ICES WGWIDE REPORT 2009

ICES ADVISORY COMMITTEE

ICES CM 2009/ACOM:12

Report of the Working Group on Widely Distributed Stocks (WGWIDE)

2 - 8 September 2009

Copenhagen, Denmark

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Contents

Executive Summary

The Working Group (WG) on Widely Distributed Stocks (WGWIDE) met in ICES headquarters, Copenhagen 2 – 8 September 2009. Participants were scientists from Spain, Russia, UK (Scotland, England & Wales), Netherlands, Norway, Faroe Islands, Iceland, Ireland and Portugal. The WG reports on the status and considerations for management of NEA Mackerel, Blue Whiting, Southern and Western Horse Mackerel stocks and Norwegian Spring Spawning Herring. The advice for North Sea horse mackerel was not updated this year.

Special requests from EU Commission regarding

- the 2007 Mackerel egg survey estimates;
- the long-term yield in the 2008 Blue whiting simulations to evaluate a proposed management plan

were addressed by WGWIDE prior to the WG meeting and reported here.

Northeast-Atlantic (NEA) Mackerel. This species is distributed in the whole ICES area and currently supports one of the most valuable European fisheries (with around 500 kt annual landings). Mackerel is fished by a variety of fleets (ranging from open boats using hand lines on the Iberian coasts to large freezer trawlers and Refrigerated Sea Water (RSW) vessels in the Northern Area. The stock is historically divided into three components, with the North Sea component considered to be over fished since the late 1970s, and the Western component contributing the vast majority of biomass and catch to the stock. The quality of sampling data remains good. The NEA mackerel assessment was treated as an update. The 2007 SSB input for the analytical assessment was based on a revised estimate of Mackerel Egg abundance from the 2007 International Survey. Fishing mortality in 2008 is estimated to be above precautionary levels. The estimate of spawning stock biomass (SSB) in 2008 has increased by 41% since 2002, a record low. Variability in recruitment has increased in recent years.

Horse Mackerel. The WG performed an analytical assessment for western horse mackerel. The assessment indicates that the current level of SSB is above that in 1982 which produced the corresponding outstanding year class. The analysis confirms strong recruitment of the 2001 year class however this is not estimated to be of the same order of magnitude as the 1982 year class. The advice for this stock is based on an agreed management plan. An analytical assessment was also conducted for southern horse mackerel. The 2 surveys were combined and a clear cohort signal was evident. The assessment was performed using Flexible Forward Age-Structured Assessment program (ASAP). This estimated an increase in SSB relative to 2003. The assessment estimated above average 2004 recruitment.

Norwegian spring spawning herring. It is the largest herring stock in the world. It is largely migratory and distributed throughout large parts of the NE Atlantic. The productivity of the stock has increased in the last 20 years as a result of strong year classes being produced more often. The WG undertook a bench-mark assessment of this stock in 2008. This was performed using recently developed assessment tools software (TASACS).The results from assessing the stock using a number of age-structured models were evaluated and the WG agreed on an assessment based on a VPA. This last model estimated spawning-stock biomass well above B_{pa} in 2009 and the highest in the recent time series. Management advice was provided based on the agreed management plan.

Blue whiting. It is a pelagic gadoid that is widely distributed in the eastern part of the North Atlantic. Due to the large population size, its considerable migratory capabilities and wide spatial distribution, much remains to be understood regarding the stock composition and dynamics. The assessment this year was considered an update and was performed using the Stochastic Multi-species (SMS) model. An alternative configuration of the 2008 WG options for SMS model was implemented this year. Results were compared with XSA, TISVPA and ICA (FLICA). The four models estimated a steep decrease in recruitment in the most recent years 2005 – 2008 resulting in a decline in SSB since its historical peak in 2003 - 2004. A new draft management plan that takes into account recent low recruitment was put forward by the Coastal states in 2008 and was evaluated by the WG by means of simulation testing.

