.45	0.000
1	0.0000	0.071	0.0089	0.049	-	0.15	0.00	0.45	0.45	0.000
2	0.0002	0.084	0.0546	0.074	-	0.15	0.05	0.45	0.45	0.057
3	0.0028	0.137	0.0690	0.098	-	0.15	0.25	0.45	0.45	0.090
4	0.0167	0.148	0.0774	0.120	-	0.15	0.70	0.45	0.45	0.103
5	0.0224	0.155	0.0989	0.135	-	0.15	0.95	0.45	0.45	0.128
6	0.0427	0.168	0.0902	0.142	-	0.15	1.00	0.45	0.45	0.146
7	0.0876	0.178	0.1230	0.147	-	0.15	1.00	0.45	0.45	0.152
8	0.1454	0.202	0.1389	0.168	-	0.15	1.00	0.45	0.45	0.171
9	0.1242	0.220	0.1349	0.193	-	0.15	1.00	0.45	0.45	0.190
10	0.1043	0.268	0.0557	0.199	-	0.15	1.00	0.45	0.45	0.220
11+	0.1221	0.323	0.0379	0.279	-	0.15	1.00	0.45	0.45	0.268
UNIT:		(kg)		(kg)	(millions)					(kg)

2005

	ADULT area		JUVENILE area							
Age	Exploit. pattern	Weight in catch	Exploit. pattern	Weight in catch	Recruit-ment	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in the stock
0	0.0000	0.000	0.0000	0.027	2663.3	0.15	0.00	0.45	0.45	0.000
1	0.0000	0.071	0.0089	0.049	-	0.15	0.00	0.45	0.45	0.000
2	0.0002	0.084	0.0546	0.074	-	0.15	0.05	0.45	0.45	0.057
3	0.0028	0.137	0.0690	0.098	-	0.15	0.25	0.45	0.45	0.090
4	0.0167	0.148	0.0774	0.120	-	0.15	0.70	0.45	0.45	0.103
5	0.0224	0.155	0.0989	0.135	-	0.15	0.95	0.45	0.45	0.128
6	0.0427	0.168	0.0902	0.142	-	0.15	1.00	0.45	0.45	0.146
7	0.0876	0.178	0.1230	0.147	-	0.15	1.00	0.45	0.45	0.152
8	0.1454	0.202	0.1389	0.168	-	0.15	1.00	0.45	0.45	0.171
9	0.1242	0.220	0.1349	0.193	-	0.15	1.00	0.45	0.45	0.190
10	0.1043	0.268	0.0557	0.199	-	0.15	1.00	0.45	0.45	0.220
11+	0.1221	0.323	0.0379	0.279	-	0.15	1.00	0.45	0.45	0.268
UNIT:		(kg)		(kg)	(millions)					(kg)

Table 6.6.3 Short term projections for Western Horse Mackerel, based on F status quo in the current year. Option 1) assuming 2001 year class is geometric mean of weak recruitment

		Adult Area			Juvenile Area			Stock		SSB			
	Year	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
F status quo (0.14)	2003	0.0540	344482	80301	0.0857	759419	98468	15909820	1347967	6643612	1008718	5823627	878757
No fishery in Juvenile area	2004	0.1387	786919	180418	0.0000	0	0	15335655	1301040	6719426	1022708	5917533	885209
No fishery in Juvenile area	2005	0.1387	761955	166380	0.0000	0	0	15135527	1260186	6566482	989437	5786137	859402
F status quo (0.14)	2003	0.0540	344482	80301	0.0857	759419	98468	15909820	1347967	6643612	1008718	5823627	878757
20% of F(1-10) in juvenile area	2004	0.1110	634870	146093	0.0282	243658	31662	15335655	1301040	6719426	1022708	5910546	887751
20% of F(1-10) in juvenile area	2005	0.1110	617443	136452	0.0282	236260	30353	15050376	1256656	6518929	989274	5732820	860246
F status quo (0.14)	2003	0.0540	344482	80301	0.0857	759419	98468	15909820	1347967	6643612	1008718	5823627	878757
40% of F(1-10) in juvenile area	2004	0.0831	479796	110816	0.0563	484758	63149	15335655	1301040	6719426	1022708	5904741	890525
40% of F(1-10) in juvenile area	2005	0.0831	469432	105008	0.0563	465231	60080	14970500	1254090	6475981	990013	5687149	862600
Current Fishery													
F status quo (0.14)	2003	0.0540	344482	80301	0.0857	759419	98468	15909820	1347967	6643612	1008718	5823627	878757
60% of F(1-10) in juvenile area	2004	0.0540	314843	72999	0.0857	734060	95878	15335655	1301040	6719426	1022708	5899711	893627
60% of F(1-10) in juvenile area	2005	0.0540	310481	70343	0.0857	697338	90582	14892284	1252371	6435652	991681	5647195	866619
F status quo (0.14)	2003	0.0540	344482	80301	0.0857	759419	98468	15909820	1347967	6643612	1008718	5823627	878757
80% of F(1-10) in juvenile area	2004	0.0277	162805	37881	0.1126	960538	125767	15335655	1301040	6719426	1022708	5895065	896470
80% of F(1-10) in juvenile area	2005	0.0277	161875	37103	0.1126	904278	118125	14823364	1251284	6400909	993647	5615086	871240
F status quo (0.14)	2003	0.0540	344482	80301	0.0857	759419	98468	15909820	1347967	6643612	1008718	5823627	878757
100% of F(1-10) in juvenile area	2004	0.0000	0	0	0.1408	1195505	156944	15335655	1301040	6719426	1022708	5891459	899696
100% of F(1-10) in juvenile area	2005	0.0000	0	0	0.1408	1115566	146651	14756663	1251181	6369369	996681	5589721	877781

Table 6.6.4 Short term projections for Western Horse Mackerel, based on F status quo in the current year. Option 2) assuming 2001 year class from SAD output (strong year class)

		Adult Area			Juvenile Area			Stock		SSB			
	Year	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
F status quo (0.14)	2003	0.0540	352785	80999	0.0857	2706446	243846	55177968	3573162	8607019	1119977	7613953	980209
No fishery in Juvenile area	2004	0.1387	984455	207415	0.0000	0	0	47322965	4179898	14716254	1742423	13369982	1555929
No fishery in Juvenile area	2005	0.1387	1750184	312967	0.0000	0	0	42484185	4086214	25710543	2967656	23364016	2675782
F status quo (0.14)	2003	0.0540	352785	80999	0.0857	2706446	243846	55177968	3573162	8607019	1119977	7613953	980209
20% of F(1-10) in juvenile area	2004	0.1110	791293	167471	0.0282	910015	97187	47322965	4179898	14716254	1742423	13291544	1552041
20% of F(1-10) in juvenile area	2005	0.1110	1384753	250270	0.0282	861239	105142	41819763	4022826	25257500	2925593	22800147	2623870
F status quo (0.14)	2003	0.0540	352785	80999	0.0857	2706446	243846	55177968	3573162	8607019	1119977	7613953	980209
40% of F(1-10) in juvenile area	2004	0.0831	595792	126669	0.0563	1802947	192770	47322965	4179898	14716254	1742423	13215080	1548456
40% of F(1-10) in juvenile area	2005	0.0831	1027370	187769	0.0563	1677529	205152	41173745	3961759	24818253	2885381	22259763	2575103
Current Fishery													
F status quo (0.14)	2003	0.0540	352785	80999	0.0857	2706446	243846	55177968	3573162	8607019	1119977	7613953	980209
60% of F(1-10) in juvenile area	2004	0.0540	389448	83195	0.0857	2718117	290977	44662328	4179898	14716254	1742423	13137050	1544988
60% of F(1-10) in juvenile area	2005	0.0540	662021	122490	0.0857	2466663	303614	35566937	3900321	24373377	2845246	21719029	2527375
F status quo (0.14)	2003	0.0540	352785	80999	0.0857	2706446	243846	55177968	3573162	8607019	1119977	7613953	980209
80% of F(1-10) in juvenile area	2004	0.0277	200682	43057	0.1126	3542390	379649	47322965	4179898	14716254	1742423	13066078	1541861
80% of F(1-10) in juvenile area	2005	0.0277	337036	63085	0.1126	3187139	391307	39929733	3845609	23975367	2809674	21240277	2485843
F status quo (0.14)	2003	0.0540	352785	80999	0.0857	2706446	243846	55177968	3573162	8607019	1119977	7613953	980209
100% of F(1-10) in juvenile are:	2004	0.0000	0	0	0.1408	4389929	471062	47322965	4179898	14716254	1742423	12993785	1538906
100% of F(1-10) in juvenile are:	2005	0.0000	0	0	0.1408	3884982	478057	39331763	3790608	23571940	2774280	20761552	2445537

Table 6.6.5 Western Horse Mackerel, Detailed summary of short term prediction
Option 1) assuming 2001 year class is geometric mean of weak recruitment

MFDP version 1a
Run: shorter_geo
Time and date: 18:05 17/09/2003
Fbar age range (Total) : 1-10 Fbar age range Fleet 1 : 1-10 Fbar age range Fleet 2 : 1-10

Year:	**2003**	F multiplier	0.9986	Fleet1Fbar	0.054							
	Adult area			Juvenile Area								
Age	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0	0	0	2663300	0	0	0	0	0
1	0	32	2	0.0087	18363	894	2292357	0	0	0	0	0
2	0.0002	414	35	0.0548	97108	7251	1958500	110982	97925	5549	89293	5060
3	0.0026	4788	654	0.0692	127322	12520	2052700	184743	513175	46186	464437	41799
4	0.0155	39419	5847	0.0786	200439	23986	2873196	296897	2011237	207828	1802027	186209
5	0.0215	18294	2848	0.0999	84852	11512	969846	123817	921354	117626	815414	104101
6	0.0426	15093	2536	0.0901	31880	4527	406289	59183	406289	59183	357751	52112
7	0.0863	34727	6193	0.1244	50067	7360	479352	73021	479352	73021	407530	62080
8	0.1438	56644	11423	0.1402	55205	9275	485526	82863	485526	82863	399395	68163
9	0.1247	43161	9481	0.1343	46485	8941	421759	79994	421759	79994	350863	66547
10	0.1032	24888	6678	0.0567	13674	2712	280511	61712	280511	61712	244001	53680
11	0.1212	107021	34604	0.0385	34024	9493	1026484	274756	1026484	274756	892915	239003
Total		344482	80301		759419	98468	15909820	1347967	6643612	1008718	5823627	878757

Year:	**2004**	F multiplier	1	Fleet1Fbar	0.0541							
	Adult area			Juvenile Area								
Age	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0	0	0	2663300	0	0	0	0	0
1	0	32	2	0.0087	18337	892	2292324	0	0	0	0	0
2	0.0002	414	35	0.0548	96852	7232	1956002	110840	97800	5542	89182	5054
3	0.0026	3726	509	0.0691	98821	9717	1595368	143583	398842	35896	360978	32488
4	0.0155	22594	3351	0.0785	114563	13709	1644436	169925	1151105	118948	1031408	106579
5	0.0216	42520	6619	0.0998	196669	26681	2250925	287368	2138379	273000	1892596	241621
6	0.0427	27504	4621	0.09	57930	8226	739296	107691	739296	107691	650994	94828
7	0.0864	22217	3962	0.1242	31941	4695	306230	46649	306230	46649	260354	39661
8	0.144	39044	7874	0.14	37946	6375	334195	57036	334195	57036	274909	46918
9	0.1249	32240	7082	0.1341	34625	6660	314592	59668	314592	59668	261712	49638
10	0.1033	24894	6680	0.0566	13639	2705	280188	61641	280188	61641	243713	53617
11	0.1214	100099	32365	0.0385	31734	8854	958799	256639	958799	256639	833994	223232
Total		315283	73100		733057	95747	15335655	1301040	6719426	1022708	5899839	893636

Year:	**2005**	F multiplier	1	Fleet1Fbar	0.0541							
	Adult area			Juvenile Area								
Age	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0	0	0	2663300	0	0	0	0	0
1	0	32	2	0.0087	18337	892	2292324	0	0	0	0	0
2	0.0002	414	35	0.0548	96852	7232	1955997	110840	97800	5542	89182	5054
3	0.0026	3722	509	0.0691	98702	9706	1593455	143411	398364	35853	360545	32449
4	0.0155	17562	2605	0.0785	89047	10656	1278183	132079	894728	92455	801690	82841
5	0.0216	24338	3789	0.0998	112571	15272	1288401	164486	1223981	156262	1083298	138301
6	0.0427	63840	10725	0.09	134465	19094	1716026	249968	1716026	249968	1511063	220112
7	0.0864	40429	7210	0.1242	58125	8544	557263	84890	557263	84890	473779	72172
8	0.144	24944	5030	0.14	24243	4073	213509	36439	213509	36439	175633	29975
9	0.1249	22191	4875	0.1341	23833	4584	216537	41070	216537	41070	180139	34166
10	0.1033	18569	4983	0.0566	10174	2018	208996	45979	208996	45979	181789	39994
11	0.1214	94881	30678	0.0385	30080	8392	908814	243259	908814	243259	790515	211594
Total		310921	70440		696428	90463	14892804	1252420	6436018	991716	5647632	866658

Table 6.6.6 Western Horse Mackerel, Detailed summary of short term prediction
Option 2) assuming 2001 year class from SAD output (strong year class)

MFDP version 1a
Run: shorter
Time and date: 18:02 17/09/2003
Fbar age range (Total) : 1-10 Fbar age range Fleet 1 : 1-10 Fbar age range Fleet 2 : 1-10

Year:	**2003**	F multiplier	0.9986	Fleet1Fbar	0.054							
	Adult area			Juvenile Area								
Age	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0	0	0	2663300	0	0	0	0	0
1	0	32	2	0.0087	18363	894	2292357	0	0	0	0	0
2	0.0002	8717	732	0.0548	2044135	152629	41226648	2336177	2061332	116809	1879619	106512
3	0.0026	4788	654	0.0692	127322	12520	2052700	184743	513175	46186	464437	41799
4	0.0155	39419	5847	0.0786	200439	23986	2873196	296897	2011237	207828	1802027	186209
5	0.0215	18294	2848	0.0999	84852	11512	969846	123817	921354	117626	815414	104101
6	0.0426	15093	2536	0.0901	31880	4527	406289	59183	406289	59183	357751	52112
7	0.0863	34727	6193	0.1244	50067	7360	479352	73021	479352	73021	407530	62080
8	0.1438	56644	11423	0.1402	55205	9275	485526	82863	485526	82863	399395	68163
9	0.1247	43161	9481	0.1343	46485	8941	421759	79994	421759	79994	350863	66547
10	0.1032	24888	6678	0.0567	13674	2712	280511	61712	280511	61712	244001	53680
11	0.1212	107021	34604	0.0385	34024	9493	1026484	274756	1026484	274756	892915	239003
Total		352785	80999		2706446	243846	55177968	3573162	8607019	1119977	7613953	980209

Year:	**2004**	F multiplier	1	Fleet1Fbar	0.0541							
	Adult area			Juvenile Area								
Age	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0	0	0	2663300	0	0	0	0	0
1	0	32	2	0.0087	18337	892	2292324	0	0	0	0	0
2	0.0002	414	35	0.0548	96852	7232	1956002	110840	97800	5542	89182	5054
3	0.0026	78439	10720	0.0691	2080193	204552	33582678	3022441	8395670	755610	7598620	683876
4	0.0155	22594	3351	0.0785	114563	13709	1644436	169925	1151105	118948	1031408	106579
5	0.0216	42520	6619	0.0998	196669	26681	2250925	287368	2138379	273000	1892596	241621
6	0.0427	27504	4621	0.09	57930	8226	739296	107691	739296	107691	650994	94828
7	0.0864	22217	3962	0.1242	31941	4695	306230	46649	306230	46649	260354	39661
8	0.144	39044	7874	0.14	37946	6375	334195	57036	334195	57036	274909	46918
9	0.1249	32240	7082	0.1341	34625	6660	314592	59668	314592	59668	261712	49638
10	0.1033	24894	6680	0.0566	13639	2705	280188	61641	280188	61641	243713	53617
11	0.1214	100099	32365	0.0385	31734	8854	958799	256639	958799	256639	833994	223232
Total		389996	83311		2714429	290582	47322965	4179898	14716254	1742423	13137481	1545023

Year:	**2005**	F multiplier	1	Fleet1Fbar	0.0541							
	Adult area			Juvenile Area								
Age	F	CatchNos	Yield	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	0	0	0	2663300	0	0	0	0	0
1	0	32	2	0.0087	18337	892	2292324	0	0	0	0	0
2	0.0002	414	35	0.0548	96852	7232	1955997	110840	97800	5542	89182	5054
3	0.0026	3722	509	0.0691	98702	9706	1593455	143411	398364	35853	360545	32449
4	0.0155	369674	54835	0.0785	1874459	224310	26905888	2780275	18834122	1946193	16875657	1743818
5	0.0216	24338	3789	0.0998	112571	15272	1288401	164486	1223981	156262	1083298	138301
6	0.0427	63840	10725	0.09	134465	19094	1716026	249968	1716026	249968	1511063	220112
7	0.0864	40429	7210	0.1242	58125	8544	557263	84890	557263	84890	473779	72172
8	0.144	24944	5030	0.14	24243	4073	213509	36439	213509	36439	175633	29975
9	0.1249	22191	4875	0.1341	23833	4584	216537	41070	216537	41070	180139	34166
10	0.1033	18569	4983	0.0566	10174	2018	208996	45979	208996	45979	181789	39994
11	0.1214	94881	30678	0.0385	30080	8392	908814	243259	908814	243259	790515	211594
Total		663033	122670		2481840	304117	40520510	3900616	24375412	2845454	21721600	2527635

Table 6.8.1 Western Horse mackerel yield per recruit analysis

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJa	SSBJan	pwnNosSpw	SSBSpwn
0	0	0	0	7.1792	0.8476	3.9482	0.7447	3.6905	0.6961
0.1	0.014	0.0617	0.012	6.7687	0.75	3.5441	0.6477	3.2889	0.6008
0.2	0.0279	0.112	0.021	6.4343	0.6721	3.216	0.5704	2.9631	0.5252
0.3	0.0419	0.1537	0.028	6.1567	0.6088	2.9448	0.5077	2.6943	0.464
0.4	0.0559	0.189	0.0333	5.9228	0.5567	2.7171	0.4561	2.4689	0.4137
0.5	0.0699	0.219	0.0375	5.723	0.5131	2.5234	0.4131	2.2775	0.372
0.6	0.0838	0.2451	0.0409	5.5502	0.4763	2.3567	0.3769	2.1131	0.337
0.7	0.0978	0.2678	0.0435	5.3992	0.4448	2.2118	0.346	1.9704	0.3072
0.8	0.1118	0.2879	0.0457	5.2661	0.4178	2.0846	0.3195	1.8455	0.2817
0.9	0.1257	0.3058	0.0474	5.1476	0.3942	1.972	0.2965	1.7352	0.2597
1	0.1397	0.3218	0.0488	5.0414	0.3736	1.8717	0.2765	1.6371	0.2405
1.1	0.1537	0.3363	0.05	4.9455	0.3555	1.7816	0.2588	1.5492	0.2237
1.2	0.1676	0.3495	0.0509	4.8584	0.3393	1.7003	0.2432	1.4701	0.2089
1.3	0.1816	0.3615	0.0517	4.7789	0.3249	1.6264	0.2293	1.3984	0.1958
1.4	0.1956	0.3726	0.0524	4.7058	0.3119	1.559	0.2169	1.3332	0.184
1.5	0.2096	0.3828	0.053	4.6383	0.3002	1.4971	0.2057	1.2735	0.1735
1.6	0.2235	0.3923	0.0535	4.5758	0.2896	1.4401	0.1956	1.2186	0.164
1.7	0.2375	0.4011	0.0539	4.5175	0.2798	1.3874	0.1864	1.168	0.1554
1.8	0.2515	0.4093	0.0542	4.4631	0.2709	1.3384	0.1779	1.1212	0.1476
1.9	0.2654	0.4171	0.0545	4.4121	0.2627	1.2928	0.1702	1.0777	0.1404
2	0.2794	0.4243	0.0548	4.3641	0.2551	1.2502	0.1631	1.0371	0.1339

Reference	F multiplier	Absolute F
Fbar(1-10)	1	0.1397
FMax	4.6524	0.6499
F0.1	0.9605	0.1342
F35%SPR	0.9829	0.1373

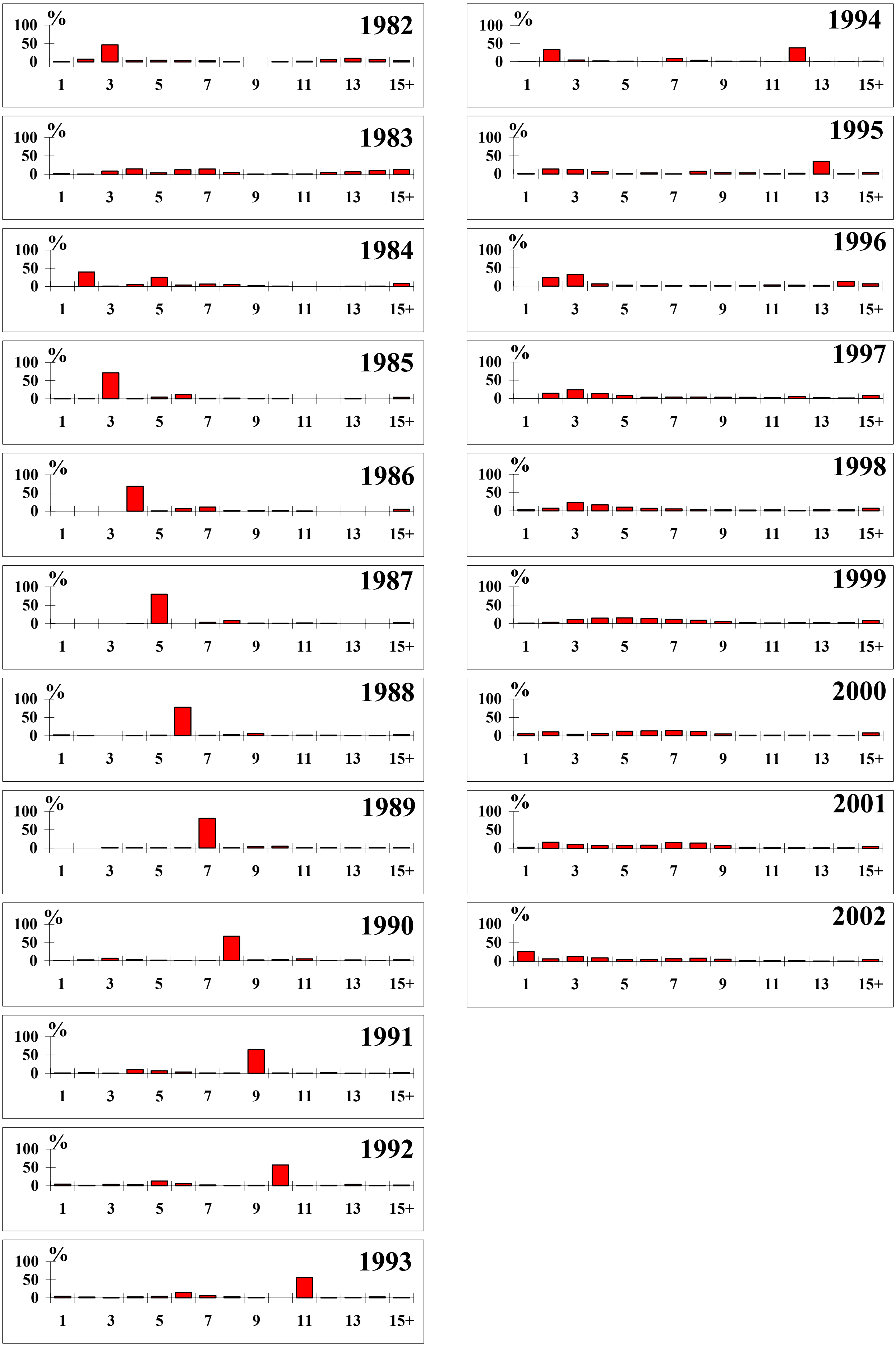


Figure 6.4.1.1 The age composition of the WESTERN HORSE MACKEREL in the international catches during 1982-2002.

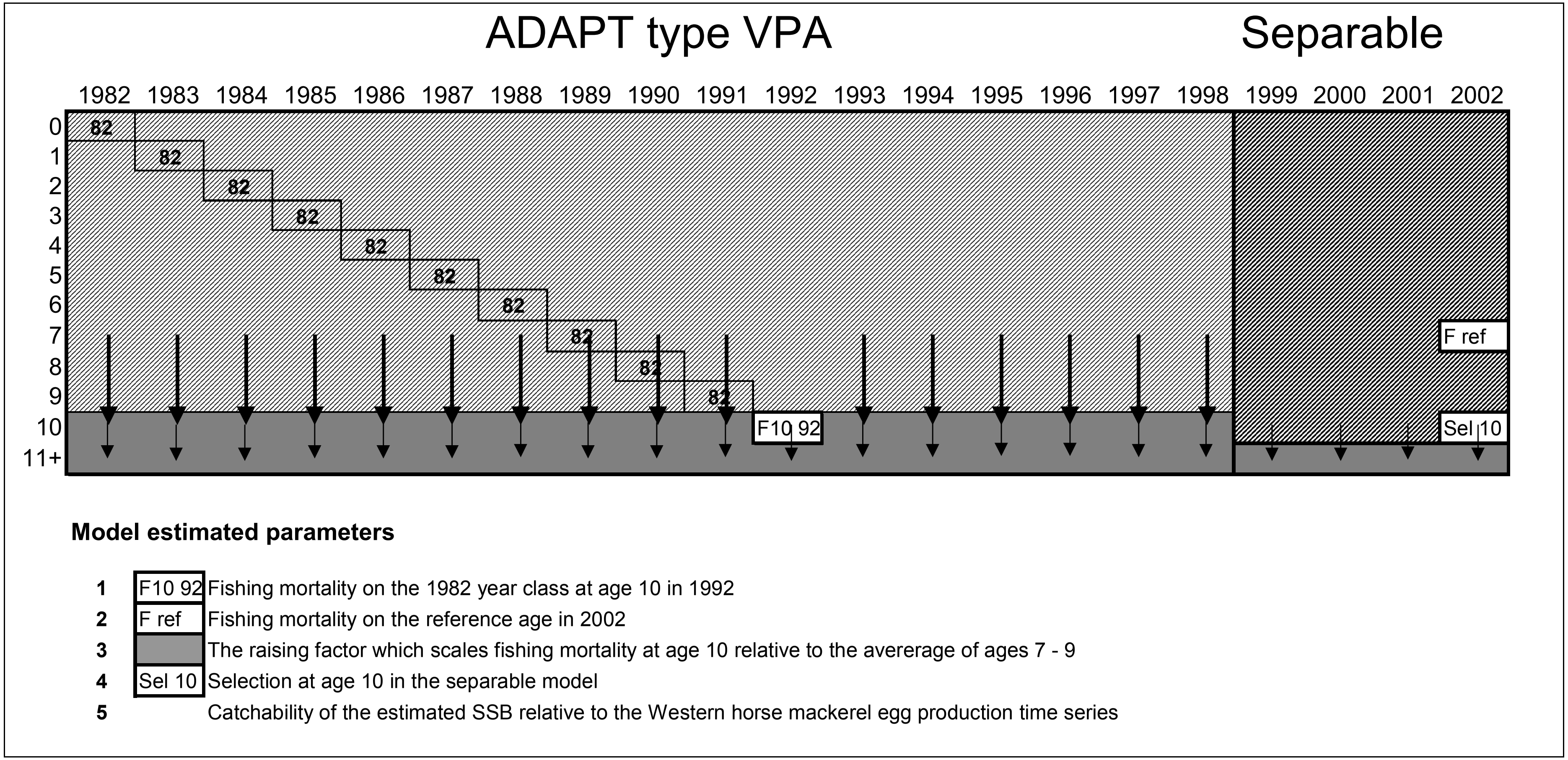
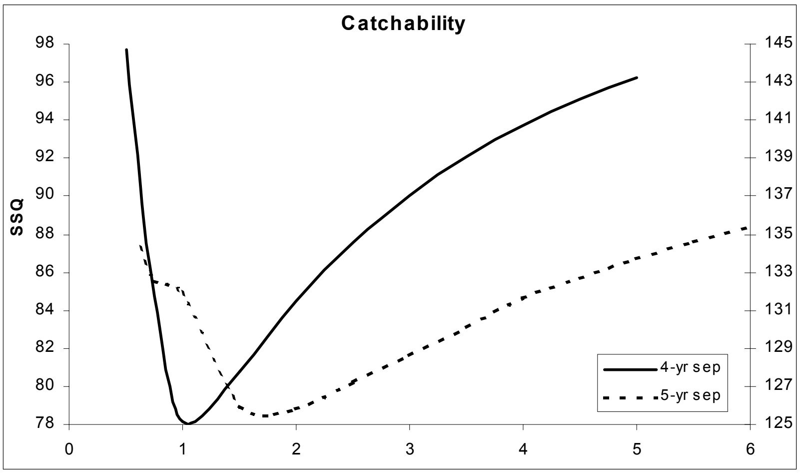
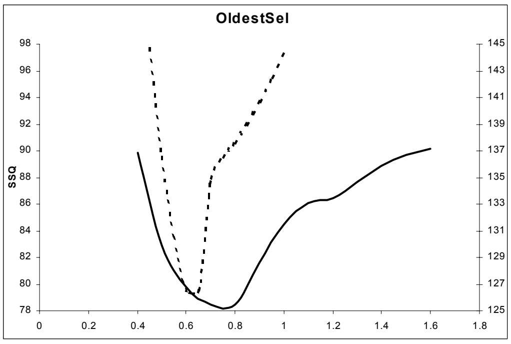


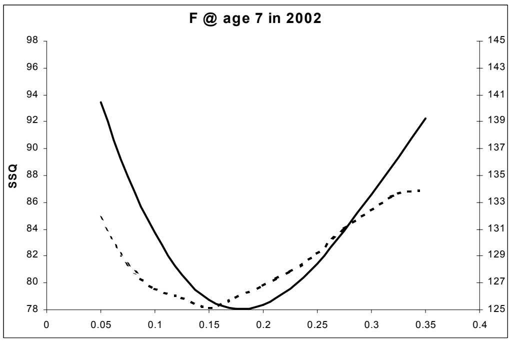
Figure 6.5.1.1 An illustration of the SAD model structure used for the assessment of the Western horse mackerel stock and the parameters estimated within the least squares minimisation.

(a)

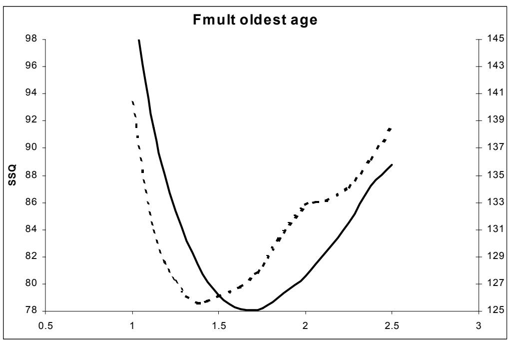


(b) **(c)**





(d) **(e)**



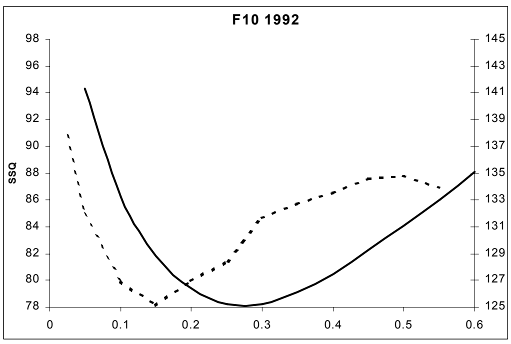


Figure 6.5.1.2 The single parameter sum of squares profiles for each of the five parameters estimated within the SAD assesment model for 4-year (solid line) and 5-year (broken line) separable periods.

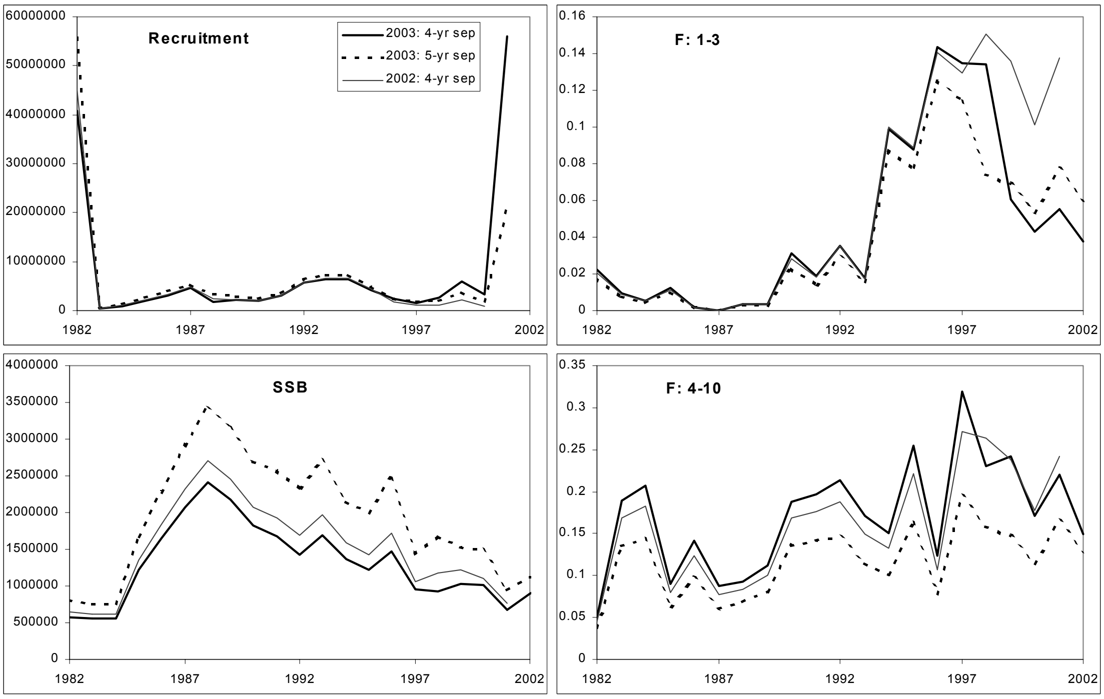


Figure 6.5.1.3 A comparison of the SAD model estimates of recruitment, SSB Fbar (1-3) and Fbar (4-10). Thick solid line: 2003 assessment with 4-year separable period. Thick broken line: 2003 assessment with 5-year separable period. Thin solid line: 2002 assessment with 4-year separable period.

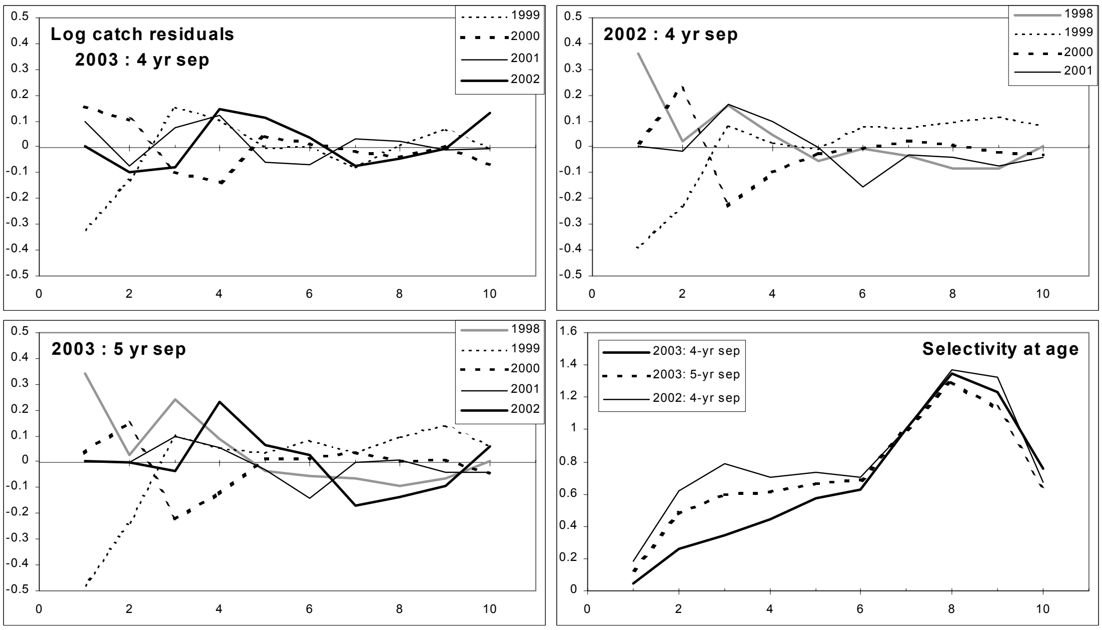


Figure 6.5.1.4 A comparison of the log-catch residuals from the separable component of the SAD model (top row and left column of plots), and estimates of selectivity at age (bottom-right plot), for two different separable periods for the 2003 assessment, and the 2002 assessment.

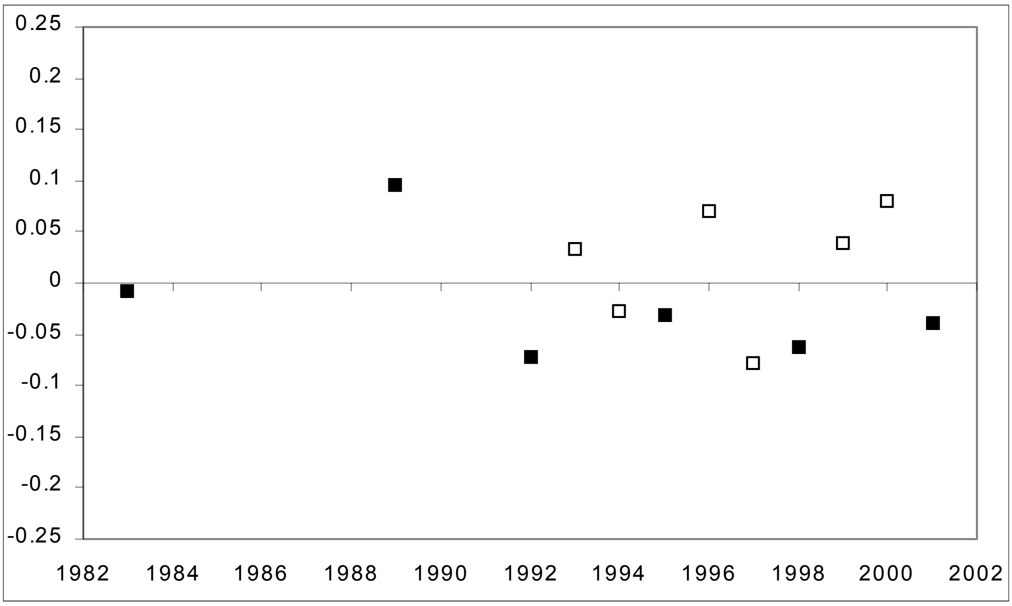


Figure 6.5.1.5 The time-series of log residuals from the SAD model fit to the Western horse mackerel egg production estimates. Solid points illustrate real data hollow point interpolated estimates of data points.

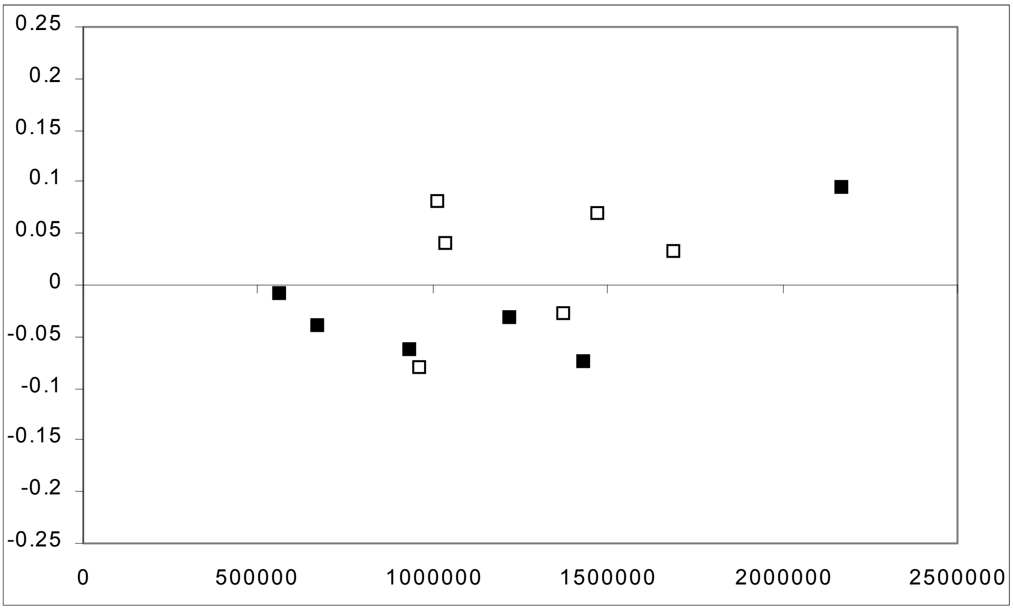


Figure 6.5.1.6 The log residuals from the SAD model fit to the Western horse mackerel egg production estimates plotted against estimated SSB. Solid points illustrate real data hollow point interpolated estimates of data points.

Figure 6.5.1.7 A comparison of the SAD model estimates of spawning stock biomass from assessments carried out in 2000, 2001 and 2002 thin lines, and 2003 thick line.

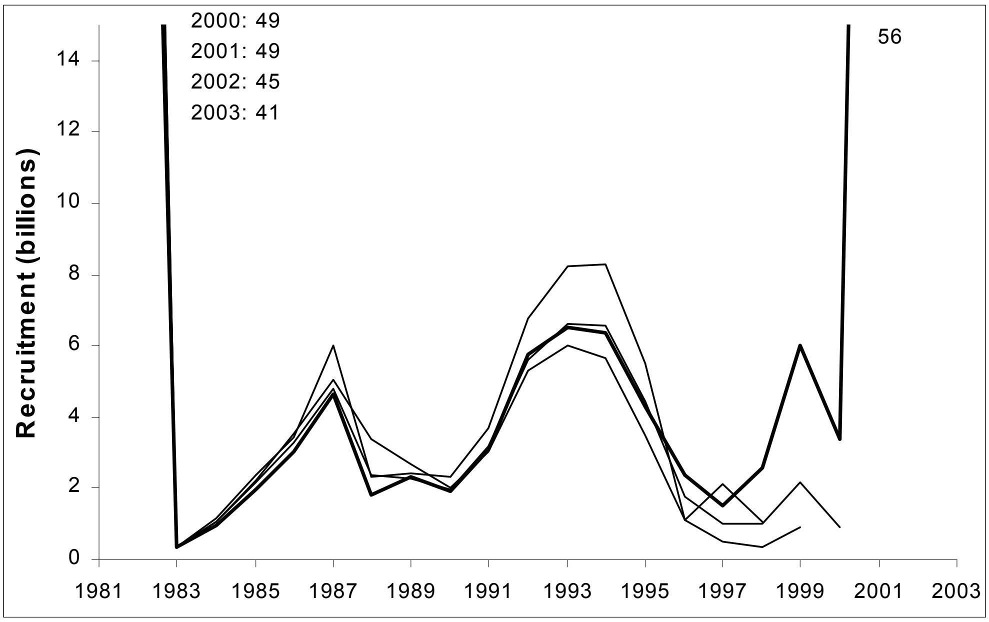


Figure 6.5.1.8 A comparison of the SAD model estimates of recruitment from assessments carried out in 2000, 2001 and 2002 thin lines, and 2003 thick line.

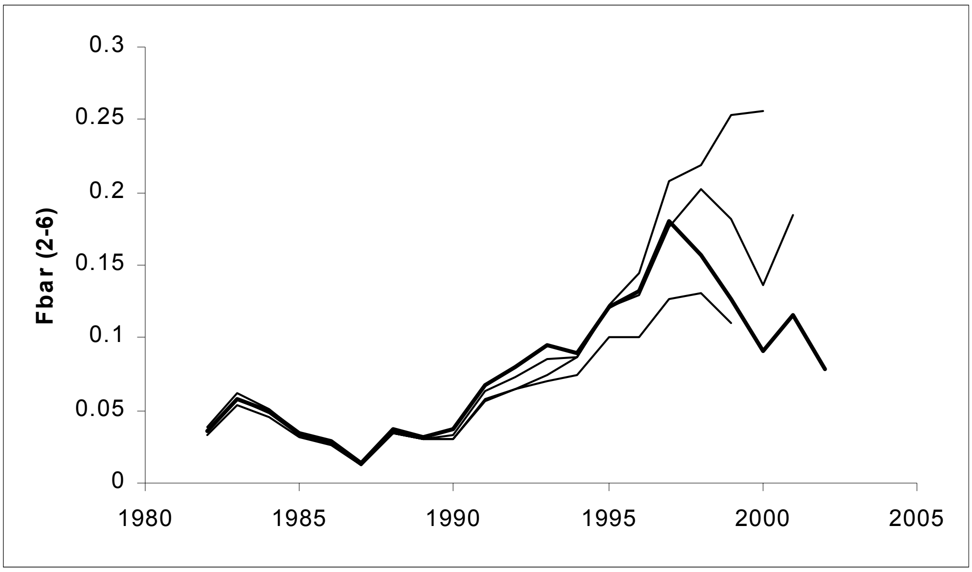


Figure 6.5.1.9 A comparison of the SAD model estimates of Fbar(2-6) from assessments carried out in 2000, 2001 and 2002 thin lines, and 2003 thick line.

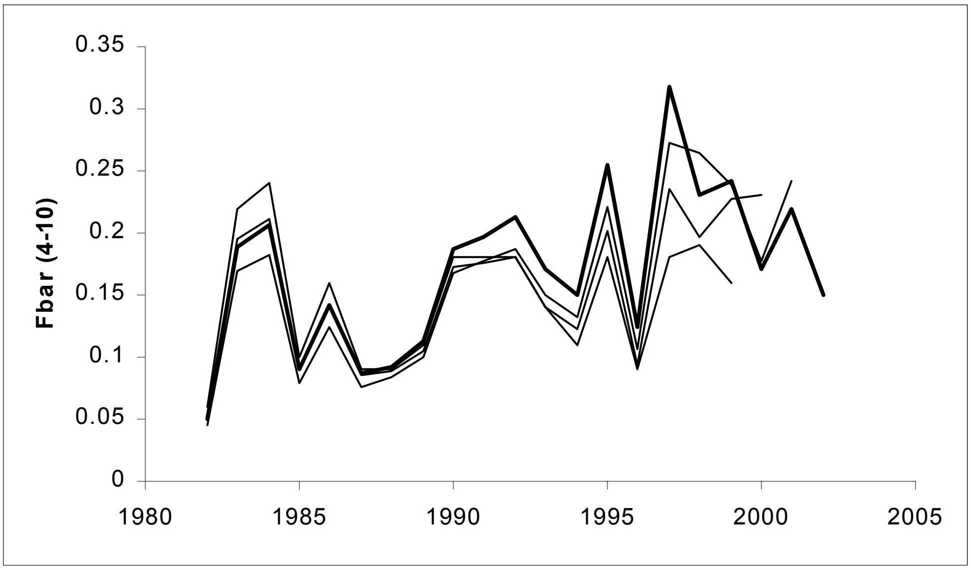


Figure 6.5.1.10 A comparison of the SAD model estimates of Fbar(4-10) from assessments carried out in 2000, 2001 and 2002 thin lines, and 2003 thick line.

Western horse mackerel

Figure 6.5.2.1 The stock summary plots for the western horse mackerel: landings; average fishing mortality ages 4 - 10 & 1 - 3; recruitment 1982 - 2001; total biomass; spawning stock biomass (SSB).

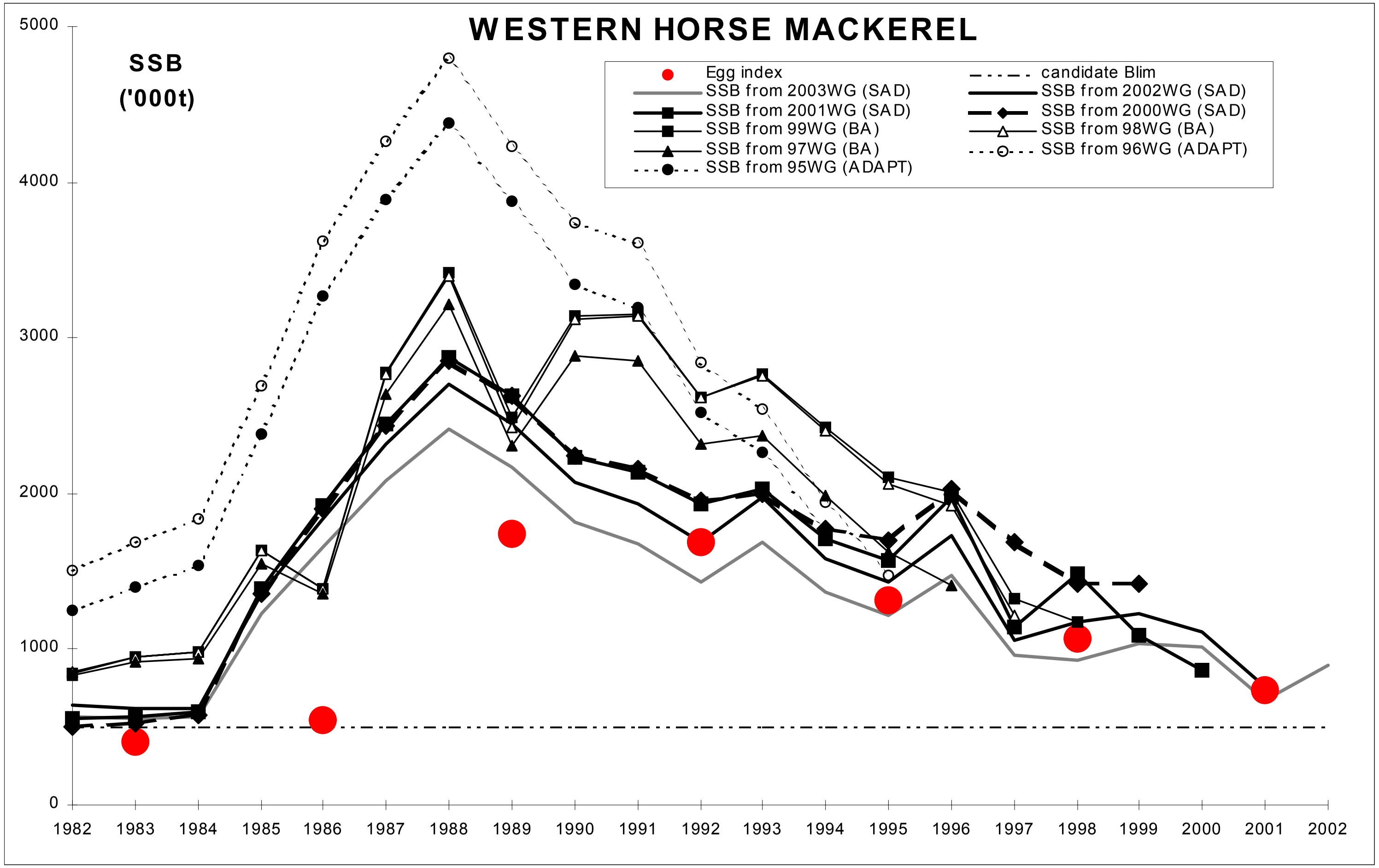


Figure 6.5.3.1 Comparison of SSB estimates as calculated at different ICES Working Group meetings. Biomass estimates of the egg surveys in 1983, 1986, 1989, 1992, 1995, 1998 and 2001 are also shown. Three different types of assessment have been carried out: 1. ADAPT assessments in 1995 and 1996; 2. BAYESIAN assessments in 1997-1999; 3. SAD assessment in 2000-2003. Egg indices shown have been scaled to incorparate the estimate of catchability from this year's final assessment (4-year separable run).

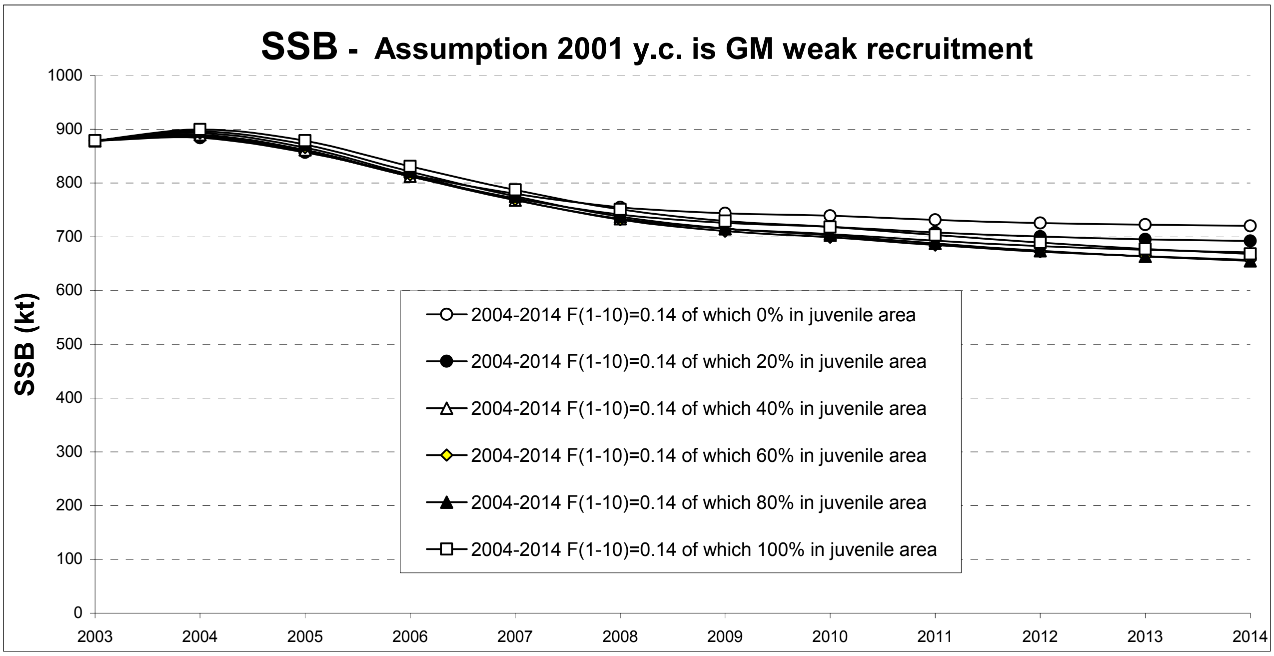


Figure 6.6.1 Medium-term predictions showing the changes in SSB over a period of 11 years based on the following scenario:
In 2003 Fsq = F0.1 = 0.14
In 2004-2014 Total F(1-10) = Fsq = F0.1 = 0.14 of wich 0%, 40%, 60%, 80% or 100% in juvenile area.
60% of F(1-10) in the juvenile area corresponds to the current situation.

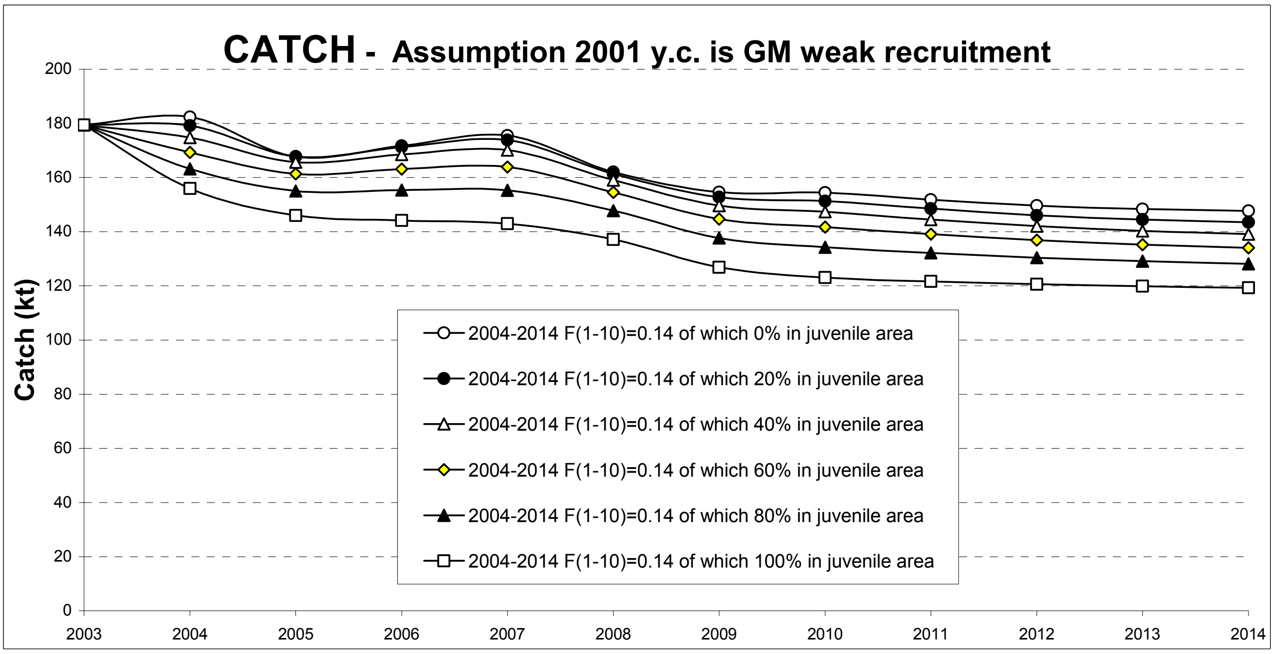


Figure 6.6.2 Medium-term predictions showing the changes in catch over a period of 11 years based on the following scenario:
In 2003 Fsq = F0.1 = 0.14
In 2004-2014 Total F(1-10) = Fsq = F0.1 = 0.14 of wich 0%, 40%, 60%, 80% or 100% in juvenile area.
60% of F(1-10) in the juvenile area corresponds to the current situation.

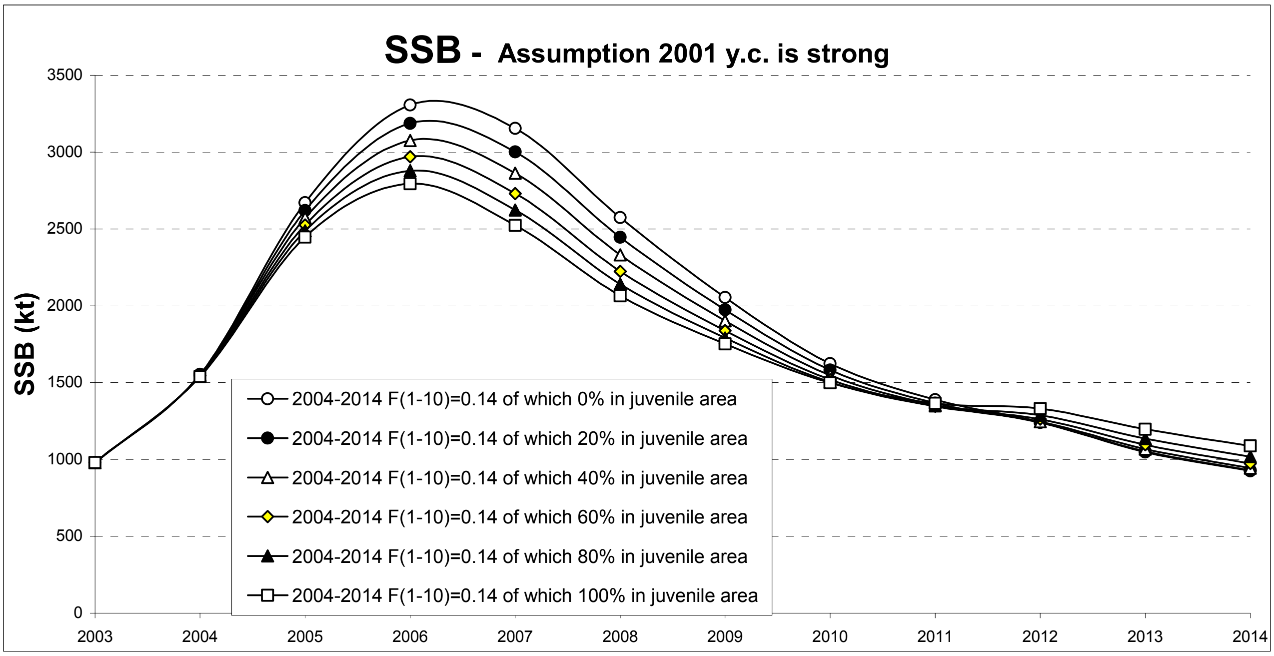


Figure 6.6.3 Medium-term predictions showing the changes in SSB over a period of 11 years based on the following scenario:
In 2003 Fsq = F0.1 = 0.14
In 2004-2014 Total F(1-10) = Fsq = F0.1 = 0.14 of wich 0%, 40%, 60%, 80% or 100% in juvenile area.
60% of F(1-10) in the juvenile area corresponds to the current situation.

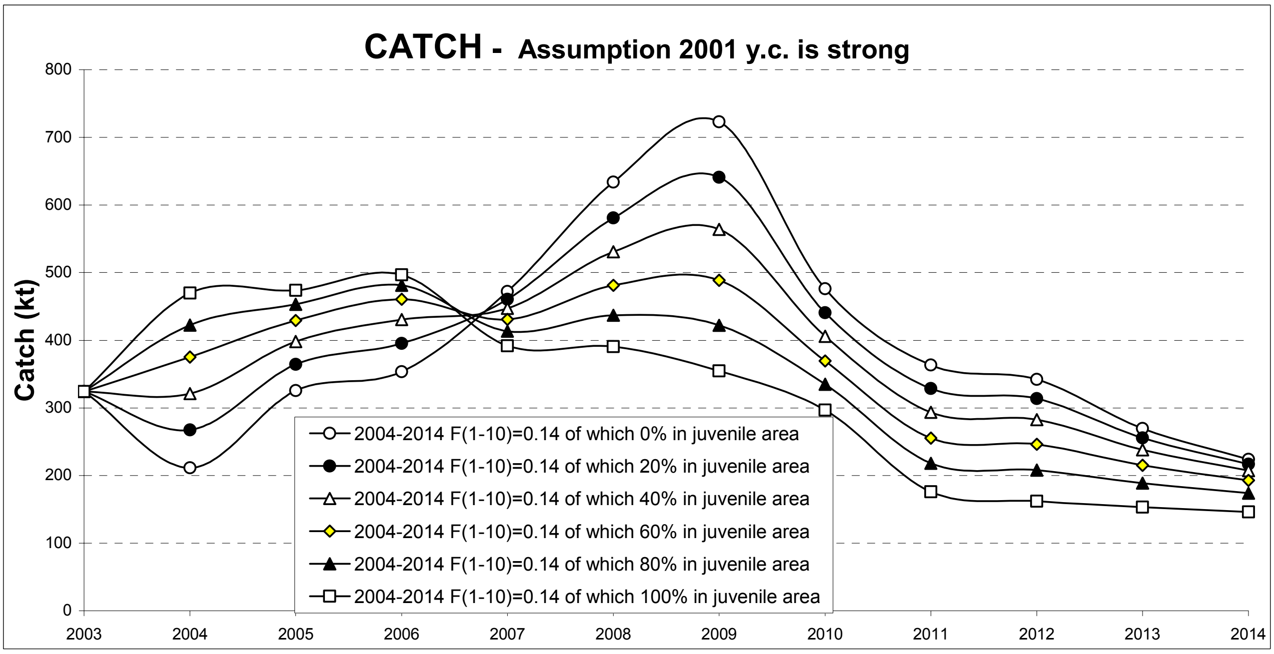


Figure 6.6.4 Medium-term predictions showing the changes in catch over a period of 11 years based on the following scenario:
In 2003 Fsq = F0.1 = 0.14
In 2004-2014 Total F(1-10) = Fsq = F0.1 = 0.14 of wich 0%, 40%, 60%, 80% or 100% in juvenile area.
60% of F(1-10) in the juvenile area corresponds to the current situation.

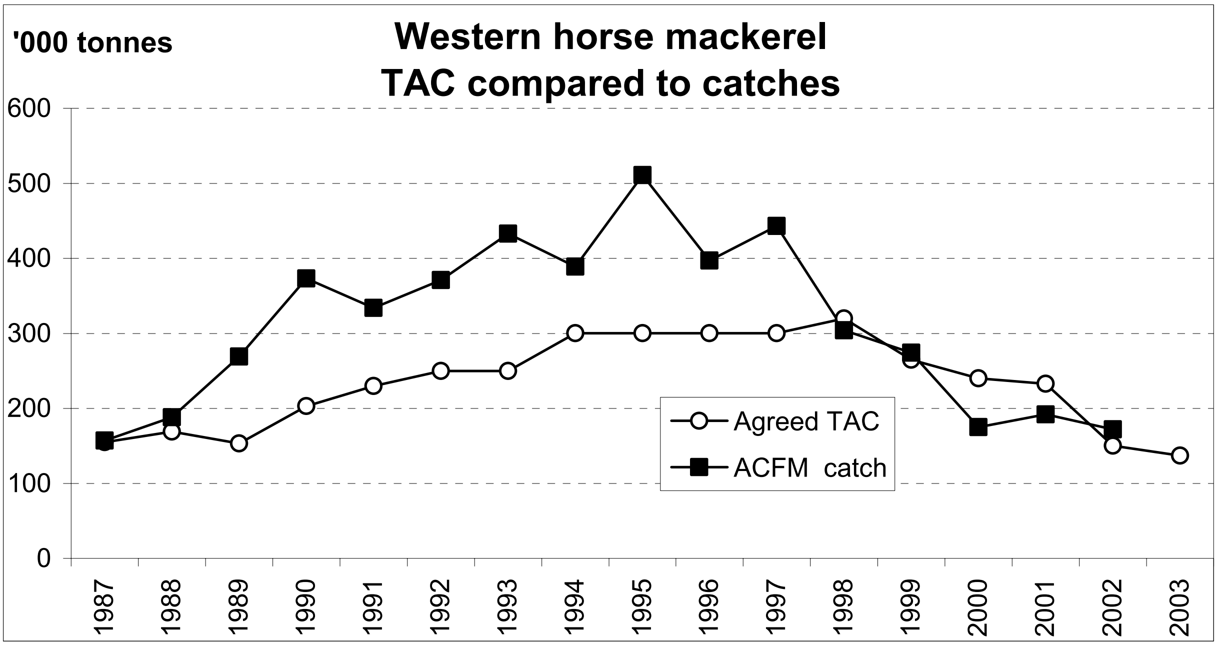


Figure 6.11.1 The agreed TAC for western horse mackerel compared to the actual catches.

7 SOUTHERN HORSE MACKEREL (DIVISIONS VIIIc AND IXa)

7.1 ICES advice Applicable to 2002 and 2003

ICES recommended that the catches in 2003 should not exceed the recent average of 49,000 t (1999-2001) and that the TAC for this stock should only apply to Trachurus trachurus. This recommendation implies a catch increase of 3,225 t as compared to 2002, whereas in the year before ICES recommended a catch decrease of 26% to less than 34,000 t :). The TAC for all Trachurus species was 73,000 t up to 1999, 68,000 t in 2000 and 2001, 57,500 t in 2002 and 55,200 t in 2003. In the last 17 years TAC was never reached.

7.2 The Fishery in 2002

Total catches from Divisions VIIIc and IXa were estimated by the Working Group to be 45,775 t in 2002 which are at the same level than the catches obtained in 2001. The catches from Subdivision IXa south in the part corresponding to the Spanish coast (Gulf of Cadiz) were available, and they have been included in the stock statistics for the first time. When comparing the catches without the Cadiz area, 2002 catches were 2.5% lower than those from 2001. From here on, all analysis exclude the Gulf of Cadiz, in order to make consistent comparisons with past years. The Cadiz catches will be included in the assessment when the whole historical series is available.

The level of catches for the southern stock is slightly below the mean level of catches obtained during the period 1990-2001: 51,759 t. The catch by country and gear is shown in Table 7.2.1 The catches by gear have been quite stable during the last three years, although there has been a significant reduction in Spanish purse seiners catches since 2000. The high level of Spanish catches reached on this stock during 1997, 1998 and 1999 was due to the increase in catches by the purse seiners. The fall in abundance of other target species, like sardine in the Spanish area, forced the purse seine fisheries to target alternative species like horse mackerel (ICES 1999a). The 2002 proportion of catches by gear presents a similar pattern to the 1997-2001 period, being the purse seine catches the most important ones in the Spanish area (60.3% of the catches) and the bottom-trawl catches in Portuguese waters (57 % of the catches).

In the Iberian Atlantic coast the catches of horse mackerel are relatively uniform over the year (Borges et al., 1995; Villamor et al., 1997), although the second and the third quarter show relatively higher catches (see Table 7.2.2). The "Prestige" oil spilled during the Autumn of 2002 lead to the establishment of temporal closed areas for fishing through almost the whole Galician coast. This probably had influence in the low value of the Spanish catches during the fourth quarter in 2002.

ICES officially reported catches are requested for "horse mackerel" whose designation includes all the species of the genus *Trachurus* in the area (T. *trachurus*, T. *mediterraneous* and T. *picturatus*), thus not only *Trachurus trachurus* L., which is the species at present moment under assessment by this Working Group. The reported catch therefore always has to be revised by the Working Group in order to eliminate species of horse mackerel other than T. trachurus (see Section 4.5).

7.3 Biological Data

7.3.1 Catch in numbers-at-age

The catch in numbers-at-age from all gears for 2002 are presented by quarter and area, and disaggregated by Subdivision: VIIIc East, VIIIc West, IXa North, IXa Central North, IXa Central South and IXa South (Table 7.3.1.1a and 7.3.1.1b). Table 7.3.1.2 present the catch in numbers by year. The 1982 year class is well represented in the catch in numbers-at-age matrix especially in Northern coasts of the Iberian Peninsula (Subdivisions Ixa North, VIIIc West and VIIIc East), but it has almost disappeared in the most recent years. The 1986 and 1987 year classes are strong, again specially in the Spanish areas, but do not reach the extremely high level of the 1982 year class. In general the catch in numbers are dominated by juveniles and young ages but in the Spanish areas the adults are much more abundant in the catches. The presence of 1991 to 1994 year classes is becoming much more notorious since 1998. In 2002 it is noticeable the catches on age 2 and on the very old ones (plus group).

The sampling scheme is believed to achieve a good coverage of the fishery. The number of fish aged seems also to be appropriate, with a total of 2,696 fish aged distributed by the 4 quarters. Catch in numbers-at-age have been obtained by applying a quarterly ALK to each of the catch length distribution estimated from the samples of each Subdivision. The sampling intensity is discussed in Section 1.3. The data before 1985 have not yet been revised according to the approved ageing methodology.

7.3.2 Mean length and mean weight-at-age

Tables 7.3.2.1a,b and 7.3.2.2a,b show the 2002 mean weights and mean lengths-at-age in the catch by quarter and Subdivision for the Spanish and Portuguese data. Table 7.3.2.3 presents the weight-at-age in the stock and in the catch. The old fishes in 2002 presented a very low mean weight-at-age value as it was found in 2000. The low quantity of big fishes in the catches taken in the period 2000-2002 (specimens greater than 35 cm), as compared with other years, could explain partially this fact. Constant mean weights-at-age in the stock have been used for the whole period based on data from 1985 to 1991. The matrix of mean weights-at-age in the stock was calculated in the following way: for each age, the mean weight in the catch in the fourth quarter of each year was averaged with the mean weight in the catch in the first quarter of the following year. Then, an overall average over the years was calculated for the final mean weight estimate for each age.

7.3.3 Maturity-at-age

The proportions of fish mature at each age (see text table below) have been considered to be constant over the assessment period. The maturity ogive used before to the 1992 assessment (ICES 1993/Assess:7) presented low estimates at the age range 5 to 8 due to lower availability of this range of fish on the catches (ICES 1993; ICES 1998a). As ACFM requested in 1992 the maturity ogive was smoothed as follows. New information on maturity ogives based on samples from Subdivisions VIIIc East, VIIIc West and IXa North was presented to the 1999 Working Group (ICES 2000a). The available data on maturity-at-age from divisions VIIIc and IXa must be analysed according the new evidence on stock structure described in section 4.2.1.

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

7.3.4 Natural mortality

According to the ageing methodology established in the ICES area (Eltink and Kuiper, 1989; ICES 1991c) the life span for the southern horse mackerel was considered to be longer than thought before (up to 40 years old). Therefore the natural mortality was revised (ICES 1992a), changing the previous level from 0.20 to the present 0.15.

7.3.5 Stock identity

New data obtained within EU funded project "HOMSIR" cast serious doubts on the current stock delimitation of horse mackerel. A more detailed explanation of those recent findings, and their implications for the definition of management units, is made in section 4.2.1.

7.4 Fishery Independent Information and CPUE Indices of Stock Size

7.4.1 Trawl surveys

There are three survey series: The Portuguese July survey, the Portuguese October survey and the Spanish October survey. The two October surveys covered Subdivisions VIIIc East, VIIIc West, IXa North (Spain) from 20-500 m depth and Subdivisions IXa Central North, Central South and South, in Portugal, from 20-750 m depth. The same sampling methodology was used in both surveys but there were differences in the gear design, as described in ICES (1991/G: 13). The Portuguese October and July survey indices and the Spanish September/October survey indices are estimated by strata for the range of distribution of horse mackerel in the area, which has been consistently sampled over the years. This corresponds to the 20-500 m strata boundaries. It was demonstrated that horse mackerel off the Portuguese shelf are stratified by length according to the depth and spawning time (ICES 1993a).

Indices from the Portuguese surveys were, until last year, based on a 48 strata in which fixed bottom trawl stations were allocated. This design led to a increase of the noise in the data because some strata were difficult to sample. A revision of those indices was carried out this year, using a new post-stratification design similar to the one used in the Spanish survey. Nine strata were defined according to depth and latitude, reflecting oceanographic and fish distribution features (Gomes et al., 2001). The new indices give a more coherent pattern and less noisy estimates of fish abundance. The gaps in the two Portuguese survey series correspond to times when surveys were carried out with a different vessel and gear (for which there is no conversion factor) or were not carried at all. In 2002 the haul duration in the bottom-trawl surveys was reduced from 1 hour (as used from 1990 to 2002) to 30 minutes. The catchability of horse mackerel in the Portuguese areas is significantly different in a non-linear way between hauls of 1 hour and 30 minutes (Murta et al, in prep.). Therefore, it is considered that a new tuning series has started in 2002, that should be analysed separately from the previous one

Table 7.4.1.1 indicates the catch rates from research vessel surveys in Kg per tow, for comparison with the total biomass trend. The Portuguese surveys show similar catch rates and variability in the data, showing the following mean and standard deviation in the time-series: 22.58 (±19.2) and 22.2 (±17.5) for July and October surveys respectively. The Spanish October survey biomass index shows a significant fall of 57.6% compared with the index obtained in 2001. The 2001 index had itself decrease steeply as compared with 2000. This series has less variability than the observed in the Portuguese series giving a mean yield of 20.6(±10.9). Table 7.4.1.2 shows the numbers-at-age from the October surveys and from the Portuguese July survey. The Spanish September/October survey and the Portuguese October survey are carried out during the fourth quarter when the recruits have entered the area. In the Spanish September/October surveys the high yields on intermediate ages (4 to 9 years old) have been characteristic during the recent years, from 1998 to 2000 (Table 7.4.1.2). In this survey the 1982 superabundant year class is the most conspicuous. In the Portuguese July survey there is a strong fall in the observed 1995 abundance indices comparing with those obtained in 1993. Since 1995 the indices are stable (except for the groups 0 and 1 which present high variability). In this survey, in 2000 and 2001, there is also an increase in the strength of the intermediate ages (5 to 8) as compared with the indices obtained since 1995.

7.4.2 Egg surveys

See section 4.7.

7.5 Effort and Catch per Unit Effort

About 40% of the total horse mackerel catch in Dvision VIIIc and Subdivision Ixa is taken with bottom trawlers. Therefore commercial bottom trawl fleets CPUE have been used to tune previous assessments. Data available are from two commercial fleets in the Spanish coasts: A Coruña bottom trawl fleet (Subdivision VIIIc West) and Avilés trawl fleet (Subdivision VIIIc East). In 1998 there was no effort data from A Coruña bottom trawl fleet, and since 1994 catch and effort information from the Avilés trawl fleet has not been supplied by the local fishermen association. Therefore, data from those years are just estimates that can not be used for assessment tuning.

Table 7.5.1 presents the commercial catch rates from the trawl fleet fishing in Subdivisions IXa Central North, IXa Central South and South (Portugal) from 1979 to 1990 and trawl fleets from Spain fishing in Subdivision VIIIc West (A Coruña) and in Subdivision VIIIc East (Avilés) from 1983 to 2002. In 2002 the A Coruña trawl fleet shows an increase of 6.4% in catch rates as compared with the values obtained in 2001. Figure 7.5.1 shows that a 27% decrease in effort of the A Coruña bottom trawl fleet when compared to 2001.

CPUE at age from the Galician (A Coruña) bottom trawl fleet (Table 7.5.2) shows that since 1997, the catch rates of juveniles (up to age 3) are at a low level. Since 1999, in that fleet, the indeces of intermediate ages (5 to 12) have increased. In 2002 that fleet showed a very high catch rate on the plus grup, being the highest rate in A Coruña trawl fleet both in the historical series of the plus group and in the whole age range for the year 2002.

Horse mackerel trawl catch rates from the Portuguese trawl fleet fishing in Division IXa are not available since 1991, and those available must be revised. A considerable amount of work is needed to explore the possibility of obtaining those indices in a reliable way. It is expected that this work can be carried out in a near future.

7.6 Data exploration

The assessment of this stock has always presented problems regarding the coherence of tuning series. This incoherence, which has been pointed out in previous reports, results in very different perceptions of the state of the stock dependent on tuning index used in exploratory XSA runs. Figures 7.6.1, 7.6.2 and 7.6.3 describe clearly the differences in catch and tuning data structure between the Portuguese and Spanish areas. From those figures the main features are:

-Tuning data from Spanish waters show similar patterns to the catch data from that area, with well defined year classes.

-The tuning series from Portuguese the area are typically more noisy, with visible year effects, as are the catch data from that area.

-Strong year classes or strong recruitment years are not always coincide between the Spanish and Portuguese areas.

-Following the trajectories of the year classes in the tuning data (Figure 7.6.3), the abundance of many cohorts seems to increase in time, especially in the data from the two Spanish commercial bottom-trawl fleets. This probably indicates the occurrence of migrations around or in-and-out of the area.

-The fact that bottom-trawl surveys show great differences between areas, reflecting to a certain extent the catch matrices from each area, suggests that the differing catch composition between areas is not fully explained just by the dynamics of the fishing fleets.

These differences in the data between areas suggest that the bulk of the catches from the Spanish and Portuguese areas may come from different stocks, being in close agreement with the results obtained by the EU funded project "HOMSIR" (see section 4.2.1). According to those results, the horse mackerel in ICES division VIIIc may probably be related to northern populations, while the fish from division IXa may be connected to a North African population. This latter hypothesis would explain the strong year effects in the data from the Portuguese area.

7.7 State of the stock

Given the new evidence regarding population structure of horse mackerel in Iberian waters, the reallocation of assessment data according to newly defined stock boundaries should be done, before meaningful assessments can be carried out. It was not possible to complete this task in time for the current working group meeting, therefore, this working group recommends that this data reallocation be done in time for next year's assessment. The HOMSIR project was unable to clarify the possible connection between fish from division IXa and North African horse mackerel, because a single North African sample was collected too much to the South, off the Mauritanian coast (see section 4.2.1). It is recommended that fish from Moroccan waters be sampled in the next spawning season, in order to test this hypothesis, and analysed using techniques that proved to be useful in the HOMSIR project.

Stock assessments carried out in the past always pointed out a stable exploitation pattern at a moderate level for the then called "southern stock". Although new evidence on stock identity makes those results unreliable, there are features in the assessment data that suggest that the former perception of the state of the stock may reflect the real trends in the Atlantic Iberian horse mackerel populations. Catches are at a stable level since 1987, and effort is likely to have been reduced due to the EU common fisheries policy. Moreover, recruitment strength seems to fluctuate around a level that looks stable over the whole assessment period. Therefore, the horse mackerel in Iberian Atlantic waters does not present any consistent signs of depletion.

7.8 Management considerations

The horse mackerel catches look stable for the last 20 years, at a seemingly sustainable level. Therefore, for the next year, while a reliable assessment is not available, this working group recommends that the current TAC of 55200 t should be maintained.

Table 7.2.1. Annual catches (tonnes) of SOUTHERN HORSE MACKEREL by countries by gear in Divisions VIIIc and IXa. Data from 1984-2002 are Working Group estimates.

Year	Portugal (Division IXa)				Spain (Divisions IXa + VIIIc)					Total VIIIc+IXa
	Trawl	Seine	Artisanal	Total	Trawl	Seine	Hook	Gillnet	Total	
1963	6,593	54,267	3,900	64,760	-	-	-	-	53,420	118,180
1964	8,983	55,693	4,100	68,776	-	-	-	-	57,365	126,141
1965	4,033	54,327	4,745	63,105	-	-	-	-	52,282	115,387
1966	5,582	44,725	7,118	57,425	-	-	-	-	47,000	104,425
1967	6,726	52,643	7,279	66,648	-	-	-	-	53,351	119,999
1968	11,427	61,985	7,252	80,664	-	-	-	-	62,326	142,990
1969	19,839	36,373	6,275	62,487	-	-	-	-	85,781	148,268
1970	32,475	29,392	7,079	59,946	-	-	-	-	98,418	158,364
1971	32,309	19,050	6,108	57,467	-	-	-	-	75,349	132,816
1972	45,452	28,515	7,066	81,033	-	-	-	-	82,247	163,280
1973	28,354	10,737	6,406	45,497	-	-	-	-	114,878	160,375
1974	29,916	14,962	3,227	48,105	-	-	-	-	78,105	126,210
1975	26,786	10,149	9,486	46,421	-	-	-	-	85,688	132,109
1976	26,850	16,833	7,805	51,488	89,197	26,291	376[1]	-	115,864	167,352
1977	26,441	16,847	7,790	51,078	74,469	31,431	376[1]	-	106,276	157,354
1978	23,411	4,561	4,071	32,043	80,121	14,945	376[1]	-	95,442	127,485
1979	19,331	2,906	4,680	26,917	48,518	7,428	376[1]	-	56,322	83,239
1980	14,646	4,575	6,003	25,224	36,489	8,948	376[1]	-	45,813	71,037
1981	11,917	5,194	6,642	23,733	28,776	19,330	376[1]	-	48,482	72,235
1982	12,676	9,906	8,304	30,886	-[2]	-[2]	-[2]	-	28,450	59,336
1983	16,768	6,442	7,741	30,951	8,511	34,054	797	-	43,362	74,313
1984	8,603	3,732	4,972	17,307	12,772	15,334	884	-	28,990	46,297
1985	3,579	2,143	3,698	9,420	16,612	16,555	949	-	34,109	43,529
1986	-[2]	-[2]	-[2]	28,526	9,464	32,878	481	143	42,967	71,493
1987	11,457	6,744	3,244	21,445	-[2]	-[2]	-[2]	-[2]	33,193	54,648
1988	11,621	9,067	4,941	25,629	-[2]	-[2]	-[2]	-[2]	30,763	56,392
1989	12,517	8,203	4,511	25,231	-[2]	-[2]	-[2]	-[2]	31,170	56,401
1990	10,060	5,985	3,913	19,958	10,876	17,951	262	158	29,247	49,205
1991	9,437	5,003	3,056	17,497	9,681	18,019	187	127	28,014	45,511
1992	12,189	7,027	3,438	22,654	11,146	16,972	81	103	28,302	50,956
1993	14,706	4,679	6,363	25,747	14,506	16,897	124	154	31,681	57,428
1994	10,494	5,366	3,201	19,061	10,864	22,382	145	136	33,527	52,588
1995	12,620	2,945	2,133	17,698	11,589	23,125	162	107	34,983	52,681
1996	7,583	2,085	4,385	14,053	10,360	19,917	214	146	30,637	44,690
1997	9,446	5,332	1,958	16,736	8,140	31,582	169	143	40,034	56,770
1998	13,221	5,906	2,217	21,334	13,150	29,805	63	118	43,136	64,480
1999	6,866	5,705	1,849	14,420	10,015	27,332	29	126	37,502	51,922
2000	7,971	4,209	2,168	15,348	10,144	23,373	59	214	33,790	49,138
2001	7,692	4,787	831	13,760	11,222	20,122	45	590	31,979	45,739
2002[3]	8,136	4,261	1,873	14,270	12,211	18,984	106	204	31,505	45,775

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

[3] Including for the first time in the series the catches (1,157 tonnes) from the Gulf of Cadiz (south of Spain).

Table 7.2.2 Southern horse mackerel catches by quarter, and c Including for the first time in the series the catches (1,157 tonnes) from the Gulf of Cadiz (south of Spain) country.

Country/Subdivision	Spain VIIIc-E, VIIIc-W, IXa-N, IXa-S		Unit:tonnes		Total
Quarter/ Year	1	2	3	4	
1984	-	-	-	-	28990
1985	-	-	-	-	34109
1986	-	-	-	-	42967
1987	5179	8678	11067	8269	33193
1988	6445	7936	7918	8464	30763
1989	7824	7480	8011	7855	31170
1990	6827	7871	7766	6783	29247
1991	5369	7220	8741	6686	28016
1992	4065	8750	10042	5445	28302
1993	5546	9227	9823	7085	31681
1994	6486	8966	9732	8343	33527
1995	6050	10328	10969	7636	34983
1996	7188	8045	8211	7193	30637
1997	6638	11132	13854	8410	40034
1998	8244	10696	13089	11107	43135
1999	7715	9589	12027	8170	37502
2000	7405	8694	11012	6679	33790
2001	5682	8481	9179	8637	31979
2002[1]	6543	9126	10439	5397	31505

Country/ Subdivision	Portugal IXa-CN, IXa-CS, IXa-S		Unit:tonnes		Total
Quarter/Year	1	2	3	4	
1984	4669	6506	3577	2358	17110
1985	1226	3055	2946	2192	9419
1986	4627	8093	7542	8264	28526
1987	3902	5474	6654	3524	19554
1988	3069	7402	7554	7100	25125
1989	4074	9096	8543	3513	25226
1990	3341	5753	5873	4992	19959
1991	3101	5630	5094	3672	17497
1992	2516	5661	7196	7281	22654
1993	5455	6401	8384	5507	25747
1994	4418	5051	6386	3206	19061
1995	3240	4618	6038	3802	17698
1996	2649	3830	4068	3506	14053
1997	4449	5370	4218	2699	16736
1998	5498	5846	6005	3995	21344
1999	3479	3991	4023	2927	14420
2000	3000	4849	4258	2241	14348
2001	2294	3666	3787	4013	13760
2002	3109	3895	4375	2891	14270

[1] Including for the first time in the series the catches (1,157 tonnes) from the Gulf of Cadiz (south of Spain, IXa south).

Table 7.3.1.1a Southern horse mackerel catch in numbers-at-age (in thousands) by quarter and area in 2002

QUARTER 1 AREA

AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	312.560	5253.038	24498.845	3250.431	37815.982	1418.276	72236.572
2	7391.661	10722.627	19743.751	4867.879	2715.067	286.742	38336.066
3	816.650	916.928	844.582	1565.154	1067.024	485.460	4879.148
4	144.849	1401.566	690.662	604.884	657.363	867.997	4222.472
5	120.733	862.286	413.663	115.061	189.438	989.146	2569.594
6	64.904	324.904	336.502	216.837	205.542	692.459	1776.245
7	106.682	308.163	822.987	216.323	285.991	705.180	2338.643
8	45.254	140.323	444.388	811.191	904.341	3439.724	5739.967
9	12.594	68.528	248.279	1004.855	1046.440	2066.698	4434.800
10	1.721	18.596	72.977	750.522	963.541	700.801	2506.437
11	0.886	11.746	48.588	708.212	1002.996	374.877	2146.419
12	0.106	15.273	40.513	245.474	379.147	92.022	772.429
13	0.048	13.593	32.193	379.472	656.918	77.857	1160.033
14	0.000	5.301	14.513	254.983	412.750	48.150	735.698
15+	0.000	12.696	16.216	1168.940	1316.166	413.834	2927.852
Total	9018.645	20075.568	48268.659	16160.219	49618.707	12659.223	146782.376

QUARTER 2	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1374.400	470.503	2190.187	4596.468	17122.904	34989.941	59370.005
2	3681.693	3020.220	34083.297	6279.629	9328.636	14757.732	67469.513
3	2974.521	2187.480	2618.059	162.415	2090.121	812.803	7870.879
4	351.525	1614.174	251.331	34.887	723.139	856.033	3479.565
5	351.132	1846.859	238.646	73.004	340.424	1109.082	3608.015
6	438.827	1339.157	589.784	261.313	322.960	811.545	3324.759
7	254.571	676.353	762.001	251.998	413.869	796.262	2900.483
8	124.031	429.574	509.764	1047.626	1440.550	4046.234	7473.748
9	118.593	455.037	494.133	1305.338	1714.104	2381.438	6350.050
10	68.982	223.677	214.573	816.844	1545.079	846.881	3647.053
11	43.021	112.264	110.510	800.267	1671.802	462.278	3157.120
12	41.277	66.488	52.361	252.902	589.756	121.404	1082.910
13	39.396	63.299	54.708	454.666	1032.094	96.886	1701.653
14	38.946	54.122	47.138	252.624	588.358	76.827	1019.067
15+	16.250	19.125	15.941	1188.720	2170.637	522.108	3916.531
Total	9917.165	12578.332	42232.434	17778.700	41094.433	62687.453	176371.351

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	1606.723	0.000	289.264	74.171	21.320	636.208	1020.963
1	12519.366	236.159	1956.538	4232.657	1502.632	14499.789	22427.775
2	4228.601	5537.979	5427.079	2151.061	100.800	5005.339	18222.258
3	1335.119	3264.088	2563.427	1725.725	406.346	371.156	8330.741
4	212.143	1432.586	1162.133	795.462	945.431	490.989	4826.601
5	346.189	1469.437	1276.871	291.121	502.120	436.729	3976.277
6	406.509	952.863	1270.850	435.255	729.242	803.479	4191.688
7	513.609	763.829	1421.686	1393.479	2489.918	2418.996	8487.909
8	585.471	559.027	1262.858	1979.766	3625.332	3641.223	11068.206
9	296.068	234.733	594.969	1599.126	1856.577	2856.401	7141.806
10	85.846	72.251	227.981	1501.726	846.153	1669.366	4317.478
11	57.024	47.496	182.013	1188.878	689.741	1383.704	3491.833
12	8.208	6.330	55.521	468.758	344.274	518.513	1393.396
13	6.194	4.168	41.377	574.584	472.747	537.789	1630.665
14	6.732	4.227	54.182	409.906	337.531	382.225	1188.070
15	53.801	36.596	36.308	1089.225	976.077	1112.003	3250.209
Total	22267.603	14621.770	17823.058	19910.900	15846.241	36763.907	104965.875

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	863.692	632.354	1947.475	154.144	343.128	12566.907	15644.007
1	4370.109	343.336	1504.016	2286.312	9594.587	14546.608	28274.859
2	8852.208	2878.031	4477.818	723.053	4362.729	1261.907	13703.538
3	1893.602	4026.239	2075.669	246.606	611.011	860.717	7820.243
4	1128.831	1963.176	535.968	418.338	738.663	1174.199	4830.344
5	586.349	696.606	392.981	173.631	320.619	394.348	1978.185
6	309.662	275.739	506.935	324.394	364.484	290.681	1762.233
7	110.165	160.414	579.841	1054.679	1306.751	1071.089	4172.773
8	48.333	83.680	309.879	1398.145	1759.613	1373.461	4924.778
9	19.758	42.851	139.957	761.871	807.182	643.509	2395.370
10	4.230	13.193	37.792	509.715	415.201	192.966	1168.866
11	2.621	13.323	40.127	397.850	346.845	150.132	948.277
12	0.578	5.557	18.679	138.937	186.703	49.443	399.319
13	0.090	1.695	7.779	195.765	253.455	64.529	523.222
14	0.000	0.000	2.061	116.946	186.599	38.260	343.865
15	0.000	0.000	0.709	289.130	565.239	72.959	928.037
Total	18190.229	11136.194	12577.686	9189.516	22162.808	34751.712	89817.916

Table 7.3.1.1b Total catch in numbers-at-age (in thousands) in 2002

TOTAL YEAR	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	2470.415	632.354	2236.739	228.314	364.448	13203.115	**19135.385**
1	18576.436	6303.037	30149.586	14365.868	66036.105	65454.615	**200885.647**
2	24154.162	22158.856	63731.946	14021.622	16507.232	21311.719	**161885.537**
3	7019.892	10394.735	8101.738	3699.900	4174.502	2530.136	**35920.903**
4	1837.347	6411.502	2640.094	1853.571	3064.596	3389.217	**19196.329**
5	1404.403	4875.187	2322.161	652.817	1352.601	2929.305	**13536.474**
6	1219.902	2892.663	2704.071	1237.799	1622.228	2598.164	**12274.828**
7	985.027	1908.759	3586.515	2916.479	4496.529	4991.526	**18884.834**
8	803.089	1212.604	2526.890	5236.728	7729.837	12500.641	**30009.788**
9	447.013	801.149	1477.338	4671.191	5424.303	7948.045	**20769.039**
10	160.780	327.717	553.323	3578.807	3769.974	3410.013	**11800.614**
11	103.552	184.829	381.239	3095.207	3711.383	2370.991	**9847.200**
12	50.168	93.648	167.073	1106.071	1499.881	781.382	**3698.222**
13	45.728	82.755	136.057	1604.487	2415.214	777.060	**5061.301**
14	45.678	63.650	117.893	1034.459	1525.238	545.461	**3332.379**
15	70.051	68.416	69.175	3736.016	5028.119	2120.904	**11092.680**
Total	**59393.642**	**58411.864**	**120901.836**	**63039.335**	**128722.189**	**146862.295**	**577331.160**

Table 7.3.1.2 Southern horse mackerel. Catch in numbers-at-age by year (in thousands)

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	393697	297486	84887	79849	26197	14665	7075	7363	3981	6270	4614	3214	2702	1699	864	4334
1986	615298	425659	96999	64701	122560	27584	13610	24346	12080	6694	8198	6349	5838	3244	2023	2963
1987	53320	618570	170015	66303	28789	81020	21825	10485	5042	3795	2337	1999	1666	951	1029	1906
1988	121951	271052	94945	39364	22598	20507	92897	17212	11669	10279	7042	4523	6050	2514	1379	3717
1989	242537	158646	70438	93590	37363	25474	22839	52657	11308	14892	11182	2728	2243	4266	1456	3791
1990	48100	164206	100833	60289	35931	14307	11786	12913	76713	9463	6562	3481	2568	2017	2430	4409
1991	31786	69544	71451	24222	33833	28678	13952	14578	11948	64501	8641	5671	3933	1970	2113	2164
1992	45629	285197	107761	51971	21596	23308	24973	14167	11384	12496	52251	4989	4043	2480	1815	4045
1993	10719	101326	262637	95182	35647	23159	22311	35258	11881	15094	5813	36062	1653	879	823	2304
1994	9435	113345	264744	93214	23624	11374	18612	22740	26587	8207	5142	2546	10266	1291	1001	1210
1995	3512	161142	124731	93349	47507	15997	11235	13608	19931	16763	8550	5664	4846	11717	2367	2809
1996	38345	35453	57096	41157	53002	27873	11580	11378	8384	19061	14339	6302	5896	3923	9571	4317
1997	8553	376888	157423	58132	34944	22297	11403	11704	17014	9206	19672	13436	4009	2045	906	7297
1998	15247	247786	149900	88318	45496	30161	32271	27189	15454	8733	7280	7682	6901	3238	3310	10426
1999	51940	120035	65577	80854	85370	37711	24491	20852	18187	10835	6802	3655	2879	1046	728	3182
2000	12652	86609	45129	48398	39134	34836	50409	40822	23393	13036	5664	6756	4147	3273	3781	4764
2001	168757	123524	66922	28901	22525	20849	19115	39586	24503	13120	11465	6870	3669	1923	2509	2347
2002	19135	200886	161886	35921	19196	13536	12275	18885	30010	20769	11801	9847	3698	5061	3332	11093

Table 7.3.2.1a Southern horse mackerel mean weight-at-age (in kg) by quarter and area in 2002

QUARTER 1 AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.025	0.024	0.023	0.032	0.017	0.017	0.020
2	0.040	0.033	0.032	0.038	0.026	0.039	0.040
3	0.056	0.074	0.070	0.082	0.085	0.078	0.088
4	0.097	0.097	0.091	0.103	0.106	0.125	0.107
5	0.120	0.116	0.120	0.135	0.129	0.136	0.132
6	0.140	0.134	0.148	0.203	0.204	0.161	0.169
7	0.159	0.156	0.163	0.208	0.217	0.158	0.178
8	0.172	0.172	0.182	0.199	0.210	0.158	0.175
9	0.216	0.228	0.228	0.222	0.236	0.175	0.204
10	0.243	0.265	0.267	0.233	0.246	0.190	0.227
11	0.261	0.287	0.289	0.249	0.270	0.206	0.253
12	0.276	0.350	0.334	0.253	0.263	0.216	0.260
13	0.290	0.382	0.357	0.293	0.304	0.244	0.299
14	0.000	0.352	0.344	0.257	0.261	0.248	0.261
15	0.000	0.429	0.435	0.282	0.268	0.225	0.269
Total	0.046	0.047	0.036	0.117	0.054	0.142	0.065

(AREA)

QUARTER 2	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.018	0.005	0.023	0.032	0.022	0.024	0.024
2	0.042	0.046	0.035	0.036	0.039	0.029	0.037
3	0.058	0.058	0.051	0.059	0.068	0.068	0.081
4	0.088	0.096	0.087	0.161	0.110	0.128	0.116
5	0.123	0.118	0.128	0.161	0.127	0.137	0.138
6	0.141	0.138	0.148	0.199	0.203	0.160	0.175
7	0.162	0.164	0.166	0.206	0.218	0.158	0.189
8	0.183	0.188	0.188	0.198	0.216	0.157	0.181
9	0.231	0.223	0.218	0.220	0.234	0.175	0.211
10	0.277	0.251	0.245	0.229	0.244	0.194	0.235
11	0.295	0.257	0.244	0.253	0.269	0.212	0.259
12	0.336	0.321	0.316	0.252	0.262	0.223	0.274
13	0.324	0.315	0.314	0.301	0.304	0.236	0.308
14	0.349	0.341	0.334	0.258	0.262	0.246	0.280
15	0.395	0.389	0.389	0.278	0.273	0.225	0.271
Total	0.067	0.101	0.047	0.112	0.095	0.053	0.074

QUARTER 3	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.017	0.000	0.016	0.038	0.039	0.031	0.054
1	0.030	0.053	0.030	0.050	0.031	0.039	0.057
2	0.055	0.060	0.056	0.062	0.053	0.048	0.068
3	0.070	0.073	0.072	0.080	0.120	0.097	0.089
4	0.099	0.100	0.100	0.102	0.125	0.120	0.112
5	0.128	0.124	0.126	0.159	0.137	0.166	0.145
6	0.153	0.143	0.150	0.191	0.160	0.188	0.177
7	0.171	0.161	0.165	0.187	0.158	0.181	0.181
8	0.192	0.185	0.188	0.206	0.167	0.184	0.193
9	0.214	0.214	0.217	0.226	0.189	0.200	0.214
10	0.243	0.245	0.250	0.254	0.235	0.230	0.245
11	0.247	0.249	0.264	0.252	0.246	0.233	0.248
12	0.322	0.317	0.318	0.264	0.340	0.243	0.279
13	0.332	0.331	0.343	0.276	0.276	0.246	0.269
14	0.333	0.331	0.348	0.286	0.338	0.256	0.296
15	0.664	0.667	0.402	0.276	0.384	0.263	0.321
Total	0.054	0.094	0.101	0.156	0.181	0.114	0.138

QUARTER 4	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.037	0.027	0.031	0.030	0.028	0.017	0.022
1	0.044	0.043	0.042	0.039	0.044	0.030	0.043
2	0.050	0.062	0.057	0.050	0.050	0.058	0.088
3	0.072	0.080	0.072	0.106	0.105	0.102	0.101
4	0.104	0.091	0.092	0.124	0.121	0.111	0.128
5	0.115	0.111	0.134	0.156	0.131	0.126	0.160
6	0.134	0.142	0.155	0.166	0.157	0.154	0.179
7	0.171	0.172	0.174	0.164	0.153	0.149	0.163
8	0.199	0.203	0.201	0.171	0.164	0.154	0.168
9	0.213	0.223	0.220	0.198	0.192	0.172	0.193
10	0.237	0.247	0.250	0.236	0.245	0.198	0.234
11	0.263	0.272	0.278	0.234	0.255	0.203	0.240
12	0.278	0.294	0.301	0.252	0.359	0.216	0.301
13	0.299	0.313	0.331	0.246	0.288	0.201	0.262
14	0.000	0.000	0.418	0.274	0.354	0.227	0.313
15	0.000	0.000	0.513	0.265	0.394	0.255	0.343
Total	0.059	0.080	0.074	0.137	0.098	0.047	0.089

Table 7.3.2.1b Total mean weight-at-age (in kg) in 2002

TOTAL YEAR	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.024	0.027	0.029	0.033	0.028	0.018	**0.021**
1	0.033	0.025	0.025	0.038	0.022	0.028	**0.027**
2	0.047	0.045	0.037	0.041	0.040	0.036	**0.040**
3	0.064	0.073	0.065	0.082	0.083	0.086	**0.072**
4	0.100	0.096	0.095	0.109	0.116	0.120	**0.105**
5	0.121	0.119	0.127	0.154	0.132	0.139	**0.128**
6	0.143	0.139	0.150	0.188	0.174	0.168	**0.158**
7	0.167	0.162	0.166	0.182	0.166	0.167	**0.168**
8	0.190	0.186	0.189	0.194	0.180	0.165	**0.177**
9	0.218	0.221	0.220	0.219	0.213	0.184	**0.204**
10	0.257	0.250	0.250	0.241	0.242	0.211	**0.234**
11	0.267	0.258	0.263	0.249	0.264	0.223	**0.249**
12	0.333	0.324	0.319	0.257	0.292	0.235	**0.272**
13	0.325	0.327	0.334	0.283	0.297	0.241	**0.286**
14	0.347	0.341	0.343	0.270	0.290	0.252	**0.281**
15	0.000	0.000	0.408	0.278	0.307	0.246	**0.289**
Total	**0.056**	**0.076**	**0.053**	**0.131**	**0.090**	**0.075**	**0.078**

Table 7.3.2.2.a Southern horse mackerel mean length-at-age (in cm) by quarter and area in 2002

QUARTER 1 AREA

AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	14.1	14.0	13.7	15.5	12.1	12.4	13.0
2	16.6	15.5	15.3	16.3	14.3	16.4	18.6
3	18.7	20.5	20.1	21.4	21.8	21.0	24.2
4	22.6	22.6	22.1	23.2	23.4	24.8	24.0
5	24.3	24.1	24.3	25.6	25.2	25.6	26.0
6	25.6	25.3	26.1	29.4	29.4	27.2	28.1
7	26.8	26.7	27.0	29.6	30.0	26.9	28.8
8	27.5	27.5	28.1	29.2	29.6	27.0	28.0
9	29.8	30.3	30.3	30.3	30.9	28.0	29.4
10	31.0	31.9	32.0	30.9	31.5	28.8	30.6
11	31.8	32.8	32.9	31.6	32.5	29.6	31.7
12	32.5	35.2	34.6	31.8	32.3	30.1	32.1
13	33.0	36.2	35.4	33.4	33.9	31.4	33.7
14	0.0	35.3	35.0	32.0	32.2	31.7	32.2
15	0.0	37.7	37.8	32.9	32.4	30.4	32.4
Total	17.2	16.7	15.3	22.3	15.4	25.1	18.2

QUARTER 2

AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	12.6	8.1	13.7	15.4	13.5	13.9	14.1
2	16.8	17.4	15.8	16.1	16.5	14.9	16.7
3	18.9	18.9	18.1	19.2	20.0	20.1	26.2
4	21.8	22.5	21.8	27.2	23.8	25.1	25.6
5	24.5	24.2	24.9	27.2	25.0	25.7	27.2
6	25.7	25.5	26.2	29.2	29.4	27.1	30.1
7	27.0	27.1	27.2	29.5	30.0	27.0	30.1
8	28.1	28.4	28.4	29.1	29.9	26.9	28.5
9	30.4	30.1	29.8	30.2	30.8	28.0	30.1
10	32.3	31.3	31.1	30.7	31.4	29.0	31.3
11	32.9	31.5	30.9	31.7	32.5	29.9	32.3
12	34.6	34.1	33.9	31.8	32.2	30.4	33.4
13	34.2	33.9	33.9	33.8	33.9	31.1	34.5
14	35.1	34.8	34.6	32.1	32.3	31.6	33.7
15	36.6	36.4	36.4	32.7	32.6	30.5	32.5
Total	18.7	21.8	16.7	21.6	19.9	16.8	19.4

QUARTER 3

AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	11.8	0.0	11.7	16.4	16.5	14.9	32.7
1	14.6	17.6	14.5	17.9	15.2	16.5	24.6
2	18.1	18.7	18.3	19.3	18.3	17.8	22.6
3	19.7	20.0	20.0	21.2	24.5	22.7	23.8
4	22.5	22.5	22.5	23.1	24.9	24.5	24.3
5	24.6	24.4	24.5	26.9	25.6	27.3	27.2
6	26.2	25.6	26.0	28.7	27.1	28.6	29.4
7	27.3	26.7	27.0	28.4	27.0	28.2	29.2
8	28.5	28.0	28.2	29.4	27.4	28.4	29.7
9	29.6	29.6	29.7	30.5	28.6	29.2	30.6
10	31.0	31.1	31.3	31.8	30.8	30.7	31.8
11	31.1	31.2	31.9	31.7	31.2	30.9	31.8
12	34.2	34.0	34.1	32.2	34.9	31.3	32.8
13	34.7	34.6	35.0	32.7	32.3	31.4	32.3
14	34.7	34.6	35.2	33.1	35.0	31.8	33.5
15	44.2	44.3	37.0	32.7	36.5	32.2	34.6
Total	16.8	21.5	21.5	25.6	27.3	22.4	27.0

QUARTER 4

AGE	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	15.8	14.0	14.6	14.8	14.3	12.4	13.7
1	16.7	16.6	16.4	16.4	17.2	15.0	18.5
2	17.6	18.9	18.3	18.0	18.1	18.9	29.7
3	19.9	20.8	20.0	23.4	23.3	23.1	25.9
4	22.8	21.8	21.8	24.8	24.6	23.8	28.3
5	23.6	23.3	25.0	26.8	25.2	24.9	31.6
6	25.0	25.5	26.4	27.4	26.9	26.7	31.0
7	27.3	27.4	27.5	27.2	26.6	26.4	27.6
8	28.8	29.0	28.9	27.6	27.2	26.7	27.6
9	29.6	30.0	29.9	29.1	28.7	27.8	28.9
10	30.7	31.2	31.3	31.0	31.2	29.1	30.9
11	31.9	32.2	32.5	30.8	31.6	29.4	31.1
12	32.5	33.1	33.4	31.7	35.6	30.0	33.4
13	33.4	33.9	34.6	31.3	32.8	29.1	31.8
14	0.0	0.0	37.6	32.6	35.6	30.5	34.0
15	0.0	0.0	40.5	32.3	36.9	31.8	35.0
Total	18.3	20.5	19.4	24.3	21.2	16.2	22.9

Table 7.3.2.2b Total southern horse mackerel mean length-at-age (in cm) in 2002

TOTAL YEAR	IXaS	IXaCS	IXaCN	IXaN	VIIIcW	VIIIcE	Total
0	13.2	14.0	14.2	15.3	14.4	12.5	**12.9**
1	14.9	13.8	13.9	16.3	13.2	14.7	**14.2**
2	17.2	17.0	16.0	16.8	16.6	15.9	**16.4**
3	19.3	20.1	19.4	21.4	21.4	21.7	**20.2**
4	22.6	22.3	22.2	23.6	24.2	24.5	**23.1**
5	24.2	24.1	24.6	26.6	25.3	25.8	**24.8**
6	25.7	25.5	26.1	28.6	27.8	27.5	**26.7**
7	27.2	26.9	27.1	28.2	27.3	27.5	**27.4**
8	28.4	28.2	28.3	28.8	28.1	27.3	**27.9**
9	29.8	29.9	29.9	30.1	29.8	28.4	**29.3**
10	31.6	31.3	31.3	31.2	31.3	29.8	**30.8**
11	31.9	31.5	31.8	31.6	32.2	30.4	**31.5**
12	34.5	34.2	34.1	32.0	33.3	30.9	**32.5**
13	34.3	34.3	34.6	33.0	33.5	31.1	**33.0**
14	35.0	34.8	35.0	32.5	33.2	31.6	**32.9**
15	0.0	0.0	37.1	32.7	33.8	31.4	**33.1**
Total	**17.6**	**19.7**	**17.1**	**23.4**	**19.3**	**18.8**	**19.0**

Table 7.3.2.3 Southern horse mackerel mean weight-at-age in the stock and in the catch by year

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1986	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1987	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1988	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1989	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1990	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1991	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1992	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1993	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1994	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1995	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1996	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1997	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1998	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
1999	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
2000	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
2001	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381
2002	0.000	0.032	0.055	0.075	0.105	0.127	0.154	0.176	0.213	0.240	0.269	0.304	0.318	0.348	0.355	0.381

Mean weight at age in the catch

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	0.014	0.027	0.070	0.091	0.117	0.132	0.152	0.182	0.249	0.264	0.284	0.312	0.320	0.344	0.357	0.378
1986	0.016	0.029	0.055	0.076	0.104	0.137	0.185	0.194	0.209	0.290	0.301	0.319	0.329	0.339	0.349	0.349
1987	0.024	0.031	0.049	0.058	0.096	0.106	0.131	0.161	0.198	0.211	0.246	0.302	0.288	0.352	0.361	0.358
1988	0.027	0.036	0.066	0.082	0.111	0.126	0.156	0.156	0.202	0.239	0.249	0.275	0.314	0.333	0.327	0.355
1989	0.016	0.041	0.062	0.089	0.109	0.132	0.152	0.189	0.200	0.203	0.248	0.320	0.345	0.359	0.375	0.389
1990	0.016	0.035	0.047	0.076	0.124	0.130	0.155	0.170	0.182	0.214	0.260	0.272	0.316	0.345	0.368	0.388
1991	0.016	0.033	0.063	0.102	0.133	0.151	0.168	0.173	0.193	0.196	0.233	0.236	0.280	0.304	0.323	0.372
1992	0.018	0.029	0.048	0.078	0.105	0.141	0.162	0.173	0.182	0.191	0.214	0.240	0.278	0.313	0.341	0.387
1993	0.015	0.034	0.040	0.064	0.109	0.155	0.171	0.202	0.225	0.225	0.255	0.250	0.321	0.364	0.397	0.461
1994	0.021	0.036	0.058	0.069	0.097	0.142	0.182	0.205	0.226	0.250	0.276	0.299	0.295	0.343	0.363	0.391
1995	0.029	0.036	0.058	0.091	0.110	0.139	0.173	0.189	0.218	0.235	0.273	0.291	0.305	0.290	0.362	0.392
1996	0.013	0.029	0.066	0.104	0.130	0.154	0.181	0.206	0.212	0.226	0.257	0.279	0.260	0.313	0.310	0.441
1997	0.022	0.033	0.054	0.091	0.123	0.149	0.171	0.202	0.209	0.246	0.233	0.265	0.313	0.350	0.390	0.347
1998	0.025	0.038	0.062	0.093	0.122	0.152	0.173	0.195	0.208	0.226	0.257	0.260	0.266	0.306	0.335	0.387
1999	0.021	0.033	0.055	0.086	0.122	0.143	0.167	0.201	0.221	0.238	0.275	0.305	0.293	0.401	0.471	0.501
2000	0.023	0.037	0.059	0.089	0.116	0.139	0.152	0.169	0.181	0.215	0.222	0.224	0.240	0.225	0.243	0.279
2001	0.021	0.033	0.073	0.094	0.120	0.135	0.155	0.175	0.196	0.225	0.234	0.257	0.263	0.273	0.324	0.349
2002	0.021	0.027	0.040	0.072	0.105	0.128	0.158	0.168	0.177	0.204	0.234	0.249	0.272	0.286	0.281	0.289

Table 7.4.1.1 SOUTHERN HORSE MACKEREL. CPUE indices from research surveys.

Year	Portugal IXa (20-500 m depth) Bottom trawl (20-mm codend) Kg/h March	kg/h Jun-Jul	kg/h Oct	Spain VIIIc & IXa North (20-500m depth) kg/30 minutes Sept-Oct
1979		12.2	5.5	-
1980		20.6	2.5	-
1981		11.6	1.8	-
1982		42.1	36.9	-
1983		79.1	24.6	37.97
1984		-	-	51.98
1985		9.5	3.8	20.93
1986		4.8	23.5	10.14
1987		-	6.9	-
1988		-	26.0	12.05
1989		14.9	11.7	15.48
1990		14.4	21.5	9.62
1991		11.8	16.9	4.92
1992	17.5	38.0	40.8	20.30
1993	100.24	35.6	57.6[1]	18.11
1994	_	49.3[3]	12.4	21.61
1995	_	9.8	18.9	21.99
1996	_	_	23.25[2]	26.75
1997	_	21.0	59.6	14.43
1998	_	14.3	15.4	27.99
1999	_	3.1[2]	10.1[2]	21.26
2000	_	9.4	6.7	25.60
2001	_	8.0	48.8	17.95
2002	_	_	_	11.39

1.- Revised
2.- In 1996 and 1999 the surveys was carried out with a different vessel and different gear. There is no estimation of the calibration factor.
3.- In 1994 this survey was carried out with a different gear. There is no estimation of the calibration factor.

Table 7.4.1.2 Southern Horse Mackerel. CPUE at age from surveys.

Portuguese October Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985																
1986																
1987																
1988																
1989																
1990	512.092	155.622	17.091	12.782	8.122	6.867	5.991	4.059	6.072	2.649	1.035	0.292	0.318	0.113	0.127	0.085
1991	368.432	31.464	20.498	16.412	13.542	5.729	1.915	1.358	1.443	1.917	0.998	0.741	0.378	0.094	0.021	0.040
1992	225.533	686.049	159.245	38.330	24.187	13.014	8.211	6.160	4.542	3.851	6.967	2.164	1.373	0.388	0.221	0.071
1993	1505.320	268.642	338.764	167.844	34.349	5.495	3.554	3.417	0.785	1.290	0.856	2.238	0.576	0.376	0.087	0.082
1994	4.147	7.780	59.971	47.331	14.426	3.231	0.715	1.673	0.737	0.495	0.320	0.127	0.036	0.000	0.000	0.014
1995	12.355	33.941	88.959	125.383	41.345	10.775	1.788	0.752	0.324	0.229	0.167	0.416	0.448	0.636	0.226	0.175
1996*																
1997	1913.822	72.043	95.547	23.722	41.938	34.189	11.128	7.077	5.014	3.937	2.089	0.934	0.168	0.179	0.121	0.127
1998	39.938	50.809	90.788	71.327	2.723	2.814	1.861	1.070	0.536	0.291	0.145	0.022	0.003	0.000	0.000	0.000
1999*																
2000	1.455	13.907	18.474	24.501	14.034	7.591	4.445	1.187	0.439	0.129	0.027	0.008	0.003	0.001	0.000	0.000
2001	903.468	43.371	5.646	25.553	98.921	9.137	10.272	13.991	7.494	3.341	1.844	0.325	0.181	0.178	0.012	0.000
2002 [1]																

Spanish October Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	182.630	84.360	322.510	467.600	7.090	6.500	4.710	4.050	4.840	5.390	3.580	0.880	0.840	0.260	0.770	5.010
1986	289.420	44.600	12.640	7.000	41.810	4.920	5.150	11.110	4.680	7.200	8.540	3.050	1.310	0.800	0.980	3.840
1987	217.665	64.153	20.035	8.053	18.482	16.448	5.100	7.979	5.662	5.879	4.712	4.630	1.470	1.389	4.147	0.001
1988	145.910	14.650	14.220	9.000	5.130	8.170	54.990	5.050	5.730	6.850	4.800	2.600	7.030	1.650	2.410	17.550
1989	115.000	6.540	1.900	21.300	4.680	17.500	15.620	65.040	7.680	10.470	26.160	0.570	0.410	4.770	0.400	5.440
1990	26.620	17.790	2.730	2.680	15.920	5.680	7.630	6.090	73.350	3.050	4.730	0.860	0.810	0.600	0.770	1.670
1991	48.470	15.370	5.100	0.150	1.440	1.820	0.710	0.640	2.170	28.900	6.420	6.520	2.220	1.070	2.780	0.640
1992	85.470	44.810	0.740	1.050	0.350	2.080	4.470	4.360	5.730	5.090	47.600	5.060	1.620	0.600	0.180	3.550
1993	138.619	31.848	3.447	0.630	2.199	4.546	13.762	17.072	4.513	4.422	3.881	22.057	0.235	0.041	0.228	0.256
1994	937.761	64.849	20.936	1.332	1.510	2.535	4.887	9.632	11.578	2.473	1.530	0.911	4.512	0.361	0.194	0.433
1995	38.308	172.564	12.492	6.941	5.806	3.845	6.311	9.659	14.481	11.868	3.503	1.930	0.340	8.609	0.101	0.049
1996	43.288	47.240	26.844	19.573	35.014	19.058	6.602	11.004	2.733	21.892	7.012	1.079	1.723	0.033	3.657	0.078
1997	13.866	21.891	6.529	9.419	7.730	6.327	3.911	3.995	12.424	3.947	10.330	7.708	0.506	0.350	0.109	2.585
1998	22.701	7.359	20.450	26.250	54.150	28.340	19.390	11.049	4.552	2.623	0.897	2.132	2.238	0.491	0.259	2.493
1999	30.744	50.190	17.429	3.930	19.331	18.302	10.964	13.575	11.888	8.618	4.186	0.924	1.198	0.068	0.054	0.103
2000	82.066	15.513	4.885	10.151	22.200	32.770	50.779	19.532	6.091	6.497	1.262	0.402	0.844	0.849	3.983	1.049
2001	100.998	33.875	23.985	12.557	6.815	4.238	1.308	30.670	18.740	3.667	6.075	3.411	0.470	0.571	0.187	0.439
2002	1.244	2.699	3.393	3.359	7.747	3.511	4.556	10.136	13.114	7.981	4.078	2.271	0.625	1.033	1.710	0.148

July Portuguese Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985																
1986																
1987																
1988																
1989	60.871	45.302	61.294	37.372	10.140	5.846	5.898	3.692	0.450	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1990	37.549	29.178	67.893	46.460	14.379	6.851	3.686	2.640	6.170	3.849	1.951	0.496	0.439	0.203	0.123	0.133
1991	36.959	29.995	8.894	3.267	3.723	4.385	3.147	2.953	2.987	6.169	3.828	2.981	1.793	0.812	0.260	0.334
1992	293.437	922.089	30.372	13.328	7.647	5.426	4.244	3.750	3.189	3.749	8.569	3.131	2.234	0.724	0.290	0.101
1993	8.529	188.439	303.711	101.404	19.742	41.708	83.385	48.772	8.984	5.286	0.341	0.861	0.045	0.015	0.001	0.000
1994*																
1995	28.856	32.139	13.539	42.402	36.483	11.385	2.931	1.633	0.752	0.358	0.214	0.326	0.277	0.295	0.159	0.119
1996*																
1997	58.076	362.460	96.818	9.945	12.425	4.641	4.235	1.158	0.292	0.157	0.120	0.516	0.024	0.016	0.017	0.006
1998	86.829	178.183	74.747	45.480	11.541	4.930	2.994	1.573	0.887	0.476	0.331	0.060	0.019	0.007	0.000	0.000
1999*																
2000	31.740	22.709	5.601	8.179	5.585	6.154	9.641	5.914	2.690	1.317	0.345	0.148	0.121	0.090	0.000	0.000
2001	2.300	3.642	12.555	7.727	7.066	8.238	9.822	9.108	3.702	1.336	0.827	0.367	0.222	0.204	0.015	0.017
2002 [2]																

* The surveys were carried out with a different gear (1994), and with a different vessel and gear (1996 and 1999)

[1] In 2002 started a new series in which the duration of the trawling per haul has changed from one hour to thirty minutes

[2] In 2002 there was no survey.

Table 7.5.1.- SOUTHERN HORSE MACKEREL. CPUE series in commercial fisheries.

Year	Division IXa (Portugal)	Division VIIIc (Spain)	
	Trawl	Trawl	
		Sub-div. VIIIc East Aviles	Sub-div. VIIIc West A Coruña
	kg/h	kg/Hp.day. 10^{-2}	kg/Hp.day.10^{-2}
1979	87.7	-	-
1980	69.3	-	-
1981	59.1	-	-
1982	56.2	-	-
1983	98.0	123.46	90.4
1984	55.9	142.94	135.87
1985	24.4	131.22	118.00
1986	41.6	116.90	130.84
1987	71.0	109.02	176.65
1988	91.1	88.96	146.63
1989	69.5	98.24	172.84
1990	98.9	125.35	146.27
1991	n.a.	106.42	145.09
1992	n.a.	73.70	163.12
1993	n.a.	71.47	200.50
1994	n.a.	137.56	136.75
1995	n.a.	130.44*	124.11
1996	n.a.	145.64*	156.50
1997	n.a.	89.56*	117.39
1998	n.a.	93.28*	n.a.
1999	n.a.	91.05*	121.75
2000	n.a.	72.07*	107.60
2001	n.a.	110.37*	115.07
2002	n.a.	125.74*	122.42

* There was no data provided by local fishermen asociation. Catches and effort data were estimated.

Table 7.5.2 Southern horse mackerel, CPUE at age from fleets. (In the Aviles fleet, catches and effort were estimated from 1995 onwards)

Effort unit: Fishing trips/100 * mean HP

A Coruña bottom trawl fleet

YEAR	Effort	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	30255	3	12	134	399	19	42	39	25	27	43	22	8	3	1	3	27
1986	26540	3	79	58	118	400	40	31	22	15	15	41	16	6	10	2	33
1987	23122	1	33	113	92	143	672	76	61	13	22	20	16	8	2	1	13
1988	28119	5	167	258	58	58	51	408	40	29	22	11	11	16	4	2	9
1989	29628	23	152	48	115	56	57	38	299	40	103	78	6	2	23	2	16
1990	29578	1	84	128	37	71	17	27	39	394	21	27	5	6	6	7	15
1991	26959	1	1	41	2	20	39	27	65	49	376	37	17	12	2	9	5
1992	26199	0	191	60	10	9	54	99	48	46	51	361	12	6	3	0	8
1993	29670	0	34	467	39	51	95	87	210	56	79	16	209	1	0	1	1
1994	26393	2	79	270	12	8	20	92	146	165	34	18	4	45	1	0	1
1995	28000	0	7	122	84	37	25	36	64	129	102	33	12	2	47	1	1
1996	23818	0	1	29	14	65	89	51	62	41	125	108	36	15	14	59	3
1997	23668	0	2	3	2	6	13	14	32	52	49	86	80	34	18	6	40
1998		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1999	20154	0	0	2	5	35	46	65	99	118	65	37	23	17	5	3	14
2000	20048	0	0	3	6	15	49	87	96	71	55	22	34	26	17	20	26
2001	19958	0	0	0	1	7	17	41	90	87	97	69	45	32	15	19	14
2002	14549	0	0	0	1	3	2	12	21	52	64	61	62	26	39	27	90

Effort unit: Fishing days/100 * mean HP

Avilés bottom trawl fleet

YEAR	Effort	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1985	9856	1	167	613	574	13	18	16	13	17	21	14	4	4	1	4	19
1986	11000	36	223	271	174	527	42	19	14	10	8	9	2	1	1	0	2
1987	8309	1	244	350	166	48	396	40	19	7	9	6	5	3	1	1	4
1988	9047	181	264	53	23	18	19	148	14	17	22	15	12	22	6	5	27
1989	8063	65	275	62	105	50	42	18	100	13	38	35	1	1	18	2	15
1990	8492	1	726	373	257	72	19	21	24	192	10	13	3	4	4	4	9
1991	7677	39	495	882	41	85	51	10	12	9	67	3	2	1	1	1	1
1992	13000	2	35	21	65	34	60	63	20	16	19	114	3	1	1	0	7
1993	7635	0	215	462	77	44	23	18	42	6	14	2	35	1	0	0	1
1994	9620	1	47	632	12	6	17	69	118	135	25	14	3	38	1	0	0
1995	6146	1	182	441	141	70	32	25	39	89	71	31	12	4	37	1	1
1996	4525	0	225	608	129	230	128	32	24	22	49	32	10	4	4	17	0
1997	5061	0	48	10	15	34	43	36	49	83	34	76	42	8	2	0	14
1998	5032	0	0	2	34	34	63	93	102	63	28	16	16	11	3	4	5
1999	6829	0	0	4	17	101	139	86	74	78	39	13	5	5	0	0	0
2000	4347	0	9	6	7	15	54	82	80	56	31	14	17	12	10	12	13
2001	2450	0	0	11	35	60	79	100	170	98	54	29	15	12	4	6	3
2002	1907	0	0	0	24	88	99	52	60	252	124	38	24	6	5	5	25

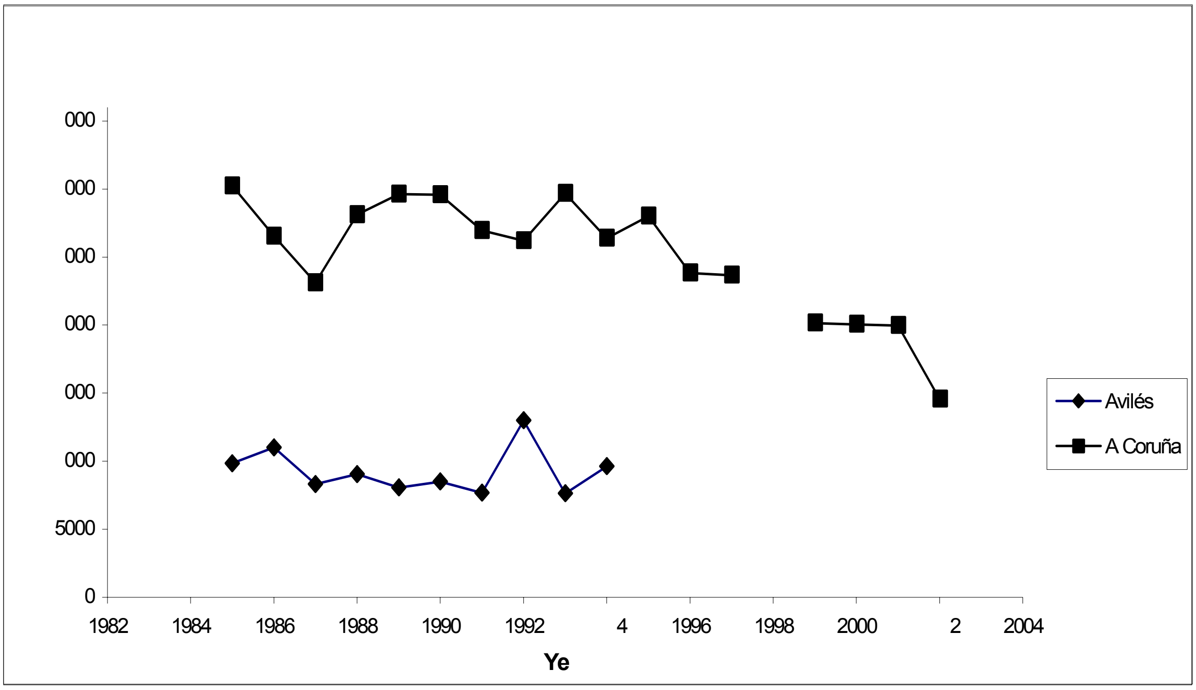


Figure 7.6.1. Proportion of catches by year in each age of the historical series of catches and of the summer Portuguese bottom trawl survey

(Include figure!!!, it is in the file of figures)

Figure 7.6.2. Proportion of catches by year in each age of the historical series of catches of the Autumn Portuguese and Spanish surveys and the two Spanish commercial fishing fleets.

(Include figure!!!!, it is in the file of figures)

Figure 7.6.3. Year class (log numbers-at-age) trajectories in the catches and tuning series.

(Include figure!!!!, it is in the file of figures)

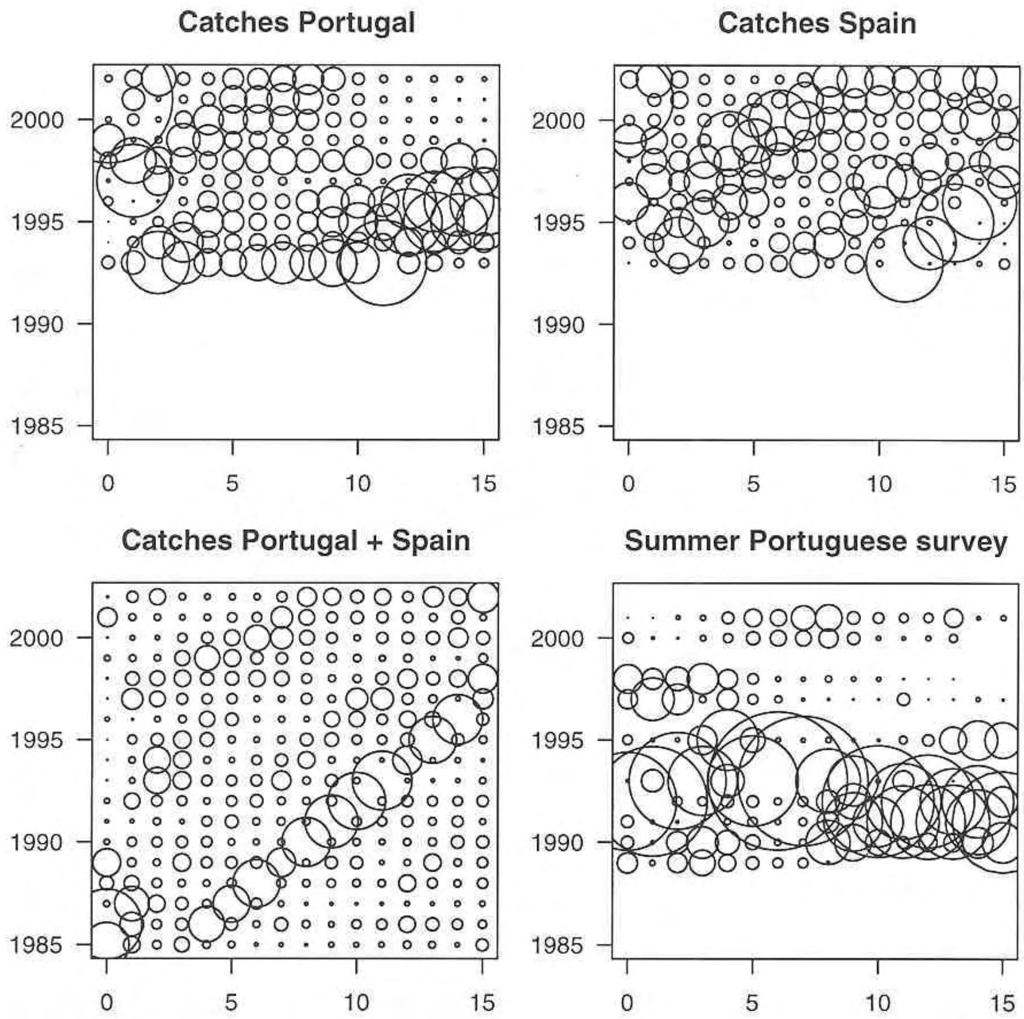


Figure 7.6.1 Proportion of catches by year in each age of the historical series of catches of the summer Portuguese bottom trawl survey.

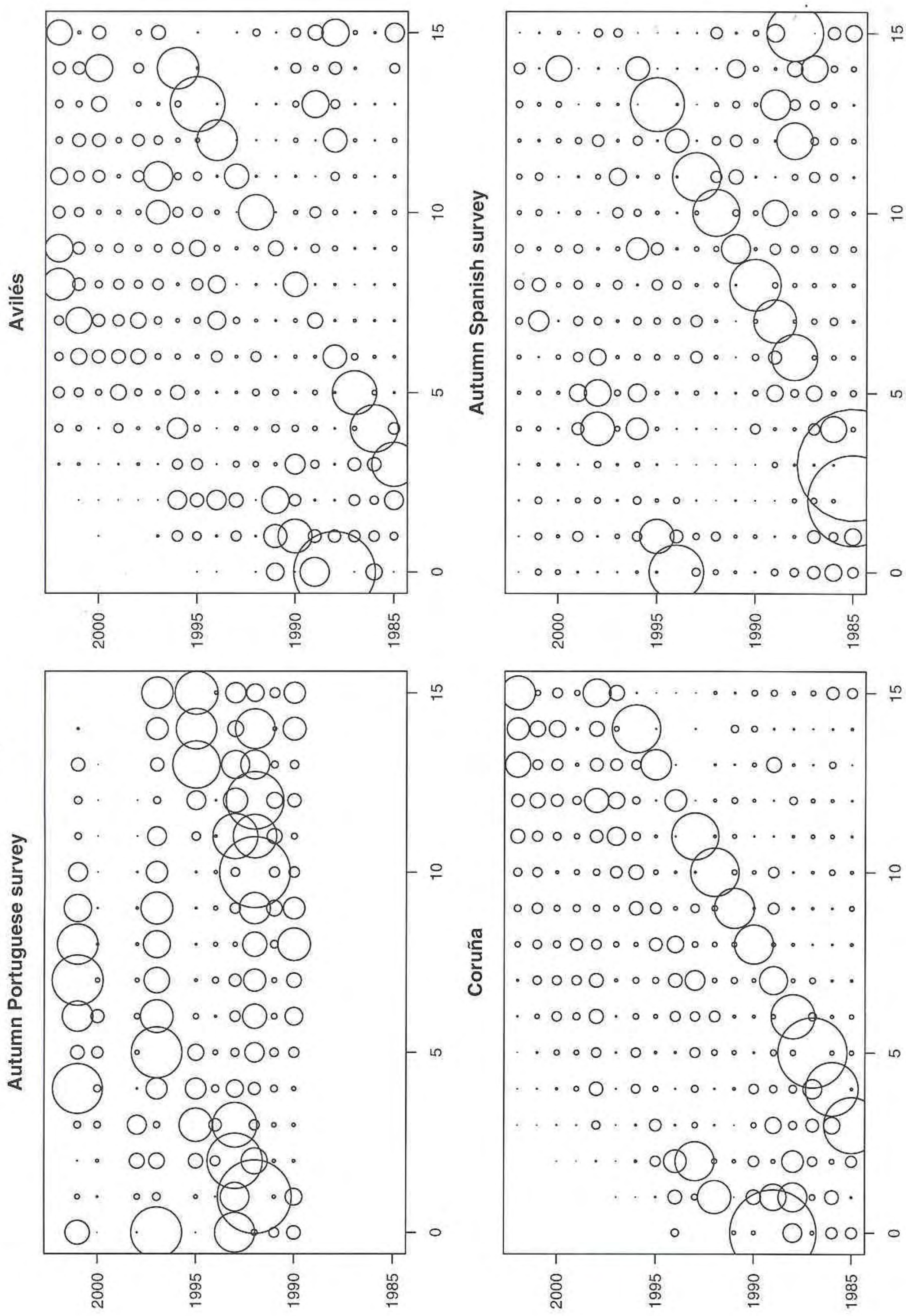


Figure 7.6.2 Proportion of catches by year in each age of the historical series of catches of the autumn Portuguese and Spanish surveys and the two Spanish commercial fishing fleets.

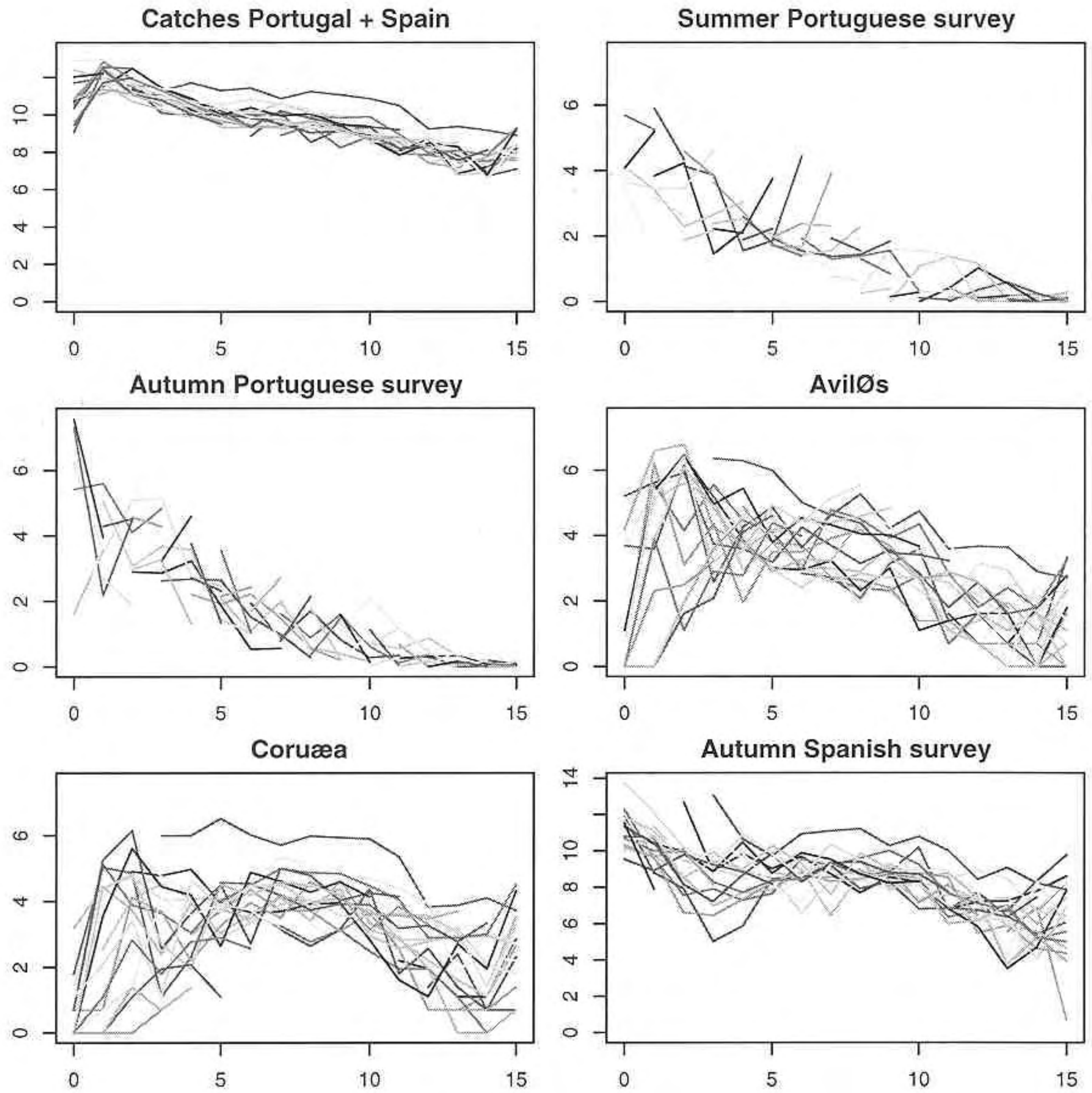


Figure 7.6.3 Year class (log numbers-at-age) trajectories in the catches and tuning series.

8 SARDINE GENERAL

8.1 The fishery

Information on sardine catch in the northern Moroccan area and in the south-western Mediterranean was available to the WG (Silva and Chlaida, 2003 WD, Giráldez, personal communication).

Sardine landings from the Northern Stock of Morocco (from 32º 00 N to 35º 45 N of Latitude) are presented for the period 1960-2002 on an annual basis (Table 8.1). The Northern sardine fishery off Morocco is the smallest of the four fisheries considered along the coast, with landings ranging from 3,6 to 33,3 thousand tonnes in the period 1960-2002 (mean=14,9±7,7 thousand tones). Landings show an increasing trend until the beginning of the 1980's, stabilise during ten years and decrease sharply from 1993 onwards. There is some indication that this trend is reversing in recent years. The fishing fleet operating in this area is composed of around 100 traditional Moroccan coastal purse-seiners (gross tonnage 40 tonnes and 250 HP) that mainly catch sardine, horse mackerel and anchovy, and land in the ports of Larache, and Casablanca (FAO, 2001). The northern Morocco fishery is strongly seasonal, as are the fisheries in the Iberian waters, with most landings (>60%) occurring in the second half of the year.

Length distributions are available for the Northern Morocco fishery in 1996 and 1997 (Table 8.2), showing that 50% of the catches were composed of fish less than 15 cm . Similar sizes of sardine are predominant in Cadiz landings in 1996 and 1998 however, a few larger individuals appeared in Cadiz but not in northern Morocco in both years. The smallest individuals (modal length around 12 cm) entered the Moroccan fishery during the second semester in 1996 and from the second to the fourth quarter in 1997, suggesting an extended recruitment season, which is the general pattern in the western and southern Iberian waters.

Sardine catches in the south-western Mediterranean area adjacent to the Gibraltar Strait (Alboran Sea) have fluctuated between 2,6 and 10,9 thousand tonnes (mean=5,2±2,3 thousand tones) since 1963 (Table 8.1). Length distribution of the catches in 1991-1993 have a bimodal shape and show a predominance of 10-20 cm individuals (overall median length=14 cm) (Figure 8.1).

Landings in the Gulf of Cadiz show a negative correlation (Spearman's rho= -0.43, p=0.04), with those from northern Morocco in the period 1978-2002 but no correlation with those from the Alboran Sea, although in is some periods these two series present similar variations with one or two years lag (Figure 8.2 and Table 8.1). According to the information available from these three areas, landings are dominated by small individuals, the lengths being slightly larger in Cadiz (median=16) than in both Alboran (median=14) and north Morocco (median=14.5) (Figure 8.3).Commercial catch data for 2001 from the northern areas (VIIIa,d, VII, VIa and IVc) was provided by the UK, Ireland and Germany (Table below). France did not report any catches, however, there are indications that this nation catch a significant amount of sardine. The total reported catch in 2002 was 14,393 t and thus increased 73% compared to last year (8,319 t). A small percentage of the catch was sampled for age (12%) and length (85%) in areas VIId,e,h and VIIIa in the fourth quarter. Length distributions for subareas VIIe,h and VIIIa are presented in Table 8.3. 87% of the reported catches were taken in Subarea VII (12,455 t, whereof 11,302 t were taken in Division VIIe). 277 t were reported from as far north as Division VIa and for the first time reported from IVc (1,268 t) (see Table below). As in previous years, the fishery mainly took place in the 4th quarter (9,945 t; 70 % of the total catch).

Reported catch of sardine in the northern areas (VIIIad, VIId,e,f,g,h, Via and IVc) in 2001

Area	1	2	3	4	Grand Total
IVc		152	145	970	1 268
VIa			7	270	277
VIId		94	5	183	282
VIIe	1 568	3	1 328	8 404	11 302
VIIf		33	1	2	35
VIIg	143				143
VIIh	600			94	694
VIIIa		249	119	23	390
VIIId		3			3
Grand Total	2 310	534	1 604	9 945	14 393

Table 8.1 Sardine landings by year (tonnes) in the northern Morocco fishery, in the Alboran Sea and in the Gulf of Cadiz (ICES Division IXaS-Cadiz).

Year	Morocco	Alboran Sea	Cadiz
1960	4749		
1961	3598		
1962	5436		
1963	8030	9400	
1964	11740		
1965	6891	8671	
1966	13631	7049	
1967	11521	3422	
1968	12213	2886	
1969	10941	2885	
1970	12979	7455	
1971	10642		
1972	25701	4658	
1973	19297		
1974	5624		
1975	10575		
1976	33280		
1977	8555		
1978	29282	5342	5619
1979	17702	3852	3800
1980	20755	3275	3120
1981	30761	2560	2384
1982	28174	3608	2442
1983	17379	3461	2688
1984	13028	4869	3319
1985	20422	10116	4333
1986	19066	10872	6757
1987	18531	5908	8870
1988	17338	5495	2990
1989	16093	3547	3835
1990	15176	5075	6503
1991	18177	8570	4834
1992	20214	8218	4196
1993	27723	4724	3664
1994	18055	4229	3782
1995	17853	3620	3996
1996	11497	2922	5304
1997	7154	2611	6780
1998	5567	3064	6594
1999	4277	3699	7846
2000	6790	6619	5081
2001	6302	6458	5066
2002	18516	3918	11689

Table 8.2 Quarterly length distributions of sardine catches in the northern Morocco fishery in 1996 and 1997.

	1996					1997				
Quarter	Quarter 1	Quarter 2	Quarter 3	Quarter 4	TOTAL	Quarter 1	Quarter 2	Quarter 3	Quarter 4	TOTAL
Sampled weight	84.85	119.58	78.56	53.92	336.91	62.26	38.34	93.71	33.56	227.87
Landed weight	1477	2722	3651	3647	11497	1251.6	1446.572	2290.323	2165.808	7154.303
9.5	0	0	0	0	0	0	50	78	0	128
10	9	4	0	120	133	0	702	852	0	1554
10.5	120	322	0	0	442	0	2494	2290	0	4783
11	594	850	514	1749	3707	100	4499	2949	0	7548
11.5	1192	2220	801	3765	7978	202	2695	5467	0	8363
12	3246	4479	4235	12269	24230	2020	2577	8137	0	12734
12.5	6617	6543	7159	17574	37893	8548	4123	5603	174	18447
13	10805	12988	7349	34459	65601	14312	4761	2703	1128	22904
13.5	12096	16445	4944	19663	53148	12939	6265	1707	1176	22086
14	7587	20335	3687	15567	47175	9272	6583	1377	2501	19733
14.5	5571	17277	14501	11061	48411	3392	6303	2739	3202	15636
15	4004	11504	17430	16899	49837	4885	3242	5549	5791	19468
15.5	3212	7571	13647	7703	32133	1143	2878	10625	13411	28057
16	3107	5484	6609	6668	21869	1086	2834	18067	18991	40978
16.5	1801	4078	10390	2351	18621	502	3180	10646	12116	26444
17	884	2374	4411	2178	9848	322	2731	8087	4076	15215
17.5	367	1081	2385	441	4274	141	1486	4657	1310	7593
18	204	239	106	200	749	91	425	2912	355	3784
18.5	33	51	8	115	207	37	35	1395	127	1594
19	66	84	0	12	162	33	0	802	46	881
19.5	26	10	0	0	36	2	0	115	0	117
20	16	11	0	12	39	0	0	8	0	8
20.5	0	5	0	0	5	0	0	0	0	0
21	0	0	0	0	0	2	0	0	0	2
21.5	0	0	0	0	0	0	0	0	0	0
Total number	61560	113955	98174	152808	426497	59028	57864	96763	64404	278059
Mean length,cm	13.83	14.14	14.75	13.69	14.07	13.58	13.80	14.89	15.75	14.59
Mean weight,g	23.99	23.89	37.19	23.87	26.96	21.20	25.00	23.67	33.63	25.73

Table 8.3 Length distribution of sardine from German catches in 2002, in ICES sub-divisions VII and VIII, in the fourth quarter.

18.5		3	1	4
19		0	1	1
19.5	1	12	1	15
20	1	6	1	8
20.5	1	9	2	12
21	5	34	2	41
21.5	6	34	2	42
22	14	107	3	124
22.5	11	106	3	121
23	34	141	5	180
23.5	20	122	5	147
24	20	102	5	128
24.5	8	70	4	81
25	4	53	2	59
25.5	1	20		21
26	0	8		8
26.5	1	2		3

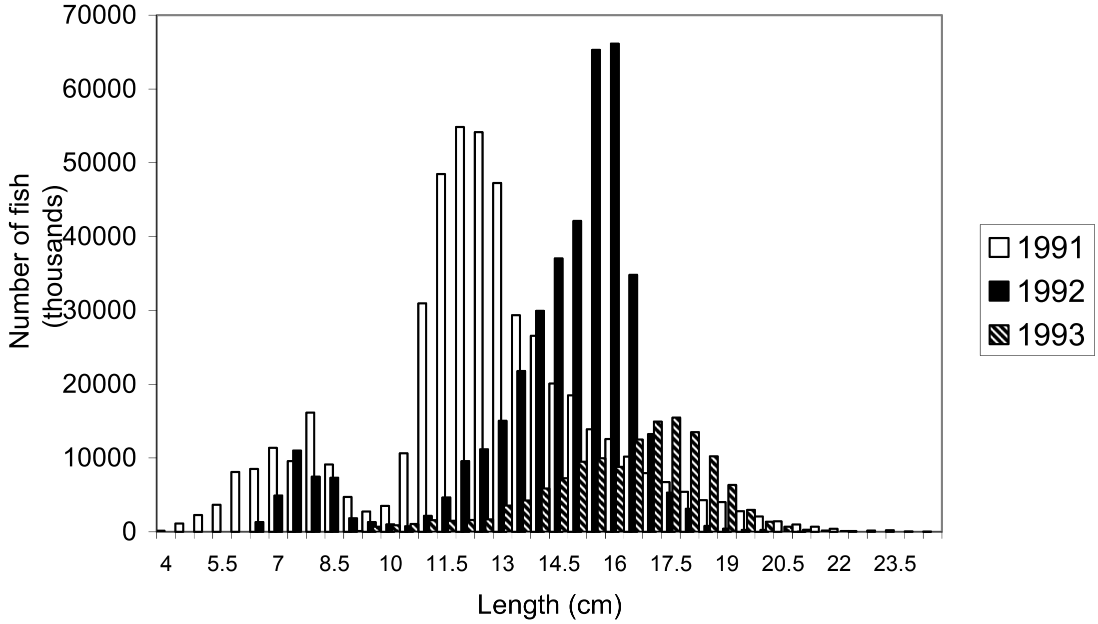


Figure 8.1 Length distributions of sardine catches in the Alboran Sea (southwestern Mediterranean) in 1991-1993.

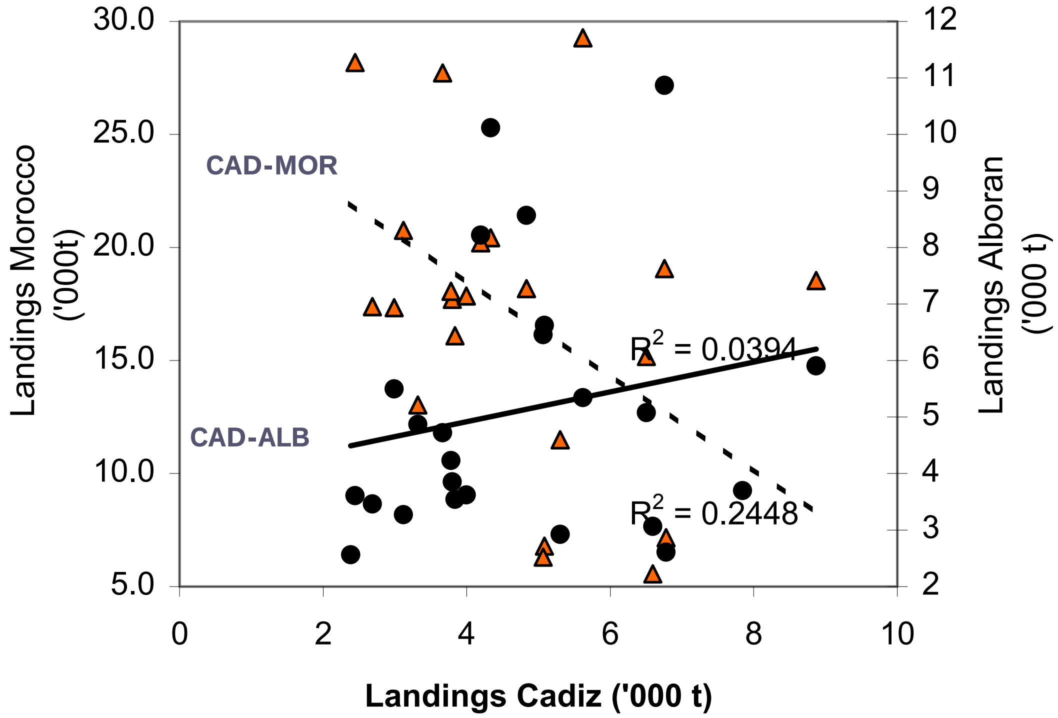


Figure 8.2 Scaterplot of annual sardine landings from the Gulf of Cadiz, Northern Morocco and the Alboran Sea in the period 1978-2002. Linear regression lines for the comparison between Cadiz landings with those from the northern Morocco and the Alboran Sea are shown.

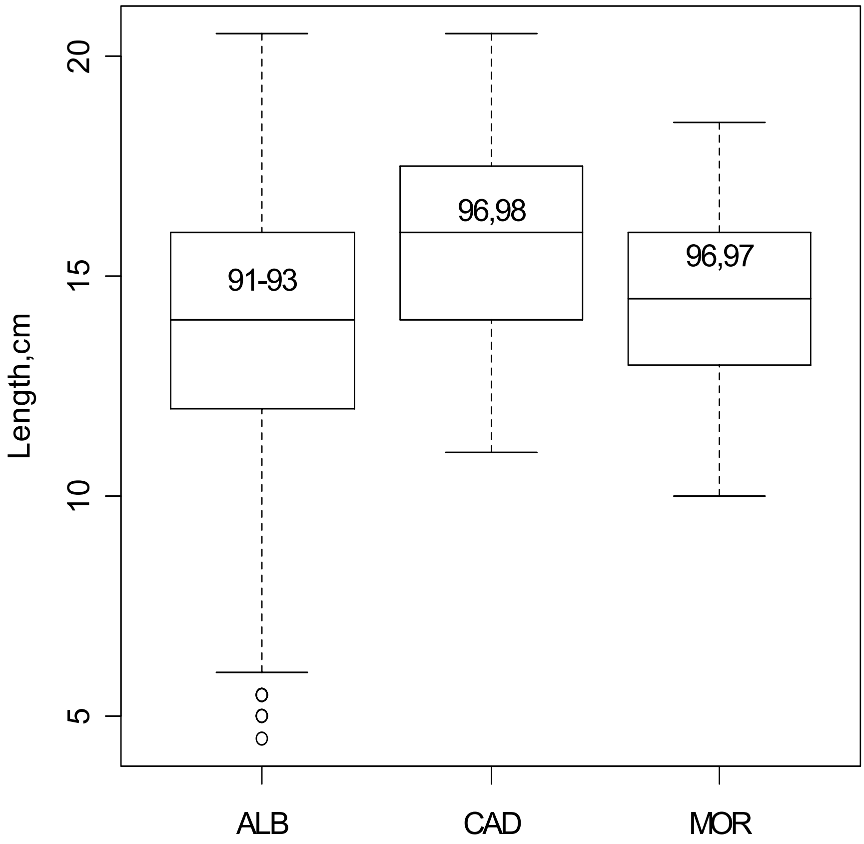


Figure 8.3 Boxplots of length distributions of sardine landings in the Alboran Sea (ALB), in the Gulf of Cadiz (CAD) and in the Northern Morocco fishery (MOR). Annual data for the years shown inside the boxes were pooled.

9 Sardine in VIIIc and IXa

9.1 ACFM Advice Applicable to 2003

Both the absolute levels and the historical trends in sardine fishing mortality and spawning stock size are uncertain due to conflicting signals in the data coming from different areas. Large fluctuations in recruitment, temporal variations in spatial distribution and a possible mis-specification of the stock unit contribute to this uncertainty. Different assessment methods were explored and these provided different perceptions of the state of the stock depending on their structural assumptions and on the way each model interprets both the conflicting signals and the noise in the data. However, the models explored indicate that the spawning stock biomass increased from a historical low as a result of the strong 2000 year class and there are also indications of average 2001 recruitment. The control of fishing effort (closed periods and limitation of fishing days and catches), continued to be enforced in both Portugal and Spain. ACFM did not accept any of the assessments presented by the MHSA Working Group (ICES 2002a) as a basis to define the state of the stock, however, a catch of no more than 100 000 tonnes in 2003 was recommended to prevent a short-term decline in the SSB.

9.2 The fishery in 2002

Management measures implemented in each country since 1997 continued to be enforced in 2002.

In Spain, from 1th February to 31st March there was a ban for the purse seine fishery and sardine catches were not allowed. Also, a maximum allowable catch of 7,000 Kg per fishing day of >15cm sardines, and a maximum allowable catch of between 11 and 15 cm sardines was set, as well as a per week limitation in the number of fishing days (4 in Galicia, 5 in the rest of Spain). Catches of juvenile sardines between 11 and 15 cm are limited to 500 kg per fishing day. The Galician fishery was closed in part of November and in December 2002 due to the oil spill disaster of the "Prestige".

In Portugal, a closure of the purse-seine fishery took place in the northern part (north of the 39º42" north) of the Portuguese coast from the 15th of February to 15th of April and the yearly quota for the Producers Organization was limited to 75.0 thousand tons.

As estimated by the Working Group, sardine landings in 2002 remained stable comparatively to 2001. Total landings in in divisions VIIIc and IXa were 99,673 t (32,136 t from Spain and 67,536 t from Portugal). The bulk of the landings (99%) were made by purse seiners. Table 9.2.1 summarises the quarterly landings and their relative distribution by ICES Subdivision. Major changes in landings by area were observed in Cadiz and IXa-North. In Cadiz, landings doubled when compared to those from 2001 and reached a historical high of 11,689 tonnes. In south Galicia, 4562 t were landed in 2002, corresponding to a 45% decrease relative to 2002. Most of the catches (62%) were landed in the second semester (mainly in the third quarter) and were lowest on the first quarter due to fishery bans that take place in both countries. The proportion of landings in the Northern areas of the stock (VIIIc and IXaN) decreased 20% after the considerable recovery observed in 2001. The series of annual landings from both Spain and Portugal are available from 1940 (Figure 9.2.1 and Table 9.2.2).

9.3 Fishery independent information

9.3.1 DEPM – based SSB estimates

9.3.1.1 2002 SSB estimate

As stated in the Terms of Reference of the 2003 SGSBSA (ICES 2003h), DEPM-based estimates of SSB for the 2002 survey are provided to the WG from the SGSBSA, as well as a first quality evaluation of the Iberian sardine DEPM time-series (see section 9.3.1.2 below). No new Egg survey was carried during 2003, and next surveys in both Spain and Portugal are expected for 2005.

SSB estimate for 2002 for the whole Iberian Peninsula was 442.6 thousand tonnes, with a CV of 28 %. This SSB estimate is about 1.6 times that of 1999 (269 thousand tonnes, CV = 37 %), while CV was reduced due to the intensification of adult sampling and the use of post-stratification both in Spain and Portugal (ICES 2003h, Stratoudakis and

Bernal WD 2003). Estimates of SSB for 2002 is considered by the SGSBSA as a reliable and robust estimate, due to the coincidence in point estimates obtained with considerable different methods (see Section 9.3.1.2 below).

The increase in SSB in 2002 relative to the 1999 values is mainly due to an increase in SSB in western Portugal, while SSB estimates in the Southern Portuguese coast decrease slightly and SSB in the Spanish coast shows an increase (also see comments in Section 9.3.1.2 below and Table 9.3.1.2.4).

9.3.1.2 Revision of DEPM-based SSB estimates

A revision of the DEPM in both anchovy and sardine has been undertaken both by a recently finished EU project (EU 99/080 "Using environmental variables with improved DEPM methods to consolidate the series of sardine and anchovy estimates") and in the last SGSBSA meeting. Revised adult parameters series for each year and country, as well as egg production estimates for Iberian sardine are provided to this WG in Stratoudakis and Bernal (WD 2003), following a recommendation of the last SGSBSA. A final review of the full time-series of DEPM based SSB estimates, with standardised methodology across years and countries, both using traditional and model-based DEPM, is postponed until next SGSBSA in 2005.

Sampling intensity in Spain and Portugal through the SEPM time-series is shown in Table 9.3.1.2.1, and a revision of traditional DEPM parameters for different strata both in Spain and Portugal are shown in Tables 9.3.1.2.2 and 9.3.1.2.3 respectively. Estimates of SSB for the 1990 Spanish survey are provided for the first time to this WG.

Table 9.3.1.2.4 summarizes the DEPM based SSB estimates that the SGSBSA consider reliable to be used in sardine assessment; i.e.:

- a series with 5 points (1988, 1990, 1997, 1999 and 2002) for northern Spain.
- a series of 3 points (1988, 1999, 2002) for western Portugal.
- a series of 2 points (1999 and 2002) for the stock area.

Area based SSB estimates are provided in case an area based assessment model is implemented, and thus larger datasets can be used. Otherwise, only two estimates for the whole Iberian Peninsula are considered reliable for use in Iberian sardine assessment. An additional estimate for 1997 is expected to be available once a revision of the unexplained low spawning fraction estimate found in Portuguese waters is made.

Additionally, a full implementation of newly developed methodology to improve DEPM based SSB estimates was carried out for the first time (ICES 2003h, Stratoudakis and Bernal WD 2003) using the 1999 and 2002 surveys. The new methods include:

– A new bayesian framework for ageing sardine eggs.
– New automatic software to evaluate sampling areas and area represented by a sampling point.
– New generation of Generalised Additive Models (GAMs, Hastie and Tibsharani 1995, Wood 2000) to model spatial distribution of both egg production and adult parameters

Results of this new analysis are shown in Table 9.3.1.2.4 and Figures 9.3.1.2.1 and 9.3.1.2.2. Figure 9.3.1.2.1. show the spatial distribution of adult and egg parameters in relation to distances along the Iberian coast. Egg production in 1999 is concentrated in Southern Portugal, while fecundity in this area is the lower along the Iberian coast for this survey, as already described by Stratoudakis and Frier (WD 2001). Previous work (Stratoudakis and Frier, opus.cit.) demonstrated that that situation can produce bias in the SSB estimate if appropriate post-stratification or spatial modeling of the data is carried out. Figure 9.3.1.2.2 shows for the first time a comparison between spatial distribution of DEPM-based SSB estimates and acoustic derived energies. Results from this comparison show that areas of high biomass are similar in both methods, although slightly displaced offshore in the DEPM, probably due to prevailing oceanographic conditions displacing egg distributions offshore.

SSB estimates with any of the three methods are similar, even when the underlying assumptions and methods differ considerably (see section 9.3.1.2 below and report of the SGSBSA) and so the estimate is considered to be robust to the estimation method.

Based on the analysis of the spatial structure of adult parameters (Figure 9.3.1.2.1) and in previous works relating bias to absence of adequate post stratification when a strong spatial structure of the adult and egg production parameters is present in the population (Stratoudakis and Frier, WD 2001), the SGSBSA decided that spatial structure should be taken into account into the SSB estimate in order to avoid bias, either by post-stratification in the traditional framework or by modeling the spatial structure of the DEPM parameters.

The SGSBSA decided that the new methods provided as an output of the GAM project, and the undergoing work carried out by some of the SGSBSA members show promising results, both in improving the SSB estimate precision and in reducing possible bias associated with spatial structure miss-specification. Nevertheless, the SGSBSA decided to adopt the post-stratified SSB estimates as the most reliable ones for this year, and postpone the decision on whether to adopt GAM-based estimates as the current estimates of DEPM based SSB to the next SGSBSA meeting in 2005.

9.3.2 Acoustic surveys

The methodology used in Portuguese and Spanish acoustic surveys was standardized within the framework of the Planning Group for Pelagic Acoustic Surveys in ICES 1999c). Spring surveys were undertaken within the framework of the EU DG XIV project "Data Directive".

9.3.2.1 Summary of acoustic survey data

Figure 9.3.2.1.1 presents the total abundance (in numbers) and population structure in the different acoustic survey series carried out to assess the sardine stock. Figure 9.3.2.1.2 shows the total biomass estimates from the same surveys and the estimates of the spawning stock biomass from DEPM surveys.

In the northern Spanish area, the abundance in numbers of sardine shows a decreasing trend from 1986 to 1999 with considerable inter-annual variability up to 1993. An important recovery is noted since 2000, due to the strong 2000 recruitment with the population number in 2003 achieving a level comparable to that observed in 1986. However, the structure of the population is quite different in the 1980's and in second half of the 1990' s; in the earlier period, it was dominated by older fish (age groups 5 and 6+ made up about half of the estimated numbers) while in recent years these age groups correspond to about 15% of the population. This explains the decreasing trend in the biomass of the population between the two periods (a decrease of 33% is observed between the average biomass for the periods 1986-1993 and 1996-2003) which is also evident in the SSB estimates from the DEPM surveys.

In the Portuguese waters, the level of sardine abundance in the recent years is higher that that observed in the 1980 surveys, however this perspective is strongly influenced by the November survey that estimated the 2000 very strong year class close to recruitment time. Additionally, there are large gaps in this survey series which make difficult the comparison between the two periods. The population structure is dominated by age groups 0-3 which make up around 75% of the catches and appears to be relative stable along the series. The March survey series supports the described age structure also for the Gulf of Cadiz area and suggests a slightly increase in the abundance of the population since 2000 that is confirmed by the DEPM estimates.

9.3.2.2 Portuguese Acoustic Surveys 2003

Each year two surveys are routinely performed off the Portuguese continental shelf and Gulf of Cadiz, during March (late spawning season) and November (early spawning and recruitment season) with the main objective to estimate sardine and anchovy abundance in the ICES Division IXa. The November 2002 survey was not completed due to very bad weather and only the IXa-S-Algarve area was sufficiently covered to permit estimating abundance (Figure 9.3.2.2.1). The February 2003 survey covered all the Portuguese area and the Gulf of Cadiz (Figure 9.3.2.2.2). The Continuous Underway Fish Eggs Sampler (CUFES) was also used to monitor the sardine egg abundance and to collect some hydrographical parameters (surface temperature, salinity and fluorescence). The main results from these surveys are presented in Marques and Morais (WD 2002).

In the November 2002 survey, the abundance of sardine in IXa-S-Algarve was the lowest of all the survey series (324,247 individuals corresponding to 16,6 thousand tonnes) and the population showed a low percentage of juveniles (Table 9.3.2.2.1). In the few other surveyed areas, sardine was generally scarce except in the zone front of Lisbon where a very high density of adult individuals was observed (Figure 9.3.2.2.2).

Sardine abundance in the February 2003 survey was estimated as 432 thousand tonnes (13 290 million individuals) of which 359 thousand tonnes were distributed in the Portuguese waters (Table 9.3.2.3). Most of the biomass (70%) was distributed in the western coast (OCN and OCS areas). Sardine distribution in the OCN area was shifted to deeper waters, when compared with the pattern in recent years: normally, the main concentrations of sardine are found inside the 50 meters depth contour but in this survey the largest concentrations frequently reached 100 m depth. The population structure in this survey is comparable to that of previous surveys. .However, both age groups two (2001 year class) and three (2000 year class) are better represented than in recent surveys, confirming the above average strength of the corresponding year classes. There are indications of a poor 2002 year class off the Portuguese coast and the Gulf of Cadiz, the only significant amounts of juvenile fish were observed in the Lisbon region (Table 9.3.2.2.1 and Figure 9.3.2.2.1.).

9.3.2.3 Spanish April 2003 Acoustic Survey

In April 2003 the Spanish acoustic survey, carried out on board R/V 'Thalassa', covering Spanish waters in Division VIIIc and IXa N and the northern part of Portugal (IXa Central North). Together with the acoustic and CUFES sampling, extensive studies on plankton and primary production were undertaken along the surveyed area. Data from the 2003 survey were used for the 2003 assessment, but no working document with main results from the acoustic survey was presented to the WG.

Table 9.3.2.3 and Figure 9.3.2.3 show the sardine acoustic estimate. The abundance estimated in 2003 in the Spanish area is at the same level than in 2002. Age 3 group is the most abundant, corresponding to the 2000 strong year class , as expected. In area VIIIc E, mainly in its eastern part, age group 2 is the most abundance group, which could come from the French waters. High concentrations were observed in Galician waters (with integration values bigger than 10 thousand square meters) distributed very close to the coast line.

9.4 Biological data

Biological data were provided by Spain and Portugal. In Spain samples for age length keys were pooled on a half year basis for each Subdivision while the length/weight relationship was calculated for each quarter. Age length keys and length/weight relationship from the Cádiz area were also used. In Portugal both age length keys and length/weight relationship were compiled on a quarterly and Subdivision basis

9.4.1 Catch numbers-at-age

Landings were grouped by length classes (0.5 cm) and later applied on a quarterly basis to the age length keys of each Subdivision. Table 9.4.1.1 shows the quarterly length distribution. Mean length from the Cantabrian Sea (VIIIc) is the highest in the area, as it has been observed in past WGs. As in previous years, the smallest fish were caught in Ixa-S(Cadiz) and IXa-CN.

Table 9.4.1.2 shows the catch-at-age in numbers for each quarter and Subdivision. In Table 9.4.1.3, the relative contribution of each age group in each Subdivision is shown as well as their relative contribution to the catches.

9.4.2 Mean length and mean weight-at-age

Mean length and mean weight-at-age by quarter and Subdivision are shown in Tables 9.4.2.1 and 9.4.2.2.

9.4.3 Maturity-at-age

The maturity ogive for 2002 was based on biological samples collected during the spawning period. In the Portuguese area samples were taken during the acoustic survey undertaken in November 2001. Age groups were shifted one year. In the Spanish area, samples were also collected during the acoustic survey performed in 2002. Samples for each country were weighted according to the results of the acoustic surveys. The maturity ogive is presented below:

Age	0	1	2	3	5	5	6+
% mature fish	0	48.9	93.6	97.4	98.3	98.5	100

Maturity of the age group 1 is larger than in previous years, which was considered to be very low. A revision of the time-series of the maturity ogive and the possible effects of changes in methodology may have in its estimation is on progress.

9.4.4 Natural mortality

Natural mortality was estimated at 0.33 by Pestana (1989), and is considered constant for all ages and years.

9.5 Effort and catch per unit effort

Concerns about the effort measurements have been expressed in previous WG, and it has prevented this data to be used in the assessment. No new information on fishing effort review has been presented, and thus the situation remains the same.

9.6 Recruitment forecasting and Environmental effects

No new WD were presented to this year WG, but some feedback from an forthcoming EU project SARDYN is expected in next WG´s.

9.7 State of the stock

9.7.1 Data and model exploration

9.7.1.1 Background

Last year, the WG was not able to present a final assessment for Iberian sardine, because results from the exploratory analysis indicate substantial differences in the output between the available models; AMCI and ICA. AMCI was for the first time used in the assessment of Iberian sardine, as a exploratory tool to analyse some reported problems in the application of ICA for this particular fishery. Differences on the stock assessment using the AMCI and ICA models under different scenarios were large, specially in the perception of the stock on the 90´s . The WG was unable to decide which of these models was appropriate to assess the sardine stock, due to the following reasons:

- The adequacy of some differences in the estimation approach/assumptions of the ICA and AMCI model were impossible to test in biological/fishery grounds. This mainly refers to:
    - How the selectivity pattern is estimated/assumed in both models and the fact that no conclusive independent data on possible changes in selectivity patterns across years, areas and/or age classes was available to the working group.
    - How the plus group age class is treated in each model and the lack of independent data on how important the 6+ group is in the stock.
- It was difficult to asses which of the models were assigning more appropriate relative weights to the sources of information used in the assessment
- Limited experience in the comparison between the ICA and AMCI software.
- Difficulties in comparing the goodness of fit of the ICA and AMCI models.

In order to overcome this problems, the 2002 WG recommended further investigation on the differences between AMCI and ICA and a revision of the independent sources of information used to fit the assessment models. Also, the new DEPM-based SSB estimate for 2002 and a new acoustic estimate for 2003, as well as feedback from a dedicated EU project SARDYN, in relation to questions regarding sardine distribution, migration and biology were expected to help overcoming last year situation.

Following those recommendations, a complete and extensive WD comparing the performance of AMCI and ICA, and highlighting the assumptions of both models, as well as their adequacy for this particular stock was presented (Skagen WD 2003). Also, all expected new data (new DEPM-based SSB estimate and a revision of previous SSB estimates, as well as a new acoustic estimate) was provided to the WG. Only the expected feedback from SARDYN failed, due to a delay in the start of this project.

9.7.1.2 Changes in selectivity and catchability.

Results from Skagen (WD 2003) show that Iberian sardine fishery shows some special features that difficult its study using conventional assessment tools. Mortality signals extracted from the catch data (Figure 9.7.1.2.1) show large fluctuations in the mortality of young ages in the time-series, and specially a large dip in middle 90's. Mortality signals in the acoustic surveys (Figure 9.7.1.2.2) show clear differences between the signals from the Spanish March survey and the Portuguese surveys. Apparent negative mortalities (numbers increasing with age) are shown in the Spanish survey, suggesting a net immigration of fishes into the area covered by the Spanish survey. This is further investigated by plotting the age composition of the acoustic survey in Spain (Figure 9.3.2.1.1). A clear trend in age composition in the Spanish survey is shown, with adult fish dominating the early part of the time-series (up to 1994), some intermediate years (1996-2000) with low numbers in general, and specially very low numbers of the later ages in comparison with the previous period, and recent years (200-2003) showing a large influence of the 2000 year class. These results are also shown in Silva (WD 2003), where additional information that suggest that Southern Galicia (Atlantic part of NW corner of Spain) show a mortality pattern more similar to West Portugal than to the Cantabric area. No clear trend of change in the Portuguese acoustic survey can be found, although large year variability and the effect of different strong year classes (1996 and 2000) is clear in the data.

These results indicate a change in selectivity through the time-series (Figure 9.7.1.2.1) and a change in the composition of the surveys, which can be due to some change in the survey catchabilities or to changes in the composition of the population. Both changes will produce a change in the apparent survey catchability used in the assessment model. Given that the Cantabric area appears now as mainly an area suffering inmigration (following the mortality curves shown in Figure 9.7.1.2.2), changes in the immigration intensity relative to the "resident" abundance will also change the apparent survey catchability.

9.7.1.3 Robustness of ICA to violation of assumptions

The application of ICA to sardine assessment was extensively explored in order to outline how the final estimates of mortality and abundance are influenced by the data (Skagen, WD2003). The analysis was carried out by forcing terminal fishing mortality and terminal selection to a range of values and looking at the fit of the model to the various individual data; a change in the residuals for a data set or for a particular observation highlights the need of a higher or lower mortality estimate to fit the model to that particular data set or observation. With the standard ICA software, it is not possible to fix the terminal S or F parameters at given values, therefore, a model similar to ICA was set on an Excel spreadsheet and tested with the sardine data from the 2002 Working Group sardine assessment. The outputs of this assessment were reproduced almost exactly with the spreadsheet ICA version. Using this tool, the behaviour of catch and survey residuals was analysed when fitting the model to catch data alone and to both catch and survey data and by screening a range of fixed values of both the terminal S (considered as the ratio of fishing mortality-at-age 5 relative to fishing mortality at reference age, age 3) and the terminal F.

Figure 9.7.1.3.1 summarises the effect of the choice of terminal S and terminal F on the trajectories of fishing mortality. The choice of terminal F mainly affects the most recent years while changes in the terminal S affect particularly the oldest ages but appears for all separable years (Skagen, WD2003). The effect of selection is carried out to the earlier period due to the fact that ICA uses the estimated selection in the beginning of the separable period to start the VPA for the earlier period. It was observed that the catch data have some influence on the choice of terminal F and little impact on the choice of terminal S. The best fit to the catch data alone is achieved with smaller stock numbers, mainly in the period from 1996 onwards. The fit to the surveys with the constraint set by the catches is mostly a compromise between improving the fit to the Spanish survey at the expense of the Portuguese surveys. Overall, the fit to both the catch data alone and to catch and survey data is dominated by a small number of data points, which also create generally large residuals, either because they are outliers or because the model assumptions are not appropriate.

The adequacy of some assumptions of the ICA model applied to sardine in recent years, constant catchability and two periods of separable selection, were discussed on the light of the results from previous assessments and of the exploratory analysis of catch and survey data carried out by Skagen (WD 2003). The evolution of log-catch-ratios shows a dip decrease in selection for the young individuals (LCR for ages 1 and 3) in the first half of the 1990's that appears to have reversed in recent years and a slight downward trend in selection for the whole data series (Figure 9.7.1.2.1). On the other hand, an increase in the selection of older individuals (LCR between ages 3 and 5) is observed. The ICA model interprets this change in selection adapting the overall fishing mortality level and therefore, the estimates of population numbers. The sharp increase in selection of young individuals from 1995 to 1998 appears to be responsible by the increase in the reference fishing mortality in the same period.

Changes in catchability-at-age with time are suggested by both the Spanish and the Portuguese survey data (see Section 9.7.1.2). The Portuguese March survey indicates an increase in the catchability of the young fish and a decrease in the old fish in recent years (since 1996). The Spanish March survey is dominated by older individuals but their abundance has decreased considerably in the 1990's, a trend that is opposite to that indicated by the Portuguese surveys. Although these catchability changes could arise from changes in the survey equipment or methodology, it is more likely that they are a consequence of changes in the distribution and age structure of the population in the Portuguese and Spanish areas, as discussed in section 9.7.1.2. The ICA model assumes a constant catchability for each survey series and will therefore apply an approximately average catchability estimate to the whole time-series. If this estimate does not reflect the pattern in some of the years, the model will possibly adjust the population numbers by trying to adapt the mortality in those years.

To try to overcome this problem, an ICA run (RUN 1) using only the recent surveys (1996-2003) was carried out and the output was compared to a run similar to that selected as the best ICA run in last year's assessment (basis run). The change in survey and catch residuals from the basis run to run 1 are shown in Figures 9.7.1.3.2 and 9.7.1.3.3. From these plots, a decrease in the residuals at young ages and an increase at old ages occurs in the Spanish survey and the opposite trend is seen in the Portuguese November survey when only the recent surveys are used in the assessment. A negative trend is observed in the residuals from the Portuguese March survey and catch residuals are generally homogeneously distributed with some isolated large values in the mid 1990's.

The overall fit of the model did not show a considerable improvement due to the influence of recent catchability estimates for each survey on the estimates of the population in the earlier period.

An additional run was carried out, as an attempt to improve the estimation of survey catchability: in this run (RUN 2), the abundance estimates from the two March survey series, Portuguese and Spanish, were combined (summed) for the period where both estimates are available, 1996-2003. The November Portuguese survey was not used in this run but the DEPM estimates were kept as absolute indices. The pattern of residuals was improved in this trial, however, the catchability variation with age became more acceptable mainly for the Spanish March survey. Merging the Portuguese and Spanish March surveys seems a reasonable option to calibrate the combined Portuguese and Spanish catch-at-age data. In fact, the two surveys cover different areas of the stock which have complementary age structures that have not been stable with time (see also Section 9.7.1). However, if it is shown that the two surveys do not cover the same stock unit or that they provide an assessment of only a part of the stock, then they should not be combined. In case it is possible to merge them, a calibration is needed to establish how their estimates should be combined.

The perspective of the stock given by the ICA exploratory runs is shown in Figure 9.7.1.3.4. The base run provides a perception of the stock history which is considerably optimistic and does not reflect the historical trend indicated by the catch and survey information in both Portuguese and Spanish waters (see section 9.3.2 and 9.7.1.2). The SSB estimated by the model fits reasonably well to that given by the DEPM survey (absolute SSB estimator) in 1999 but not in 2002, where it is approximately the double. Runs 1 and 2 estimates of SSB, recruitment and fishing mortality are generally overlapping and indicate a less higher stock in the 1990's than in the 1980's which is more consistent with the perspective from the data.

The accumulated experience with the ICA model and the above exploration highlight that ICA is not able to cope with the apparent changes in survey catchability and selection observed in the sardine data, it is very sensitive to options regarding the separable period and does not estimate mortality in the plus group. In addition, the stock perspective provided by ICA shows large deviations from that derived from survey data. Therefore, the WG decided not to use ICA as the method to assess the sardine stock.

9.7.1.4 Using AMCI to assess Iberian sardine

Potentially, AMCI allows to analyse fishery data that shows gradual changes in selectivity across years and age classes and changes in catchability (Skagen 2000). Thus, in theory no restrictive assumptions about these parameters are imposed. Nevertheless, special care should be taken when too many parameters are to be fitted in the model, as overparameterisation can happens, and related bias in the assessment can occur.

A number of trial runs using AMCI were set to try to find those that better analyse the available data on Iberian sardine. A brief description of the different runs is shown in Table 9.7.1.4.1. Run 0 follows the preferred option last year. It does explore AMCI potential to model smooth changes in catchability and selectivity, but fixing the selectivity to be fixed from age 3+ onwards. Alternatives tried include:

1 fixing the catchability for all time-series (making AMCI use more similar assumptions to ICA),

2 using a separable period and only the recent acoustic surveys (to avoid possible changes in catchability),

3 downweighting the 6+ group in order to test the sensitivity of the model to the behavior of this group, and

4 allowing the selectivity to change smoothly for all years and ages but restricting the change in catchability to a step function, with the two periods of different catchabilities specified as 1984-1992 and 1993-2003.

All runs use the acoustic time-series as a relative index, and DEPM-based SSB estimates as absolute. DEPM estimates are provided by the SGSBSA (see section 9.3.1). All DEPM estimates have been revised by the SGSBSA and not reliable years have been taken out of the assessment, while the reliability of the remaining ones have been proven by consistency with different estimation methods. Also, all trials have use a common weight of each independent series, equal to the weight of the catches in the model. Natural mortality is set to 0.33, the spawning quarter is the first quarter and the recruitment quarter is the fourth quarter.

The option of allowing both selectivity and catchability to change smoothly for all ages and years was not considered, as the model may be overparameterised, and problems in distinguish between selectivity and catchability may appear.

Main changes in the different runs are the estimated survey catchabilites, given the different assumptions used, and the estimated selection pattern. Also, for the special case of downweighting the 6+ group, trajectories of SSB and F in the past are very different than in the rest of the models, reflecting the importance of this group in past catches and surveys.

Figure 9.7.1.4.1 shows the different estimated catchabilites in run 0, run 1, run 3 and run 4.

Figure 9.7.1.4.1a shows the trends in catchability when a flexible trend is allowed in the model (Run 0). The modelled catchabilites pick up an increase in 6+ catchability from 86 to 94 in the Spanish survey and a decreasing trend from 96 onwards. Catchabilities are in general higher for older ages in the Spanish survey, and for intermediate ages in the two Portuguese surveys. Nevertheless, the trajectories show a large degree of noise and probably incorporate interannual variability and miss-interpretation between catchability and selectivity.

Figure 9.7.1.4.1b shows the catchability trends obtained when catchability is set to fixed in all the time-series (Run 1). The modelled catchabilities are relatively higher for older ages in the Spanish survey, while relative low for the 6+ class in the Portuguese surveys. In absolute values, the catchability of both the Spanish March and the Portuguese November survey is lower than the Portuguese March survey, and some large values observed in Figure 9.7.1.4.1a are smooth out. The changes in the age composition in the recent Spanish surveys and in the catches are not very well represented by this catchability model.

Figure 9.7.1.4.1c shows the catchability trends obtained when a separable period and only the recent acoustic surveys are used (Run 2). Using this model, absolute values of the Spanish catchability is smaller than in the previous ones, while catchabilites of intermediate ages in the Portuguese November survey show a large value, higher than the catchabilites observed in previous runs. This pattern tries to reproduce the actual situation of Iberian sardine, with larger part of the stock in Portuguese waters, so catchability of the Spanish surveys are regarded as very low. Nevertheless, this option did not take into account any past history of the stock and rely on the catchability and selectivity patterns estimated in the separable period to be used back in the past history.

Figure 9.7.1.4.1d shows the catchability trends obtained with the step catchability function, split into two periods (84-93, 94-03) (Run 4). Catchabilites of older ages decrease in the recent period in the Spanish Survey, while generally increases in the Portuguese November survey. This perception of the stok is believed to represent both real changes in the catchability (increase in catchability in the Portuguese survey) and possible changes in the population composition which cause an apparent change in catchability (changes in relative catchability in the Spanish survey).

Figure 9.7.1.4.2 shows the different selection patterns obtained with the assumptions used (Run 0, Run 3 and Run 4)

Figure 9.7.1.4.2a shows the fitted selection pattern when selection of ages 3 to 6+ is fixed (Run 0). The variations in the flat top reflect changes in absolute mortalities in the different years. Selectivity increases gradually for the initial ages up to the assumed flat top, and for the initial years, the selection pattern is forced to create an abrupt peak in age 2+.

Figure 9.7.1.4.2b shows the fitted selection pattern when selection is allowed to vary smoothly through all ages, but the 6+ group is downweighted (Run 3). The selection pattern shows a smooth increase through all ages, without too much differences between years.

Figure 9.7.1.4.2c shows the fitted selection pattern when selection is allowed to vary smoothly through all ages, and all ages get the same weight in the analysis (except age 0+ which is downweighted in all runs, Run 4). Selection in the initial years of the time-series show a flat top similar to that assumed in Run 0, but selection in recent years show a peak in age 5 while a decrease in selectivity in age 6+. This pattern represent a change in selectivity in recent years when age 6+ dissapeared from catches, specially in the Cantabric coast, where the presence of the 6+ class was more important in older years.

Figure 9.7.1.4.3 shows the different recruitment, SSB and F trajectories for the different runs. Recruitment values are very similar for all runs. Run 0, Run 1 and Run 2 are very similar in all the trajectories, while Run 3 and Run 4 differ slightly on the perception of the relative high of previous SSB peaks, due to differences in the estimated F values. Run 3 show very high mortalities in the initial years of the time-series, with a steady decreasing trend in the time-series. This reduces the SSB estimates of the initial years of the time-series, while increases the SSB levels in recent years. The explanation of the large F values in the initial years is due to the downweighting of the 6+ group. As residuals in this group are not very important for the fit, the model allow for a large mortality which will produce low numbers in this group. This is in conflict with the observed abundances of 6+ in the surveys and in the catches, and so when the 6+ is not downweighted, all models produce a lower F value for the old period. Run 4 estimate lower mortalities in the first half of the 90's, thus increasing the SSB values in this period. There are two things that can explain this difference:

- On the 1988-1996 period, there are only Spanish surveys (and one Portuguese survey) to adjust the catch data. The catchability in these period may be slightly overestimated in the split model and thus the mortalities maybe subestimated.

- Also, over this period, there is an observed abrupt decrease in the log catch ratios of young ages (see Figure 9.7.1.2.1). The decrease is quite spikey and the model acts reducing the general F values to accommodate this dip.

Some questions remain on which catchability assumption, split catchability (Run 4) or smooth catchability (Run 0) represent better the Iberian sardine stock through the time-series. Nevertheless, the signals of overparameterisation and the spikey catchability signals observed in the smooth catchability model prevent the WG to use the smooth model. Also, although abrupt, the change in catch ratio observed in the data could represent a real situation with an abrupt change in fish mortality through the mid 90's, which is accomodated by a decrease in mortality in the model represented by Run 4. Fixed catchability models, as well as models with downweighting of 6+ age class are regarded as unrealistic, due to the reasons explained above. Using only recent years of the survey time-series does not improve the performance of the model, and represent a loss of information about the past history of the stock. Due to these reasons, the WG decided that the split catchability model represent the actual understanding of the Iberian sardine stock adequately, and outperforms the rest of the trial runs used to explore the data. Thus, the model represented by Run 4 is the one decided to be used in the final assessment.

9.7.2 Stock assessment

Stock assessment of sardine this year is carried out for the first time using the AMCI software, due to the reasons outlined in section 9.7.1 above. The selected AMCI run from the exploratory analysis comprise the following model options:

- M = 0.33, 1st quarter=spawning quarter, 3rd quarter= recruitment quarter

- Smooth model of selectivity across all ages and through the time-series (AMCI gain set to 0.2)

- Fixed catchability split in two periods, 1984-1992 and 1993-2003

- Acoustic survey index used as relative, DEPM-based SSB as absolute. Same weight for both series and equivalent to the weight of catches (all weights set to 1)

- Downweighting of 0 group (weight of 0.1)

Table 9.7.2.1 shows the input data used for the assessment, and Tables 9.7.2.2-4 the output of the assessment. Figure 9.7.2.1 shows the evolution of recruitment, SSB and F for the time-series. Recruitment for 2002 is predicted low by the model, while SSB increases from 2001and arrives up to 501 thousand tonnes in 2002. This increase is due to the influence of the 2000 year class. Fishing mortality trend continue to be decreasing, arriving in 2002 to the lower value in the time-series (F=0.23).

Figure 9.7.2.2 shows the catch residuals and Figure 9.7.2.3 the survey residuals. Some downwards trend and a below 0 median of the catch residuals is apparent in figure 9.7.2.2. Nevertheless, this trend is mainly caused by age 0 catches, which are downweighted in the model, and are known to be not well represented by the surveys. Residual trend of the other age classes do not show any alarming trend. Survey residuals show a small, opposite, trend in recent years in the Spanish March survey and in the Portuguese November survey. As both indexes enter the model as independent series for the whole stock, these trends probably cancel out each other.

Survey catchability is shown in Figure 9.7.1.4.1d. Catchabilites in both the Spanish March survey and the Portuguese November survey show a large change in the two selected periods (84-93, 94-03). Survey catchability of age 6+ was large in the first period in the Spanish March survey, in agreement with the observations in Figure 9.7.2.1.12. In this first period, there is an increasing trend in catchability with age in the Spanish survey, while catchabilities are lower for old and young ages in comparison with intermediate ones in the Portuguese November survey. In the second, more recent, period, there is a general decrease in catchability in the Spanish survey, specially in the 6+ age class. In the Portuguese November survey on the other hand, there is an increase in catchability, specially in young and old year classes (with the exception of 6+ which remains very low). The Portuguese Match survey shows in this period a similar catchability pattern than the November Portuguese survey.

Selection pattern across years and ages is shown in Figure 9.7.1.4.2c. Selection patterns in older years show a very similar trend to the one assumed in ICA, with increasing selectivity for older ages and a flat top of constant selectivity for ages 3 to 6. Nevertheless, in recent years, there is an increase in selectivity on ages 4 and 5, while a decrease in selectivity in age 6+. This represent the disappearance of the 6+ group in the cathes, even more intensively than from the surveys.

Non parametric bootstrap on log residuals of survey and catches, and parametric bootstrap on DEPM-based SSB estimates, assuming a log-normal distribution with variance equal to 0.3, was carried out to obtain a series of bootstrap estimates of recruitment, SSB, mortality and catches. Figure 9.7.2.6 shows the mean trajectories of recruitment, SSB and F-values trajectories for 499 bootstrap runs, as well as the 90% confidence intervals and the estimated standard deviationt Mean trajectory is computed by taking the mean yearly value of either recruitment, SSB or mortality for all bootstrap runs. Estimate coefficient of variance (CV) of the SSB and F estimates are 18% and the estimate CV of Recruitment is 14%.

Figure 9.7.2.7 shows the relation between F-values and SSB for the time-series in all bootstrap years. Mean trajectory for this plot was computed by grouping F-values in 30 classes and computing average F and average SSB in each of this classes. 90% confidence intervals and estimated standard deviations are also shown in the plot.

9.7.3 Reliability of the assessment

The major difficulties in the assessment of the sardine stock in recent years are due to apparent changes in selection and catchability that are believed to reflect ecological differences within the areas and not real changes in the fishery or methodological changes in surveys. Different changes in selection and catchability are observed in different areas of the stock and these areas are covered by different acoustic surveys with are then use to tune the total catches-at-age coming from the whole area. In pratice, this situation results in a conflict between the signals given by each of the surveys in the model. This conflict is dealt with by different models in different ways and also within the same model depending on the weighting of the different sources of information and on the influence that each of the sources has on the estimation of the final fishing mortalities. Uncertainties regarding the absolute stock abundance and to the relation between the biomass levels in recent years when compared to the 1980's has added uncertainty to the selection of an adequate assessment model.

The changes in catchability violate one of the main assumptions of ICA (constant catchability). Assumptions regarding the selection pattern have a limited flexibility in ICA that was shown not to be able to treat the apparent changes selection in a satisfactory way. The AMCI model selected this year has the possibility to model both changes in selection and catchability, although it was set up using two periods of fixed catchability to avoid overparametrisation. The selection of the final model took mainly into account the improve in the survey catchability pattern achieved by splitting the survey series in two periods. Furthermore, the selection pattern estimated by the model reflects satisfactorily the variations in the catch-at-age data that have plausible biological basis. The model fit, both regarding catch and survey residuals does not show a significant improve comparatively to the other models explored: catch residuals are relatively low and random except for the 0-group (which is downweighted in the catches) and survey residuals are also relatively random except in recent years of the Spanish survey and also in recent years of the November survey.

The perception of the stock history provided by the selected model is in agreement with the perception of the fishery and with the abundance and age composition of the population shown by the acoustic surveys. Furthermore, the absolute biomass level estimated in recent years is comparable with the DEPM-based SSB estimates that are currently considered reliable estimates of the absolute stock biomass.

The WG considers that a considerable progress was made in the assessment of this stock regarding the selected AMCI model, due the larger flexibility of this model that permits to accommodate some of the assumptions implicit in the data. The perspective of the stock provided in this assessment is believed to be closer to the actual state of the stock than in previous assessments. However, the perspective of the stock in the Spanish waters continues to indicate a lower abundance level than that provided by the overall stock picture. There is still the need to review some of the acoustic data that were highlighted as possible outliers in the exploratory analysis and to investigate how the Portuguese and Spanish survey estimates compare in the perspective of merging them in the future.

9.8 Catch predictions

A deterministic short-term prediction was carried out using results from the final assessment (AMCI run 8). Recruitment in 2002 was assumed to be low, as it was observed in the acoustic surveys. The AMCI estimate was also low, but due to the low precision of this estimate, it was replaced by the geometric mean of the recruitments below 25% percentile, and numbers-at-age 1 in 2003 were calculated according to it. Recruitment in the following years was estimated as the geometric mean of the recruitments for the whole time-series (1978-2002).

Weights-at-age in the stock and in the catch were calculated as the arithmetic mean value of the three last years (2000-2002). The maturity ogive and the exploitation pattern corresponded to the 2002 values. As in the assessment, input value for natural mortality was 0.33 and input values for the proportion of F and M before spawning were 0.25.

Input values and results are shown in Tables 9.8.1.1 and 9.8.1.2. Fishing 100000 tons in 2003 and continue fishing at that level, that is equal to $F_{(2-5)} = 0.20$, the predicted yield in 2004 (104443 t) is close to that observed in 2002. However, SSB will decrease from 513 thousand t. in 2003 to 473 thousand t. and 453 thousand t. in the following years, if no new strong year classes enter the fishery.

9.9 Uncertainty in the assessment

The main sources of uncertainty of the current sardine assessment are related to the definition of the outer limits of the stock unit and to the scarce knowledge on the movements and migrations of fish between areas both within the current stock boundaries and across these boundaries. The Cantabric area is nowadays regarded as an area with large inmigration, but inmigration intensity and relative importance of the possible sources of inmigrants are unknown. Northern limit of the stock (French coast) does not reflect the continuity observed in sardine egg distribution, and the presence of fish with different age classess in the inner bay of biscay on the Spanish acoustic survey have been hypothesised as fishes coming from the French area. During the last french acoustic surveys, large fluctuations of sardine abundance were observed from one year to another, and the relation between these fluctuactions and the inmigration into the Cantabric area is unknown. In future years, the French acoustic and biological data can be a valuable source of information for improving the understanding the sardine dynamics in this area. There are also increasing doubts regarding the validity of the southern stock boundary (e.g Silva, in press). A migration pattern from recruitment areas off the west Iberian coast to the northern Spanish coast is suggested by the age composition of the population in the two areas (e.g. Skagen, 2003 WD), however the movement of fish between the Cantabrian and the adjacent French area is also a plausible hypothesis, and the relative importance of both sources are unknown. This situation also highlights the need of assessment methods that are able to take into account the spatial distribution in sardine population and its dynamics. This is one of the expected outcomes of the EU project Sardyn that is on course.

The associated uncertainty with the SSB trajectory estimated by the bootstrap estimates makes it difficult to compare the absolute levels and relative importance of the biomass peaks in the historical trajectory. The reliability of recent stock biomass levels has improved due to the DEPM-based SSB estimates but past absolute biomass levels are still very uncertain. Reliable biomass estimates for earlier years are available on a regional basis and these can by incorporated into assessment if an area-based model is applied to this stock.

9.10 Reference points for management purposes

The Study Group on the Precautionary Approach to Fisheries Management (ICES 1998b) did not consider any reference points for sardine. In addition, ACFM concluded that since the state of the stock in relation to precautionary reference points is considered to be unknown, no precautionary approach reference points are proposed.

The reliability of the recent estimates of the absolute size of this stock improved and the historical trend provided by the current assessment is compatible with the various sources of information. However, historical absolute biomass levels remain uncertain. The WG believes that a considerable progress was made in the effort to find an appropriate model to describe the stock. However, the stability of the assessment with the current model has still to be assessed. Therefore the Working Group concluded that no reference points for management purposes should be suggested.

9.11 Harvest control rules

No harvest control rules were proposed for sardine by the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998b).

9.12 Management considerations

At present the Spawning Stock Biomass of this stock is considered high due to the strong 2000 year class. The assessment indicates a SSB of 500 thousand tonnes which corresponds to 75% of the highest value of this series. The DEPM-based SSB estimate for this stock in 2002 is comparable to the model estimate (442 thousand tonnes) indicating a 65% increase from 1999. Fishing mortality shows a decreasing trend since 1998. Management measures undertaken by Spain and Portugal to reduce the fishing effort and the overall catches may have contributed to this decrease.

The 2000 year class has been confirmed as a good year class with a strength comparable to the one from 1991. However, unlike the 1991 year class, the 2000 recruitment was restricted to the north Portuguese coast although it was observed to extend to the adjacent areas in the following year (Galicia and southwest Portugal). On the other hand, the abundance of sardine in the Cantabrian area continues to be low when compared to the mid 1980's. The population structure in this area is now dominated by young age groups contrary to the historical dominance of old sardine (age 6+), what might by a sign of the intense exploitation level. The assessment suggests that the 2001 year class is also above average and there is some support to this from both Portuguese and Spanish survey data. On the other hand, the 2002 year class seems to be one of the lowest in all the historical series. Therefore, short-term catch predictions indicate that catches in 2004 will be at the current level if fishing mortality is maintained, however, the SSB will decrease from 2003 onwards, unless a new strong year class enters the stock. These predictions highlight the dependence of the stock on the recruitment strength and alert to the possibility of a reversal in the current optimistic situation in the short-term.