1 Introduction

1.1 Terms of Reference (ToR)

2008/2/ACOM12 The **Working Group on Widely Distributed Stocks** [WGWIDE] (Chair: Beatriz Roel, UK) will meet from at ICES Headquarters, 2–8 September 2009 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below).

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

WGWIDE will report by 15 September 2009 for the attention of ACOM.

Fish Stock	**Stock Name**	**Stock Coord.**	**Assess. Coord. 1**	**Assess. Coord. 2**	**Advice**
her-noss	Herring in the Northeast Atlantic (Norwegian spring-spawning herring)	Iceland	Norway	Russia	Advice
hom-nsea	Horse mackerel (*Trachurus trachurus*) in Division IIIa, Division IVb,c and VIId (North Sea stock)	Norway	Netherlands	Denmark	Same advice as last year
hom-soth	Horse mackerel (*Trachurus trachurus*) in Division IXa (Southern stock)	Spain	Spain	Portugal	Advice
hom-west	Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)	Norway	UK (England & Wales)	Netherlands	Advice
mac-nea	Mackerel in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)	Ireland	UK (Scotland)	Netherlands	Advice
whb-comb	Blue whiting in Subareas I-IX, XII and XIV (Combined stock)	Spain	Denmark	Russia	Advice

1.2 List of Participants

Beatriz Roel (Chair)	United Kingdom
Frans van Beek	Netherlands
Thomas Brunel	Netherlands
Andrew Campbell	Ireland
Gersom Costas	Spain
Afra Egan	Ireland
Asta Gudmundsdóttir	Iceland
Jens Christian Holst	Norway
Åge Høines	Norway
Svein A. Iversen	Norway
Jan Arge Jacobsen	Faroe Islands
Teunis Jansen	Denmark
Alexander Krysov	Russian Federation
Charlotte Main	United Kingdom
Manolo Meixide	Spain

Alberto Murta	Portugal
Leif Nøttestad	Norway
Jose de Oliveira	United Kingdom
Gudmundur J. Oskarsson	Iceland
Lisa Readdy	United Kingdom
Maxim Rybakov	Russian Federation
Sonia Sanchez	Spain
Erling Kåre Stenevik	Norway
Jens Ulleweit	Germany
Dmitry A. Vasilyev	Russian Federation
Morten Vinther	Denmark

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 coverage for mackerel continued to increase and now stands at 88%, the highest in the time series. The proportion of the horse mackerel catch sampled increased from 62% in 2007 to 77% in 2008, but still only few countries provide data. Therefore relatively large proportions of the fishing area and are only partly or not covered at all. Norwegian spring spawning herring and blue whiting sampling covers 94% and 90% of the total catch, respectively.

In general, to facilitate age-structured assessment, samples should be obtained from all countries with catches of the relevant species.

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

Mackerel

YEAR	TOTAL CATCH (WG CATCH)	% CATCH COVERED BY SAMPLING PROGRAMME*	NO. SAMPLES	NO. MEASURED	NO. 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
2003	617,330	80	1,212	148,501	19,779
2004	611,461	79	1,380	177,812	24,173
2005	543,486	83	1,229	164,593	20,217
2006	472,652	85	1,604	183,767	23,467
2007	579,379	87	1,267	139,789	21,791
2008	611,063	88	1,234	141,425	24,350

***Percentage related to working group catch.**

The total number of samples is similar to last year. The number of measured samples is also similar and the number of aged samples increased by approximately 10%. 88% of the total catch was covered by national sampling programmes, a slight increase on the figure for the previous year. It should be noted that this figure is based on the total sampled catch and thus the largest catching nations that can sample 100% of their catch mask any deficiencies at national level and with more widely dispersed fisheries. For example, the Netherlands and Germany both show reduced levels of sampling coverage (85% to 50% and 97% to 77% respectively).