In addition, there are uncertainties regarding the stock unit and movements both within stock subareas and with areas adjacent to the current boundaries that may affect the dynamics of the stock in ways that are not expected. Therefore, a close monitoring of the this stock is still needed. The WG considers that sardine catches should be kept at a level similar to that in 2002 (100 thousand tonnes) to prevent a short-term decline in the SSB.

9.13 Stock identification, composition, distribution and migration in relation to climatic effects

No new information on stock identification, composition, distribution or migration was presented in this WG. Nevertheless, there is an important amount of ongoing work within in relation to this issues which are expected to report to the WG in soon. Most of this work is being carried out within the EU project SARDYN, which main objectives include sardine stock identification, dynamics and the development of sardine specific assessment models.

Table 9.2.1: Quaterly distribution of sardine landings (t) in 2002 by ICES Sub-Division. Above absolute values; below, relative numbers

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	3660	1961	551	1810	**7982**
VIIIc-W	508	2204	3505	1685	**7903**
IXa-N	59	1791	1734	978	**4562**
IXa-CN	1913	6164	12815	12693	**33585**
IXa-CS	4077	5554	8285	5053	**22969**
IXa-S (A)	2186	3283	3681	1832	**10982**
IXa-S (C)	2735	2066	4105	2783	**11689**
Total	**15137**	**23024**	**34676**	**26835**	**99673**

Sub-Div	1st	2nd	3rd	4th	Total
VIIIc-E	3.67	1.97	0.55	1.82	**8.01**
VIIIc-W	0.51	2.21	3.52	1.69	**7.93**
IXa-N	0.06	1.80	1.74	0.98	**4.58**
IXa-CN	1.92	6.18	12.86	12.74	**33.70**
IXa-CS	4.09	5.57	8.31	5.07	**23.04**
IXa-S (A)	2.19	3.29	3.69	1.84	**11.02**
IXa-S (C)	2.74	2.07	4.12	2.79	**11.73**
Total	**15.19**	**23.10**	**34.79**	**26.92**	

Table 9.2.2: Iberian Sardine Landings (tonnes) by sub-area and total for the period 1940-2002.

	Sub-area										
Year	VIIIc	IXa North	IXa Central North	IXa Central South	IXa South Algarve	IXa South Cadiz	All sub-areas	Div. IXa	Portugal	Spain (excl.Cadiz)	Spain (incl.Cadiz)
1940	66816		42132	33275	23724		**165947**	**99131**	**99131**	**66816**	**66816**
1941	27801		26599	34423	9391		**98214**	**70413**	**70413**	**27801**	**27801**
1942	47208		40969	31957	8739		**128873**	**81665**	**81665**	**47208**	**47208**
1943	46348		85692	31362	15871		**179273**	**132925**	**132925**	**46348**	**46348**
1944	76147		88643	31135	8450		**204375**	**128228**	**128228**	**76147**	**76147**
1945	67998		64313	37289	7426		**177026**	**109028**	**109028**	**67998**	**67998**
1946	32280		68787	26430	12237		**139734**	**107454**	**107454**	**32280**	**32280**
1947	43459	21855	55407	25003	15667		**161391**	**117932**	**96077**	**65314**	**65314**
1948	10945	17320	50288	17060	10674		**106287**	**95342**	**78022**	**28265**	**28265**
1949	11519	19504	37868	12077	8952		**89920**	**78401**	**58897**	**31023**	**31023**
1950	13201	27121	47388	17025	17963		**122698**	**109497**	**82376**	**40322**	**40322**
1951	12713	27959	43906	15056	19269		**118903**	**106190**	**78231**	**40672**	**40672**
1952	7765	30485	40938	22687	25331		**127206**	**119441**	**88956**	**38250**	**38250**
1953	4969	27569	68145	16969	12051		**129703**	**124734**	**97165**	**32538**	**32538**
1954	8836	28816	62467	25736	24084		**149939**	**141103**	**112287**	**37652**	**37652**
1955	6851	30804	55618	15191	21150		**129614**	**122763**	**91959**	**37655**	**37655**
1956	12074	29614	58128	24069	14475		**138360**	**126286**	**96672**	**41688**	**41688**
1957	15624	37170	75896	20231	15010		**163931**	**148307**	**111137**	**52794**	**52794**
1958	29743	41143	92790	33937	12554		**210167**	**180424**	**139281**	**70886**	**70886**
1959	42005	36055	87845	23754	11680		**201339**	**159334**	**123279**	**78060**	**78060**
1960	38244	60713	83331	24384	24062		**230734**	**192490**	**131777**	**98957**	**98957**
1961	51212	59570	96105	22872	16528		**246287**	**195075**	**135505**	**110782**	**110782**
1962	28891	46381	77701	29643	23528		**206144**	**177253**	**130872**	**75272**	**75272**
1963	33796	51979	86859	17595	12397		**202626**	**168830**	**116851**	**85775**	**85775**
1964	36390	40897	108065	27636	22035		**235023**	**198633**	**157736**	**77287**	**77287**
1965	31732	47036	82354	35003	18797		**214922**	**183190**	**136154**	**78768**	**78768**
1966	32196	44154	66929	34153	20855		**198287**	**166091**	**121937**	**76350**	**76350**
1967	23480	45595	64210	31576	16635		**181496**	**158016**	**112421**	**69075**	**69075**
1968	24690	51828	46215	16671	14993		**154397**	**129707**	**77879**	**76518**	**76518**
1969	38254	40732	37782	13852	9350		**139970**	**101716**	**60984**	**78986**	**78986**
1970	28934	32306	37608	12989	14257		**126094**	**97160**	**64854**	**61240**	**61240**
1971	41691	48637	36728	16917	16534		**160507**	**118816**	**70179**	**90328**	**90328**
1972	33800	45275	34889	18007	19200		**151171**	**117371**	**72096**	**79075**	**79075**
1973	44768	18523	46984	27688	19570		**157533**	**112765**	**94242**	**63291**	**63291**
1974	34536	13894	36339	18717	14244		**117730**	**83194**	**69300**	**48430**	**48430**
1975	50260	12236	54819	19295	16714		**153324**	**103064**	**90828**	**62496**	**62496**
1976	51901	10140	43435	16548	12538		**134562**	**82661**	**72521**	**62041**	**62041**
1977	36149	9782	37064	17496	20745		**121236**	**85087**	**75305**	**45931**	**45931**
1978	43522	12915	34246	25974	23333	5619	**145609**	**102087**	**83553**	**56437**	**62056**
1979	18271	43876	39651	27532	24111	3800	**157241**	**138970**	**91294**	**62147**	**65947**
1980	35787	49593	59290	29433	17579	3120	**194802**	**159015**	**106302**	**85380**	**88500**
1981	35550	65330	61150	37054	15048	2384	**216517**	**180967**	**113253**	**100880**	**103264**
1982	31756	71889	45865	38082	16912	2442	**206946**	**175190**	**100859**	**103645**	**106087**
1983	32374	62843	33163	31163	21607	2688	**183837**	**151463**	**85932**	**95217**	**97905**
1984	27970	79606	42798	35032	17280	3319	**206005**	**178035**	**95110**	**107576**	**110895**
1985	25907	66491	61755	31535	18418	4333	**208439**	**182532**	**111709**	**92398**	**96731**
1986	39195	37960	57360	31737	14354	6757	**187363**	**148168**	**103451**	**77155**	**83912**
1987	36377	42234	44806	27795	17613	8870	**177696**	**141319**	**90214**	**78611**	**87481**
1988	40944	24005	52779	27420	13393	2990	**161531**	**120587**	**93591**	**64949**	**67939**
1989	29856	16179	52585	26783	11723	3835	**140961**	**111105**	**91091**	**46035**	**49870**
1990	27500	19253	52212	24723	19238	6503	**149429**	**121929**	**96173**	**46753**	**53256**
1991	20735	14383	44379	26150	22106	4834	**132587**	**111852**	**92635**	**35118**	**39952**
1992	26160	16579	41681	29968	11666	4196	**130250**	**104090**	**83315**	**42739**	**46935**
1993	24486	23905	47284	29995	13160	3664	**142495**	**118009**	**90440**	**48391**	**52055**
1994	22181	16151	49136	30390	14942	3782	**136582**	**114401**	**94468**	**38332**	**42114**
1995	19538	13928	41444	27270	19104	3996	**125280**	**105742**	**87818**	**33466**	**37462**
1996	14423	11251	34761	31117	19880	5304	**116736**	**102313**	**85758**	**25674**	**30978**
1997	15587	12291	34156	25863	21137	6780	**115814**	**100227**	**81156**	**27878**	**34658**
1998	16177	3263	32584	29564	20743	6594	**108924**	**92747**	**82890**	**19440**	**26034**
1999	11862	2563	31574	21747	18499	7846	**94091**	**82229**	**71820**	**14425**	**22271**
2000	11697	2866	23311	23701	19129	5081	**85786**	**74089**	**66141**	**14563**	**19644**
2001	16798	8398	32726	25619	13350	5066	**101957**	**85159**	**71695**	**25196**	**30262**
2002	15885	4562	33585	22969	10982	11689	**99673**	**83787**	**67536**	**20448**	**32136**

Div. IXa = IXa North + IXa Central-North + IXa Central-South + IXa South-Algarve + IXa South-Cadiz

Table 9.3.1.2.1 Level of sardine DEPM sampling off Iberia: number of ichthyoplankton (total) and fishing stations (with sardine) by year and stratum.

Variable	Year	9.13.1.1 outh	W Port	Galicia	W Cant	E Cant	Total
Eggs	1988	59	245	188	230	93	825
	1990	-	-				
	1997	139	245	188	175	141	888
	1999	151	274	141	189	60	815
	2002	156	328	129	109	75	797
Adults	1988	1	10	14	9	6	40
	1990	-	-	8	1	3	12
	1997	10	16	-	3	6	35
	1999	11	29	1	-	6	47
	2002	32	42	7	11	10	102

Table 9.3.1.2.2 Spanish estimates of DEPM parameters.

Year	Variable	GAL	W CANT	E CANT	Total
1988	Egg production				2.97 (33)
	Female weight	64.9 (6)	79.3 (8)	86.3 (3)	
	Batch fecundity	27.3 (6)	33.8 (9)	33.9 (3)	
	Spawning fraction	0.08 (20)	0.13 (11)	0.21 (13)	
	Sex ratio	0.35 (12)	0.65 (11)	0.66 (33)	
	Spawning biomass	**134.2 (66)**	**33.5 (30)**	**12.5 (56)**	**180.2 (50)**
1990	Egg production				1.78 (58)
	Female weight	68.1 (12)	83.7 (2)	83.6 (1)	
	Batch fecundity	26.9 (26)	33.0 (19)	33.0 (20)	
	Spawning fraction	0.10 (32)	0.11 (91)	0.20 (20)	
	Sex ratio	0.56 (8)	0.53 (38)	0.45 (28)	
	Spawning biomass	**24.2 (40)**	**46.1 (72)**	**7.4 (27)**	**77.7 (45)**
1997	Egg production				0.72 (82)
	Female weight				70.1 (6)
	Batch fecundity				26.5 (5)
	Spawning fraction				0.18 (15)
	Sex ratio				0.52 (11)
	Spawning biomass				**20.7 (84)**
1999	Egg production				0.34 (44)
	Female weight				66.3 (41)
	Batch fecundity				21.8 (12)
	Spawning fraction				0.14 (26)
	Sex ratio				0.55 (45)
	Spawning biomass				**13.4 (77)**
2002	Egg production	0	0.66 (32)	0.20 (31)	0.86
	Female weight	67.6 (11)	78.6 (8)	77.7 (6)	
	Batch fecundity	23.6 (13)	27.7 (8)	26.9 (6)	
	Spawning fraction	0.243 (38)	0.075 (14)	0.125 (20)	
	Sex ratio	0.519 (7)	0.604 (14)	0.494 (22)	
	Spawning biomass	**0**	**41.3 (39)**	**9.4 (44)**	**50.7 (33)**

Table 9.3.1.2.3 DEPM parameter estimates off Portugal

Year	Variable	W PORT	SOUTH	Total
1988	Egg production	1.25 (41)	NA	
	Female weight	39.4 (7)	NA	
	Batch fecundity	13.9 (8)	NA	
	Spawning fraction	0.140 (20)	NA	
	Sex ratio	0.473 (9)	NA	
	Spawning biomass	**53.5 (48)**	**NA**	**NA**
1997	Egg production	1.10 (34)	3.24 (39)	
	Female weight	48.5 (7)	43.09 (7)	
	Batch fecundity	18.0 (6)	16.1 (6)	
	Spawning fraction	?	?	
	Sex ratio	0.659 (4)	0.576 (6)	
	Spawning biomass	**?**	**?**	**?**
1999	Egg production	2.07 (30)	3.15 (34)	
	Female weight	45.8 (6)	42.1 (6)	
	Batch fecundity	18.6 (6)	17.6 (6)	
	Spawning fraction	0.133 (19)	0.070 (32)	
	Sex ratio	0.681 (5)	0.540 (7)	
	Spawning biomass	**56.3 (37)**	**199.3 (48)**	**255.6 (38)**
2002	Egg production	1.32 (24)	0.89 (36)	
	Female weight	48.4 (8)	40.4 (5)	
	Batch fecundity	16.0 (10)	12.6 (6)	
	Spawning fraction	0.024 (28)	0.039 (29)	
	Sex ratio	0.611 (3)	0.612 (5)	
	Spawning biomass	**272.3 (39)**	**119.6 (47)**	**391.9 (31)**

Table 9.3.1.2.4 SSB estimates (thousand tones, CV in brackets) by stratum, country and overall for each DEPM year (NA: data not available or not sufficient for estimation; ? – data available but currently not reliable). Values and columns in bold indicate series than can be used for assessment.

Year	WPORT	SOUTH	GAL	WCANT	ECANT	Portugal	Spain	Total
1988	**53.5 (48)**	NA	134.2 (60)	33.5 (30)	12.5 (56)	NA	**180.2 (50)**	**NA**
1990	**NA**	NA	24.2 (40)	46.1 (77)	7.4 (27)	NA	**77.5 (45)**	**NA**
1997	**?**	?	NA	NA	NA	?	**20.7 (84)**	**?**
1999	**56.3 (37)**	199.3 (48)	NA	NA	NA	255.6 (38)	**13.4 (77)**	**269.0 (37)**
2002	**272.3 (39)**	119.6 (47)	0	41.3 (39)	9.4 (44)	391.9 (31)	**50.7 (33)**	**442.6 (28)**

Table 9.3.1.2.5 Sardine spawning biomass estimates (thousand tones, CV in brackets) by stratum, country and overall for 1999 and 2002, based on post-stratified traditional estimates (PS-trad) and GAM-based estimates (GAM).

Year	WPORT	SOUTH	GAL	WCANT	ECANT	Portugal	Spain	Total
1999 PS-trad	56.3 (37)	199.3 (48)	NA	NA	NA	255.6 (38)	13.4 (77)	269.0 (37)
1999 GAM	47.0	241.6	1.9	12.5	13.5	288.6	27.9	316.5
2002 PS-trad	272.3 (39)	119.6 (47)	0	41.3 (39)	9.4 (44)	391.9 (31)	50.7 (33)	442.6 (28)
2002 GAM	291.2	99.8	6.6	33.3	11.5	391.0	51.4	442.4

Table 9.3.2.2.1 Sardine Assessment from the 2003 Portuguese November Acoustic Survey. Number of fish in thousands and biomass in tons.

AREA IXa S (Algarve)

AGE	0	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	355	7407	3755	1256	1405	640	1070	768	16657
% Biomass	2.1	44.5	22.5	7.5	8.4	3.8	6.4	4.6	
Abundance (N in '000)	10128	169079	71890	20884	19968	8827	14337	9133	324247
% Abundance	3.1	52.1	22.2	6.4	6.2	2.7	4.4	2.8	
Mean Weight	35.1	43.8	52.2	60.2	70.4	72.5	74.6	84.1	51.4
Mean Length	16.7	17.9	18.8	19.7	20.6	20.8	21	21.7	18.7

Table 9.3.2.2.2 Sardine Assessment from the 2003 Portuguese Spring Acoustic Survey
Number of fish in thousands and biomass in tons.

AREA IXa CN

AGE	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	39336	36609	55195	10268	9306	2731	35	153480
% Biomass	25.6	23.9	36.0	6.7	6.1	1.8	0.0	
Abundance (N in '000)	1929640	1118498	1345707	236989	181925	47992	450	4861200
% Abundance	39.7	23.0	27.7	4.9	3.7	1.0	0.0	
Mean Weight	20.4	32.7	41	43.3	51.2	56.9	78.7	31.6
Mean Length	14.8	17.2	18.5	18.8	19.9	20.5	22.8	16.8

AREA IXa CS

AGE	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	50531	48658	31516	7305	3850	2709	808	145376
% Biomass	34.8	33.5	21.7	5.0	2.6	1.9	0.6	
Abundance (N in '000)	3395537	1117686	621941	127141	59078	36830	11897	5370111
% Abundance	63.2	20.8	11.6	2.4	1.1	0.7	0.2	
Mean Weight	14.9	43.5	50.7	57.5	65.2	73.5	67.9	27
Mean Length	12.8	18.4	19.3	20.1	20.9	21.8	21.3	15.1

AREA IXa S

AGE	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	914	29064	14154	4674	5140	4278	1535	59759
% Biomass	1.5	48.6	23.7	7.8	8.6	7.2	2.6	
Abundance (N in '000)	30071	659598	279899	73897	77026	61434	19484	1201410
% Abundance	2.5	54.9	23.3	6.2	6.4	5.1	1.6	
Mean Weight	30.4	44.1	50.6	63.2	66.7	69.6	78.8	50
Mean Length	15.8	18.1	19	20.4	20.8	21	21.9	18.8

TOTAL PORTUGAL

AGE	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	90781	114331	100865	22247	18296	9718	2378	358615
% Biomass	25.3	31.9	28.1	6.2	5.1	2.7	0.7	
Abundance (N in '000)	5355248	2895782	2247547	438027	318029	146256	31831	11432721
% Abundance	46.8	25.3	19.7	3.8	2.8	1.3	0.3	
Mean Weight	17	39	45	51	58	66	75	31
Mean Length	13.5	17.9	18.8	19.4	20.3	21.0	21.7	16.2

AREA IXa S (Cadiz)

AGE	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	14912	35330	13179	5992	2556	1434	104	73508
% Biomass	20.3	48.1	17.9	8.2	3.5	2.0	0.1	
Abundance (N in '000)	486910	914575	278150	111369	43135	22089	1372	1857600
% Abundance	26.2	49.2	15.0	6.0	2.3	1.2	0.1	
Mean Weight	0.0	38.6	47.4	53.8	59.2	64.9	76.0	40
Mean Length	0.0	17.5	18.8	19.7	20.3	21.0	22.3	17.6

TOTAL

AGE	1	2	3	4	5	6	7+	TOTAL
Biomass (Tonnes)	105693	149661	114044	28239	20852	11152	2482	432123
% Biomass	24.5	34.6	26.4	6.5	4.8	2.6	0.6	
Abundance (N in '000)	5842158	3810357	2525697	549396	361164	168345	33203	13290321
% Abundance	44.0	28.7	19.0	4.1	2.7	1.3	0.2	
Mean Weight	18	39	45	51	58	66	75	33
Mean Length	13.8	17.8	18.8	19.5	20.3	21.0	21.7	16.4

Table 9.3.2.3 Sardine Assessment from the 2003 Spanish Spring Acoustic Survey
Number of fish in thousands and biomass in tons.

AREA VIIIcE

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	1417	37378	37776	27926	16588	6684	3280	593	494	222	132358
% Biomass	1.1	28.2	28.5	21.1	12.5	5.0	2.5	0.4	0.4	0.2	100
Abundance (N in '000)	30141	606398	517660	350695	187646	73782	34120	6031	5175	2687	1814335
% Abundance	1.7	33.4	28.5	19.3	10.3	4.1	1.9	0.3	0.3	0.1	100
Mean Weight	46	61	71	78	86	88	94	96	93	81	71
Mean Length	18.6	20.2	21.3	21.9	22.7	22.9	23.3	23.5	23.3	22.3	21.3

AREA VIIIcW

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	240	5471	18665	5350	1258	967	165				32116
% Biomass	0.7	17.0	58.1	16.7	3.9	3.0	0.5				100
Abundance (N in '000)	5703	89014	283030	70289	15127	10977	1837				475978
% Abundance	1.2	18.7	59.5	14.8	3.2	2.3	0.4				100
Mean Weight	42	60	64	74	81	86	88				66
Mean Length	17.9	20.2	20.7	21.6	22.2	22.7	22.8				20.8

AREA IXaN

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	255	3724	13389	2489	421	148					20425
% Biomass	1.2	18.2	65.6	12.2	2.1	0.7					100
Abundance (N in '000)	6531	78360	240549	38599	6366	1917					372322
% Abundance	1.8	21.0	64.6	10.4	1.7	0.5					100
Mean Weight	38	47	55	63	65	76					54
Mean Length	17.5	18.6	19.6	20.5	20.7	21.8					19.5

TOTAL

AGE	1	2	3	4	5	6	7	8	9	10	TOTAL
Biomass (Tonnes)	1912	46573	69830	35765	18267	7798	3445	593	494	222	184899
% Biomass	1.0	25.2	37.8	19.3	9.9	4.2	1.9	0.3	0.3	0.1	100
Abundance (N in '000)	42375	773772	1041239	459583	209138	86677	35957	6031	5175	2687	2662635
% Abundance	1.6	29.1	39.1	17.3	7.9	3.3	1.4	0.2	0.2	0.1	100
Mean Weight	44	59	65	76	85	88	94	96	93	81	67
Mean Length	18.3	20.1	20.8	21.8	22.6	22.8	23.3	23.5	23.3	22.3	21.0

Table 9.4.1.1a: Sardine length composition (thousands) by ICES Sub-Division in the first quarter 2002.

				First Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5								
11				21		4		25
11.5				85		19		104
12				233	11	157		401
12.5		47	1	405	52	334		839
13	161	12	1	1 015	230	504	2 286	4 210
13.5	225	22		1 401	109	1703	5 860	9 319
14	322			1 622	387	2955	14 942	20 228
14.5	682		2	1 566	384	2854	10 500	15 988
15	1 403	10	11	2 636	532	3844	8 447	16 881
15.5	1 926		45	3 623	771	3410	5 590	15 365
16	2 347	10	136	6 314	1 272	4091	7 175	21 344
16.5	920	6	153	9 312	2 017	4697	4 880	21 985
17	206	12	78	10 182	4 818	3750	7 103	26 150
17.5	67		9	7 181	6 151	2522	2 152	18 081
18	176	16	4	4 159	8 049	2181	3 906	18 490
18.5	66	16	23	1 825	8 801	2482	2 439	15 650
19	393	16	44	1 084	10 512	3717	2 570	18 334
19.5	1 153	105	42	626	10 368	4487	186	16 967
20	1 823	408	82	544	9 466	4645	108	17 076
20.5	3 572	983	100	335	7 789	3263		16 043
21	4 636	910	72	179	5 175	2120		13 093
21.5	6 900	1 228	69	17	2 298	733		11 245
22	9 942	837	61	29	659	301		11 829
22.5	5 840	723	40	23	230	39		6 896
23	3 962	482	14		123			4 582
23.5	1 464	319	14		5	4		1 806
24	586	117	2					704
24.5	87	10						97
25	35							35
25.5								
26								
26.5								
27								
27.5								
28								
28.5								
29								
Total	48 894	6 290	1 003	54 416	80 209	54 814	78 143	323 769
Mean L	20.9	21.7	19.1	16.8	19.2	17.6	15.7	18.
sd	2.55	1.51	2.44	1.5	1.55	2.33	1.59	2.64
Catch	**3 660**	**508**	**59**	**1913**	**4077**	**2186**	**2 735**	**15 137**

Table 9.4.1.1b: Sardine length composition (thousands) by ICES Sub-Division in the second quarter 2002.

				Second Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5								
11				37				37
11.5				11				11
12				122				122
12.5	2			220				222
13	5		26	491	58			580
13.5	17		121	1 115	257	8		1 519
14	32		214	3 121	335	78	746	4 527
14.5	35		493	3 227	798	116	4 591	9 260
15	30		256	4 827	1 621	162	10 977	17 872
15.5	49	18	326	6 114	1 860	402	11 652	20 421
16	108	22	457	7 080	1 832	1807	9 376	20 681
16.5	423	115	651	10 147	2 803	4569	4 557	23 265
17	660	235	2 342	16 686	3 463	10919	3 124	37 430
17.5	594	463	4 220	25 497	7 659	14205	1 926	54 564
18	365	1 225	6 821	27 832	10 913	12060	1 880	61 095
18.5	338	2 117	5 150	20 740	13 158	7482	1 464	50 448
19	713	3 184	4 991	8 811	13 625	5278	1 377	37 978
19.5	1 419	4 616	3 879	3 764	10 859	3804	820	29 160
20	2 281	4 807	1 672	1 878	10 149	3342	731	24 860
20.5	2 873	4 936	725	831	8 832	1758	614	20 568
21	2 832	2 876	243	423	6 953	758	66	14 150
21.5	3 025	2 440	185	158	3 520	352	33	9 711
22	3 195	1 722	179	60	1 187	82		6 425
22.5	2 505	936	70	24	311	9		3 856
23	1 414	637	47	2	172			2 272
23.5	534	376	47		120			1 078
24	206	240	8		58			513
24.5	15	26	10		26			76
25	19		5		40			64
25.5	57							57
26	246							246
26.5	213							213
27	133							133
27.5	38							38
28	19							19
28.5								
29								
Total	24 395	30 990	33 136	143 216	100 608	67 192	53 933	453 470
Mean L	21.2	20.4	18.6	17.6	19.1	18.2	16.3	18.4
sd	1.95	1.36	1.33	1.4	1.63	1.17	1.37	1.91
Catch	**1 961**	**2204**	**1 791**	**6164**	**5554**	**3283**	**2 066**	**23 024**

Table 9.4.1.1c: Sardine length composition (thousands) by ICES Sub-Division in the third quarter 2002.

				Third Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5								
9								
9.5								
10				1 128				1 128
10.5		6		1 070				1 076
11		101		732				833
11.5		435		165				600
12		472		679				1 151
12.5	13	205	4	1 425				1 646
13	25	215	62	3 674	20			3 995
13.5	56	113	114	7 946	47			8 275
14	49	79	219	7 981	54			8 382
14.5	16	25	173	6 713	316			7 242
15	13	13	138	4 310	1 077		229	5 779
15.5	10		54	5 628	2 712	135	551	9 089
16			42	9 862	5 478	570	4 418	20 371
16.5	3		109	17 940	8 152	1763	13 865	41 832
17	4		571	21 023	14 908	5592	24 822	66 921
17.5	2	10	1 382	20 706	12 493	10196	17 336	62 124
18	7	50	3 359	29 391	13 970	12005	10 344	69 127
18.5	8	158	4 599	31 610	15 170	9708	7 035	68 288
19	67	1 147	5 494	28 757	17 435	7515	2 738	63 153
19.5	707	4 402	4 647	18 651	15 472	4233	2 167	50 279
20	1 023	9 319	3 330	11 525	13 132	3301	860	42 490
20.5	1 093	11 248	1 684	5 794	6 706	1607	241	28 372
21	1 001	7 670	1 103	3 303	3 740	769	246	17 831
21.5	853	4 066	255	907	1 088	172	18	7 360
22	611	2 091	80	715	259	88		3 845
22.5	523	1 150	15	253	5			1 947
23	131	393	2	3	5			535
23.5	129	262						391
24	56	88						143
24.5	10	27						37
25								
25.5								
26		4						4
26.5								
27								
27.5								
28								
28.5								
29								
Total	6 407	43 748	27 438	241 892	132 239	57 653	84 870	594 247
Mean L	21.	20.5	19.2	17.7	18.6	18.6	17.6	18.3
sd	1.6	1.82	1.26	2.08	1.44	1.04	.89	1.87
Catch	**551**	**3505**	**1 734**	**12815**	**8285**	**3681**	**4 105**	**34 676**

Table 9.4.1.1d: Sardine length composition (thousands) by ICES Sub-Division in the fourth quarter 2002.

				Fourth Quarter				
Length	**VIIIc E**	**VIIIc W**	**IXa N**	**IXa CN**	**IXa CS**	**IXa S**	**IXa S (Ca)**	**Total**
7								
7.5								
8								
8.5						0		
9						0		
9.5						0		
10				12		0		12
10.5				26	13	0		40
11				70	22	0		93
11.5				449	88	0		537
12			10	532	108	0		650
12.5		4	20	1 354	132	0		1 510
13		17	115	3 407	98	0		3 636
13.5		102	365	4 657	96	0		5 220
14		227	882	6 279	118	5		7 511
14.5		541	670	6 906	195	3		8 315
15		421	1 658	7 559	182	0	41	9 862
15.5		359	906	5 713	254	17	63	7 311
16		135	213	5 746	284	0	83	6 461
16.5		98	111	10 681	433	166	1 111	12 599
17		13	79	19 004	1 213	517	4 286	25 112
17.5		8	35	23 556	3 049	1396	6 803	34 846
18	3	10	27	32 708	6 844	2359	5 521	47 473
18.5	83	62	77	32 898	9 456	4332	5 897	52 804
19	1 159	67	259	28 872	12 169	5131	11 315	58 972
19.5	1 589	780	920	20 498	11 255	4858	6 615	46 515
20	3 523	2 167	2 575	14 774	10 968	4379	4 172	42 558
20.5	3 731	4 279	2 787	12 329	7 052	2329	3 223	35 731
21	3 587	3 680	2 152	5 709	4 866	1180	66	21 240
21.5	2 733	2 741	1 230	1 541	2 803	556	21	11 625
22	2 145	1 664	761	1 376	1 203	141		7 291
22.5	1 362	1 383	235	66	329	13		3 389
23	786	1 105	16	363	87	0		2 357
23.5	469	761	16	33	23	0		1 302
24	204	491	12	51		0		757
24.5	221	50				0		271
25	56					0		56
25.5	11					0		11
26	11							11
26.5								
27								
27.5								
28								
28.5								
29								
Total	21 674	21 162	16 131	247 169	73 343	27 383	49 218	456 080
Mean L	21.2	20.9	19.	18.1	19.5	19.5	18.9	18.8
sd	1.2	2.13	2.82	1.96	1.38	1.03	1.06	2.
Catch	**1 810**	**1685**	**978**	**12693**	**5053**	**1832**	**2 783**	**26 835**

Table 9.4.1.2: Catch in numbers (thousands) at age by quarter and by SubDivision in 2002

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	First Quarter Total
0	0	0	0	0	0	0	0	0
1	8215	137	337	10614	6789	23583	51558	101233
2	4087	1646	348	41727	30538	12109	22653	113109
3	11286	1709	159	2464	13871	6050	2674	38213
4	10053	1582	93	800	14164	6305	1258	34254
5	8709	761	40	95	7983	2382	0	19970
6	4592	369	21	40	2609	2612	0	10242
7	1709	86	5	10	863	501	0	3175
8	0	0	0	6	776	0	0	782
9	244	0	0	0	206	0	0	450
10	0	0	0	0	0	0	0	0
Total	55756	77800	1003	53542	78143	48894	6290	321428
Catch	3660	508	59	1913	4077	2186	2735	15137

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Second Quarter Total
0	0	0	0	0	3611	0	0	3611
1	1529	636	4197	44347	13887	29300	37897	131794
2	4949	17360	23174	91027	36471	18693	12133	203807
3	6637	7475	5164	7086	14099	6281	2525	49268
4	4971	3188	345	2263	15418	4787	1377	32349
5	3933	1398	147	445	10363	3476	0	19761
6	1625	746	84	129	5534	2047	0	10166
7	604	187	26	20	1721	732	0	3290
8	0	0	0	23	676	201	0	900
9	89	0	0	0	384	43	0	516
10	0	0	0	0	71	0	0	71
Total	145339	102234	33136	65562	53933	24338	30990	455533
Catch	1961	2204	1791	6164	5554	3283	2066	23024

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Third Quarter Total
0	181	1671	1643	44837	7110	0	3122	58564
1	1024	10545	9448	64680	47549	32230	62826	228302
2	2502	20418	14913	125182	46661	15325	13072	238073
3	1558	5848	863	14581	14742	3062	4297	44951
4	633	4581	535	4749	8372	2212	728	21810
5	257	452	28	1769	3222	710	655	7093
6	167	0	0	198	1694	1312	104	3474
7	84	174	7	69	167	450	66	1017
8	0	0	0	0	57	220	0	277
9	0	0	0	53	0	0	0	53
10	0	58	0	0	1	0	0	59
Total	256115	129574	27438	55520	84870	6407	43748	603672
Catch	551	3505	1734	12815	8285	3681	4105	34676

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Fourth Quarter Total
0	0	1836	4884	34657	2835	0	497	44707
1	3510	3673	2855	59505	21044	10700	24740	126026
2	8747	7266	5454	125139	31222	8759	12321	198909
3	5203	3581	1605	18849	10338	3371	6003	48949
4	2150	4095	1128	5263	6235	1832	3052	23754
5	1092	305	137	890	3541	989	1873	8826
6	691	0	0	213	1767	709	411	3790
7	281	139	63	0	373	278	321	1454
8	0	0	0	0	134	72	0	206
9	0	0	0	0	0	20	0	20
10	0	270	6	0	0	0	0	276
Total	244515	77488	16131	26730	49218	21674	21162	456918
Catch	1810	1685	978	12693	5053	1832	2783	26835

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Whole Year Total
0	181	3507	6527	79494	13555	0	3619	106882
1	14278	14991	16837	179145	89269	95812	177022	587354
2	20286	46690	43889	383075	144891	54886	60180	753898
3	24684	18613	7791	42980	53051	18763	15499	181382
4	17807	13445	2101	13075	44188	15137	6415	112167
5	13990	2915	351	3199	25109	7557	2528	55650
6	7075	1115	105	579	11604	6680	515	27672
7	2678	587	101	98	3124	1961	387	8936
8	0	0	0	28	1644	494	0	2166
9	333	0	0	53	590	64	0	1039
10	0	328	6	0	72	0	0	406
Total	101313	102190	77709	701725	387097	201354	266164	1837552
Catch	7982	7903	4562	33585	22969	10982	11689	99673

Table 9.4.1.3: Relative distribution of sardine catches. Upper pannel, relative contribution of each group within each Sub-Division. Lower pannel, relative contribution of each Sub-Division within each Age Group.

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0%	3%	8%	11%	4%	0%	1%	6%
1	14%	15%	22%	26%	23%	48%	67%	32%
2	20%	46%	56%	55%	37%	27%	23%	41%
3	24%	18%	10%	6%	14%	9%	6%	10%
4	18%	13%	3%	2%	11%	8%	2%	6%
5	14%	3%	0%	0%	6%	4%	1%	3%
6+	10%	2%	0%	0%	4%	5%	0%	2%
	100%	100%	100%	100%	100%	100%	100%	100%

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
0	0%	3%	6%	74%	13%	0%	3%	100%
1	2%	3%	3%	31%	15%	16%	30%	100%
2	3%	6%	6%	51%	19%	7%	8%	100%
3	14%	10%	4%	24%	29%	10%	9%	100%
4	16%	12%	2%	12%	39%	13%	6%	100%
5	25%	5%	1%	6%	45%	14%	5%	100%
6+	25%	5%	1%	2%	42%	23%	2%	100%

Table 9.4.2.1: Sardine Mean length at age by quarter and by SubDivision in 2002

							First	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	15.7	15.2	16.4	14.6	16.5	15.5	15.0	15.2
2	20.4	20.9	19.4	17.1	18.4	17.9	16.8	17.7
3	21.6	21.5	21.0	18.9	19.6	19.6	18.7	20.1
4	22.0	22.4	22.2	19.7	20.3	20.3	18.8	20.8
5	22.6	22.7	22.4	20.6	20.7	20.5	0.0	21.6
6	22.8	22.7	22.3	20.8	21.1	20.6	0.0	21.8
7	22.6	23.0	22.4	21.3	21.2	21.1	0.0	22.0
8	0.0	0.0	0.0	22.3	21.8	0.0	0.0	21.8
9	23.8	0.0	0.0	0.0	21.8	0.0	0.0	22.8
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

							Second	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.0	0.0	0.0	0.0	15.1	0.0	0.0	15.1
1	16.9	18.7	16.5	16.2	17.2	17.4	15.7	16.5
2	19.8	19.9	18.7	18.1	18.7	18.2	17.2	18.4
3	21.2	20.6	19.0	19.1	19.5	19.0	19.2	19.7
4	21.7	22.1	21.7	20.0	20.4	19.5	19.7	20.6
5	23.2	22.4	22.1	20.7	20.7	20.0	0.0	21.2
6	22.9	22.2	22.0	21.1	21.1	20.6	0.0	21.4
7	22.6	22.0	21.8	21.5	21.4	20.8	0.0	21.5
8	0.0	0.0	0.0	20.3	22.5	20.8	0.0	22.1
9	23.8	0.0	0.0	0.0	21.9	22.3	0.0	22.2
10	0.0	0.0	0.0	0.0	21.8	0.0	0.0	21.8

							Third	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	14.1	12.5	16.2	14.2	16.0	0.0	16.7	14.5
1	19.9	20.6	19.1	17.3	17.7	18.0	17.5	17.8
2	21.0	20.6	19.4	18.9	19.1	18.9	18.1	19.1
3	21.4	21.4	20.8	19.7	19.8	19.4	18.6	19.9
4	22.4	21.7	20.9	20.6	20.3	19.9	20.1	20.7
5	22.9	21.8	21.8	21.2	20.7	20.5	18.8	20.8
6	23.4	0.0	0.0	22.4	20.7	20.7	19.4	20.9
7	22.3	22.3	22.3	22.0	21.6	20.9	20.3	21.4
8	0.0	0.0	0.0	0.0	21.3	21.0	0.0	21.1
9	0.0	0.0	0.0	22.8	0.0	0.0	0.0	22.8
10	0.0	24.4	0.0	0.0	22.8	0.0	0.0	24.3

							Fourth	Quarter
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	0.0	15.1	15.0	14.7	15.6	0.0	17.3	14.9
1	19.8	20.7	20.4	17.7	18.8	18.8	18.4	18.3
2	20.9	21.0	20.6	19.1	19.5	19.6	19.1	19.4
3	21.4	21.8	21.4	20.4	20.4	20.0	19.4	20.5
4	22.4	22.5	21.5	21.2	21.0	20.5	20.1	21.3
5	23.3	21.8	21.8	21.7	21.2	20.7	20.3	21.3
6	23.6	0.0	0.0	22.1	21.7	21.0	19.3	21.7
7	22.4	22.3	22.3	0.0	21.6	21.2	20.3	21.5
8	0.0	0.0	0.0	0.0	21.8	21.7	0.0	21.7
9	0.0	0.0	0.0	0.0	0.0	21.8	0.0	21.8
10	0.0	24.3	24.3	0.0	0.0	0.0	0.0	24.3

							Whole	Year
Age	**VIIIc-E**	**VIIIc-W**	**IXa-N**	**IXa-CN**	**IXa-CS**	**IXa-S**	**IXa-S (Ca)**	**Total**
0	14.1	13.9	15.3	14.4	15.7	0.0	16.8	14.7
1	17.2	20.5	18.6	17.0	17.8	17.3	16.5	17.2
2	20.6	20.4	19.2	18.6	18.9	18.6	17.6	18.8
3	21.4	21.2	19.7	19.9	19.8	19.4	19.0	20.1
4	22.0	22.1	21.4	20.7	20.4	20.0	19.7	20.8
5	22.8	22.3	22.0	21.2	20.8	20.3	19.9	21.3
6	22.9	22.3	22.0	21.9	21.1	20.7	19.3	21.5
7	22.6	22.3	22.2	21.8	21.4	21.0	20.3	21.7
8	0.0	0.0	0.0	20.7	22.1	21.0	0.0	21.8
9	23.8	0.0	0.0	22.8	21.8	22.1	0.0	22.5
10	0.0	24.3	24.3	0.0	21.8	0.0	0.0	23.9

Table 9.4.2.2: Sardine Mean weight at age by quarter and by SubDivision in 2002

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							First	Quarter
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.035	0.039	0.034	0.025	0.032	0.026	0.031	0.029
2	0.069	0.061	0.073	0.040	0.044	0.041	0.042	0.043
3	0.080	0.074	0.079	0.054	0.053	0.053	0.054	0.062
4	0.084	0.086	0.089	0.062	0.059	0.058	0.055	0.068
5	0.090	0.088	0.092	0.071	0.064	0.061	0.000	0.076
6	0.093	0.087	0.091	0.074	0.067	0.061	0.000	0.078
7	0.090	0.089	0.095	0.077	0.068	0.066	0.000	0.081
8	0.000	0.000	0.000	0.089	0.074	0.000	0.000	0.074
9	0.103	0.000	0.000	0.000	0.074	0.000	0.000	0.090
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Second	Quarter
0	0.000	0.000	0.000	0.000	0.027	0.000	0.000	0.027
1	0.042	0.040	0.056	0.033	0.040	0.044	0.034	0.037
2	0.066	0.056	0.066	0.046	0.051	0.048	0.045	0.051
3	0.080	0.059	0.074	0.055	0.057	0.054	0.060	0.062
4	0.086	0.086	0.090	0.064	0.065	0.058	0.065	0.070
5	0.104	0.090	0.094	0.072	0.068	0.061	0.000	0.076
6	0.099	0.089	0.091	0.076	0.072	0.066	0.000	0.077
7	0.096	0.088	0.089	0.081	0.074	0.068	0.000	0.078
8	0.000	0.000	0.000	0.066	0.087	0.067	0.000	0.082
9	0.110	0.000	0.000	0.000	0.079	0.079	0.000	0.085
10	0.000	0.000	0.000	0.000	0.078	0.000	0.000	0.078

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Third	Quarter
0	0.023	0.038	0.016	0.026	0.039	0.000	0.040	0.029
1	0.072	0.064	0.080	0.047	0.053	0.058	0.047	0.052
2	0.086	0.066	0.081	0.062	0.067	0.067	0.052	0.065
3	0.092	0.083	0.091	0.071	0.075	0.074	0.057	0.075
4	0.107	0.085	0.097	0.081	0.080	0.079	0.075	0.084
5	0.115	0.096	0.096	0.088	0.085	0.087	0.060	0.085
6	0.124	0.000	0.000	0.104	0.086	0.090	0.066	0.090
7	0.106	0.104	0.104	0.098	0.097	0.092	0.076	0.096
8	0.000	0.000	0.000	0.000	0.092	0.095	0.000	0.094
9	0.000	0.000	0.000	0.108	0.000	0.000	0.000	0.108
10	0.000	0.000	0.141	0.000	0.113	0.000	0.000	0.140

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Fourth	Quarter
0	0.00	0.03	0.03	0.03	0.03	0.00	0.04	0.03
1	0.07	0.07	0.08	0.05	0.06	0.06	0.05	0.05
2	0.08	0.08	0.08	0.06	0.07	0.07	0.06	0.06
3	0.08	0.08	0.09	0.07	0.08	0.07	0.06	0.08
4	0.10	0.09	0.10	0.08	0.09	0.08	0.07	0.09
5	0.11	0.09	0.09	0.09	0.09	0.08	0.07	0.09
6	0.12	0.00	0.00	0.09	0.10	0.08	0.06	0.09
7	0.10	0.10	0.10	0.00	0.09	0.08	0.07	0.09
8	0.00	0.00	0.00	0.00	0.10	0.09	0.00	0.09
9	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.09
10	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.13

Age	VIIIc-E	VIIIc-W	IXa-N	IXa-CN	IXa-CS	IXa-S	IXa-S (Ca)	Total
							Whole	Year
0	0.023	0.029	0.022	0.026	0.035	0.000	0.041	0.028
1	0.046	0.059	0.078	0.042	0.051	0.046	0.040	0.045
2	0.074	0.062	0.075	0.055	0.058	0.055	0.048	0.057
3	0.082	0.067	0.083	0.068	0.065	0.060	0.059	0.069
4	0.087	0.086	0.095	0.078	0.069	0.063	0.066	0.075
5	0.096	0.090	0.093	0.085	0.072	0.066	0.069	0.079
6	0.097	0.088	0.091	0.091	0.077	0.071	0.061	0.081
7	0.093	0.094	0.096	0.093	0.076	0.075	0.071	0.083
8	0.000	0.000	0.000	0.071	0.082	0.083	0.000	0.082
9	0.105	0.000	0.000	0.108	0.077	0.083	0.000	0.088
10	0.000	0.127	0.130	0.000	0.079	0.000	0.000	0.121

Table 9.7.1.4.1 Different runs with both the AMCI software and their main assumptions.

	AMCI Runs	Run names
Base run	▪ Constant selectivity for ages 3+ onwards • Gradual changes in selectivity pattern for ages below 3+ and through years • Gradual change in catchability • Default AMCI weights for DEPM and other sources • Downweight of 0+ group	– **Run 0**
Fix catchability	• Catchability fixed for all time-series	– **Run 1**
Recent surveys	• Fixed Catchability • Only recent (> 1996) surveys	– **Run 2**
6+ group	• Downweight of 6+ group • Gradual changes in selectivity pattern for all ages and through years	– **Run 3**
Split catchability	• Gradual changes in selectivity pattern for all ages and through years • Catchability split in two periods (84-92, 93-03)	– **Run 4**

Table 9.7.2.1a: Input to the AMCI assessment model: Catch data per year and age class (thousand individuals).

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986
0	869437	674489	856671	1025961	62000	1070000	118000	268000	304000
1	2296646	1535557	2037400	1934838	795000	577000	3312000	564000	755000
2	946698	956132	1561971	1733725	1869000	857000	487000	2371000	1027000
3	295360	431466	378785	679001	709000	803000	502000	469000	919000
4	136661	189107	156922	195304	353000	324000	301000	294000	333000
5	41744	93185	47302	104545	131000	141000	179000	201000	196000
6	16468	36038	30006	76466	129000	139000	117000	103000	167000

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	1437000	521000	248000	258000	1580579	498265	87808	120797	30512
1	543000	990000	566000	602000	477368	1001856	566221	60194	189147
2	667000	535000	909000	517000	436081	451367	1081818	542163	280715
3	569000	439000	389000	707000	406886	340313	521458	1094442	829707
4	535000	304000	221000	295000	265762	186234	257209	272466	472880
5	154000	292000	200000	151000	74726	110932	113871	112635	70208
6	171000	189000	245000	248000	105186	80579	120282	72091	64485

Age	1996	1997	1998	1999	2000	2001	2002
0	277053	208570	449115	246016	489836	219973	106882
1	101267	548594	366176	475225	354822	1172301	587354
2	347690	453324	501585	361509	313972	256133	753897
3	514741	391118	352485	339691	255523	195897	181381
4	652711	337282	233672	177170	194156	126389	112166
5	197235	225170	178735	105518	97693	75145	55650
6	46607	70268	105884	72541	64373	49547	40219

Table 9.7.2.1b : Input to the AMCI assessment model: Survey data, Spanish March survey.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1987	44000	36000	4000	390000	118000	245000
1988	224056	63832	73627	64156	848302	885665
1990	69072	56015	272946	53317	87541	582299
1991	25415	208127	163708	400984	62373	574261
1992	167959	77477	88392	30956	116886	122791
1993	238561	427333	135919	126078	145795	1117949
1996	10639	54249	90547	350825	213842	24779
1997	56495	263095	125658	123331	65713	61002
1998	509838	103126	80396	33762	20590	25410
1999	214525	160375	134618	124313	28357	64013
2000	91656	285808	435440	242249	188879	68124
2001	975603	262883	186538	142929	98945	66062
2002	270396	760202	448599	651658	318591	163290
2003	42375	773772	1041239	459583	209138	136528

Table 9.7.2.1b (Cont'd) : Input to the AMCI assessment model: Survey data, Portuguese March survey.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1996	1624985	2082197	2414528	2906008	386476	11964
1997	6344145	3238140	1551784	1260213	1360066	202795
1998	1636191	4014982	2190882	1433972	1185007	979993
1999	5711743	2552623	1460677	844435	595713	469137
2000	6581454	2169927	1221678	756681	531945	613224
2001	18684340	774490	515440	337330	275530	183680
2002	12407967	6131089	655527	436980	231591	265765
2003	5842158	3810357	2526697	549396	361164	201548

Table 9.7.2.1c : Input to the AMCI assessment model: Survey data, Portuguese November survey.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1984	2956621	5733231	1152160	1036826	528343	76423	40140
1985	2063177	2743525	4548240	1083437	839215	143789	69987
1986	2493102	1611895	1669563	658385	322912	127266	49634
1987	3714540	2379377	1343695	928682	665600	236473	79903
1992	6349072	5480539	1157103	1002580	437424	108224	18772
1997	2424702	1961202	906448	728899	1040594	771805	322421
1998	8680376	1809393	1214608	823316	396247	367120	220416
1999	3696787	798000	646000	391121	4593424	382447	164649
2000	30871080	1615890	246620	89920	121900	93970	66460
2001	8955265	5394731	694782	521626	116260	124615	49336

Table 9.7.2.1d: Input to the AMCI assessment model: Mean weight in the Catches (kg)

Year	Age0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1978	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1979	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1980	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1981	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1982	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1983	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1984	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1985	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1986	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1987	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1988	0.017	0.034	0.052	0.060	0.068	0.072	0.100
1989	0.013	0.035	0.052	0.059	0.066	0.071	0.100
1990	0.024	0.032	0.047	0.057	0.061	0.067	0.100
1991	0.020	0.031	0.058	0.063	0.073	0.074	0.100
1992	0.018	0.045	0.055	0.066	0.070	0.079	0.100
1993	0.017	0.037	0.051	0.058	0.066	0.071	0.100
1994	0.020	0.036	0.058	0.062	0.070	0.076	0.100
1995	0.025	0.047	0.059	0.066	0.071	0.082	0.100
1996	0.019	0.038	0.051	0.058	0.061	0.071	0.100
1997	0.022	0.033	0.052	0.062	0.069	0.073	0.100
1998	0.024	0.040	0.055	0.061	0.064	0.067	0.100
1999	0.025	0.042	0.056	0.065	0.070	0.073	0.100
2000	0.025	0.037	0.056	0.066	0.071	0.074	0.100
2001	0.023	0.042	0.059	0.067	0.075	0.079	0.100
2002	0.028	0.045	0.057	0.069	0.075	0.079	0.100
2003	0.028	0.045	0.057	0.069	0.075	0.079	0.100

Table 9.7.2.1d (cont'd): Input to the AMCI assessment model: Mean weight in the Stock (kg)

Year	Age0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1978	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1979	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1980	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1981	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1982	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1983	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1984	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1985	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1986	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1987	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1988	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1989	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1990	0.000	0.015	0.038	0.050	0.064	0.067	0.100
1991	0.000	0.019	0.042	0.050	0.064	0.071	0.100
1992	0.000	0.027	0.036	0.050	0.062	0.069	0.100
1993	0.000	0.022	0.045	0.057	0.064	0.073	0.100
1994	0.000	0.031	0.040	0.049	0.060	0.067	0.100
1995	0.000	0.029	0.050	0.062	0.072	0.079	0.100
1996	0.000	0.036	0.047	0.061	0.069	0.075	0.100
1997	0.000	0.025	0.050	0.058	0.068	0.074	0.100
1998	0.000	0.023	0.041	0.053	0.061	0.067	0.100
1999	0.000	0.020	0.039	0.054	0.062	0.068	0.100
2000	0.000	0.017	0.043	0.059	0.064	0.067	0.100
2001	0.000	0.017	0.042	0.058	0.075	0.080	0.100
2002	0.000	0.020	0.045	0.061	0.069	0.076	0.100
2003	0.000	0.020	0.045	0.061	0.069	0.076	0.100

Table 9.7.2.1d (cont'd): Input to the AMCI assessment model: Maturity ogive

Year	Age0	Age1	Age2	Age3	Age4	Age5	Age6
1978	0	0,65	0,95	1	1	1	1
1979	0	0,65	0,95	1	1	1	1
1980	0	0,65	0,95	1	1	1	1
1981	0	0,65	0,95	1	1	1	1
1982	0	0,65	0,95	1	1	1	1
1983	0	0,65	0,95	1	1	1	1
1984	0	0,65	0,95	1	1	1	1
1985	0	0,65	0,95	1	1	1	1
1986	0	0,65	0,95	1	1	1	1
1987	0	0,65	0,95	1	1	1	1
1988	0	0,65	0,95	1	1	1	1
1989	0	0,23	0,83	0,91	0,92	0,94	0,98
1990	0	0,6	0,81	0,88	0,89	0,94	0,99
1991	0	0,74	0,91	0,96	0,97	1	1
1992	0	0,79	0,91	0,95	0,98	1	1
1993	0	0,47	0,93	0,94	0,97	0,99	1
1994	0	0,8	0,89	0,96	0,96	0,97	1
1995	0	0,73	0,98	0,97	0,99	1	1
1996	0	0,83	0,89	0,92	0,96	1	1
1997	0	0,73	0,92	0,95	0,97	0,99	1
1998	0	0,72	0,92	0,96	0,99	1	1
1999	0	0,62	0,91	0,99	1	1	1
2000	0	0,26	0,91	0,95	0,95	1	1
2001	0	0,39	0,9	0,96	0,99	1	1
2002	0	0,49	0,94	0,97	0,98	0,99	1
2003	0	0,49	0,94	0,97	0,98	0,99	1

Table 9.7.2.2: Recruit, SSB and F estimates from the AMCI assessment model.

Year	Recruits	SSB	F	Catch
1978	11372576	287689	0,38	173761
1979	12963996	352291	0,39	162454
1980	14363770	431608	0,29	204861
1981	9501528	535601	0,35	242574
1982	6842104	563487	0,33	214148
1983	19612910	522262	0,29	176636
1984	7165749	576961	0,26	215114
1985	6100579	670203	0,26	219928
1986	5191591	603668	0,33	192838
1987	9299334	500991	0,32	176283
1988	5563235	439950	0,34	157273
1989	5681586	373056	0,37	146539
1990	5233848	336944	0,43	142966
1991	12457198	342900	0,32	132785
1992	10553737	460031	0,28	131196
1993	4468554	519001	0,34	144949
1994	4353234	526404	0,23	138725
1995	3842821	574774	0,25	126755
1996	4517620	494939	0,26	115179
1997	3519468	426555	0,34	117250
1998	3773028	345729	0,41	112033
1999	3625930	287821	0,38	95793
2000	13172605	246289	0,38	87272
2001	9148660	293065	0,29	102903
2002	3635335	501795	0,23	101741
2003	9000000	564128	0,23	0

Table 9.7.2.3. Fishing mortalities

Total yearly fishing mortalities at age

	1978	1979	1980	1981	1982	1983	1984	1985
0	0.0685	0.0647	0.0488	0.0692	0.0515	0.0461	0.0358	0.0352
1	0.2768	0.2713	0.2086	0.2464	0.2106	0.1725	0.1794	0.1599
2	0.4158	0.4080	0.3248	0.3979	0.3772	0.3144	0.2659	0.2671
3	0.3868	0.3900	0.2790	0.3450	0.3239	0.2927	0.2707	0.2726
4	0.3637	0.3894	0.2774	0.3203	0.3128	0.2745	0.2447	0.2463
5	0.3581	0.3852	0.2664	0.3242	0.3075	0.2681	0.2521	0.2449
6	0.3180	0.3397	0.2345	0.3045	0.3230	0.3036	0.2688	0.2364
Fref	0.3811	0.3931	0.2869	0.3469	0.3303	0.2874	0.2584	0.2577

Total yearly fishing mortalities at age

	1986	1987	1988	1989	1990	1991	1992	1993
0	0.0458	0.0668	0.0737	0.0680	0.0697	0.0665	0.0551	0.0514
1	0.1973	0.1820	0.1862	0.1884	0.2077	0.1497	0.1305	0.1339
2	0.3440	0.3216	0.3261	0.3283	0.3561	0.2505	0.2221	0.2445
3	0.3171	0.3259	0.3517	0.3769	0.4356	0.3394	0.3011	0.3688
4	0.3364	0.3064	0.3456	0.3676	0.4757	0.3451	0.3185	0.3773
5	0.3185	0.3229	0.3237	0.3893	0.4734	0.3463	0.2985	0.3573
6	0.2782	0.2595	0.2823	0.2912	0.3468	0.2463	0.2156	0.2482
Fref	0.3290	0.3192	0.3368	0.3655	0.4352	0.3203	0.2851	0.3370

Total yearly fishing mortalities at age

	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0297	0.0255	0.0313	0.0426	0.0616	0.0580	0.0520	0.0360
1	0.0706	0.0716	0.0635	0.1007	0.1227	0.1304	0.1344	0.1105
2	0.1453	0.1501	0.1521	0.2093	0.2439	0.2324	0.2283	0.1769
3	0.2607	0.2842	0.3126	0.3911	0.4342	0.3906	0.3801	0.2827
4	0.2815	0.2996	0.3307	0.4632	0.5148	0.4687	0.4584	0.3518
5	0.2495	0.2536	0.2455	0.3153	0.4355	0.4202	0.4446	0.3434
6	0.1572	0.1619	0.1470	0.1688	0.1787	0.1551	0.1493	0.1163
Fref	0.2342	0.2469	0.2602	0.3447	0.4071	0.3780	0.3779	0.2887

Total yearly fishing mortalities at age

	2002	2003
0	0.0289	0.0289
1	0.0887	0.0887
2	0.1420	0.1420
3	0.2269	0.2269
4	0.2824	0.2824
5	0.2757	0.2757
6	0.0934	0.0934
Fref	0.2318	0.2318

Table 9.7.2.4 Stock numbers at age

Stocknumbers at age,
Data by 1. Jan., except at youngest age which are
at recruitment time

	1978	1979	1980	1981	1982	1983	1984	1985
0	11370.1	12960.1	14360.9	9499.6	6840.6	19608.8	7164.2	6099.3
1	7305.1	9002.5	10300.7	11596.1	7515.8	5509.0	15876.7	5861.0
2	3486.9	3981.8	4934.1	6010.8	6516.2	4377.3	3333.0	9539.4
3	1206.4	1654.0	1903.5	2563.5	2902.7	3212.7	2297.9	1836.6
4	577.7	589.1	805.1	1035.3	1305.2	1509.5	1723.6	1260.3
5	174.8	288.7	286.9	438.6	540.3	686.3	824.7	970.1
6	72.9	126.0	205.7	275.0	373.8	480.2	632.2	808.1

Stocknumbers at age,
Data by 1. Jan., except at youngest age which are
at recruitment time

	1986	1987	1988	1989	1990	1991	1992	1993
0	5190.6	9297.1	5562.0	5680.1	5232.1	12453.4	10551.9	4467.8
1	4992.8	4204.3	7373.9	4380.9	4499.5	4137.5	9880.1	8467.6
2	3590.8	2946.8	2519.6	4400.6	2608.7	2628.2	2561.0	6233.8
3	5250.5	1830.1	1535.9	1307.3	2278.3	1313.5	1470.8	1474.4
4	1005.4	2748.9	949.8	776.8	644.7	1059.5	672.5	782.5
5	708.2	516.3	1454.7	483.3	386.6	288.0	539.4	351.6
6	1004.6	917.2	777.4	1178.0	868.3	614.5	491.8	572.7

Stocknumbers at age,
Data by 1. Jan., except at youngest age which are
at recruitment time

	1994	1995	1996	1997	1998	1999	2000	2001
0	4352.6	3842.2	4517.2	3519.0	3772.8	3625.8	13173.7	9149.5
1	3598.5	3582.4	3175.6	3712.2	2859.3	3007.8	2901.1	10603.9
2	5324.9	2410.6	2397.4	2142.7	2413.1	1818.2	1898.0	1823.3
3	3509.5	3310.5	1491.4	1480.3	1249.5	1359.4	1036.1	1086.0
4	733.0	1944.0	1791.2	784.4	719.7	581.9	661.3	509.3
5	385.8	397.7	1035.8	925.2	354.8	309.2	261.8	300.6
6	498.1	522.1	541.1	918.4	1043.0	792.1	633.7	513.1

Stocknumbers at age,
Data by 1. Jan., except at youngest age which are
at recruitment time

	2002	2003
0	3635.6	(9000.0)
1	7483.3	2994.7
2	6825.7	4923.1
3	1098.3	4257.5
4	588.5	629.3
5	257.6	319.0
6	481.7	456.0

Table 9.8.1.1. Sardine (VIIIc and IXa). Input data for the deterministic short-term prediction

MFDP version 1a
Run: sarw2003tac
Time and date: 20:12 17/09/03
Fbar age range: 2-5

2003								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	6883936	0.33	0.00	0.25	0.25	0.000	0.029	0.025
1	2641697	0.33	0.49	0.25	0.25	0.018	0.089	0.041
2	4922547	0.33	0.94	0.25	0.25	0.043	0.142	0.057
3	4257061	0.33	0.97	0.25	0.25	0.059	0.227	0.067
4	629306	0.33	0.98	0.25	0.25	0.069	0.282	0.074
5	319053	0.33	0.99	0.25	0.25	0.074	0.276	0.077
6	456461	0.33	1.00	0.25	0.25	0.100	0.093	0.100

2004								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	6883936	0.33	0.00	0.25	0.25	0.000	0.029	0.025
1	.	0.33	0.49	0.25	0.25	0.018	0.089	0.041
2	.	0.33	0.94	0.25	0.25	0.043	0.142	0.057
3	.	0.33	0.97	0.25	0.25	0.059	0.227	0.067
4	.	0.33	0.98	0.25	0.25	0.069	0.282	0.074
5	.	0.33	0.99	0.25	0.25	0.074	0.276	0.077
6	.	0.33	1.00	0.25	0.25	0.100	0.093	0.100

2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	6883936	0.33	0.00	0.25	0.25	0.000	0.029	0.025
1	.	0.33	0.49	0.25	0.25	0.018	0.089	0.041
2	.	0.33	0.94	0.25	0.25	0.043	0.142	0.057
3	.	0.33	0.97	0.25	0.25	0.059	0.227	0.067
4	.	0.33	0.98	0.25	0.25	0.069	0.282	0.074
5	.	0.33	0.99	0.25	0.25	0.074	0.276	0.077
6	.	0.33	1.00	0.25	0.25	0.100	0.093	0.100

Input units are thousands and kg - output in tonnes

Table 9.8.1.2 Sardine. Prediction with management option table.

MFDP version 1a
Run: sarwg2003tac
Sardine (VIIIc+IXa), 2003 WG
Time and date: 18:02 17/09/03
Fbar age range: 2-5

Basis for 2003: TAC = 100000 tons.; Recruitment 2002: GM of values below 25% percentile = 3782 millions
Recruitment 2003 to 2005: GM 1978-2002= 6884 millions

2003					2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
626441	513205	0.8812	0.2042	100000	596411	496317	0.0	0.000	0	663895	554469
					.	493685	0.1	0.023	12552	653024	541965
					.	491069	0.2	0.046	24855	642384	529798
					.	488468	0.3	0.070	36913	631970	517958
					.	485883	0.4	0.093	48733	621775	506436
					.	483312	0.5	0.116	60320	611796	495222
					.	480757	0.6	0.139	71680	602027	484307
					.	478217	0.7	0.162	82817	592463	473682
					.	475691	0.8	0.185	93736	583100	463338
					.	473181	0.9	0.209	104443	573931	453269
					.	470685	1.0	0.232	114943	564954	443464
					.	468204	1.1	0.255	125240	556163	433918
					.	465737	1.2	0.278	135339	547553	424622
					.	463285	1.3	0.301	145244	539122	415569
					.	460847	1.4	0.324	154960	530864	406751
					.	458424	1.5	0.348	164491	522776	398163
					.	456014	1.6	0.371	173841	514853	389798
					.	453619	1.7	0.394	183014	507092	381648
					.	451237	1.8	0.417	192015	499488	373708
					.	448870	1.9	0.440	200846	492039	365972
					.	446516	2.0	0.463	209513	484741	358434

Input units are thousands and kg - output in tonnes

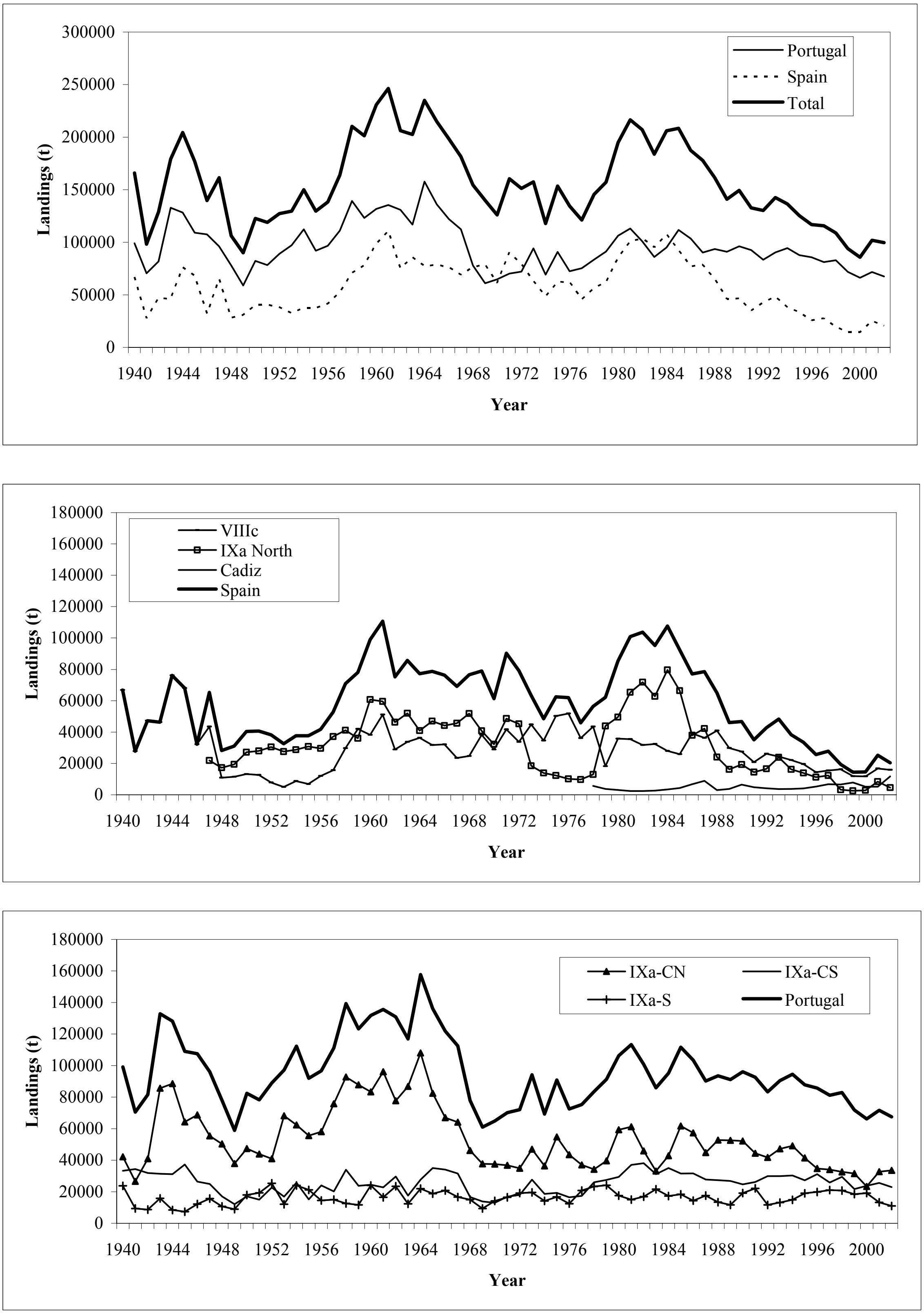


Figure 9.2.1: Annual landings of sardine, by country (upper pannel) and by ICES Sub-Division and country

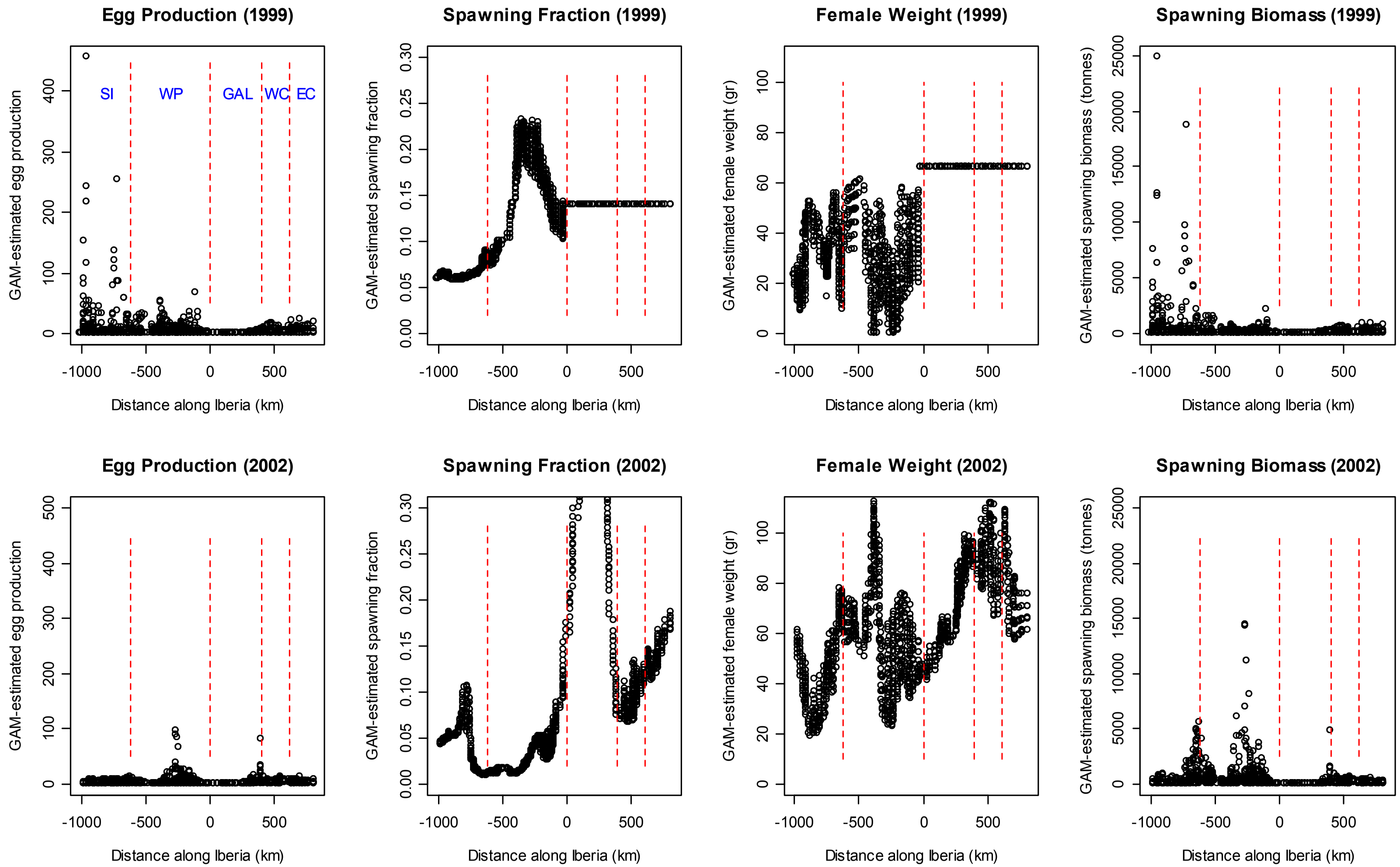


Figure 9.3.1.2.1 GAM-based estimates of sardine egg production (left), spawning fraction (second left), female weight (second right) and spawning biomass (right) along Iberia in the 1999 (top) and 2002 (bottom) DEPM surveys. Limits between strata are indicated with vertical broken lines.

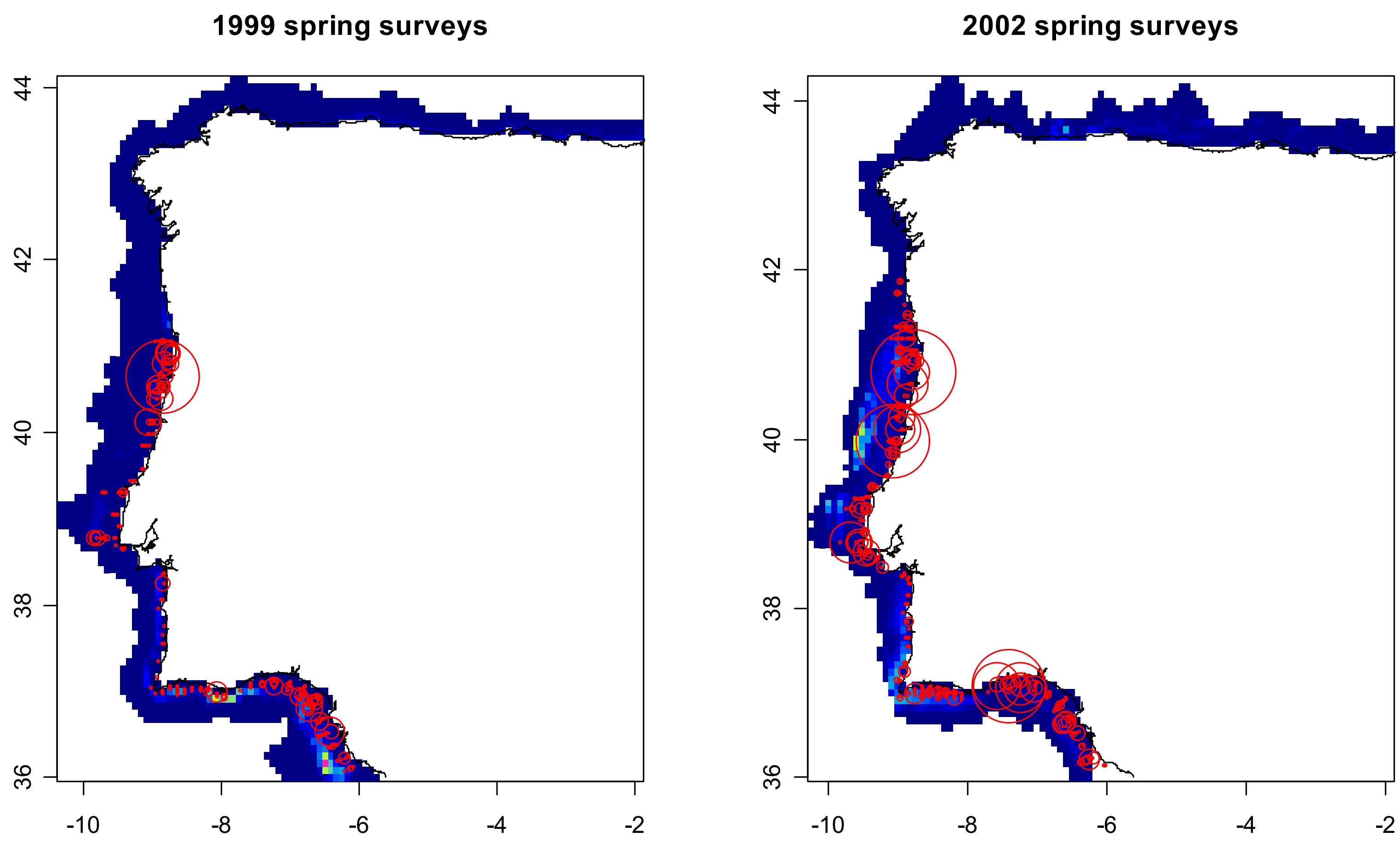
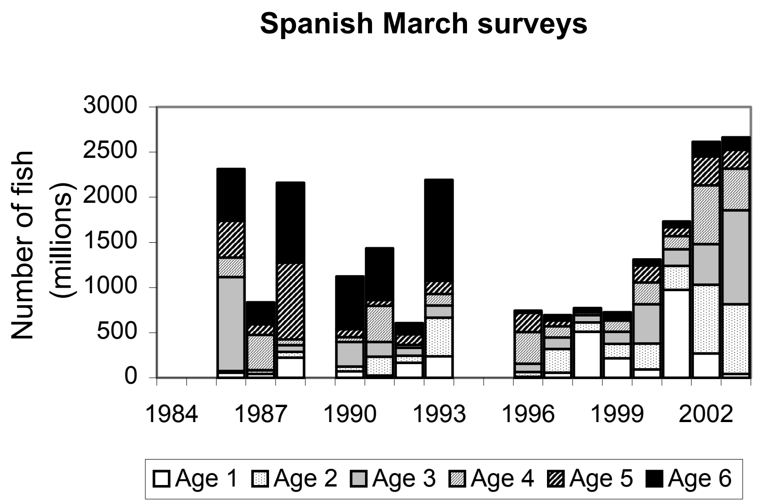
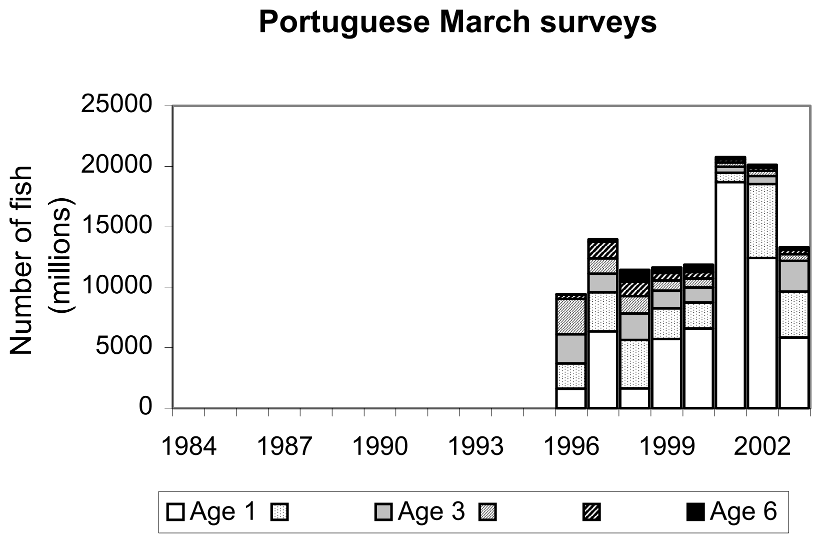


Figure 9.3.1.2.2 Distribution of GAM-based estimate of spawning biomass (image plots) during the 1999 (left) and 2002 (right) DEPM surveys and acoustic energy attributed to sardine during the respective Portuguese spring acoustic surveys (red circles). Colour scale and circle radius are comparable across surveys.





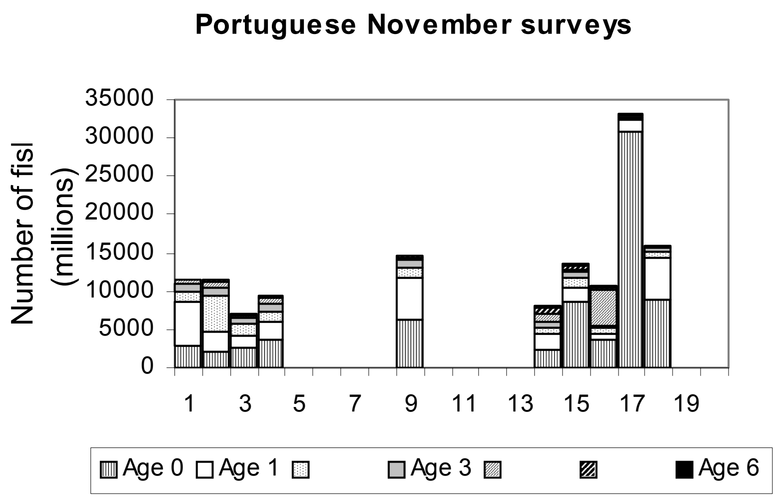


Figure 9.3.2.1.1 Total abundance and age structure of, in number, of sardine estimated in the acoustic surveys. The Spanish March survey series covers area VIIIc and IXa-N (Galicia), the Portuguese March surveys covers the Portuguese area and the Gulf of Cadiz (Subdivisions IXa-CN, IXa-CS, IXa-S-Algarve and IXa-S-Cadiz) and the Portuguese November survey covers only the Portuguese waters.

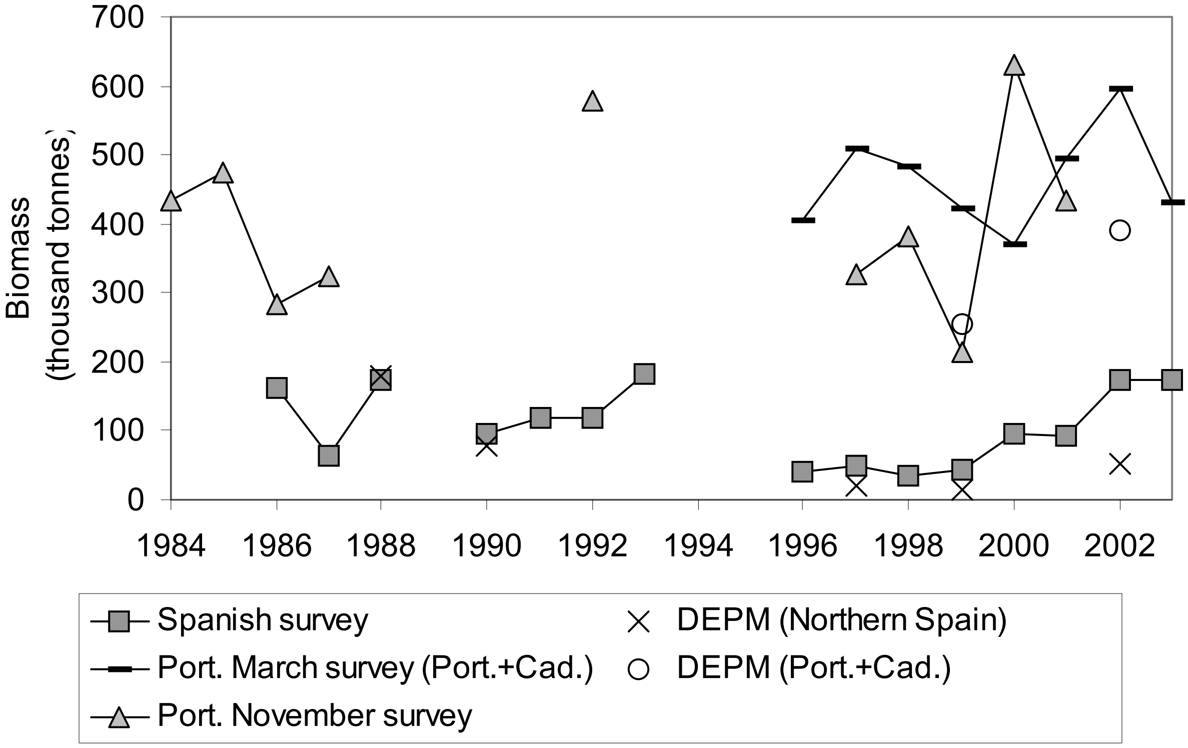


Figure 9.3.2.1.2 Total sardine biomass (thousand tonnes) estimated in the different series of acoustic surveys and SSB estimates from the DEPM series covering the northern area and the west and southern area of the stock.

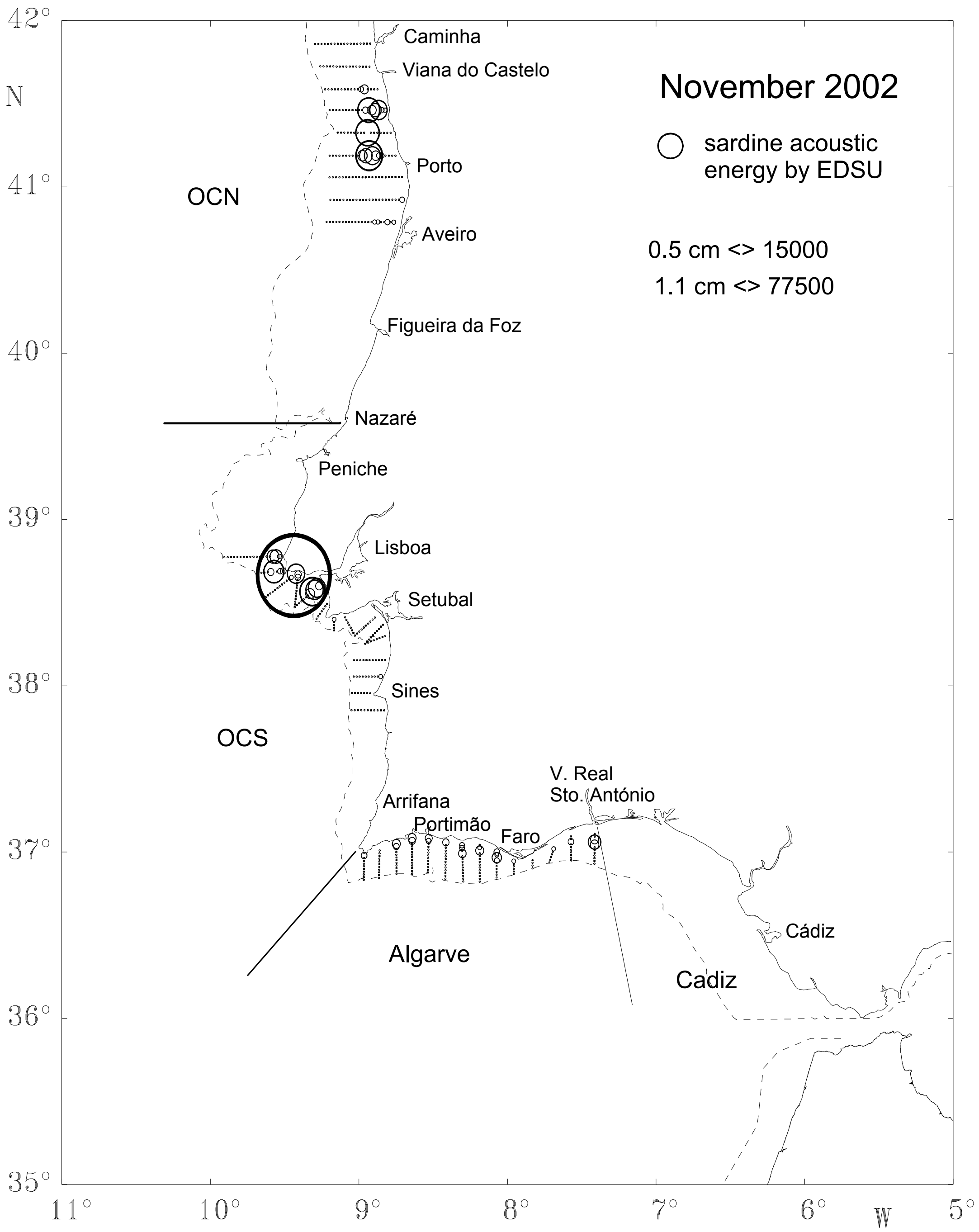


Figure 9.3.2.2.1 Portuguese November acoustic survey in 2002: sardine acoustic energy per nautical mile. Circle diameter is proportional to the square root of the acoustic energy (SA m2/nm2).

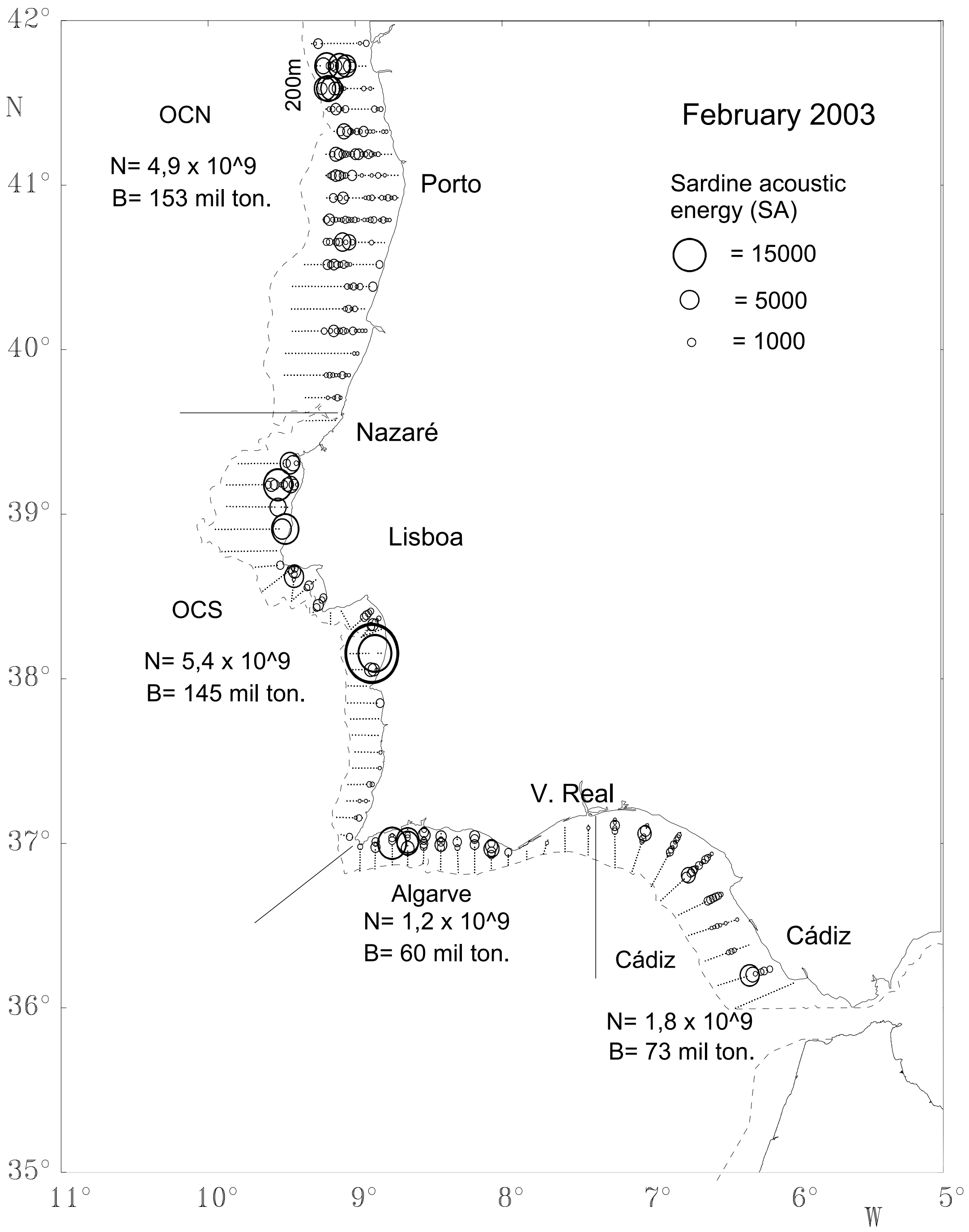
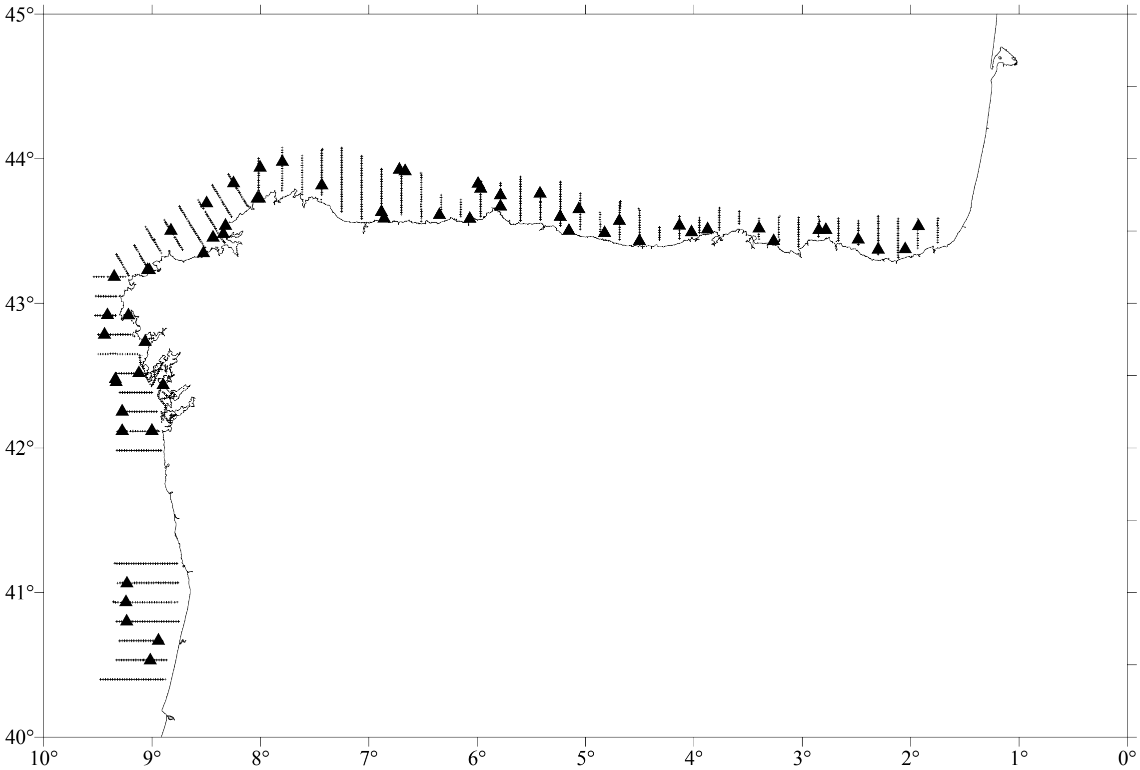
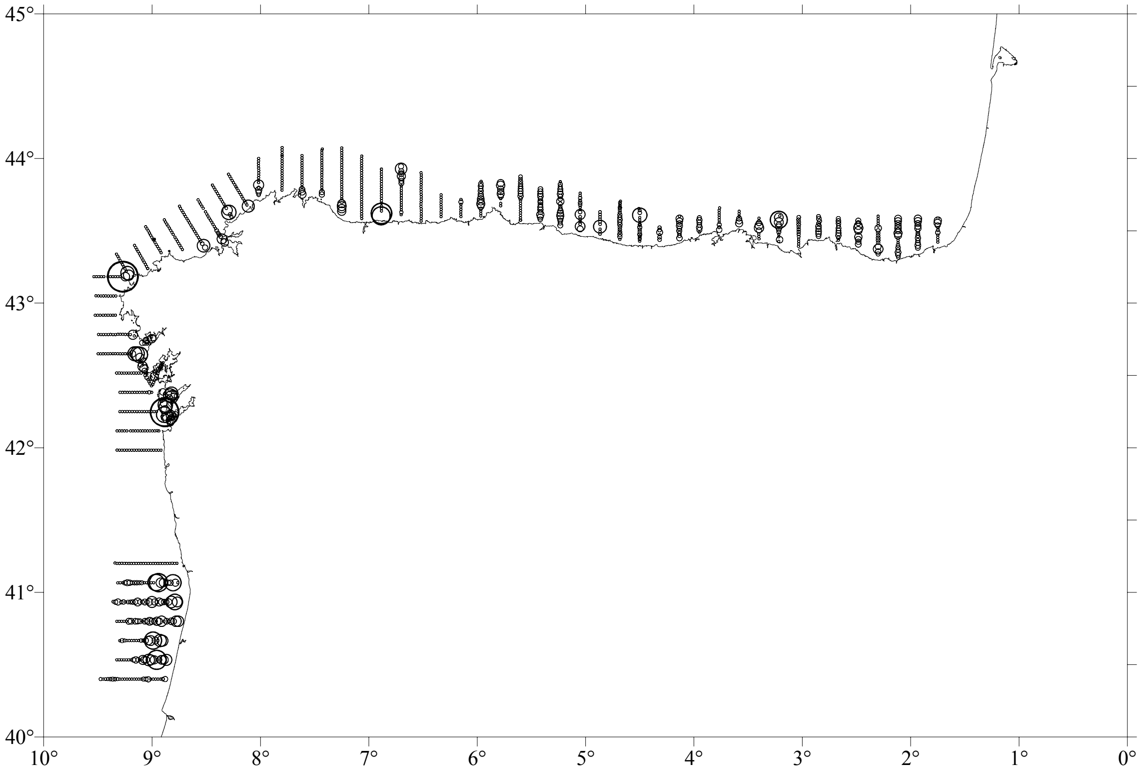


Figure 9.3.2.2.2 Portuguese February acoustic survey in 2003: sardine acoustic energy per nautical mile and abundance by area, in number and biomass. Circle diameter is proportional to the square root of the acoustic energy (SA m2/nm2).





Sardine distribution (circles scaled by square root; max=19071 m^2/nmi^2)

Figure 9.3.2.3 Cruise tracks, fishing stations and sardine distribution as observed in the Spanish acoustic survey in 2003

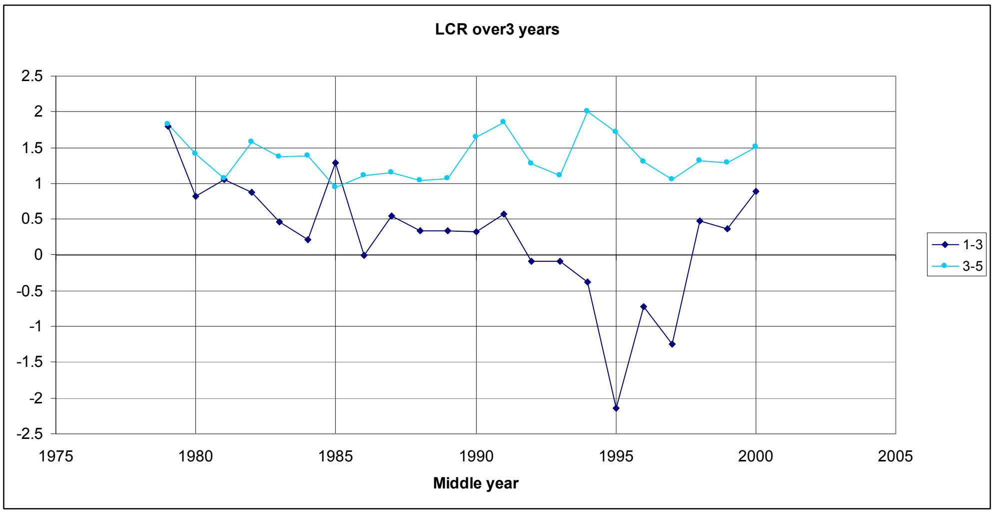


Figure 9.7.1.2.1 Log catch ratios on ages 1-3 and 3-5

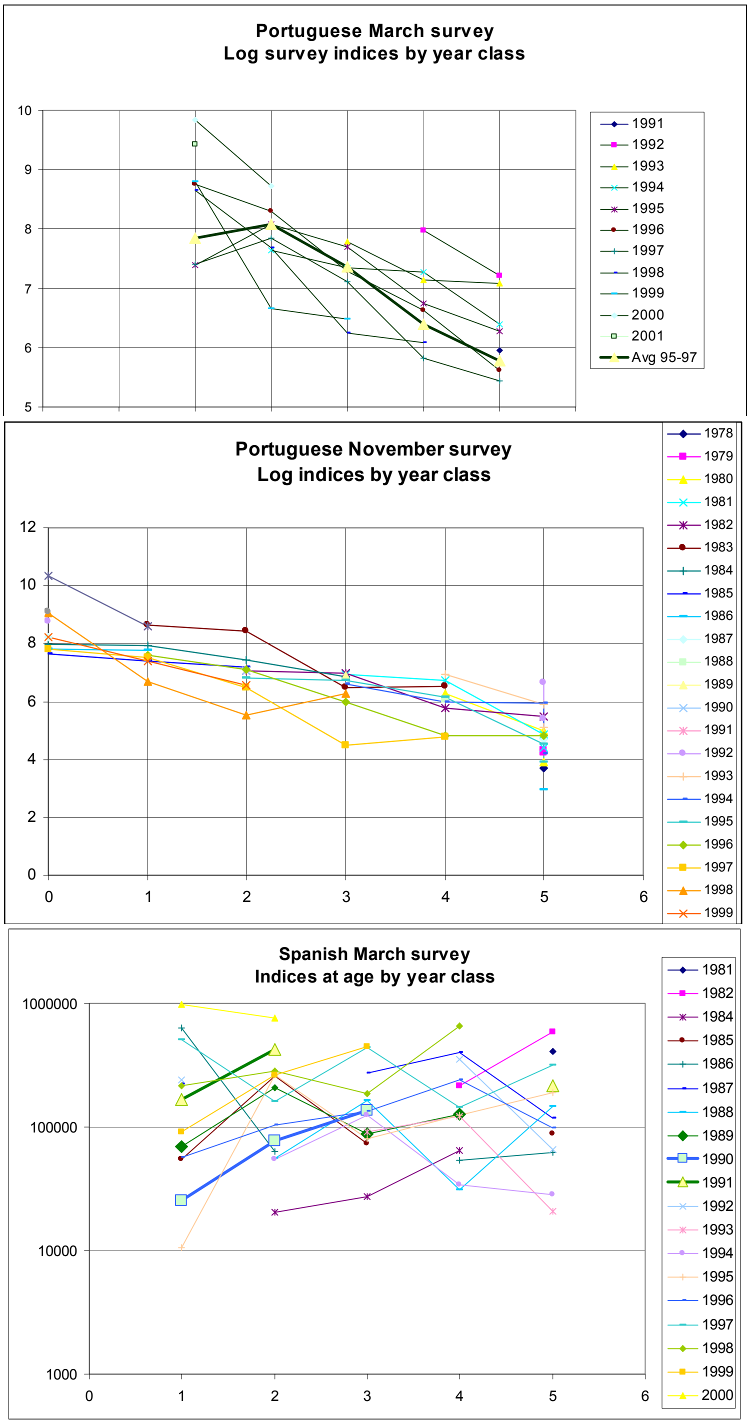


Figure 9.7.1.2.2 Log catch ratio index from the acoustic surveys. From top to bottom Portuguese March survey, Portuguese November survey and Spanish March survey.