Denmark, Iceland, Ireland, Norway, Portugal, Russia and Spain all sampled over 90% of their catch. For the first time, Faeroes provided sample data, covering over 90% of their catch. Samples from the Scottish fishery covered 81% of catches. As in previous years, England & Wales sample a smaller fraction, corresponding to the handline fishery in areas VIIe and VIIf. The remaining countries (of which France and Sweden had significant catches) failed to sample any catches.

The sampling summary of the mackerel catching countries is shown in the following table:

COUNTRY	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	NO. SAMPLES	NO. MEASURED	NO. AGED
Belgium	2	0	0	0	0
Denmark	26,726	99	10	873	873
Faroe Islands	11,289	94	5	219	110
France	15,602	0	0	0	0
Germany	15,502	77	46	16,174	1,910
Iceland	112,286	99	25	754	677
Ireland	44,760	99	38	6,639	3,136
Jersey	7	0	0	0	0
Netherlands	19,972	50	38	3,751	950
Norway	121,524	92	127	16,692	3,704
Portugal	2,381	100	282	24,214	772
Russia	32,728	99	98	24,472	908
Spain	64,637	100	429	28,175	5,606
Sweden	3,664	0	0	0	0
UK (England & Wales)	2,302	37	57	7,441	2,048
UK (Northern Ireland)	5	0	0	0	0
UK (Scotland)	109,842	81	79	12,021	3,656
Total	583,229	88	1,234	141,425	24,350

*** Percentage based on Working Group catch**

The following table describes the mackerel sampling levels by relating numbers measured and aged to the size of the catch in each ICES division. Areas where insufficient sampling was carried out include IIIa (883t), Vb (332t), VIIc (209t), VIIh (936t), VIIId (1,346t). This was also the case with several of these areas in previous years. No sampling was carried out in areas IIId and VIIa,g although the corresponding catches were minor.

AREA	OFFICIAL CATCH	WG CATCH	NO SAMPLES	NO AGED	NO MEASURED	NO AGED/ 1000 TONNES*	NO MEASURED/ 1000 TONNES*
IIa	110,819	110,801	115	1,315	24,982	10	230
IIIa	883	883	0	0	0	0	0
IIId	2	2	0	0	0	0	0
IVa	206,164	228,536	211	7,931	33,610	40	160
IVb	553	529	1	25	156	50	280
IVc	330	286	2	50	189	150	570
Va	37,535	37,535	11	331	394	10	10
Vb	332	332	0	0	0	0	0
VIa	97,029	96,935	72	3,409	14,117	40	150
VIIa	6	6	0	0	0	0	0
VIIb	25,362	26,569	16	1,075	2,610	40	100
VIIc	209	94	0	0	0	0	0
VIId	4,227	4,295	4	100	372	20	90
VIIe	373	2,240	21	869	3,042	2,330	8,155
VIIf	667	667	40	1,279	4,994	1,918	7,487
VIIg	17	17	0	0	0	0	0
VIIh	936	1,415	0	0	0	0	0
VIIj	21,213	22,996	26	1,488	4,169	70	200
VIIIa	6,684	7,134	4	100	401	10	60
VIIIb	8,682	8,585	62	1,202	3,683	140	420
VIIIcE	43,463	43,463	274	2,635	18,321	60	420
VIIIcW	7,159	7,159	35	771	2,541	110	350
VIIId	1,346	1,346	0	0	0	0	0
IXaN	6,855	6,855	58	998	3,630	150	530
IXaCN	2,381	2,381	282	772	24,214	320	10,170
Total	583,229	611,063	1,234	24,350	141,425	40	240

*** Based on official catches**

Horse Mackerel

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

YEAR	TOTAL CATCH (WG CATCH)	% CATCH COVERED BY SAMPLING PROGRAMME*	NO. SAMPLES	NO. MEASURED	NO. 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	1,768	235,697	8,561
2003	241,830	79	1,568	200,563	12,377
2004	216,361	68	1,672	213,066	16,218
2005	234,876	78	2,315	241,629	15,866
2006	215,277	72	1,623	231,344	12,009
2007	187,995	62	1,321	174,897	10,749
2008	198,085	77	1,362	186,800	11,915

*** Percentage related to Working Group catch**

There was an increase in overall sampling for horse mackerel from 2007 to 2008. This is the second highest sampling level since 1992. As usual the large numbers of measured fish are due to intensive length measurement programs in the southern areas. In 2008, 76% of the horse mackerel measured were from Division IXa.

Countries that carried out sampling were Ireland, the Netherlands, Norway, Portugal and Spain and covered 93-100% of their catches. France and Lithuania took considerable catches without providing any catch data to the Working Group. The lack of sampling data for relatively large portions of the horse mackerel catches 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 2008:

COUNTRY	OFFICIAL CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Belgium	3	0			
Denmark	5,318	0			
Faroe Islands	841	0			
France	14,872	0			
Germany	12,882	0			
Ireland	36,509	93	51	8,747	3,289
Lithuania	5,548	0			
Netherlands	63,087	96	93	13,879	2,200
Norway	12,244	99	40	2,138	270
Portugal	9,278	100	760	130,642	1,999
Spain	34,169	95	418	31,394	4,157
Sweden	44	0			
UK (Scotland)	1,083	0			
Sum (WG catch)	198,085	77	1,362	186,800	11,915

* Percentage based on Working Group catch

The following tables have information broken down by horse mackerel stock.

The horse mackerel sampling intensity for the Western stock (areas) was as follows:

COUNTRY	OFFICIAL CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	5,261	0			
Faroe Islands	841	0			
France	12,626	0			
Germany	11,708	0			
Ireland	35,612	94	50	8,467	3,202
Lithuania	5,548	0			
Netherlands	43,648	93	68	10,320	1,700
Norway	12,223	99	40	2,138	270
Spain	19,851	100	264	19,866	2,841
Sweden	9	0			
UK (Scotland)	1,077	0			
Sum (WG catch)	139,471	70	422	40,791	8,013

* Percentage based on Working Group catch

The horse mackerel sampling intensity for the North Sea stock (IVb,c, VIId and the eastern part of IIIa) was as follows:

COUNTRY	OFFICIAL CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Belgium	3	0			
Denmark	57	0			
France	2,246	0			
Germany	1,174	0			
Ireland	897	100	1	280	87
Netherlands	19,439	100	25	3,559	500
Norway	21	0			
Sweden	35	0			
UK (Scotland)	6	0			
Sum (WG catch)	34,749	89	26	3,839	587

* Percentage based on Working Group catch

The horse mackerel sample intensity is higher than usual and is caused by the Netherlands which has an extensive sampling program..

The horse mackerel sampling intensity for the Southern stock (areas) was as follows:

COUNTRY	OFFICIAL CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Portugal	9,278	100	760	130,642	1,999
Spain	14,318	96	154	11,528	1,316
Sum (WG catch)	23,596	98	914	142,170	3,315

* Percentage based on Working Group catch

The horse mackerel sampling intensity by division was as follows:

Area	Official Catch	WG Catch	N samples	N aged	N measured	N aged per 1000t	N measured per 1000t
Iia	572	572	0			0	0
IIIa	30	30	0			0	0
Iva	13,974	13,018	41	357	2,418	27	186
Ivb	975	382	0				
Ivc	9,550	1,948	0				
Va	0	0					
Vb	0	0					
Via	29,648	25,868	37	2,491	5,970	96	231
Vib	0	0	0				
VIIa	0	0	0				
VIIb	27,885	24,009	27	1,026	4,246	43	177
VIIc	3,001	1,689	4	100	417	59	247
VIId	12,099	31,389	25	500	3,559	16	113
VIIe	10,008	12,337	13	325	2,149	26	174
VIIf	180	180	0				
VIIg	0	0					
VIIg	3,200	56,85	1	25	168	4	30
VIIj	27,663	23,403	19	510	2,395	22	102
VIIk	53	53	0				
VIIIa	10,020	10,007	12	300	2,446	30	244
VIIIb	1,388	1,646	26	138	1,864	84	1132
VIIIc	19,345	19,345	239	2,728	18,182	141	940
VIIId	2,657	2,894	4	100	816	35	282
IxaCN	4,014	4,014	554	1,999	87,504	498	21,800
IxaCS	3,910	3,910	76		5,688	0	1,455
IxaN	13,715	13,715	152	1,316	11,366	96	829
IxaS	1,957	1,957	132		37,612	0	19,219
Sum	195,844	198,085	1362	1,1915	186,800	60	943