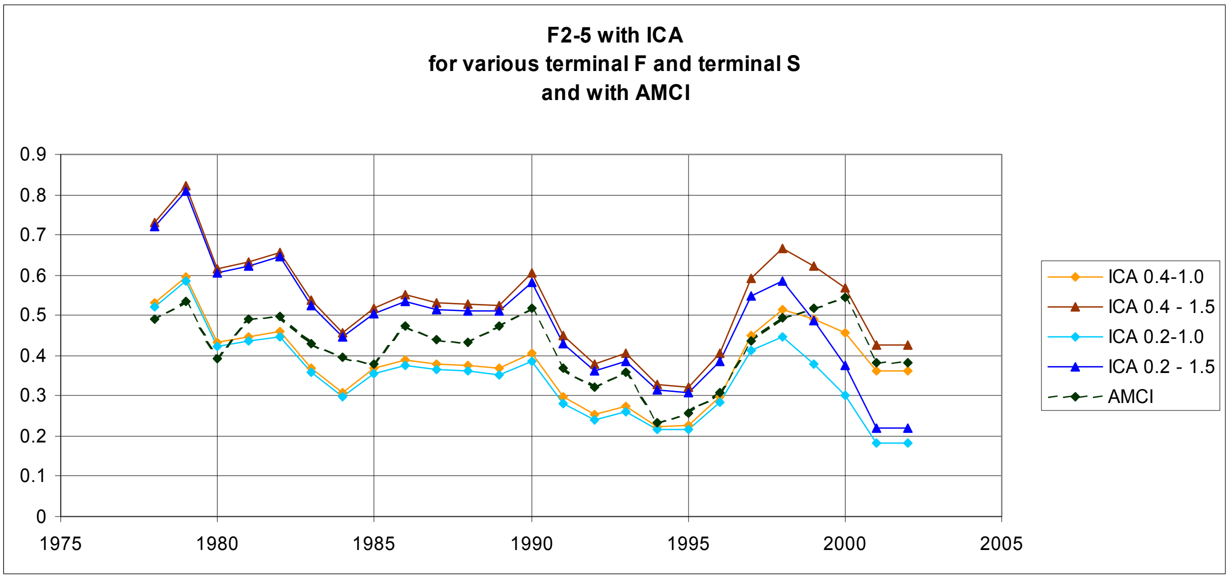
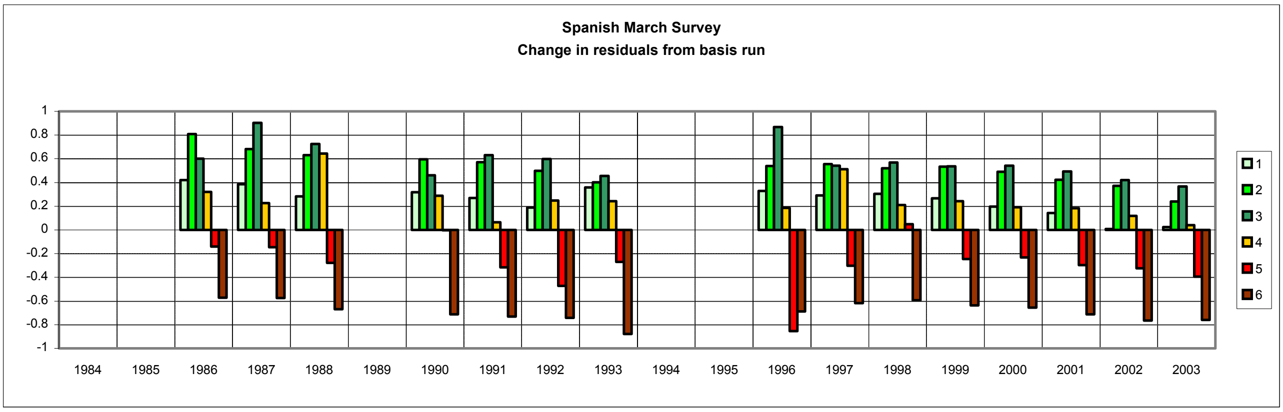
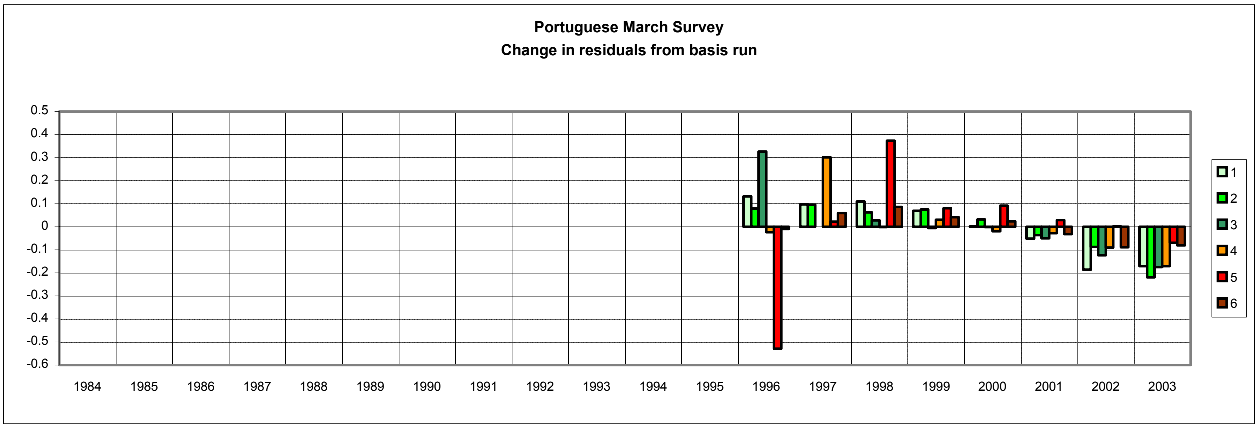


Figure 9.7.3.1 F2-5 for ICA runs with fixed terminal F at 0.2 or 0.4, and terminal S at 1.0 or 1.5. The F2-5 estimated within an AMCI run is shown for comparative purposes.





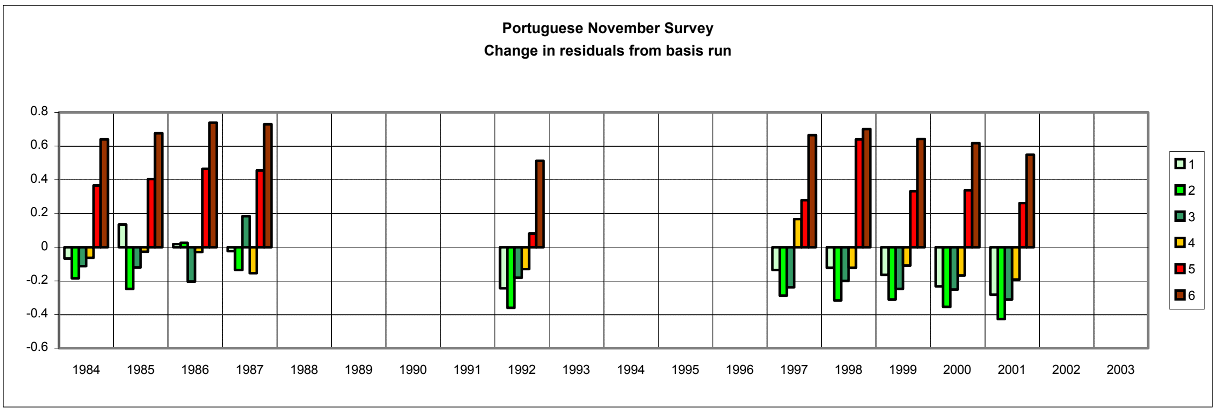


Figure 9.7.1.3.2 Change in survey residuals from the ICA base run (similar to last years final ICA run) to run 1 (using only recent acoustic surveys). The change is computed as basis run residual s-run 1 residuals.

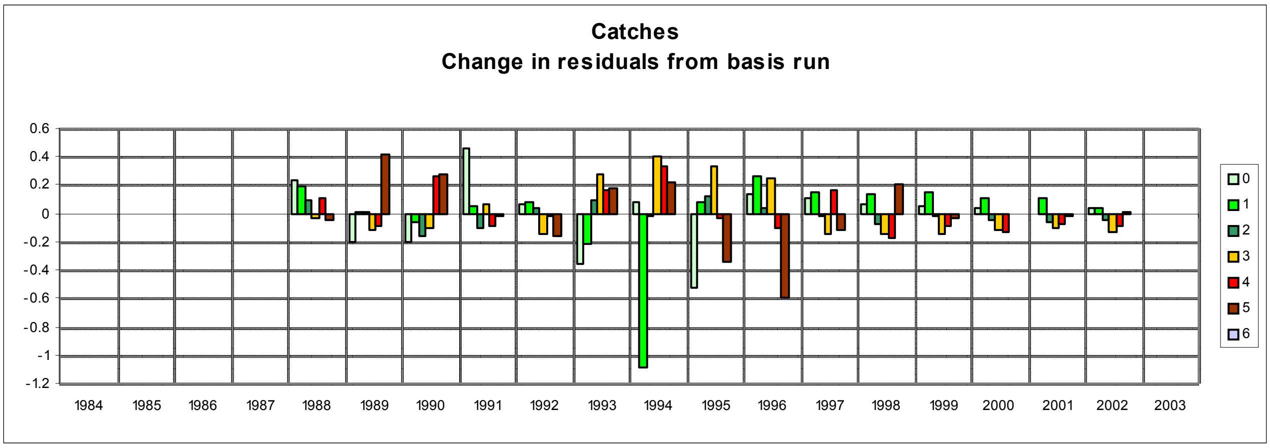
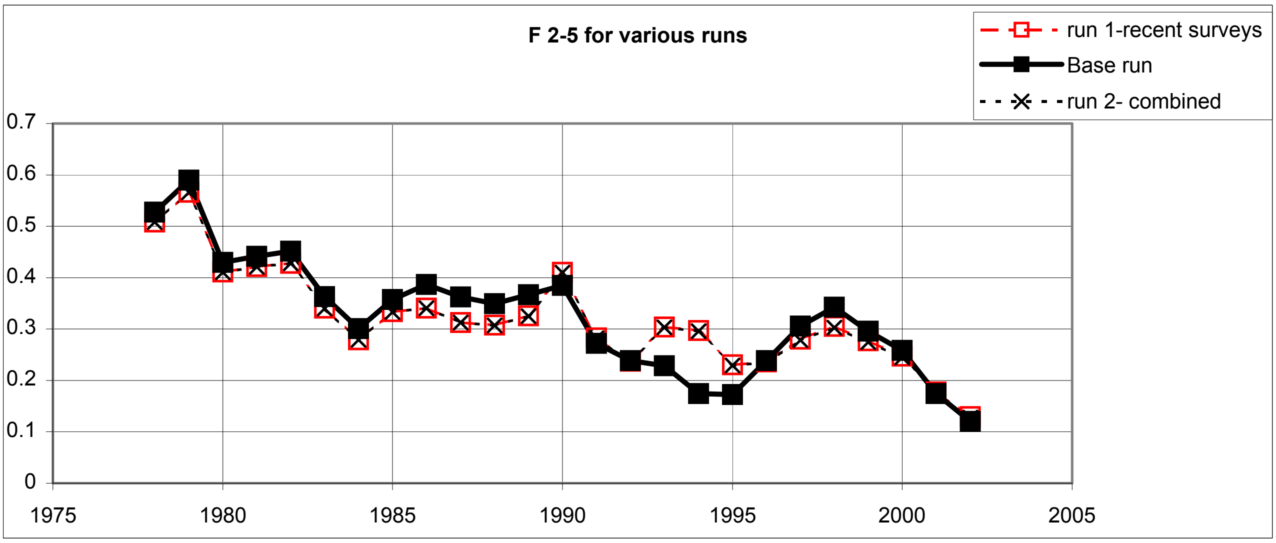


Figure 9.7.1.3.3 Change in catch residuals from the ICA base run (similar to last years final ICA run) to run 1 (using only recent acoustic surveys). The change is computed as basis run residual s-run 1 residuals.



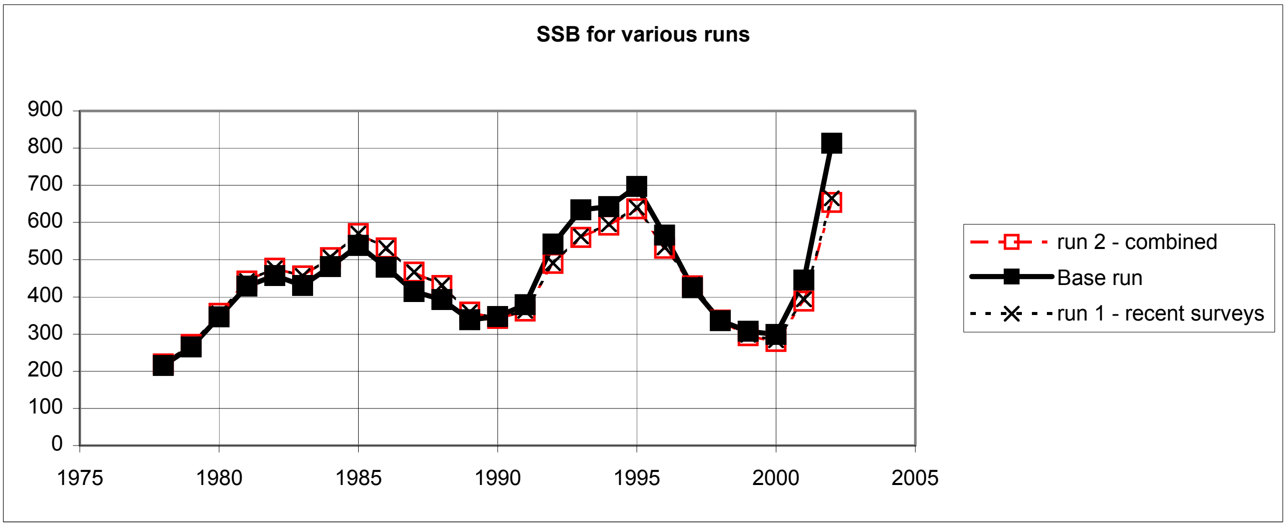


Figure 9.7.1.3.4 Trajectories of fishing mortality (top) and SSB (bottom) of the sardine stock from the ICA exploratory runs.

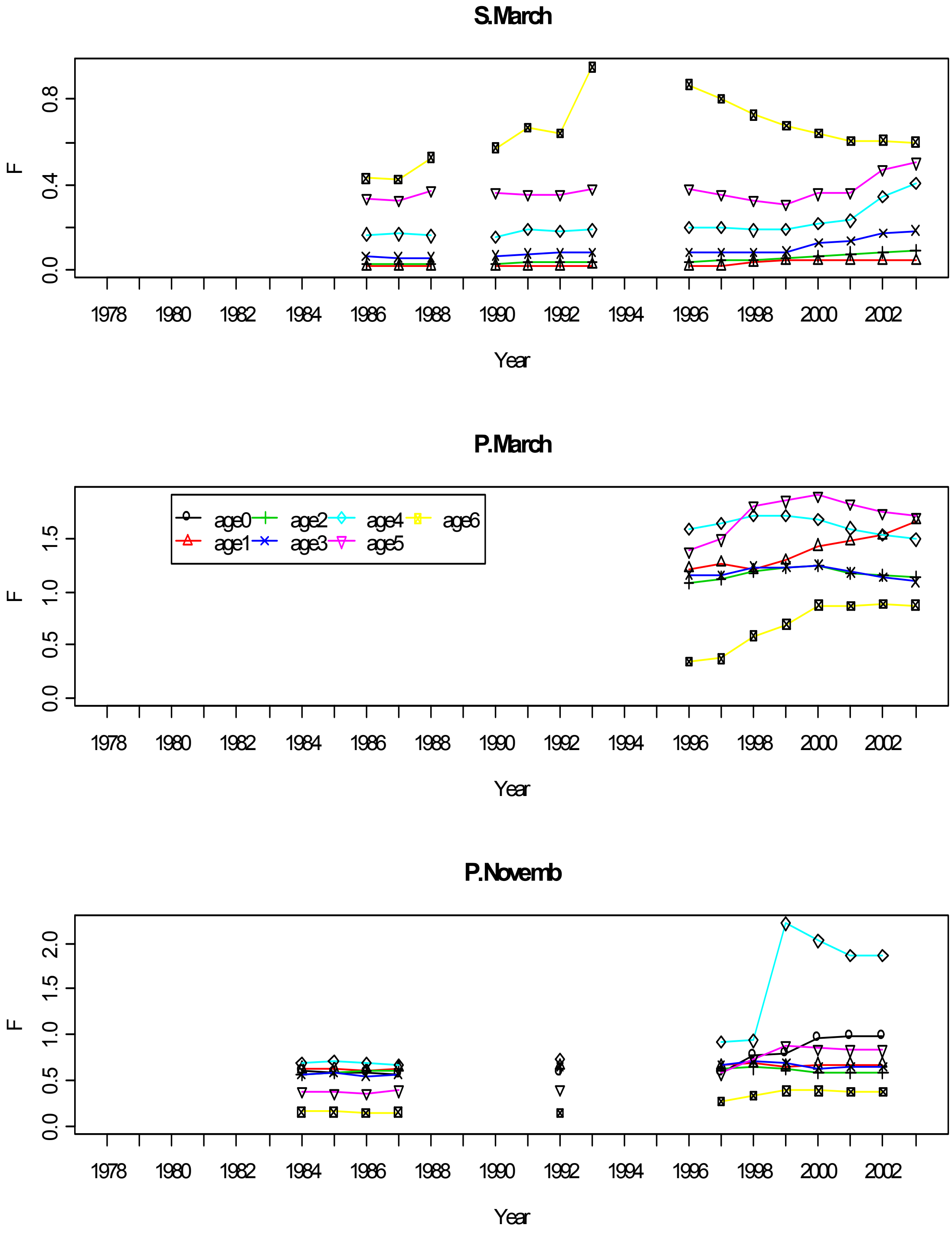


Figure 9.7.1.4.1a Smooth catchability trend in Run 0

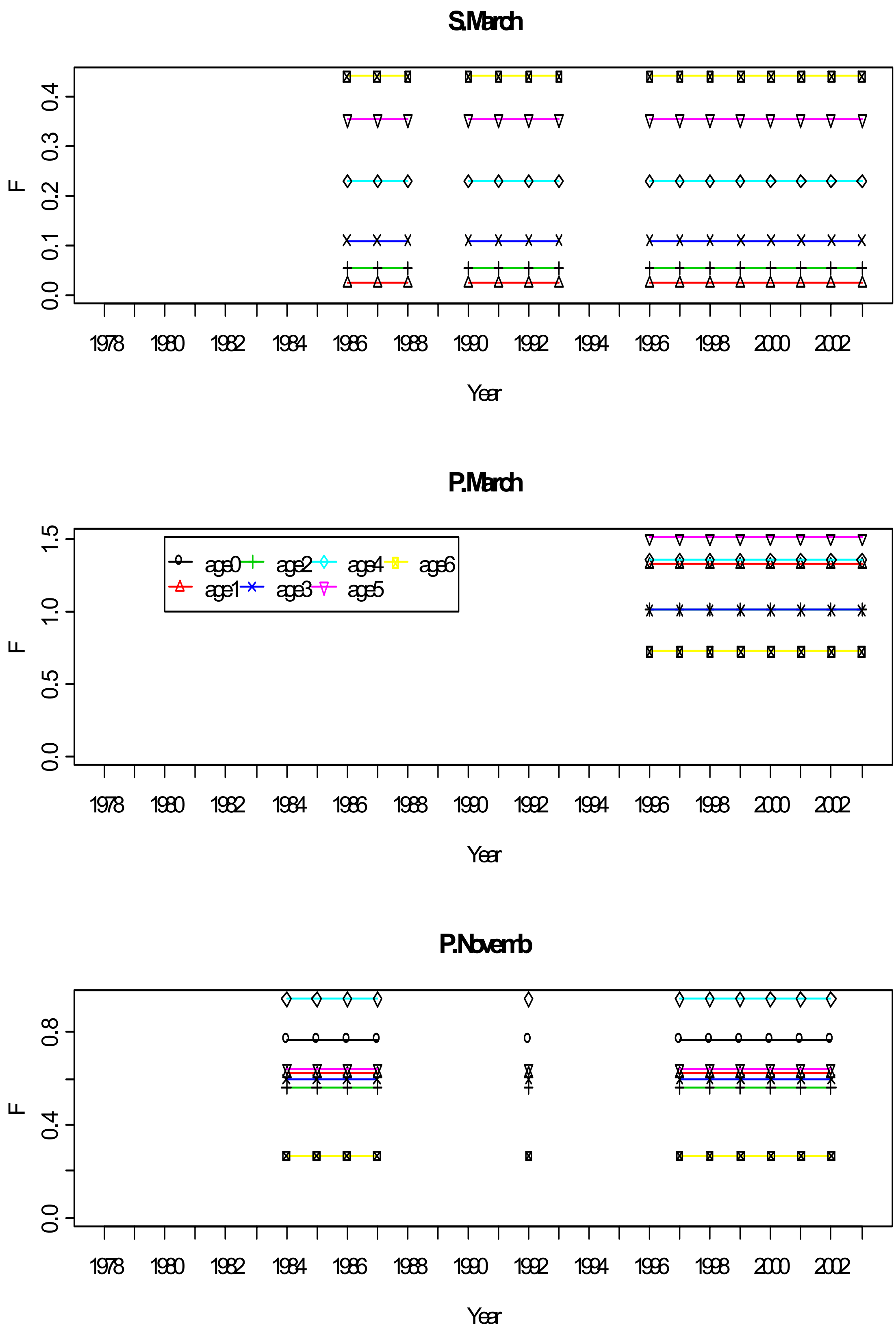


Figure 9.7.1.4.1b Fixed catchability trends in Run 1.

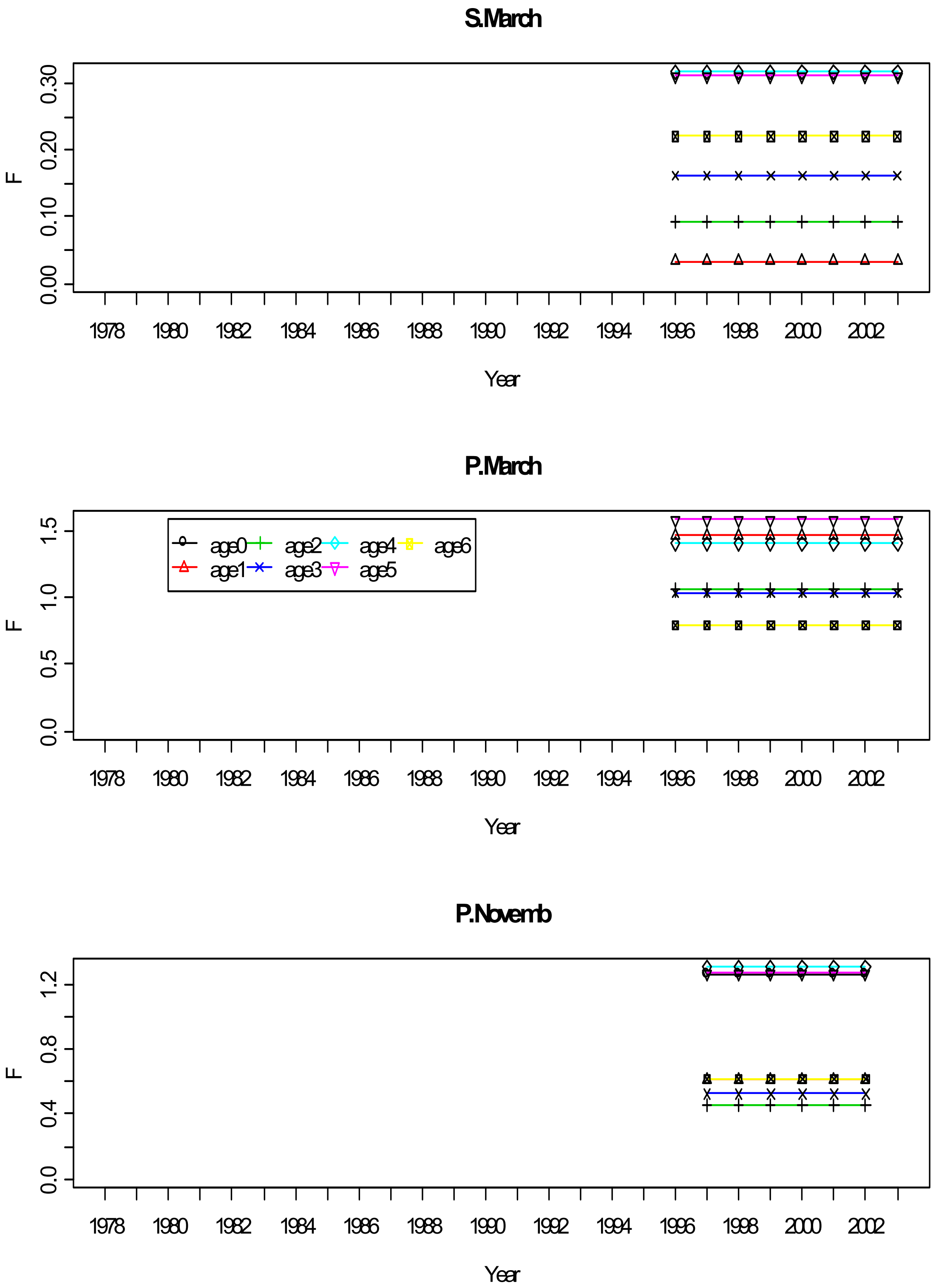


Figure 9.7.1.4.1c Catchability trends in recent years alone (Run 2)

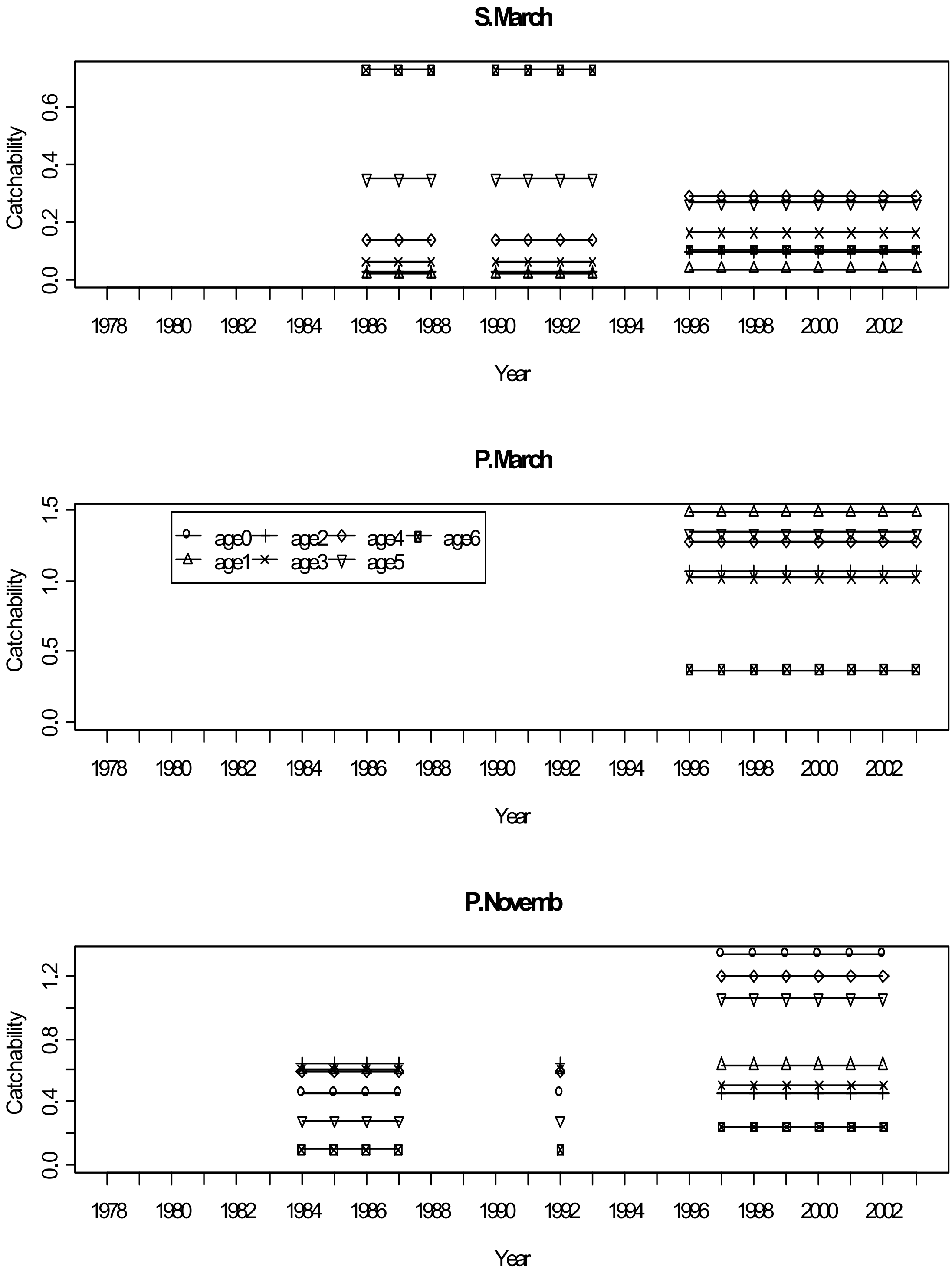


Figure 9.7.1.4.1d Catchability trends in two split periods

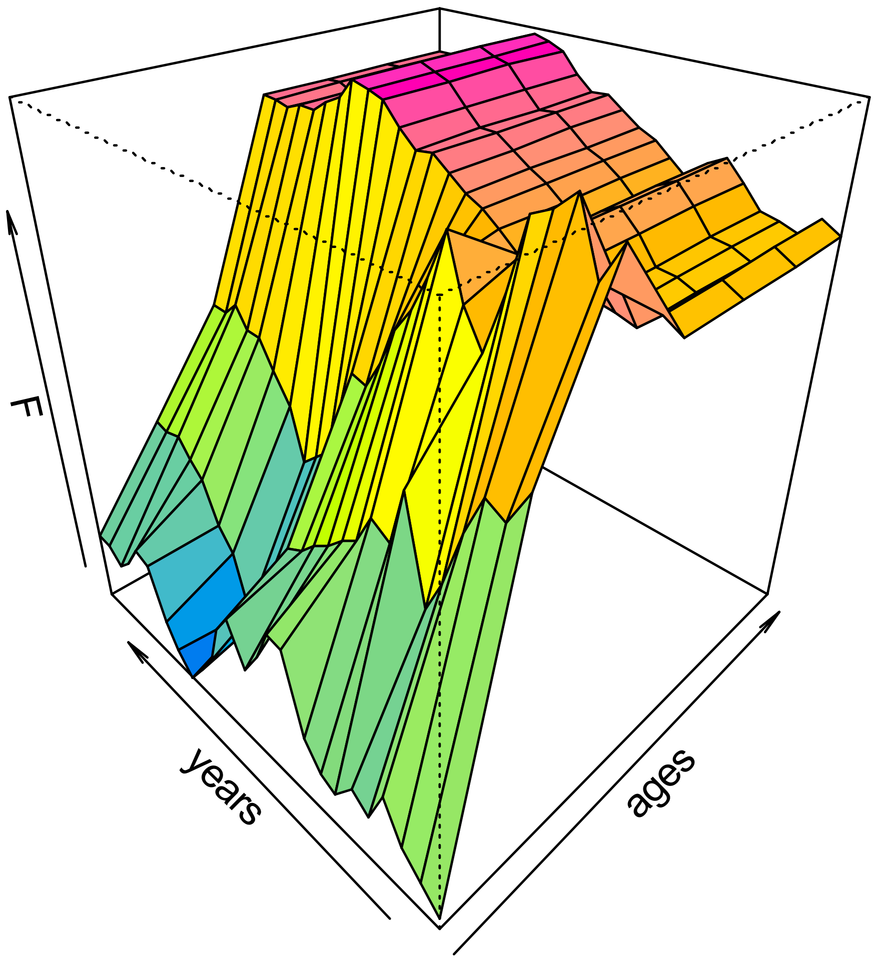


Figure 9.7.1.4.2a Selection pattern for Run 0.

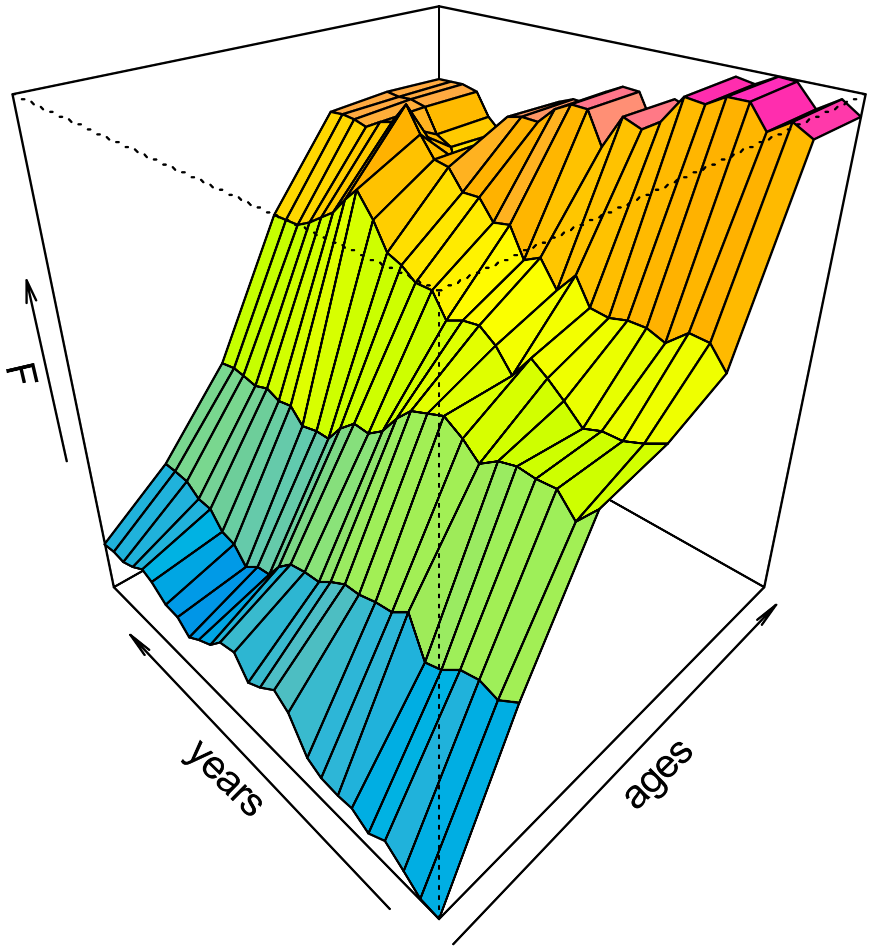


Figure 9.7.1.4.2b Selection pattern for Run 3

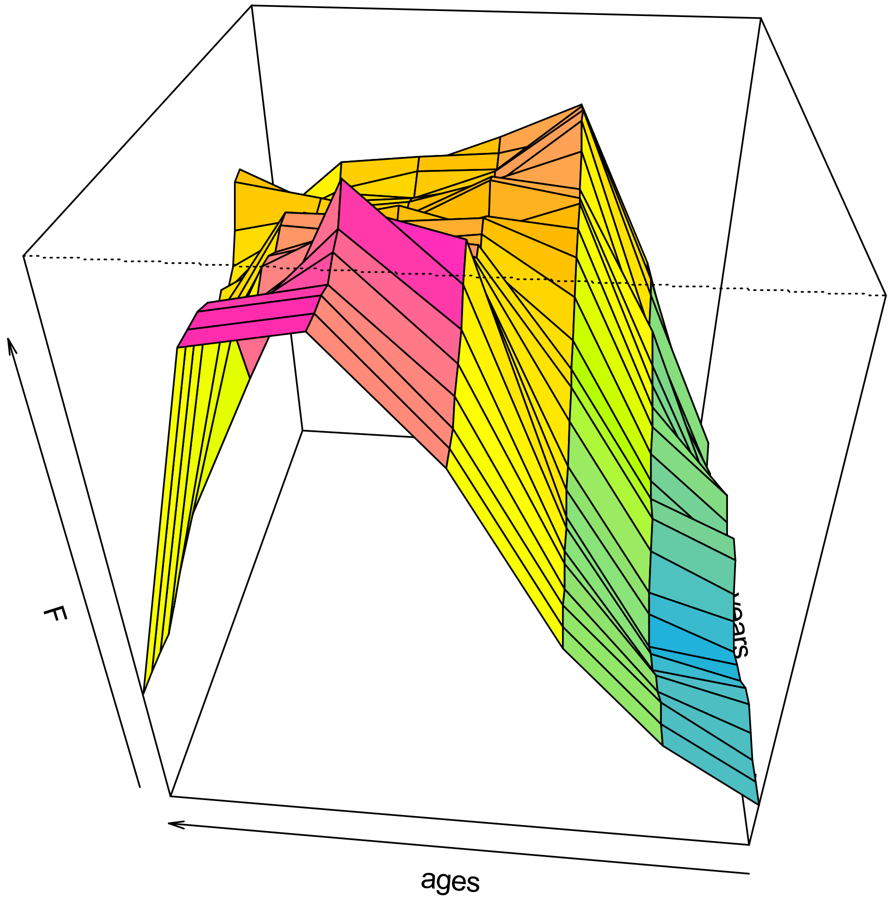


Figure 9.7.1.4.2c Selection pattern for Run 4. Opposite to previous plots, in this one recent years are the ones nearest to the reader (in perspective).

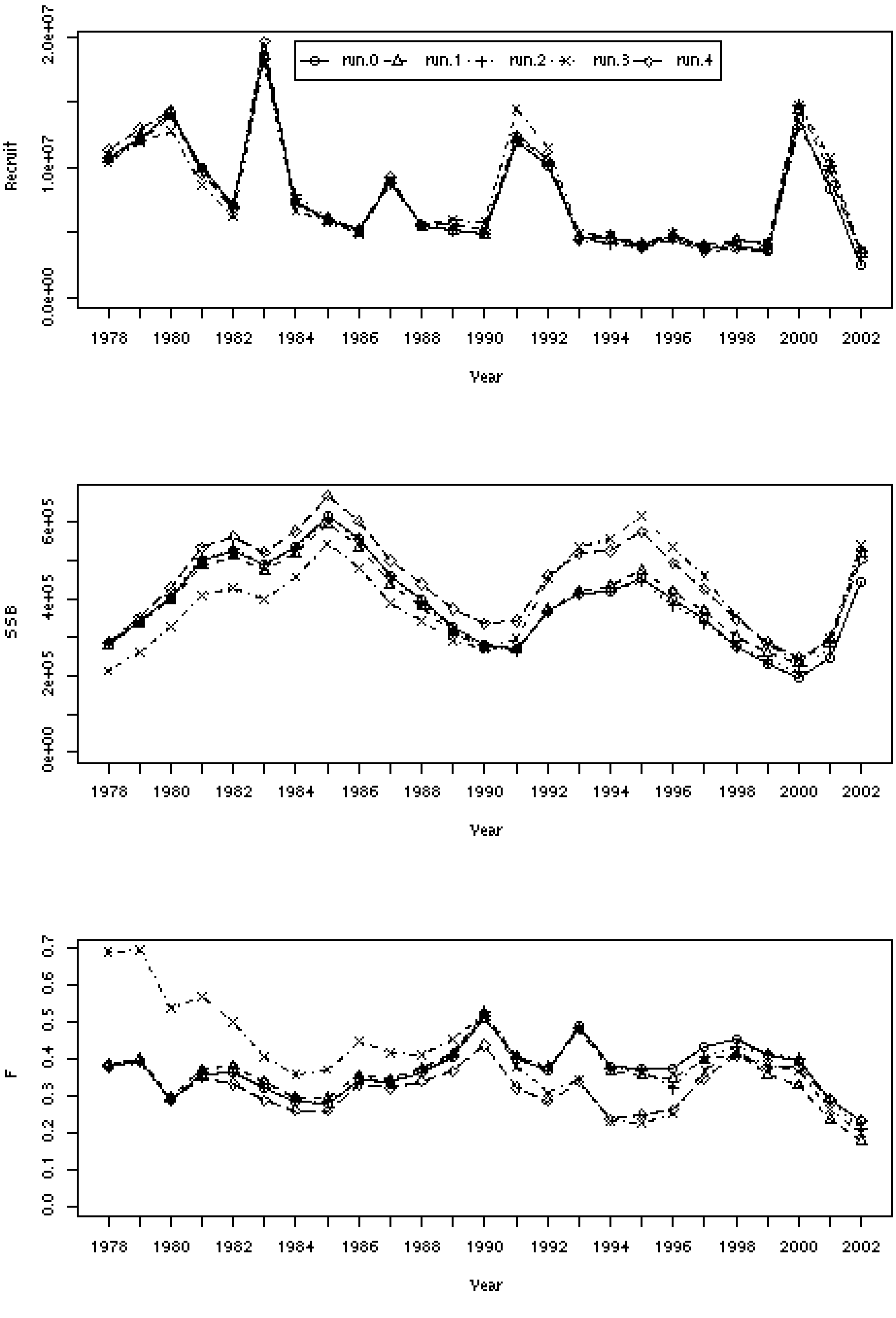


Figure 9.7.1.4.3 Comparison of the Recruitment, SSB and F trajectories over the different AMCI runs for the assessment of Iberian sardine.

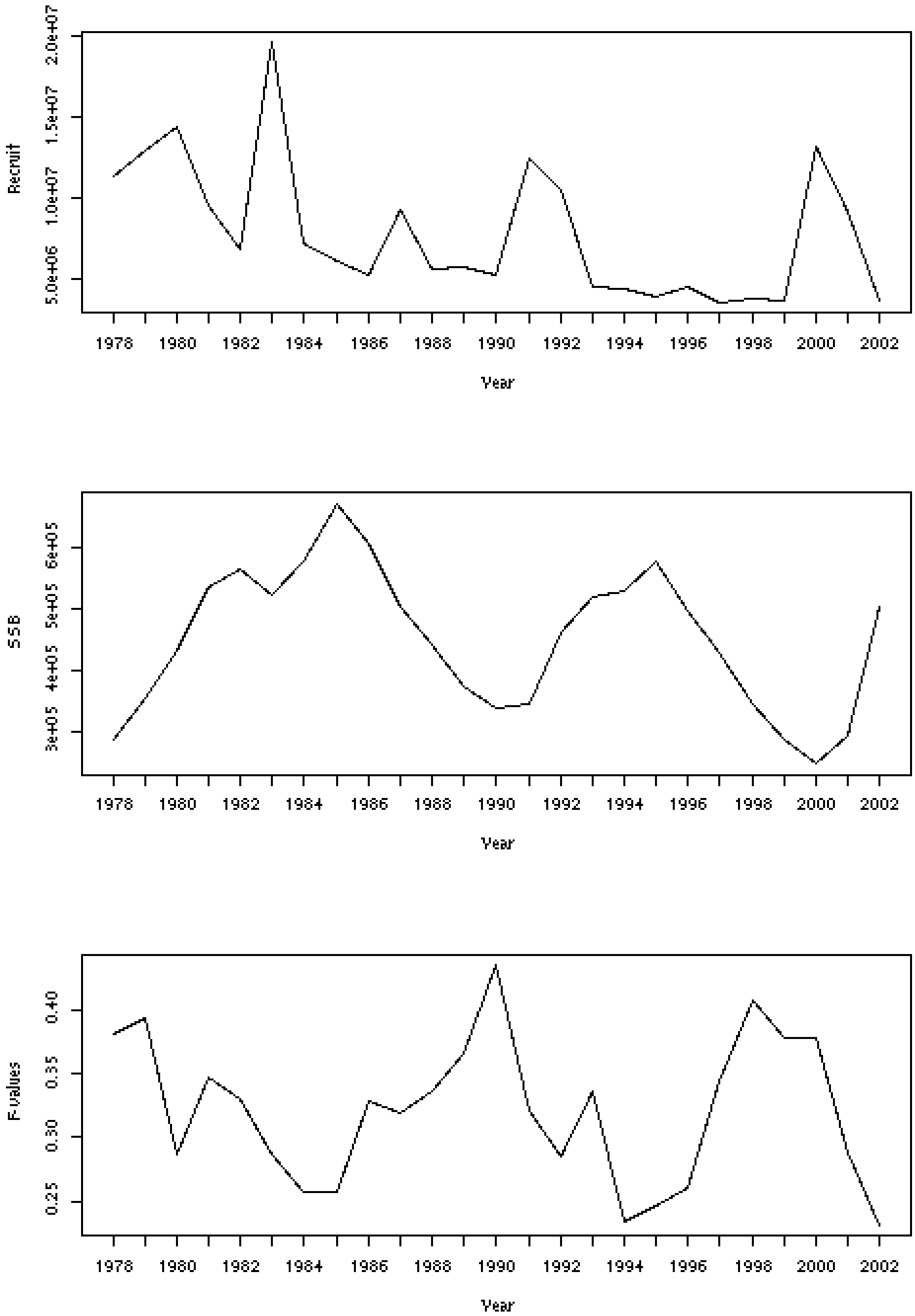


Figure 9.7.2.1 Recruitment (top), SSB (middle) and F (bottom) trajectories from the sardine AMCI assessment.

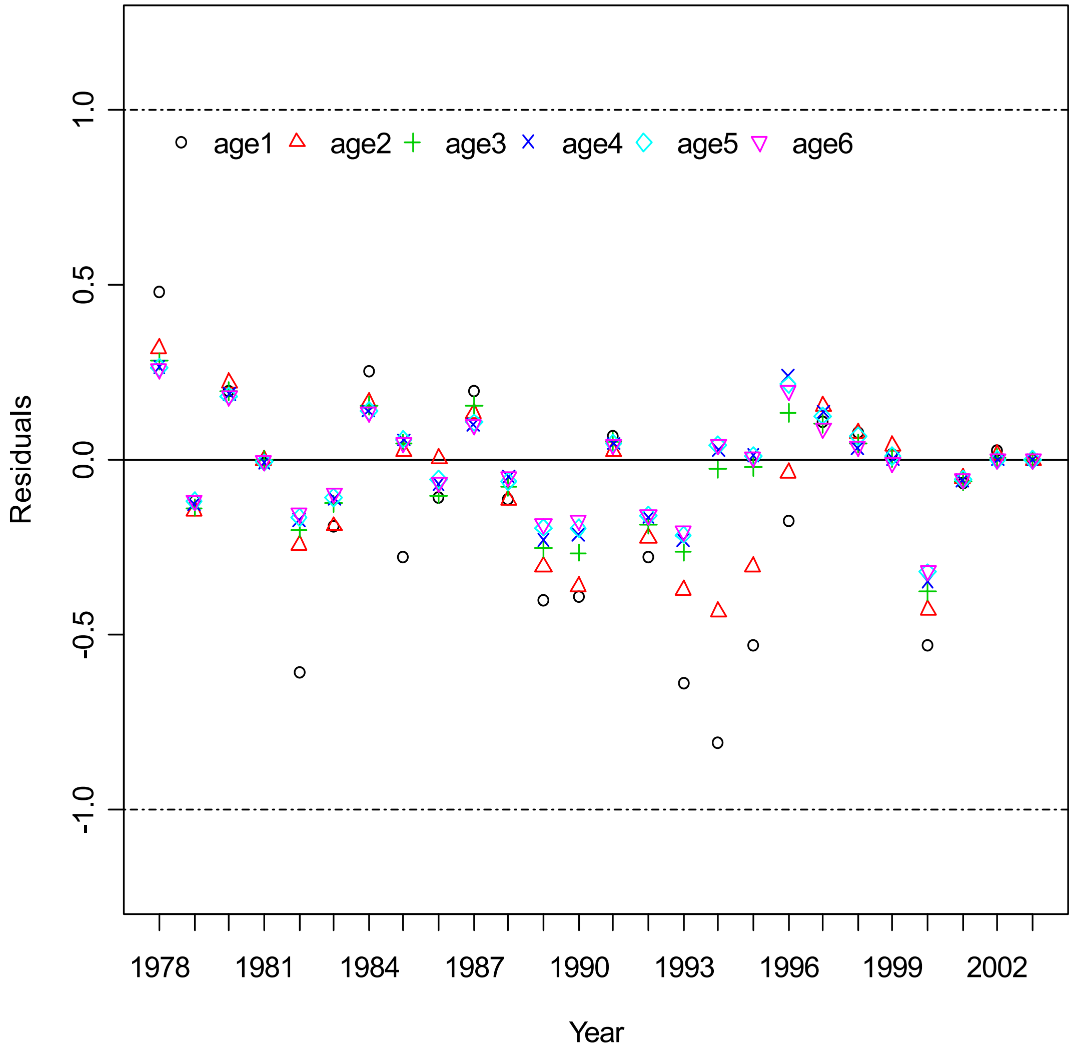


Figure 9.7.2.2 Catch residuals in the assessment model. Different colours and symbols represent the different ages.

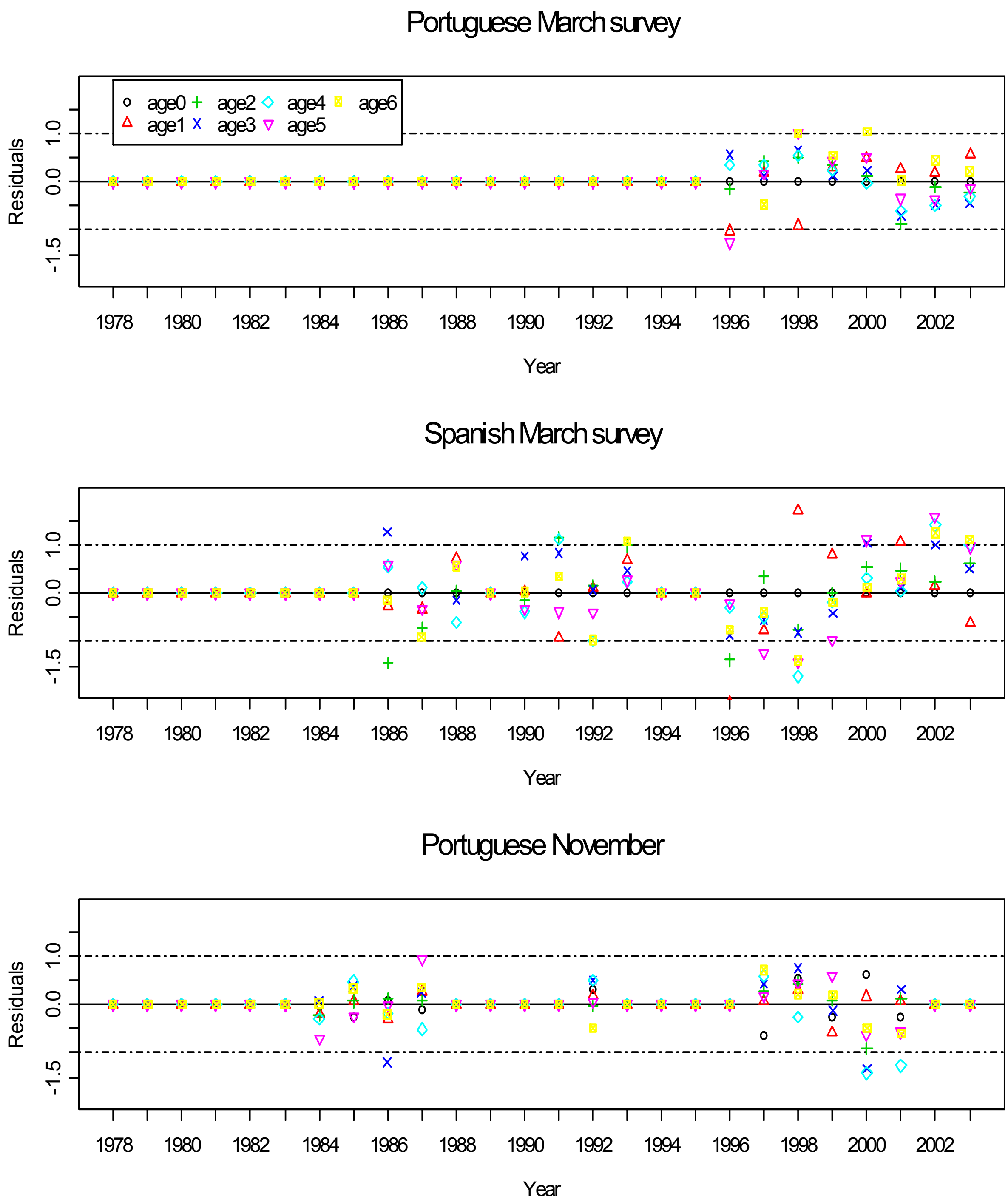


Figure 9.7.2.3 Survey residual for the three different acoustic surveys used in the analysis.

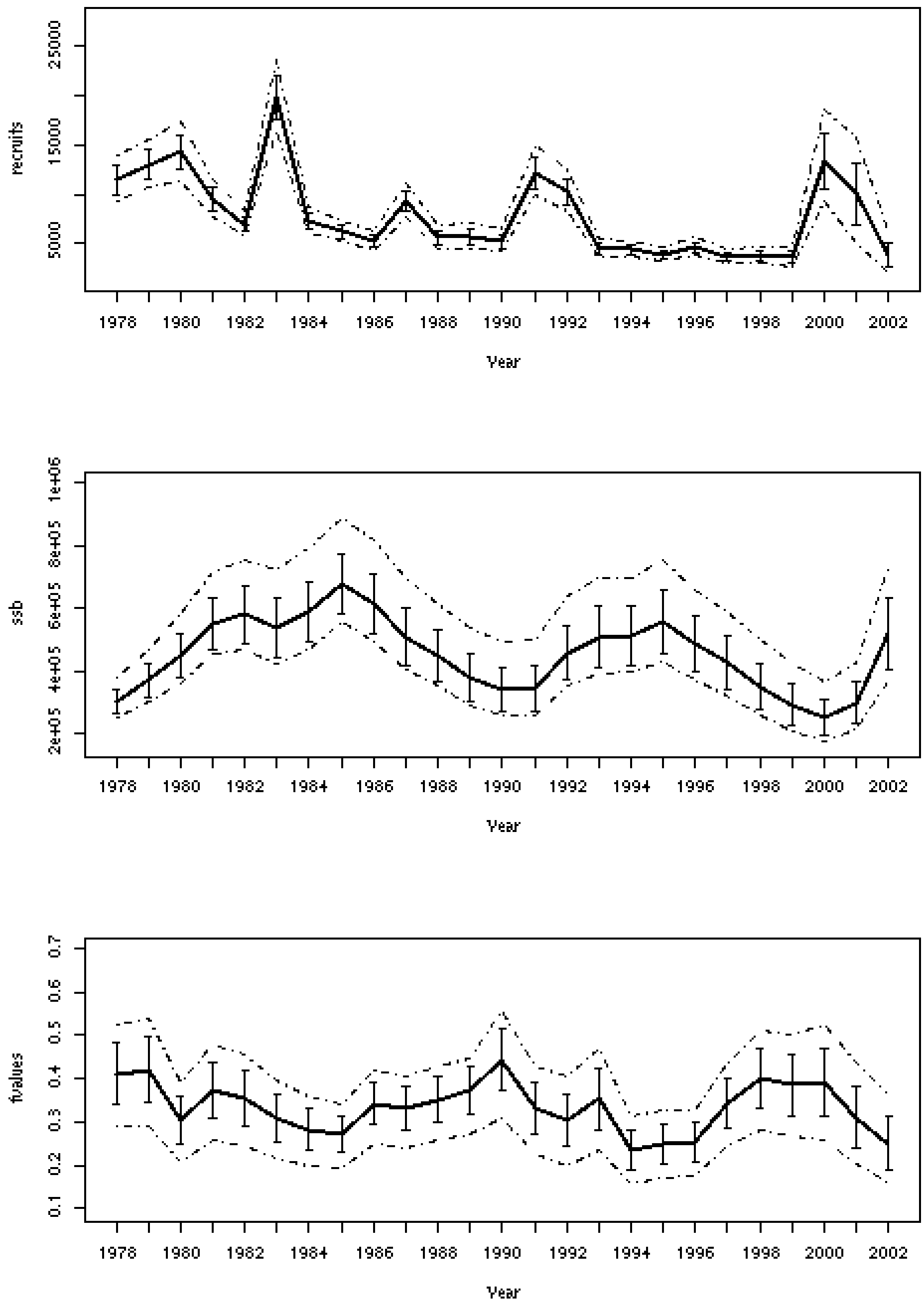


Figure 9.7.2.6 Bootstrap trajectories of Recruitment (top), SSB (center) and F (bottom) for the assessment model. Bold line indicates average trajectory. Dotted lines represent the 90% limits and vertical lines represent mean plus minus the standard deviation of the bootstrap runs for any given run..

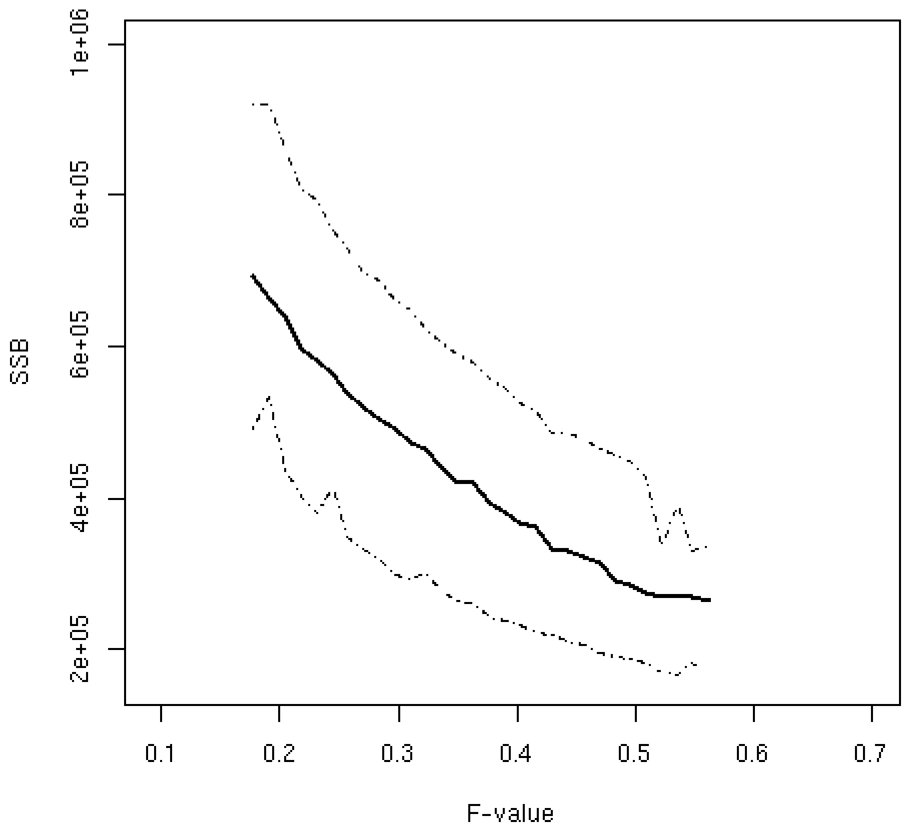


Figure 9.7.2.7 Relation between SSB and F for the bootstrap runs of the assessment model. Bold line is the average trajectory, dotted line represent the 90% confident intervals.

10 ANCHOVY – GENERAL

10.1 Stock Units

The WG reviewed the basis for the discrimination of the stocks in Subarea VIII and Division IXa. No detailed study has been made to discriminate sub-populations along the whole European Atlantic distribution of the anchovy. Morphological studies have shown large variability among samples of anchovies coming from different areas, from the central part of the Bay of Biscay to the West of Galicia (Prouzet and Metuzals, 1994; Junquera, 1993). These authors explained that the variability is reflecting the different environments in the recruitment zones where the development of larvae and juveniles took place. They suggested that the population may be structured into sub-populations or groups with a certain degree of reproductive isolation. In the light of information like the well defined spawning areas of the anchovy at the South-east corner of the Bay of Biscay (Motos *et al*., 1996) and the complementary seasonality of the fisheries along the coasts of the Bay of Biscay (showing a general migration pattern; Prouzet *et al.,* 1994), the WG considers that the anchovy in this area has to be dealt with as a single management unit for assessment purposes. Recent genetic studies carried out on samples collected during 2001 and 2002 French acoustic surveys seem to show that two well separate types of fish exist but that they are both present all over the distribution area of the species in the Bay of Biscay. This is totally in agreement with the idea to deal with this population as a single management unit for assessment purposes at the stage of the art.

Some observations made in 2000 during the PELASSES survey in winter suggest the presence of anchovy in the Celtic Sea (Carrera, 2000). So far, these observations not affect our perception of one stock in the Bay of Biscay area. Anchovy found in the Celtic sea area is probably linked to the population of anchovy found in the Channel in spring by the professional fisheries.

Junquera (1993) suggested that anchovy in the Central and Western part of Division VIIIc may be more closely related to the anchovy found off the Western Galician coasts than with the anchovy at the South-east corner of the Bay of Biscay (where the major fishery takes place). Morphological studies, as mentioned previously, are influenced by environmental conditions and further investigations, especially on genetic characteristics, are necessary in order to be more certain. The WG considers that for assessment and management purposes the anchovy population along the Atlantic Iberian coasts (Division IXa) should be dealt with as a management unit independent of the one in the Bay of Biscay.

In Division IXa, the differences found between areas in length distributions, mean length- and mean weight-at-age, and maturity-length ogives, which were estimated from both fishery data and acoustic surveys, support the view that the populations inhabiting IXa may be not enterely homogeneus, showing different biological characteristics and dynamics (ICES 2001/ACFM:06). The recent catch distribution of anchovy along Division IXa confirms that anchovy fishery is mainly concentrated in the Spanish waters of the Gulf of Cadiz (more than 80% of total landings), which is also corroborated by direct estimates of the stock biomass (about 90% of total biomass). Such data seem to suggest the existence of an anchovy stable population in the Gulf of Cadiz which may be relatively independent of the remaining populations in Division IXa. These others populations seem to be latent ones, which only develop when suitable environmental conditions take place, as occurred in 1995. (See section 12 and Ramos *et al*., 2001)

Recent studies on anchovy catches between North of Morocco, the Gulf of Cadiz and South of Portugal (Silva and Chlaida, WD 2003) show parallel changes of the catches in the period 1963-2000. There is a need for further studies on the dynamic on the anchovy in IXa and its possible connection with anchovies from other areas.

10.2 Distribution of the Anchovy Fisheries

The observations collected by the members of the Working group allowed to define the principal areas of fishing according to quarters. **Table 10.2.1** shows the distribution of catches of anchovy by quarters for the period 1991-2002.

In Subarea VIII the seasonal fisheries during 2002 reveal a successive failure of the catches: First it was the failure in the 2002 Spring Spanish purse seine fishery, followed by a reduction of the French autumn catches. During the first quarter in 2002, the main fishery (predominantly by the French fleet) was located around the Gironde estuary from 44°N up to 47°N. During the second quarter, the main landings (predominantly Spanish) were caught in the Southern part of the Bay of Biscay (south of 45°N.), mainly in Subareas VIIIb and VIIIc. During the third and fourth quarter in 2002, the main fishery was located in the Center (VIIIb) and in the North (VIIIa) and the main production corresponded to the French fleets but some Spanish purse seiners stayed to fish in the North.

Anchovy fishery in Division IXa in 2002 was again located in the Gulf of Cadiz area (Spanish part of the Subdivision IXa South) throughout the year as observed in recent years. Highest landings this year from this Division occurred during the second and third quarters, which were mainly caught by the Spanish fleets fishing in the Gulf of Cadiz. Spanish catches from the Subdivision IXa North were negligible. Portuguese anchovy landings from Division IXa in 2002 were relatively low as compared with the Spanish ones, although they also occurred throughout the year. Most of the Portuguese anchovy was caught in the Subdivision IXa Central North during the second half of the year and in the South (Algarve area) during the second and third quarters.

Table 10.2.1: Catch (t) distribution of ANCHOVY fisheries by quarters in the period 1991-2002.

Q 1	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	1049	2	6	1	126	0	36	2797	1259	-
1992	1125	0	26	0	0	187	756	3666	958	-
1993	767	0	3	1	0	69	1605	4147	1143	-
1994	690	0	0	0	0	5	62	4601	786	27
1995	185	1	203	12	0	0	35	2380		
1996	41	0	1289	11	116	61	9	2345	0	-
1997	908	6.0	164	2	12	43	58	1548	925	-
1998	1782	109	424	192	472			4725	0	
1999	1638	65	91	76	65			4008	0	0
2000	416	61	41	0	88			4003	0	0
2001	1052	13	27	0	598			1406	0	0
2002	1775	80	6	3	14			3947	350	0

Q 2	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	3692	0	10	14	90	295	5848	3923	650	-
1992	1368	0	10	0	11	457	17532	2538	275	-
1993	921	0	6	0	25	24	10157	6230	658	-
1994	2055	0	0	0	1	79	11326	6090	163	75
1995	80	7	1989	1233	23	36	14843	6153		
1996	807	1	227	6	1	404	9366	8723	0	-
1997	1110	2	49	4	0	81	4375	3065	598	-
1998	2175	0	191	51	2215			5505	0	
1999	1995	0	4	7	7138			4169	0	0
2000	668	0	5	1	14690			3755	0	0
2001	3233	3	30	4	13462			7629	0	0
2002	2964	2	14	1	3312			2118	90	0

Q 3	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	703	0	0	0	24	15	145	386	1744	-
1992	499	0	4	27	192	390	632	191	4108	-
1993	167	0	0	0	1	8	1206	1228	6902	-
1994	210	8	29	1	61	6	1358	2341	3703	15
1995	148	52	1817	4043	1	10	55	3620		
1996	586	0	189	22	134	146	1362	171	6930	-
1997	2007	0	44	2	202	3	735	4189	2651	-
1998	2877	12	49	5	1579			205	11671	0
1999	1617	0	139	318	949			351	5750	0
2000	673	0	0	7	1238			211	8804	0
2001	3278	3	107	13	1314			249	8788	0
2002	2705	6	200	11	381			3181	2223	0

Q 4	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	274	0	171	0	205	692	148	91	805	-
1992	4	1	96	6	8	18	204	27	5533	-
1993	105	1	13	0	0	0	574	1005	5106	-
1994	80	0	198	116	6	13	895	341	2520	14
1995	157	271	2716	42	398	148	18	2080		
1996	398	12	1002	5	21	12	158	204	4016	-
1997	589	0	353	54	93	83	530	1225	1354	-
1998	2710	32	231	123	27			1	5217	0
1999	692	30	723	12	98			0	4266	0
2000	603	0	25	2	98			266	3843	0
2001	1091	0	234	11	36			624	6042	0
2002	817	2	213	5	5			1041	845	0

TOTAL	DIVISION IXa				SUB-AREA VIII					
Year	IXa South	IXa CS	IXa CN	IXa North	VIIIc West	VIIIc Central	VIIIc East	VIIIb	VIIIa	VIIId
1991	5717	3	187	15	445	1003	6177	7197	4458	-
1992	2996	1	136	33	211	1053	19122	6422	10874	-
1993	1960	1	22	1	26	101	13542	12609	13809	-
1994	3035	8	227	117	68	103	13641	13373	7172	130
1995	571	331	6725	5329	421	194	14951	14233		
1996	1831	13	2707	44	272	623	10895	11442	10946	-
1997	4614	8	610	62	307	210	5698	10027	5528	-
1998	9543	153	894	371	4294			10436	16888	0
1999	5942	96	957	413	8249			8529	10016	0
2000	2360	61	71	10	16113			8235	12647	0
2001	8655	19	397	27	15410			9908	14831	0
2002	8262	90	433	21	3713			10288	3508	0

- Not available

11 ANCHOVY - SUB-AREA VIII

11.1 ACFM Advice and STECF recommendations applicable to 2003

ICES advice from ACFM in November 2002 stated "ICES recommends that a preliminary TAC for 2003 is set to 12 500 t, in order to keep SSB above $\mathbf{B}_{pa}$ in 2003. This is based on the conservative assumption that recruitment in 2002 and beyond is 7.8 billion (mean of the below mean year classes in the historical series. This TAC should be re-evaluated in the middle of the year 2003, based on the development of the fishery and on the results from acoustic and egg surveys in May-June".

STECF (2003, November meeting. SEC (2003), 102) agreed with ICES assessment but considered that "a provisional TAC for anchovy in the Bay of Biscay and in-year revision is only necessary if spawning stock biomass in the assessment year is below a predefined level. If SSB is estimated to be above this predefined levels, STECF considers that it would be appropriate to set a final annual TAC".

And STECF recommended, "ICES should indicate an appropriate level of spawning stock biomass below which it will be necessary to agree a provisional TAC for anchovy. Since SSB in 2002 (56,300 t) was above $\mathbf{B}_{pa}$ (36,000 t) a provisional TAC of 12,500 t advised by ICES may not be appropriate. STECF recommends that a final annual TAC for anchovy in the bay of Biscay be set for 2003 to avoid the need to re-evaluate stock status after the surveys in 2003. STECF reiterates its recommendation that harvest control rules be formulated to implement an effective two stage management regime".

The European Fishery Commission finally decided to set an annual TAC at the level of 33,000t, as traditionally had been done, but in addition the EC decided to revise by an in-season assessment the status of the Bay of Biscay anchovy stock, in case a modification of the management decision should be taken, as well as to develop an alternative management strategy for the stock of anchovy in the Bay of Biscay.

11.2 The fishery in 2002

Two fleets operate on anchovy in the Bay of Biscay: Spanish purse seines and French pelagic trawlers. The pattern of each fishery has not changed in recent years, although the number of vessels is gradually being reduced in recent years (Table 11.5.1).

Spanish purse seine fleet: The Spanish fleet is composed of purse seines (around 215 boats). That operated mainly in spring. This spring fishery operates at the southeastern corner of the Bay of Biscay in Divisions VIIIc and b and accounts for more than 80 % of the Spanish annual catches.

Until 1995, the Spanish purse seines were allowed to fish anchovy in Sub-division VIIIb only during the spring season and under a system of fishing licences (Anon. 1988), while Division VIIIa was closed to them for the whole year. Since 1996 this fleet can fish anchovy throughout the year in Sub-area VIII with the same system of fishing licences.

The major part of this fleet goes for tuna fishing in summer time and by then they use small anchovies as live bait for its fishing. These catches are not landed but the observations collected from logbooks and fisherman interview (up to 1999) indicate that they are supposed to be less than 5 % of the total Spanish catches. Since 1999, a part of the Spanish fleet goes to fish in the VIIIa during summer and autumn and lands significant amounts of fish as in 2001 (Table 11.2.1.3).

French Pelagic Trawlers: The French fleet is mainly composed of pelagic trawlers (about 70 boats fishing in pairs), operative in summer, autumn and winter. Until 1992, they also operated in the spring season, but due to a bilateral agreement between France and Spain the spring season is not presently used as fishing season by the pelagic trawlers. The major fishing areas are the north of the VIIIb in the first half of the year and VIIIa, mainly, during the second half. The VIIIc area is prohibited to the French pelagic fleet.

There are also some French purse seines located in the Basque country and in the southern part of Brittany, which have recently increased in numbers (reaching in 2002 the number of 81). They fish mainly in the spring season in VIIIb and a part of them in autumn in the north of the Bay of Biscay.

11.2.1 Catches for 2002 and first half of 2003

In 2002 a total of 17,507 tonnes were caught in Subarea VIII (Table 11.2.1.1 and Figure 11.2.1.1). This is a 56.4% decrease compared to the level of 2001 catches. The Spanish and French fishery decreased their landings in 71.7 % and 35.7 % respectively. As usual, the main Spanish fishery took place in the second quarter (72.6%) but the French catches unlike other years was more abundant in the first half of the year (58%) (Table 11.2.1.3 and Figure 11.2.1.2).

The seasonal fisheries by countries are well described in the MHSAWG report (ICES 2003), and, in summary, about 85 % of the Spanish landings are caught in divisions VIIIc and VIIIb mostly in spring, while the French landings are caught in divisions VIIIb in Winter (22 %) or in Summer and autumn in division VIIIa (67 %) (Table 11.2.1.3).

In 2003 international catches of the first half of the year amounted to about 4,238 t, which is the lowest catches in the series since 1987 (Table 11.2.1.1**)**. The seasonal fisheries reveal a successive failure of the catches since the first half of 2002 to first half of 2003: First it was the failure in the 2002 spring Spanish purse seine fishery (Figure 11.2.1.3 a), followed by a reduction of the French autumn catches (Figure 11.2.1.3 b) and finally another failure occurred in 2003 in the first half of the year for both the French (Figure 11.2.1.3 b) and the Spanish fisheries (Figure 11.2.1.3 a). The failures of the first half of the year in the Spanish fishery in both years and in the French fishery in 2003 suppose the lowest catches recorded since 1987 for the first half of the year. And the reduction of the French catches in the second half of 2002 is the most remarkable since 1992, but stronger reductions occurred in 1989 and 1991Low catches of the French fleet in the first half of 2003 may be also related to the Prestige oil spill.

11.2.2 Discards

There are no estimates of discards in the anchovy fishery but it does not appear to be a significant problem.

11.3 Biological data

11.3.1 Catch in numbers at Age

Table 11.3.1.1 provides the age compositions by quarters and by countries in 2002. In 2002 the age composition for both countries was based on routine sampling of catches for length and for grade compositions and on biological samples collected from surveys and market sampling: Both half of the years had length and biological samples. The age composition in 2002 is different compared to the previous years. For both countries, age 2 predominated in the catches of the first half of the year, while usually age 1 is the one predominating. In the second half of the year, age 1 predominated in the French catches. In the Spanish catches age 1 predominated only in the quarter 3. For the international catches 2-year-old anchovies make up 51.8% of the landings, followed by age 1 with 41 %. The 3rd age group represented 7.2 % and the age 0 represented very low proportions of the catches, about 0.01%.

Table 11.3.1.2 records the age composition of the international catches since 1987, on a half-yearly basis. 1-year-old anchovies predominate largely in the catches during both halves of most of the years (except for the years 1991, 1994 and 1999). A few catches of immature, 0 age group, appear during the second half of the year. The estimates of the catches at age on annual basis since 1987 is presented along with the inputs to the assessment in Table 11.7.2.1

In Table 11.3.1.2 the catches at age of the first half of 2003 are included for Spain and the total catches for France. The French catches at age are not available at present but according to the small size of anchovies caught at the French fishery, the 1 age group could have predominated their catches. However, for Spain, the ages 2 and 3 are both well represented (45.3% and 36.6% respectively) in the spring catches of 2003, and group 1 age supposed a low proportion of the catches (18.1%). Given the low level of the French catches in the first half of 2003, the international catches will be dominated by the 2 and 3 years old anchovies appearing in the Spanish catches.

The age composition of the spring Spanish catches shows a failure of catches at age 1 in the two most recent years in comparison to 2001 (Figure 11.3.1.1), that suggests a reduction of recruitment may be happening in these years. This indication is in agreement with the strong reduction of catches occurring in this period.

The catches of anchovy corresponding to the Spanish live bait fishery have not been provided since 2000. The Table 11.3.1.3 gives the data available for the period 1987 – 1999. These are traditionally catches of small anchovy mainly of

0 and 1 year old groups amounting about 5 hundred tonnes or less. In the year when the strongest failure of recruitment occurred (2001), live bait catches were minima if any, since according to fishermen it was impossible to find any juveniles in the Bay of Biscay (ICES 2003).

11.3.2 Mean Length at age and mean Weight at Age

Table 11.3.2.1 shows the distribution of length catches and the variation of mean length and weight by quarters in 2002.

For the first quarter, the main fishery is the French one. On average the Spanish catches had a mean size higher than the French ones. Both fisheries show the same length range. (Figure 11.3.2.1**).**

For the second quarter, the Spanish fishery is the main one and showed a unimodal distribution with a modal length of 17 cm (mostly age 2). On average, the anchovies landed by the French fleet are smaller than those caught by the Spanish one in the second quarter (Figure 11.3.2**.**2).

For the third quarter, the main fishery is the French one. The French anchovy catches had a bimodal length distribution. The Spanish had one modal witch is in the middle of the bimodal French catches. (Figure 11.3.2.3).

For the fourth quarter, the size distribution of the French and Spanish landings was similar. **(**Figure 11.3.2**.**4).

The series of mean weight at age in the fishery by half year, from 1987 to 2001, is shown in Table 11.3.2**.**2. The French mean weights at age in the catches are based on biological sampling from scientific survey and commercial catches.

Spanish mean weights at age were calculated from routine biological sampling of commercial catches. The series of annual mean **weight at age in the fishery** is shown with the inputs to the assessment in Table 11.7.2**.**1.These annual values for the fishery represent the weighted averages of the half-year values per country, according to their respective catches in numbers at age.

The values of mean **weight at age for the stock** appear with the inputs to the assessment in Table 11.7.2.1**.** These values are the ones estimated for the spawners during the DEPM surveys of 1990-2002. For the years 1993, 1996,1999 and 2000, when no estimate of mean weight at age for the stock existed, the average of the rest of the years is taken.

11.3.3 Maturity at Age

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

11.3.4 Natural Mortality

For the purpose of the assessment applied in the WG, a constant natural mortality of 1.2 is used. However, the natural mortality for this stock is high and probably variable. Natural mortality estimates after Prouzet et al, 1999 suggest that this parameter could vary between 0.5 to 3. From the results obtained, M (natural mortality) can vary widely among years and it seems that the assumption of a constant M used for the current management procedure is a strong simplification of the actual population dynamic.

11.4 Fishery-Independent Information

11.4.1 Egg surveys

Egg surveys to estimate the spawning stock biomass (SSB) of the Bay of Biscay anchovy through the Daily Egg Production Method (DEPM) have been implemented from 1987 to 2003, with a gap in 1993 **(**Table 11.4.1**.**1). The map of egg abundance and the positive spawning area for 2003 is shown in Figure 11.4.1.1.

One of the smallest spawning areas of the whole series of DEPM surveys was recorded in 2002. As the Daily Fecundity was not yet available for the 2002, the biomass estimate used in the past year working group was initially based on a regression of past SSB estimates on Daily Egg production (P_0) and Spawning Area (SA) and the Julian day of the middle of the survey dates (ICES 2002a). This gave a figure of about 50,905 tonnes for 2002. An update is available for 2002 (Santos et al. 2003 WD), which makes use of actual fecundity estimates for this year and gives a figure of 30,697 t (with a CV of 13.2%) (Table 11.4.1.1**)**, well below the predicted value. The complete application of the DEPM 2003 has now led to provide estimates of the population in numbers at age as well (Table 11.4.1.1).

Parameter	Estimate	S.e.	CV
DEP	2.3E+12	3E+11	0.1273
R'	0.5388	0.0039	0.0072
S	0.3023	0.0088	0.0292
F	16825.0	772.1	0.0459
Wf	35.86	1.3522	0.0377
Daily Fec.	76.41	2.7314	0.0357
Biomass	30,697	4058.94	0.1322
Wt	29.6686	1.7474	0.0589
POPULATION	1038.7	153.5	0.1478
Pa 1	0.2695	0.0549	0.2038
Pa 2	0.6009	0.0442	0.0736
Pa 3	0.1297	0.0128	0.0984
Nage 1	283.6	85.0	0.2998
Nage 2	621.3	83.4	0.1343
Nage 3	133.8	18.5	0.1384

In previous years the SSB, when the adult samples were not yet processed, a preliminary estimated was set using the relationship between SSB (spawning stock biomass), SA (spawning area) and P_{tot}(Daily Egg Production in the spawning area). This year in the spawning area the percentage of stations with just 1 or 2 eggs was 40%. This percentage of stations with very few eggs is very large in relation to the percentages encountered along the historical series. In consequence it was consider considered that this year the relation SSB, SA and P_{tot} might not be adequate since the eggs were very spread in what is an atypical situation.

Therefore, in order to provide preliminary biomass estimates for 2003, the relationship between *SSB* (spawning stock biomass) and P_{tot} (total egg production) (on which the DEPM is based), was fitted to the historical DEPM series (Santos et al, WD2003). A GLM relating SSB and Ptot, with variance proportional to the mean was applied

$$\mathrm{E}(SSB) = aP_{tot}$$

Resulting fitted model was:

$$\mathrm{E}(SSB) = 15287\ P_{tot}$$

Preliminary biomass estimates for 2003 were obtained by predicting from the fitted model for the total egg production estimate for 2003. The variance associated to each of the biomass estimates was computed by the Delta method:

$$Var(S\hat{S}B) = Var(\hat{a}\ \hat{P}_{tot}) = \hat{P}_{tot}^{\ 2}\ Var(\hat{a}) + \hat{a}^2\ Var(\hat{P}_{tot}) + Var(\hat{a})Var(\hat{P}_{tot})$$

Predicted biomass estimate and the correspondent coefficient of variation for 2003 estimates is 32,866 (C.V=0.28)

The current preliminary estimate is near the acoustic preliminary estimate of biomass for 2003 of about 29,428 t. This DEPM 2003 estimate indicates a substantial decrease in Biomass most likely related to a poor presence of age 1 in 2002 (poor recruitment occurring in 2001).

Population at age estimates for the DEPM survey in 2003 is given in Table 11.4.1.1

Parameter	Estimate	S.e.	CV
Biomass	32,866	9351.05747	0.2845
Wt	18.29	1.33	0.07
POPULATION	1,797	527.6	0.2937
Pa 1	0.8094	0.0336	0.0416
Pa 2	0.1370	0.0245	0.1786
Pa 3	0.0536	0.0129	0.2414
Nage 1	1,454	431.3	0.2966
Nage 2	246.1	84.6	0.3437
Nage 3	96.3	36.6	0.3801

The whole series of DEPM biomass estimates since 1987 are presented in Figure 11.4.1.2. A total of 15 years of SSB estimates and 11 years of population at ages estimates are now available for the assessment of this anchovy and these values are taken as absolute estimators of the spawning stock biomass and population in numbers at age of anchovy in the Bay of Biscay.

11.4.2 Acoustic surveys

The French acoustic survey estimates available from 1983 to date are shown in Table 11.4.2.1. The figures for 1991 and 1992 were revised and updated for a FAR programme on anchovy (Cendrero ed., 1994). In 1993, 1994 and 1995, the survey was targeted only on anchovy ecological observations and mainly close to the Gironde estuary. The Gironde is one of the major spawning areas for anchovy in the Bay of Biscay. In 1997, 1998 the surveys were broadened in scope to provide acoustic abundance indices for anchovy as well as the ecological work (Anon. 1993b).

In 2000 and 2001 a series of co-ordinated acoustic surveys were planned covering the whole continental shelf of south-western part of Europe (from Gibraltar to the English Channel). These were carried out within the frame of the EU Study Project PELASSES. The main objective of these cruises was the abundance estimation using the echo-integration method of the pelagic fish species present off the Portuguese, Spanish and French coast. Surveys were conducted in spring, using two research vessels: R/V Noruega for the southern area (from Gibraltar to Miño river – south Galicia) and R/V Thalassa for the northern area (North Spain and France) and combining two different survey methodologies: acoustics and CUFES.

In 2002 and 2003, France continued regular spring surveys, using the same method as in the PELASSES project. These also followed the same transect layout in the overall area (Figure 11.4.2.1). The last survey took place in June 2003 (PELGAS03) from May 27th to June 25th on board R/V Thalassa. A total of 3500 nautical miles were survey, of which, c. 3000 nautical miles were considered for the anchovy evaluation (Figure 11.4.2.1). Identification of echo-traces was based on 65 pelagic hauls (Figure 11.4.2.2).

In 2003 the anchovy distribution and the related environmental conditions were markedly different from the general perception built up over the last 20 years.

1- Anchovy biomass was quite low, but widely spread from the Spanish coast to west of Brittany.

2- Hydrological conditions in 2003 appeared more similar to summer conditions in previous years than to spring conditions in those years. It is difficult to determine if the unusual anchovy distribution is in response to this change or is a real change in the fish behaviour.

3- Anchovy distribution extended further north than in previous years, and into two new areas.

- Concentrations of 1 year old fish close to the coast in southern Brittany
- Surface schools of big anchovy (2 and 3 years old) in the middle of the platform. These schools were not trawl able by the RV used in the survey

4- In the traditional areas (French coast in southern Biscay and along the shelf break), anchovy was observed mainly in deep waters (>140 m instead of 90 to 110 m usually)

5- Anchovy was generally seen on the echogram as small soft echo-traces scattered between 10 and 25 m above the bottom, and generally mixed with small horse mackerel

This unusual geographical distribution of fish made the echogram scrutiny and allocation to species quite difficult using the standard method - separation into strata with similar echotraces and haul results (Massé,J, WD2001). This method was considered unsatisfactory and gave high CVs. Two other methods were considered;

- A global survey estimate, i.e. all acoustic data and hauls considered as a single stratum. This was considered as unrealistic and also gave very high CVs

- Individual EDSU classified according to school typology and distance to diagnostic hauls. This is a reasonably well developed methodology and gave lower CVs and so was adopted. (Figure 11.4.2.3)

The main results from this acoustic assessment summarised by area is shown in the text table below:

Area	Biomass (t)
zone:"Plateau"	108
zone:"Fer a cheval"	8,549
zone:"Gironde"	4,914
zone:"Arcachon"	3,307
zone:"Adour"	2,393
TOTAL	**19,271**

One unusual aspect of the fish distribution and aggregative behaviour on this survey was the presence of many small schools close to the surface (0 – 15m deep) in the northern part of the survey area. These schools were very difficult to catch due to avoidance and lack of a suitable gear. Occasional small catches indicated that these schools were probably sardine and anchovy. Analysis of CUFES samples showed substantial numbers of anchovy eggs indicating the presence of adult fish. Trawls on deeper echotraces showed NO anchovy in these depths suggesting that these adult fish must have been in the surface traces, however, it was not possible to partition these traces between anchovy and sardine.

One approach to resolve this problem was to use the CUFES data to predict the anchovy abundance. This was based on a comparison between CUFES and acoustic data in the southern part of the survey area where acoustic observations of anchovy were well substantiated. Two areas were used in the analysis:

- In the coastal area in front of the Loire estuary. 1 year old anchovy were seen here between in the series of surveys (2000-2003)

- Transects north of Belle Ile (N of 47°N), in the outer part of the shelf (>150 m) where small surface schools were present. Samples showed large anchovy - age 2 and 3.

Estimates from this approach are presented in the text table below:

ZONE	North - large	Loire	General
AREA (nm²)	4,899.7	1,334.2	11,819.8
Number of eggs/m3	8.4	13.5	9.5
Eggs abundance coefficient	41,157.48	18,011.7	112,288.1
Acoustic biomass (t)			19,275
Estimated biomass (t)	7,065	3092	

The final estimate of biomass was therefore based on:

- 19271 t for the southern part where acoustic data can be adequately allocated to species.

- 10157 t for the northern surface schools based on CUFES comparison.

Therefore, the overall total biomass of anchovy estimate was 29,428 t. Even though the uncertainties for these procedures are greater than usual, the WG adopted that number for the assessment

Based on length frequency distributions by area and using a global age/length key, the number of individuals (10^6) by age and area during PELGAS03 is given in Table 11.4.2.1.

11.5 Effort and Catch per Unit Effort

The evolution of the fishing fleets during recent years is shown in Table 11.5.1. The number of French mid-water trawlers involved in the anchovy fishery increased continuously since 1984 up to 1994. Afterwards this fleet has been slightly decreasing. However in the most recent years purse seines are increasing.

The fishing effort developed by the two countries is nowadays similar although the fishing pattern is different, mainly since 1992 when the Pelagic French Fleet stopped the Fishery in spring during the spawning season of anchovy in the Bay of Biscay. In the nineties the effort may have been at the level that existed in this fishery at the beginning of the 1980's (Anon. 1996/Assess:7), but the stop of the French pelagic fleet in spring allows to prevent a catch of a too large number of fish before their first spawning.

11.6 Recruitment forecasting and environment.

The anchovy spawning population heavily depends upon the strength of the recruitment. This means that the dynamics of the population directly follow those of the recruitment with a very small buffer. The forecast of the fishery and the population depends therefore on the provision of an estimate of the next year anchovies at age 1. Given the absence of quantitative recruitment surveys prior to the fishery, the only information presently available is the one concerning the influence of the environment on the recruitment of anchovy.

Two environmental indices were available to this WG (Borja's upwelling index –pers. comm..-, Petitgas et al. WD2003) (Table 11.6.1) and a review of the role of these environmental indices in setting the anchovy recruitment in the Bay of Biscay was made by Uriarte et al. (2002) and by Petitgas et al. (WD2003).

The Upwelling index of Borja *et al*. (1996; 1998) showed the positive influence of the northern and eastern winds of medium and low intensity blowing in spring and early summer in the Bay of Biscay for the onset of good levels of recruitment at age 1 for the anchovy population in the next year. This index was built up with a long series of Recruitment based on CPUE data for the period 1967-1996 and the most recent assessments of recruitment up to that from 1999 confirmed that relationship. However the latest recruitment estimates, and particularly the recruitment from 2000, rendered not statistically significant the role of this index (at alpha 5%) (Uriarte et al. 2002). The estimates of this Upwelling index since 1986 are reported in Table 11.6.1, updated with the 2003 value. The actual R^2 for the series of estimates is 21.5% (with a probability of being due to randomness of 6.3%).

The value obtained in 2003 of Borja's Upwelling index is low and therefore the index itself tends to suggest worse recruitment than average for 2003. However Figure 11.6.1 shows that this index has been low since 1988, while recruitment since then has been two times low and two times high. Therefore the conclusion derived is that not used of the index for any predictive purposes can be done.

The second index relating environment with the recruitment of anchovy is provided by Petitgas et al. (WD2003) (Table 11.6.1). They used a 3D hydrodynamic physical model (IFREMER, Brest) that simulates processes occurring over the Biscay French continental shelf to construct environmental variables that relate directly to the physical processes that occur in the sea. According to R^2 criterion, the best linear regression was built from two physical factors (Allain et al., 1999):

1. Up welling index (UPW), which is the summed positive "vertical speed" over the period March-July along the Landes coast (SW France). Vertical speed corresponds to the weekly mean vertical current from the bottom to the surface (tide effects have been filtered). This variable is therefore rather similar to the one produced by Borja et al. (1996, 1998) on the sole basis of wind data and has also a positive effect.

2. Stratification breakdown index (SBD), which is a binary variable describing stratification breakdown events in June or July concerning the waters above the whole continental shelf. These events are linked with periods of strong westerly

winds (>15 m/s) in June or July, which last several days and could have caused important larvae mortality (after the peak spawning).

These two variables explained about 70 % of the recruitment inter-annual variability between 1986-1999. Recruitments in the most recent years have dropped the coefficient of determination of Allain's 3d model index to 54% (period 1987-2003, Petitgas et al. WD2003), lessening its predictive power (Uriarte et al 2002). Nevertheless, the spring-summer up-welling is confirmed to favour recruitment, while the negative role of the stratification breakdown was corroborated by the bad recruitment that occurred in 2001.

In the series 1986-2003 (Figure 11.6.2), the model adjusted and predicted well most of low recruitments and this was due to the SBD negative effect. However the low recruitment produced in 2002 (leading to the low SSB levels obtained by the surveys in 2003) was not predicted by the model (which pointed to about average recruitment). On the other hand, the 3D hydroghaphic model has a worse performance in predicting high recruitment (Petitgas WD2003). The very high age-1 recruitment in 2001 appears as an outlier in the series (more than 11 billions individuals at age 1 in 2001). In summary the model was not able to predict (model fit 1987-1998) nor to adjust (model fit 1987-2003) the very high recruitment observed in 2001 neither the low recruitment in 2003. This made the variance explained by the model to drop to 54 %. Other environment processes that are not included in the indices and in the box of Southern Biscay French shelf (south of 46°30N) could be a reason why (Petitgas WD203).

For 2003 the model predicts a medium recruitment value (no SBD and medium UPW). However the uncertainties in the predictions of this model for the most recent years make too risky to rely on this index to forecast the recruitment occurring during 2003.

The fact that the negative role on the onset of anchovy recruitment arising from the stratification breakdown events in June or July has been confirmed (SBD binary variable in Allain's 3-D model) makes this variable useful to identify bad recruitments scenarios for forecasting purposes. On the contrary, the failure to forecast low recruitment occurred in 2002, indicates that the absence of stratification breakdown events is not sufficient to exclude the possibility of recruitment failures during that year.

A recent ICES paper (Oliveira et al 2003) aimed at studying under what circumstances incorporating environmental indices would lead to improvements in managing this anchovy stock in terms of reducing the risk of falling below $\mathbf{B}_{lim}$ and increasing yields. The work concludes that for desirably low levels of risk (below 0.5 in 20 years), improvements from models subject to observation errors vs. current Working Group approaches (in term of risk and average catch) are only attainable for r2 = 0.5 and when a significant number of observations, 30 in the study, are available to fit the environmental index-recruitment relationships. This puts the current environmental models for anchovy at the edge, but not yet ready, for helping the formulation of management advice (because they may have predictive r2 values of about 0.3-0.5 based on only 17 years of observations).

According to the results of that paper and given the imprecision in recent years of the models available, the WG considers that it would not be advisable to rely yet on these environmental indices to forecast recruitment. However, the WG recognises that in the case of the anchovy fishery, a reliable environmental index would be invaluable. Investigations should definitely be continued into these indices with the aim of improving their reliability and forecasting power, until a better modelling and/or understanding of the precision for forecasting is obtained.

An environmental stock recruitment relationship in the context of Ricker formulation (as in Uriarte et al. 2002), was fitted by a GLM with a log link and variance proportional to the mean. The fitted model is included in Table 11.6.1. Figure 11.6.3 shows the years(1989,1991 and 2002) when major deviations occurred between assessed values and expected recruitments according to this model (2000, 2001 etc). This model has been used to modelling the population in search of Harvest control rules in the context of average environmental variables occurring in future (according to the values given at the bottom of the Table 11.6.1).

11.7 State of the stock

11.7.1 Data exploration and Models of assessment

The assessment of the anchovy fishery performed up to now using ICA has been based on fitting a separable selection model for fishing mortality, assuming a constant natural mortality, with the auxiliary information provided by the direct estimates of biomass and population in numbers at age. The acoustic and egg surveys performed by France and Spain have allowed such analysis and for the current year new estimates of biomass in 2003 are again available from both methods. The assumption of constant Natural mortality, fixed in the assessment to 1.2, may not be correct for this stock since it is suspected to be highly variable (Prouzet et al. 1999).

A careful selection of the appropriate weighting factors for the catches at age in the estimation process for the assessment was undertaken in 2000 (ICES 2001). It showed that the fitting to the separable model could be improved by down weighting ages 0 and 3, which can be considered marginal ages in terms of their percentage in the catch. Therefore the WG adopted the same weighting factors for this year‘s assessment i.e., down weighting ages 0 and 3 to 0.01 and 0.1 respectively. In addition catch at age 3 in 1991 was found to be an outlier and was strongly down-weighted to 0.0001.

This year the WG has started with an assessment similar and with the same settings as the one produced in the last year, just including the new input data available: the catches at age in 2002, the population at age estimates for the DEPM and acoustic surveys in 2002 and 2003. The separable model is this time restricted to the period 1988-2002 (due to the limitation of the maximum number of years ICA allows for the separable constraint). The results can be compared with those from the last year in Figure 11.7.1.1. Both are very close to each other; the only difference being that recruitment in 2000 and subsequently biomass 2001 fall down by about 30%. But this assessment confirms the failure of recruitment in 2001 pointed out the last year, as well as the general moderate recent levels of fishing mortality.

Last year (ICES 2003) it was shown that no major changes in the fishing pattern are evidenced for the period 1987-2001; therefore, the assumption of single separable period was justified.

Tuning the assessment using the DEPM and acoustic indices both as aggregated indices of biomass and as aged structured indices was already discussed and accepted in previous years (ICES CM1999 2001 and 2003), despite the correlation inherent to that use of the input data. This is made in order to gain age structure information. The years with age structure information are not all the same for acoustic and the DEPM and therefore they complement each other. In addition, while introducing these tunning indices they are downweighted by 0.5 so that the double use of them is somehow compensated in an ad hoc manner. Beyond this, the assessment uses the DEPM indices as absolute estimators of the population abundance, which may strongly influence the final estimates of Biomass and Fishing mortalities. This year the sensitivities to the use of this DEPM biomass estimate as relative or absolute was tested once more**: Figure 11.7.1.2** shows the influence of dealing the DEPM estimates as relative instead as absolute. This does not lead to any noticeable change in the perception of the population nor in recruitment neither in biomass, although some decrease in the fishing mortality has occurred. This is due to a change in the perception of the degree of exploitation of age 3 (decrease in the fishing pattern for this age), but this age is a marginal age group in the catches and its contribution to the objective function is heavily downweighted. Therefore that change in F has no major implication. In previous years this exercise led to a drastic reduction in the level of biomasses by about 30-35% all over the historical series and conversely increasing the average level of fishing mortality. This has not been any more the case due probably to the decrease in the perception of the exploitation of age 3. The working group considers that the assumption that the DEPM surveys are unbiased and absolute estimators of biomass is valid given the long series of daily fecundity estimates at peak spawning time available for this population (Motos 1996, Santos et al. 2003 WD).

On the other hand, given the potential showed by the biomass dynamic model attempted in last year WG, it was decided by this working group to continue exploring that approach. Similarly to ICA, in order to test the sensitivity of the assessment to the use of the DEPM index as relative or absolute, the biomass dynamic model was fitted using both DEPM and Acoustics as relative indices and the standard approach which takes DEPM as absolute and Acoustics as relative. Figure 11.7.1.3 compares the recruitment (in mass) and spawning biomass for these two cases, in which almost no differences were found.

11.7.2 Stock assessment

This year two assessments are presented; on the one hand the standard ICA assessment and on the other hand the Biomass delay model last year essayed (see below). The Working group considered both reliable assessment tools. The former is more demanding of age structure information and therefore of assumptions and risk of over-parameterisation than the latter. However since the Biomass model is still under development, (testing, programming, inclusion of variance estimates, objective function refinements etc) the Working Group considered it premature to rely only on the biomass model so far. Therefore both are presented, keeping ICA as the standard one, but admitting that the biomass model is probably as good as ICA and can suppose the future standard model for anchovy.

ICA

Inputs for the assessment with ICA (Patterson and Melvin 1996) are summarised in **Table** 11.7.2.1. The assessment uses as tuning data the DEPM (1987- 2003, 16 surveys) and the Acoustic (1989-2003, 10 surveys available) estimates both as indices of biomass and as population in numbers at age. The Acoustic estimates are treated as relative and DEPM as absolute; and both are down-weighted to 0.5 (because of the double use made of the indices as aggregated and disaggregated by age indices). For 1996, 1999, 2000 and 2003 the DEPM SSB biomasses included in the assessment are the ones obtained from models relating the Egg production and final estimates of Biomass for these surveys.

Catch-at-age data on an annual basis are presented in the Table 11.7.2.1. The assessment performed used similar settings to the ones chosen for the 2002 assessment. The assessment assumes a constant natural mortality of 1.2, around the average value estimated earlier (Anon., 1995/Assess: 2, Prouzet et al. 1999).

The separable model of fishing mortality is applied over a period of 15 years (1988-2002), where the first year (1987) will be subject to a VPA based estimate. The catch data of 1988 are down-weighted in the separable analysis because the French data are considered to be more unreliable than for the rest of the years. In addition, the DEPM population as numbers at age estimates for the two first years (1987-1988), were not based on sufficient reliable information; therefore, those years are down-weighted.

Catches for ages 0 and 4 are down-weighted to 0.01 in the assessment because they represent about 3% for age 0 and less than 1% for age 4 of the total catch. Age 3 is down-weighted to 0.1 because it also represents a small percentage in the catch around 3% and down-weighting results in an improvement in the fitting of the separable model to ages 1 and 2 (ICES CM2002).

$$\sum_{a=0}^{a=4}\sum_{y=1988}^{y=02}\lambda_{a,y}\left(Ln\left(C_{a,y}\right)-Ln\left(F_y\cdot S_a.\overline{N}_{a,y}\right)\right)^2$$

$$+\lambda_{DEPM}\sum_{y=1988}^{y=2003}\left[Ln\left(SSB_{DEPM}\right)-Ln\left(\sum_{a=1}^{5}N_{a,y}\cdot O_a\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2$$

$$+\sum_{y=1988}^{2003}\sum_{a=1}^{3+}\lambda_{DEPM,a}\left[Ln\left(SP_{DEPM,a,y}\right)-Ln\left(N_{a,y}\cdot\exp\left(-P_F\cdot F_y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

$$+\lambda_{acoustics}\sum_{y=1989}^{2003}\left[Ln\left(SSB_{acoustic}\right)-Ln\left(Q_{acoustic}\sum_{a=1}^{5}N_{a,y}\cdot W_{a,y}\cdot\exp\left(-P_F F_Y\cdot S_a-P_M.M\right)\right)\right]^2+$$

$$+\sum_{y=1989}^{2003}\sum_{a=1}^{2+}\lambda_{acoustics,a}\left[Ln\left(SP_{acoustic}\right)-Ln\left(Q_{a,y}\cdot N_{a,y}\cdot\exp\left(-P_F\cdot F_Y\cdot S_a-P_M\cdot M\right)\right)\right]^2$$

The assessment was achieved by a non-linear minimisation of the following objective function:

with constraints on:

$S_2 = 1$, $S_5 = S_4 = 0.79$

and for reaching the interim year 2003 $F_{2003} = F_{2002}$ and weight at age in the stock in 2003 are those average since 1990-2002

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

N : population abundance on the first of January

O : maturity ogive, percentage of maturity

M : Natural Mortality

F_Y : Annual fishing mortality for the separable model

S_a : selection at age for the separable model

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

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

Q_a and $Q_{a,Y}$: catchability coefficients for the acoustic survey

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

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

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

(set respectively to ages 0 to 5 at 0.01, 1, 1, 0.1, 0.01, 0.01)

λ_{DEPM} and $\lambda_{\mathrm{acoustics}}$ are the weighting factor for the indices and/or ages (all equal a priori to 0.5) (see last portion of Table 11.7.2.2)

Results of the assessment are presented in Table 11.7.2.2 and Figure 11.7.2.1.

As compared with the latest ICES assessment, this one shows a clear decreasing trend in SSB since 2001. The latest 2 estimates of recruitment are the 2nd and 3rd lowest in the time series.

Biomass difference-delay model

In the last WGMHSA (ICES 2003) a biomass difference-delay model (Schnute, 1987), based on the model applied to squid by Roel & Butterworth (2000), was first attempted for modelling the Bay of Biscay anchovy population dynamics.

The model seeks to estimate recruitment at age 1 at the beginning of each year (in mass) accounting for the signals of inter-annual biomass variations obtained from the direct surveys (DEPM and acoustics) and the level of total catches (in tonnes) produced each year. Two different seasons are considered. The first period goes from the 1st January to the 15th May and allows to obtain intermediate population biomass estimates at the time the surveys are usually conducted, so that fitting can be made. The second period just leads the surviving biomass to the beginning of the next year, when the new recruitment at age 1 enters into the population. Denoting by $B_{y,s,a}$ the population biomass (in tonnes) at the beginning of the period s of year y of the age class a, the biomass dynamic model can be formulated as follows:

For the first period the total biomass is equal to the new recruitment (in mass) and the biomass surviving from the previous year

$$B_{y,1,1+} = B_{y,1,1} + B_{y,1,1+} = B_{y,1,1} + B_{y-1,2,1+}e^{-gf_2} - C_{y-1,2,1+}e^{-g(f_2-h_2)}$$

and for the second period, the total biomass equals to that surviving since the beginning of the year

$$B_{y,2,1+} = B_{y,1,1+}e^{-gf_1} - C_{y,1,1+}e^{-g(f_1-h_1)}$$

where, g is a biomass decreasing rate accounting for growth G and natural mortality M rates ($g = M - G = 1.2 - 0.52 = 0.68$), f_1 and f_2 are fractions of the year corresponding to each period ($f_1 = 0.375$ and $f_2 = 0.625$) and h_1 and h_2 are fractions within each period corresponding to the elapsed time from the beginning of period to the date when catches were taken on average.

Assuming the total biomass and biomass at-age-1 estimates from the direct surveys (DEPM and Acoustics) have log normal observation error distributions, the model seeks the values of the survivors at the beginning of 1987 ($B_{1987,1,2+}$) and recruitments in mass ($B_{y,1,1}$) at the beginning of the year from 1987 to 2003 by a non-linear minimisation of the following objective function:

$$\sum_y \left(\ln(B_{depm,y,2,1}) - \ln(q_{depm}B_{y,2,1})\right)^2 + \sum_y \left(\ln(B_{depm,y,2,1+}) - \ln(q_{depm}B_{y,2,1+})\right)^2 +$$

$$+\sum_y \left(\ln(B_{ac,y,2,1}) - \ln(q_{ac} B_{y,2,1})\right)^2 + \sum_y \left(\ln(B_{ac,y,2,1+}) - \ln(q_{ac} B_{y,2,1+})\right)^2$$

where the recruitment at the beginning of the year $B_{y,1,1}$ is constrained to be greater than 3,000 tonnes just to avoid any negative values. The model was fitted in an Excel workbook.

The model was fitted using DEPM as absolute (q_{depm} fixed to 1) and the Acoustics as relative (q_{ac} to be estimated) indices. Different initial values were essayed to ensure that an absolute minimum was attained and the initial values for the final runs were taken from the ICA assessment output.

Table 11.7.2.3 presents the input data used for fitting the biomass dynamic model. Results are shown in Table 11.7.2.4 along with the fitted values from the former ICA assessment. Figure 11.7.2.2 shows the estimated recruitment at age 1 and the total spawning biomass at the beginning of the second period (15th May) with the DEPM and Acoustics indices used for the tuning. Residuals (in log scale) with respect to the DEPM and Acoustics indices are shown in Table 11.7.2.5.

11.7.3 Reliability of the assessment and uncertainty of the estimation

The assessment with ICA is heavily influenced by the surveys (DEPM and acoustics). The model fits well the aggregated indices of biomass, with no skewness or kurtosis and no clear trends in the log-residuals (Table 11.7.2.2 and Figure 11.7.2.1). The absolute residuals from the separable model are high both across years and ages, particularly for ages 0 and 3, which are the ones down-weighted in the assessment. The best fit is achieved for ages 1 and 2, which are the most important age groups in the catches and the population. Some uncertainties in the DEPM SSB estimates arise from the use of regression methods in 1996, 1999 and 2003. The assessment shows a well-defined minimum at the converged level of fishing mortality for the most recent year in the analysis (2002).

Table 11.7.3.1 shows that some changes arise between the output of the assessment performed in year 2002 and the current assessment (**Figures 11.7.1.1 a,b,c)**. The biomasses of the last 3 years are being reduced a bit, probably due the reduction of the SSB estimate from the DEPM survey in 2002 from 50,900 to 30,700 tonnes. Nevertheless the perception of the biomass in 2002 is still around 50,000. The perception of the population in 2003 is in any case of about 29,200 t, the expected value given the coincident estimates at that level provided by the acoustic and the DEPM surveys for this year. The recruitments at age 0 in 2001 and 2002 are close to the lowest values of the series.

Due to the high levels of biomasses estimated since 1998, the current levels of fishing mortality are far below those at the beginning of the nineties. Even for 2002, as the reduction in biomass was followed by a reduction of catches, the fishing mortality did not rise up.

The WG considers that this assessment reflects the trends in population abundance and fishing mortality.

The biomass dynamic model gave similar and consistent results with ICA for most of the years(Figure 11.7.1.3). Major differences in both recruitment and spawning biomass were found in 1993 and 2000. It should be noticed that for 1993 there is no survey (neither DEPM nor Acoustics) available for tuning the biomass model while ICA makes use of the catch-at-age data. In 2000 the surveys provide only aggregated indices that pointed out to different levels of biomass. The biomass model estimate is close to the mean value of both indices estimates whereas the use by ICA of the age structure favours the acoustics estimate. Beyond this, the consistency between both types of assessments reflects on one hand, that the catches at age data do not contain very contrasting information with the survey data. And on the other hand, that ICA is basically driven by the surveys, which contain by themselves sufficient information as to point out the basic changes in recruitment and spawning biomass. Catch at age analysis for this short lived species cannot converge to the true population levels and makes the results of the assessment absolutely dependent of the survey indices.

The simplicity and potential showed by the biomass dynamic model makes it appealing for this population. However, this model is still under development. Currently the fit is based on the DEPM and acoustics direct surveys both as total and as age-1 biomass. Age-1 biomass, which allows for a better fitting of the recruitment, is derived from the age composition of the correspondent surveys. However, in some years the DEPM and acoustics age-1 indices make use of common age composition data, leading to correlated age-1 indices. This should be avoided by including only one of the disaggregated indices for these years. In order to test the sensitivity of the biomass model to the use of these partly correlated tuning indices the following alternative tunings were attempted:

a) DEPM as aggregated and acoustics as disaggregated

b) DEPM as disaggregated and acoustics as aggregated

In both cases the results (Figure 11.7.3.1) resulted to be rather similar to these presented in section 11.7.2 that uses both indices disaggregated by ages. For future assessments the correlation existing between the age-composition data should be analysed for an optimum use of the available data, avoiding all possible correlation. Further work related to the bio-mass dynamic model should comprise estimation and analysis of the variance associated to the assessment.

The WG group considered that the biomass model can be as good as ICA (with less risk of over-parameterisation) and therefore considers that proper standardisation, testing and variance estimation are made for the next year so that it by then can be adopted as the standard for the assessment of this species.

11.8 Catch Prediction

Given the two assessments presented the WG decided to make parallel projections based on the two models of the as-sessment, with some variation in the format of the advice when the biomass model is used, by which projections of half year basis are available to managers in case they want to go in that direction.

Standard age structured catch prediction

The population and the fishery in the prediction year depend largely on the incoming recruitment, which takes place in the interim year of the assessment. As the level of recruitment during this year is unknown, a precautionary scenarios for the recruitment during 2003 for the projections of the fishery in 2004 was adopted, which is further explained at the end of this section.

Inputs for the assessment: Precautionary approach for Recruitment assumes for recruitment (age 0 in 2003) the geomet-ric mean of those below the median in the historical series. (Mean of 1987, 88, 90, 93, 94, 98, 2001 & 2002 equal to 7,692.136 millions)

The inputs for the scenario are given in Tables 11.8.1. The population at age 1 in 2003 has been taken directly from the ICA assessment output despite of being dependent on the preliminary biomass estimates from the surveys. Weights at age in the catch correspond to the average values recorded since 1989 (14 years). Weights at age in the stock correspond to the average from 1990 (the first year of accurate assessment of this parameter, 13 years in total) as in the assessment input.

Projections were performed under F status quo constraint for 2003 what results in about 11,000 tonnes. This is a likely estimate given the very low catches obtained during the first semester of 2003. The *status quo* fishing mortality was set equal to the average of the last 6 years (1997-2002), the period of rather constant fishing mortality.

The outputs for this scenario are given in Tables 11.8.2. Under this precautionary recruitment scenario fishing mortality about F status-quo or at lower levels seem to stabilise or increase the level of SSB respectively, whereas fishing levels higher that F would prevent any neat recovery of the population or may even decrease further the SSB if the exploita-tion is higher than 1.6 the F status quo.

In order to make clear the sensitivity of the projection above to a change in the recruitment scenario regime, in Table 11.8.2 an estimate of the expected spawning biomass in 2005 arising from a geometric mean recruitment in 2004 is shown. This serves to realise how fast the population can recover to average levels in case an improvement of the re-cruitment levels would occur in 2004.

Catch prediction based on the biomass based model

Based on the biomass dynamic model (see section 11.7.2) deterministic projections of the spawning biomass in 2004 and 2005 (at the beginning of the two periods -1st January and 15th May-) are given by the following equations:

$$B_{2004,1,1+} = B_{2004,1,1} + B_{2003,2,1+}e^{-gf_2} - C_{2003,2,1+}e^{-g(f_2-h_2)}$$

$$B_{2004,2,1+} = B_{2004,1,1+}e^{-gf_2} - C_{2004,1,1+}e^{-g(f_2-h_2)}$$

$$B_{2005,1,1+} = B_{2005,1,1} + B_{2004,2,1+}e^{-gf_2} - C_{2004,2,1+}e^{-g(f_2-h_2)}$$

$$B_{2005,2,1+} = B_{2005,1,1+}e^{-gf_2} - C_{2005,1,1+}e^{-g(f_2-h_2)}$$

Spawning biomass at the beginning of the second period in 2003, $B_{2003,2,1+}$, was taken as estimated from the biomass model in section 11.7.2. The fractions of year corresponding to the elapsed time from the beginning of the period to the date where catches were taken on average (h_1 and h_2) were taken as the mean of previous years.

The scenario of recruitment is the same as considered in the standard ICES projection method (forwarded to age 1 in 2004), but transformed into biomass at the beginning of the year using average weights at age (corrected for the start of the year). Then, the recruitment at age 1 (in tonnes) entering the population at the beginning of 2004 and 2005 assumed to be 31,380 tonnes.

Catch in the second period in 2003 was taken as 8.313 tonnes, based on the F status quo assumption (10,980 tonnes) minus the catches recorded in the first period (2,667 tonnes).

Different levels of catches in the first half-year of 2004 and 2005 and in the second half-year of 2005 (January to mid May) were considered covering a range from 0 to 20,000 tonnes. The implications of any cross selections of allowable catches for these two periods in terms of SSB in 2004 and 2005 are presented Table 11.8.3. Annual catches result from the addition of the catches in the two half-year periods.

A different, but more standard, table is provided for this biomass model projection with fixed proportions of catches by half year periods at the historical average percentage (Table 11.8.4**).** Annual catches ranging from 0 to 40,000 tonnes were considered and the implications of these catches in terms of SSB in 2004 and 2005 are shown in the table. The results of this projection are very consistent with the standard age structured projection made with the MPDF program.

Considerations about projections

The strength of the recruitment occurring during 2003 is uncertain. The Working group assumed the geometric mean below the median of past estimates. On the other hand, the best available environmental recruitment model (from the 3D hydrographical modeling, Petitgas WD2003) suggests an average situation in 2003. According to experience this can be associated with any level of recruitment.

Information from the French fishermen, who are presently exploiting anchovy in the northern part of the Bay of Biscay, indicates an exceptional presence of juveniles meshed in their trawl that they never observed before in this northern part. However, information from skippers of the Spanish live baits boats suggests low juvenile abundance in the south of the Bay of Biscay. So contradictory signals arrive from the fleets in space. Therefore, as noticed earlier the WG is not in the position of forecast this year recruitment of 2003.

Taking into account the current low biomass estimate in 2003 caused by recent poor recruitments, the working group members preferred to work on a precautionary approach by calculating forecast according to a low recruitment basis following the precautionary approach presented in past years.

Other scenarios like the standard geometric mean recruitment presented in previous years or far more precautionary (selecting the geometric mean of the recruitments below the first percentile) are available at the WG files, although the WG considered that its proposal is congruent with the implementation of the precautionary approach to managing fisheries, and with past year practices.

11.9 Reference points for management purposes

Reference points, $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$, have been defined for this stock by ACFM (ICES 1998).

$\mathbf{B}_{lim}$ was defined as the level of biomass below which the recruitment is impaired or the dynamics is unknown. The Working Group estimated a value of $\mathbf{B}_{lim}$ equal to 18,000 tonnes for anchovy (ICES 1998), which corresponded to the minimum spawning biomass estimated by then with the assessment model (corresponding to 1989) (Table 10.1.6 in WG report). Nowadays, the lowest historical Spawning Biomass estimated in the current assessment is 21,053 t (still corresponding to year 1989). This biomass was the minima but it was capable of producing a significant high recruitment subsequently under favourable environmental conditions. The direct estimates of SSB from surveys produced for

1989 were slightly below 18,000 t at about 16,000 t. Therefore the WG considers that the reference point of 18,000 t for $\mathbf{B}_{lim}$ is in any case a good compromise between the analytical assessment and the direct estimates of biomass for that year, which was finally able to produce a good recruitment. Therefore the WG stay at its previous definition of $\mathbf{B}_{lim}$ at 18,000 t.

$\mathbf{B}_{pa}$**:** was defined as a biomass level at which some management action to protect the stock needs to be taken. Originally, a $\mathbf{B}_{pa}$ = 36,000 t of anchovy was estimated and defined as the SSB level which could withstand two successive poor recruitments. Although that $\mathbf{B}_{pa}$ level was not thoroughly evaluated it was adopted by ACFM. This $\mathbf{B}_{pa}$ definition has created a long debate in the MHSAWG due to the fact that the definition given did not correspond to the standards proposed by ICES to define that level and hence has caused a lot of misunderstanding. In addition even that level of 36 000 t may not correspond properly with its definition and may not secure to stay above $\mathbf{B}_{lim}$ in the next year of its estimation (according to the simulations presented two years ago (Uriarte & Rueda WD 2001, ICES 2002a).

The WG believes that the $\mathbf{B}_{pa}$ definition could be defined in the context of simulating Harvest Control Rules for this fishery of anchovy and according to the suggestions of STECF of defining a threshold biomass level in the interim year below which a two stage TAC management could be triggered.

Reference points for fishing mortality rates: Short-lived species can be split into those that die after spawning like capelin, salmon (marine phase) and maybe Norway pout and those that do not as anchovy or sandeels etc. (ICES CM 2003c). For the former group as capelin the precautionary approach consist in defining escapement biomasses such as to let an amount of spawners survive the fishery to secure reproduction at a level, which is not impaired by a too low SSB. This minimum SSB serves as a $\mathbf{B}_{lim}$ value. For the second group of short-lived species, which do not die after spawning, F reference points can be used in management in addition to SSB reference points.

In general, the exploitation of pelagic species should be undertaken with special care, keeping fishing mortality at a moderate level due to the risks of over fishing at low levels of biomass and taking into account that several of these stocks have collapsed (Ulltang 1980, Csirke 1988, Pitcher 1995). Mace and Sissenwine (1993) recommended that the higher the natural mortality, the larger should be the escapement percentage of spawning biomass per recruit in relation to the virgin state (the criterion of %SPR). They also indicated that small pelagic species could be poorly resistant to exploitation since for these species the %SPR corresponding to $\mathbf{F}_{med}$ can be as high as 40 to 60 %. Patterson (1992) suggest that a moderate and sustainable rate of exploitation could be F= 0.67 M. These reviews are based on knowledge of medium size species, rather than short lived species such as anchovy, but given current knowledge, they may be taken as a first approximation to sustainable levels of fishing mortality. In general, a target F between F40% and F66% of SPR is frequently adopted for small pelagic or short living species.

By the moment no definitive $\mathbf{F}_{pa}$ is set and a proper definition should be made in the context of adopted harvest control rules for this population.

11.10 Harvest Control Rules

A regime consisting of an initial annual TAC, which is revised in the middle of the year, after the survey estimate of biomass becomes available, was tested by means of a simulation framework. The simulation framework consists of an operating model of the stock dynamics and a model of the management process containing the harvest rules. The framework is described in the following section.

Evaluation of harvest control rules by means of a simulation framework

Operating Model

The model of the stock dynamics is based on the biomass based model used by the 2002 Working Group to assess the stock, documented in the Report. The model differentiates two periods: one starting on the 1st January to 15th May, and the second period, starting on the 15th of May to the end of the year. In the second period the total biomass (as survivors) is projected to the beginning of the next year when estimates of the new Recruitment biomass at age 1 are generated.

Recruitment at-age-1 was generated on the basis of a stock-recruitment relationship described in Section 11.6 of the report from the 2003 Study Group on Anchovy in Season Assessment (SGAISA: Anon. 2003) corrected for natural mortality:

$$R = a\ SSB_y e^{-bSSBy} e^{\xi}$$

where $\xi \sim N(0,\sigma^2)$, and σ^2 corresponds to the mean squared error from the fit to the historic recruitment.

The operating model was parameterised on the basis of the results from the biomass-based assessment performed by SGAISA. The biomass was projected forward for 10 years starting at the 1^+ biomass level in May 2003 as estimated by the SGAISA.

Management rules

TAC advice is provided twice a year. At the beginning of the year an initial annual allowable catch (TAC_{init}) is provided assuming average recruitment and, when the survey results become available 15th May on average, the TAC is revised (TAC_{rev}). The TACs are computed as fractions of the estimated biomass projected to the middle of the year. The formulae applied to calculate the TACs are the following:

$$TAC_{init} = \gamma^{'}(\delta\hat{R}_{MY} + \hat{B}_{MY,2+})$$
$$TAC_{rev} = \gamma'\ (\hat{B}_{MY,1+})$$

where $\hat{R}_{MY}$ is the mean historic recruitment in mass (62470 t) projected to mid-year after catch, growth and natural mortality where taken into account,

$\hat{B}_{MY,2+}$ and $\hat{B}_{MY,1+}$ are perceived biomasses ages 2+ and 1+ respectively projected to mid- year; $\hat{B}_{MY,2+}$ is based on the survey estimate of biomass 1^+ in the same year and $\hat{B}_{MY,2+}$ corresponds to the previous year survey estimate projected forward to the start of the year and

γ' and δ are fixed parameters which vary between the TAC procedures proposed.

The mid-year projections are based on discrete equations assuming a fraction of the TAC (α) is taken in the middle of the period (*f*) starting when the biomass was estimated up to the middle of the year. Two periods are considered here: a 6 months first period and a second period between the 15th of May and the 31st of June, with α_i proportional to the duration of each period *i*. In general terms the biomass projected to the middle of the year is:

$$\hat{B}_{a,MY} = (\hat{B}_a e^{-gf/2} - \alpha TAC)e^{-gf/2}$$

where $\hat{B}_a$ is the biomass estimate based on the survey. Making the necessary substitutions:

$$TAC = \frac{\gamma'\hat{B}_a e^{-gf}}{1+\gamma'\alpha e^{-gf/2}}$$

In the operating model, the catch in the first period ($C_{y,1,1+}$) corresponds to:

$$C_{y,1,1+} = \alpha_1\ TAC_{init}$$

and in the second period

$$C_{y,2,1+} = TAC_{rev} - C_{y,1,1+}$$

It is assumed that the TAC is taken in full unless the biomass is not able to sustain it in which case the catch will correspond to 95% of the existing biomass.

The perceived biomasses are equal to the 'true' biomass times a log-normal error which corresponds to the average CV = 0.28 of the DEPM May surveys (ICES 2003h). The proportion γ' is constant for the TAC procedure, however, if the estimated biomass at the start of the year is below reference points γ' is reduced according to the following:

$$\gamma' = \gamma k$$

where

$k = 1$	for $SSB \geq B_{pa}$
$k = (SSB - B_{\lim})/(B_{pa} - B_{\lim})$	for $B_{\lim} \leq SSB < B_{pa}$
$k = 0$	for $SSB < B_{\lim}$

where $\mathbf{B}_{pa}$ was taken as 36,000 t

The simulations were run for a range of values of γ and δ .

Management Scenarios

A number of scenarios have been simulated as variations from the base case for comparison of the performance statistics. The scenarios are the following:

1. Base Case. The TACs are computed as fractions of the estimated biomass projected to the middle of the year. If the estimated biomass at the start of the year is below reference points γ' is reduced linearly. Recruitment is assumed equal to the average over the historical series.

2. With recruitment survey. The same as above but TAC advice at the beginning of the year is based on the results from a recruitment survey with a CV of 25%.

3. Cap the TAC. The TAC is not allowed to exceed a certain level. Scenarios are TAC capped = 33, 36 and 40 thousand tons.

4. Constant TAC. The TAC is implemented 'blindly', i.e. irrespective of the status of the stock.

5. Constant TAC incorporating exceptional circumstances. Annual TAC is put in place at the beginning of the year. But, if the survey estimate of biomass in year *y* is below reference points the TAC is revised in the middle of that same year. The $TAC_{rev,y}$ and $TAC_{init,y+1}$ are reduced linearly in the same way described for the base case. If the biomass is below $\mathbf{B}_{lim}$ the fishery is closed from July $_y$ to July $_{y+1}$. A range of values for the fixed TACs was tested.

6. June-to-June TAC. The TAC is set once a year after the results from the survey become available.

Results

Results from the simulations are presented in terms of performance statistics (*ps*), which indicate the impact of the various TAC rules proposed on the sustainability and productivity of the stock. The *ps* computed are the following:

a) The average catch, CAV, is the mean uptake in the 10-year projection period over 1000 simulations;

b) Probability of falling below $\mathbf{B}_{pa}$ = 36000 and

c) Probability of falling below $\mathbf{B}_{lim}$ = 18000 at least once in a 10-year projection period.

d) Average frequency of the TAC_{rev} not being taken because the biomass could not sustain it.

e) Average recommended TACs, initial and revised.

Results in terms of performance statistics are shown in Table 11.10.1 for management options corresponding to values of the rate of exploitation (γ) and for fractions of the recruitment (δ) taken in the TAC_{init} from 0.5 to 1 for the base case. The risk levels increase rapidly as γ increases but less so when the recruitment fraction δ is low. This illustrates the potential advantages of protecting the juveniles by means of measures such as area closures. The average catch also increases with the exploitation rate, however, at very high levels of exploitation the fishery is not being able to sustain the catch allowed by the TAC and the average catch drops as a result, option shown on the bottom right of Table I. When the exploitation rate is high, reducing the fraction of recruits caught in the fishery could prevent biomass decline. An exploitation rate γ of 0.5 would provide a catch level of about 29 000t with a risk of falling below $\mathbf{B}_{lim}$ <5%.

Results from alternative scenarios are shown in Figures 11.10.1-4. Comparison of the performance of the base case with the one where information on recruitment was available before the initial TAC was set, are shown in Figure 11.10.1 in terms of average 10-year catch and risk of falling below $\mathbf{B}_{lim}$. Specifically, at risk levels of just under 10% there is a gain of almost 10 thousand tons by protecting the recruits. Results suggest that at risk levels below 0.05 the yields from the stock will be equivalent when the recruits are protected from the fishery (delta =0.5) and when a survey to predict recruitment is in place. A survey would be more advantageous at higher exploitation levels.

Comparisons of the base with alternative scenarios are illustrated in Figure 11.10.2-4**.** Examinations of 10-year average catch and associated risk suggest that limiting the upper bound of the TAC, for a given risk level, results in lower yields than when the recruitment is protected (δ = 0.5), (Figure 11.10.2). At the same time for similar harvest rates managing with a ceiling TAC results in similar catch levels but at lower risk levels, therefore benefits for the stability of population and catches are produced.

Examination of Figure 11.10.3 suggests that constant catch regimes for given catch levels are generally more risky than the other options considered. Of the two options considered, the one, which reduces the catch when the SSB is below reference points results in more conservative management. Basically, if we consider the risk vs. yields trade-off, the last option is more effective. The results from simulation of a June to June management scenario suggests that this approach performs slightly worse than the equivalent for the base case (Figure 11.10.4).

It is emphasised that the results presented are very dependent on the assumptions made about the dynamics both of the stock and the fishery. For illustration of the framework a number of complexities concerning the dynamics of the fishery are either simplified or ignored. Some of those aspects could be easily incorporated at a later stage if the framework presented appears useful to test TAC rules for this particular anchovy stock.

The WG considered that the modelling programme developed at the working allows for testing a wide range of management scenarios, which participants in the fishery would like to consider. However no concrete scenario is proposed. The options of management explored are examples of obvious interest to managers and are presented for the purpose of promoting a discussion with interest parties and managers. The WG considered that current or other management procedures should be considered by managers for the WG to further evaluate or to test; and according to those analysis managers could take decisions. It is not the role of the WG to propose a concrete Harvest Control Rule given the direct implications it may have on the fisheries involved and that very different HCR may have similar levels of risk but very different implications to the fisheries involved.

11.11 Management Measures and Considerations

This resource has been managed since 1979 to 2003 through the establishment of fixed annual TACs, but no biological background (apart from fixing catches to the historical average) is behind it.

Management goals and ICES

From a biological point of view, managing this type of short living population in the context of the PA should aim at assuring minimum levels of Spawning biomass above $\mathbf{B}_{lim}$ in the context of a moderate exploitation such as F between F40% and F66% of SPR (spawning per recruit). This can be achieved by setting goals related to:

- Maximize recruitment to spawning.
- Assure a minimum amount of survivors at the end of the year to enter new year as a buffer for the cases of low recruitment entering the population.

Since 1999 ICES suggests setting management objectives compatibles with the reference points given in section 11.9 aiming at minimizing the risk of falling below $\mathbf{B}_{lim}$ (18 000 t).

Reviewing potential Management procedures solely based on TACs

Management procedures have to be adopted in accordance with the monitoring and forecasting tools available.

The problem of the current management by annual TACs is that no reliable forecasting procedure of the Recruitment entering to the population is available and thus TACs have been set so far regardless of what the actual level of recruitment will be.

For that reason ICES has proposed a two stage TAC management procedure (ICES 2002d). But to set the initial TAC ICES says that "To avoid the possibility of advising a TAC that could turn out to be too high resulting in excessive fishing mortality and stock depletion, the incoming recruitment will have to be assumed at a low level. This results in a cautious primary advice, but would allow an increase in the TAC in the second half of the year if a mid-year revision showed that the stock could sustain a higher TAC. This would be in accordance with the precautionary approach." ICES continues to provide advice in accordance with its previous proposal: "a two-stage regime, where a preliminary TAC is set at the beginning of the year based on an analytic assessment in autumn, and revised according to the fishery in the first half of the year, and survey results obtained in May-June from acoustic and Daily Egg Production Method (DEPM). In order to be precautionary, the preliminary TAC set at the beginning of the year aims at keeping the stock safely above $\mathbf{B}_{\mathrm{lim}}$ even if the incoming year class is poor".

The only way to overcome this situation is either by setting predictor tools of recruitment in advance to the setting of the initial (or annual) TACs and/or providing other alternative management tools that would meet the goals of the management in accordance with the PA policy of the EU.

The STECF suggests that the two step regime should only be implemented for the years when the biomass in the interim year was below a certain biomass threshold limit. It says: "a provisional TAC for anchovy in the Bay of Biscay and in-year revision is only necessary if spawning stock biomass in the assessment year is below a predefined level. If SSB is estimated to be above this predefined levels, STECF considers that it would be appropriate to set a final annual TAC", and STECF recommends, "ICES should indicate an appropriate level of spawning stock biomass below which it will be necessary to agree a provisional TAC for anchovy."

Potential for provision of recruitment estimates in advance of the setting of the TAC.

The environmental indexes have been tested during the last years (Petitgas WD 2003, Uriarte et al 2002) and are a promising and a developing tool for overcoming the difficulties for Recruitment forecasts. Oliveira et al (WD 2003) show that benefits by incorporating that information in the advice for annual TACs settings can be expected to be noticeable when the forecasting tool achieves a sufficient predictive power (about 50% of R2) and are based on a sufficient number of observations (about 30).

Recruitment surveys either on Juveniles in autumn or for age 1 in Mars could provide indexes of recriotment to overcome that situation as well. Given the crisis that the fishery was encountering in the last two years, two autumn surveys for the assessment of juvenile anchovies in the Bay of Biscay will be attempted this year, organised by AZTI and IFREMER, as a way to improve the advice on management. However, since this is the first year of a standard survey on juveniles, no other than a qualitative advice will be obtained. The only quantitative comparison would be based on the surveys carried out within JUVESU project (CT97-3374). Those results could be submitted to STCEF by November this year.

In accordance with these considerations and given the benefits shown in the exploration of harvest control rules when Recruitment indices are available, the WG recommends be established direct surveys on juveniles (0 group) or pre-recruits (1 year old) in order to improve advise for the management of this fishery. They strongly recommend to Ifremer and AZTI to collaborate in order to increase their effort by coordinating their respective surveys or doing a common one.

Alternative management proposals

Recent French surveys carried out in the Bay of Biscay comprised acoustics, CUFES, hydrology, primary and secondary production, genetics and top predator components such as mammals and birds. Based on this, it is apparent that the evolution of the anchovy population is strongly dependant on environmental factors as well as the fishery itself. The fishery should probably be considered as an aggravating factor when the biomass is at low levels. A recent study of anchovy population dynamics in the Bay of Biscay (Vaz & Petitgas, 2002) showed the large effect of the first year mortality on the population dynamics and confirmed the importance of recruitment for this anchovy stock. It showed that a permanent increase of the first year mortality would have resulted in population extinction and, that a reduction would have resulted in short term population demographic explosion. This study also revealed the particular importance of the area of the Gironde estuary where a substantial part of the total spawning population can be found. The spatial distribution of length was very consistent across years: the habitat of small fish (age-1 predominantly) was coastal and related to river plumes of Gironde and Adour. Fixed strata (sites Figure 11.11.1) were defined and served to build a spatially explicit age-specific matrix population model. The model was used to evidence the contribution of the life history traits on the dynamics of the stock and as well as that of spawning habitats. The study also showed that changes in the fertility rates of the first reproducing age class (age class 1) or in the mortality rates in the first age class (age class 0) of the population could result in large variations in the global population growth rate. Therefore, the growth of the modelled population strongly depended on both first year mortality and fertility rates in the Gironde area.

Based on this, new management considerations for future harvest control considered for anchovy should go beyond just a single TAC regulation. This might include:

- Limiting fishing during the first semester in particular areas known to be important for the stock dynamics (e;g; Gironde area, or the area which was already accepted in 2000), where the fishery could be closed at least for certain periods and/or a minimum landing length to avoid catches of 0 group and young 1 group

- Imposing limits to fish size in the landings by recommending a maximum grade to protect age 0 and 1 before spawning. A maximum grade around 50 (the exact level should be determined) would be preferred to a minimum size, which will probably induce discard after sorting.

The exploration carried out in this working group of the impact harvest control rules, incorporating a protection of the recruits suggest that such measures will result in better utilisation of the stock.

Timing of the formulation of TAC

Given the biological and ecological reality of anchovy, the benefits of managing the fishery for periods going from July in year y to July in y+1 (just after recruits at age 1 have been assessed and have already spawned) instead of from January to December should be evaluated.

In the absence of tools for monitoring of predicting recruitments, managers can consider the convenience of setting the TAC for the periods between 1st of July to 30 June next year, just after the acoustic and DEPM estimates are available. Then the exploitation will be regulated simply according to the Spawning Biomass at the beginning of that period which is the 100% of the population. The TAC could include as in the current formulations the assumption of a precautionary level of recruitment occurring between January and June that will always be used to add an allowable amount of catches to be taken in that period. The advantage of setting the TAC in July instead of January is that the former is not formulated at the moment when the unknown recruitment will predominate the population, but when an estimate of such recruitment is finally available. Evaluations of the possible advantages of such change in the timing of the TAC formulation in the context of annual TAC were presented in the former section.

Table 11.2.1.1: Annual catches (in tonnes) of Bay of Biscay anchovy (Subarea VIII) As estimated by the Working Group members.

COUNTRY	FRANCE	SPAIN	SPAIN	INTERNATIONAL
YEAR	**VIIIab**	**VIIIbc, Landings**	**Live Bait Catches**	**VIII**
1960	1,085	57,000	n/a	58,085
1961	1,494	74,000	n/a	75,494
1962	1,123	58,000	n/a	59,123
1963	652	48,000	n/a	48,652
1964	1,973	75,000	n/a	76,973
1965	2,615	81,000	n/a	83,615
1966	839	47,519	n/a	48,358
1967	1,812	39,363	n/a	41,175
1968	1,190	38,429	n/a	39,619
1969	2,991	33,092	n/a	36,083
1970	3,665	19,820	n/a	23,485
1971	4,825	23,787	n/a	28,612
1972	6,150	26,917	n/a	33,067
1973	4,395	23,614	n/a	28,009
1974	3,835	27,282	n/a	31,117
1975	2,913	23,389	n/a	26,302
1976	1,095	36,166	n/a	37,261
1977	3,807	44,384	n/a	48,191
1978	3,683	41,536	n/a	45,219
1979	1,349	25,000	n/a	26,349
1980	1,564	20,538	n/a	22,102
1981	1,021	9,794	n/a	10,815
1982	381	4,610	n/a	4,991
1983	1,911	12,242	n/a	14,153
1984	1,711	33,468	n/a	35,179
1985	3,005	8,481	n/a	11,486
1986	2,311	5,612	n/a	7,923
1987	4,899	9,863	546	15,308
1988	6,822	8,266	493	15,581
1989	2,255	8,174	185	10,614
1990	10,598	23,258	416	34,272
1991	9,708	9,573	353	19,634
1992	15,217	22,468	200	37,885
1993	20,914	19,173	306	40,393
1994	16,934	17,554	143	34,631
1995	10,892	18,950	273	30,115
1996	15,238	18,937	198	34,373
1997	12,020	9,939	378	22,337
1998	22,987	8,455	176	31,617
1999	13,649	13,145	465	27,259
2000	17,765	19,230	n/a	36,994
2001	17,097	23,052	n/a	40,149
2002	10,988	6,519	n/a	17,507
2003(1st half)	1,031	3,207	n/a	4,238
2003*	3,049	3,220	n/a	6,269
AVERAGE	6,311	27,316	318	33,723
(1990-02)				

***Provisional estimate Up to 1st Sept 2003**

Table 11.2.1.2. Monthly catches of the Bay of Biscay anchovy by country (Sub-area VIII) (without live bait catches)

COUNTRY: FRANCE Units: t. 1000

YEAR\MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	0	1,113	1,560	268	148	582	679	355	107	87	4,899
1988	0	0	14	872	1,386	776	291	1,156	2,002	326	0	0	6,822
1989	704	71	11	331	648	11	43	56	70	273	9	28	2,255
1990	0	0	16	1,331	1,511	127	269	1,905	3,275	1,447	636	82	10,598
1991	1,318	2,135	603	808	1,622	195	124	419	1,587	557	54	285	9,708
1992	2,062	1,480	942	783	57	11	335	1,202	2,786	3,165	2,395	0	15,217
1993	1,636	1,805	1,537	91	343	1,439	1,315	2,640	4,057	3,277	2,727	47	20,914
1994	1,972	1,908	1,442	172	770	1,730	663	2,125	3,276	2,652	223	0	16,934
1995	620	958	807	260	844	1,669	389	1,089	2,150	1,231	855	22	10,892
1996	1,084	630	614	206	150	1,568	1,243	2,377	3,352	2,666	1,349	0	15,238
1997	2,235	687	24	36	90	1,108	1,579	1,815	1,680	2,050	718		12,022
1998	1,523	2,128	783	0	237	1,427	2,425	4,995	4,250	2,637	2,477	103	22,987
1999	2,080	1,333	574	55	68	948	1,015	922	3,138	1,923	1,592	0	13,649
2000	2,200	948	825	5	58	1,412	2,190	2,720	3,629	2,649	1,127	0	17,765
2001	717	517	143	46	47	1,311	1,078	3,401	4,309	2,795	2,732	0	17,097
2002	1,435	2,561	1,560	1	30	758	350	979	1,957	771	578	0	10,978
Average 87-02	1,224	1,073	618	382	589	922	841	1,774	2,637	1,798	1,099	44	13,001
in percentage	9.4%	8.3%	4.8%	2.9%	4.5%	7.1%	6.5%	13.6%	20.3%	13.8%	8.5%	0.3%	100%
Average 92-02	1,597	1,360	841	150	245	1,217	1,144	2,206	3,144	2,347	1,525	17	15,792
in percentage	10.1%	8.6%	5.3%	1.0%	1.6%	7.7%	7.2%	14.0%	19.9%	14.9%	9.7%	0.1%	100%

COUNTRY: SPAIN

YEAR\MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	4,133	3,677	514	81	54	28	457	202	265	9,864
1988	6	0	28	786	2,931	3,204	292	98	421	118	136	246	8,266
1989	2	2	25	258	4,295	795	90	510	116	198	1,610	273	8,173
1990	79	6	2,085	1,328	9,947	2,957	1,202	3,227	2,278	123	16	10	23,258
1991	100	40	23	1,228	5,291	1,663	91	60	34	265	184	596	9,573
1992	360	384	340	3,458	13,068	3,437	384	286	505	63	94	89	22,468
1993	102	59	1,825	3,169	7,564	4,488	795	340	198	65	546	23	19,173
1994	0	9	149	5,569	3,991	5,501	1,133	181	106	643	198	74	17,554
1995	0	0	35	5,707	11,485	1,094	50	9	6	152	48	365	18,951
1996	48	17	138	1,628	9,613	5,329	1,206	298	266	152	225	17	18,937
1997	43	1	81	2,746	2,672	877	316	585	1,898	331	203	185	9,939
1998	35	235	493	371	4,602	1,083	1,518	44	47	3	22	1	8,455
1999	8	26	52	4,626	4,214	1,396	1,037	26	911	207	615	27	13,144
2000	18	0	99	1,952	11,864	3,153	958	342	413	346	83	0	19,230
2001	243	48	337	2,203	14,381	3,102	1,436	1	126	1,055	120	1	23,052
2002	1	0	13	914	2,476	1,340	323	56	1,013	381	1	0	6,519
Average 87-02	65	52	386	2,505	7,004	2,496	682	382	523	285	269	136	14,785
in percentage	0.4%	0.3%	2.6%	16.9%	47.4%	16.9%	4.6%	2.6%	3.5%	1.9%	1.8%	0.9%	100%
			3.4%			81.2%			10.7%			4.7%	
Average 92-02	78	71	324	2,940	7,812	2,800	832	197	499	309	196	71	16,129
in percentage	0.5%	0.4%	2.0%	18.2%	48.4%	17.4%	5.2%	1.2%	3.1%	1.9%	1.2%	0.4%	100%

Total

COUNTRY: FRANCE + SPAIN

	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Average 92-02	1,675	1,430	1,165	3,091	8,057	4,017	1,976	2,403	3,643	2,656	1,721	88	31,921
in percentage	5.2%	4.5%	3.6%	9.7%	25.2%	12.6%	6.2%	7.5%	11.4%	8.3%	5.4%	0.3%	100%

COUNTRY: INTERNATIONAL

YEAR\MONTH	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1987	0	0	454	5246	5237	782	229	636	707	812	309	352	14763
1988	6	0	42	1657	4317	3979	584	1253	2423	445	136	246	15088
1989	706	73	36	588	4943	806	132	566	186	472	1619	301	10429
1990	80	6	2101	2658	11459	3083	1471	5132	5553	1570	652	92	33856
1991	1418	2175	626	2036	6913	1858	215	479	1621	822	238	882	19282
1992	2422	1864	1282	4241	13125	3448	719	1488	3291	3228	2489	89	37685
1993	1738	1864	3362	3260	7906	5927	2110	2979	4254	3342	3273	70	40086
1994	1972	1917	1591	5741	4761	7231	1796	2306	3382	3295	421	74	34487
1995	620	958	842	5967	12329	2764	439	1098	2155	1382	903	387	29843
1996	1132	647	752	1834	9763	6897	2449	2675	3617	2818	1575	17	34176
1997	2278	688	105	2782	2762	1985	1895	2400	3578	2381	921	185	21961
1998	1558	2363	1276	371	4839	2510	3943	5039	4298	2640	2500	104	31442
1999	2088	1360	626	4681	4282	2345	2052	948	4049	2130	2207	27	26794
2000	2219	948	925	1957	11922	4565	3148	3063	4043	2995	1210	0	36994
2001	960	565	479	2249	14428	4413	2514	3403	4435	3850	2852	1	40149
2002	1436	2561	1573	915	2506	2098	673	1034	2970	1152	578	0	17497
Average 87-02	1290	1124	1004	2886	7593	3418	1523	2156	3160	2083	1368	177	27783
in percentage	4.6%	4.0%	3.6%	10.4%	27.3%	12.3%	5.5%	7.8%	11.4%	7.5%	4.9%	0.6%	100%
Average 92-02	1675	1430	1165	3091	8057	4017	1976	2403	3643	2656	1721	87	31919
in percentage	5.2%	4.5%	3.6%	9.7%	25.2%	12.6%	6.2%	7.5%	11.4%	8.3%	5.4%	0.3%	100%

Table 11.2.1.3: ANCHOVY catches in the Bay of Biscay by country and divisions in 2002 (without live bait catches)

COUNTRIES	DIVISIONS	QUARTERS				CATCH (t)	
		1	2	3	4	ANNUAL	%
SPAIN	VIIIa	0	0	659	228	886	13.6%
	VIIIb	0	1,418	352	149	1,920	29.5%
	VIIIc	14	3,312	381	5	3,713	57.0%
	TOTAL	15	4,730	1,392	382	6,519	100%
	%	0.2%	72.6%	21.4%	5.9%	100.0%	
FRANCE	VIIIa	348	90	1,564	617	2,619	23.8%
	VIIIb	5,222	700	1,719	732	8,373	76.2%
	VIIIc	0	0	0	0	0	0.0%
	TOTAL	5,570	790	3,283	1,349	10,992	100%
	%	50.7%	7.2%	29.9%	12.3%	100.0%	
INTERNATIONAL	VIIIa	348	90	2,223	845	3,505	20.0%
	VIIIb	5,222	2,118	2,071	881	10,293	58.8%
	VIIIc	14	3,312	381	5	3,713	21.2%
	TOTAL	5,585	5,520	4,675	1,731	17,511	100.0%
	%	31.9%	31.5%	26.7%	9.9%	100.0%	

The separation of Spanish catches during the second half of the year between VIIIa and VIIIb are only approx. estimations

Table 11.3.1.1: ANCHOVY catch at age in thousands for 2002 by country, division and quarter (without the catches from the live bait tuna fishing boats).

units: thousands

	QUARTERS	1	2	3	4	Annual total
	AGE	**VIIIbc**	**VIIIbc**	**VIIIabc**	**VIIIabc**	**VIIIabc**
SPAIN	0	0	0	155	84	239
	1	93	31,254	34,178	5,971	71,496
	2	294	98,406	17,110	5,511	121,321
	3	47	13,655	1,589	452	15,742
	4	0	0	0	0	0
	TOTAL(n)	434	143,315	53,030	12,019	208,798
	W MED.	33.75	33.24	26.46	31.92	31.44
	CATCH. (t)	14.6	4730.2	1392.2	382.1	6,519.1
	SOP	14.6	4764.3	1403.1	383.6	6,565.6
	VAR. %	100.27%	100.72%	100.78%	100.39%	100.71%
	QUARTERS	**1**	**2**	**3**	**4**	**Annual total**
	AGE	**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**	**VIIIab**
FRANCE	0	0	0	29	0	29
	1	61,384	10,480	62,975	26,268	161,106
	2	103,967	14,551	39,651	14,856	173,026
	3	21,291	2,893	749	256	25,188
	4	67	8	0	0	76
	TOTAL(n)	186,709	27,933	103,403	41,380	359,424
	W MED.	29.83	28.18	31.75	32.59	30.57
	CATCH. (t)	5,569.7	787.1	3,282.9	1,348.4	10,988
	SOP	5,266	776	3,395	1,348	10,784
	VAR. %	94.5%	98.5%	103.4%	100.0%	98.15%
	QUARTERS	**1**	**2**	**3**	**4**	**Annual total**
	AGE	**VIIIabc**	**VIIIabc**	**VIIIabc**	**VIIIabc**	**VIIIabc**
TOTAL Sub-area VIII	0	0	0	183	84	267
	1	61,476	41,734	97,153	32,239	232,602
	2	104,261	112,957	56,760	20,368	294,346
	3	21,338	16,548	2,337	708	40,931
	4	67	8	0	0	76
	TOTAL(n)	187,142	171,247	156,434	53,399	568,222
	W MED.	29.84	32.42	29.95	32.44	30.89
	CATCH. (t)	5,584.3	5,517.3	4,675.1	1,730.5	17,507
	SOP	5,280	5,540	4,798	1,732	17,350
	VAR. %	94.6%	100.4%	102.6%	100.1%	99.10%

Table 11.3.1.2 Catches at age of anchovy fishery in the Bay of Biscay on half year basis as reported up to 1998 to ICES WGs and updated since then.. Units: Thousands.

INTERNATIONAL

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	38,140	0	150,338	0	180,085	0	16,984	0	86,647	0	38,434	0	63,499	0	59,934
1	218,670	120,098	318,181	190,113	152,612	27,085	847,627	517,690	323,877	116,290	1,001,551	440,134	794,055	611,047	494,610	355,663
2	157,665	13,534	92,621	13,334	123,683	10,771	59,482	75,999	310,620	12,581	193,137	31,446	439,655	91,977	493,437	54,867
3	31,362	1,664	9,954	596	18,096	1,986	8,175	4,999	29,179	61	16,960	1	5,336	0	61,667	1,325
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0
5	8,920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	431,448	173,494	398,971	529,130	294,445	219,927	915,283	615,671	663,677	215,579	1,211,647	510,015	1,239,046	766,523	1,049,714	471,789
Intern.Catches	11,718	3,590	10,003	5,579	7,153	3,460	19,386	14,886	15,025	4,610	26,381	11,504	24,058	16,334	23,214	11,417
Var. SOP	100.7%	100.4%	98.3%	101.9%	98.5%	99.3%	100.7%	99.1%	97.6%	98.5%	99.6%	99.9%	101.1%	99.5%	101.0%	100.2%
Annual Catch		15,308		15,581		10,614		34,272		19,635		37,885		40,392		34,631

YEAR	1995		1996		1997		1998		1999		2000		2001		2002		2003
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half
Age 0	0	49,771	0	109,173	0	133,232	0	4,075	0	54,357	0	5,298	0	749	0	267	
1	522,361	189,081	683,009	456,164	471,370	439,888	443,818	598,139	220,067	243,306	559,934	396,961	460,346	507,678	103,210	129,392	
2	282,301	21,771	233,095	53,156	138,183	40,014	128,854	123,225	380,012	142,904	268,354	64,712	374,424	98,117	217,218	77,128	
3	76,525	90	31,092	499	5,580	195	5,596	3,398	17,761	525	84,437	18,613	19,698	5,095	37,886	3,045	
4	4,096	7	2,213	42	0	0	155	0	108	0	0	0	4,948	0	76	0	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total #	885,283	260,719	949,408	619,034	615,133	613,329	578,423	728,837	617,948	441,092	912,725	485,584	859,417	611,639	358,390	209,832	
Intern.Catches	23,479	6,637	21,024	13,349	10,704	11,443	12,918	18,700	15,381	11,878	22,536	14,458	23,095	17,054	11,102	6,406	4,238
Var. SOP	101.5%	98.2%	99.5%	100.4%	99.7%	102.1%	100.6%	94.8%	102.0%	103.0%	100.8%	97.6%	100.8%	101.1%	97%	102%	
Annual Catch		30,116		34,373		22,147		31,617		27,259		36,994		40,149		17,507	

SPAIN

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	35,452	0	141,918	0	174,803	0	11,999	0	81,536	0	13,121	0	63,499	0	59,022
1	134,390	40,172	210,641	47,480	110,276	13,165	719,678	234,021	210,686	21,113	751,056	72,154	578,219	75,865	257,050	47,065
2	119,503	7,787	61,609	2,690	92,707	9,481	47,266	43,204	139,327	1,715	131,221	5,916	266,612	11,904	315,022	24,971
3	27,336	1,664	7,710	596	8,232	1,986	8,139	4,999	2,657	61	10,067	1	967	0	44,622	1,325
4	14,831	58	1,356	0	54	0	0	0	0	0	0	0	0	0	0	0
5	8,920	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	304,980	85,134	281,414	192,684	211,270	199,435	775,083	294,222	352,670	104,425	892,344	91,192	845,798	151,268	616,694	132,383
Catch Spain	8,777	1,632	6,955	1,804	5,377	2,981	16,401	7,273	8,343	1,583	21,047	1,621	17,206	2,272	15,219	2,478
Var. SOP	100.7%	99.7%	97.9%	100.6%	97.1%	99.5%	100.9%	99.5%	94.7%	98.2%	99.3%	100.5%	100.8%	100.2%	101.3%	99.6%
Annual Catch		10,409		8,759		8,358		23,674		9,926		22,669		19,479		17,697

YEAR	1995		1996		1997		1998		1999		2000		2001		2002		2003
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd haf	1st half
Age 0	0	31,101	0	52,238	0	91,400	0	4,075	0	29,057	0	439	0	748	0	239	0
1	367,924	17,611	542,127	72,763	296,261	123,011	217,711	57,847	134,411	87,191	389,515	71,547	378,136	54,151	31,347	40,149	15,072
2	206,387	1,333	163,010	12,403	74,856	9,435	41,171	9,515	231,384	37,644	199,233	8,640	327,090	43,487	98,700	22,621	37,807
3	57,214	90	14,461	499	1,927	195	4,002	9	10,051	525	50,834	2,085	18,854	464	13,702	2,041	30,499
4	4,096	7	2,213	42	0	0	155	0	108	0	0	0	4,948	0	0	0	43
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	635,621	50,142	721,810	137,945	373,044	224,041	263,039	71,445	375,954	154,416	639,583	82,711	729,029	98,851	143748.2	65049.3	83,421
Catch Spain	18,322	902	16,774	2,361	6,420	3,897	6,818	1,812	10,323	3,287	17,087	2,143	20,314	2,738	4,745	1,774	3,207
Var. SOP	102.1%	100.1%	99.5%	100.4%	99.5%	98.7%	98.9%	99.8%	102.1%	101.7%	101.1%	100.7%	102.1%	101.7%	101%	101%	97.77%
Annual Catch		19,224		19,135		10,317		8,630		13,610		19,230		23,052		6,519	

FRANCE

YEAR	1987		1988		1989		1990		1991		1992		1993		1994	
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Age 0	0	2,688	0	8,419	0	5,282	0	4,985	0	5,111	0	25,313	0	0	0	912
1	84,280	79,925	107,540	142,634	42,336	13,919	127,949	283,669	113,191	95,177	250,495	367,980	215,836	535,182	237,560	308,598
2	38,162	5,747	31,012	10,644	30,976	1,290	12,216	32,795	171,293	10,866	61,916	25,530	173,043	80,073	178,415	29,896
3	4,026	0	2,245	0	9,863	0	36	0	26,522	0	6,893	0	4,369	0	17,045	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total #	126,468	88,360	140,797	161,697	83,175	20,492	140,200	321,449	311,007	111,154	319,303	418,823	393,248	615,255	433,020	339,406
Catch France	2,941	1,958	3,048	3,775	1,776	479	2,985	7,613	6,682	3,027	5,334	9,883	6,851	14,062	7,994	8,939
Var. SOP	100.4%	101.0%	99.0%	102.5%	102.6%	97.8%	99.2%	98.7%	101.3%	98.6%	100.5%	99.8%	101.6%	99.4%	100.3%	100.4%
Annual Catch		4,899		6,822		2,255		10,598		9,708		15,217		20,914		16,934

YEAR	1995		1996		1997		1998		1999		2000		2001		2002		2003
Periods	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd haf	1st half
Age 0	0	18,670	0	56,936	0	41,832	0	0	0	25,300	0	4,859	0	1	0	29	
1	154,437	171,470	140,882	383,401	175,109	316,877	226,107	540,293	85,656	156,115	170,418	325,413	82,210	453,527	71,864	89,243	
2	75,914	20,438	70,085	40,753	63,327	30,579	87,683	113,710	148,628	105,260	69,121	56,072	47,334	54,630	118,518	54,507	
3	19,311	0	16,631	0	3,653	0	1,594	3,389	7,710	0	33,603	16,528	844	4,631	24,184	1,005	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	0	
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total #	249,662	210,578	227,598	481,089	242,089	389,288	315,384	657,392	241,994	286,676	273,142	402,873	130,388	512,789	214641	144783	
Catch France	5,157	5,735	4,251	10,987	4,284	7,546	6,099	16,888	5,058	8,591	5,449	12,316	2,782	14,316	6,357	4,631	1,031
Var. SOP	99.4%	97.9%	102.8%	99.8%	100.0%	103.9%	102.5%	94.3%	101.7%	103.4%	99.8%	97.0%	100.5%	101.3%	95%	102%	
Annual Catch		10,892		15,238		11,830		22,987		13,649		17,765		17,097		10,988	

Table 11.3.1.3. Spanish half - yearly catches of anchovy (2nd semester) by age in ('000) of Bay of Biscay anchovy fro
(from ANON 1996 and Uriarte et al. WD1997)

Since 1999 onwards are not being estimated.

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	10,020	97,581	6,114	11,999	12,716	2,167	3,557	7,872	10,154	8,102	33,078
1	24,675	17,353	6,320	21,540	13,736	14,268	20,160	5,753	10,885	6,100	8,238
2	1,461	203	1,496	139	0	0		477	209	522	58
3	912	3	0	0	0	0		0	0	0	0
Total	37,068	115,140	13,930	33,677	26,452	16,435	23,717	14,102	21,248	14,724	41,375
Catch (t)	546	493	185	416	353	200	306	143.2	273.2	197.5	378
mean W (g)	14.7	4.3	13.3	12.4	13.3	12.1	12.9	10.2	15.8	13.4	9.14

Table 11.3.2.1. Length distribution ('000) of anchovy in Dividion VIIIa,b,c by country and quarters in 2001

	QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4	
Length (half cm)	**France VIIIab**	**Spain VIIIbc**	**France VIIIab**	**Spain VIIIbc**	**France VIIIab**	**Spain VIIIabc**	**France VIIIab**	**Spain VIIIabc**
3.5								
4								
4.5								
5								
5.5								
6								
6.5								
7								
7.5								
8								
8.5								
9								
9.5					1			
10					6			
10.5					11			
11	5		41		22	6		
11.5	15	2	123		30	1,648	24	29
12	45	0	370		29	3,315	27	55
12.5	2,791	3	724	177	117	2,171	143	37
13	2,801	5	806	371	162	1,912	251	31
13.5	11,063	19	2,073	1,555	1,356	3,203	485	53
14	5,567	19	1,324	4,960	3,885	1,362	1,402	26
14.5	19,342	18	3,302	7,312	9,902	2,587	2,058	125
15	38,481	23	5,163	11,120	20,552	2,441	3,124	281
15.5	35,782	18	4,772	12,082	17,711	5,067	5,251	905
16	41,442	26	5,454	17,960	11,679	8,065	7,039	2844
16.5	16,811	43	2,193	19,470	8,125	10,003	7,060	3503
17	8,958	77	1,163	24,040	4,722	5,824	6,815	2378
17.5	3,163	73	389	17,985	5,631	3,653	3,863	1104
18	310	67	26	13,073	8,532	1,103	2,440	470
18.5	59	21	5	8,832	6,998	536	848	163
19	59	16	5	3,696	3,505	89	443	10
19.5	11	3	1	461	428	23	93	6
20	4	1		187		23	14	
20.5				32				
21								
21.5								
22								
22.5								
23								
23.5								
24								
24.5								
25								
25.5								
26								
Number('000)	186,709	432	27,933	143,315	103,403	53,030	41,380	12,019
Catch (t)	5,570	15	789	4,730	3,283	1,392	1,348	382
Mean Length(cm)	16	17	15	17	16	16	17	17
Mean Weight(g)	30	34	28	33	32	26	33	32

Table 11.3.2.2.: Mean weight at age in the national and international catches of anchovy in SubArea VIII on half year basis. Units: grams.

INTERNATIONAL																
YEAR	**1987**		**1988**		**1989**		**1990**		**1991**		**1992**		**1993**		**1994**	
Sources	Anon. (1989 & 1991)		Anon. (1989)		Anon. (1991)		Anon. (1991)		Anon. (1992)		Anon. (1993)		Anon. (1995)		Anon. (1996)	
Periods	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**
Age 0	0.0	11.7	0.0	5.1	0.0	12.7	0.0	7.4	0.0	14.4	0.0	12.6	0.0	12.3	0.0	14.7
1	21.0	21.9	20.8	23.6	19.5	24.9	20.6	23.8	18.5	25.1	19.6	23.0	15.5	20.9	16.8	25.3
2	32.0	34.2	30.3	30.4	28.5	35.2	28.5	27.7	25.2	29.0	30.9	28.8	27.0	29.4	26.8	28.1
3	37.7	39.2	34.5	44.5	29.7	42.7	44.8	40.8	28.2	39.0	37.7	27.4	30.5	0.0	30.7	30.0
4	41.0	40.0	37.6	0.0	27.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	42.0	0.0	48.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	27.3	20.8	24.6	10.7	23.9	15.6	21.3	24.0	22.1	21.1	21.7	22.5	19.6	21.2	22.3	24.3
SOP	11,795	3,605	9,828	5,685	7,043	3,434	19,515	14,752	14,668	4,538	26,264	11,497	24,314	16,257	23,440	11,442
mean weight 3	39.3	39.2	35.0	44.5	29.7	42.7	44.8	40.8	28.2	39.0	37.7	27.4	30.5	30.5	30.7	30.0

YEAR	**1995**		**1996**		**1997**		**1998**		**1999**		**2000**		**2001**		**2002**	
Sources:	Anon. (1997)		Anon. (1998)		Anon. (1999)		Anon (2000)		WG data		WG data		WG data		WG data	
Periods	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**
Age 0	0.0	15.1	0.0	12.0	0.0	11.6	0.0	10.2	0.0	15.7	0.0	19.3	0.0	14.3	0.0	9.5
1	22.5	26.9	19.1	23.2	14.4	20.3	21.8	23.7	17.1	27.0	21.7	28.2	22.7	27.5	25.0	28.8
2	32.3	31.3	29.3	27.7	26.9	30.1	24.3	27.7	29.8	33.5	29.1	33.0	31.8	31.1	31.6	33.4
3	36.4	36.4	35.0	35.7	32.0	29.7	31.9	28.7	34.7	38.9	32.8	36.9	36.3	38.6	42.8	36.5
4	37.3	29.1	46.1	39.7	0.0	0.0	31.9	0.0	55.9	0.0	0.0	0.0	40.7	0.0	45.6	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	26.9	25.0	22.2	21.6	17.3	19.1	22.5	24.3	25.4	27.7	24.9	29.0	27.1	28.2	30.9	30.6
SOP	23,830	6,520	21,066	13,139	10,672	11,687	12,996	17,727	15,686	12,229	22,715	14,106	23,272	17,247	11,073	6,415
mean weight 3+	36.5	35.9	35.8	36.0	32.0	29.7	31.9	28.7	35.3	38.9	32.6	36.9	36.3	38.6	43.4	36.5

SPAIN																
YEAR	**1987**		**1988**		**1989**		**1990**		**1991**		**1992**		**1993**		**1994**	
Periods	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**
Age 0	0.0	11.6	0.0	4.7	0.0	12.6	0.0	5.9	0.0	14.3	0.0	13.0	0.0	12.3	0.0	14.7
1	21.4	21.0	21.3	21.7	20.6	25.3	20.6	24.4	18.5	16.4	21.5	18.2	16.4	15.5	18.7	19.6
2	33.0	39.3	32.4	35.7	29.3	36.0	29.0	28.9	28.1	22.4	32.6	24.4	29.5	26.6	29.2	25.4
3	38.0	39.2	34.6	44.5	27.3	42.7	44.9	40.8	34.4	39.0	44.5	27.4	43.3	0.0	32.0	30.0
4	41.0	40.0	37.6	0.0	27.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	42.0	0.0	48.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	29.0	19.1	24.2	9.4	24.7	14.9	21.4	24.6	22.4	14.9	23.4	17.9	20.5	15.0	25.0	18.6
SOP	8,841	1,628	6,811	1,814	5,222	2,966	16,555	7,234	7,900	1,555	20,904	1,629	17,352	2,276	15,424	2,467
mean weight 3	39.6	39.2	35.2	44.5	27.3	42.7	44.9	40.8	34.4	39.0	44.5	27.4	43.3	43.3	32.0	30.0

YEAR	**1995**		**1996**		**1997**		**1998**		**1999**		**2000**		**2001**		**2002**	
Periods	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**
Age 0	0.0	16.1	0.0	11.2	0.0	10.8	0.0	10.2	0.0	10.4	0.0	14.0	0.0	14.3	0.0	9.7
1	24.8	20.1	19.9	19.3	14.1	21.1	24.2	24.7	18.6	21.3	23.6	25.8	23.6	25.2	24.4	24.2
2	35.2	33.4	31.9	29.0	28.6	27.4	32.3	35.3	33.0	31.0	31.2	28.2	32.5	30.9	35.4	33.1
3	38.2	36.4	40.2	35.7	41.7	29.7	35.3	52.1	40.6	38.9	36.8	28.2	36.6	44.7	38.0	31.7
4	37.3	29.1	46.1	39.7	0.0	0.0	31.9	0.0	55.9	0.0	0.0	0.0	40.7	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	29.4	18.0	23.1	17.6	17.1	17.2	25.6	25.3	28.0	21.7	27.0	26.1	28.1	27.7	33.2	27.5
SOP	18,703	903	16,696	2,170	6,386	3,847	6,746	1,809	10,544	3,344	17,278	2,157	20,477	2,740	4,779	1,787
mean weight 3+	38.1	35.9	41.0	36.0	41.7	29.7	35.2	52.1	41.1	38.9	36.4	28.2	36.6	44.7	38.0	31.7

FRANCE																
YEAR	**1987**		**1988**		**1989**		**1990**		**1991**		**1992**		**1993**		**1994**	
Periods	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**
Age 0	0.0	13.0	0.0	12.1	0.0	17.0	0.0	11.0	0.0	15.6	0.0	12.3	0.0	0.0	0.0	11.6
1	20.4	22.3	19.8	24.3	16.6	24.5	20.6	23.3	18.7	27.1	13.8	23.9	13.1	21.7	14.8	26.1
2	28.7	27.2	26.1	29.0	26.0	29.6	26.5	26.1	22.9	30.0	27.5	29.8	23.2	29.8	22.6	30.3
3	35.4	0.0	34.0	0.0	31.7	0.0	29.0	0.0	27.6	0.0	27.9	0.0	27.6	0.0	27.3	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	23.4	22.4	21.4	23.9	21.9	22.9	21.1	23.4	21.8	26.8	16.8	23.6	17.7	22.7	18.5	26.4
SOP	2,954	1,977	3,017	3,871	1,821	469	2,961	7,518	6,768	2,984	5,361	9,867	6,962	13,981	8,016	8,975

YEAR	**1995**		**1996**		**1997**		**1998**		**1999**		**2000**		**2001**		**2002**	
Periods	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**	**1st half**	**2nd half**
Age 0	0.0	13.5	0.0	12.7	0.0	13.4	0.0	0.0	0.0	21.8	0.0	19.8		20.4	0.0	7.9
1	17.2	27.6	15.8	23.9	14.9	20.0	19.5	23.6	14.6	30.2	17.2	28.7	18.5	27.8	25.3	30.9
2	24.5	31.1	23.3	27.3	24.9	31.0	20.6	27.1	24.8	34.3	23.2	33.6	26.5	31.5	28.5	33.5
3	31.4	0.0	30.5	0.0	26.8	0.0	23.2	28.6	27.1	0.0	26.8	38.0	30.0	38.0	45.5	46.4
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	20.5	26.7	19.2	22.8	17.7	20.1	19.8	24.2	21.2	31.0	19.9	29.7	20.8	28.4	29.3	32.0
SOP	5,127	5,617	4,370	10,969	4,286	7,840	6,250	15,918	5,142	8,885	5,437	11,949	2,795	14,508	6,294	4,628

TABLE 11.4.1.1 Daily Egg Production Method.: Egg surveys on the Bay of Biscay anchovy.
(From ICES2001/ACFM06 updated for the 2001 from Uriarte et a. Working Document 2002) and for 2002 from Santos& Uriarte Working Document 2002 (preliminary estimate))

YEAR		1987	1988	1989(*)	1989(*)	1990	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Period of year		2 - 7 June	21 - 28 May	10 - 21 May	14-24 June	4 - 15 May	29 May- 15 June	16May- 07Jun	16May- 13Jun	No survey	17 May- 3June.	11 - 25 May	18 - 30 May	9 - 21 May	18 May - 8 June	22 May - 5 June	2 May - 20 May	14 May - 8 June	6-21 May	22May- 9Jun
Julian Mid Day		155	145	136	171	130	158	148	151		146	138	144	135	149	149	131	147	134	
Positive area (km^2)		23,850	45,384	17,546	27,917	59,757	69,471	24,264	67,796		48,735	31,189	28,448	50,133	73,131	51,019	37,883	72,022	35,980	42,535
Surveyed area (km^2)		34,934	59,840	37,930	-	79,759	-	84,032	92,782		60,330	51,698	34,294	59,587	83,156	61,533	63,192	92,376	56,176	70,041
Po (Egg/ 0.05m^2)(+ Area)		4.60	5.52	2.08	1.50	3.78	5.21	2.55	4.27		3.93	4.98	4.87	2.69	3.83	3.65	3.45	5.89	3.28	2.53
Total Daily Egg Production		2.20	5.01	0.73	0.83	5.02	7.24	1.24	5.81		3.83	3.09	2.77	2.70	5.6	3.72	2.61	8.48	2.34	2.15
(* Exp(-12))	C.V.	0.39	0.24	0.4	-	0.15	-	0.06	0.14		0.14	0.07	0.16	0.07	0.05	0.09	0.19	0.087	0.127	0.28
SSB (t)		29,365	63,500	11,861	10,058	97,239	77,254	19,276	90,720	--	60,062	54,700	39,545	51,176	101,976	69,074	44,973	124,132	**30,697**	**32,866**
	C.V.	0.48	0.31	0.41	-	0.17	-	0.14	0.20		0.17	0.09	0.16	0.10	0.09	0.15	0.15	0.20	0.13	0.28
TOTAL anchovy numbers		1,129	2,675	470		5,843		966	5,797	--	2,954	2,644		3,738	6,282			6,048	1,039	1,797
(millions)	C.V.							0.14	0.25		0.19	0.11		0.16	0.13			0.23	0.1451	0.2937
No/age:	1	**656.0**	**2,349.0**	**246.0**		**5,613.0**		**670.5**	**5,571.0**		**2,030.0**	**2,257.0**		**3,242.6**	**5,466.7**			**4,362.2**	**283.6**	**1,454.3**
	C.V.							0.16	0.26		0.23	0.13		0.17	0.15			0.27	0.30	0.30
(millions)	2	**331.0**	**258.0**	**206.0**		**190.0**		**290.3**	**209.3**		**874.0**	**329.0**		**482.1**	**759.5**			**1,562.0**	**621.3**	**246.1**
	C.V.							0.17	0.22		0.19	0.23		0.10	0.14			0.22	0.13	0.34
	3+	**142.0**	**68.0**	**18.0**		**40.0**		**4.8**	**16.7**		**49.3**	**58.0**		**13.1**	**56.3**			**123.5**	**133.8**	**96.3**
	C.V.							0.42	0.51		0.30	0.30		0.27	0.36			0.37	0.14	0.38

(*) Likely subestimate according to authors (Motos &Santiago,1989). It inputs the assessment raised up by 1sd (DEPM SSB89=16,720 t)
(**) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area)
(***) Estimates based on a log lineal model of biomass as function of positive spawning area and Po (Egg production per unit area) and Julian day of the mid day of the survey

Table 11.4.2.1: Evaluation of Anchovy abundance index from French acoustic surveys in the Bay of Biscay.

YEAR	**1983**	**1984**	**1989 (2)**	**1990**	**1991**	**1992**	**1994**	**1997**	**1998**	**2000**	**2001**	**2002**	**2003**
DATE	20/4-25/4	30/4-13/5	23/4-2/5	12/4-25/4	6/4-29/4	13/4-30/4	15/5-27/5	6/5-22/5	20/5-7/6	18/04 - 14/05	27/04 - 6/06	6/05 - 6/06	27/5 - 25/6
Surveyed area	3,267	3,743	5,112	3,418 (3)	3388 (3)	2440(3)	2300(3)	1726(3)	9,400 5600 (3)	6,781	21,300	10,667	12,917
Biomass (t)	50,000	38,500	15,500	60-110,000 (4)	64,000	89,000	35,000	63,000	57,000	98,484	137,200 (5)	97,051	29,428
Number (10(-6))**	2,600	2,000	805	4,300-7,500 (4)	3,173	9,342	*na*	3351	*na*		7892 (6)	3569	1451
Number of 1-group(10(-6))**	1,800 (1)	600	400	4,100-7,500 (4)	1,873	9,072	*na*	2481	*na*		6163 (6)	831	983
Number of age 2-group(10(-6))**	800	1,400	405	0 -200 (4)	1,300	270	*na*	870	*na*		1728 (6)	2738	468
Anchovy mean weight	19.2	19.3	19.3	*na*	20.2	9.5	*na*	18.8	*na*		16.8 (6)	27.2	20.28

(1) Rough estimation
(2) Assumption of overestimate
(3) Positive area
(4) uncertainty due to technical problems
(*) area where anchovy shools have been detected
(5) For the assessment performed in the WG of year 2001 the value used for 2001 biomass was 132800t becouse the definitive figure from the survey arrived too late to the WG
(6) based on the biomass estimate of areas 2, 4, 6 and 7 (13 2600 t)

Table 11.5.1: Evolution of the French and Spanish fleets for ANCHOVY in Subarea VIII (from Working Group members). Units: Numbers of boats.

	France				Spain		
Year	**P. seiner**	**P. trawl**		**Total**	**P. seiner**		**Total**
1960	52	0	(1)	52	571		623
1972	35	0	(1)	35	492		527
1976	24	0	(1)	24	354		378
1980	14	n/a	(1)	14	293		307
1984	n/a	4	(1)	4	306		310
1987	9	36	(1)	45	282		327
1988	10	61	(1)	71	278		349
1989	2	51	(1)	53	215		268
1990	30	80	(2)	110	266		376
1991	30	115	(2)	145	250		395
1992	13	123	(2)	136	244		380
1993	21	138	(2)	159	253		412
1994	26	150	(2)	176	257		433
1995	26	120	(2)	146	257		403
1996	20	100	(2)	120	251		371
1997	26	136	(2)	162	267		429
1998	26	100	(2)	126	266		392
1999	26	100	*	126	250		376
2000	17	97	(5)	114	238	(3, 4)	352
2001	66	86	(5)	152	220	(3,4)	372
2002	81	71	(5)	152	215	(3, 4)	367

* provisional

(1) Only St. Jean de Luz and Hendaya.

(2) Maximun number of potential boats; the number of pelagic trawling gears is roughly half of this number due to the fishing in pairs of mid-water trawlers.

n/a = Not available.

(3) Provisional figure according to the number of licences for purse seining in EC Waters

(4) Provisional estimate

(5) The actual number of pelagic trawlers with fishing licencies that were fishing for several months --- - - - from 2000 to 2002 were of 83, 69, 51 respectively.

Tabla 11.6.1: Series of Upwelling indexes from Borja et al. (1996,98 Updated for this WG)
and Allain et al. (1999) & Petitgas et al (WD2003) including the Destratification variable

	Pers.Comm. **Borja's et al. (1996,00)**	**Petitgas et al. (WD2003)**	
Year	Upwelling	Upwelling	SBD
1986	617.5	20.49	0
1987	508.4	47.25	1
1988	473.2	35.88	1
1989	970.9	45.45	0
1990	905.9	50.00	1
1991	1,076.3	110.74	0
1992	1,128.8	47.16	0
1993	570.9	53.03	0
1994	905.0	29.20	0
1995	1,204.0	74.99	0
1996	973.0	50.17	0
1997	1,230.5	100.04	0
1998	461.0	58.49	0
1999	402.0	32.68	0
2000	391.0	65.32	0
2001	418.0	57.93	1
2002	642.0	65.32	0
2003	424.0	57.93	0

Table 11.6.2 Environmental stock recruitment relationship for anchovy: Formula called in "R" language, parameters fitted and analysis of deviance.

```
Call:
glm(formula = rec ~ offset(log(ssb)) + ssb + up.allain + sbd,
    family = quasi(link = log, variance = "mu"), data = newrecruit.dat[-
length(newrecruit.dat$ssb),
        ])

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-61.355  -30.078    9.977   31.286   48.591

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.771e-01  4.113e-01  -0.674 0.514434
ssb         -1.863e-05  4.088e-06  -4.557 0.000821 ***
up.allain    5.930e-03  3.746e-03   1.583 0.141750
sbd         -1.119e+00  2.919e-01  -3.834 0.002775 **
---
Signif. codes:  0 `***' 0.001 `**' 0.01 `*' 0.05 `.' 0.1 ` ' 1

(Dispersion parameter for quasi family taken to be 1711.38)

    Null deviance: 117455  on 14  degrees of freedom
Residual deviance:  19501  on 11  degrees of freedom
AIC: NA

Number of Fisher Scoring iterations: 3

Mean values of indices

Mean Allain upwelling: 55.89
Mean Stratification breakdown: 0.25
```

Table 11. 7. 2. 1 INPUTs for the Bay of Biscay anchovy assessment

ASSESSMENT MADE IN SEP 2003 FOR THE WORKING GROUP ON MHS AND ANCHOVY

Output Generated by ICA Version 1.4

Anchovy in subarea Sep WG on MHSA

Catch in Number

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	38.1	150.3	180.1	17.0	86.6	38.4	63.5	59.9	49.8	109.2	133.2	4.1	54.4	5.3	0.7
1	338.8	508.3	179.7	1365.3	440.2	1441.7	1405.1	850.3	711.4	1139.2	911.3	1042.0	463.4	956.9	968.0
2	171.2	106.0	134.5	135.5	323.2	224.6	531.6	548.3	304.1	286.3	178.2	252.1	522.9	333.1	472.5
3	33.0	10.6	20.1	13.2	29.2	17.0	5.3	63.0	76.6	31.6	5.8	9.0	18.3	103.0	24.8
4	14.9	1.4	1.0	1.0	1.0	1.0	1.0	1.0	4.1	2.3	1.0	1.0	1.1	1.0	4.9
5	8.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

x 10 ^ 6

AGE	2002
0	0.3
1	232.6
2	294.3
3	40.9
4	1.0
5	1.0

x 10 ^ 6

Table 11. 7. 2. 1 (Cont'd)

Predicted Catch in Number

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	5.7	27.4	20.8	66.4	58.6	23.9	21.6	32.9	58.8	40.2	13.3	23.0	29.2	5.8	7.3
1	446.5	160.8	1589.5	542.6	2012.5	1424.7	815.0	732.6	1313.1	826.1	929.8	460.4	998.1	931.3	178.1
2	144.7	169.3	114.2	435.9	181.7	565.0	594.1	322.8	309.5	199.7	275.6	488.9	295.2	454.2	413.2
3	10.0	16.4	38.1	7.5	37.9	13.1	67.8	65.4	36.6	10.2	20.7	48.9	105.8	42.9	64.8
4	37.0	1.2	3.9	2.7	0.7	2.9	1.7	7.9	8.0	1.3	1.1	3.7	10.7	15.6	6.2

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.011700	.005100	.012700	.007400	.014400	.012600	.012300	.014700	.015100	.011900	.011600	.010200	.015700	.019300	.014300
1	.021300	.021900	.020300	.021800	.020300	.020600	.017800	.020300	.023700	.019900	.017200	.022900	.022300	.024400	.025200
2	.032100	.030300	.029000	.028100	.025400	.030600	.027400	.026900	.032200	.031100	.027600	.026000	.030800	.029900	.031600
3	.037700	.035000	.031000	.043300	.028200	.037700	.030500	.030700	.036400	.040100	.031900	.030700	.034800	.033600	.036800
4	.041000	.037600	.027100	.040500	.040500	.040500	.040500	.040500	.037300	.046000	.040500	.031900	.055900	.040500	.040700
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

AGE	2002
0	.009500
1	.027100
2	.032100
3	.042300
4	.045600
5	.042000

Table 11. 7. 2. 1 (Cont'd)

Weights at age in the stock (Kg)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	.013000	.013000	.013000	.010000	.015000	.012000	.012000	.015000	.012000	.012000	.012000	.012000	.012000	.012000	.012000
1	.021700	.022600	.021000	.016200	.016800	.015400	.016000	.017100	.019000	.016000	.011900	.014600	.016000	.016800	.016000
2	.033000	.029800	.029000	.029500	.028000	.031700	.028900	.025800	.031100	.028900	.026600	.029900	.028900	.028500	.028900
3	.038000	.034100	.033000	.034600	.034000	.031700	.034500	.032300	.034100	.034500	.037400	.036900	.034500	.034800	.034500
4	.041000	.042500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500	.040500
5	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000	.042000

AGE	2002
0	.012000
1	.022300
2	.033200
3	.035900
4	.040500
5	.042000

Natural Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
1	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
2	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
3	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
4	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000
5	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000	1.2000

Table 11. 7. 2. 1 (Cont'd)

AGE	2002
0	1.2000
1	1.2000
2	1.2000
3	1.2000
4	1.2000
5	1.2000

Proportion of fish spawning

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE	2002
0	0.0000
1	1.0000
2	1.0000
3	1.0000
4	1.0000
5	1.0000

Table 11. 7. 2. 1 (Cont'd)

Indices of Spawning Biomass

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	29.36	63.50	16.72	97.24	19.28	90.72	*******	60.06	54.70	39.55	51.18	101.98	69.07	44.97	124.13

x 10 ^ 3

	2002	2003
1	30.70	32.87

x 10 ^ 3

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	15.50	*******	64.00	89.00	*******	35.00	*******	*******	63.00	57.00	*******	98.48	137.20

x 10 ^ 3

	2002	2003
1	97.05	29.43

x 10 ^ 3

Table 11. 7. 2. 1 (Cont'd)

Age-structured indices

DEPM SUVEYS (Ages 1 to 3+)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	656.0	2349.0	346.9	5613.0	670.5	5571.0	*******	2030.1	2257.0	*******	3242.6	5466.7	*******	*******	4362.2
2	331.0	258.0	290.5	190.0	290.3	209.3	*******	874.3	329.0	*******	482.1	759.5	*******	*******	1562.0
3	142.0	68.0	25.4	40.0	4.8	16.7	*******	49.3	58.0	*******	13.1	56.3	*******	*******	123.5

x 10 ^ 3

AGE	2002	2003
1	283.6	1454.3
2	621.3	246.1
3	133.8	96.3

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+)

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	400.0	*******	1873.0	9072.0	*******	*******	*******	*******	2481.0	*******	*******	*******	6163.0	831.0	983.2
2	405.0	*******	1300.0	270.0	*******	*******	*******	*******	870.0	*******	*******	*******	1728.0	2738.0	467.8

x 10 ^ 3

Table 11. 7. 2. 2: Outputs for the Bay of Biscay anchovy assessment:

Fishing Mortality (per year)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0077	0.0028	0.0024	0.0048	0.0042	0.0042	0.0033	0.0036	0.0040	0.0056	0.0024	0.0016	0.0017	0.0022	0.0021
1	0.3401	0.3442	0.2989	0.5903	0.5105	0.5132	0.3968	0.4366	0.4852	0.6834	0.2942	0.2008	0.2045	0.2685	0.2582
2	1.2624	0.7997	0.6944	1.3714	1.1859	1.1923	0.9218	1.0142	1.1273	1.5876	0.6835	0.4664	0.4750	0.6238	0.5998
3	0.1239	0.7280	0.6321	1.2483	1.0795	1.0854	0.8391	0.9232	1.0261	1.4451	0.6221	0.4245	0.4324	0.5678	0.5460
4	0.5763	0.6318	0.5486	1.0834	0.9369	0.9420	0.7282	0.8012	0.8906	1.2542	0.5399	0.3684	0.3753	0.4928	0.4739
5	0.5763	0.6318	0.5486	1.0834	0.9369	0.9420	0.7282	0.8012	0.8906	1.2542	0.5399	0.3684	0.3753	0.4928	0.4739

AGE	2002
0	0.0019
1	0.2361
2	0.5485
3	0.4993
4	0.4333
5	0.4333

Table 11. 7. 2. 2 (Cont'd)

Population Abundance (1 January)

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	8521.	3457.	19259.	7405.	27324.	23971.	12637.	10407.	14226.	18063.	28652.	13940.	23583.	22807.	4729.
1	1953.	2547.	1038.	5786.	2219.	8195.	7190.	3794.	3123.	4268.	5410.	8609.	4192.	7091.	6854.
2	365.	419.	544.	232.	966.	401.	1477.	1456.	738.	579.	649.	1214.	2121.	1029.	1633.
3	481.	31.	57.	82.	18.	89.	37.	177.	159.	72.	36.	99.	229.	397.	166.
4	55.	128.	5.	9.	7.	2.	9.	5.	21.	17.	5.	6.	19.	45.	68.
5	33.	3.	4.	2.	3.	3.	3.	3.	3.	2.	4.	5.	5.	4.	4.

x 10 ^ 6

AGE	2002	2003
0	6482.	11683.
1	1421.	1949.
2	1595.	338.
3	270.	278.
4	29.	49.
5	5.	7.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
1	0.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.5000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.0500	0.1000	0.1000	0.0001	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
4	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100

Table 11. 7. 2. 2 (Cont'd)

Predicted SSB Index Values

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	41152.	41023.	21054.	51008.	30537.	71817.	999990.	53371.	43219.	39975.	45722.	95382.	76532.	90866.	91219.

	2002	2003
1	51292.	29200.

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	23.66	*******	34.31	80.70	*******	59.97	*******	*******	51.38	107.18	*******	102.11	102.50

x 10 ^ 3

	2002	2003
1	57.64	32.81

x 10 ^ 3

Table 11. 7. 2. 2 (Cont'd)

Predicted Age-Structured Index Values

DEPM SUVEYS (Ages 1 to 3+) Predicted

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	939.6	1223.0	509.5	2472.2	984.9	3632.0	*******	1743.7	1402.7	*******	2660.5	4425.9	*******	*******	3428.8
2	113.3	161.9	221.1	68.4	311.0	128.8	*******	508.7	244.5	*******	265.3	550.2	*******	*******	694.5
3	294.3	67.5	27.4	29.4	9.5	31.6	*******	67.5	64.1	*******	19.0	50.9	*******	*******	105.1

x 10 ^ 3

AGE	2002	2003
1	718.5	985.1
2	695.0	147.3
3	135.9	149.6

x 10 ^ 3

ACOUSTIC SURVEYS (ages 1 to 2+) Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	671.1	*******	1349.2	4978.1	*******	*******	*******	*******	3501.6	*******	*******	*******	4482.9	935.6	1282.6
2	572.5	*******	809.2	404.2	*******	*******	*******	*******	654.0	*******	*******	*******	1809.7	1863.2	663.1

x 10 ^ 3

Table 11. 7. 2. 2 (Cont'd)

Fitted Selection Pattern

AGE	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	0.0061	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035	0.0035
1	0.2694	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304	0.4304
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.0981	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103	0.9103
4	0.4565	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900
5	0.4565	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900	0.7900

AGE	2002
0	0.0035
1	0.4304
2	1.0000
3	0.9103
4	0.7900
5	0.7900

Table 11. 7. 2. 2 (Cont'd)

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1- 3	SoP (%)
1987	8520610	187108	41151	15308	0.3720	0.5754	99
1988	3457070	121612	41023	15581	0.3798	0.6240	100
1989	19258670	290148	21053	10614	0.5041	0.5418	100
1990	7404540	177922	51008	34272	0.6719	1.0700	99
1991	27324060	475187	30536	19634	0.6430	0.9253	101
1992	23971280	429583	71816	37885	0.5275	0.9303	100
1993	12636910	311139	82227	40293	0.4900	0.7192	99
1994	10406610	264576	53370	34631	0.6489	0.7913	99
1995	14226450	259419	43218	30115	0.6968	0.8796	99
1996	18062740	305045	39974	34373	0.8599	1.2387	100
1997	28652330	427176	45721	22337	0.4885	0.5333	99
1998	13940160	333380	95382	31617	0.3315	0.3639	102
1999	23583030	420296	76532	27259	0.3562	0.3706	97
2000	22806770	437962	90865	36994	0.4071	0.4867	100
2001	4729050	222265	91218	40564	0.4447	0.4680	100
2002	6481970	173484	51292	17507	0.3413	0.4280	9
2003			29200				

No of years for separable analysis : 15
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1987 . . . 2002
Number of indices of SSB : 2
Number of age-structured indices : 2

Parameters to estimate : 40
Number of observations : 154

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1988	0.7997	23	0.5004	1.2781	0.6296	1.0159	0.8230
2	1989	0.6944	19	0.4721	1.0214	0.5703	0.8455	0.7080
3	1990	1.3714	17	0.9644	1.9501	1.1459	1.6412	1.3937
4	1991	1.1859	17	0.8426	1.6690	0.9961	1.4118	1.2041
5	1992	1.1923	19	0.8118	1.7512	0.9800	1.4507	1.2155
6	1993	0.9218	19	0.6276	1.3539	0.7577	1.1216	0.9397
7	1994	1.0142	18	0.7056	1.4578	0.8428	1.2204	1.0317
8	1995	1.1273	19	0.7648	1.6616	0.9249	1.3740	1.1496
9	1996	1.5876	16	1.1487	2.1941	1.3460	1.8725	1.6093
10	1997	0.6835	20	0.4612	1.0130	0.5592	0.8354	0.6974
11	1998	0.4664	22	0.3009	0.7230	0.3729	0.5833	0.4782
12	1999	0.4750	22	0.3027	0.7455	0.3774	0.5978	0.4877
13	2000	0.6238	20	0.4150	0.9378	0.5067	0.7680	0.6375
14	2001	0.5998	19	0.4075	0.8828	0.4925	0.7306	0.6116
15	2002	0.5485	19	0.3750	0.8023	0.4518	0.6660	0.5589
Separable Model: Selection (S) by age								
16	0	0.0035	68	0.0009	0.0134	0.0018	0.0070	0.0044
17	1	0.4304	9	0.3566	0.5195	0.3911	0.4738	0.4324
	2	1.0000	Fixed : Reference Age					
18	3	0.9103	24	0.5662	1.4635	0.7144	1.1598	0.9374
	4	0.7900	Fixed : Last true age					

Table 11. 7. 2. 2 (Cont'd)

Separable model: Populations in year 2002

19	0	6481969	25	3898249	10778151	5000746	8401929	6703824
20	1	1421351	18	997528	2025245	1186435	1702780	1444734
21	2	1594668	14	1210794	2100246	1385638	1835230	1610486
22	3	269957	20	179986	404903	219518	331986	275794
23	4	28978	29	16116	52108	21481	39092	30307

Separable model: Populations at age

24	1988	127898	61	38615	423614	69423	235627	154146
25	1989	4524	108	535	38208	1523	13437	8182
26	1990	9069	32	4773	17233	6536	12584	9569
27	1991	7066	34	3610	13830	5016	9954	7493
28	1992	1813	34	920	3572	1282	2562	1924
29	1993	9039	35	4485	18216	6322	12924	9636
30	1994	4772	36	2323	9803	3305	6890	5105
31	1995	21179	32	11155	40212	15270	29375	22343
32	1996	17170	35	8484	34749	11983	24603	18318
33	1997	5113	46	2061	12689	3216	8130	5694
34	1998	5763	34	2929	11336	4080	8139	6117
35	1999	19442	25	11737	32206	15028	25152	20097
36	2000	44835	26	26712	75255	34425	58395	46428
37	2001	67826	29	38024	120985	50485	91123	70848

SSB Index catchabilities

DEPM

Absolute estimator. No fitted catchability.

Acoustic

Linear model fitted. Slopes at age :

38	2	Q	1.124	12	.9946	1.637	1.124	1.449	1.286

Age-structured index catchabilities

DEPM SUVEYS (Ages 1 to 3+)

Absolute estimator. No fitted catchability.

ACOUSTIC SURVEYS (ages 1 to 2+)

Linear model fitted. Slopes at age :

39	1	Q	.9983	17	.8454	1.667	.9983	1.411	1.205
40	2	Q	1.625	17	1.374	2.731	1.625	2.308	1.967

Table 11. 7. 2. 2 (Cont'd)

Residuals about the model fit

Separable Model Residuals

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	3.277	1.881	-0.203	0.265	-0.423	0.977	1.018	0.415	0.620	1.199	-1.186	0.860	-1.707	-2.051	-3.308
1	0.130	0.111	-0.152	-0.209	-0.334	-0.014	0.042	-0.029	-0.142	0.098	0.114	0.006	-0.042	0.039	0.267
2	-0.312	-0.230	0.171	-0.299	0.212	-0.061	-0.080	-0.060	-0.078	-0.114	-0.089	0.067	0.121	0.040	-0.339
3	0.054	0.202	-1.060	1.355	-0.802	-0.907	-0.073	0.158	-0.146	-0.569	-0.834	-0.983	-0.027	-0.548	-0.460
4	-3.276	-0.159	-1.352	-1.005	0.351	-1.071	-0.502	-0.657	-1.249	-0.269	-0.069	-1.225	-2.366	-1.148	-1.822

Spawning biomass index residuals

DEPM

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.3375	0.4369	-0.2302	0.6452	-0.4601	0.2337	*******	0.1181	0.2356	-0.0108	0.1127	0.0668	-0.1025	-0.7033	0.3081

	2002	2003
1	-0.5134	0.1183

Acoustic

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	*******	*******	-0.4229	*******	0.6233	0.0979	*******	-0.5385	*******	*******	0.2039	-0.6315	*******	-0.0361	0.2916

	2002	2003
1	0.5211	-0.1088

Table 11. 7. 2. 2 (Cont'd)

AGE-STRUCTURED INDEX RESIDUALS

DEPM SUVEYS (Ages 1 to 3+)

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.359	0.653	-0.384	0.820	-0.385	0.428	*******	0.152	0.476	*******	0.198	0.211	*******	*******	0.241
2	1.072	0.466	0.273	1.022	-0.069	0.486	*******	0.542	0.297	*******	0.597	0.322	*******	*******	0.811
3	-0.729	0.008	-0.076	0.307	-0.683	-0.638	*******	-0.315	-0.100	*******	-0.369	0.101	*******	*******	0.162

Age	2002	2003
1	-0.930	0.390
2	-0.112	0.513
3	-0.015	-0.440

ACOUSTIC SURVEYS (ages 1 to 2+)

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.5175	*******	0.3280	0.6002	*******	*******	*******	*******	-0.3446	*******	*******	*******	0.3183	-0.1186	-0.2658
2	-0.3461	*******	0.4741	-0.4034	*******	*******	*******	*******	0.2854	*******	*******	*******	-0.0462	0.3850	-0.3488

Table 11. 7. 2. 2 (Cont'd)

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1988 to 2002

Variance	0.0486
Skewness test stat.	-3.8301
Kurtosis test statistic	-0.7034
Partial chi-square	0.1715
Significance in fit	0.0000
Degrees of freedom	38

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR DEPM

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

Variance	0.0626
Skewness test stat.	-0.5068
Kurtosis test statistic	-0.4984
Partial chi-square	0.0920
Significance in fit	0.0000
Number of observations	1
Degrees of freedom	16
Weight in the analysis	0.5000

DISTRIBUTION STATISTICS FOR Acoustic

Linear catchability relationship assumed
Last age is a plus-group

Variance	0.0932
Skewness test stat.	-0.1261
Kurtosis test statistic	-0.7683
Partial chi-square	0.0769
Significance in fit	0.0000
Number of observations	10
Degrees of freedom	9
Weight in the analysis	0.5000

Table 11. 7. 2. 2 (Cont'd)

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR DEPM SUVEYS (Ages 1 to 3+)

Index used as absolute measure of abundance

Age	1	2	3
Variance	0.0798	0.1154	0.0508
Skewness test stat.	0.1404	2.0191	-2.0929
Kurtosis test statisti	-0.6719	-0.6717	-0.4006
Partial chi-square	0.0739	0.1249	0.0617
Significance in fit	0.0000	0.0000	0.0000
Number of observations	13	13	13
Degrees of freedom	13	13	13
Weight in the analysis	0.3333	0.3333	0.3333

DISTRIBUTION STATISTICS FOR ACOUSTIC SURVEYS (ages 1 to 2+)

Linear catchability relationship assumed

Age	1	2
Variance	0.0650	0.0538
Skewness test stat.	0.2256	0.1333
Kurtosis test statisti	-0.7729	-0.9326
Partial chi-square	0.0268	0.0239
Significance in fit	0.0000	0.0000
Number of observations	7	7
Degrees of freedom	6	6
Weight in the analysis	0.3750	0.3750

Table 11. 7. 2. 2 (Cont'd)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	90.6946	154	40	114	0.7956
Catches at age	75.5189	75	37	38	1.9873
SSB Indices					
DEPM	2.0047	16	0	16	0.1253
Acoustic	1.6770	10	1	9	0.1863
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	9.5930	39	0	39	0.2460
ACOUSTIC SURVEYS (ages 1 to 2+)	1.9010	14	2	12	0.1584

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	4.1020	154	40	114	0.0360
Catches at age	1.8484	75	37	38	0.0486
SSB Indices					
DEPM	0.5012	16	0	16	0.0313
Acoustic	0.4192	10	1	9	0.0466
Aged Indices					
DEPM SUVEYS (Ages 1 to 3+)	1.0659	39	0	39	0.0273
ACOUSTIC SURVEYS (ages 1 to 2+)	0.2673	14	2	12	0.0223

Table 11.7.2.3: Input data for the Biomass Dynamic Model for the Bay of Biscay anchovy

g	0.680
f1	0.375
f2	0.625

			CATCH at AGE DATA			DEPM		ACOUSTICS	
Year	h1	h2	C(y,1,1)	C(y,1,2+)	C(y,2, 1+	B(y,2,1)	B(y,2,1+)	B(y,2,1)	B(y,2,1+)
1987	0.307	0.194	2,711	5,607	6,543	14,235	29,365		
1988	0.325	0.177	2,602	1,262	10,954	53,087	63,500		
1989	0.282	0.233	1,723	2,152	4,442	7,282	16,720		
1990	0.307	0.206	9,314	1,259	23,574	90,650	97,239		
1991	0.235	0.198	3,903	6,288	8,196	11,271	19,276	28,322	64,000
1992	0.254	0.218	11,933	4,433	21,026	85,571	90,720	84,439	89,000
1993	0.237	0.238	6,414	7,763	25,431				
1994	0.233	0.205	3,795	9,807	20,150	34,674	60,062		35,000
1995	0.292	0.175	5,718	8,832	14,815	42,906	54,700		
1996	0.276	0.198	4,570	4,675	23,833		39,545		
1997	0.208	0.262	4,323	2,912	13,256	38,536	51,176	38,498	63,000
1998	0.199	0.257	5,898	2,089	23,588	80,357	101,976		57,000
1999	0.230	0.263	2,067	8,828	15,511		69,074		
2000	0.257	0.200	6,298	5,712	24,882		44,973		98,484
2001	0.298	0.220	5,481	5,986	28,671	73,198	124,132	90,928	137,200
2002	0.183	0.239	1,962	5,776	9,754	6,352	30,697	17,723	97,051
2003	0.258	0.218	344	2,322		22,831	32,866	15,732	29,430

Table 11.7.2.4: Recruitment and spawning biomass estimates from ICA and Biomass Dynamic Model assessments.