Norwegian Spring Spawning Herring (NSSH)

Year	Total catch	% catch covered by sampling programme	No. samples	No. Measured	No. Aged
2000	1,207,201	86	389	55956	10901
2001	766,136	86	442	70005	11234
2002	807,795	88	184	39332	5405
2003	789,510	71	380	34711	11352
2004	794,066	79	503	48784	13169
2005	1,003,243	86	459	49273	14112
2006	968,958	93	631	94574	9862
2007	1,266,993	94	476	56383	14661
2008	1,545,656	94	722	81609	31438

95% of the total catch was covered by national sampling programmes. The following table gives a summary of the sampling activities of the NSSH catching countries. The sampling coverage by country is between 74 to 100%. No sampling was carried by Greenland and Germany but catches of these countries represent together only 0.8% of the total catch.

COUNTRY	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	31,128	100	12	1520	1504
Faroe Islands	74,261	89	14	960	462
Germany	8,338	0	0	0	0
Greenland	3,810	0	0	0	0
Iceland	217,602	76	89	4067	6334
Ireland	7,903	100	1	86	86
Norway	961,603	100	451	46563	20300
Russia	193,119	100	110	23247	1548
Scotland	19,737	100	5	617	204
The Netherlands	28,155	57	40	4549	1000
Total	1,545,656	94	722	81609	31438

*** Percentage based on Working Group catch**

Shown in the following table are the NSSH sampling levels by relating numbers measured and aged to the size of the catch in each ICES division.

AREA	OFFICIAL CATCH	WG CATCH	NO SAMPLES	NO AGED	NO MEASURED	NO AGED/ 000 TONNES	NO MEASURED/ 000 TONNES
IIa	1,473,616	1,473,616	604	26724	69724	18	47
IIb	22,943	22,943	11	189	2190	8	95
IVa	2,721	2,721	60	2632	6610	967	2429
Ib	2,962	2,962	14	584	1370	197	463
Va	40,978	40,978	29	1135	1425	28	35
Vb	2,395	2,395	3	135	200	56	84
XIVa	41	41	1	39	90	951	2195
Total	1,545,656	1,545,656	722	31438	81609	20	53

*** Based on official catches**

Blue Whiting

YEAR	TOTAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	NO. SAMPLES	NO. MEASURED	NO. AGED
2000	1,412,928	*	1136	125162	13685
2001	1,780,170	*	985	173553	17995
2002	1,556,792	*	1037	116895	19202
2003	2,321,406	*	1596	188770	26207
2004	2,377,569	*	1774	181235	27835
2005	2,026,953	*	1833	217937	32184
2006	1,966,140	*	1715	190533	27014
2007	1,610,090	87	1399	167652	23495
2008	1,246,465	90	927	113749	21844

* no figures given

90% of the total catch was covered by national sampling programmes. The sampling summary of the blue whiting catching countries is shown in the following table. No sampling were carried out by France, Lithuania and Scotland, representing together 4.6% of the total catch. All other countries are sampling for length and age.