	BIOMASS DYNAMIC MODEL				ICA	
	depm absolute & acoustics relative					
year	B(y,1,1)	B(y,1,1+)	B(y,2,1)	B(y,2,1+)	B(y,1,1)	B(y,2,1+)
1987	21,716	45,694	14,237	27,462	26,505	41,151
1988	58,868	71,937	43,095	52,001	34,567	41,023
1989	10,497	36,406	6,515	24,569	14,087	21,053
1990	106,683	119,340	73,765	82,368	77,241	51,008
1991	23,791	59,904	14,885	37,150	30,720	30,536
1992	109,057	127,207	73,505	83,483	103,998	71,816
1993	58,002	96,623	39,101	61,958	94,799	82,227
1994	49,182	70,137	34,660	41,992	53,463	53,370
1995	68,659	80,964	47,794	48,982	48,897	43,218
1996	47,139	68,245	32,251	44,234	56,273	39,974
1997	53,863	64,953	37,874	43,868	53,052	45,721
1998	90,644	108,958	64,997	77,333	103,577	95,382
1999	69,745	101,930	52,165	69,100	55,271	76,532
2000	64,863	97,905	44,443	64,773	98,169	90,865
2001	126,294	149,997	92,649	105,331	90,369	91,218
2002	14,854	61,940	9,787	41,199	26,113	51,292
2003	21,630	41,057	16,441	29,348	26,451	29,200

Table 11.7.2.5: Residuals (log scale) with respect to DEPM and Acustics indexes for the Biomass Dinamic Model

	RESIDUALS (in log scale)			
	depm absolute & acoustics relative			
	for DEPM		for acoustics	
year	**B(y,2,1)**	**B(y,2,1+)**	**B(y,2,1)**	**B(y,2,1+)**
1987	0.000	-0.067		
1988	-0.209	-0.200		
1989	-0.111	0.385		
1990	-0.206	-0.166		
1991	0.278	0.656	-0.643	-0.544
1992	-0.152	-0.083	-0.139	-0.064
1993				
1994	0.000	-0.358		0.182
1995	0.108	-0.110		
1996		0.112		
1997	-0.017	-0.154	-0.016	-0.362
1998	-0.212	-0.277		0.305
1999		0.000		
2000		0.365		-0.419
2001	0.236	-0.164	0.019	-0.264
2002	0.432	0.294	-0.594	-0.857
2003	-0.328	-0.113	0.044	-0.003
MEAN	-0.014	0.008	-0.222	-0.225
VAR	0.047	0.073	0.131	0.171
SD	0.216	0.270	0.362	0.413

Table 11.7.3.1: Stock: Anchovy Sub- area VIII.. Historical quality of the assessment.
Assessment Quality Control Diagram 1

Average F(1-3,u)																
Date of assessment	Year															
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1989																
1990																
1991																
1992																
1993																
1994																
1995																
1996	1.014	0.99	0.993	1.992	1.343	0.926	0.901	0.825								
1997	0.554	0.678	0.61	1.449	0.892	0.585	0.643	0.738	0.855							
1998	0.541	0.617	0.629	1.299	0.891	0.574	0.679	0.862	1.172	0.414						
1999	0.501	0.581	0.615	1.258	0.863	0.565	0.679	0.861	1.238	0.486	0.251					
2000	0.589	0.527	1.048	0.8787	0.892	0.7	0.775	0.863	1.195	0.517	0.385	0.577				
2001	0.596	0.533	1.053	0.901	0.902	0.702	0.772	0.859	1.21	0.517	0.353	0.37	0.574			
2002	0.594	0.533	1.052	0.901	0.902	0.705	0.774	0.86	1.212	0.517	0.353	0.357	0.447	0.333		
2003	0.624	0.5418	1.07	0.9253	0.9303	0.7192	0.7913	0.8796	1.2387	0.5333	0.3639	0.3706	0.4867	0.468	0.428	

Remarks: Assessment of 1996 – 2003 performed using ICA

Table 11.7.3.1: Continued
Assessment Quality Control Diagram 2

Recruitment (age 0) Unit: millions															
Date of assessment	Year class														
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1989															
1990															
1991															
1992															
1993															
1994															
1995															
1996	3310	21395	7272	27393	27677	15551	14273	14963							
1997	3641	21990	7506	28271	28003	14455	12335	14650	17065						
1998	4294	19052	7206	27767	25764	13877	10454	14051	210443	30950					
1999	4387	19082	7319	28402	25305	13334	10275	13397	20231	34647	2977				
2000	3473	19652	7587	27632	24103	12789	10405	14514	18197	25830	7841	12582			
2001	3461	19288	7456	27443	24011	12717	10405	14254	18262	28812	13387	18419	38397		
2002	3466	19308	7467	27378	23985	12681	10411	14232	18220	28780	14268	25530	32708	4356	
2003	3458	19259	7405	27324	23971	12637	10407	14226	18063	28652	13940	23583	22807	4729	6482

Remarks: Assessment of 1996 – 2003 performed using ICA

Table 11.7.3.1: Continued
Assessment Quality Control Diagram 3

	Spawning stock biomass ('000 t)														
Date of assessment	Year														
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1989															
1990															
1991															
1992															
1993															
1994															
1995															
1996	16,356	60,886	29,395	69,621	93,342	68,487	55,670								
1997	17,782	63,438	29,569	71,261	95,497	65,521	46,671	47,188							
1998	19,112	55,649	28,391	69,737	88,690	60,978	45,126	40,617	54,783						
1999	23,389	55,844	28,794	71,236	87,618	58,755	43,727	37,098	49,641	118,593					
2000	21,582	51,966	31,476	72,975	81,638	53,953	43,316	41,558	46,158	87,436	51,230	46,750			
2001	21,265	51,031	30,641	72,241	81,905	53,638	43,310	39,816	46,136	96,063	74,552	70,323	95,352		
2002	21,306	51,291	30,791	72,368	82,507	53,563	43,363	40,128	46,182	96,087	77,885	97,971	126,033	58,129	
2003	21,053	51,008	30,536	71,816	82,227	53,370	43,218	39,974	45,721	95,382	76,532	90,865	91,218	51,292	29,200

Remarks: Assessment of 1996 – 2003 performed using ICA

Table 11.8.1: Inputs for projections of the population and catches for the Bay of Biscay anchovy ir

Precautionary recruitment (Geometric mean of those below median R)= 7,692,136
Mean weight at age at the stock (1990-2003) and at catches (1989-2002)
Fbar age range: 1-3 Average F for the period 1997-2002

2003				**INPUTS**				
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
0	7,692,136	1.2	0	0.4	0.375	0.0123	0.0020	0.0130
1	1,948,600	1.2	1	0.4	0.375	0.0165	0.2437	0.0217
2	338,070	1.2	1	0.4	0.375	0.0292	0.5662	0.0292
3	277,530	1.2	1	0.4	0.375	0.0346	0.5154	0.0349
4	49,352	1.2	1	0.4	0.375	0.0405	0.4473	0.0406
5	6,574	1.2	1	0.4	0.375	0.0420	0.4473	0.0420

N_age 0 7,692,136 in 2004 and 2005

Table 11.8.2: Catch option prediction for the anchovy fishery in Subarea VIII in 2003.
Precautionary Recruitment Scenario

MFDP version 1a
Run: **Precautinary Recruitment**
Anchovy in subarea VIII WG2001- Bay of Biscay anchovy Exploratory run
Time and date: 19:45 13/09/03
Fbar age range: 1-2

2003				
Biomass	SSB	FMult	FBar	Landings
148,519	**29,779**	1	0.4049	11,075

							Alternatively if R0(2004)=Geometric Mean then
2004 Biomass	**2004 SSB**	**2004 FMult**	**2004 FBar**	**2004 Landings**	**2005 Biomass**	**2005 SSB**	**2005 SSB**
150,668	35,705	0	0	0	159,446	41,301	57,876
.	35,223	0.1	0.0405	1,272	158,615	40,177	56,588
.	34,749	0.2	0.081	2,507	157,815	39,104	55,353
.	34,283	0.3	0.1215	3,706	157,042	38,078	54,166
.	33,824	0.4	0.162	4,870	156,297	37,098	53,026
.	33,372	0.5	0.2025	6,000	155,577	36,160	51,930
.	32,927	0.6	0.243	7,099	154,883	35,262	50,877
.	32,489	0.7	0.2835	8,166	154,213	34,403	49,863
.	32,058	0.8	0.3239	9,204	153,565	33,579	48,886
.	31,634	0.9	0.3644	10,213	152,940	32,790	47,945
.	31,216	1	0.4049	11,195	152,335	32,033	47,038
.	30,805	1.1	0.4454	12,150	151,751	31,306	46,163
.	30,400	1.2	0.4859	13,079	151,187	30,609	45,319
.	30,002	1.3	0.5264	13,983	150,641	29,939	44,504
.	29,609	1.4	0.5669	14,863	150,113	29,296	43,716
.	29,222	1.5	0.6074	15,721	149,603	28,677	42,954
.	28,842	1.6	0.6479	16,556	149,109	28,081	42,217
.	28,467	1.7	0.6884	17,370	148,631	27,508	41,504
.	28,098	1.8	0.7289	18,163	148,168	26,956	40,814
.	27,734	1.9	0.7694	18,936	147,720	26,424	40,145
.	27,376	2	0.8099	19,689	147,287	25,912	39,496

Input units are thousands and kg - output in tonnes

Table 11.8.3: Spawning Biomass at the beginning of the second period (15th May) in 2004 (in italics) and 2005 (in bold) for different recruitment and catch options by half-year periods.

C(y,2,1+) denotes catches during the second period (15th May - 31st December) of 2003

R is recruitment in mass at the begining of the year

recruitment scenario: precautionary approach (geometric mean of the values below the median)

C(y,2,1+)	8313																			
R	31380	**Catch 1st half-year 2004/ Catch 1st half-year 2005**																		
	Catch 1st half year	**0**		**2500**		**5000**		**7500**		**10000**		**12500**		**15000**		**17500**		**20000**		
Catch 2nd half-year 2004	Year	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	**2004**	**2005**	
	0	*34298*	**41682**	*32943*	**39032**	*31587*	**36381**	*30232*	**33731**	*28876*	**31081**	*27521*	**28431**	*26165*	**25781**	*24810*	**23131**	*23454*	**20481**	
	2500	*34298*	**40215**	*32943*	**37565**	*31587*	**34915**	*30232*	**32265**	*28876*	**29614**	*27521*	**26964**	*26165*	**24314**	*24810*	**21664**	*23454*	**19014**	
	5000	*34298*	**38748**	*32943*	**36098**	*31587*	**33448**	*30232*	**30798**	*28876*	**28148**	*27521*	**25498**	*26165*	**22847**	*24810*	**20197**	*23454*	**17547**	
	7500	*34298*	**37281**	*32943*	**34631**	*31587*	**31981**	*30232*	**29331**	*28876*	**26681**	*27521*	**24031**	*26165*	**21381**	*24810*	**18731**	*23454*	**16081**	
	10000	*34298*	**35815**	*32943*	**33165**	*31587*	**30514**	*30232*	**27864**	*28876*	**25214**	*27521*	**22564**	*26165*	**19914**	*24810*	**17264**	*23454*	**14614**	
	12500	*34298*	**34348**	*32943*	**31698**	*31587*	**29048**	*30232*	**26398**	*28876*	**23748**	*27521*	**21097**	*26165*	**18447**	*24810*	**15797**	*23454*	**13147**	
	15000	*34298*	**32881**	*32943*	**30231**	*31587*	**27581**	*30232*	**24931**	*28876*	**22281**	*27521*	**19631**	*26165*	**16981**	*24810*	**14330**	*23454*	**11680**	
	17500	*34298*	**31415**	*32943*	**28764**	*31587*	**26114**	*30232*	**23464**	*28876*	**20814**	*27521*	**18164**	*26165*	**15514**	*24810*	**12864**	*23454*	**10214**	
	20000	*34298*	**29948**	*32943*	**27298**	*31587*	**24648**	*30232*	**21997**	*28876*	**19347**	*27521*	**16697**	*26165*	**14047**	*24810*	**11397**	*23454*	**8747**	

Table 11.8.4: Total Spawning Biomass at the beginning of the second period (15th May) in 2004 and 2005 for different annual catch options. the proportion of catches taken in each half year is assumed to be the mean of the historical series.

scenario for recruitment: precautionary approach (geometric mean of the values below the median)

				SSB
Annual Catch	**Catch 1st period**	**Catch 2nd period**	**B(2004,2,1+)**	**B(2005,2,1+)**
0	0	0	34298	41682
2500	904	1596	33461	39484
5000	1808	3192	32624	37286
7500	2712	4788	31786	35089
10000	3615	6385	30949	32891
12500	4519	7981	30112	30693
15000	5423	9577	29275	28496
17500	6327	11173	28437	26298
20000	7231	12769	27600	24100
22500	8135	14365	26763	21903
25000	9038	15962	25926	19705
27500	9942	17558	25088	17507
30000	10846	19154	24251	15310
32500	11750	20750	23414	13112
35000	12654	22346	22577	10914
37500	13558	23942	21740	8717
40000	14461	25539	20902	6519

Table 11.10.1 Performance statistics corresponding to the base case.

Fract R δ		γ 0.3	0.4	0.5	0.6	0.7
0.5	**Av. Catch**	21385	25620	28726	30703	32109
	P<Blim	0.007	0.026	0.057	0.099	0.132
	P<Bpa	0.177	0.346	0.496	0.602	0.686
	n C<TAC	0.384	0.62	1.058	1.575	2.164
	Av. TAC1	13276	15391	16965	18206	19292
	Av. TAC2	21888	26412	30133	33246	36041
0.6	**Av. Catch**	21307	25574	28623	30525	31866
	P<Blim	0.008	0.026	0.059	0.099	0.14
	P<Bpa	0.174	0.346	0.489	0.597	0.689
	n C<TAC	0.404	0.594	0.965	1.553	2.045
	Av. TAC1	14476	16932	18818	20343	21676
	Av. TAC2	21851	26311	29931	32906	35467
0.7	**Av. Catch**	21271	25499	28455	30276	31363
	P<Blim	0.008	0.029	0.059	0.107	0.147
	P<Bpa	0.173	0.344	0.486	0.595	0.686
	n C<TAC	0.391	0.576	0.9	1.381	1.878
	Av. TAC1	15675	18470	20667	22467	24038
	Av. TAC2	21817	26217	29734	32547	34841
0.8	**Av. Catch**	21261	25447	28337	29952	30916
	P<Blim	0.009	0.032	0.061	0.112	0.165
	P<Bpa	0.17	0.339	0.484	0.588	0.678
	n C<TAC	0.384	0.573	0.864	1.31	1.822
	Av. TAC1	16871	20004	22505	24568	26393
	Av. TAC2	21786	26123	29531	32142	34209
0.9	**Av. Catch**	21208	25354	28232	29768	30638
	P<Blim	0.01	0.032	0.072	0.124	0.181
	P<Bpa	0.168	0.337	0.479	0.584	0.676
	n C<TAC	0.338	0.493	0.828	1.226	1.607
	Av. TAC1	18067	21535	24333	26663	28723
	Av. TAC2	21758	26033	29323	31731	33537
1	**Av. Catch**	21190	25298	28035	29558	30360
	P<Blim	0.01	0.032	0.078	0.137	0.209
	P<Bpa	0.167	0.336	0.482	0.582	0.675
	n C<TAC	0.333	0.52	0.841	1.151	1.539
	Av. TAC1	19260	23060	26150	28746	31041
	Av. TAC2	21733	25947	29092	31325	32834

Table 11.10.2 Performance statistics corresponding to the case where there is information about recruitment level.

δ		γ 0.3	0.4	0.5	0.6	0.7
0.5	**Av. Catch**	21418	25704	28662	30852	32591
	P<Blim	0.01	0.032	0.053	0.086	0.116
	P<Bpa	0.192	0.348	0.499	0.607	0.675
	n C<TAC	0.377	0.665	1.069	1.681	2.26
	Av. TAC1	14435	16915	18791	20306	21626
	Av. TAC2	21934	26529	30376	33746	36826
0.6	**Av. Catch**	21374	25584	28632	30777	32495
	P<Blim	0.009	0.03	0.051	0.084	0.112
	P<Bpa	0.189	0.341	0.485	0.602	0.661
	n C<TAC	0.388	0.629	1.02	1.586	2.194
	Av. TAC1	15877	18775	21030	22879	24501
	Av. TAC2	21898	26452	30235	33514	36479
0.7	**Av. Catch**	21331	25564	28551	30753	32347
	P<Blim	0.01	0.031	0.051	0.077	0.11
	P<Bpa	0.186	0.327	0.472	0.588	0.652
	n C<TAC	0.377	0.602	0.989	1.517	2.061
	Av. TAC1	17319	20635	23265	25443	27353
	Av. TAC2	21869	26383	30106	33298	36150
0.8	**Av. Catch**	21281	25519	28523	30621	32292
	P<Blim	0.01	0.031	0.051	0.078	0.115
	P<Bpa	0.186	0.323	0.46	0.579	0.647
	n C<TAC	0.355	0.568	0.917	1.395	1.975
	Av. TAC1	18761	22492	25492	27992	30176
	Av. TAC2	21849	26327	29994	33098	35835
0.9	**Av. Catch**	21277	25441	28505	30562	32109
	P<Blim	0.01	0.027	0.05	0.078	0.109
	P<Bpa	0.184	0.318	0.449	0.571	0.637
	n C<TAC	0.327	0.575	0.893	1.352	1.891
	Av. TAC1	20203	24346	27710	30522	32973
	Av. TAC2	21840	26285	29898	32917	35546
1	**Av. Catch**	21364	25426	28397	30491	32008
	P<Blim	0.01	0.026	0.052	0.079	0.108
	P<Bpa	0.183	0.309	0.44	0.562	0.636
	n C<TAC	0.314	0.519	0.839	1.299	1.786
	Av. TAC1	21644	26196	29914	33033	35734
	Av. TAC2	21843	26260	29821	32762	35281

Table 11.10.3 Performance statistics corresponding to the harvest where the TAC cannot exceed 33 thousand tons.

		γ				
δ		**0.3**	**0.4**	**0.5**	**0.6**	**0.7**
0.5	**Av. Catch**	19292	21909	23620	24824	25612
	P<Blim	0.002	0.01	0.016	0.03	0.04
	P<Bpa	0.11	0.199	0.269	0.33	0.376
	n C<TAC	0.238	0.224	0.221	0.254	0.31
	Av. TAC1	14007	17013	19674	22105	24366
	Av. TAC2	19139	21687	23348	24448	25199
0.6	**Av. Catch**	19265	21878	23567	24801	25591
	P<Blim	0.003	0.008	0.019	0.031	0.04
	P<Bpa	0.11	0.197	0.267	0.33	0.37
	n C<TAC	0.227	0.19	0.177	0.259	0.26
	Av. TAC1	15205	18551	21521	24235	26749
	Av. TAC2	19124	21658	23300	24375	25098
0.7	**Av. Catch**	19252	21847	23567	24763	25592
	P<Blim	0.003	0.009	0.018	0.034	0.044
	P<Bpa	0.109	0.195	0.27	0.329	0.371
	n C<TAC	0.245	0.203	0.152	0.175	0.224
	Av. TAC1	16402	20086	23363	26357	29122
	Av. TAC2	19112	21633	23253	24307	24987
0.8	**Av. Catch**	19248	21839	23544	24691	25474
	P<Blim	0.003	0.011	0.019	0.037	0.052
	P<Bpa	0.106	0.193	0.269	0.325	0.369
	n C<TAC	0.21	0.189	0.129	0.147	0.216
	Av. TAC1	17598	21617	25199	28467	31474
	Av. TAC2	19102	21612	23209	24240	24886
0.9	**Av. Catch**	19259	21867	23522	24708	25451
	P<Blim	0.004	0.012	0.024	0.042	0.056
	P<Bpa	0.107	0.193	0.271	0.325	0.373
	n C<TAC	0.192	0.12	0.112	0.124	0.152
	Av. TAC1	18792	23145	27028	30563	33811
	Av. TAC2	19097	21593	23169	24170	24770
1	**Av. Catch**	19246	21886	23535	24713	25427
	P<Blim	0.004	0.012	0.031	0.049	0.068
	P<Bpa	0.107	0.193	0.27	0.324	0.375
	n C<TAC	0.167	0.159	0.112	0.098	0.124
	Av. TAC1	19984	24669	28848	32648	36140
	Av. TAC2	19095	21577	23136	24094	24649

Table 11.10.4 Performance statistics corresponding to the harvest where the TAC cannot exceed 36 thousand tons.

δ		γ				
		0.3	**0.4**	**0.5**	**0.6**	**0.7**
0.5	**Av. Catch**	19716	22586	24386	25691	26724
	P<Blim	0.003	0.01	0.02	0.031	0.047
	P<Bpa	0.114	0.221	0.293	0.369	0.408
	n C<TAC	0.232	0.224	0.255	0.297	0.463
	Av. TAC1	13890	16779	19297	21567	23671
	Av. TAC2	19572	22334	24171	25417	26275
0.6	**Av. Catch**	19684	22553	24361	25644	26609
	P<Blim	0.003	0.01	0.021	0.036	0.046
	P<Bpa	0.116	0.216	0.289	0.37	0.411
	n C<TAC	0.249	0.255	0.205	0.271	0.362
	Av. TAC1	15088	18318	21146	23698	26054
	Av. TAC2	19554	22298	24112	25327	26140
0.7	**Av. Catch**	19676	22527	24374	25627	26538
	P<Blim	0.003	0.011	0.022	0.038	0.05
	P<Bpa	0.115	0.214	0.289	0.365	0.413
	n C<TAC	0.238	0.207	0.184	0.222	0.316
	Av. TAC1	16286	19854	22989	25818	28424
	Av. TAC2	19540	22265	24052	25238	26006
0.8	**Av. Catch**	19653	22536	24341	25588	26453
	P<Blim	0.003	0.013	0.025	0.039	0.059
	P<Bpa	0.114	0.209	0.288	0.367	0.411
	n C<TAC	0.22	0.177	0.187	0.215	0.294
	Av. TAC1	17482	21387	24826	27927	30769
	Av. TAC2	19528	22236	23996	25152	25856
0.9	**Av. Catch**	19666	22537	24298	25582	26393
	P<Blim	0.004	0.012	0.029	0.047	0.067
	P<Bpa	0.111	0.209	0.287	0.364	0.416
	n C<TAC	0.201	0.166	0.161	0.216	0.221
	Av. TAC1	18676	22915	26654	30018	33101
	Av. TAC2	19520	22211	23946	25038	25699
1	**Av. Catch**	19648	22489	24279	25547	26348
	P<Blim	0.004	0.012	0.032	0.055	0.083
	P<Bpa	0.111	0.208	0.292	0.363	0.417
	n C<TAC	0.169	0.15	0.185	0.157	0.176
	Av. TAC1	19869	24439	28476	32100	35414
	Av. TAC2	19515	22188	23896	24933	25524

Table 11.10.5 Performance statistics corresponding to the harvest where the TAC cannot exceed 40 thousand tons.

δ		γ				
		0.3	**0.4**	**0.5**	**0.6**	**0.7**
0.5	**Av. Catch**	20127	23274	25376	26742	27737
	P<Blim	0.004	0.011	0.025	0.038	0.051
	P<Bpa	0.128	0.235	0.326	0.408	0.453
	n C<TAC	0.26	0.238	0.298	0.397	0.624
	Av. TAC1	13766	16525	18883	20977	22895
	Av. TAC2	20028	23033	25079	26489	27490
0.6	**Av. Catch**	20083	23233	25297	26755	27666
	P<Blim	0.004	0.011	0.025	0.04	0.053
	P<Bpa	0.127	0.232	0.322	0.405	0.446
	n C<TAC	0.283	0.255	0.271	0.356	0.493
	Av. TAC1	14965	18065	20733	23109	25279
	Av. TAC2	20008	22989	25003	26372	27312
0.7	**Av. Catch**	20058	23230	25275	26678	27597
	P<Blim	0.004	0.011	0.026	0.044	0.06
	P<Bpa	0.124	0.232	0.321	0.399	0.447
	n C<TAC	0.256	0.221	0.225	0.318	0.412
	Av. TAC1	16163	19602	22579	25232	27646
	Av. TAC2	19990	22948	24925	26256	27132
0.8	**Av. Catch**	20062	23190	25215	26575	27488
	P<Blim	0.004	0.013	0.027	0.047	0.07
	P<Bpa	0.121	0.227	0.317	0.395	0.452
	n C<TAC	0.225	0.208	0.229	0.281	0.442
	Av. TAC1	17360	21136	24417	27337	29992
	Av. TAC2	19974	22910	24854	26120	26940
0.9	**Av. Catch**	20047	23146	25164	26525	27380
	P<Blim	0.004	0.013	0.032	0.053	0.08
	P<Bpa	0.121	0.225	0.317	0.395	0.454
	n C<TAC	0.215	0.175	0.185	0.281	0.321
	Av. TAC1	18554	22665	26245	29430	32315
	Av. TAC2	19963	22875	24777	25981	26711
1	**Av. Catch**	20033	23116	25116	26463	27361
	P<Blim	0.005	0.014	0.039	0.061	0.098
	P<Bpa	0.12	0.229	0.32	0.393	0.46
	n C<TAC	0.203	0.161	0.216	0.214	0.267
	Av. TAC1	19747	24190	28063	31513	34630
	Av. TAC2	19955	22843	24697	25836	26493

Table 11.10.6 Performance statistics corresponding to constant catch harvest strategies. The first two columns are related to a constant catch fixed TAC management regime and the two last ones to the case where the TAC is reduced when the estimated SSB is below reference points

	Constant Catch		Constant Catch with reduction if SSB<RefP	
	TAC (000't)		TAC (000't)	
Av. Catch	20	20000	30	26008
P<Blim		0.053		0.058
P<Bpa		0.22		0.362
n C<TAC		0.29		0.266
Av. TAC1		20000		24876
Av. TAC2		20000		25593
Av. Catch	22	22000	31	26642
P<Blim		0.084		0.065
P<Bpa		0.275		0.385
n C<TAC		0.503		0.303
Av. TAC1		22000		25498
Av. TAC2		22000		26243
Av. Catch	24	24000	32	27265
P<Blim		0.124		0.071
P<Bpa		0.332		0.41
n C<TAC		0.787		0.369
Av. TAC1		24000		26108
Av. TAC2		24000		26878
Av. Catch	26	26000	33	27899
P<Blim		0.158		0.079
P<Bpa		0.398		0.424
n C<TAC		1.14		0.437
Av. TAC1		26000		26706
Av. TAC2		26000		27501
Av. Catch	28	28000	34	28475
P<Blim		0.196		0.086
P<Bpa		0.464		0.446
n C<TAC		1.545		0.501
Av. TAC1		28000		27292
Av. TAC2		28000		28111
Av. Catch	30	29595	35	28941
P<Blim		0.227		0.092
P<Bpa		0.511		0.472
n C<TAC		1.959		0.577
Av. TAC1		30000		27858
Av. TAC2		30000		28702
Av. Catch	32	31015	36	29364
P<Blim		0.265		0.102
P<Bpa		0.569		0.495
n C<TAC		2.437		0.656
Av. TAC1		32000		28411
Av. TAC2		32000		29279

Figure 11.2.1.1: Bay of Biscay anchovy: Historical evolution of the fishery since 1940

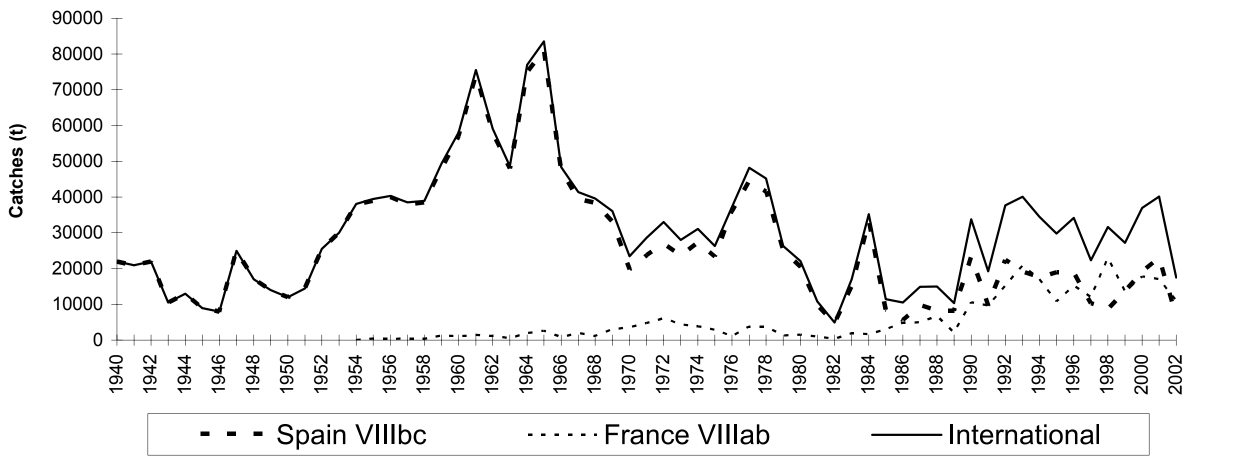
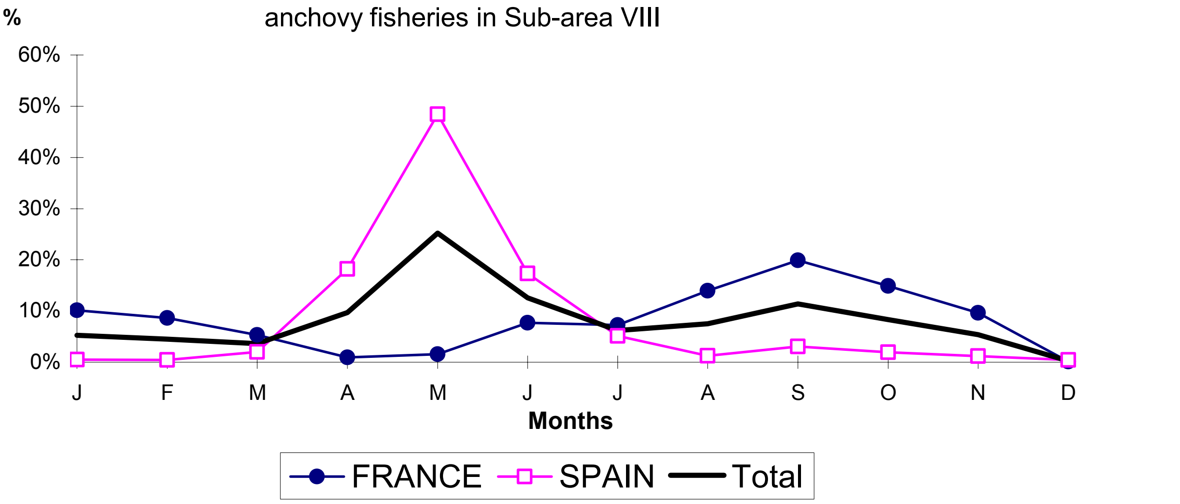
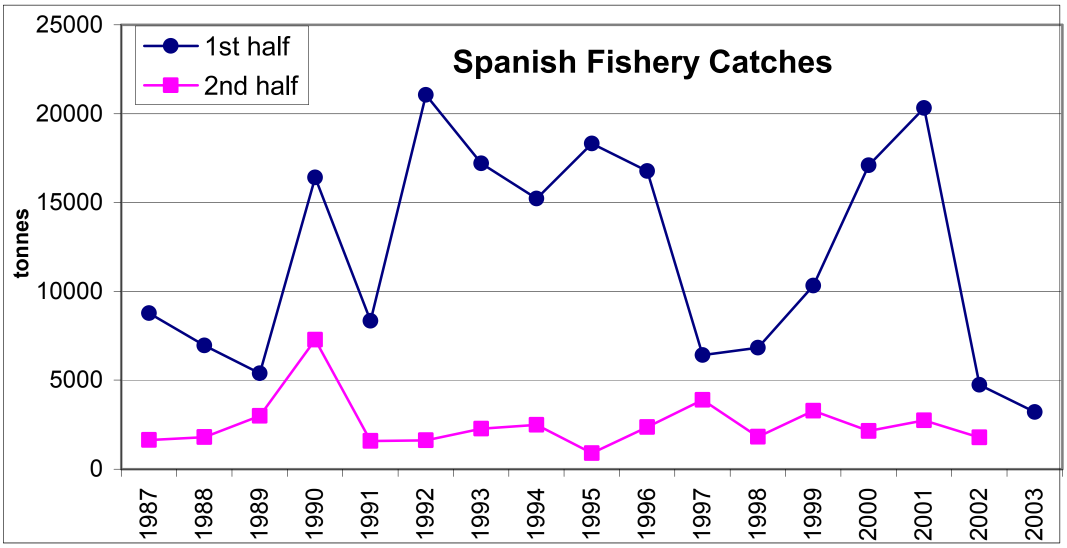


Figure 11.2.1.2: Mean monthly catches (1992-2002) for the French and Spanish anchovy fisheries in Sub-area VIII





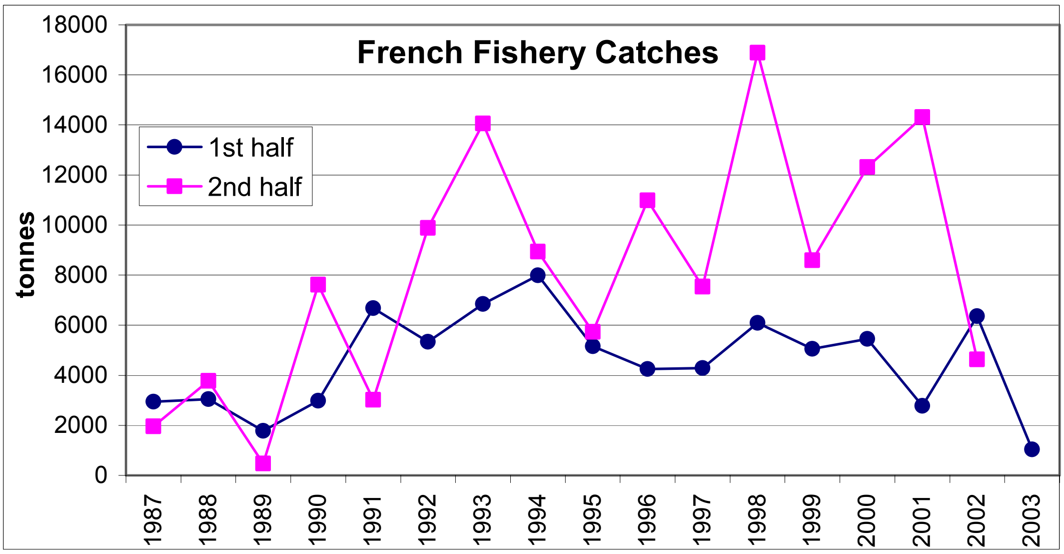


Figure 11.2.1.3: Seasonal catches of anchovy by countries since 1987:
a)Upper graphic Spanish fishery catches for the first and the second half of the year
b)Bottom graphic: French fishery catches for the first and the second half of the year

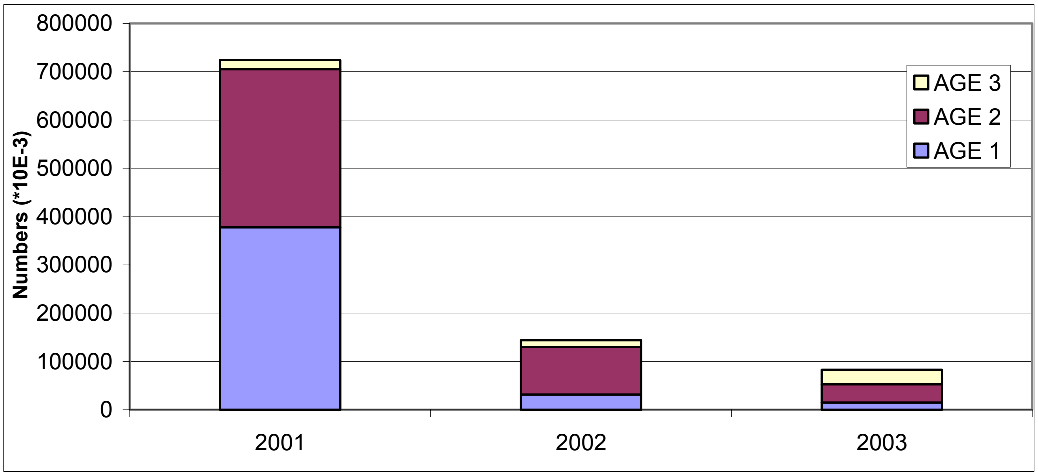
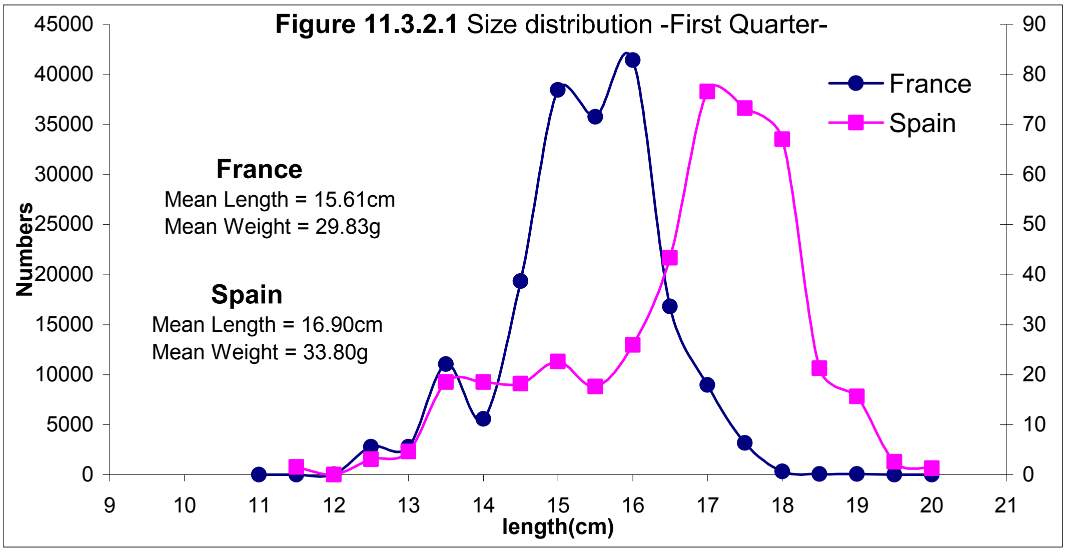


Figure11.3.1.1: Age composition of anchovy catches obtained in the spanish spring Fishery from 2001 to 2003



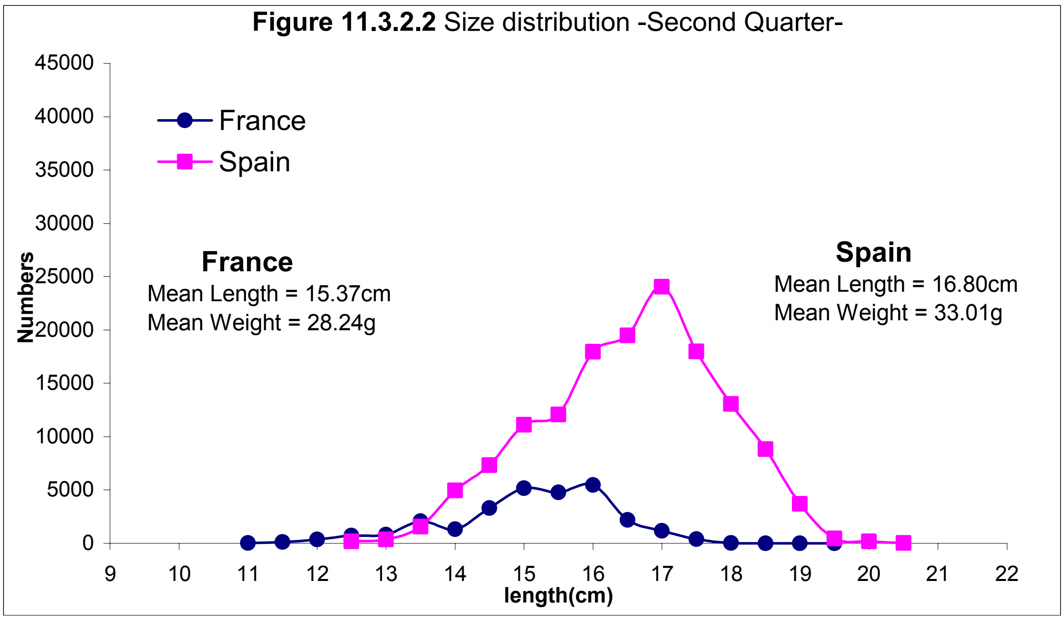


Figure 11.3.2.3 Size distribution -Third Quarter-

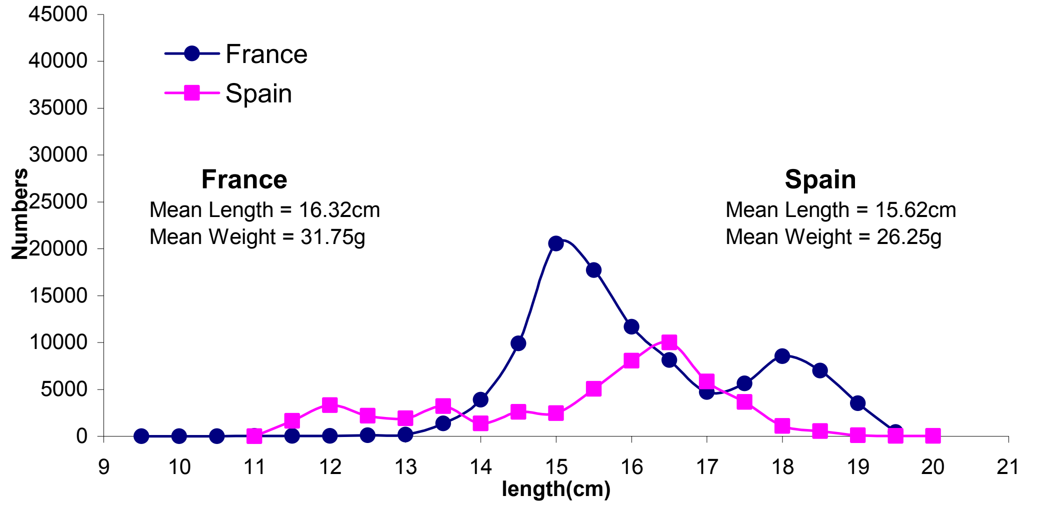
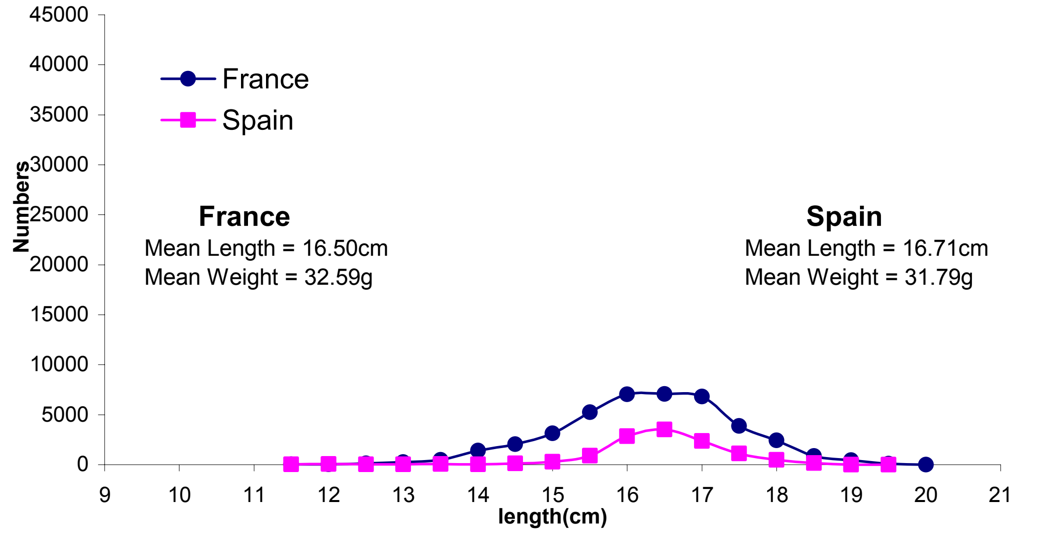


Figure 11.3.2.4 Size distribution -Fourth Quarter-



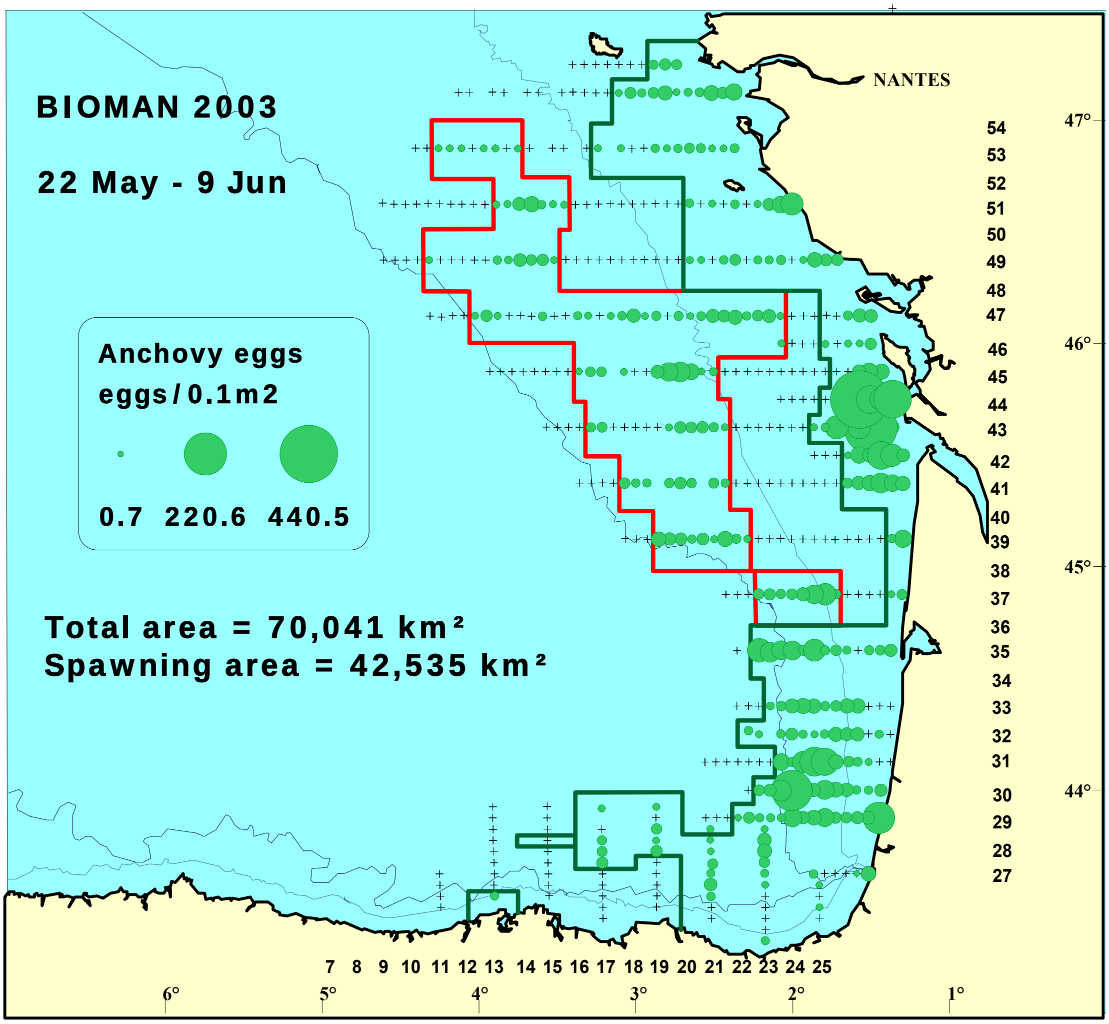


Figure 11.4.1.1: Anchovy egg/0.1m^2 distribution found during BIOMAN 2003. Solid line encloses the positive spawning area.

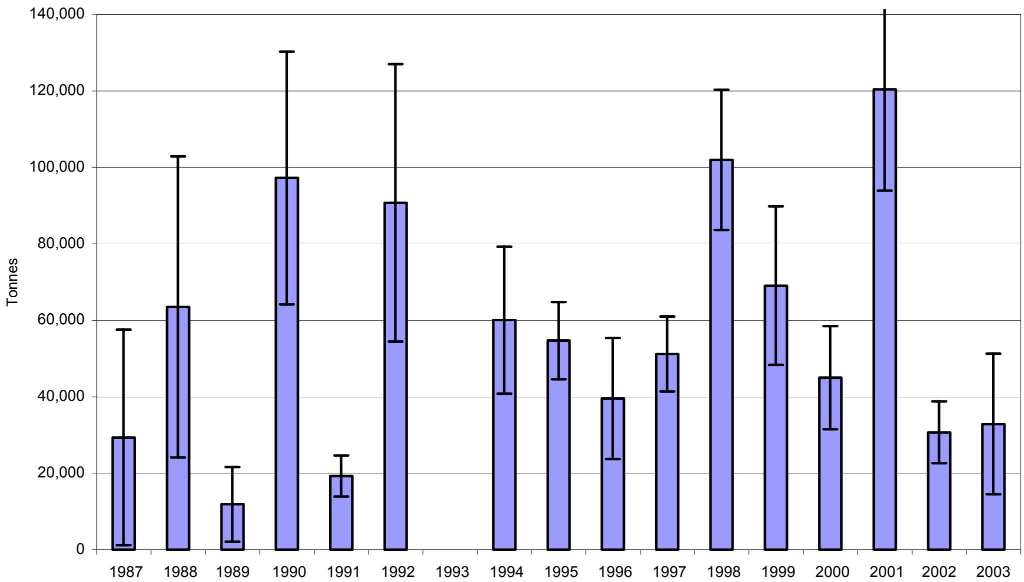


Figure 11.4.1.2: Series of biomass estimates obtained for the bay of Biscay anchovy by the daily Egg production Meted since 1987, bounded by ± 2 s.e of the estimate.

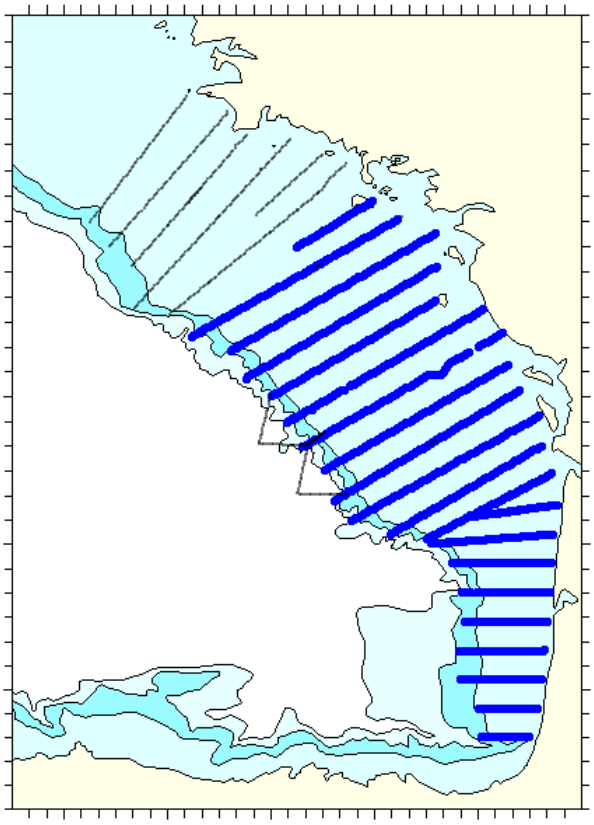


Figure 11.4.2.1 Transects prospected during PELGAS03. The 6 northern transects were not fully processed at the date of the present WGMHMSA meeting but no anchovy was observed in this area.

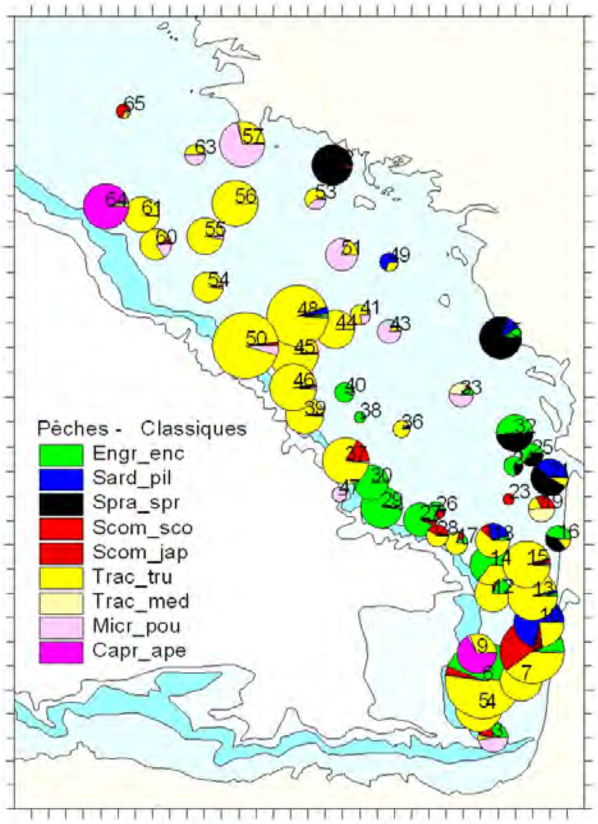


Figure 11.4.2.2 Species distribution according to identification hauls

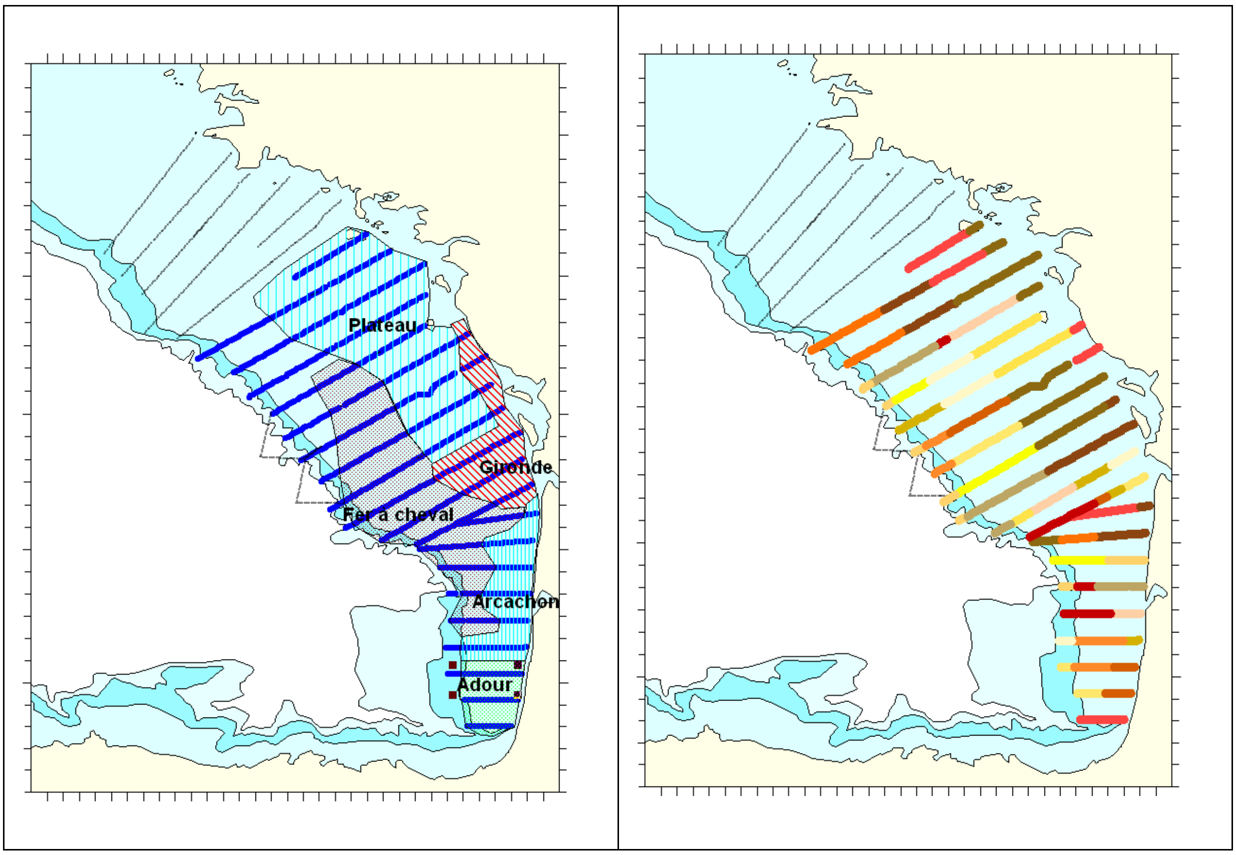


Figure 11.4.2.3: Areas taken into account for assessment of anchovy (left) and segments attributed to each haul according to similar echoes for identification and association to school types (right).

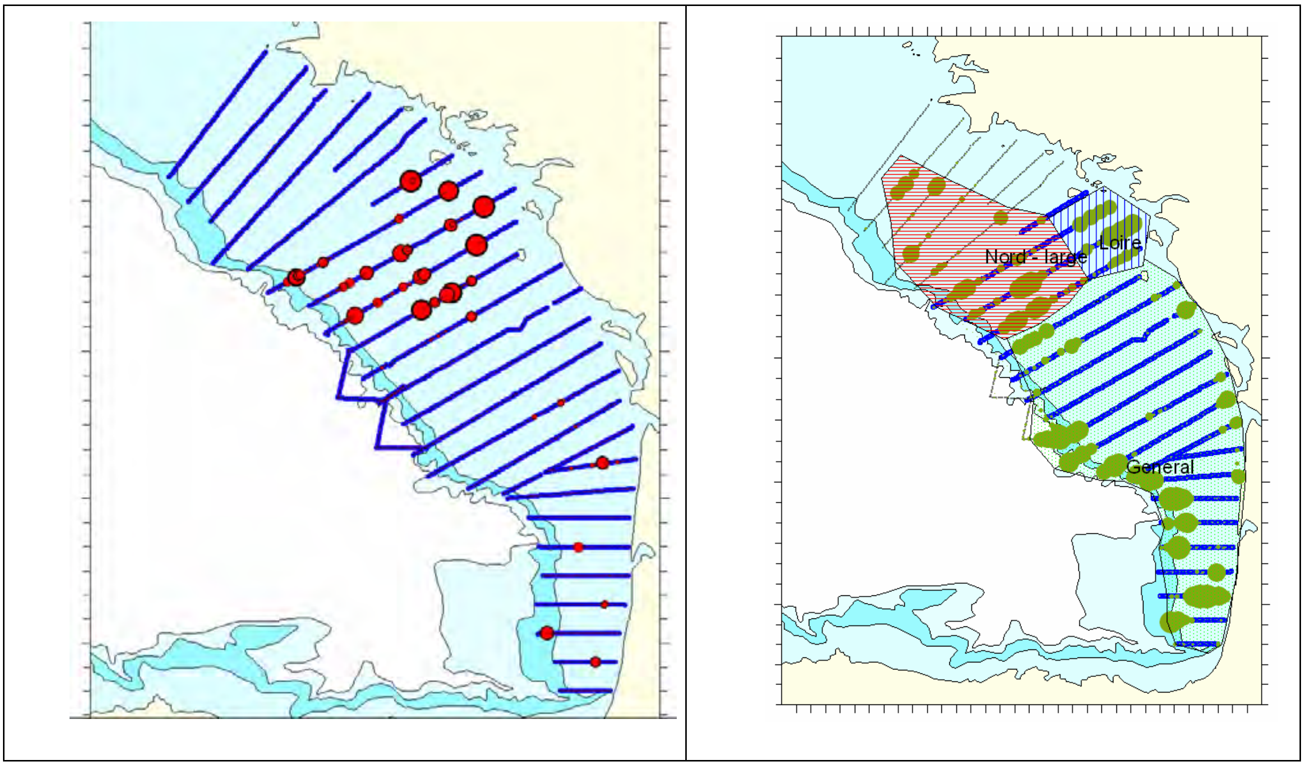


Figure 11.4.2.4: D4 energies (red dots) corresponding to surface schools observed in the northern area (left) and areas taken into consideration for attributing surface echoes to anchovy according to abundance of eggs (green dots) in corresponding areas (right).

Figure 11.6.1 Recent trajectories of Assessed Recruitment at age 0 and Borja's Upwelling index

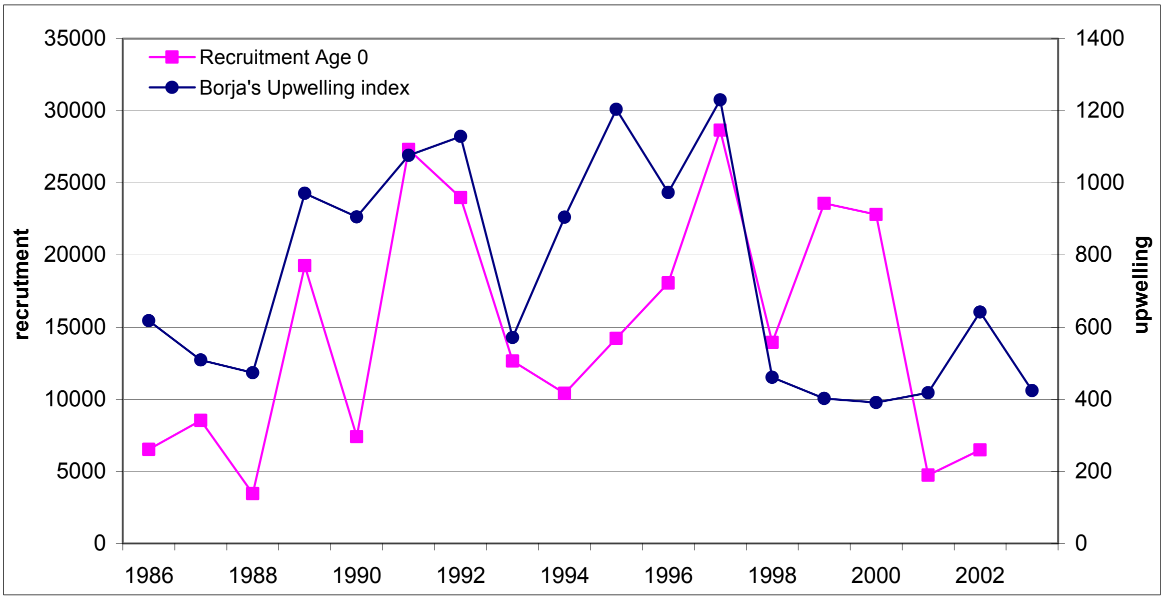
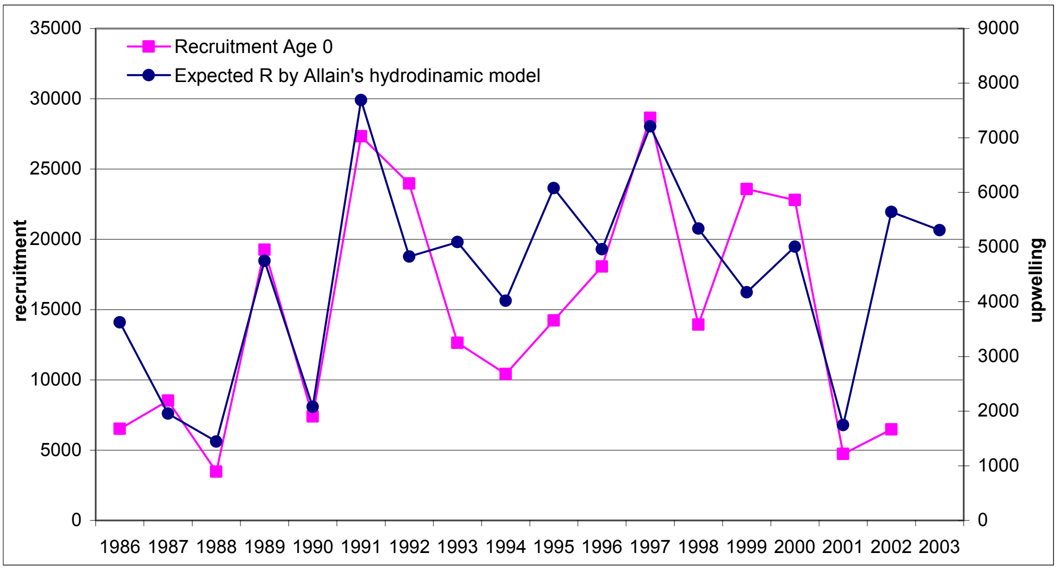


Figure 11.6.2 Recent trajectories of Assessed Recruitment at age 0 and modelled R from the 3d hydrodinamic Allain's index



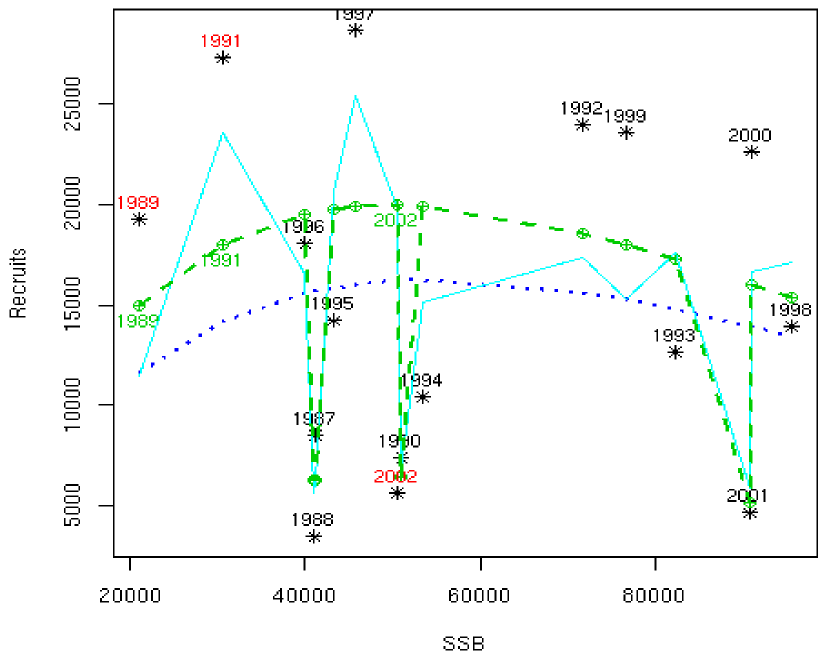
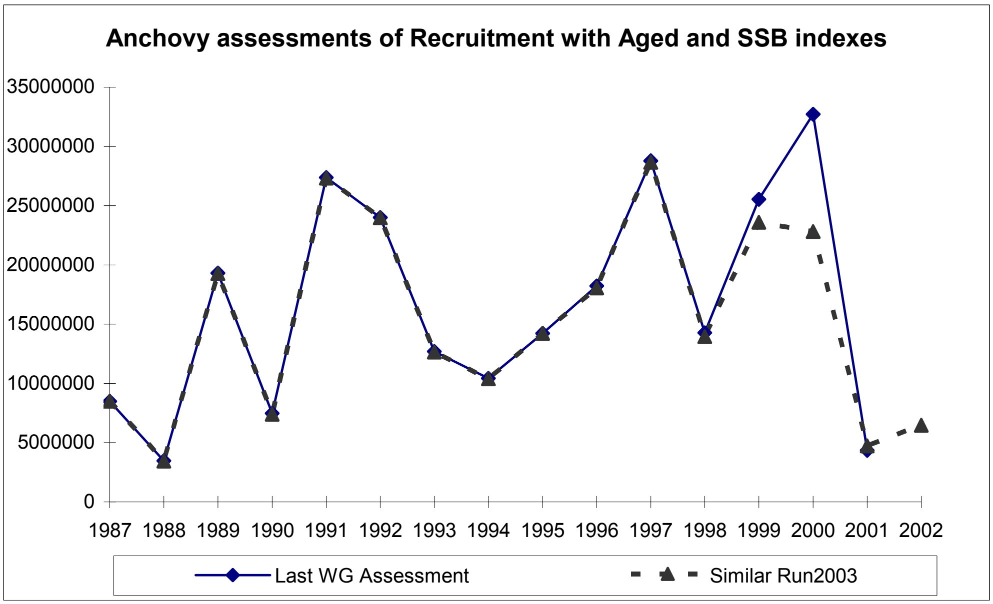
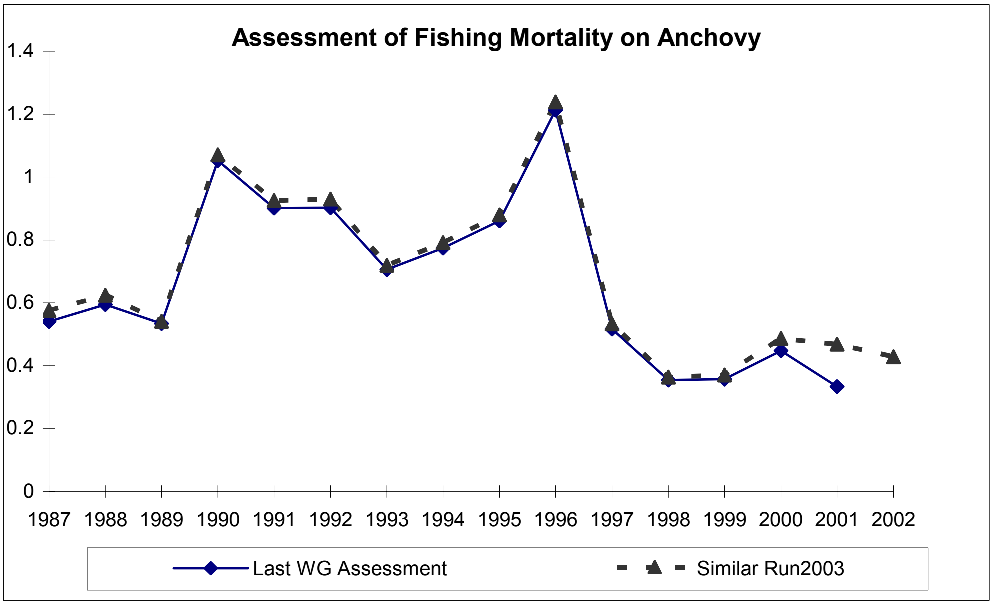


Figure 11.6.3 Updated environmental – stock - recruitment models as in Uriarte et al. 2002. Continuous line corresponds to the Ricker model including the two environmental covariates (upwelling and SBD indices). Discontinuous line corresponds to the Ricker model with SBD as additional covariate. Dotted line is the Ricker curve under average environmental conditions.





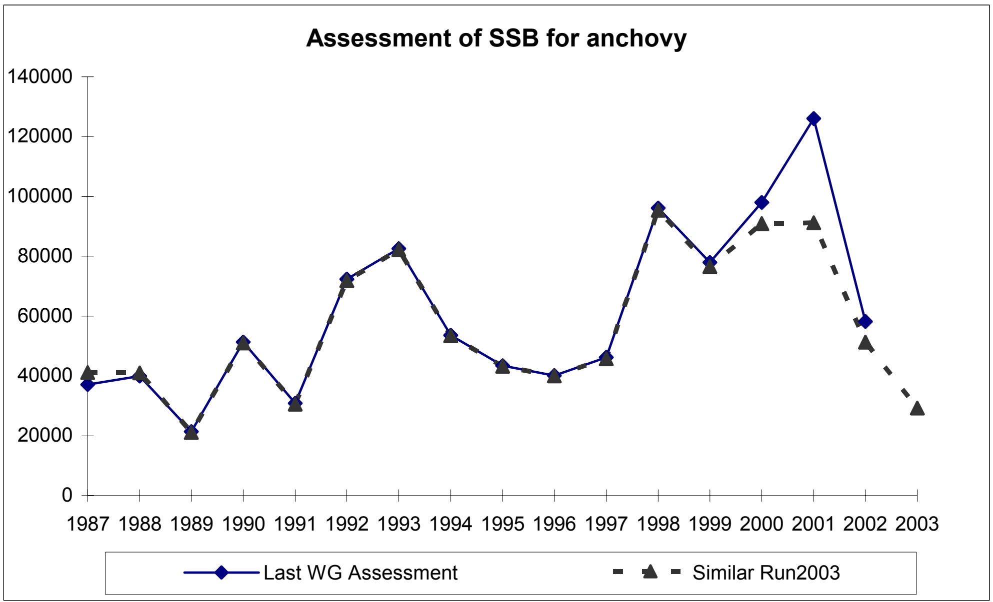


Figure 11.7.1.1: Current assessment(2003) and comparison with two alternative ones

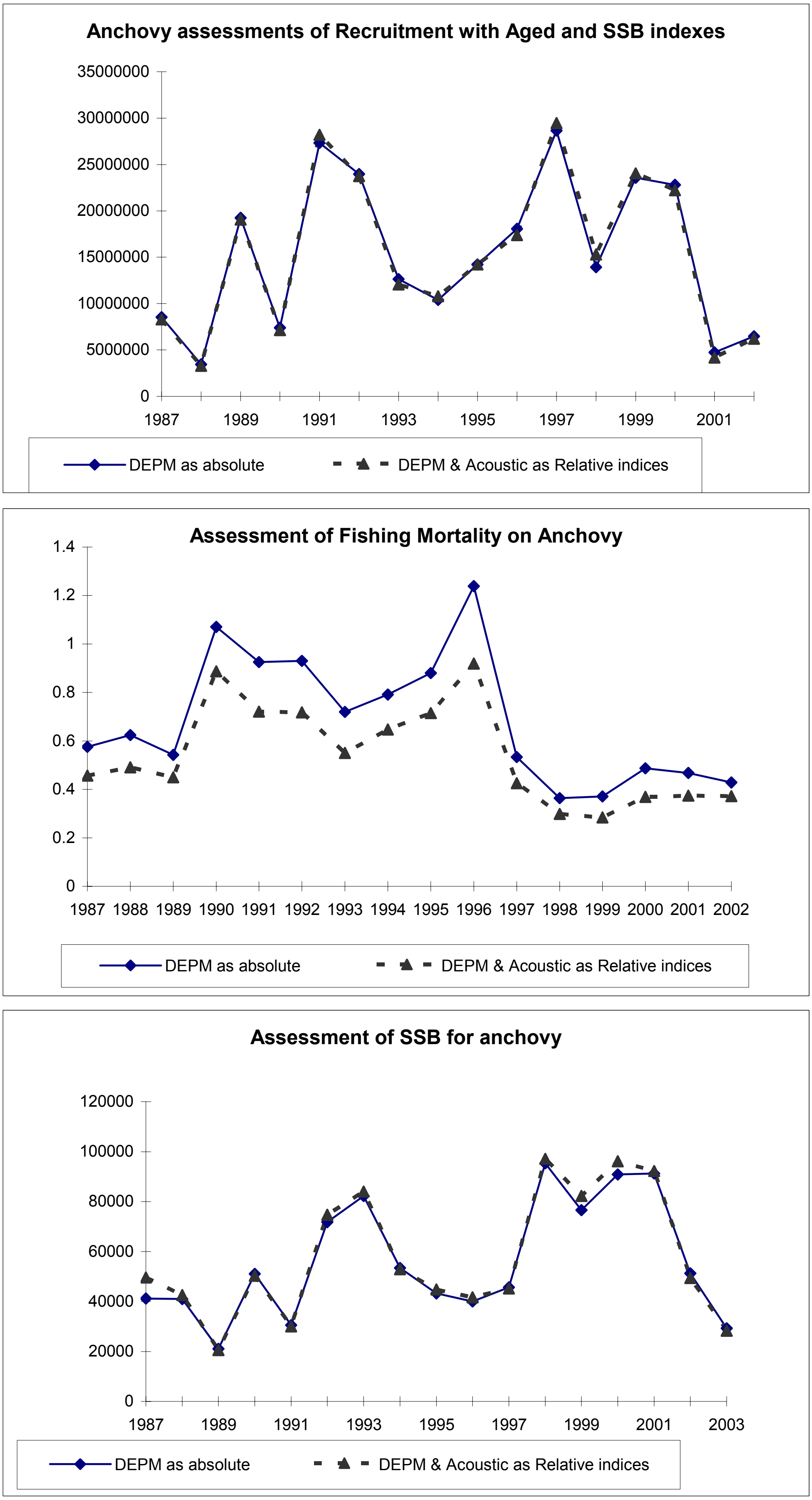


Figure 11.7.1.2: Current assessment (2003) and comparison with two alternative ones

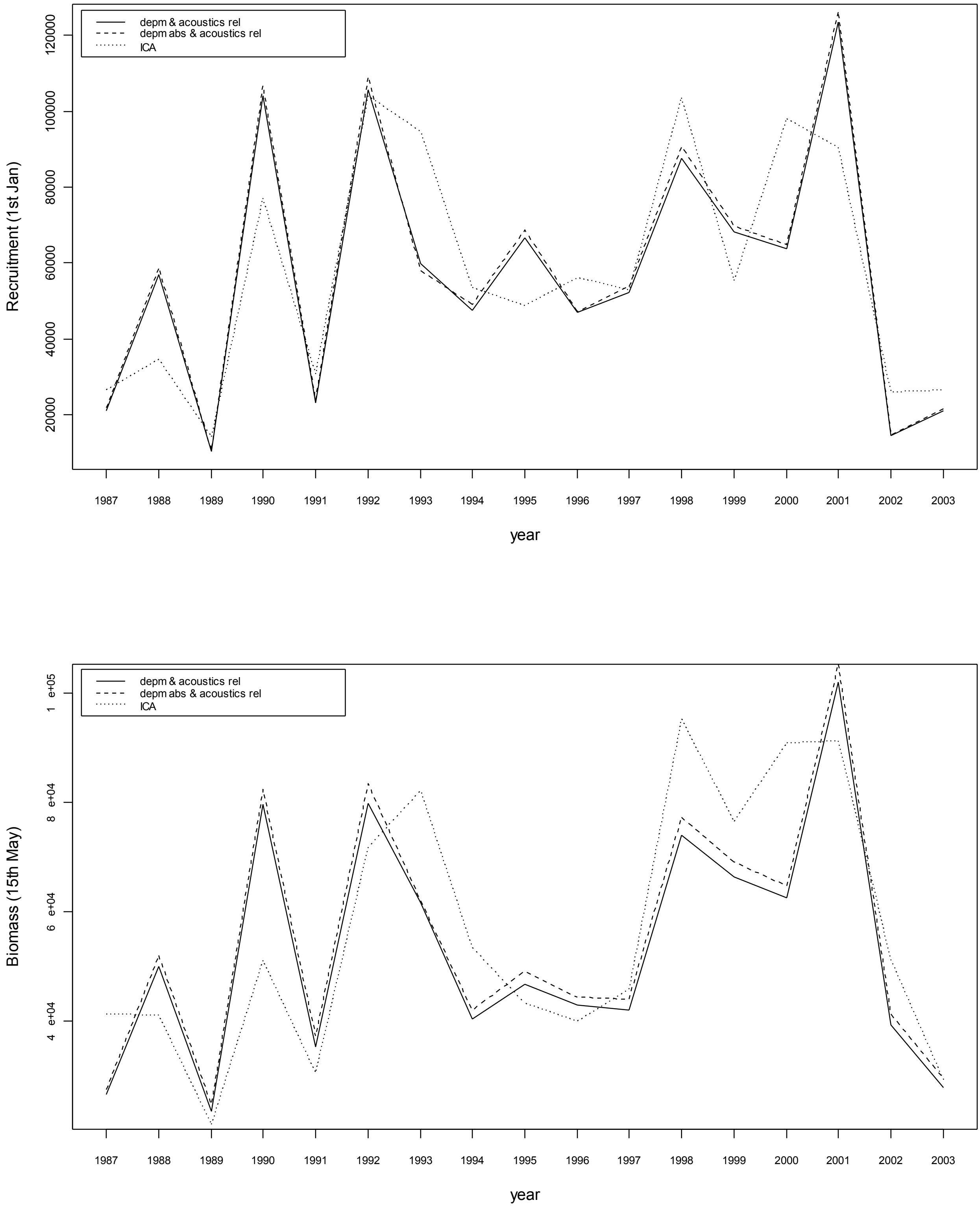
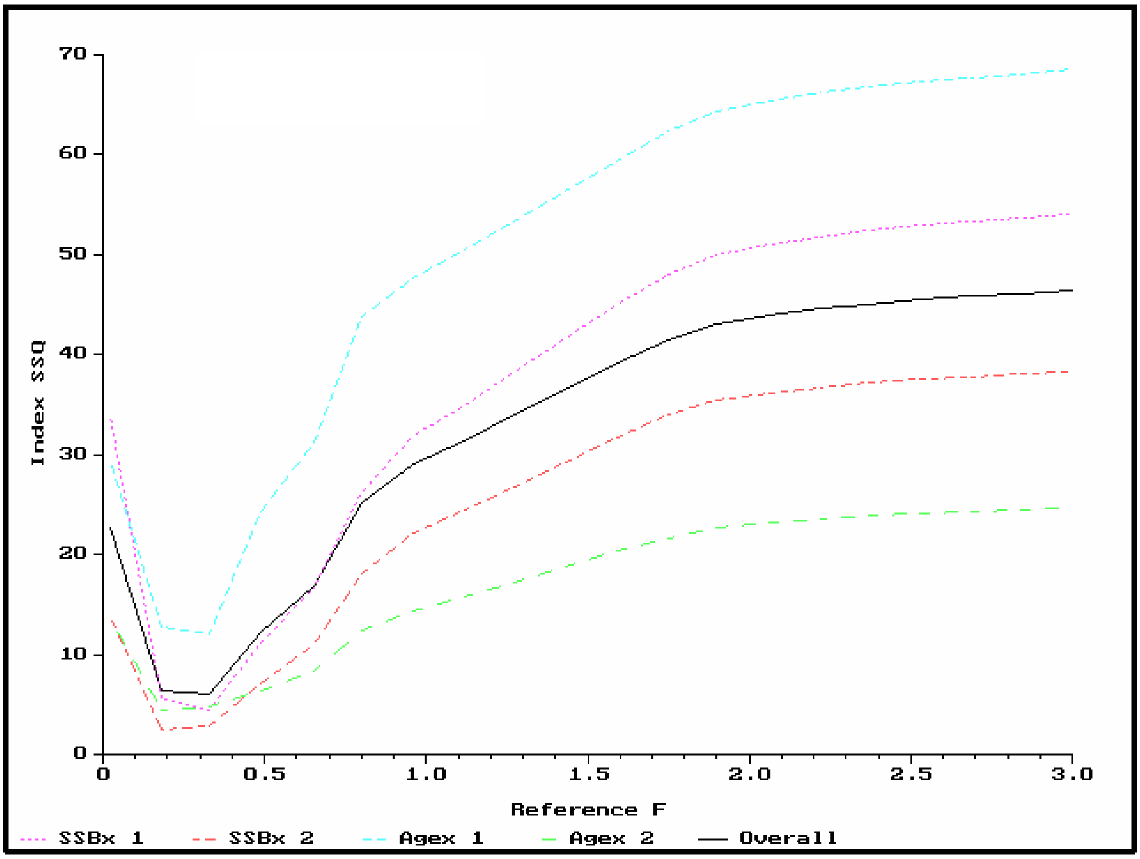


Figure 11.7.1.3 Comparison of the assessment of the Bay of Biscay anchovy recruitment and spawning biomass from ICA and from the biomass dynamic model taking DEPM and Acoustics indices as relative and taking DEPM as absolute and Acoustics as relative.



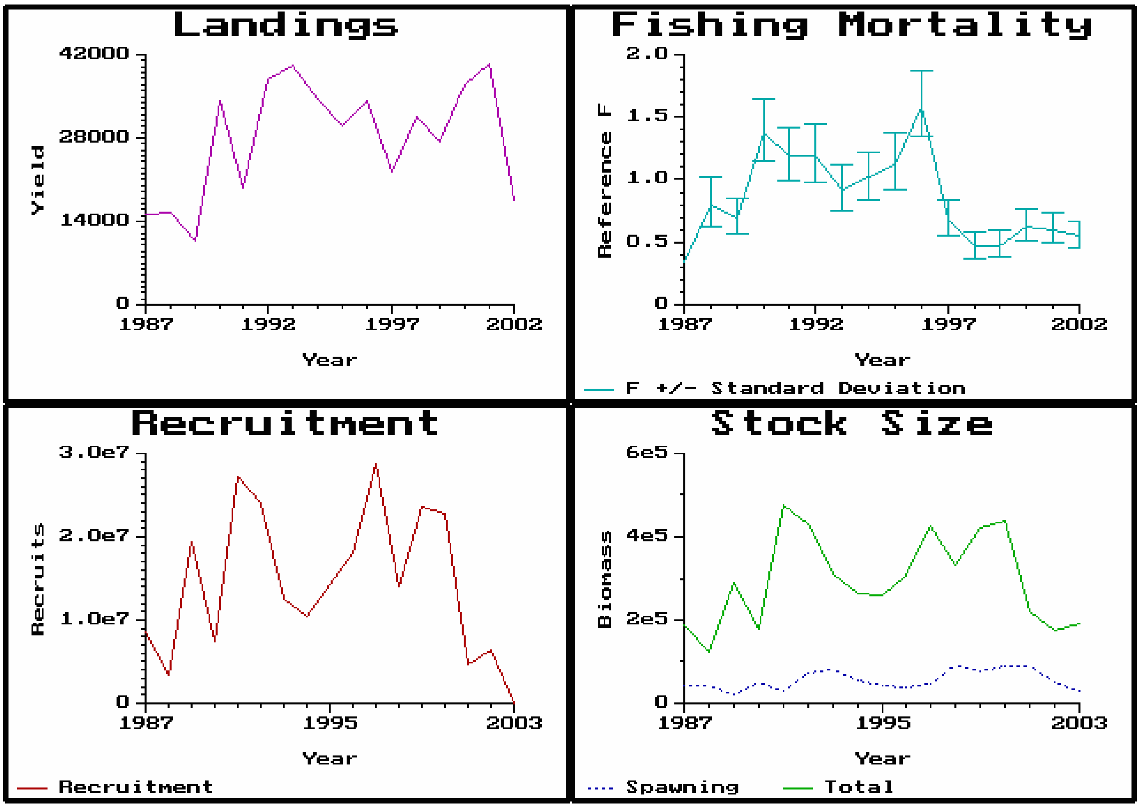


Figure 11.7.2.1: Fitting graphics of the assessment of the Bay of Biscay anchovy.

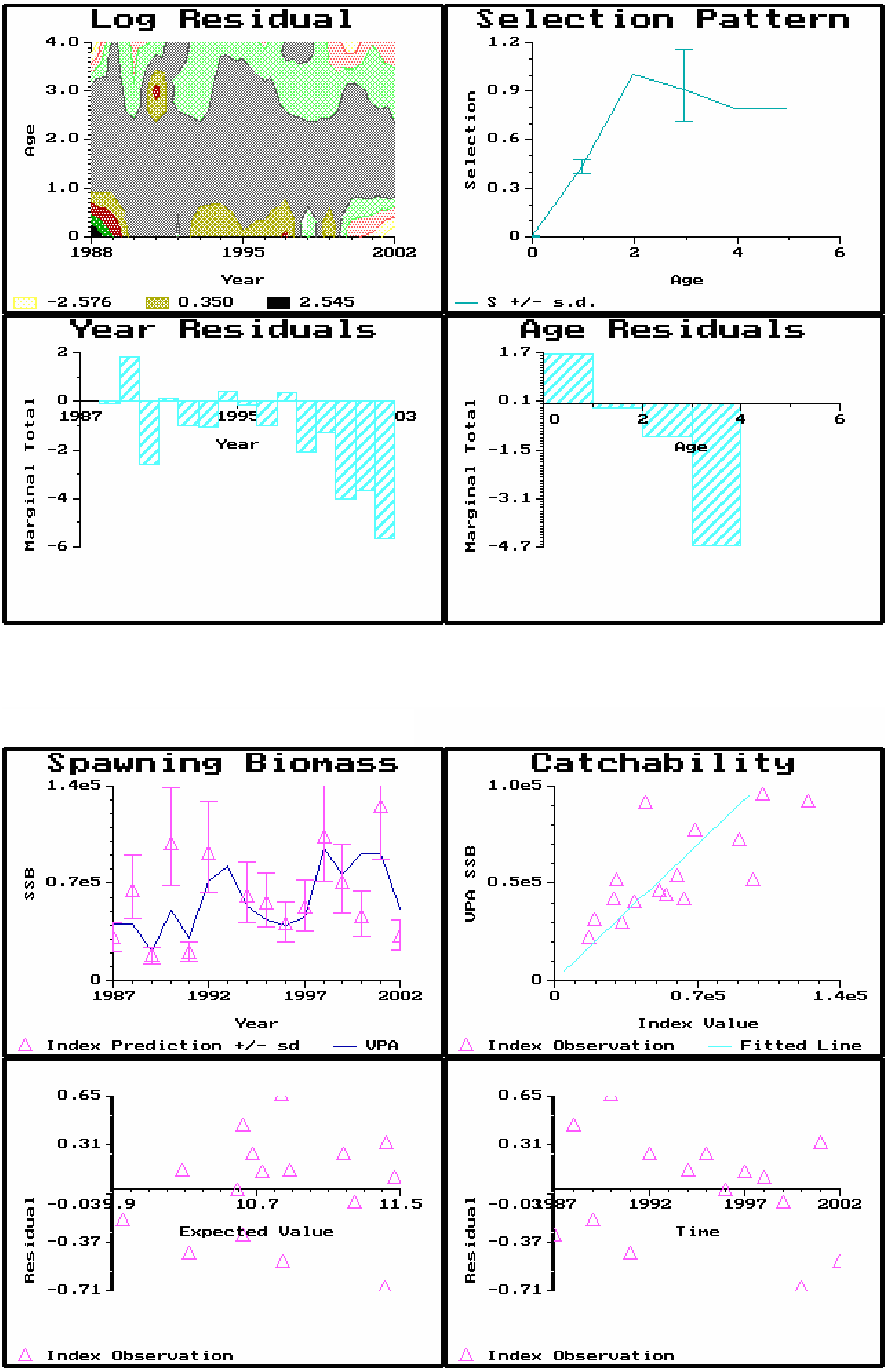


Figure 11.7.2.1 (Cont'd)

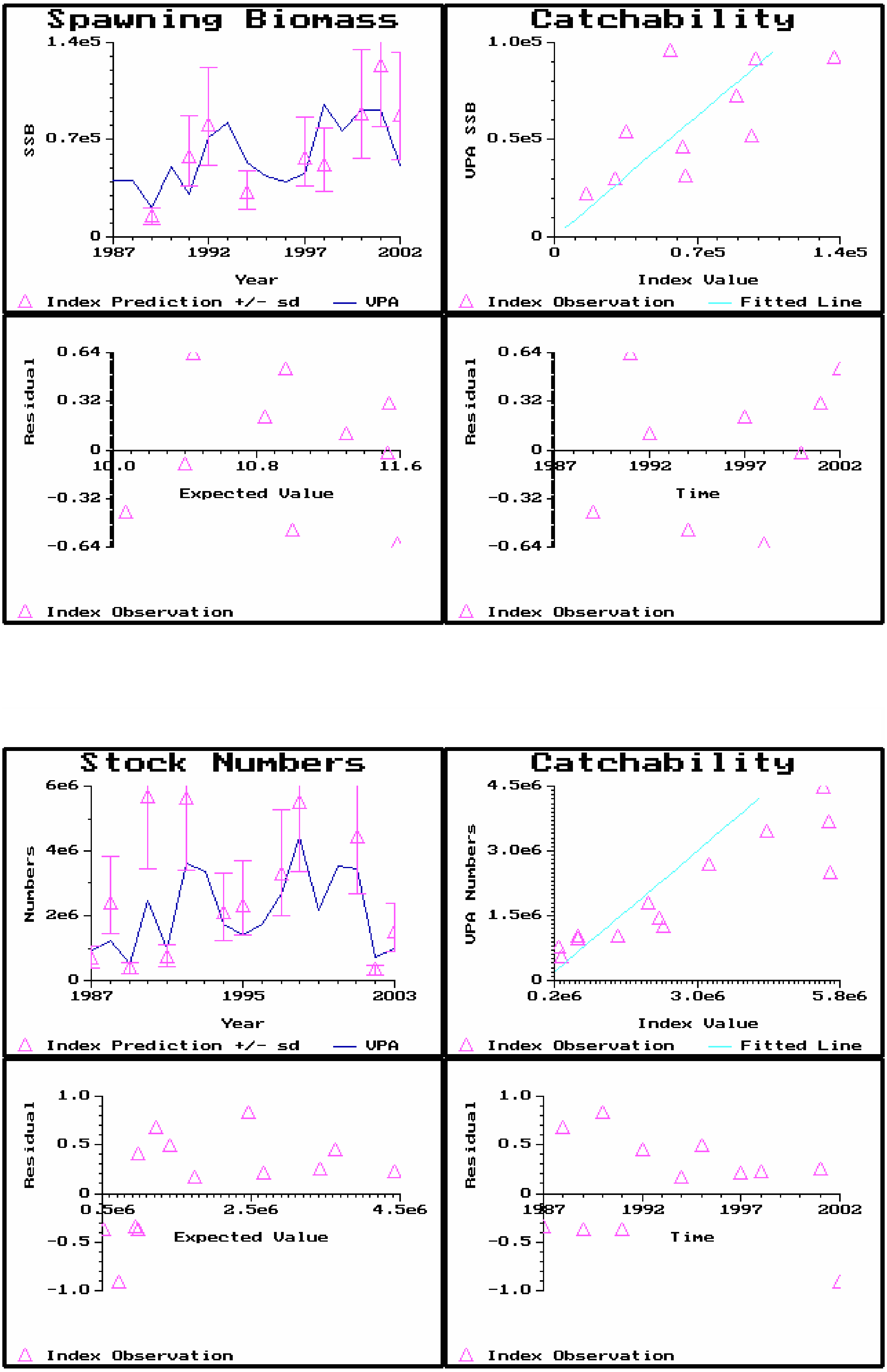


Figure 11.7.2.1 (Cont'd)

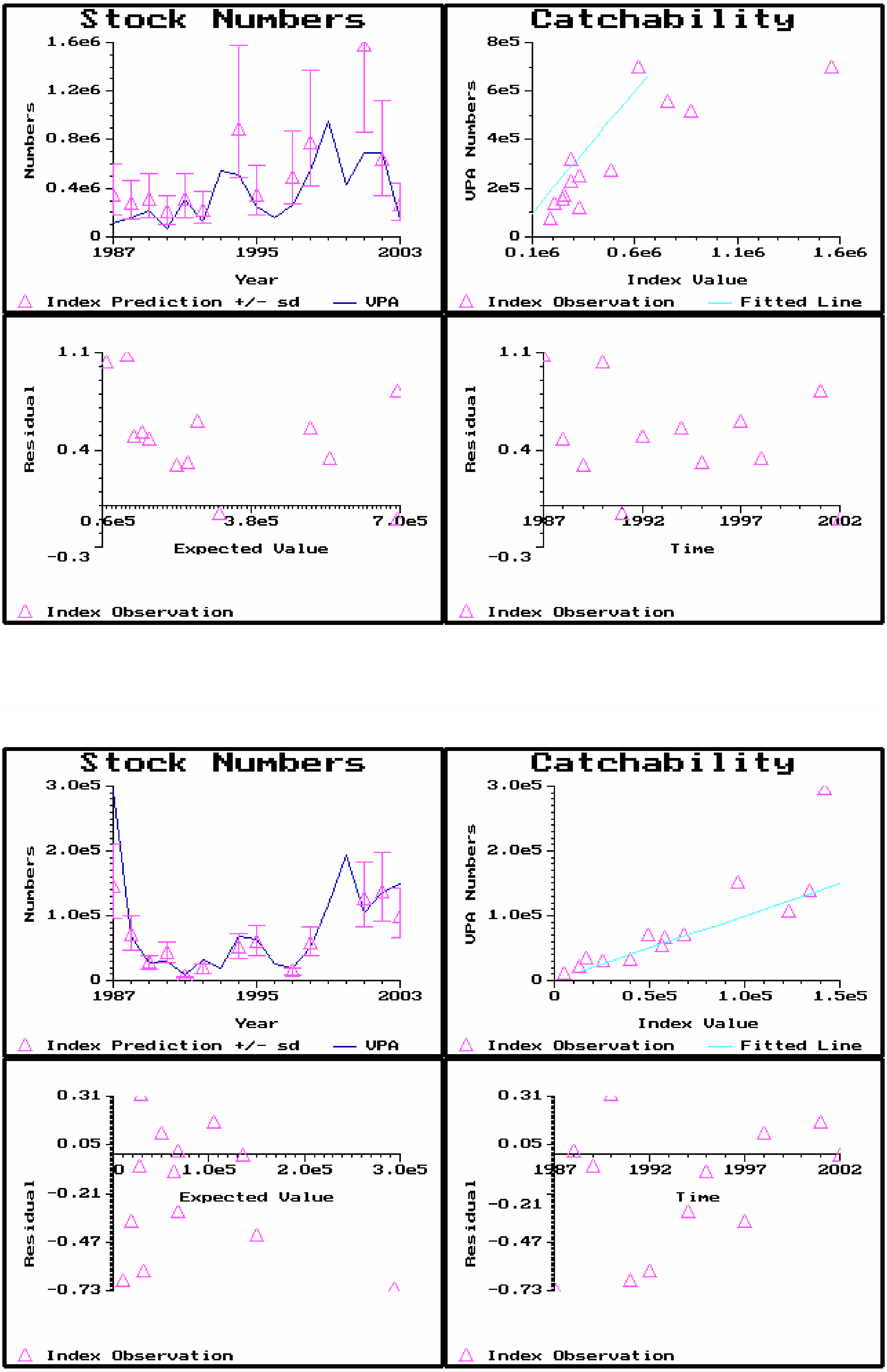
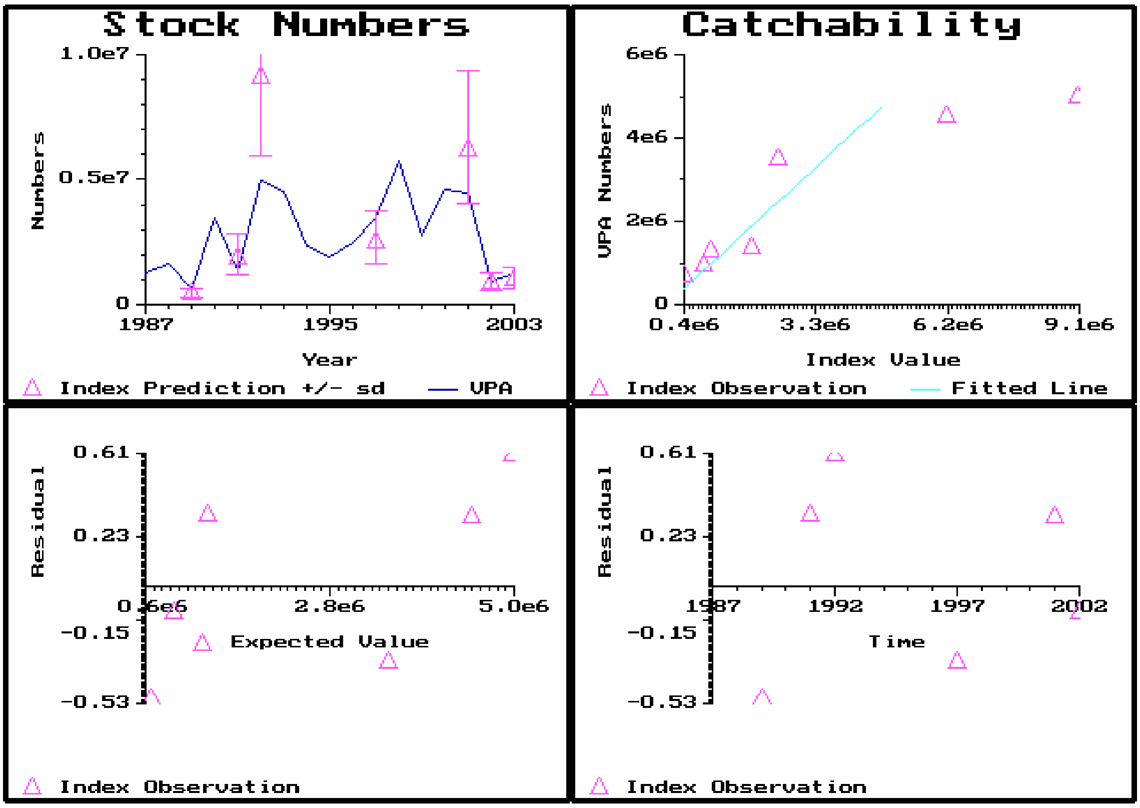


Figure 11.7.2.1 (Cont'd)



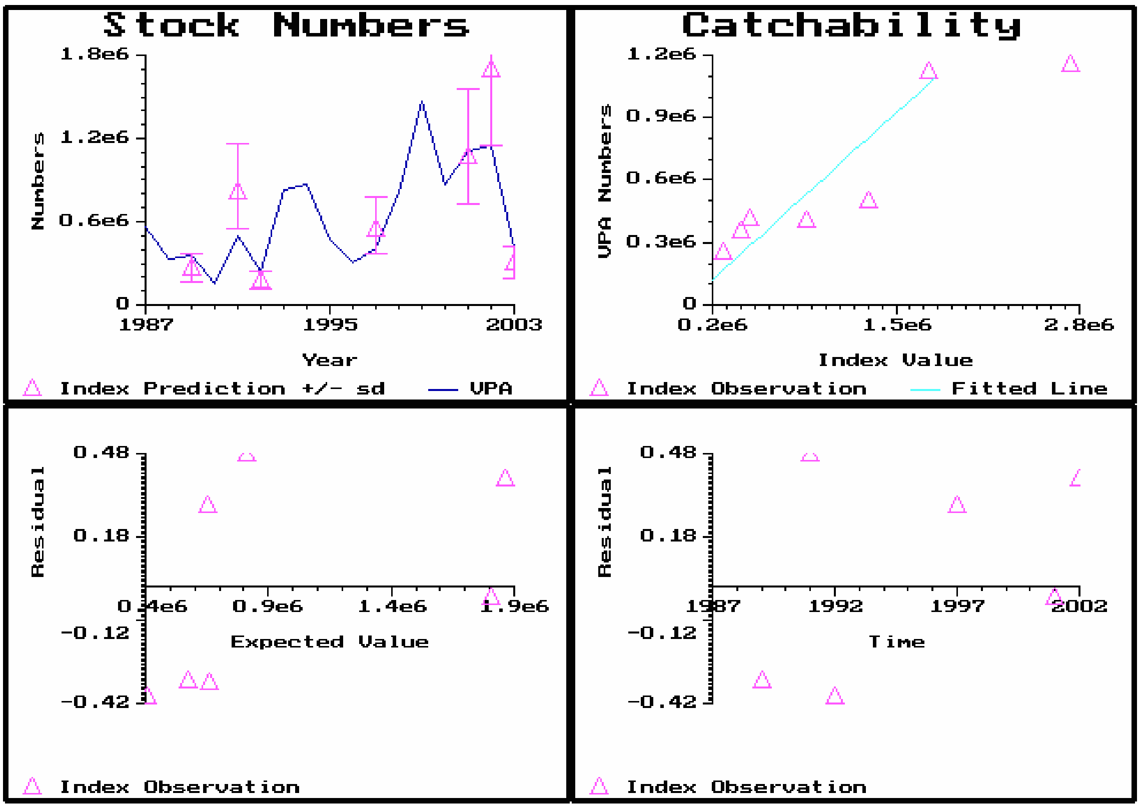


Figure 11.7.2.1 (Cont'd)

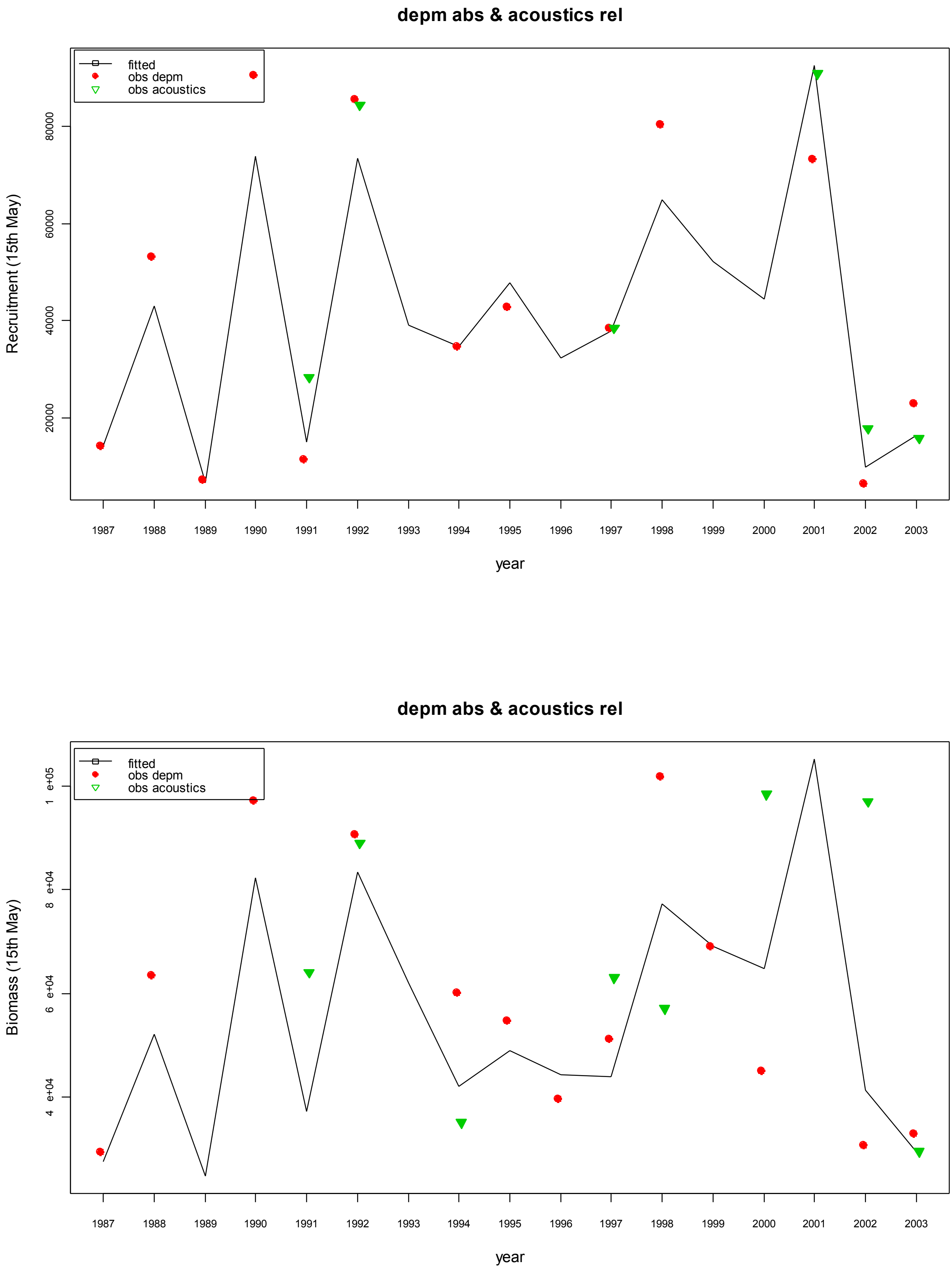


Figure 11.7.2.2 Assessment of the Bay of Biscay anchovy recruitment and spawning biomass from the biomass dynamic model with DEPM as absolute an Acoustics as relative indexes. Red circles and green triangles correspond to DEPM and Acoustics observations respectively.