COUNTRY	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	18,134	97	14	1,036	1,036
Faroe Islands	225,004	100	45	4,306	2,040
France	11,723	0	0	0	0
Germany	25,259	80	20	10,809	801
Iceland	159,307	97	55	4,485	2,697
Ireland	22,852	83	16	3,306	1,600
Lithuania	5,339	0	0	0	0
Netherlands	76,458	99	74	14,376	1,850
Norway	418,289	100	197	7,603	1,583
Portugal	4,220	100	220	26,536	6,192
Russia	225,163	73	52	19,843	2,404
Spain	14,342	100	234	21,449	1,641
UK(Scotland)	38,150	0	0	0	0
Total	1,183,149	90	925	113,396	21,783

The following table describes the blue whiting sampling levels by relating numbers measured and aged to the size of the catch in each ICES division.

AREA	OFFICIAL CATCH	WG CATCH	NO. SAMPLES	NO. AGED	NO. MEASURED	NO. AGED/ 1000 TONNES*	NO. MEASURED/ 1000 TONNES*
IIa	68,039	67,867	93	1,412	14,744	21	217
IIb	172	172	6	300	2,379	1744	13831
IIIa	185	185	0	0	0	0	0
IVa	35,734	35,734	44	252	903	7	25
IVb	142	142	0	0	0	0	0
IXa	4,220	4,220	220	6,192	26,536	1467	6288
Va	313	313	0	0	0	0	0
Vb	195,393	194,664	58	2,174	4,646	11	24
VIa	277,352	279,285	91	3,489	11,399	13	41
VIb	183,524	183,524	28	1,161	2,575	6	14
VIIa	6	6	0	0	0	0	0
VIIb	11,862	11,143	1	100	218	8	18
VIIc	401,484	402,261	115	3,870	17,208	10	43
VIIf	0,6	1	0	0	0	0	0
VIIIabd	0	3	0	0	0	0	0
VIIIc	14,343	14,344	234	1,641	21,449	114	1495
VIIj	25	25	2	50	573	2000	22920
VIIk	11,037	12,168	26	839	10,299	76	933
XII	40,408	40,408	9	364	820	9	20
Total	1,244,239	1,246,465	927	21,844	113,749	18	91

* Based on official catches

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 under reporting or species and area misreporting. These discussions applied particularly to mackerel and horse mackerel in the northern areas.

The working group considers that the best estimates of catch it can produce are likely to be underestimates.

For mackerel and horse mackerel it was previously concluded that in the southern areas the catch figures appear to be satisfactory.

1.3.3 Discards

In pelagic fisheries discarding occurs in a sporadic way compared to demersal fisheries. This is because the nature of pelagic fishing is to pursue schooling fish, creating hauls with low diversity of species and sizes and consequently often extreme fluctuation in discard rates (100% or null discards). Extreme discards occur especially during ´slippage´ events, when the entire catch is released. The main reasons for ´slipping´ are daily or total quota limitations, illegal size and mixture with unmarketable by-catch. Quantifying such discards at a population level is extremely difficult as they vary considerably between years, seasons, species targeted and geographical region.

Discard estimates of pelagic species from pelagic fisheries and demersal fisheries have been published by several authors. Discard percentages of pelagic species from demersal fisheries were estimated between 3% to 7% (Borges *et al*., 2005) of the total catch in weight, while from pelagic fisheries were estimated between 3% to 17% (Pierce *et al*. 2002; Hofstede and Dickey-Collas 2006, Dickey-Collas & van Helmond 2007, Ulleweit & Panten 2007, Borges *et al*. 2008). Slipping estimates have been published for the Dutch freezer trawler fleet only, with values at around 10% in numbers (Borges *et al*. 2008). Nevertheless, the majority of these estimates were associated with very large variances and composition estimates of ´slippages´ are liable to strong biases and are therefore open to criticism.

Borges *et al*. (2008) show that for the Dutch freezer trawler fleet between 2002 and 2005, the most important commercial species discarded is mackerel, accounting for 40% of total pelagic discards. Other important discarded species are herring (18%), horse mackerel (15%) and blue whiting (8%). These discards are also the consequence of fisheries targeted at other species (e.g. mackerel in the horse mackerel and herring targeted fisheries). The most important non-commercial species is boarfish accounting for 5% of the discards. Dutch-owned freezer-trawlers also operate in European waters under German, UK, and French flags.