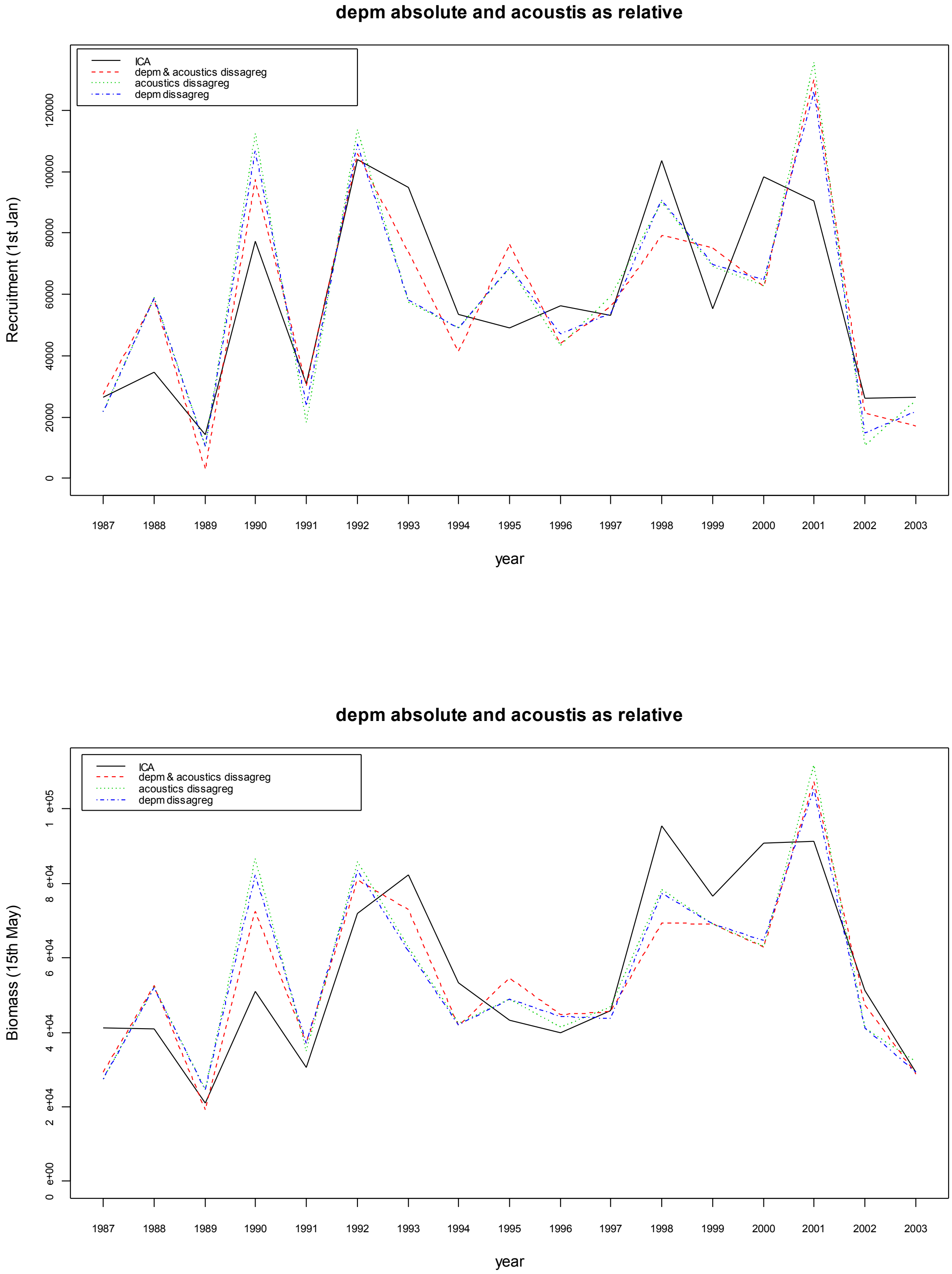


Figure 11.7.3.1: Comparison of different tuning indices for the biomass dynamic model

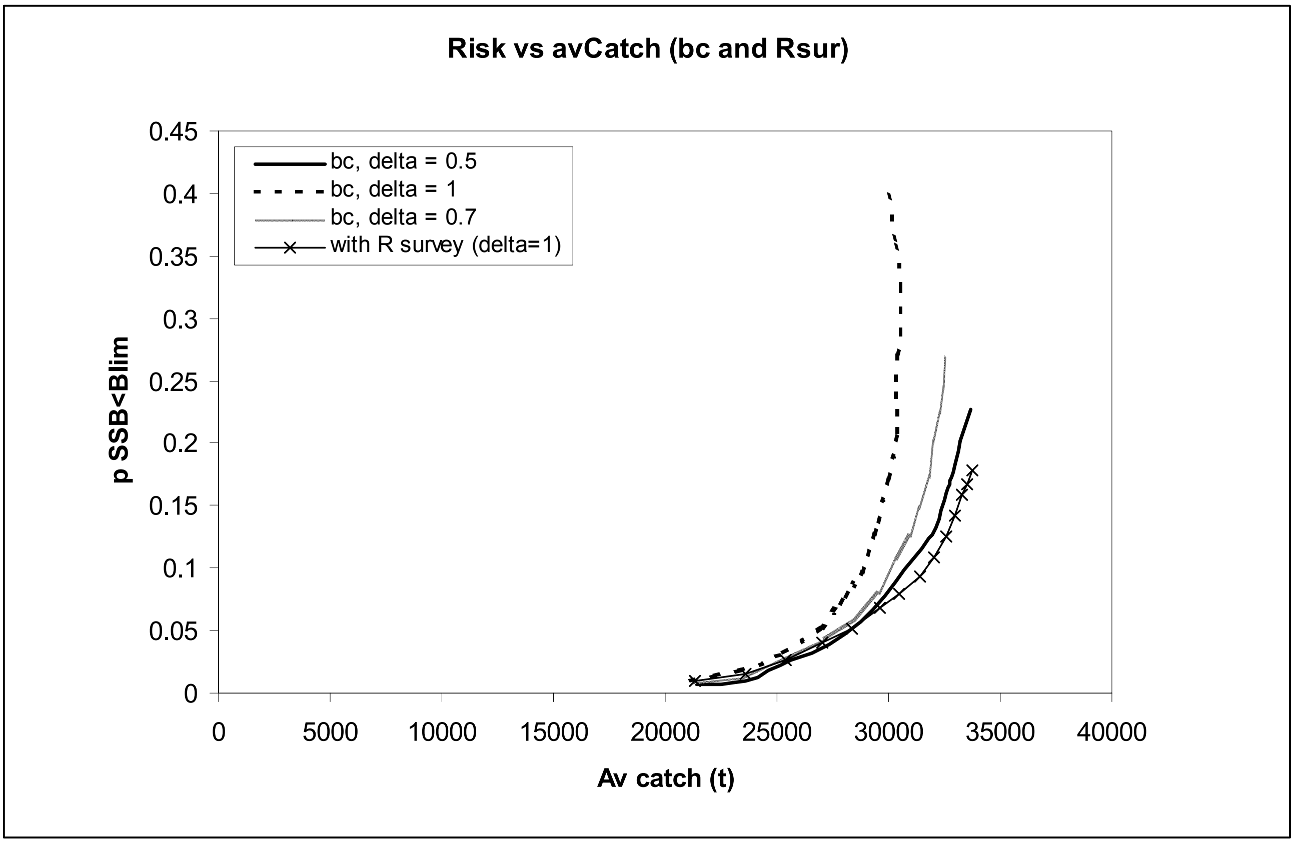


Figure 11.10.1 Average catch in 10-year projections vs risk of falling below Blim at increasing levels of exploitation (0.3 to 0.95). The curves correspond to a range of proportions of recruitment (δ) taken in the 1st period assuming at the start of the year that recruitment is average (base case) or that an estimate of recruitment becomes available before the TAC_{init} is set (equivalent to a recruitment survey in place).

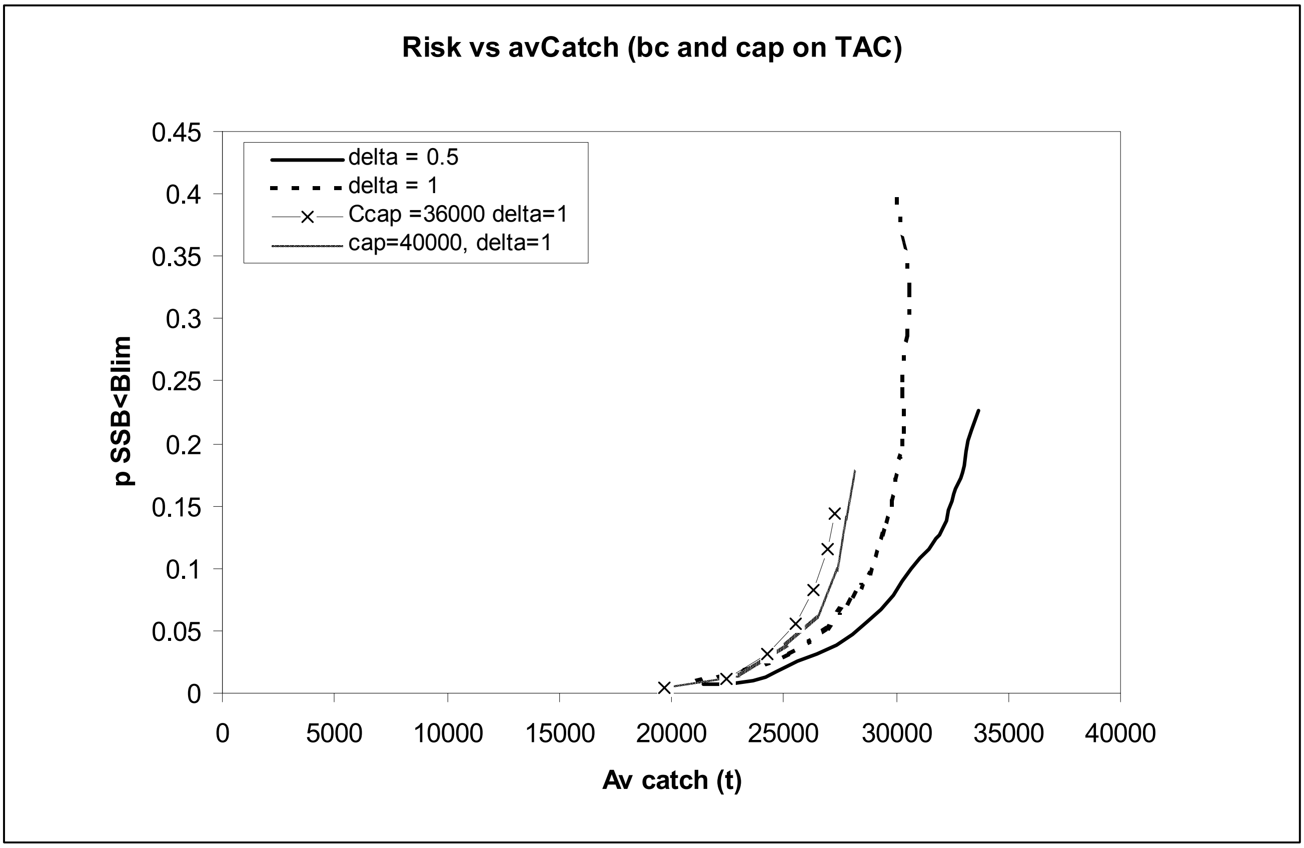


Figure 11.10.2 Average catch in 10-year projections vs risk of falling below Blim at increasing exploitation levels (from 0.3 to 0.95). The curves correspond to a range of proportions of recruitment (δ) taken in the 1st period and then two options are compared: a) the TAC can fluctuate freely (base case) and b) the TAC cannot exceed 36 or 40 thousand tons (TAC capped).

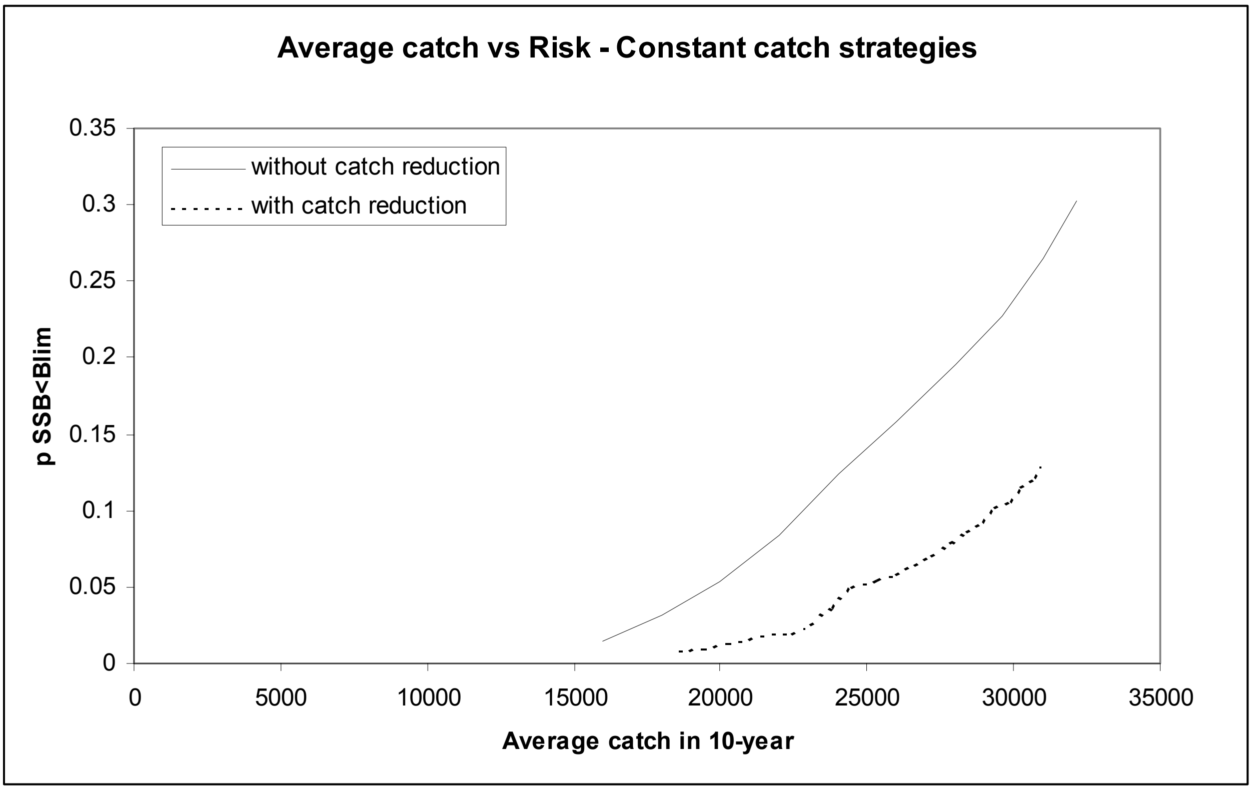


Figure 11.10.3 Average catch in 10-year projections vs risk of falling below Blim at increasing constant catch. The curves correspond to the cases where a) the TAC is applied is only reduced when the biomass cannot sustain it and b) when the TAC is reduced if SSB is below reference points.

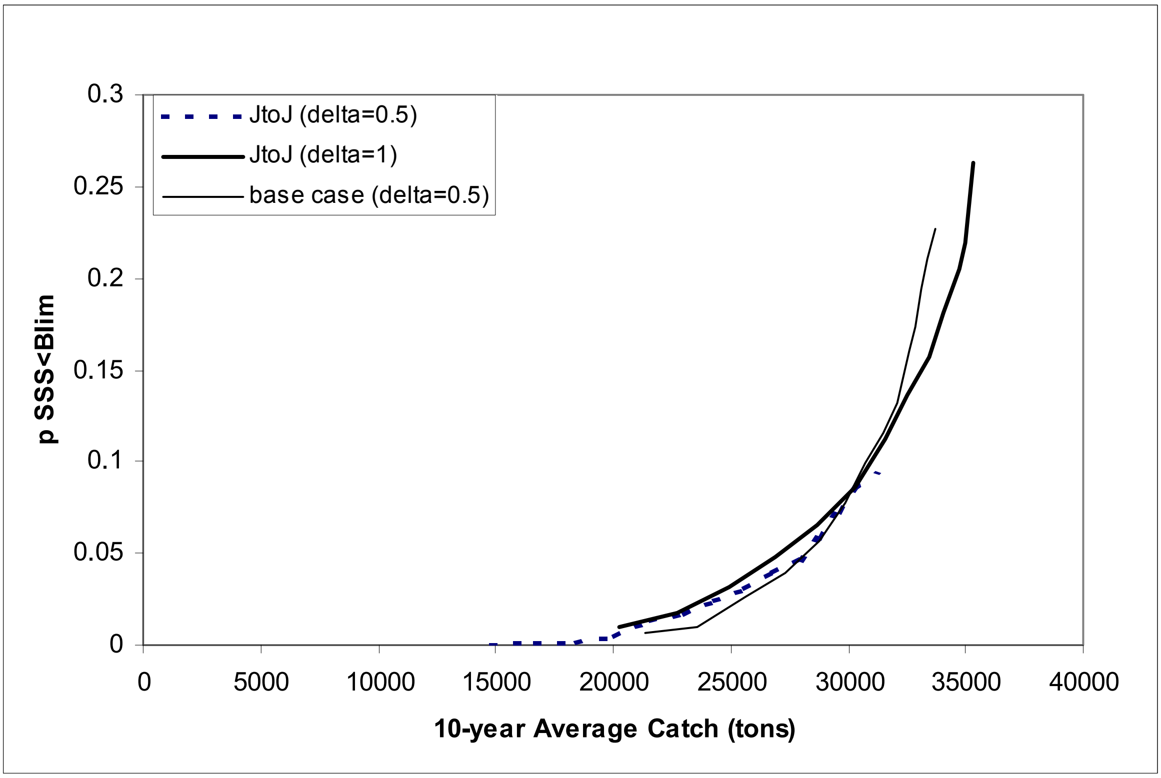


Figure 11.10.4 Average catch in 10-year projections vs. risk of falling below Blim at increasing constant catch. Comparison between the base case and the results from a TAC rule applied once a year in June (J to J) for two levels of protection of the recruits (delta = 0.5 and 1).

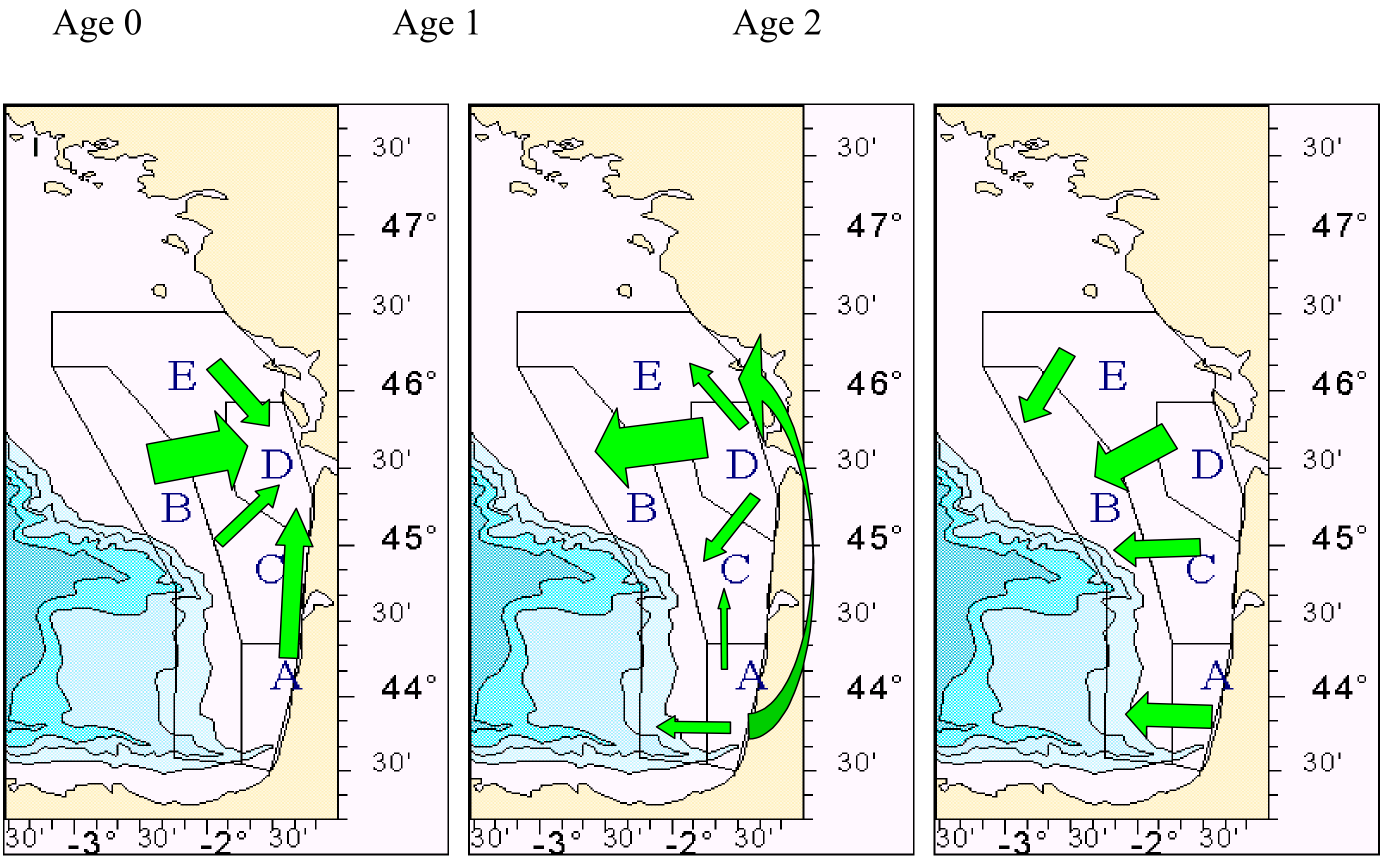


Figure 11.11.1 Apparent migration patterns and rates of the three first age class and between the five sub-populations (Vaz & Petitgas, 2002)

12 ANCHOVY IN DIVISION IXa

12.1 ACFM Advice Applicable to 2002 and 2003

The ACFM advice on management from ICES recommendations stated that catches in 2001 and 2002 were restricted to 4,900 t (ICES C.M. 2002a). This recommended catch level was decreased to 4,700 t for 2003, which corresponds to the level of mean catches from the period 1988-2001, excluding 1995, 1998, and 2001 (ICES C.M. 2003a). This last level should be kept until the response of the stock to the fishery is known. ACFM is aware that the state of this resource can change quickly, and therefore it considered appropriate the development and implementation of a management plan including an in-year monitoring of both the stock and the fishery with corresponding regulations.

The agreed TAC for anchovy in 2002 and 2003 (for Subareas IX and X and CECAF 34.1.1) is of 8,000 t. Anchovy catches in Division IXa in 2002 were 8,806 t.

12.2 The Fishery in 2002

12.2.1 Landings in Division IXa

Anchovy total catches in 2002 were 8,806 t, these catches being at about the same level observed in 2001 (9,098 t), (Table 12.2.1.1, Figure 12.2.1.1). This relatively stable trend was observed in all Subdivisions.

As usual, the anchovy fishery in 2002 was mainly harvested by purse seine fleets (99% of total catches). Portuguese and Spanish purse-seine landings accounted for 97% and 99% of their respective national total catches (Table 12.2.1.2). However, unlike the Spanish Gulf of Cadiz fleet, the remaining purse-seine fleets in the Division only target on anchovy when its abundance is high. Trawl (both Spanish and Portuguese) and Portuguese artisanal landings were small compared to the whole anchovy fishery in the Division.

12.2.2 Landings by Subdivision

The anchovy fishery was mainly located in 2002 in the Subdivision IXa South (8,262 t, *i.e.*, 94% of total catch in the whole Division, Table 12.2.2.1, Figure 12.2.1.1). As observed in recent years, the bulk of these catches was fished again in the Spanish Gulf of Cadiz (7,870 t against 393 t landed in the Algarve). Excepting catches from IXa Central-North (433 t, only 5% of total catch), the relative importance of the remaining Subdivisions was negligible.

The Spanish fishery in 2002 followed the same distribution pattern described for recent years, with almost the whole anchovy being fished in the Gulf of Cadiz waters (only 21 t in Subdivision IXa North, *i.e.*, southern Galician waters). This usual distribution pattern of the Spanish fishery only shifted in 1995, when favourable environmental conditions in the northwestern coastal waters of the Iberian Peninsula favoured an increased level of anchovy abundance in Subdivisions IXa North and Central-North.

The Portuguese anchovy fishery in 2002 also showed the same pattern that the one observed last year, with catches mainly distributed between Subdivisions IXa Central-North (433 t, 47% of total Portuguese catches) and IXa South (Algarve, 393 t, 43%), and scanty catches in IXa Central-South (90 t, 10%). Historically, each of these Subdivisions has shown alternate periods of relatively high and low landings, anchovy fishery being located either in the IXa South (before 1984) or in the IXa Central-North (after 1984) (see Table 12.2.1.1 and Pestana, 1996).

Seasonal distribution of catches by country and Subdivisions in 2002 is shown in Table 12.2.2.1. Although with a different intensity, anchovy catches were recorded throughout the year in all Subdivisions. In the northernmost Subdivisions catches occurred mainly in the second half in the year, those ones from Portuguese waters of the IXa Central-South in the first quarter, whereas anchovy fishery season in IXa South occurred throughout spring-summer months.

12.3 Fishery-Independent Information

12.3.1 Acoustic Surveys

Portuguese Surveys

Results on anchovy distribution and abundance from Portuguese acoustic surveys in November 2002 and February 2003 as well as a correction of the March 2002 estimates have been provided to this WG (Marques and Morais, WD 2003). The surveyed area in these surveys included the waters of the Portuguese continental shelf and those of Spanish Gulf of Cadiz (Subdivisions IXa Central-North, Central-South and South), between 20 and 200 m depth (Figure 12.3.1.1 and 12.3.1.2).

The correction of the March 2002 acoustic estimates was performed because the errors detected in the S_A values attributed to the Cadiz area. Since these errors were small (2 EDSU), all the estimates for the remaining areas in that survey were maintained. The new anchovy biomass estimate for the Cadiz area is 19,629 t (3,731 million fish) instead of the 22,183 t (4,261 million fish) previously estimated (Table 12.3.1.1).

The November 2002 survey was not completed due to very bad weather and only the Algarve zone was properly sampled. However, the low frequency of anchovy occurrence in trawls and the low acoustic energy recorded for the species in the area led to the decision of not to perform any abundance estimation.

In the February 2003 survey the anchovy biomass for the whole surveyed area was estimated at 24,677 t (2,328 million fish) (Table 12.3.1.1). This biomass estimate is at about the same level as those recorded in previous years although it was almost exclusively supported by the Gulf of Cadiz anchovy, which accounted for 99.5% of the estimated total biomass. In the remaining areas only small concentrations were detected in the southern part of the Subdivision IXa Central-South, the coast in front of Lisbon being devoid of anchovy in comparison to previous years (Figure 12.3.1.3).

The population size composition for each subarea is presented in Figures 12.3.1.4 and 12.3.1.5. Anchovy sizes in the OCS subarea (Subdivision IXa Central-South) ranged between 8 and 13 cm. Their size distribution was unimodal with fish measuring between 10.5 and 12 cm accounting for 86% of the estimated total number. Gulf of Cadiz anchovy showed a wider length range (5.5-16.5 cm) and a size composition characterised by two well-defined modal classes, the smaller one at 6 cm and the larger mode at 13 cm.

Spanish Surveys

Spanish acoustic surveys aimed at sardine have been conducted in Subdivision IXa North and Division VIIIc since 1983. Results from these surveys for the Subdivision IXa North have shown the scarce presence or even the absence of anchovy in this area (Carrera *et al*., 1999; Carrera, 1999, 2001).

The first time that Spain acoustically surveyed the Gulf of Cadiz anchovy (Subdivision IXa South) was in June 1993. The total biomass estimated at that time in this survey was 6,569 t (ICES C.M. 1995/Assess:02).

Another one (SIGNOISE) has been carried out in February 2002 in order to have an inter-calibration between the R/V 'Cornide de Saavedra' and the new built Spanish R/V 'Vizconde de Eza'. The objective was mainly to check the new vessel which was designed following the ICES recommendations on ship noise and therefore to test the effect of the vessel noise on the acoustic estimation (Carrera, WD 2003). This survey occurred in the Gulf of Cadiz because anchovy is generally present there in multispecies communities and it was appropriate to the objective of behaviour comparison between vessels.

The survey was carried out along an appropriate transects grid and fishing stations were randomly distributed either with bottom and pelagic trawls (Figure 12.3.1.6) allowing comparison between vessels and doing an assessment of pelagic species as well.

A preliminary analysis did not render significant between-vessels differences in both school meristics (number of schools seen, i.e. avoidance) and metrics (school morphology, i.e. escaping reaction) except that school numbers seemed always to be lower at a second pass whatever the second vessel is and that the 'Cornide' detected the schools deeper than the 'Vizconde' without any changes in the school morphology. This suggests a stronger vertical avoidance to the "noisy old vessel". It was unfortunately the only approach available as the acoustic equipment in the 'Vizconde' was not properly calibrated and energies comparisons were not possible

From the analysis of fishing stations data, the surveyed area was split into 3 regions:

- Southern region: few shoals of anchovy. Fish showing the highest mean length in the sampled area (14.8 cm).
- Central region: anchovy was almost the only species and occurred in a thick bottom layer. Mean length was estimated at 11.1 cm.
- Northern region: anchovy was still predominant and it was seen either in bottom layers in deeper water or thick schools near shore with other fish species. Anchovies in this region showed a mean length of 13.4 cm.

The total backscattering energy –S_A values (363108 m^2/nm^2)- was allocated into fish species, resulting 68% attributed to anchovy (Figure 12.3.1.7), 17% to sardine and 10% to chub mackerel (*Scomber japonicus*). Table 12.3.1.2 summarises the anchovy assessment. Giving the unexpected anchovy occurrence and the thickness of the bottom layer, with almost pure anchovy, the assessment gave for the whole area a total biomass of 212,935 t, corresponding to 18202 million fish. This estimate strongly contrast with the one provided by the Portuguese survey in the same area just one month after.

Length distributions by region and the total sampled area are illustrated in Figure 12.3.1.8. Size ranged from 7 and 17 cm, with a mean length of 12.6 cm.

The Working Group regards this survey as a positive development and encourages its continuation. Furthermore, given the contrasting results obtained from the Spanish and Portuguese surveys in the Subdivision IXa South, the WG recommends that results from the above Spanish inter-calibration experiment be provided if possible to the next WG meeting.

12.4 -Biological Data

12.4.1 Catch Numbers-at-age

Catch-at-age data from the whole Division IXa are only available from the Spanish Gulf of Cadiz fishery (Subdivision IXa South). Data from the Spanish fishery in Subdivision IXa North were not available since commercial landings were negligible.

The whole otolith collection from Gulf of Cadiz anchovy (since 1988) is being revised following the standards adopted in the Workshop on anchovy otoliths from Subarea VIII and Division IXa in 2002 (Uriarte *et al*., WD 2002; ICES 2003a). The new ALK's resulting from this revision are expected to be presented in the next year's WG. Therefore, results herein described will correspond to those obtained from the application of ALK's based on pre-workshop age reading criteria.

The age composition of the Gulf of Cadiz anchovy landings from 1988 to 2002 is presented in Table 12.4.1.1 and Figure 12.4.1.1. The catch-at-age series shows that 0, 1 and 2 age groups support the Gulf of Cadiz anchovy fishery and that the success of this fishery largely depends on the abundance of 1 year-old anchovies. The contribution of age-2 anchovies usually accounts for less than 1% of the total annual catch (excepting 1997, 1999, 2001, and 2002, with contributions oscillating between 2% and 7%). Likewise, age-3 anchovies only occurred in the first quarter in 1992 but their importance in the total annual catch that year was insignificant.

The relative importance of 0- and 1-age groups in the fishery has experienced some changes through the series. Thus, 1 year-old anchovies constituted almost the whole of anchovy landed in the period 1988-1994 (with percentages higher than 80%). Between 1995 and 1997 the contribution of this age group decreased down to between 25% (1996) and 50% (1995), whereas since 1998 onwards the relative importance of 1 year-old anchovies was increased again, although up to percentages between 60-89%. The contribution of the 0-age group was relatively low in the 1988-1994 catches, although its importance was considerably increased since 1995 onwards (mainly in the 1995-1997 period).

Total catch in the Gulf of Cadiz in 2002 was 800 million fish which represents an overall increase of 11% compared to the previous year (723 million). A relatively important increase was observed in the age group 1 (31% increase), whereas age groups 0 and 2 experienced notable decreases of 53% and 25% respectively.

Landings of the 0 age-group anchovies are restricted to the second half of the year, whereas 1 and 2 year-old catches are present throughout the year (Table 12.4.1.1).

12.4.2 Mean Length- and Mean Weight-at-age

Length Distributions by Fleet

Spain provides annual length compositions of anchovy landings in Division IXa from 1988 to 2002 for Subdivision IXa South and from 1995 to 1999 for Subdivision IXa North. Portugal has not provided length distributions of landings in Division IXa.

Quarterly Gulf of Cadiz anchovy length distributions in 2002 are shown in Table 12.4.2.1 and Figure 12.4.2.1. Table 12.4.2.2 shows annual length distributions since 1988. Figure 12.4.2.2 compares length distributions in Subdivisions IXa South and IXa North since 1995. Note that, with the exception of 1998, the fish caught in the North are larger than 12.5 cm.

Smaller mean sizes and weights in the Gulf of Cadiz anchovy fishery are usually recorded in the first and fourth quarters as a consequence of the large number of juveniles captured. However, this was not the situation observed in 2002 from the highest mean values recorded for these variables in the third and fourth quarters (11.8-12.1 cm and 12.3-12.4 g, Table 12.4.2.1). The high mean values reached in the fourth quarter evidences a scarce occurrence of small anchovies in the catches in relation to previous years (Figure 12.4.2.1).

Mean length and weight in the annual catch (11.1 cm and 9.7 g) were at the same level that those estimated in 2001 and both annual estimates are the highest ones in the whole series (Table 12.4.2.2, Figures 12.4.2.1 and 12.4.2.2).

Mean Length- and Mean Weight-at-age in Landings

Mean length- and mean weight-at-age data are only available for Gulf of Cadiz anchovy catches (Tables 12.4.2.3 and 12.4.2.4). The analysis of small samples of otoliths from Subdivision IXa North in 1998 and 1999 rendered estimates of mean sizes at ages 1, 2 and 3 of 15.5 cm, 17.6 cm and 17.9 cm respectively (ICES 2000a and ICES 2001). A sample of 78 otoliths from the same area was recently collected during the PELACUS 0402 acoustic survey. Mean lengths-at-age 1 and 2+ were 13.7 cm and 17.0 cm (Begoña Villamor, pers. comm.). Comparisons of these estimates with the ones from the Gulf of Cadiz anchovy indicate that southern anchovies attain smaller sizes at age.

Seasonally, 0 age-group anchovies off the Gulf of Cadiz are larger and heavier in the fourth quarter. The 1 and 2 year-old anchovies exhibit a clear and persistent pattern through the years, showing the larger mean length and heavier mean weight in the second half in the year.

12.4.3 Maturity-at-age

Previous biological studies based on commercial samples of Gulf of Cadiz anchovy (Millán, 1999) indicate that its spawning season extends from late winter to early autumn with a peak spawning time for the whole population occurring from June to August. Length at maturity was estimated at 11.09 cm in males and 11.20 cm in females. However, it was evidenced that size at maturity may vary between years, suggesting a high plasticity in the reproductive process in response to environmental changes.

Annual maturity ogives for Gulf of Cadiz anchovy are shown in Table 12.4.3. They represent the estimated proportion of mature fish at age in the total catch during the spawning period (second and third quarters) after raising the ratio of mature-at-age by size class in monthly samples to the monthly catch numbers-at-age by size class.

12.4.4 Natural Mortality

Natural mortality is unknown for this stock. By analogy with anchovy in Subarea VIII, natural mortality is probably high (M=1.2 is used for the data exploration, see Section 12.6).

12.5 Exploring data for the assessment

Effort and Catch per Unit Effort

Data on nominal fishing effort (number of fishing trips) and CPUE indices of anchovy in Division IXa only correspond to the Spanish purse-seine fleets both in the Gulf of Cadiz (since 1988) and in Subdivision IXa North (since 1995), (Tables 12.5.1 and 12.5.2; Figures 12.5.1 and 12.5.2). However, no CPUE data for Spanish fleets in IXa North are available in last years (including 2002) because of the low catches.

The description of the recent dynamics of Spanish fleets in the Gulf of Cadiz was summarised in the last year's WG report. Fleets' behaviour in 2000 and 2001 was mainly driven by the drastic reduction of the fishing effort exerted by the Barbate single-purpose purse-seine fleet in those years. Most of vessels of this fleet (the main responsible for anchovy exploitation in both the Moroccan and Gulf of Cadiz fishing grounds in previous years) accepted a tie-up scheme in those years because the EU-Morocco Fishery Agreement was not renewed. However, in 2002 these vessels were fishing again in the Gulf of Cadiz entailing a remarkable increase in the overall nominal fishing effort.

Standardisation of the Barbate's single-purpose fleet CPUE

The Barbate's single-purpose fleet CPUE has been used in the two last years as a tuning biomass index both in the analytical and biomass dynamics models used for data exploration. This fleet has been traditionally characterised by 'high' tonnage vessels (49 GRT on average) as compared to the remaining fleets operating in the Gulf. However, since the end of the 90's, the fleet size has been increased by the incorporation of medium-light tonnage vessels, either by new launching or by shift of fishing modality (from multi-purpose to single-purpose). CPUE series fitted to both models did not take into account the different relative fishing power of vessels composing this fleet during the last years and hence CPUE standardisation was needed.

Standardised half-year CPUE series of this fleet (***CPUE1*** and ***CPUE2***) has been provided to this group WG (Ramos *et al.*,WD 2003). CPUE standardisation was based on the fitting of quarterly log-transformed CPUE's from fleet types composing the Barbate's single-purpose fleet (high tonnage fleet: 1988-2002; medium-light tonnage fleet: 1997-2002) to a GLM (without interaction) with the form (Robson, 1966; Gavaris, 1980):

$$LnCPUE_{(ft_i,\,quarter_i)} = \mathrm{int}\,ercept + quarter + fleettype$$

Reference fleet and period used in the standardisation were the high tonnage fleet and the first quarter in 1988 respectively. Half-year standardised CPUEs for the whole fleet were computed from the quotient between the sum of raw quarterly catches and that of standardised quarterly efforts within the respective half-year period. The resulting standardised CPUE series is shown in Table 12.5.3.

12.6 Fishery-based recruitment indices

Last year's trials with the biomass based (delay-difference) model (Schnute, 1987; Roel and Butterworth, 2000; ICES 2003a) used the aggregated and not-standardised CPUE of the Sanlúcar fleet for the period including the fourth quarter in the year and the first quarter in the next year as a fishery-based recruitment index. However, this last series was not fitted to the model because it showed conflicting trends with the other tuning biomass indices (aggregated half-year CPUE series) and the model did not converge if this series was included. Problems were also found when fitting input data to the model suggesting the need of additional information on recruitment (ICES 2003a).

In this context, new standardised catch rates time-series have been provided to this WG this year as alternative fishery-based recruitment indices (Ramos *et al.*, WD 2003). Standardisation procedures were the same as those described in the above section. The resulting indices (catch rates) contain age-structured information on the anchovy recruitment to the Gulf of Cadiz fishery and they were estimated taking into account those fleets (Sanlucar and Barbate ones) and fishing grounds that better reflected this process. Two 'overall' indices (***INDEX1*** and ***INDEX2***) were estimated by jointly considering the recruits in a given year (age-0 fish) and their strength (as age-1 fish) in the first quarter in the next one. These indices differed in the extent of the recruitment period in the year (either in the fourth quarter only, ***INDEX1***, or through the second half of the year, ***INDEX2***), (Table 12.5.4, Figure 12.5.3). Additionally, different age-structured catch rates were also estimated for further testing of their suitability as recruitment indices.

Annual trends of the above indices were compared with those ones from both the Portuguese acoustic estimates of biomass (aggregated and age-structured) in the Subdivision IXa South (Figure 12.5.4), and an anchovy pre-recruitment index (***Pre-rec***) that summarises the incorporation of pre-recruits into the Guadalquivir river estuary, one of the main anchovy nursery areas in the region (Figure 12.5.5).

Time-series of pre-recruitment and age-0 fishery-based indices showed a highly positive correlation. This high correspondence between the above time-series coincides with the expected pattern describing the pre-recruitment-recruitment process in the Gulf. However, the ***Pre-rec***. index showed a strong negative correlation with the age-0 fish biomass estimated in November acoustic surveys. An inspection of data showed that the more conflicting data point in the November acoustic surveys series is that from 1998 (Figure 12.5.5). ***Pre-rec*** index (direct estimate) and fishery-based recruitment indices (both 'overall' and Age0 ones) all show the same signal in that year either predicting or indicating a good recruitment. Conversely, the age 0 fish biomass estimated from the November 1998 acoustic survey was the lowest of its time-series. Recent aggregated acoustic estimates have been revised and corrected by using MOVIES+ software due to the problems posed by the interpretation of acoustic data in the Algarve-Gulf of Cadiz area (ICES 2003a and this WG), but the application of this procedure only dates back to 2001.

At present, this validation of fishery-based recruitment indices is still difficult because the shortness of time-series of population direct estimates. Moreover, 'overall' indices might be needed of some refinement because the possible mixing of true recruits with older fish in their estimation. The Working Group also remarked the need to be cautious when interpreting the trends showed by all these catch rates since they may be more indicative of the fleet dynamics (including the effects of management measures) than that exhibited by the population. Notwithstanding, the Working Group appreciates these new efforts in providing this kind of information about anchovy from an area currently featured by limited direct estimates. In this last context, the pre-recruitment index (***Pre-rec***) shows as a good alternative to the fishery-based ones, and it was considered by the WG as a positive development and encourages the continuation of their provision to this WG in next years.

The performance of all these indices only can be assessed by the realisation of new exploratory runs with the biomass based model. Unfortunately, it was not possible to complete this task in time for the current Working Group meeting, therefore, this WG encourages that new trials be conducted and presented to the next meeting with these new data once the shortcomings in the estimation procedures be solved.

12.7 Data Exploration

Data availability and some fishery (recent catch trajectories) and biological evidences have justified in previous years a separate data exploration of anchovy in Subdivision IXa South (Algarve and Gulf of Cadiz) (Ramos *et al*., WD 2001; ICES 2002a).

12.7.1 Data exploration with the *ad hoc* separable model

An *ad hoc* seasonal separable model implemented and run on a spreadsheet has been used in the last two years for data exploration of anchovy catch-at-age data in IXa South from 1995 onwards. Data in this model are analysed by half-year-periods, those from the Algarvian anchovy being previously compiled by applying Gulf of Cadiz ALKs (Table 12.6.1). Weights-at-age in the catches are estimated as usual, whereas weights-at-age in the stock correspond to yearly estimates calculated as the weighted mean weights-at-age in the catches for the second and third quarters.

The separable model is fitted to half-year catch-at-age data and to two aggregated biomass indices: an annual CPUE from the Barbate single-purpose purse-seine fleet, and acoustic estimates of biomass from Portuguese surveys. Catches-at-age are assumed to be linked by the usual catch equations; the relationship between the index series and the stock sizes is assumed linear. A constant selection pattern is assumed for the whole period. Parameters estimated are selectivity at age for both half-year-periods in relation to the reference age (age 1), recruitment, survey catchability (k1) and CPUE catchability (k2) and annual F values per half-year-period. Parameters are estimated by minimising the sum of squares of the log-residuals from the catch-at-age, the CPUE and the acoustics biomass data. F values for 1995 are computed as an average of the Fs in subsequent years.

This same model has been fitted this year to catch-at-age data from the period 1995 to 2002. The CPUE-based tuning index also covered the same period, and the acoustic estimates of biomass included those ones from the years 1998 to 2002. For the purpose of the data exploration has been performed two different runs based on the following settings:

RUN 0: settings as in the last year Working Group, with a not standardised fishery-based biomass tuning index (CPUE series) and the whole series of Portuguese acoustics estimates.

RUN 1: like RUN 0 but replacing the above not-standardised CPUE series by the standardised ones.

As stated last year catches in the year 2000 were low as only a small fraction of the Barbate purse-seine fleet operated in that year (Figure 12.6.1). Therefore, the CPUE in that year as an index of resource abundance may contain additional uncertainty, and fitting the model to both the CPUE and the acoustic survey time-series seemed sensible. The model fits the catch-at-age and the CPUE data reasonably well regardless of the run considered (Figure 12.6.1).

The acoustic estimates of biomass, the average biomass and the biomass at the time of the acoustic survey as estimated by the model shows that the fit to the acoustic data was poor (Figure 12.6.2). This is likely to be related to the facts that the two biomass indices show conflicting trends but the CPUE time-series has more information than the acoustic one so, the former will be more powerful in any regression. It was noticed that Fs in year 2001 and 2002 are about half or even lower of the estimated Fs for year 1998 while both the catches in tons and the estimated CPUE's are rather similar (Figure 12.6.1).

Residuals from the model fit to the catch-at-age data are plotted in Figure 12.6.3 suggesting that they broadly conform to assumptions of normality. The SSQ profile shown in the same Figure suggests that the confidence intervals around the estimate of k1 (acoustic survey catchability) are probably wide. The point estimate (k1 about 4 regardless the run considered) seemed high and similar considerations to the ones made by the Working Group in the two last years still apply (see ICES 2002a).

According to the model, fishing mortality seemed to have been increasing until 1999 and then gone down in 2000, remaining relatively low in the last years (Figure 12.6.1). Although catches in tonnes in 1998 and 2001-2002 are similar, the numbers caught in the last two years were far less because the weights-at-age in these years were close to double the 1998 ones. In addition, the model estimates for 2001 and 2002 high CPUE levels in the period which, linked to a high estimate of average biomass, results in a comparatively low fishing mortality. Given the catch data and the level of natural mortality adopted, the estimated selectivity for age 2 ($S_{2,1st\,S}$ = 1.18 and $S_{2,2nd\,S}$ = 1.5) is in agreement with the perception of the impact of the fishery on the stock. Run 1 was considered as the final one and the outputs of this exploratory assessment are summarised in Table 12.6.2.

The suitability of the seasonal model itself and the biomass tuning indices used in the assessment were discussed by the WG members since the model, as currently implemented, assesses the population biomass mainly according to catch levels. Other analytical models might also be used for the assessment although the WG recognises that this is not just the problem but the shortness of time-series of direct estimates of the population. In this context,, the Working Group laid stress on the necessity of the inclusion in the model of an absolute scaling factor of the biomass population and hence the Working Group recommends that direct surveying of the anchovy in Subdivision IXa South by Egg (DEPM) surveys be pursued in the short-term.

Although the assessment presented here is considered preliminary and only for the purpose of data exploration, the results suggest that the capacity in the fishery prior to 2000 may result in relatively high fishing mortality even when the stock is at an average biomass level as, for example, in 1997-1999 (Figure 12.6.2). By analogy with the anchovy stock in Subarea VIII, this stock may fluctuate widely due to variations in recruitment largely driven by environmental factors. Given current uncertainty in stock status, the Working Group considered unwise to allow further increases in fishing capacity if sustainable utilisation is to be ensured.

12.8 Reference Points for Management Purposes

It is not possible to determine limit and precautionary reference points based on the available information.

12.9 Harvest Control Rules

Harvest control rules cannot be provided, as reference points are not determined.

12.10 Management Considerations

The regulatory measures in place for the anchovy purse-seine fishing were the same as for the previous years and are summarised as follows:

- Minimum landing size: 10 cm total length.
- Minimum vessel tonnage of 20 GRT with temporary exemption.
- Maximum engine power: 450 h.p.
- Purse-seine maximum length: 450 m.
- Purse-seine maximum depth: 80 m.
- Fishing time limited to 5 days per week, from Monday to Friday.
- Cessation of fishing activities from Saturday 00:00 h to Sunday 12:00 h.
- Fishing prohibition inside bays and estuaries.

It must be pointed out that the Spanish purse-seine fleet in the Gulf of Cadiz does not observe the normal voluntary closure of three months (December to February) since 1997.

The WG recommends that effective effort should not increase above recent levels. Further, WG recommends that the fishery should not be allowed to further expand until the stock is properly assessed and there is evidence that the stock could support higher fishing pressure.

Table 12.2.1.1. Portuguese and Spanish annual landings (tonnes) of anchovy in Division IXa (from Pestana, 1989 and 1996, and Working Group members).

	Portugal				Spain			
Year	**IXa C-N**	**IXa C-S**	**IXa South**	**Total**	**IXa North**	**IXa South**	**Total**	**TOTAL**
1943	7121	355	2499	9975	-	-	-	-
1944	1220	55	5376	6651	-	-	-	-
1945	781	15	7983	8779	-	-	-	-
1946	0	335	5515	5850	-	-	-	-
1947	0	79	3313	3392	-	-	-	-
1948	0	75	4863	4938	-	-	-	-
1949	0	34	2684	2718	-	-	-	-
1950	31	30	3316	3377	-	-	-	-
1951	21	6	3567	3594	-	-	-	-
1952	1537	1	2877	4415	-	-	-	-
1953	1627	15	2710	4352	-	-	-	-
1954	328	18	3573	3919	-	-	-	-
1955	83	53	4387	4523	-	-	-	-
1956	12	164	7722	7898	-	-	-	-
1957	96	13	12501	12610	-	-	-	-
1958	1858	63	1109	3030	-	-	-	-
1959	12	1	3775	3788	-	-	-	-
1960	990	129	8384	9503	-	-	-	-
1961	1351	81	1060	2492	-	-	-	-
1962	542	137	3767	4446	-	-	-	-
1963	140	9	5565	5714	-	-	-	-
1964	0	0	4118	4118	-	-	-	-
1965	7	0	4452	4460	-	-	-	-
1966	23	35	4402	4460	-	-	-	-
1967	153	34	3631	3818	-	-	-	-
1968	518	5	447	970	-	-	-	-
1969	782	10	582	1375	-	-	-	-
1970	323	0	839	1162	-	-	-	-
1971	257	2	67	326	-	-	-	-
1972	-	-	-	-	-	-	-	-
1973	6	0	120	126	-	-	-	-
1974	113	1	124	238	-	-	-	-
1975	8	24	340	372	-	-	-	-
1976	32	38	18	88	-	-	-	-
1977	3027	1	233	3261	-	-	-	-
1978	640	17	354	1011	-	-	-	-
1979	194	8	453	655	-	-	-	-
1980	21	24	935	980	-	-	-	-
1981	426	117	435	978	-	-	-	-
1982	48	96	512	656	-	-	-	-
1983	283	58	332	673	-	-	-	-
1984	214	94	84	392	-	-	-	-
1985	1893	146	83	2122	-	-	-	-
1986	1892	194	95	2181	-	-	-	-
1987	84	17	11	112	-	-	-	-
1988	338	77	43	458		4263	4263	4721
1989	389	85	22	496	118	5330	5448	5944
1990	424	93	24	541	220	5726	5946	6487
1991	187	3	20	210	15	5697	5712	5922
1992	92	46	0	138	33	2995	3028	3166
1993	20	3	0	23	1	1960	1961	1984
1994	231	5	0	236	117	3035	3152	3388
1995	6724	332	0	7056	5329	571	5900	12956
1996	2707	13	51	2771	44	1780	1824	4595
1997	610	8	13	632	63	4600	4664	5295
1998	894	153	566	1613	371	8977	9349	10962
1999	957	96	355	1408	413	5587	6000	7409
2000	71	61	178	310	10	2182	2191	2502
2001	397	19	439	855	27	8216	8244	9098
2002	433	90	393	915	21	7870	7891	8806

(-) Not available

(0) Less than 1 tonne

Table 12.2.1.2. Anchovy catches (tonnes) by gear and country in Division IXa in 1988-2002.

Country/Quarter	1988*	1989*	1990*	1991*	1992	1993	1994	1995*	1996	1997	1998	1999	2000	2001	2002
SPAIN	4263	5454	6131	5711	3028	1961	3153	5900	1823	4664	9349	6000	2191	8244	7891
Purse seine IXa North		118	220	15	33	1	117	5329	44	63	371	413	10	27	21
Purse seine IXa South	4263	5336	5911	5696	2995	1630	2884	496	1556	4410	7830	4594	2078	8180	7847
Trawl IX a South						330	152	75	224	190	1148	993	104	36	23
PORTUGAL	458	496	541	210	275	23	237	7056	2771	632	1613	1408	310	855	915
Trawl					4	9	1		56	46	37	43	6	16	13
Purse seine	458	496	541	210	270	14	233	7056	2621	579	1541	1346	297	806	888
Artisanal					1	1	3		94	7	35	20	7	32	13
Total	4721	5950	6672	5921	3303	1984	3390	12956	4594	5295	10962	7409	2502	9098	8806

* Portuguese catches not differentiated by gear

Table 12.2.2.1. Quarterly anchovy catches (tonnes) in Division IXa by country and Subdivision in 2002.

		QUARTER 1		QUARTER 2		QUARTER 3		QUARTER 4		ANUAL	
COUNTRY	SUBDIVISIONS	C(t)	%	C(t)	%	C(t)	%	C(t)	%	C (t)	%
	IXa North	3	15.2	1	6.8	11	54.2	5	23.9	21	0.3
SPAIN	**IXa South**	1700	21.6	2814	35.8	2566	32.6	789	10.0	7870	99.7
	TOTAL	1704	21.6	2816	35.7	2577	32.7	794	10.1	7891	
	IXa Central North	6	1.3	14	3.3	200	46.1	213	49.2	433	47.3
PORTUGAL	**IXa Central South**	80	89.6	2	2.3	6	6.2	2	1.9	90	9.8
	IXa South	75	19.1	150	38.2	140	35.6	28	7.1	393	42.9
	TOTAL	161	17.6	166	18.2	345	37.7	242	26.5	915	
	IXa North	3	15.2	1	6.8	11	54.2	5	23.9	21	0.2
	IXa Central North	6	1.3	14	3.3	200	46.1	213	49.2	433	4.9
TOTAL	**IXa Central South**	80	89.6	2	2.3	6	6.2	2	1.9	90	1.0
	IXa South	1775	21.5	2964	35.9	2705	32.7	817	9.9	8262	93.8
	TOTAL	1865	21.2	2982	33.9	2922	33.2	1037	11.8	8806	

Table 12.3.1.1. Estimated abundance in number (millions) and biomass (tonnes) from Portuguese acoustic surveys by area and total.

		Portugal				Spain	TOTAL
Survey	Estimate	Central-North	Central-South	South (Algarve)	Total	South (Cadiz)	
November 1998	Number	30	122	50	203	2346	2549
	Biomass	313	1951	603	2867	30092	32959
March 1999	Number	22	15	*	37	2079	2116
	Biomass	190	406	*	596	24763	25359
November 2000	Number	4	20	*	23	4970	4994
	Biomass	98	241	*	339	33909	34248
March 2001	Number	25	13	285	324	2415	2738
	Biomass	281	87	2561	2929	22352	25281
November 2001	Number	35	94	-	129	3322	3451
	Biomass	1028	2276	-	3304	25578	28882
March 2002	Number	22	156	92	270	3731 **	4001 **
	Biomass	472	1070	1706	3248	19629 **	22877 **
February 2003	Number	0	14	*	14	2314	2328
	Biomass	0	112	*	112	24565	24677

* Due to the distribution observed during the survey, the last transect (near the border with Spain) that normally belongs to sub-area Algarve was included in Cadiz.
** Corrected estimates after detection of errors in the S_A values attributed to the Cadiz area (Marques & Morais, WD 2003)

Table 12.3.1.2. February 2002 Spanish acoustic survey in the Gulf of Cadiz. Summary table of anchovy acoustic assessment. Area denotes 'homogeneous zone' (i.e. no differences in length distribution from K-S test), N the number of values inside this area, Mean and δ^2 the mean backscattering energy attributed to anchovy and its variance, Model the geostatistic model when available, Surface expressed in nm^2, Fishing st. the fishing stations used to characterise the length structure inside this area, and the acoustic estimates of abundance and biomass.

SUMMARY ASSESSMENT
SURVEY: SIGNOISE 0202 - ANCHOVY DATA

Zone	Area	No	Mean	δ^2	Model	v*	nugget/model	Surface	Fishing st.	PDF	No (million fish)	Biomass (tonnes)
IXa-Cádiz	South Cádiz	17	30.94	2586.134	100; Sph(2500;3.5)	211.61	2.80%	181	VE01-VE03	st01	37	684
	Central Cádiz	41	1556.66	5306273	Sph(5306273;3)	201035	0.00%	363	CS02-CS03-CS04-VE04-VE05	st02	6457	51555
	North Cádiz	91	1990.50	22487300	5000000;sph(17487300;3)	323411	17.00%	736	CS07-CS08-CS09-CS10-CS11-VE08-VE10	st03	11707	160695
	Total	***149***	***1647.54***					***1280***			***18202***	***212935***

Table 12.4.1.1. Spanish catch in numbers ('000) at age of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2002) on a quarterly(Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm .

1988	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	13204	55286	0	68490	68490
	1	89197	188073	87183	18794	277269	105976	383245
	2	0	0	1928	0	0	1928	1928
	3	0	0	0	0	0	0	0
	Total (n)	89197	188073	102315	74080	277269	176394	453663
	Catch (t)	730	1815	1164	553	2545	1718	4263
	SOP	728	1810	1164	552	2537	1716	4253
	VAR.%	100	100	100	100	100	100	100

1989	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	2652	7981	0	10633	10633
	1	199286	302223	69570	3471	501509	73042	574551
	2	0	0	5747	0	0	5747	5747
	3	0	0	0	0	0	0	0
	Total (n)	199286	302223	77969	11452	501509	89421	590930
	Catch (t)	1314	2579	1327	110	3892	1437	5330
	SOP	1311	2563	1322	110	3874	1432	5306
	VAR.%	100	101	100	100	100	100	100

1990	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	18313	316191	0	334504	334504
	1	341850	206863	99526	5373	548713	104900	653612
	2	185	0	929	0	185	929	1114
	3	0	0	0	0	0	0	0
	Total (n)	342035	206863	118768	321565	548897	440333	989230
	Catch (t)	2273	1544	1169	740	3816	1909	5726
	SOP	2271	1543	1166	739	3814	1905	5719
	VAR.%	100	100	100	100	100	100	100

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	11537	45411	0	56948	56948
	1	351314	334722	36156	1189	686036	37345	723381
	2	0	4053	1591	376	4053	1968	6021
	3	0	0	0	0	0	0	0
	Total (n)	351314	338775	49284	46977	690089	96261	786350
	Catch (t)	1049	3673	701	273	4722	975	5697
	SOP	1035	3638	696	271	4672	968	5640
	VAR.%	101	101	101	101	101	101	101

1992	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	2415	0	0	2415	2415
	1	159677	147523	42707	86	307200	42793	349993
	2	182	0	861	41	182	902	1084
	3	63	0	0	0	63	0	63
	Total (n)	159922	147523	45983	127	307445	46110	353555
	Catch (t)	1125	1367	499	4	2492	503	2995
	SOP	1120	1364	498	4	2484	502	2986
	VAR.%	100	100	100	100	100	100	100

1993	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	13797	23517	0	37314	37314
	1	73104	81486	12120	2025	154590	14145	168735
	2	576	649	0	12	1225	12	1237
	3	0	0	0	0	0	0	0
	Total (n)	73680	82135	25917	25555	155815	51472	207287
	Catch (t)	767	921	167	105	1688	272	1960
	SOP	761	914	166	105	1675	271	1946
	VAR.%	101	101	100	100	101	100	101

1994	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	1794	960	0	2755	2755
	1	130013	217610	5150	3512	347622	8662	356285
	2	1	31	4576	691	32	5267	5299
	3	0	0	0	0	0	0	0
	Total (n)	130014	217641	11521	5163	347655	16684	364339
	Catch (t)	690	2055	210	80	2745	290	3035
	SOP	687	2045	210	80	2732	290	3022
	VAR.%	100	100	100	101	100	100	100

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	11256.3	23240.7	0	34497	34497
	1	19579	6928	6851	602	26508	7453	33961
	2	189	0	0	0	189	0	189
	3	0	0	0	0	0	0	0
	Total (n)	19769	6928	18107	23843	26697	41950	68647
	Catch (t)	185	80	148	157	265	305	571
	SOP	184	79	148	157	264	305	568
	VAR.%	101	101	100	100	101	100	100

1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	413465	71074	0	484540	484540
	1	12772	130880	11550	7281	143652	18832	162483
	2	13	882	826	333	894	1159	2053
	3	0	0	0	0	0	0	0
	Total (n)	12785	131761	425842	78688	144546	504530	649076
	Catch (t)	41	807	585	348	848	933	1780
	SOP	36	743	621	306	779	926	1706
	VAR.%	114	109	94	113	109	101	104

1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	237283	96475	0	333758	333758
	1	67055	123878	69278	19430	190933	88708	279641
	2	22601	9828	11649	745	32429	12394	44823
	3	0	0	0	0	0	0	0
	Total (n)	89656	133706	318211	116650	223362	434860	658223
	Catch (t)	906	1110	2006	578	2016	2584	4600
	SOP	844	1273	1923	596	2117	2519	4635
	VAR.%	107	87	104	97	95	103	99

1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	75708	360599	0	436307	436307
	1	325407	384529	220869	84729	709936	305599	1015535
	2	11066	879	1316	0	11944	1316	13260
	3	0	0	0	0	0	0	0
	Total (n)	336473	385408	297893	445329	721881	743221	1465102
	Catch (t)	1773	2113	2514	2579	3885	5092	8977
	SOP	1923	2127	2599	2654	4050	5254	9304
	VAR.%	92	99	97	97	96	97	96

1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	40549	84234	0	124784	124784
	1	249922	115218	86931	20276	365140	107207	472348
	2	10982	18701	2450	146	29683	2596	32279
	3	0	0	0	0	0	0	0
	Total (n)	260904	133919	129931	104656	394823	234587	629410
	Catch (t)	1335	1983	1582	687	3318	2269	5587
	SOP	1330	1756	1391	673	3087	2064	5150
	VAR.%	100	113	114	102	107	110	108

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	41028	77780	0	118808	118808
	1	75141	65947	46460	9949	141088	56409	197497
	2	638	2670	523	14	3307	537	3844
	3	0	0	0	0	0	0	0
	Total (n)	75779	68617	88011	87743	144395	175755	320150
	Catch (t)	329	660	655	537	989	1193	2182
	SOP	327	659	666	535	986	1201	2187
	VAR.%	101	100	98	100	100	99	100

2001	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	30987	127140	0	158126	158126
	1	98687	227388	177264	37992	326075	215256	541331
	2	4155	14028	4535	624	18183	5159	23342
	3	0	0	0	0	0	0	0
	Total (n)	102842	241416	212785	165756	344258	378541	722800
	Catch (t)	924	3031	3195	1066	3955	4261	8216
	SOP	908	3014	3145	1065	3922	4210	8132
	VAR.%	102	101	102	100	101	101	101

2002	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0	0	0	45129	29271	0	74399	74399
	1	218090	304295	149120	36565	522385	185685	708070
	2	2004	6083	8808	620	8087	9428	17515
	3	0	0	0	0	0	0	0
	Total (n)	220094	310378	203057	66456	530471	269512	799984
	Catch (t)	1700	2814	2566	789	4515	3355	7870
	SOP	1617	2778	2524	818	3937	3342	7737
	VAR.%	105	101	102	96	115	100	102

Table 12.4.2.1. Length distribution ('000) of Anchovy in Division IXa by country and Sub-divisions in 2002.

	QUARTER 1			QUARTER 2			QUARTER 3			QUARTER 4			TOTAL		
Length (cm)	**SPAIN IXa North**	**PORTUGAL IXa CN,CS,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa CN,CS,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa CN,CS,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa CN,CS,S**	**SPAIN IXa South**	**SPAIN IXa North**	**PORTUGAL IXa CN,CS,S**	**SPAIN IXa South**
3.5	-	-	77	-	-	0	-	-	0	-	-	0	-	-	77
4	-	-	77	-	-	0	-	-	129	-	-	69	-	-	275
4.5	-	-	557	-	-	467	-	-	416	-	-	23	-	-	1463
5	-	-	1486	-	-	1706	-	-	527	-	-	152	-	-	3871
5.5	-	-	1679	-	-	4381	-	-	2558	-	-	124	-	-	8742
6	-	-	1211	-	-	6688	-	-	5033	-	-	846	-	-	13779
6.5	-	-	2420	-	-	8774	-	-	5642	-	-	932	-	-	17768
7	-	-	2669	-	-	6730	-	-	3334	-	-	1506	-	-	14238
7.5	-	-	2994	-	-	4982	-	-	5792	-	-	1033	-	-	14800
8	-	-	3968	-	-	4572	-	-	4712	-	-	886	-	-	14137
8.5	-	-	6092	-	-	5227	-	-	5211	-	-	1681	-	-	18211
9	-	-	11182	-	-	12233	-	-	4047	-	-	2523	-	-	29985
9.5	-	-	17389	-	-	44594	-	-	2148	-	-	2200	-	-	66330
10	-	-	23721	-	-	39611	-	-	1204	-	-	3196	-	-	67732
10.5	-	-	29733	-	-	25030	-	-	3817	-	-	1780	-	-	60360
11	-	-	29119	-	-	21313	-	-	15166	-	-	973	-	-	66572
11.5	-	-	23461	-	-	22415	-	-	17619	-	-	2256	-	-	65752
12	-	-	23701	-	-	29538	-	-	21282	-	-	5056	-	-	79576
12.5	-	-	16791	-	-	16854	-	-	19741	-	-	8460	-	-	61848
13	-	-	9747	-	-	17055	-	-	20537	-	-	7343	-	-	54683
13.5	-	-	7074	-	-	15993	-	-	21841	-	-	9976	-	-	54884
14	-	-	2877	-	-	9749	-	-	13300	-	-	6089	-	-	32016
14.5	-	-	1041	-	-	6159	-	-	13822	-	-	5033	-	-	26055
15	-	-	394	-	-	4201	-	-	7739	-	-	1941	-	-	14275
15.5	-	-	208	-	-	1356	-	-	3593	-	-	1498	-	-	6655
16	-	-	219	-	-	521	-	-	2328	-	-	868	-	-	3936
16.5	-	-	130	-	-	98	-	-	703	-	-	14	-	-	946
17	-	-	74	-	-	117	-	-	593	-	-	0	-	-	784
17.5	-	-	0	-	-	10	-	-	223	-	-	0	-	-	234
18	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
18.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
19	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
19.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
20	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
20.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
21	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
21.5	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
22	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0
Total N	-	-	220094	-	-	310378	-	-	203057	-	-	66456	-	-	799984
Catch (T)	3	161	1700	1	166	2814	11	345	2566	5	242	789	21	915	7870
L avg (cm)	-	-	10.7	-	-	10.7	-	-	11.8	-	-	12.1	-	-	11.1
W avg (g)	-	-	7.3	-	-	8.9	-	-	12.4	-	-	12.3	-	-	9.7

Table 12.4.2.2: Annual Length distribution ('000) of Anchovy in Division IXa from 1988 to 2002.

	1988	1989	1990	1991	1992	1993	1994	1995		1996		1997		1998		1999		2000	2001	2002
Length (cm)	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa North	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South	SPAIN IXa South
3.5											1349								266	77
4			4281	172	2	49					12677						1831	114	200	275
4.5			18371	3937	29	707					67819		1333		4656		17055	856	1649	1463
5	65		32251	54991	90	1832					160894		11492		25825		41100	5006	5489	3871
5.5	86		46584	80537	369	3247					129791		38722		57086		36181	9391	9301	8742
6			45810	43303	983	5031					52812		53185		82442		19366	12961	11832	13779
6.5		1185	44454	28102	2685	6463	6092				33640		50275		76694		20421	11446	15051	17768
7	226	3906	37065	17847	4094	6169	13330				32469		62492		68074		17749	11754	15911	14238
7.5	347	5609	34614	20448	7178	7507	20415		402		19088		42120		43197		19089	20386	10684	14800
8	1871	15959	32562	20037	15632	8325	26136		402		8949		45120		32964		20835	19704	16989	14137
8.5	7892	36001	43081	17916	22442	7748	24497		454		11776		36200		47796		15724	18590	19426	18211
9	13492	31905	53016	19745	16924	7820	22586		2799		12007		20009	156	78561		14937	19435	22924	29985
9.5	26090	36222	88097	34408	23280	8612	16520		9153		6844		13611	367	106350		17487	27397	29620	66330
10	42791	69717	115050	40656	37450	7320	26383		10743		4887		8951	754	132106		23530	34049	35897	67732
10.5	60760	82715	108001	59678	38310	9199	30570		13282		7156		12231	1486	150718		31482	26203	43145	60360
11	73499	82718	86757	67113	39426	8500	31536		8408		17343		22647	2047	158806		33604	21814	50672	66572
11.5	61624	64599	72875	63013	36883	10154	37310		7340		21738		27353	1477	133585		40004	18846	59031	65752
12	66239	50823	50592	65983	39500	24246	29363	74	5279		17855		39131	1267	99586		55614	18734	66873	79576
12.5	42651	42791	34023	54033	33181	33555	33560	711	4502		11544		45267	1178	76285		66384	14738	68648	61848
13	26053	20237	19022	45191	19867	27543	17543	3049	2299	8	6450	374	46852	2737	44979		52625	11841	59942	54683
13.5	9415	11846	12683	21333	7003	13059	9602	3381	1957	12	4468	997	38183	2403	25038	92	38719	9197	50964	54884
14	4954	8397	5779	13684	3785	5710	6493	14998	1205	258	3880	2004	19127	3038	11847	246	22962	6860	39385	32016
14.5	561	3048	1671	4097	2293	2793	5495	25944	194	335	1990	422	11268	2813	5712	497	13247	3713	23375	26055
15	6102	2147	817	2391	521	1082	4217	46371	219	375	790	48	6370	1976	2080	1075	6811	2812	16035	14275
15.5	2985	1757	402	1194	1045	525	1054	42244	8	226	703	40	3764	890	579	1160	2422	983	9402	6655
16	2995	4975	370	1943	271	75	977	44171		227	159	33	2224	560	138	1658	889	294	8305	3936
16.5	2621	7842	489	2406	225	17	443	14369		151		10	296	330		2430	246	4	5034	946
17	252	4584	275	1767	75		216	8378		104		10		438		2221		97	3065	784
17.5	109	1325	133	595	12			778		94		13		311		1717			2731	234
18		621	95	75				236		24						1045			38	
18.5			10							21						397				
19										1						317			38	
19.5																138				
20																				
20.5																				
21																				
21.5																				
22																				
Total N	453679	590930	989230	786595	353555	207287	364339	204705	68647	1835	649078	3951	658223	24231	1465102	12993	630315	327225	701921	799984
Catch (T)	4263	5330	5726	5697	2995	1960	3035	5329	571	44	1780	63	4600	371	8977	413	5587	2182	8216	7870
L avg (cm)	11.3	11.0	9.3	9.6	10.7	10.9	10.5	15.6	10.9	15.6	6.6	14.2	9.4	13.4	9.7	16.8	10.1	9.8	11.4	11.1
W avg (g)	9.4	9.0	5.8	7.2	8.4	9.4	8.3	26.0	8.3	23.7	2.6	16.1	7.0	15.3	6.3	31.8	8.1	6.8	11.3	9.7

Table 12.4.2.3. Mean length (TL, in cm) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2002) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1988	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.4	10.2		10.0	10.0
	1	10.9	11.4	12.3	12.2	11.3	12.3	11.6
	2			16.4			16.4	16.4
	3							
	Total	10.9	11.4	12.0	10.7	11.3	11.5	11.3

1989	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.1	10.9		10.5	10.5
	1	10.1	10.8	13.3	13.3	10.5	13.3	10.9
	2			16.9			16.9	16.9
	3							
	Total	10.1	10.8	13.4	11.6	10.5	13.2	11.0

1990	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.4	6.9		7.1	7.1
	1	10.1	10.4	11.8	11.5	10.2	11.8	10.5
	2	15.2		16.9		15.2	16.9	16.6
	3							
	Total	10.1	10.4	11.5	7.0	10.2	8.2	9.3

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			10.7	9.4		9.7	9.7
	1	7.2	11.5	13.1	16.1	9.3	13.2	9.5
	2		14.9	17.1	17.1	14.9	17.1	15.6
	3							
	Total	7.2	11.5	12.7	9.7	9.3	11.2	9.6

1992	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.5			9.5	9.5
	1	10.0	11.1	12.0	15.9	10.5	12.0	10.7
	2	16.3		15.7	16.7	16.3	15.7	15.8
	3	16.9				16.9		16.9
	Total	10.0	11.1	12.0	16.2	10.5	12.0	10.7

1993	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			6.3	7.7		7.2	7.2
	1	11.5	11.7	12.2	13.8	11.6	12.4	11.7
	2	14.7	14.9		16.5	14.8	16.5	14.8
	3							
	Total	11.5	11.8	9.1	8.2	11.6	8.6	10.9

1994	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.2	9.2		9.2	9.2
	1	9.3	11.0	13.3	13.9	10.4	13.5	10.5
	2	12.8	14.3	15.3	15.4	14.3	15.3	15.3
	3							
	Total	9.3	11.0	13.4	13.2	10.4	13.4	10.5

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			10.3	10.2		10.2	10.2
	1	11.3	11.8	11.4	13.0	11.5	11.6	11.5
	2	14.7				14.7		14.7
	3							
	Total	11.4	11.8	10.7	10.2	11.5	10.4	10.9

1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			5.6	7.3		5.8	5.8
	1	7.4	8.5	12.9	13.7	8.4	13.2	8.9
	2	14.0	13.9	15.2	15.6	13.9	15.3	14.7
	3							
	Total	7.4	8.5	5.8	7.9	8.4	6.1	6.6

1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.1	8.1		7.4	7.4
	1	10.0	10.5	13.1	13.0	10.3	13.0	11.2
	2	13.4	14.0	15.0	15.1	13.6	15.0	14.0
	3							
	Total	10.9	10.8	8.7	8.9	10.8	8.8	9.5

1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.1	8.8		8.5	8.5
	1	9.5	9.2	11.9	12.2	9.3	12.0	10.1
	2	13.2	14.0	15.0		13.3	15.0	13.5
	3							
	Total	9.6	9.2	10.7	9.5	9.4	10.0	9.7

1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.3		8.8	8.8
	1	8.2	12.2	12.7	12.5	9.5	12.7	10.2
	2	13.4	14.1	15.2	14.9	13.8	15.2	13.9
	3							
	Total	8.4	12.5	11.2	10.0	9.8	10.6	10.1

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.7	9.5		8.9	8.9
	1	8.2	10.9	11.9	12.5	9.4	12.0	10.2
	2	14.1	15.0	15.4	16.1	14.9	15.5	15.0
	3							
	Total	8.2	11.1	10.0	9.8	9.6	9.9	9.8

2001	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			9.9	8.4		8.7	8.7
	1	10.7	11.4	13.2	13.0	11.2	13.1	12.0
	2	15.5	16.2	16.3	16.2	16.0	16.3	16.1
	3							
	Total	10.9	11.7	12.8	9.5	11.4	11.3	11.4

2002	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			7.9	10.2		8.8	8.8
	1	10.7	10.6	12.8	13.6	10.6	12.9	11.2
	2	15.0	15.1	15.6	15.7	15.1	15.6	15.4
	3							
	Total	10.7	10.7	11.8	12.1	10.7	11.9	11.1

Table 12.4.2.4. Mean weight (in kg) at age in the Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South, 1988-2002) on a quarterly (Q), half-year (HY) and annual basis. Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

1988	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005	0.006		0.006	0.006
	1	0.008	0.010	0.012	0.011	0.009	0.012	0.010
	2			0.028			0.028	0.028
	3							
	Total	0.008	0.010	0.011	0.007	0.009	0.010	0.009

1989	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.004	0.008		0.007	0.007
	1	0.007	0.008	0.016	0.014	0.008	0.016	0.009
	2			0.034			0.034	0.034
	3							
	Total	0.007	0.008	0.017	0.010	0.008	0.016	0.009

1990	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005	0.002		0.002	0.002
	1	0.007	0.007	0.010	0.009	0.007	0.010	0.008
	2	0.023		0.032		0.023	0.032	0.031
	3							
	Total	0.007	0.007	0.010	0.002	0.007	0.004	0.006

1991	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.008	0.005		0.006	0.006
	1	0.003	0.011	0.015	0.027	0.007	0.016	0.007
	2		0.024	0.036	0.033	0.024	0.035	0.028
	3							
	Total	0.003	0.011	0.014	0.006	0.007	0.010	0.007

1992	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005			0.005	0.005
	1	0.007	0.009	0.011	0.029	0.008	0.011	0.008
	2	0.027		0.024	0.033	0.027	0.024	0.025
	3	0.030				0.030		0.030
	Total	0.007	0.009	0.011	0.030	0.008	0.011	0.008

1993	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.002	0.003		0.003	0.003
	1	0.010	0.011	0.012	0.016	0.011	0.012	0.011
	2	0.021	0.021		0.028	0.021	0.028	0.021
	3							
	Total	0.010	0.011	0.006	0.004	0.011	0.005	0.009

1994	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.005	0.005		0.005	0.005
	1	0.005	0.009	0.017	0.017	0.008	0.017	0.008
	2	0.013	0.020	0.025	0.023	0.020	0.025	0.025
	3							
	Total	0.005	0.009	0.018	0.015	0.008	0.017	0.008

1995	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.007	0.006		0.007	0.007
	1	0.009	0.011	0.010	0.014	0.010	0.010	0.010
	2	0.021				0.021		0.021
	3							
	Total	0.009	0.011	0.008	0.007	0.010	0.007	0.008

1996	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.001	0.003		0.001	0.001
	1	0.003	0.006	0.014	0.015	0.005	0.015	0.006
	2	0.018	0.017	0.023	0.023	0.017	0.023	0.020
	3							
	Total	0.003	0.006	0.001	0.004	0.005	0.002	0.003

1997	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.003	0.003		0.003	0.003
	1	0.007	0.009	0.015	0.013	0.008	0.015	0.010
	2	0.016	0.019	0.023	0.021	0.017	0.023	0.018
	3							
	Total	0.009	0.010	0.006	0.005	0.009	0.006	0.007

1998	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.003	0.005		0.004	0.004
	1	0.005	0.005	0.011	0.011	0.005	0.011	0.007
	2	0.014	0.019	0.022		0.014	0.022	0.015
	3							
	Total	0.006	0.006	0.009	0.006	0.006	0.007	0.006

1999	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.003	0.005		0.005	0.004
	1	0.005	0.012	0.014	0.012	0.007	0.013	0.008
	2	0.015	0.020	0.023	0.020	0.018	0.023	0.018
	3							
	Total	0.005	0.013	0.011	0.006	0.008	0.009	0.008

2000	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.003	0.005		0.005	0.005
	1	0.004	0.009	0.011	0.012	0.006	0.011	0.008
	2	0.018	0.024	0.025	0.027	0.023	0.025	0.023
	3							
	Total	0.004	0.010	0.008	0.006	0.007	0.007	0.007

2001	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.006	0.004		0.005	0.005
	1	0.008	0.011	0.016	0.014	0.010	0.015	0.012
	2	0.025	0.032	0.031	0.028	0.030	0.031	0.030
	3							
	Total	0.009	0.012	0.015	0.006	0.011	0.011	0.011

2002	AGE	Q1	Q2	Q3	Q4	HY1	HY2	ANNUAL
	0			0.003	0.007		0.005	0.005
	1	0.007	0.009	0.014	0.016	0.008	0.015	0.010
	2	0.019	0.025	0.027	0.026	0.024	0.027	0.025
	3							
	Total	0.007	0.009	0.012	0.012	0.008	0.012	0.010

Table 12.4.3. Maturity ogives (ratio of mature fish at age) for Gulf of Cadiz anchovy (Sub-division IXa South).

Year	Age		
	0	1	2+
1988	0	0.82	1
1989	0	0.53	1
1990	0	0.65	1
1991	0	0.76	1
1992	0	0.53	1
1993	0	0.77	1
1994	0	0.60	1
1995	0	0.76	1
1996	0	0.49	1
1997	0	0.63	1
1998	0	0.55	1
1999	0	0.74	1
2000	0	0.70	1
2001	0	0.76	1
2002	0	0.72	1

Table 12.5.1. Anchovy in Division IXa. Effort data (no. of fishing trips) for Spanish fleets in Sub-divisions IXa-South (Gulf of Cadiz) and IXa-North (Southern Galicia).(SP: single purpose; MP: multi purpose).

	SUB-DIVISION IXa SOUTH									SUB-DIVISION IXa NORTH	
	PURSE SEINE									PURSE SEINE	
Year	BARBATE (SP)	BARBATE (MP)	SANLÚCAR (SP)	SANLÚCAR (MP)	P.UMBRÍA (SP)	P.UMBRÍA (MP)	I. CRISTINA (SP)	I. CRISTINA (MP)	MEDIT. (SP)	VIGO	RIVEIRA
	No. fishing trips									No. fishing trips	
1988	3958	17	-	210	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1989	4415	39	-	234	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1990	4622	92	-	660	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1991	3981	40	-	919	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1992	3450	116	-	583	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1993	2152	5	-	225	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1994	1625	69	-	899	*n.a.*	*n.a.*	196	28	-	*n.a.*	*n.a.*
1995	528	17	-	377	*n.a.*	*n.a.*	22	17	-	1537	252
1996	1595	89	-	1659	*n.a.*	*n.a.*	76	55	-	32	3
1997	2207	115	-	1738	*n.a.*	*n.a.*	75	13	-	31	23
1998	2153	-	2234	-	*n.a.*	*n.a.*	177	30	-	134	269
1999	1762	9	2167	-	660	595	330	257	-	51	85
2000	785	2	2196	-	1776	169	572	-	-	*n.a.*	*n.a.*
2001	1281	89	1331	-	2367	22	1254	4	271	*n.a.*	*n.a.*
2002	3504	30	1091	-	2130	1	519	-	109	*n.a.*	*n.a.*

Table 12.5.2. Anchovy in Division IXa. CPUE data (Kg/fishing trip) for Spanish fleets in Sub-divisions IXa-South (Gulf of Cadiz) and IXa-North (Southern Galicia). (SP: single purpose; MP: multi purpose).(*): CPUE corresponding to an only one fishing trip.

	SUB-DIVISION IXa SOUTH									SUB-DIVISION IXa NORTH	
	PURSE SEINE									PURSE SEINE	
Year	BARBATE (SP)	BARBATE (MP)	SANLÚCAR (SP)	SANLÚCAR (MP)	P.UMBRÍA (SP)	P.UMBRÍA (MP)	I. CRISTINA (SP)	I. CRISTINA (MP)	MEDIT. (SP)	VIGO	RIVEIRA
	Kg/fishing trip									Kg/fishing trip	
1988	1047	461	-	420	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1989	1139	534	-	943	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1990	1128	287	-	643	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1991	1312	339	-	456	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1992	819	173	-	300	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1993	641	268	-	225	*n.a.*	*n.a.*	*n.a.*	*n.a.*	-	*n.a.*	*n.a.*
1994	1326	262	-	398	*n.a.*	*n.a.*	204	174	-	*n.a.*	*n.a.*
1995	377	134	-	166	*n.a.*	*n.a.*	52	25	-	2509	2286
1996	497	315	-	246	*n.a.*	*n.a.*	137	157	-	847	4
1997	1580	306	-	288	*n.a.*	*n.a.*	105	126	-	1068	639
1998	3144	-	221	-	*n.a.*	*n.a.*	242	197	-	1489	512
1999	2162	219	241	-	142	143	134	150	-	1088	1585
2000	1365	77	208	-	169	142	391	-	-	*n.a.*	*n.a.*
2001	2327	1507	249	-	948	337	1539	805	2025	*n.a.*	*n.a.*
2002	1690	651	207	-	586	2082 (*)	601	-	1070	*n.a.*	*n.a.*

Table 12.5.3. Standardised anchovy CPUE series (tonnes/fishing day) of the Barbate's single-purpose fleet.

Year	CPUE (tonnes/effective fishing day)						
	Q1	Q2	Q3	Q4	HY1	HY2	Annual
1988	1.072	1.382	0.862	0.771	**1.274**	**0.829**	**1.047**
1989	1.650	1.160	0.919	0.460	**1.297**	**0.859**	**1.139**
1990	1.613	1.119	0.841	0.707	**1.374**	**0.797**	**1.128**
1991	1.441	1.612	0.843	0.568	**1.581**	**0.743**	**1.312**
1992	1.351	0.828	0.451	0.240	**0.993**	**0.451**	**0.819**
1993	0.805	0.572	0.308	0.287	**0.642**	**0.305**	**0.588**
1994	2.113	1.341	0.584	0.276	**1.441**	**0.543**	**1.326**
1995	0.320	0.627	0	0	**0.377**	**0**	**0.377**
1996	0	0.628	0.235	0.199	**0.628**	**0.223**	**0.509**
1997	0.811	1.038	1.428	0.792	**0.917**	**1.249**	**1.051**
1998	3.205	2.435	1.072	2.582	**2.734**	**1.571**	**1.926**
1999	0.855	2.408	1.391	1.047	**1.490**	**1.303**	**1.421**
2000	1.531	1.558	0.410	0.882	**1.555**	**0.501**	**0.757**
2001	2.395	1.627	1.559	1.485	**1.788**	**1.539**	**1.638**
2002	2.759	2.757	1.674	1.420	**2.758**	**1.603**	**2.093**

Table 12.5.4. Fishery-based recruitment indices of Gulf of Cadiz anchovy (standardised catch rates in tons/fishing days).

Year	INDEX 1	INDEX 2	Age 0 (Nov.)	Age 0 (Q4)	Age 0 (HY2)	Age 1 (Mar.)	Age 1 (Q1)
1988	1.744	1.180		0.493	0.448		
1989	1.639	1.149		0.272	0.063		2.549
1990	0.729	0.557		0.669	0.418		2.016
1991	0.781	0.583		0.607	0.315		0.804
1992	0.663	0.357		0	0		0.921
1993	0.958	0.618		0.103	0.017		0.730
1994	0.366	0.310		0.127	0.136		1.014
1995	0.159	0.112		0.165	0.105		0.391
1996	0.568	0.357		0.209	0.163		0.148
1997	1.130	0.607		0.399	0.207		0.962
1998	1.156	0.655	1.453	1.099	0.424	2.029	1.370
1999	0.372	0.202	0.811	0.456	0.182	1.313	1.027
2000	1.067	0.609	0.314	0.581	0.386	0.115	0.308
2001	0.852	0.507	0.210	0.537	0.225	1.357	1.932
2002			0.217	0.193	0.106	1.486	1.132

Table 12.6.1. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Input values for the seasonal separable assessment model.

Anchovy IXa-South (Algarve+Golfo de Cádiz)
Years: 1995-2002
Fleets: All

Half-year Catch in number (in millions) at age (1995-2002)

	1995		1996		1997		1998		1999		2000		2001		2002	
AGE	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
0	0	34.50	0	495.13	0	335.67	0	465.60	0	126.26	0	129.46	0	161.95	0	77.89
1	26.51	7.45	143.75	19.89	191.06	89.10	722.99	341.82	422.57	109.26	161.65	58.89	354.92	220.76	548.23	195.09
2	0.19	0.00	0.90	1.21	32.46	12.41	12.03	1.51	32.29	2.65	3.51	0.55	19.70	5.29	8.50	9.93
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Mean weight at age in the stock (in g) and natural mortality (half-year) estimates

AGE	Mean weight								Natural
	1995	1996	1997	1998	1999	2000	2001	2002	mortality
0	7	1	3	3	3	3	6	3	0.6
1	11	6	11	7	13	10	13	10	0.6
2	23	20	21	20	20	24	32	26	0.6

Acoustic Biomass estimates (tonnes) in Sub-division IXa South (Algarve+Gulf of Cadiz) (Portuguese surveys)

Nov. 1998	Mar. 1999	Nov. 2000	Mar. 2001	Nov. 2001	Mar. 2002
30695	24763	33909	24913	25580	21335

Annual anchovy CPUE (kg/fishing trip) of the Barbate single-purpose purse-seine fleet

	1995	1996	1997	1998	1999	2000	2001	2002
Not standardised	377	497	1580	3144	2162	1365	2327	1690
Standardised	377	509	1051	1926	1421	757	1638	2093

Exploratory runs with the seasonal separable model

	CPUE	Portuguese Ac. Surv.
RUN0	Not standardised	whole series
RUN1	Standardised	whole series

Table 12.6.2. Anchovy in Sub-division IXa South (Algarve+Gulf of Cadiz) . Outputs values for the seasonal separable assessment model.