In 2009, discard estimates from the Netherlands and UK (Scotland) for mackerel, horse mackerel, Norwegian spring spawning herring and blue whiting for 2008 were provided to the working group. No discarding on freezer trawlers targeting mackerel and blue whiting was observed during three German observer trips carried out in 2008. Some of the provided discard data included sampling levels and raised discard estimates, which can be raised by trips or total landings. The exact sampling and raising procedures used are unclear and differ between different datasets, which complicates comparison. In addition, the associated sampling levels are low, and therefore the data should be treated with caution. The necessary steps involved in providing discard data to stock assessments require further research.

Because of the potential importance of significant discarding levels on pelagic species assessments the **Working Group again recommends that observers should be placed on board vessels in those areas in which discarding occurs, and existing observer programmes should be continued. Furthermore agreement should be made on sampling methods and raising procedures to allow comparisons and merging of dataset for assessment purposes.**

Mackerel

The Netherlands and Scotland provided discard data on mackerel to the working group. Age and length disaggregated data were available from the Scottish fishery in the first quarter in area VIa and for the first and fourth quarter in area IVa (more than 90% of total catches were from these areas). The estimated mackerel landings of Scotland and the Netherlands represent approximately 22% of the total landings. Mackerel catches of Germany, which observed zero discards, represent 3% of the total catch. For 2008 the total mackerel discards estimated for the Dutch and Scottish fishery were approximately 2,255t and 24,511t, respectively. Discard percentages of the total catch varied between 9% and 15%.

Horse Mackerel

In the past discards of juvenile horse mackerel have been thought to constitute a problem. However, in recent years a targeted fishery has developed on juveniles, including 1-year old fish and discarding of juveniles is now thought to be small. In 2008 the Netherlands estimated discards of 43t, accounting for less than 1% of the national landings. Horse mackerel catches of the Netherlands represent 25% of the total catch of the Western area.

Norwegian Spring Spawning Herring

The Netherlands provided data on discards in the herring fishery. In 2008, two trips out of 10 directed on herring were sampled. Overall discards rates of herring in these trips were estimated to be very low and estimated between 0.2% and 2.0% in weight. Discarding is considered to be a minor problem to the assessment of this species.

Blue Whiting

In general, discards are assumed to be minor in the blue whiting directed fishery. On a sampling trip conducted by Germany no discarding was observed. Some discard data to the working group were provided by the Netherlands. Blue whiting is also by-catch in several Spanish bottom trawl fisheries directed to a mixture of species. However, the catch rates of blue whiting in these fisheries are low.

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

An otolith exchange exercise on mackerel was carried out in spring 2009 organized and coordinated by FRS (Scotland). Spain, Portugal, France, UK, Germany, Ireland, the Netherlands and Denmark participated in the exchange. Results were not available to WGWIDE. However, following the exchange a workshop is scheduled in Lowestoft for 19-23 April 2010 to

a) review information on age estimations, otolith exchanges, workshops and validation work done so far,

b) analyse the results of the exchange programme between ageing labs using a set of otoliths (images) collected partially from tagging material and from previous WK collections with the purpose of inter-calibration of age readers involved in stock assessment, c) report on progress of the compilation of biometrics data of mackerel otoliths and

d) revise the age estimation procedures and explore the possibilities of using supplementary information for validating estimated age structures, including otolith weight distributions and length distribution in surveys and catches.

Horse mackerel

An exchange and a workshop on age reading were carried out in the Netherlands in 2006. Experienced readers and trainees participated in the exchange and in the workshop. All countries providing age reading data to the WGWIDE were represented in both the exchange and the workshop by an experienced reader. Portugal, Germany and the Netherlands provided otolith sets for the exchange. The sets represented different otolith preparation methods and stocks. Two sets consisted of otoliths from the extremely strong 1982 year-class and hence the age is considered to be known (with a certainty of approximately 95%). One set focused on younger fish which were expected to present problems based on the informal small-scale otolith exchange.