Year	Recruits Age 0 (thousands)	Average Pop. Biomass (tonnes)	Landings (tonnes)	Yield/Av.Pop. ratio	Mean F Ages 0-1
1995	805389	2952	571	0.1933	0.7122
1996	1559516	2818	1831	0.6500	0.4150
1997	3673199	13493	4613	0.3419	0.8781
1998	2283738	15084	9543	0.6327	0.8989
1999	1045633	15781	5942	0.3765	1.3186
2000	2046502	5963	2360	0.3957	0.4415
2001	2485667	20215	8655	0.4281	0.6512
2002	1303123	14387	8262	0.5743	0.3819

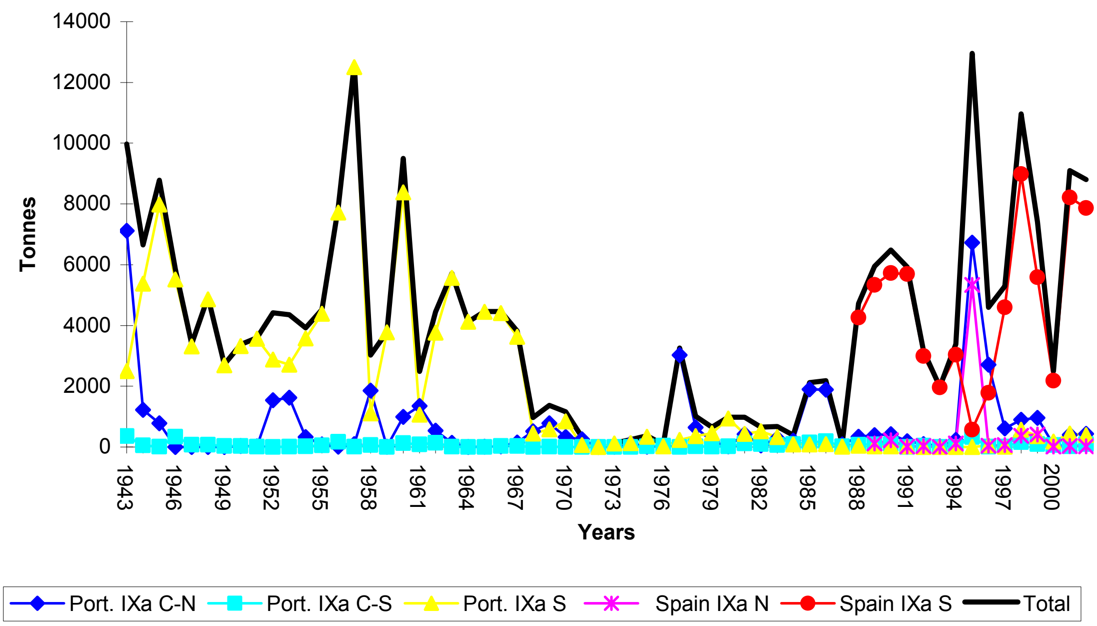


Figure 12.2.1.1. Historical series of Portuguese and Spanish anchovy landings in Division IXa (1943-2002).

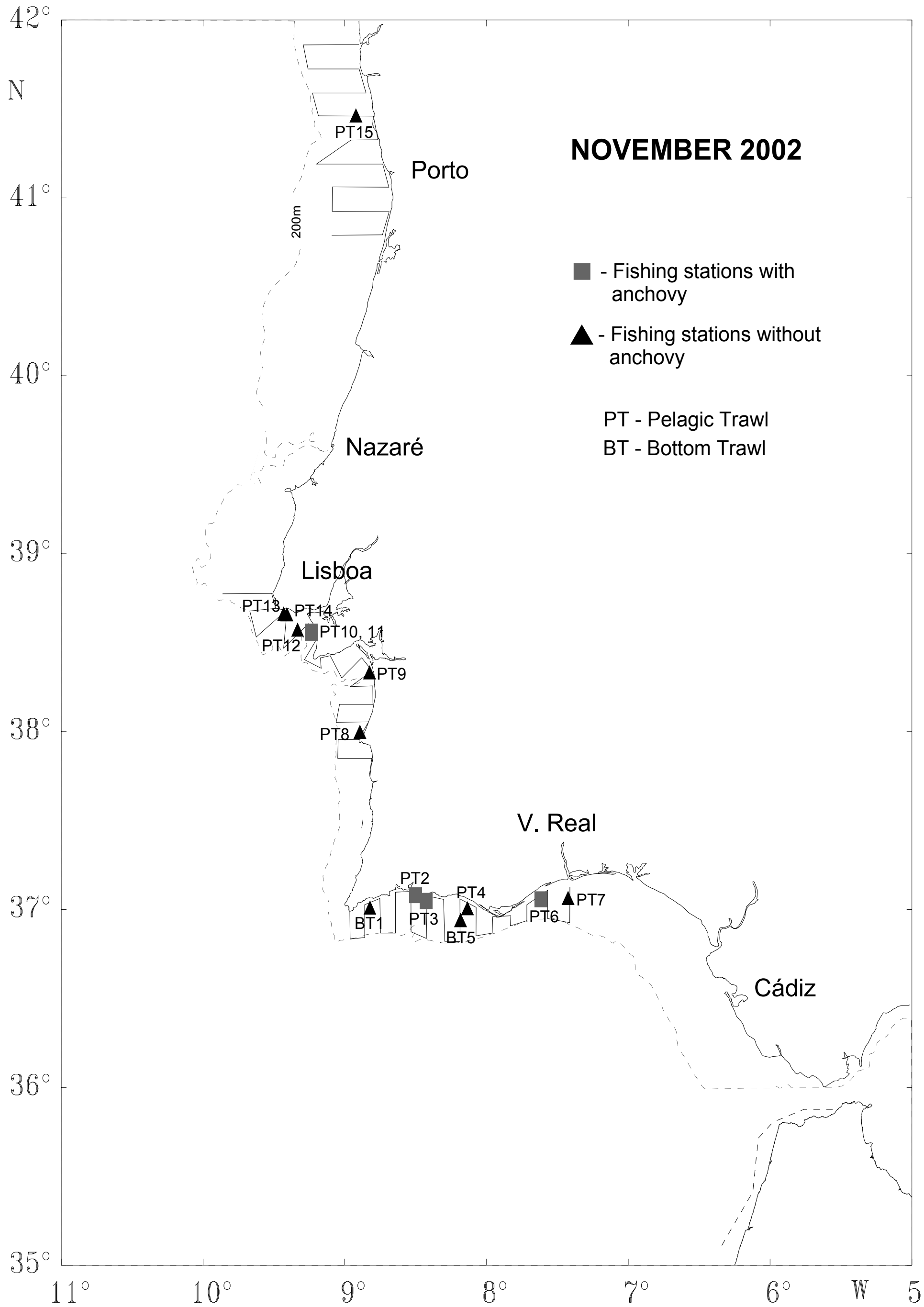


Figure 12.3.1.1 Survey track design and location of trawl stations (with and without anchovy) in November 2002 Portuguese acoustic survey.

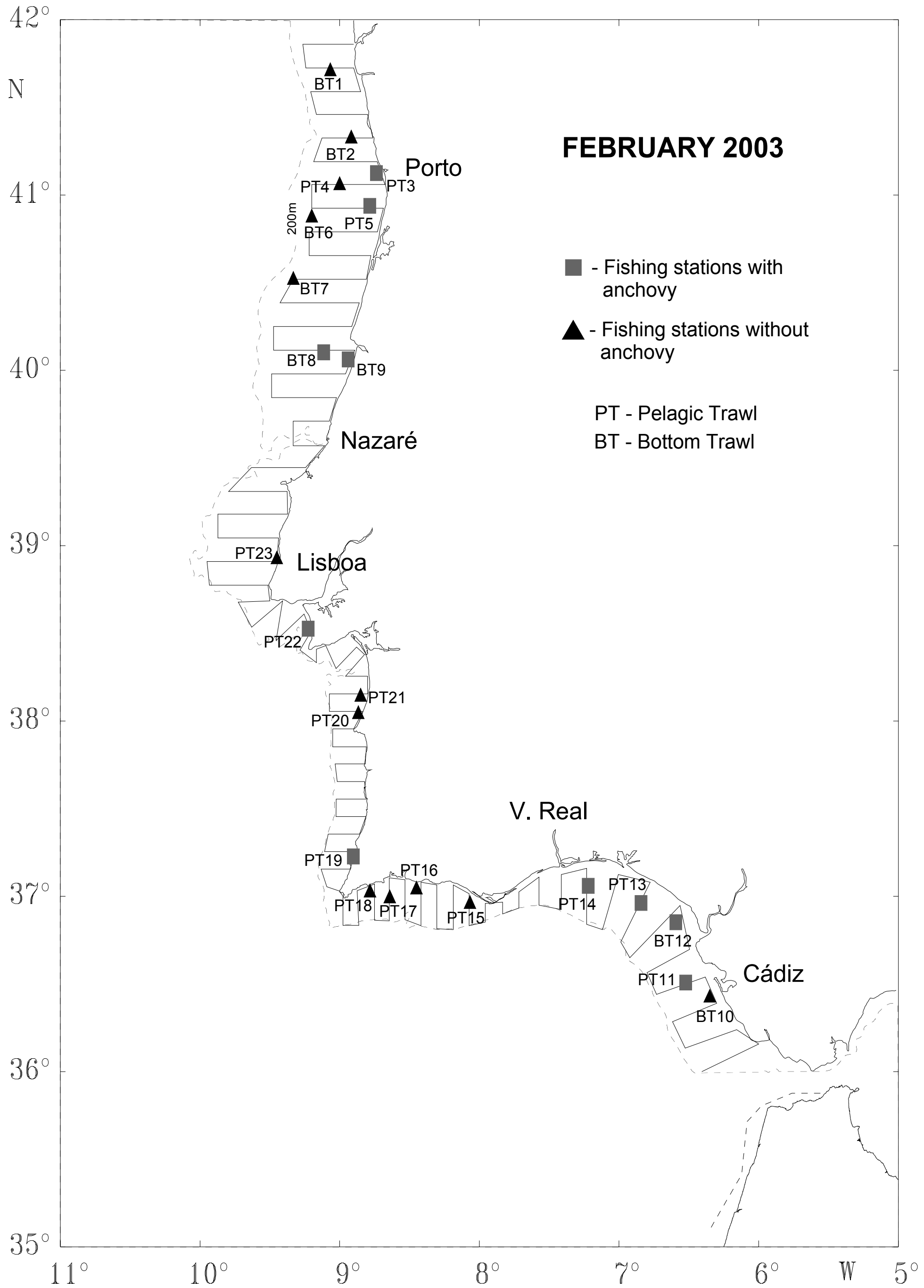


Figure 12.3.1.2 Survey track design and location of trawl stations (with and without anchovy) in February 2003 Portuguese acoustic survey.

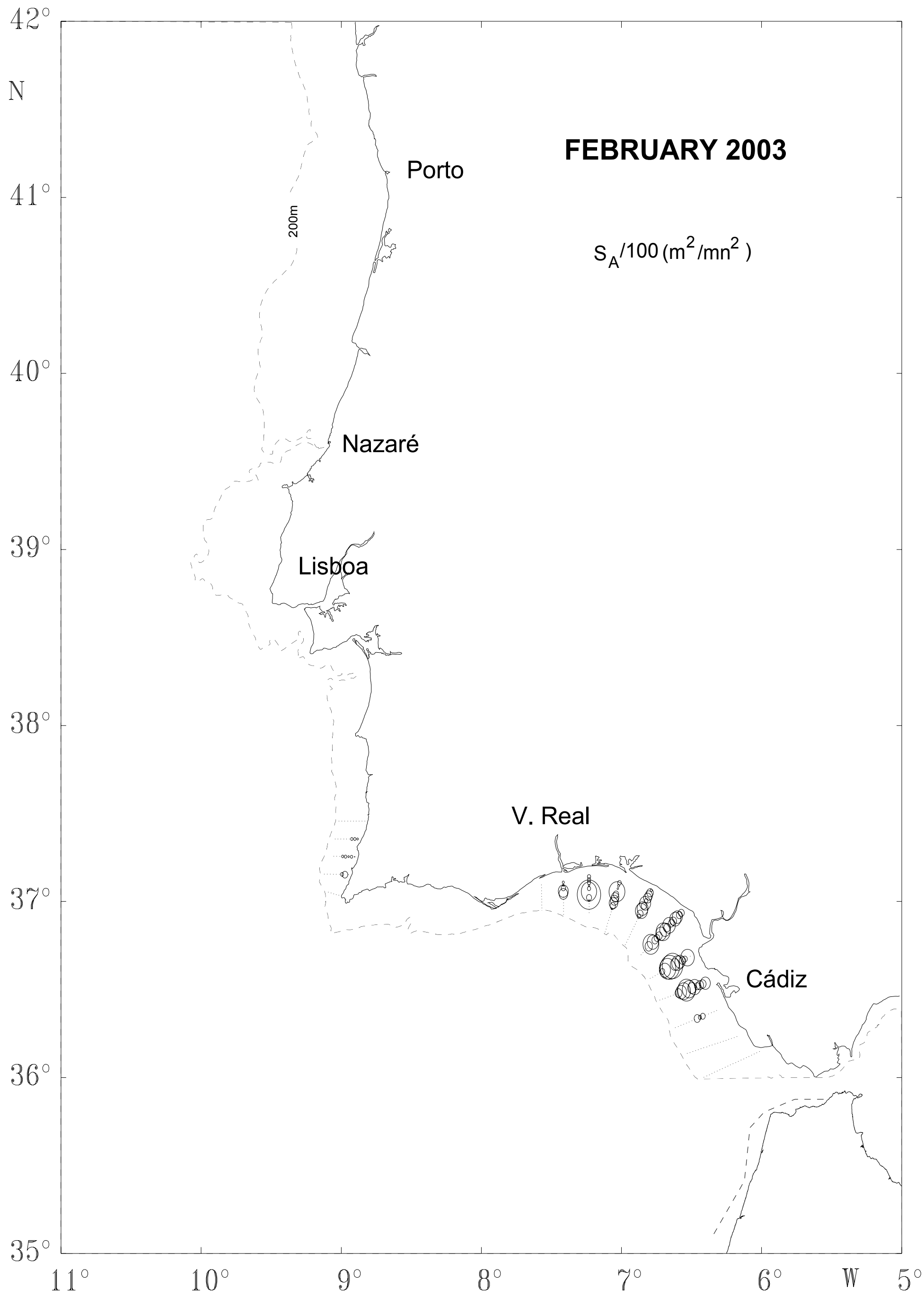


Figure 12.3.1.3 Anchovy in Division IXa: Acoustic energy distribution per nautical mile during the February 2003 Portuguese survey. Circle diameter is proportional to the square root of the acoustic energy (S_A).

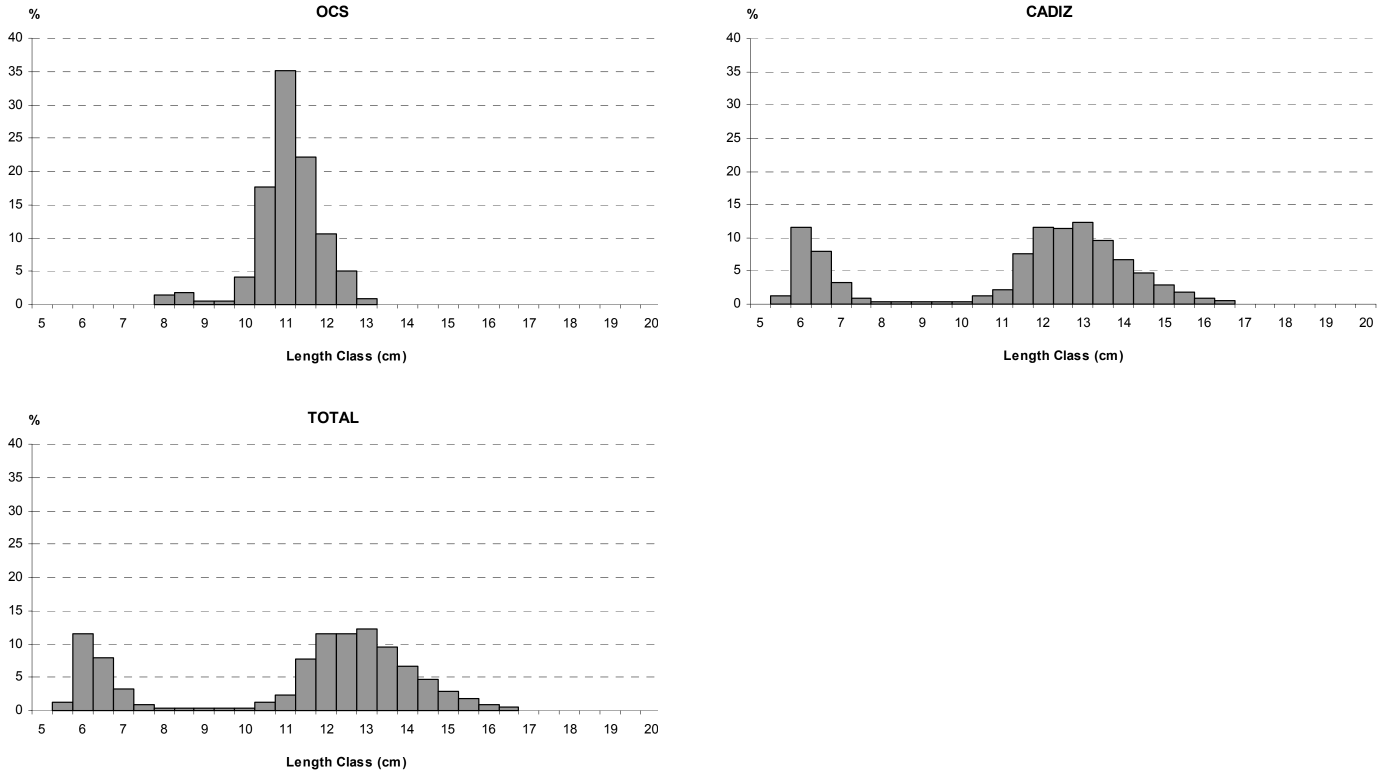


Figure 12.3.1.4 Anchovy in Division IXa: Distribution of length class frequency (%) by region during the February 2003 acoustic survey.

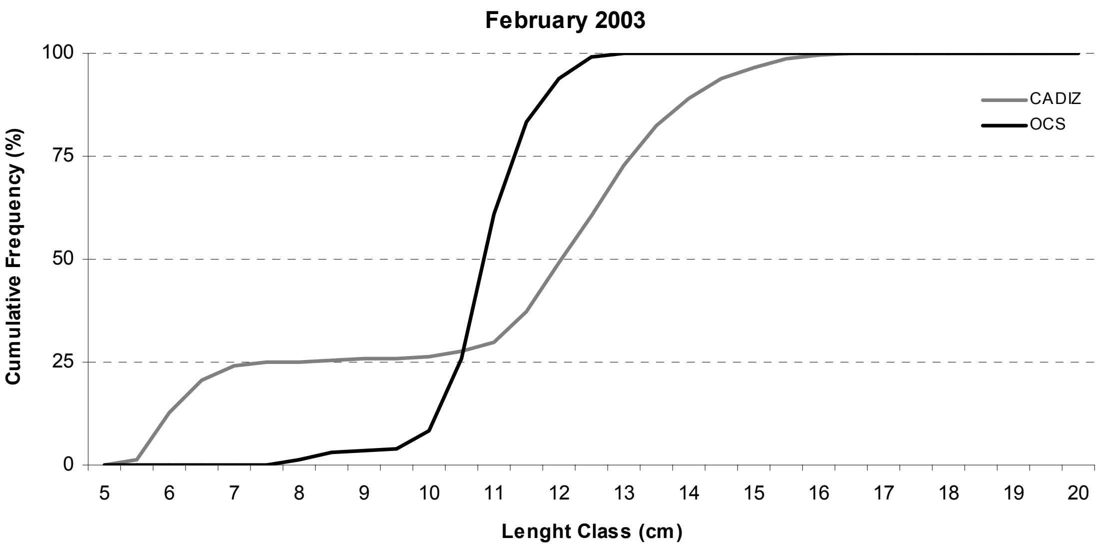


Figure 12.3.1.5 Anchovy in Division IXa: cumulative frequency (%) by length class and region during the February 2003 acoustic survey.

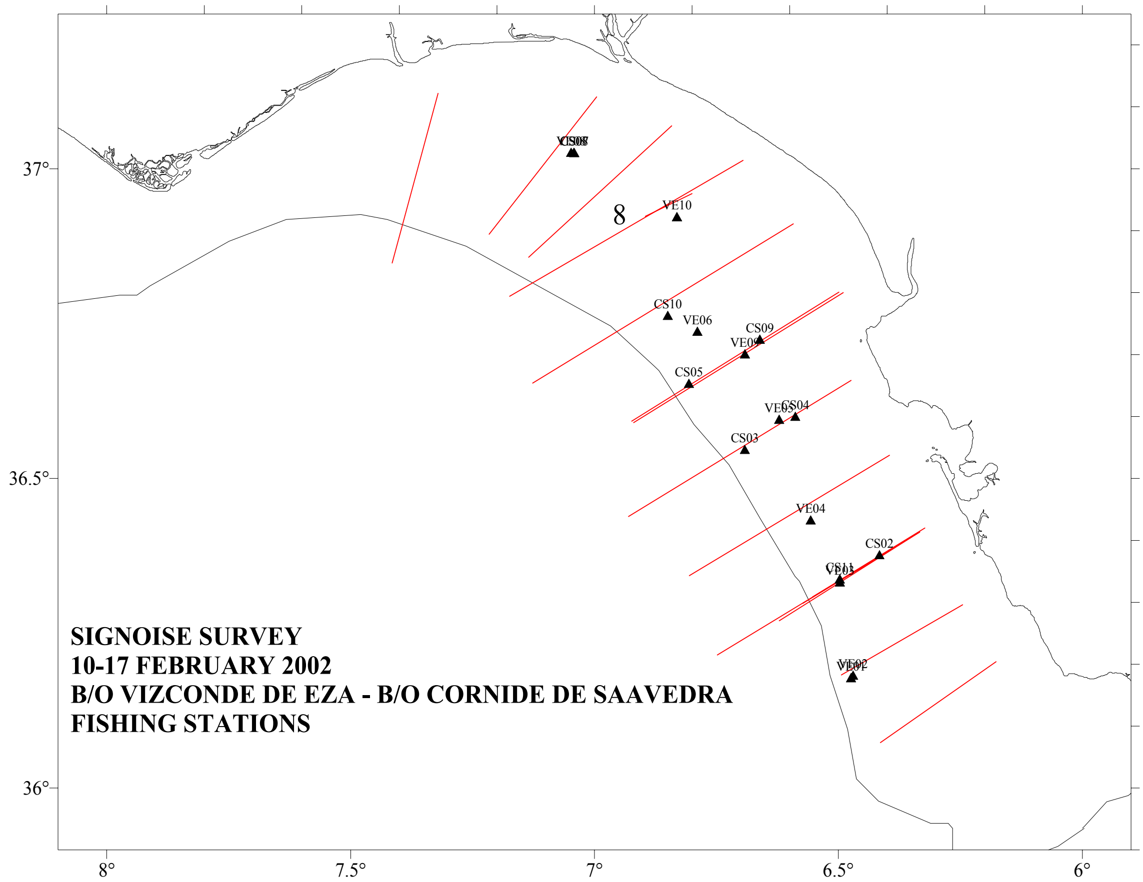


Figure 12.3.1.6 Location of trawl stations and tracks followed by the R/V Cornide de Saavedra in the February 2002 Spanish acoustic survey in the Gulf of Cadiz.

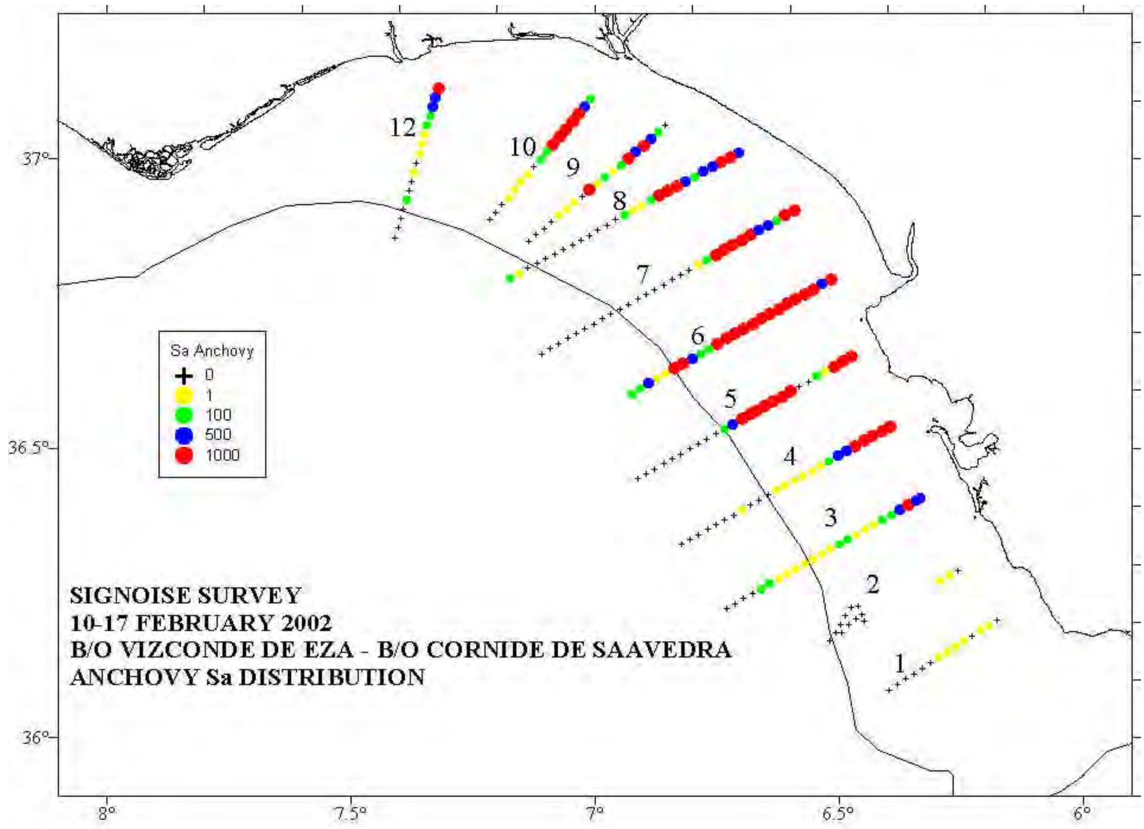


Figure 12.3.1.7 Anchovy distribution derived from the backscattering energy attributed to this fish species during the February 2002 Spanish acoustic survey in the Gulf of Cadiz.

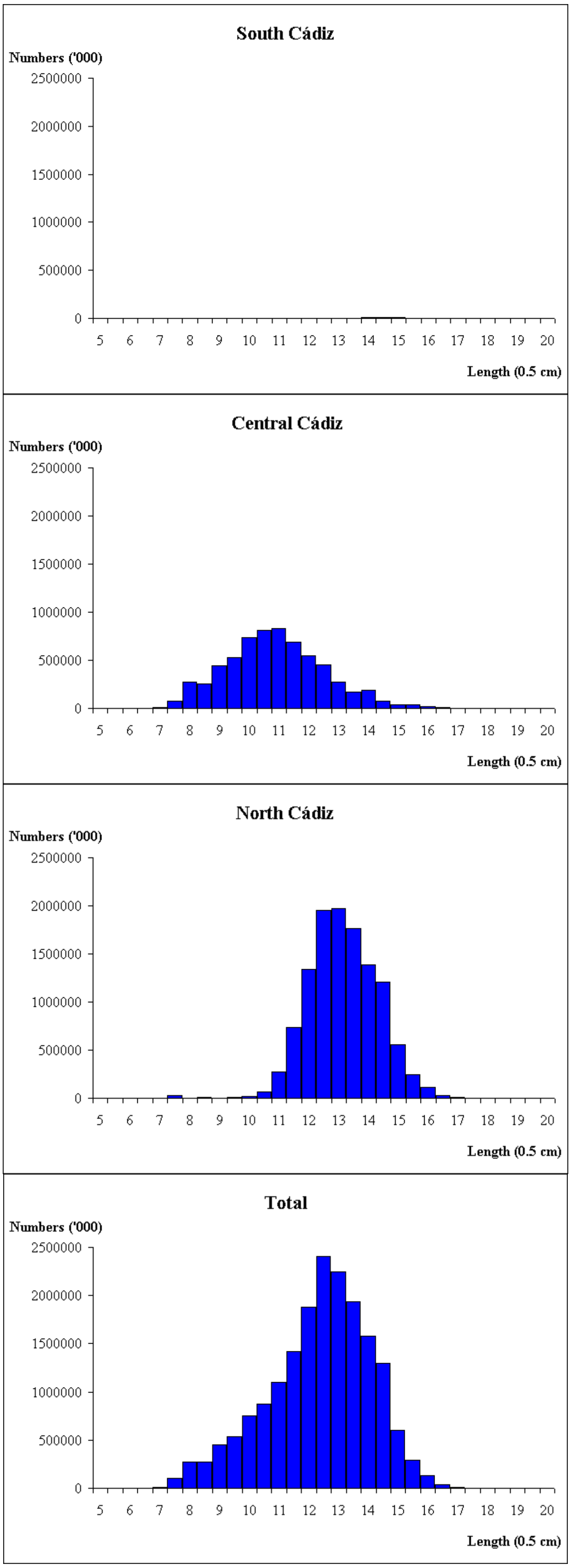


Figure 12.3.1.8 Anchovy length frequency distribution by region during the February 2002 Spanish acoustic survey in the Gulf of Cadiz.

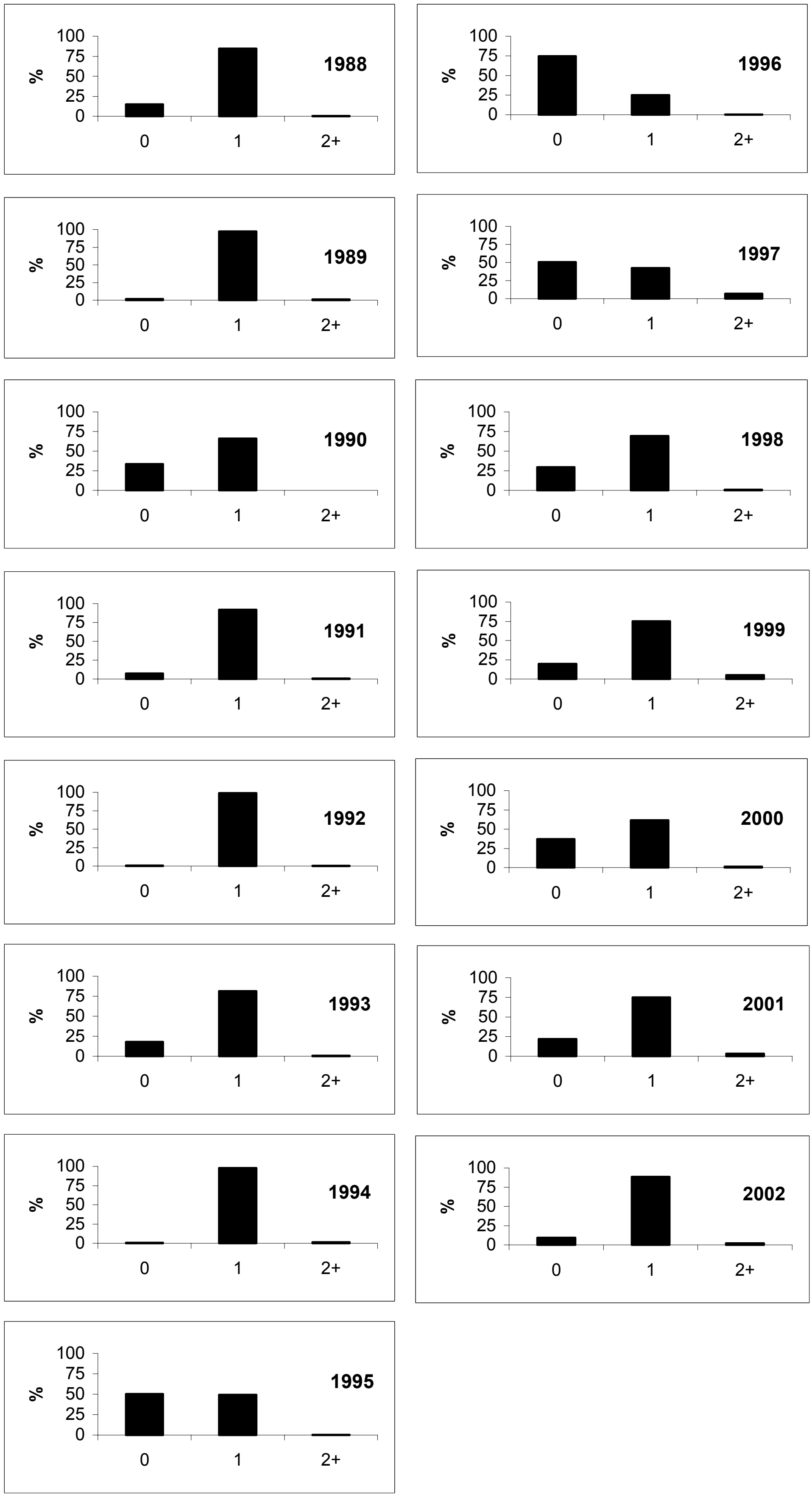


Figure 12.4.1.1. Age composition of Spanish catches of Gulf of Cadiz anchovy (Sub-division IXa-South; 1988-2002). Data for 1994 and second half in 1995 estimated from an iterated ALK by applying the Kimura and Chikuni's (1987) algorithm.

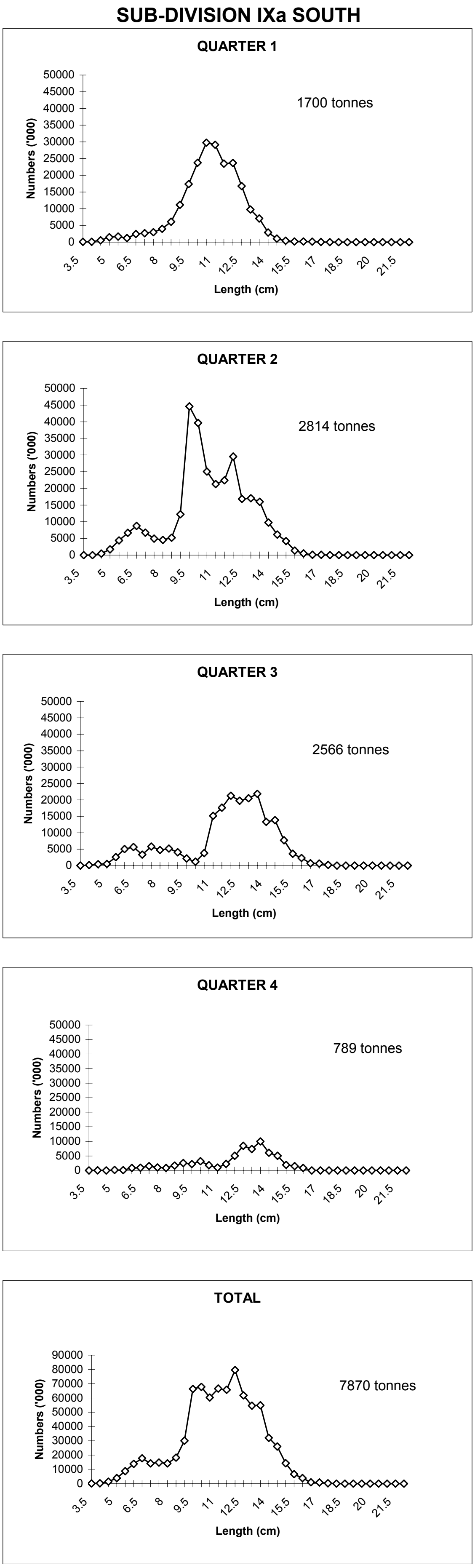


Figure 12.4.2.1. Length distribution ('000) of anchovy landings in Sub-division IXa South (Gulf of Cadiz) by quarter in 2002. Without data for Sub-division IXa North (Western Galicia).

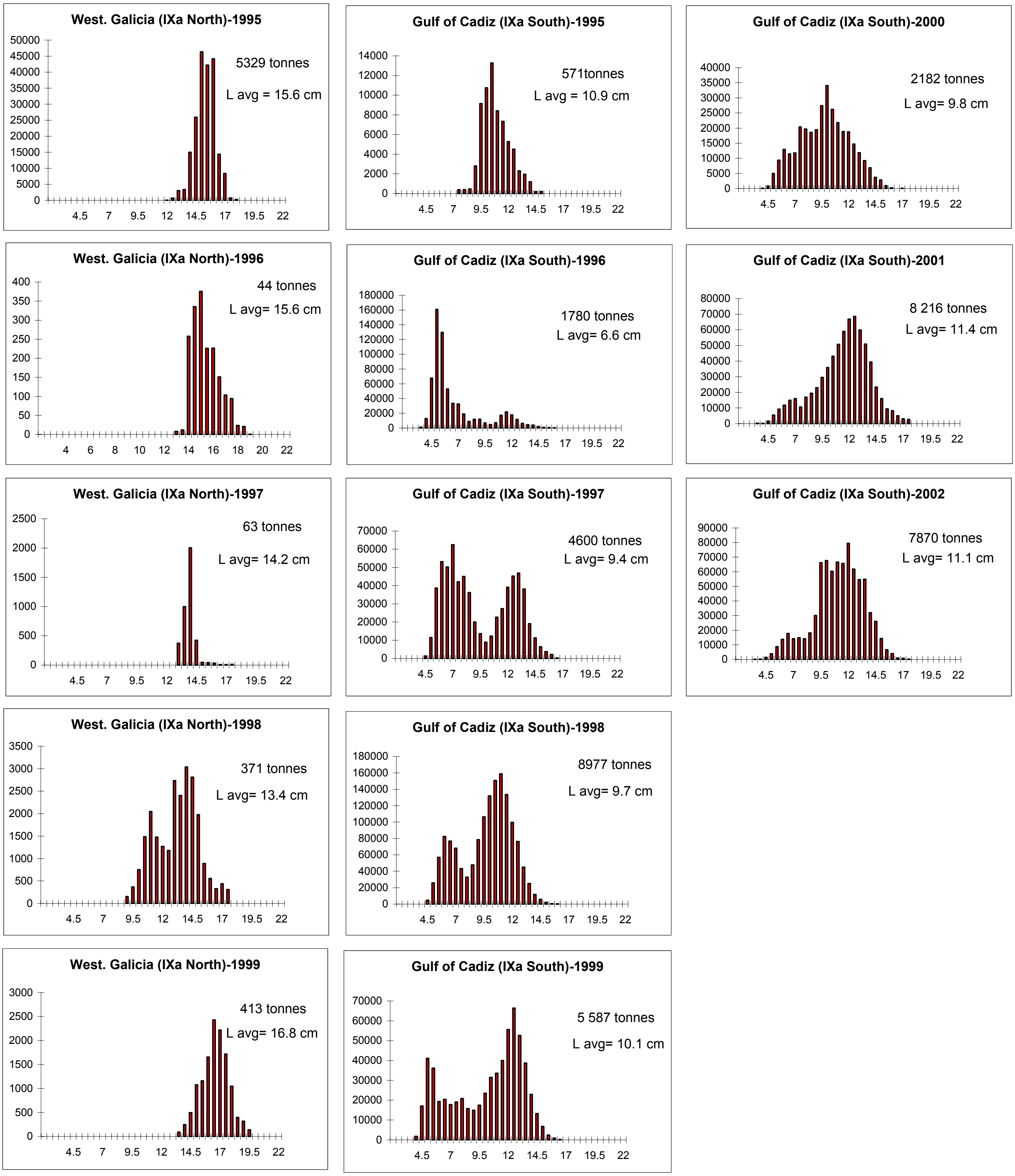


Figure 12.4.2.2. Length distribution ('000) of anchovy in Sub-divisions IXa South and IXa North (1995-2002).

Fishing effort (no of fishing trips)

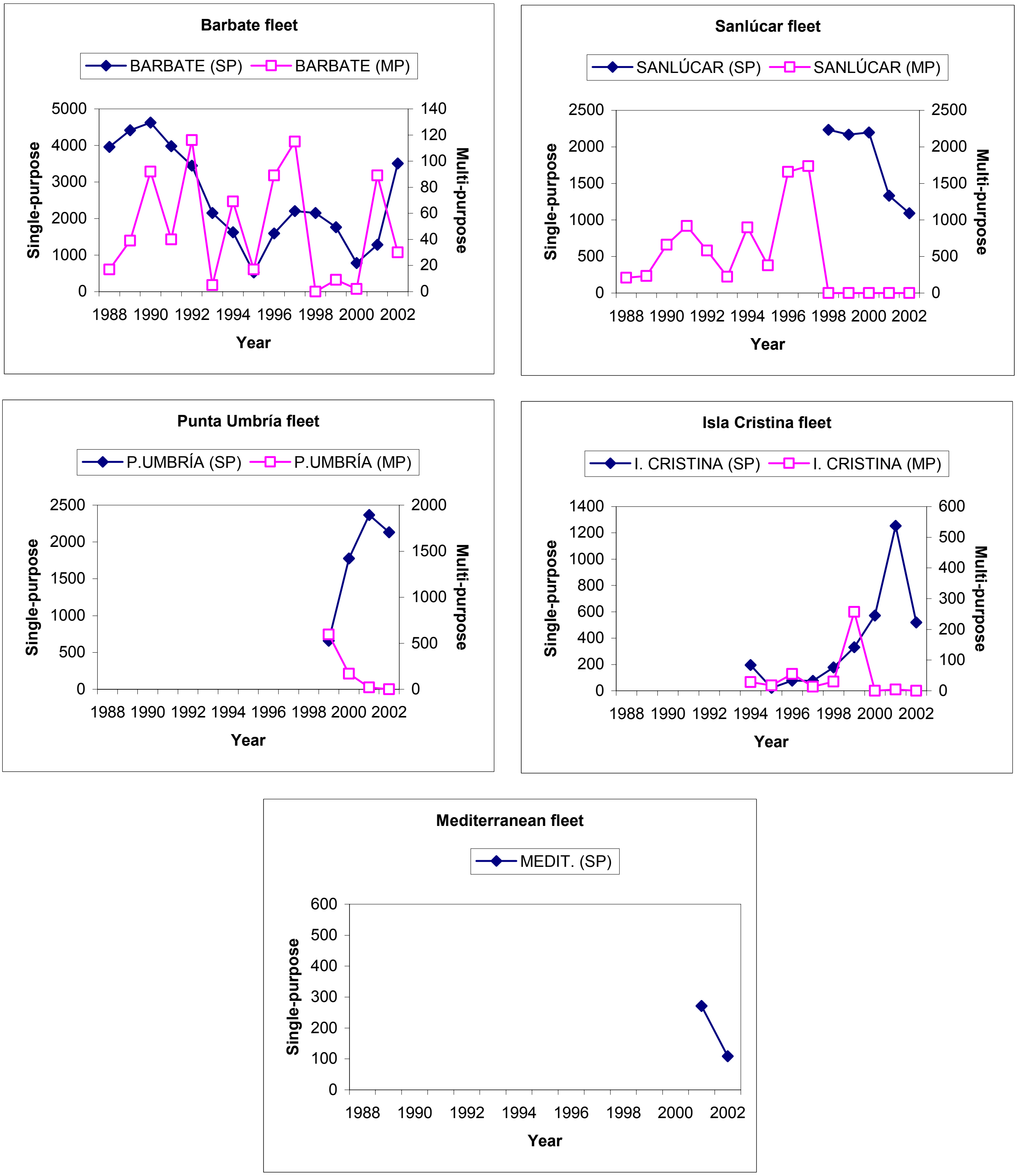


Figure 12.5.1. Anchovy in Division IXa. Spanish Effort series in commercial fisheries in Gulf of Cadiz (Sub-division IXa South). SP: Single-purpose purse-seine fleets; MP: Multi-purpose purse-seine fleets.

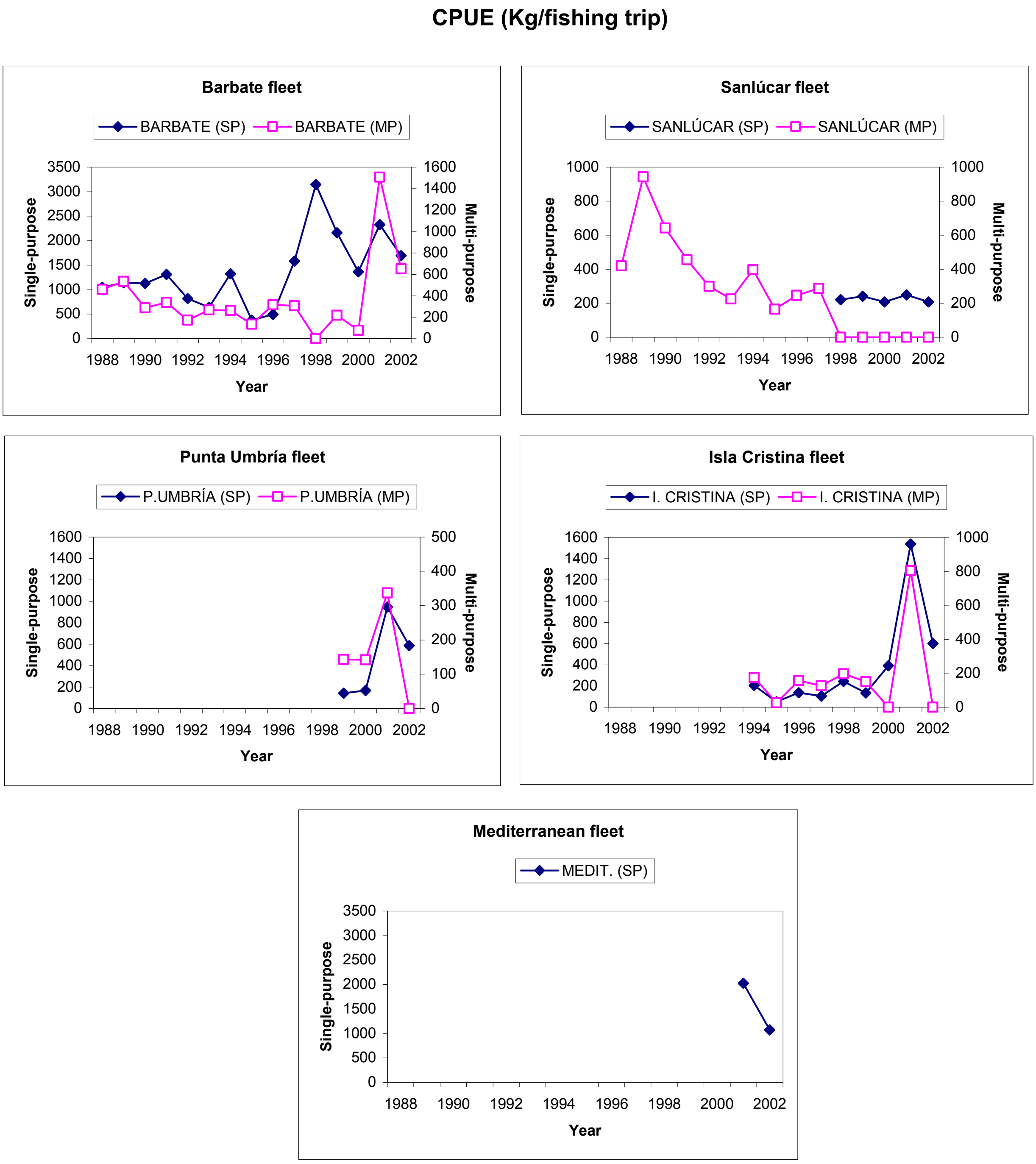


Figure 12.5.2. Anchovy in Division IXa. Spanish CPUE series in commercial fisheries in Gulf of Cadiz (Sub-division IXa South). SP: Single-purpose purse-seine fleets; MP: Multi-purpose purse-seine fleets.

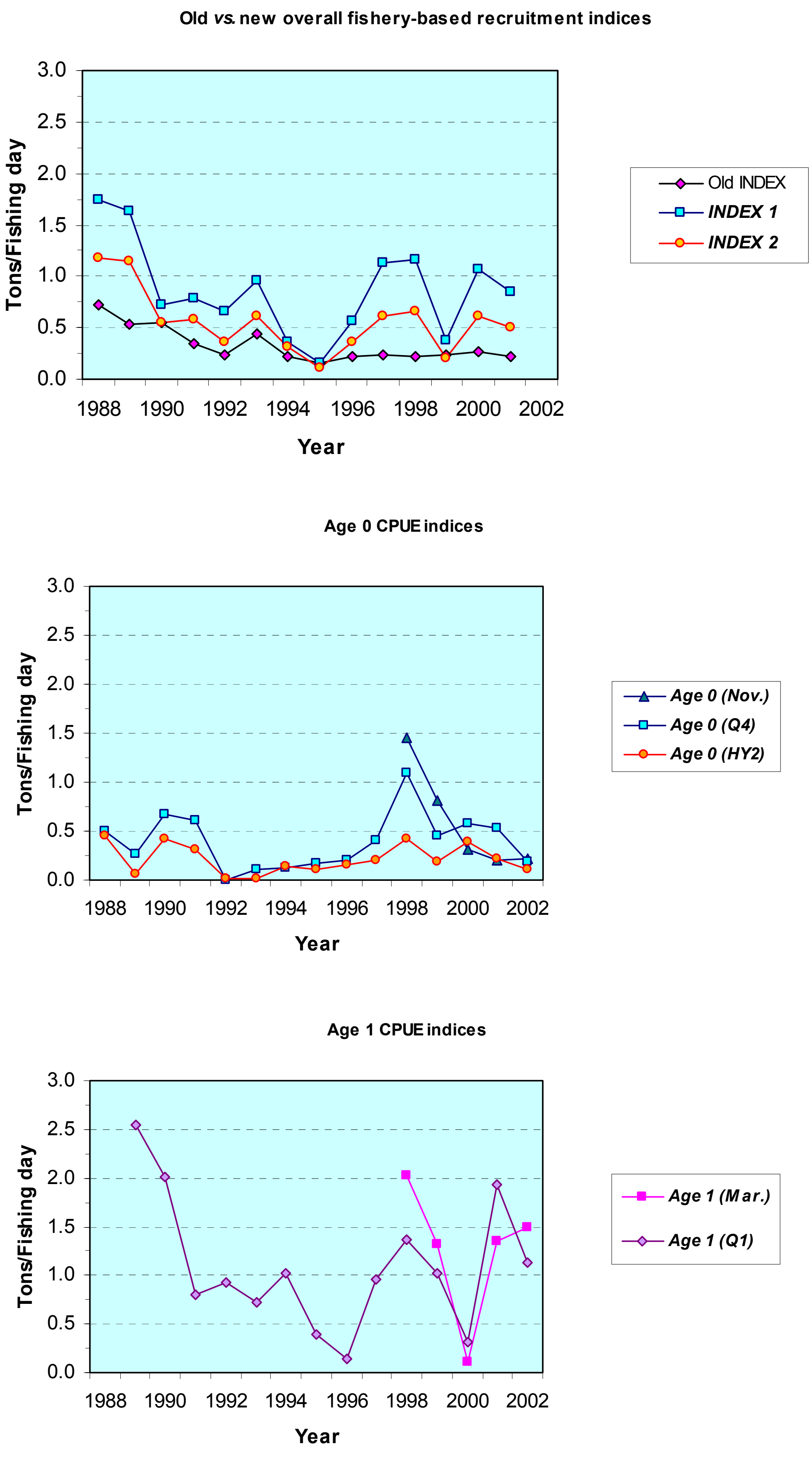


Figure 12.5.3 Fishery-based recruitment indices proposed for Gulf of Cadiz anchovy (structured catch rates expressed in standardised units of tonnes/fishing days).

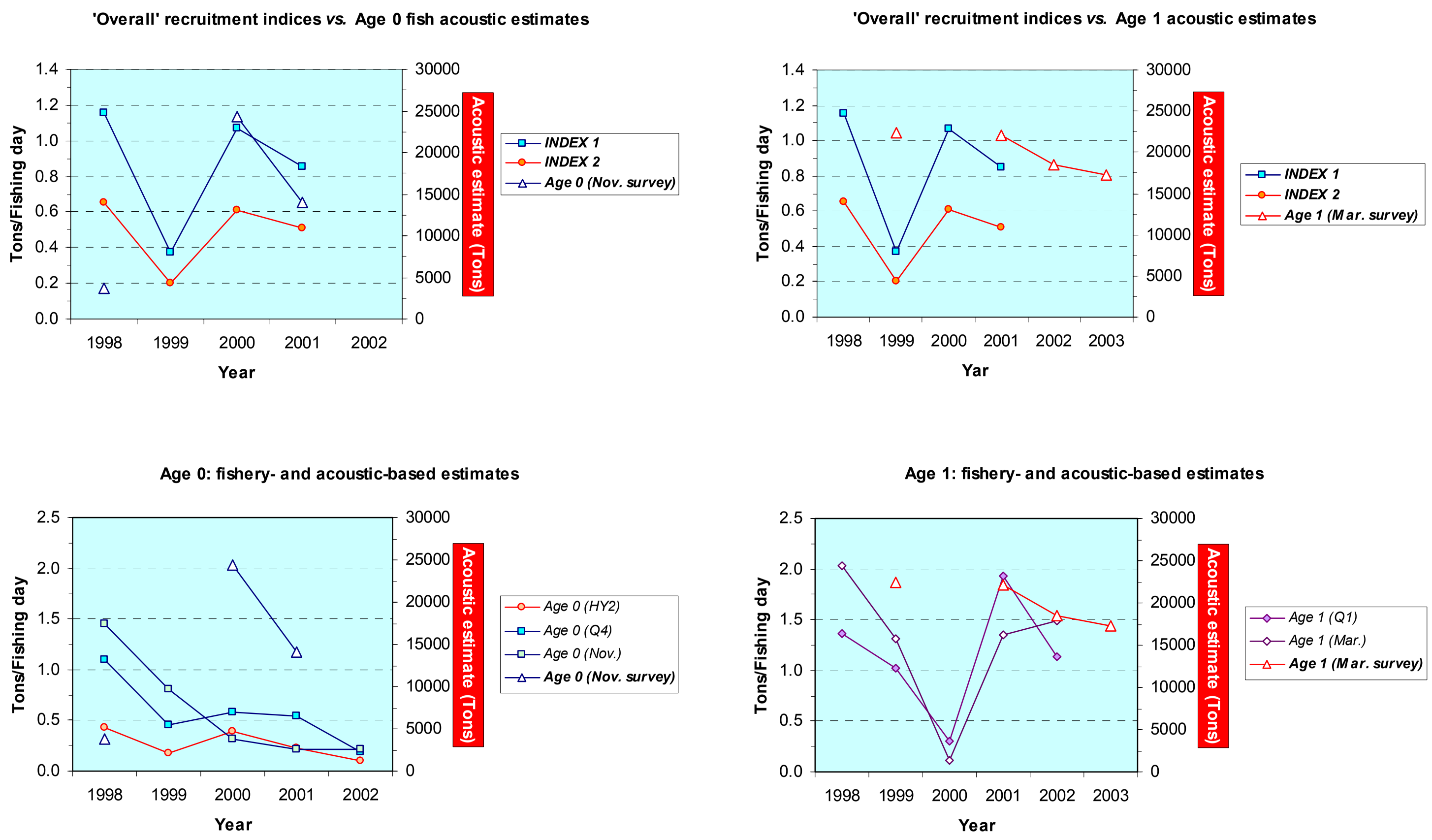


Figure 12.5.4 Comparisons of trends showed by fishery-based recruitment indices proposed for Gulf of Cadiz anchovy (structured catch rates expressed in standardised units of tonnes/fishing days) and age-structured estimates of biomass (tonnes) in Portuguese acoustics surveys in Sub-division IXa South.

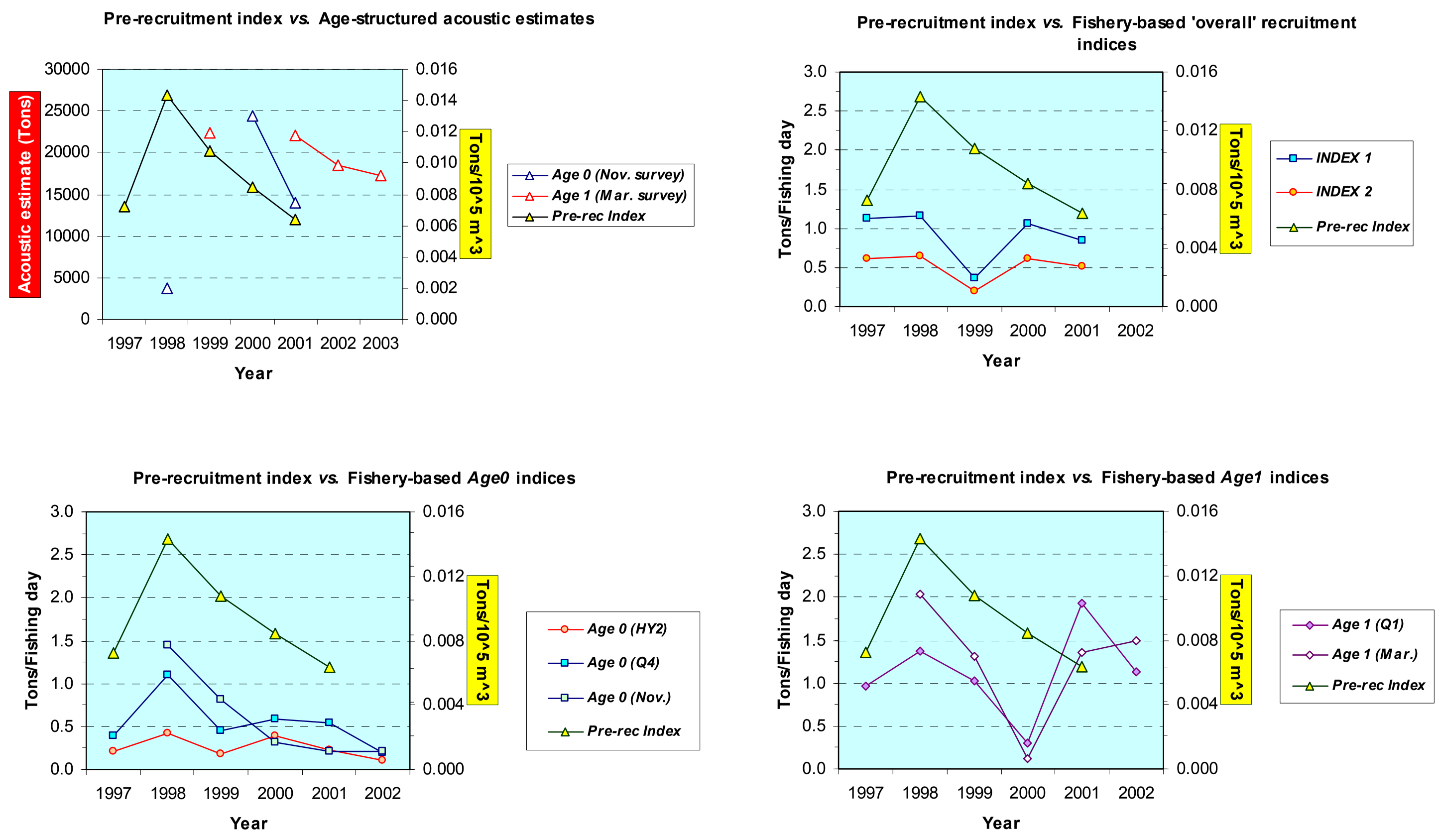


Figure 12.5.5 Comparisons of trends between acoustic estimates (upper left) and fishery-based recruitment indices proposed for Gulf of Cadiz anchovy (structured catch rates expressed in standardised units of tonnes/fishing days) and the anchovy pre-recruitment index in the Guadalquivir river estuary (tonnes/10^5 m^3).

	CPUE	Portuguese Ac. Surv.
RUN0	Not standardised	whole series
RUN1	Standardised	whole series

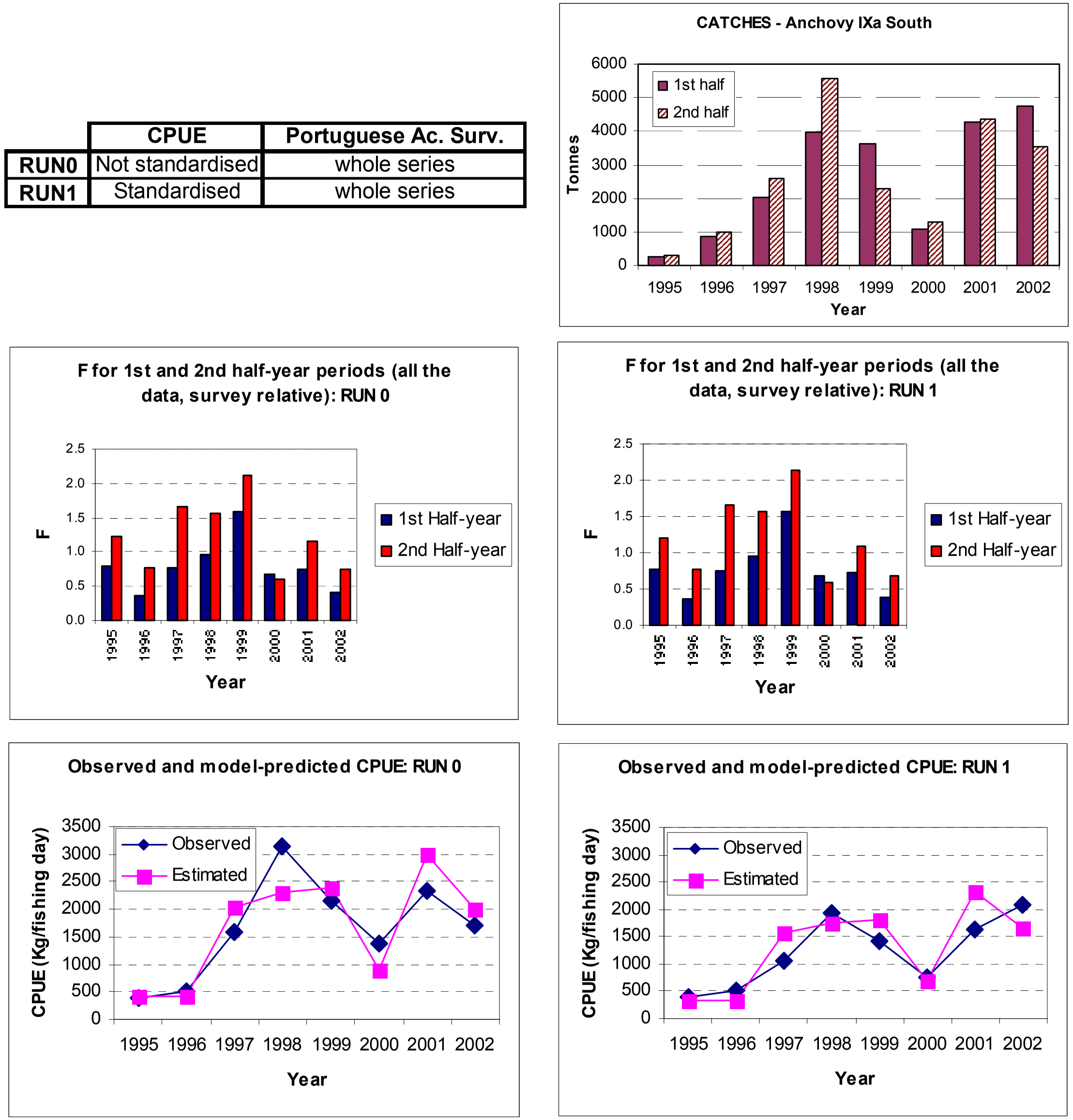


Figure 12.6.1 Anchovy in Sub-division IXa South. Catches on a half-year basis (1995-2002) and results from data exploration runs with the *ad-hoc* seasonal separable model: estimated fishing mortalities (F) by the separable model, and observed and model predicted CPUE for the Barbate single-purpose purse-seine fleet.

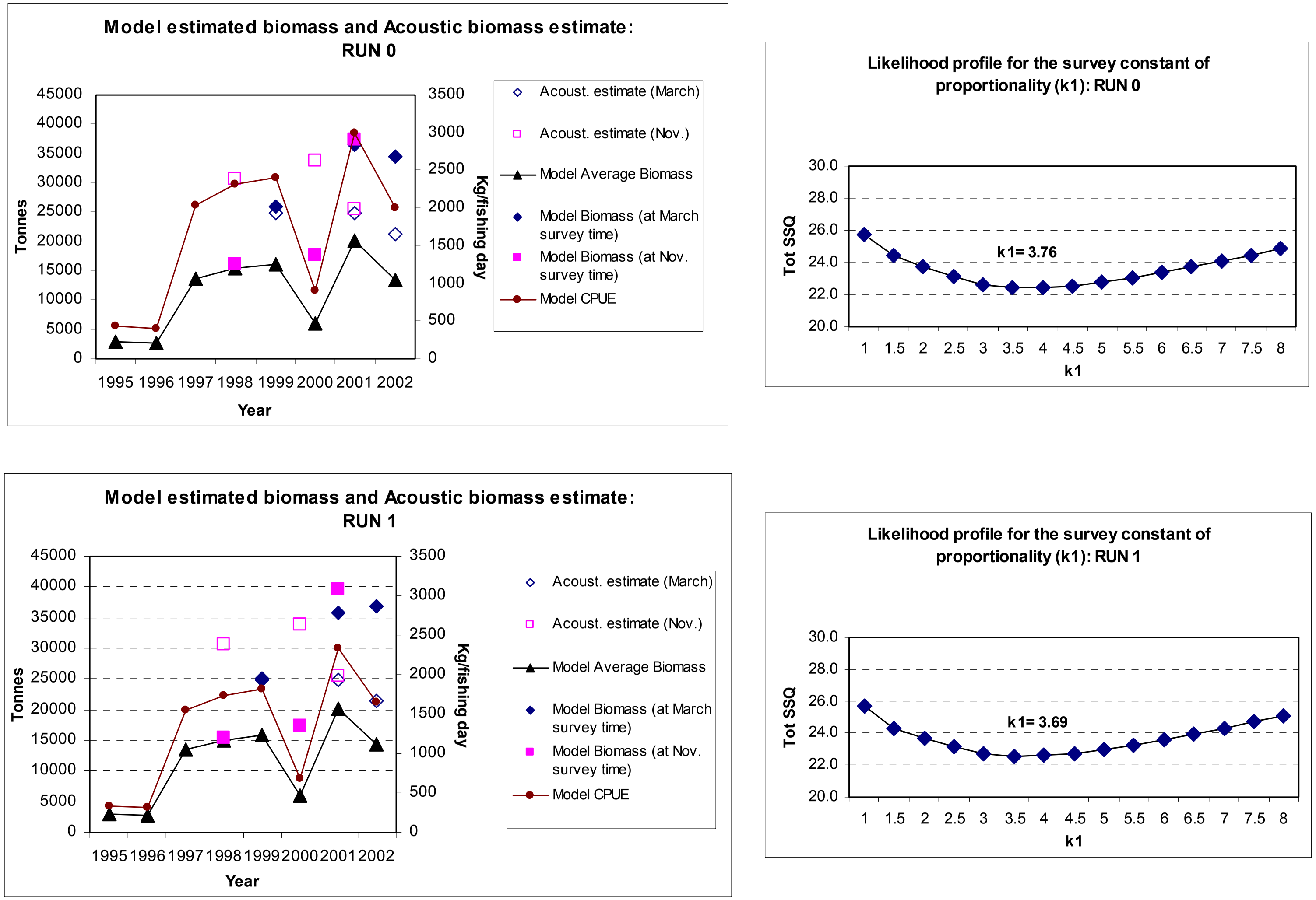
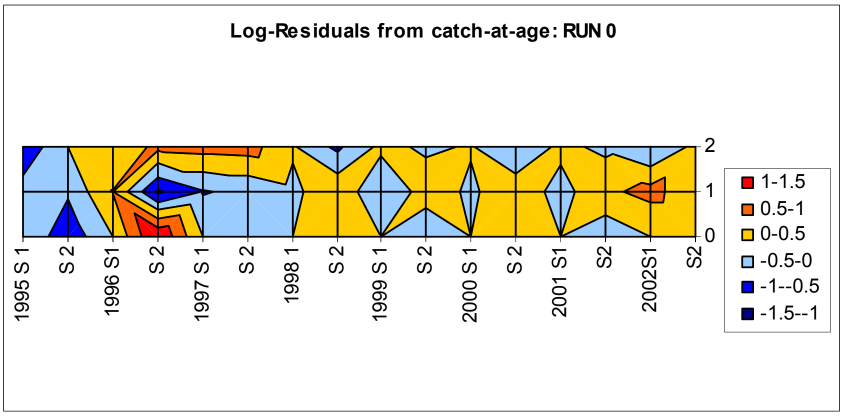


Figure 12.6.2 Anchovy in Sub-division IXa South. Results from data exploration runs with the *ad-hoc* seasonal separable model. Left: model estimated biomass and acoustic biomass estimates. Right: likelihood profile for the survey constant of proporcionality (k1).



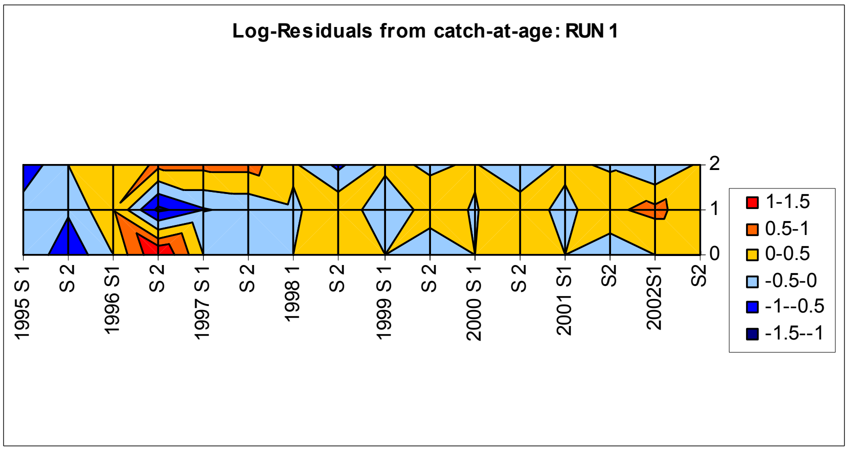


Figure 12.6.3 Anchovy in Sub-division IXa South. Results from data exploration runs with the *ad-hoc* seasonal separable model: log-residuals from catch-at-age data.

13 Recommendations

The Working Group recommends again that archives folder should be given access only to designated members of the MHSA WG

The Working Group recommends that national institutes increase national efforts to gain historic data, aiming to provide an overview which data are stored where, in which format and for what time frame.

The Working Group therefore recommends to ACFM to set $\mathbf{B}_{lim}$ for Western Horse Mackerel at 500,000 t, and to keep $\mathbf{B}_{pa}$ for NEA Mackerel at the well-established level of 2.3 Mill. t.

The Working Group recommends that French data for mackerel horse mackerel and sardine are made available to WGMHSA in 2004.

The Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. Existing observer programmes should be continued, and in the light of potentially upcoming strong year classes be intensified.

Mackerel

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

The Working Group highlights the possibility that discarding of small mackerel may again become a problem in all areas, particularly if a strong year class enters the fishery.

The Working Group again recommends that institutes examine their otolith preparation technique for mackerel before a new mackerel otolith exchange be carried out to evaluate the otolith processing techniques of all institutes that are providing age data to this Working Group.

Horse mackerel

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

The Working Group again recommends that observers should be placed on board vessels in those areas in which discarding may be a problem. Existing observer programmes should be continued, and in the light of potentially upcoming strong year classes be intensified.

Sardine

Anchovy Subarea VIII:

The WG group recommends that the biomass Model achieves proper standardisation, testing and variance estimation for next year 2004 so that it can be adopted as the standard for the assessment of this species.

The WG recommends to establish direct surveys on juveniles (0 group) or pre-recruits (1 year old) in order to improve advise for the management of this fishery. And it recommends to Ifremer and AZTI to collaborate in order to increase their effort by coordinating their respective surveys on pre-recruits or by doing a common one.

The WG recommends that the former ICES Planning Group for Pelagic Acoustic Surveys in ICES subareas VIII and IX (PG-PAS89) should be revived as an ICES/SPACC Study Group on Regional Ecology of Small Pelagics (SG-RESP).

The general objectives of such a group would be :

- To coordinate acoustic surveys in ICES subareas VIII and IX

- to understand how the biological cycle of small pelagic species is related to the ecosystem

- to increase our ability to use ecological and environmental information in the assessment and forecasting schemes of small pelagic stocks.

These general objectives would be met primarily by integrating survey data and environmental data at regional scale. Target species would be anchovy, sardine, horse mackerel and mackerel.

Anchovy in Division IXa

The Working Group recommends that direct surveying of the Subdivision IXa South anchovy by Acoustics and Egg (DEPM) surveys are pursued in the short-term given that it is impossible to carry out a reliable assessment of this population without this information, particularly by the scaling role of the absolute estimates.

The Working Group regards the 2002 Spanish (two vessels inter-calibration) acoustic survey conducted in the Gulf of Cadiz (Subdivision IXa South) as a positive development and recommends its continuation in next years. Further, given the contrasted acoustic estimates obtained in this survey by the R/V 'Cornide de Saavedra' as compared to the ones from the Portuguese survey (conducted one month after), the Working Group recommends that results from the above Spanish inter-calibration experiment be provided if available to the next WG meeting.

The Working Group recommends that previous and new age determinations of the Gulf of Cadiz anchovy according to the recommendations proposed in the 2002 Workshop on Anchovy otoliths and endorsed by this Working Group be provided to the next year meeting.

The Working Group recommends to recover all the information available on the anchovy fishery and biology (including information on age structure by Subdivision if available) off Portuguese waters.

The Working Group recommends to continue with the provision of all the information available on anchovy from the Portuguese acoustic surveys conducted in Division IXa.

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15 ABSTRACTS OF WORKING DOCUMENTS

WD 01/03

Abaunza, P., Murta, A., Molloy, J., Nascetti, G., Mattiucci, S., Cimmaruta, R., Magoulas, A., Sanjuan, A., Comesaña, S., MacKenzie, K., Iversen, S., Dahle, G., Gordo, L., Zimmermann, C., Stransky, C., Santamaria, M. T., Ramos, P., Quinta, R., Pereira, A. L., Campbell, N.

New findings on horse mackerel stock structure in the Northeast Atlantic and the Mediterranean Sea- Results of the EU-Project HOMSIR.

Document available from: Pablo Abaunza, Instituto Español de Oceanografía. Apdo: 240, 39080 Santander, Spain.

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In the ICES area, horse mackerel stocks have been defined mainly on the basis of the egg distribution. Currently, three different stocks are used for assessment purposes: The western stock (North-east continental shelf of Europe, from France to Norway); the North Sea stock (North Sea area) and the Southern stock (Atlantic waters of the Iberian peninsula). Special attention has been focused on the current stock definition, recognizing the uncertainties in the distribution limits and the lack of biological information to support such stock units. There are just a few papers about the stock structure in the ICES area and they cover only a small part of the stock distribution, or the information is so scarce that it is not possible to conclude the delineation of subpopulations. The concept of stock separation can be considered under two points of view: the genetic approach and the operational approach. In essence, the stock concept describes the characteristics of the units assumed homogeneus for a particular management purpose. Fish stocks are identified on the basis of differences in characteristics between stocks. Investigation of any single characteristic will not necessarily reveal stock differences even when "true" stock differences exist (Type I error). To overcome this difficulty, a holistic approach of fish stock identification, involving a broad spectrum of techniques, appears to be pertinent. The EU-funded HOMSIR project (A multidisciplinary approach using genetic markers and biological tags in horse mackerel (*Trachurus trachurus*) stock structure analysis), was conducted with this philosophy until June 2003, and its main results for horse mackerel in the Northeast Atlantic are briefly presented here.

- North Sea population is differentiated, especially by using parasites as biological tags, from the western areas, although a limited mixing between them could exist.
- It is proposed to revise the boundaries for the Southern stock. Various approaches distinguish the West coast of the Iberian Peninsula from the rest of the Atlantic Areas.
- The results suggest a limited mixing of the adult fraction of the population among different areas. This explains the difficulties in obtaining appropriate genetic markers.

WD 02/03

Carrera, P.

Preliminary results of the inter-ship acoustic calibration in the gulf of Cadiz signoise report.

Document available from: Pablo Carrera, Museo do Mar de Galicia Avenida Atlántida 160, 36208 Vigo, Spain.

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Ship noise is recognised as a potential source of error in fish abundance estimations, specially using acoustic equipments. Fish behaviour, either by avoidance or scaping reactions, would produce underestimation, yet, some experiences have shown no significant effect, specially in modern research vessels.

In 2001 a new research vessel was built in Spain. The R/V Vizconde de Eza a modern trawler equiped with an electrical engine and a fixed blades propeler, was designed aiming at to follow the ICES recommendations on ship noise. On the contrary, R/V Cornide de Saavedra, built 1970, has a controlable pitch propeler, thus, noiser than the R/V Vizconde de Eza.

In orther to both check the new vessel and to test the effect of noise on the acoustic estimation, a intercalibration survey between both ships was carried out in the Gulf of Cadiz. This area was chosen because of the fish abundance and the higher diversity as compaired with the nothern Spanish waters. Also, the survey was designed to provide fish abundance estimation.

WD 03/03

Dickey-Collas, M. and Eltink, A. T. G. W.

The precision of numbers at age and mean weight estimation of mackerel and horse mackerel from Dutch market sampling from 1998 to 2002.

Document available from: Mark Dickey-Collas, Animal Sciences Group, Wageningen UR, Netherlands Institute for Fisheries Research (RIVO), P.O. Box 68, 1970 AB IJmuiden, Netherlands.

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A bootstrap method for the analysis of the precision of numbers at age and weight at age is used to investigate the Dutch sampling and raising procedure for mackerel and horse mackerel. Estimates of weight at age were found to be precise (<5% for most stocks). For Western horse mackerel and NE Atlantic mackerel, the level of precision in numbers at age for the majority of the catch was found to be similar to that of other fish investigated in recent studies, and thus thought not to impact greatly on the quality of the assessment. Problems in the estimation of numbers at age were encountered for immature horse mackerel and all ages of North Sea horse mackerel. For all stocks the precision on the oldest ages was poor. Other countries that catch mackerel and horse mackerel should carry out similar exercises so that the precision of the total international catch can be assessed and then optimal sampling strategies can be determined.

WD 04/03

Iversen S. A., Skogen M. and Svendsen E.

A prediction of the Norwegian catch level of horse mackerel in 2003.

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Norway has for several years been the major nation fishing for horse mackerel in the North Sea and Norwegian Sea. This fishery is carried out in October-November in a directed fishery by purse seiners in the Norwegian economical zone (NEZ) of the northern part of the North Sea and in the southern part of the Norwegian Sea. The Norwegian fishery in NEZ is not regulated by any measures and the fishery and is considered to reflect the availability and abundance of horse mackerel in this area during the autumn. The Norwegian catch levels, except for 2000, seem to fit well with the estimated influx (wind driven model) of Atlantic water to the North Sea the first quarter of the fishing year. The estimated influx in 2003 is indicating a Norwegian catch of a similar level as in 2002 (about 30,000 tons).

WD 05/03

Marques, V. and Morais, A.

Abundance Estimation and Distribution of Sardine (*Sardina pilchardus*) and Anchovy (*Engraulis encrasicolus)* off the Portuguese Continental Waters and Gulf of Cadiz (November 2002/February 2003).

Document available from: Vítor Marques, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal.

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This paper presents the main results of the Portuguese acoustic surveys carried out during November 2002 and February 2003 with R. V. "Noruega". These surveys were supported by the Portuguese "PNAB-data collection program". Concerning the November 2002 survey, the area was not entirely covered, due to bad weather. Only Algarve zone was completely covered and the sardine abundance is provided only for this area.

The February 2003 survey covered the Portuguese continental shelf and the Gulf of Cadiz. The working document provides abundance estimates of sardine (*Sardina pilchardus*) by age classes and anchovy (*Engraulis encrasicolus*) by length classes and its distribution in the surveyed area. The total abundance estimated for sardine was 432 thousand tonnes (13.3 x 10^9 individuals). Anchovy total estimated abundance was 24.7 thousand tonnes (2328 x 10^6 individuals).

The Portuguese quarterly landings, for anchovy, by Sub-Divisions and by gear, are also presented.

A correction of the anchovy estimates for Cadiz in the March 2002 survey is presented.

WD 06/03

Massé, J.

Direct assessment of anchovy by the PELGAS03 acoustic survey.

Document available from: Jacques Masse, Laboratoire ECOHAL, IFREMER, BP 21105, 44311 Nantes Cedex 01, France.

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An acoustic survey was carried out in the bay of Biscay from May 27th to June 25th on board the French research vessel Thalassa. The objective of PELGAS03 survey was to study the abundance and distribution of pelagic fish in the Bay of Biscay. The target species were mainly sardine and anchovy but had to be considered in a multi-specific context. The results have to be used during ICES working groups in charge of the assessment of sardine, anchovy, mackerel and horse mackerel and in the frame of the Ifremer fisheries ecology program "resources variability".

To assess an optimum horizontal and vertical description of the area, two types of actions were combined : 1) Continuous acquisition by storing acoustic data from four different frequencies and pumping sea-water under the surface, in order to evaluate the number of fish eggs using CUFES system, and 2) discrete sampling at stations. Satellite imagery (temperature and sea colour) and modelisation were also used before and during the cruise to recognise the main physical and biological structures and to improve the sampling strategy. Concurrently, a visual counting and identification of cetaceans (from board) and of birds (by plane) was carried out in order to characterise the higher level predators of the pelagic ecosystem.

This survey was considered in the frame of the national FOREVAR program which is the French contribution to the international Globec programme. Furthermore, this task is formally included in the first priorities defined by the Commission regulation (EC) No 1639/2001 of 25 July 2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000.

WD 07/03

Petitgas, P. and Massé, J.

Orders of magnitude for some biological processes in Biscay anchovy population.

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The intention of this note is to open a discussion. We derive orders of magnitude for biological processes in the anchovy population that we believe are like buoys in a channel marking the route. We focus on estimates for lowest possible stock, predation mortality and age-0 fishing mortality, as these elements should also mark the route in the production of advice.

WD 08/03

Petitgas, P., Allain, G. and Lazure, p.

A recruitment index for anchovy in 2004 in Biscay.

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The IFREMER recruitment index is based on a multi-linear regression of the anchovy abundance on environmental indices. The anchovy abundance considered is the abundance at age 1 on january 1 of year y, as estimated by the ICES WG with the procedure ICA. The environmental indices are extracted from the hydrodynamic model of IFREMER for the French part of the continental shelf of Biscay. The period considered for constructing the environmental indices is march 1 to july 31 of year y-1. The regression model was adjusted using the values given in the 1998 and 2003 reports of the ICES WG. For predicting anchovy abundance at age1 in 2004, environmental indices have been extracted from the hydrodynamic model for the period march-july 2003, and the regression model fitted on the historical series used in extrapolation mode. This document is an update of that provided to the ICES WG in september 2002 which incorporates the population age 1 abundance estimate for 2003.

WD 09/03

Petitgas, P., Massé, J. and Vaz, S.

Biological basis for the management of the anchovy in Biscay based on the analysis of the spring acoustic surveys.

Document available from: Pierre Petitgas, IFREMER, BP 21105, F- 44311, Nantes, France.

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The series of spring acoustic surveys in Biscay (1983-2002) provides information on the spatial distribution of anchovy and on its biological traits. Such information has been analysed in its interaction with the population dynamics. Population dynamics interacts with vital rates in particular spatial zones. Such Result allows to revisit the basis of the present management rules and alternative rules are suggested that answer better to the conservation of the population than the present rules.

WD 10/03

Ramos, F., Millán, M. and Sobrino, I.

Searching for a fishery-based recruitment index under situations of limited direct estimates: the case of anchovy in ICES Subdivision IXa south.

Document available from: Fernando Ramos, Instituto Español de Oceanografía. P.O. Box 2609, 11006 Cádiz, Spain.

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Anchovy dynamics from Subdivision IXa south is being recently modelled by a biomass based (delay-difference) model. Problems found when fitting input data to the model suggested the need of additional information on recruitment. Direct estimates of recruitment may be inferred from the Portuguese acoustic survey series, although only since 1998. First trials with the biomass model used the aggregated and not-standardised CPUE of the Sanlúcar fleet for the period including the fourth quarter in the year and the first quarter in the next year as a fishery-based recruitment index. In the present work several new standardised catch-rates time series have been estimated as alternative fishery-based recruitment indices. Such indices contain age-structured information on the recruitment to the fishery. They have been estimated taking into consideration those fleets and fishing grounds that better reflected the recruitment to the fishery. Additionally, an anchovy pre-recruits index is presented for the first time to this WG. This index resumes the incorporation of pre-recruits to the Guadalquivir estuary, one of the main anchovy nursery areas in the region. Both this index and the biomass acoustic estimates (aggregated and age-structured) have been used as a means of validation of the fishery-based recruitment indices. However, results from this validation should be considered with caution because the shortness of the time series of data obtained from direct methods. Furthermore, a different perception of the recruitment in 1998 is obtained from the acoustic survey in relation to that showed by the pre-recruits index and fishery-based ones. Despite these problems we feel that these new fishery-based recruitment indices may be an acceptable alternative to the lacking of direct estimates. Unfortunately, the performance of these indices only can be assessed by the realisation of new assessment trials.

WD 11/03

Reid, D. G.

Investigation of correlates to observed mackerel fecundity changes 1995 to 1998.

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One of the key elements in the production of a biomass estimate for mackerel (Scomber scombrus) form the Triennial mackerel and horse mackerel egg survey is the total fecundity estimate. From 1983 onwards the value was relatively constant between 1457 and 1608 egg g^{-1} female. In 1995 this dropped dramatically to 1206, and again in 2001 to 1097. The drop in 1998 coincided with a relatively low egg production $1.49 * 10^{15}$ (cf. 1995 $1.94 * 10^{15}$). This resulted in a biomass estimate in 1995 of 2.47 million tonnes and in 1998 of 2.95 million tonnes. The combination of a drop in egg production but a rise in biomass caused some disquiet at the time and led to changes in the calculation of the SSB in the assessment – a switch from absolute to relative use of the survey index as a tuning factor. It also led to an intensified fecundity sampling programme in 2001. This provided a fecundity estimate of 1097, a further drop from 1998, and tending to confirm the validity of that estimate. The time series of the potential fecundity (eggs g^{-1}) is presented in Figure 1.

One question raised about the change in fecundity between 1995 and 1998 was whether there were any other changes in the fish sampled. Were the samples broadly similar, was there a change in condition factor and were there any other differences which might explain the change?

In this WD is set out to examine the samples collected in 1995 and 1998 to determine what, if any, differences could be seen, and whether they might explain the change in fecundity.

WD 12/03

Reid, D. G., Eltink, A. T. G. W., and Kelly, C. J.

Inferences on the changes in pattern in the prespawning migration of the western mackerel (*Scomber scombrus*) from commercial vessel data.

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The changes in the timing of the pre-spawning migration of the western spawning component of the north-east Atlantic mackerel have been dramatic over the last 30 years. While this has been widely recognized the last published information on this was by Walsh & Martin in 1986. This paper sets out to bring this work up to date using further data gathered within the SEFOS project and new data on commercial catches since 1997. The commercial data used was not official catch statistics, but was derived from these and modified based on observer data and personal contacts with vessels. Walsh & Martin showed that the migration became steadily later from 1976 to 1984. Catches in ICES Division VIa peaked in early September in 1976 and in mid December by 1984. SEFOS data showed that this continued until 1987 when it peaked in early to mid February. Thereafter, it remained fairly steady until 1994. The latest data collections shows that the peak occurred as late as early March in 1999, but has fallen back to late January/early February. There are some indications that the migration may be starting to occur earlier again. Potential links with sea temperatures at the time of the start of migration were investigated but no clear links were observed. The timing of the migration, the use of commercial vessels for such studies and the implications for management are discussed.

WD 13/03

Roel, B. A., Uriarte, A. and Ibaibarriaga, L.

A two-step TAC procedure for the anchovy of the bay of Biscay.

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The fishery for the anchovy of the bay of Biscay is managed by annual TACs usually fixed at 33 000 t, not based on scientific advice. This is due to the difficulties for managing properly this short living fish species. The resource shows strong and short-term fluctuations in biomass linked to variability in recruitment strongly influenced by environmental factors. The Spawning Stock Biomass is determined by the abundance level of the incoming year class which currently cannot be determined with sufficient accuracy to recommend an annual TAC at the beginning of the fishing season. And this situation led ICES to recommend a two stage TAC approach to review a provisional TAC set at the beginning of the year in the light of the survey estimates of the population at the middle of the year. But this procedure has not been fully tested and the EC wish for a comprehensive approach to the management of this anchovy population in the Bay of Biscay.

At present, ICES provides advice in accordance with its proposal of a two-stage regime, where a preliminary TAC is set at the beginning of the year based on an analytic assessment in the autumn, and revised according to the fishery in the first half of the year, and survey results obtained in May-June from acoustic and Daily Egg Production Method (DEPM). In order to be precautionary, the preliminary TAC set at the beginning of the year aims at keeping the stock safely above B_{lim} even if the incoming year class is poor".

Given the short-lived nature of anchovy an annual fixed TAC seems to be inappropriate. A regime consisting of an initial annual TAC which is revised after the survey estimates of biomass become available, beginning of June, was tested by means of a simulation framework

WD 14/03

Santos, M., Uriarte, A. and Ibaibarriaga, L.

Estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2002.

Document available from: Maria Santos, AZTI, Instituto Tecnológico Pesquero y Alimentario, San Sebastián, País Vasco, España.

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The assessment and scientific advice on the Bay of Biscay anchovy, entirely depends upon the availability of population direct estimates. An application of the Daily Egg Production Method (DEPM) to estimate the Biomass and population of anchovy in the Bay of Biscay has been carried out in 2002 by AZTI within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission. The survey covered southeast of the Bay of Biscay in May 2002 for estimating egg abundance and Daily egg production. Adult samples required for the estimation of adult fecundity parameters were obtained from oportunistic samples from the purse seiners and from the trawls of the acoustic survey carried out by IFREMER (Nantes).

Within this international context, the current survey contributes to its main objective, which is to provide biomass, and population estimates of the anchovy in the Bay of Biscay on a yearly basis for its submission to the ICES working group on the assessment of this species.

This document describes the definitive estimates of the level of the anchovy stock in the Bay of Biscay in 2002 that was about 30,700 tonnes

These results were also presented in the Ad hoc working group on "In season assessment of anchovy in the Bay of Biscay" to provide the Commission with scientific background for management, conducted by AZTI from 7 to 11 July, 2003, in San Sebastian (Spain).

WD 15/03

Santos, M., Uriarte, A. and Ibaibarriaga, L.

Estimates of the Spawning Stock Biomass of the Bay of Biscay anchovy (*Engraulis encrasicolus*, L.) in 2003.

Document available from: Maria Santos, AZTI, Instituto Tecnológico Pesquero y Alimentario, San Sebastián, País Vasco, España.

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The assessment and scientific advice on the Bay of Biscay anchovy entirely depends upon the availability of direct population estimates. An application of the Daily Egg Production Method (DEPM) to estimate the biomass and population of anchovy in the Bay of Biscay is been carried out in 2003 by AZTI (Technological Institute for Fisheries and Food, Pasajes) within the frame of the Spanish Fishery Monitoring National Programme contracted with the European Commission. The egg survey for estimating total daily egg production has been conducted from the end of May to the beginning of June in 2003 covering the southeast of the Bay of Biscay. Adult samples for the estimation of adult fecundity parameters for the DEPM implementation have been obtained simultaneously to the egg survey from three different sources. An acoustic survey carried out by IFREMER (Nantes), an adult sampling on board a purse-seine carried out by AZTI and opportunistic samples provided by the purse-seine fleet.

This document presents preliminary estimates of biomass and numbers at age for 2003 of the Bay of Biscay anchovy from the DEPM. These estimates are based on the relationship between the total daily egg productions (P_{tot}) and the biomass estimates from the past DEPM series. The preliminary biomass estimate was 32,866 tonnes.

These results were presented as well in the Ad hoc working group on "In season assessment of anchovy in the Bay of Biscay" to provide the Commission with scientific background for management, conducted by AZTI from 7 to 11 July, 2003, in San Sebastian (Spain).

WD 16/03

Silva, A.

Analysing sardine catches and abundance estimates by ICES sub-division.

Document available from: Alexandra Silva, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal.

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Data from the sardine fisheries and acoustic surveys in ICES Divisions VIIIc and IXa since 1991 is analysed to provide information on sardine population structure, recruitment dynamics and exploitation pattern within the stock sub-divisions.

More than 80% of the sardine population is concentrated in the western and southern areas of the Iberian Peninsula, since the early 1990's. The western Portuguese coast and the Gulf of Cadiz are currently the main recruitment areas and the relative importance of year-classes may be different off the west coast and in Cadiz waters. According to catch data, the 1991 recruitment shows up as the strongest one in most areas, however, the 2000 year-class has an outstanding strength in the North Portuguese area. The subdivisions of the sardine stock may be grouped according to the typical age structure into an adult area (subdivisions VIIIc-East+West and subdivision IXa-South Algarve) and a nursery area (subdivisions IXa-North+IXa Central North+ IXa Central South and subdivision IXa- South Cadiz). Sardines appear to move gradually from recruitment to adult areas, however which of the subdivisions are mainly "sources" and which are the corresponding "sinks" has still to be clarified.

WD 17/03

Silva, A. and Chlaida, M.

Compilation of fisheries and survey data on sardine outside the Iberian stock area.

Document available from: Alexandra Silva, Instituto de Investigção das Pescas e do Mar, Avenida de Brasília, 1449-006, Lisboa, Portugal.

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Data on sardine landings and length distributions in areas to the north and to the south of the Iberian stock boundaries is presented in this WD.

Total landings in ICES Divisions VII and VIII varied between 3 thousand and 30 thousand tonnes in the period 1981-2001, coming mainly from trawl and seine fisheries in first and fourth quarters. The length distribution of landings in areas VIIe,f has been relatively stable (in the range 12-28 cm) and show a modal length between 22 and 24 cm. Landings from the northern Morocco stock varied from 3,6 to 33,3 thousand tonnes since 1960 (mean=14,9 thousand tonnes, being dominated by small individuals (median length=14,5 cm) in a few recent years. Sardine landings from the Cadiz area have varied from 2 to 11 thousand tonnes since 1978 (mean=5,0 thousand tonnes) and the two series of landings showing opposite trends in most of the period ($r=-0.43$, $r^2=0.24$).

WD 18/03

Simmonds, J.

The use of Egg Surveys as relative or absolute measures of abundance within ICA assessments of NEA mackerel.

Document available from: John Simmonds, FRS Marine Lab., P.O.Box 101, Victoria Road, Aberdeen AB11 9DB, Scotland, United Kingdom.

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Within ICA the historic stock is determined from a period of recent catch with error in numbers at age preceded by a deterministic VPA. The total catch in tonnes is used as an absolute value without error in the model in all years individually. In the converged VPA period the stock and SSB are independent of any tuning index. Thus the historic SSB is independent of the Egg Survey whether it is used as a relative or an absolute tuning index.

The conceptual difference between an index used as ‘relative’ or ‘absolute’ in ICA

Historically there are known to be errors in the total catch and currently we are uncertain of the extent of unreported fishing mortality for North Eastern Atlantic (NEA) mackerel. Missing mortality is predominantly unreported landings or landings reported as another species but grading or slippage also contributes. Thus it might be expected that there are indeed differences in the catch and the Egg Survey. Thus for management purposes it might be supposed that fitting the Egg Survey as a relative index is the safer option. However, fitting the index as a relative value requires an extra parameter to be included in the model and recent evaluation of the variability in the assessment due to the Egg Survey (ICES CM2003/X:10 in press) suggests that over parameterisation may be a problem for the assessment.

WD 19/03

Skagen, D. W.

Mortality of NEA mackerel estimated from tag recaptures.

Document available from: Dankert W. Skagen, Institute of Marine Research, P.O Box 1870 Nordnes, 5817 Bergen, Norway

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IMR has tagged mackerel on the spawning grounds from South-West of Ireland to Rona most years since 1969. In the last decades, approximately 20 000 fish have been tagged each year, except in 2000, when fewer tags were released due to poor working conditions. Internal steel tags inserted in the belly are used. The fish is caught by hand-line and the tagging technique is highly standardised with great care taken to avoid damage of the skin. Every fish that is tagged is length measured. Fish that look damaged are taken aside and used for biological examination, including ageing.

For this study, only tag releases from the period 1984-2002 are considered. Since estimating mortalities are done by comparing the recapture from subsequent releases, and recaptures from the release year should not be included, the last year for which mortality can be estimated is 2001. Data exist for years prior to 1984, but have so far not been edited for use by the present software.

WD 20/03

Skagen, D. W.

Some analyses of the sardine assessment data.

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At the 2002 MHSA WG, both ICA and AMCI were used for trial assessments. The results were quite diverging. The WG suspected that the ICA assessment might be wrong, but was not convinced that the AMCI assessment solved the problem. Thus, neither the WG nor ACFM were able to decide on a final assessment.

This Working Document is a further analysis of the data that went into the assessment in 2002. It is an extension of ideas that emerged in the Methods WG in 2003, on exploring some signals directly in the data, and on exploring how individual data influence the final outcome of the assessment. ICA and AMCI runs are compared on this background.

WD 21/03

Slotte, A.

Historic changes in the condition of NEA mackerel – Possible effects on fecundity.

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This paper is presented the analysis that based on the significant decline in relative fecundity (number of eggs per g female) of NEA mackerel observed in 1998 and 2001 compared with previous estimates. The main question asked is whether such low fecundity years in some way may be predicted and used in the MHSAWG to estimate SSB.

WD 22/03

Stratoudakis, Y. and Bernal, M.

Revised series of sardine spawning biomass estimates from Iberian DEPM surveys: traditional and GAM-based estimation.

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Based on the work performed up to SGSBSA meeting in Malaga (June 2003) and the uncertainties described in its report, it was recommended that a Working Document should be prepared by members of the group and presented to the WGMHMSA meeting in 2003.

Study Group provides spawning biomass estimates for the stock only in years that it considers estimation to be currently reliable (1999 and 2002). These two estimates could be considered to provide an absolute estimate of stock biomass at the time of the surveys. However, simple observation of the egg distribution across surveys demonstrates that considerable changes in the spawning dynamics of sardine have occurred in the start of the 1990s. To allow some of this information to be used in assessment, the Group has also decided to provide the two series of spawning biomass estimates for sub-areas of the stock with contrasting temporal evolution: the series of 5 points in northern Spain (where the 1990 estimate is also included for the first time) and a series of 3 points for western Portugal (where a reliable estimate for southern Iberia can be obtained). These series would inevitably have to be used as relative indices of abundance in routine assessment, but could be used as absolute in corresponding area-based assessment exercises.

WD 23/03

Ulleweit, J.

Discards of Mackerel and Horse Mackerel in the German Commercial Fishery.

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As part of the EU-funded National Data Collection Program 18 German commercial fishing cruises were investigated by biological observers. The data obtained were used for calculating discard rates of mackerel and horse mackerel.

In the pelagic directed fishery, no discards of horse mackerel but discard of mackerel were found. The discard rate depended on the target species. Discards in the mackerel fishery varied between 0% and 5% of the mackerel catch. Higher mackerel discard rates were found as by-catch in the herring fishery. The discarding practice can be explained mainly by disposing of small fish.

In the non-pelagic directed fishery mackerel and horse mackerel was caught occasionally but with high rates of horse mackerel discard. Here, the discard rates can be explained by the discarding of small fish and financial considerations of the skipper.