The experienced readers were accustomed to different otolith preparation methods and different growth patterns associated with the different stocks. Generally, the readers had more difficulty if they were reading material they were not accustomed to. Horse mackerel is regarded to be a difficult species to age and this was reflected by the results of the exchange. The agreement between the experienced readers was low, especially for otoliths from the Southern stock. For the sets including the 1982 year-class the agreement with the modal age was higher than with “true” age. Comparison with the “true” ages showed an overall tendency to underestimate the age.

Norwegian Spring Spawning Herring

A scale and otolith exchange of Norwegian spring spawning herring took place in 2007-2008. Otolith and scale samples of Norwegian spring spawning herring (NSSH) from the ecosystem survey in the Nordic seas in May were provided by the Institute of Marine Research, Norway. Four countries were participating in the scale and otolith exchange; Norway, Faroe Islands, Iceland and Denmark. Norway and Iceland estimated the ages by reading scales, and Faroe Islands and Denmark estimated the ages by reading the otoliths.

Based on results from this scale and otolith exchange, the age estimate of NSSH between the four countries is very similar. High precision were obtained, and there were no relative bias between different countries. Precision of age estimates appears to be a little higher for the two countries reading scales compared to the two countries reading otoliths, but this is also influenced by technical aspect of the order the different readers are placed in the EFAN-spreadsheet. There is therefore no evidence for difference in the age estimates as a consequence of reading scales versus otoliths.

Another recent comparison (Couperus 2008) of age readings from scales and otoliths for Norwegian spring spawning herring from 2 samples taken at the ASH survey in 2008 demonstrates as well no indication that there is any difference in performance between age readings from scales and otoliths. Scales were read by readers from Denmark, otoliths by readers from the Netherlands:

Blue Whiting

PGCCDBS has identified the need of a full blue whiting ageing exchange to take place in 2009, with a workshop held after the exchange. The Institute of Marine Research, Norway, is currently coordinating the exchange and will also carry out the workshop. The last workshop on blue whiting age took place in June 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

There is inadequate sampling for stock weights during the spawning season.

Horse Mackerel

No issues regarding biological data for horse mackerel were raised during the WG.

Norwegian Spring Spawning Herring (NSSH)

The proportion mature at age used in assessment is based on various surveys and not always well documented. Furthermore, one survey which supplied the main information on maturity stopped in 2008. There is a potential problem of obtaining random samples of proportion mature at age from survey for NSSH due to the different catchability of mature and immature fish of the same age groups caused by spatial segregation. An alternative method for estimating proportion mature at age was presented to the Working Group in 2008 (Stenevik 2008). This method involves back-calculation of proportion mature at age from fully matured year-classes. IMR (Norway) has agreed to put effort into updating estimates on proportion mature at age from recent years with this method and compare it with data on direct measurements on proportion mature at age from the Nordic ecosystem survey. Based on the findings of this evaluation the most reliable method will be adopted in future. This evaluation was planned for 2009 but had to be postponed.

Blue Whiting

Since 1995 the blue whiting stock has been assessed as one unit. Recently, there is growing evidence that there may be several components in the Northeast Atlantic blue whiting stock. This concern was addressed by a special request from Ireland 2008. In the answer from ICES on this request it was stated that it is difficult to determine how many possible sub-populations may exist. In many of the studies carried out to date samples have not been sufficiently large to identify separate components. A more extended coordinated sampling programme across the stock area is required to solve this issue.

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 have again this year been 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 catch and discards are available in this file. Efforts were made to use the Intercatch system this year in parallel to the existing system (see Sec.1.3.8 for details).

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 WGWIDE:

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.

Overall, data quality has improved and sampling deficiencies have been reduced compared to earlier years, 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, so only catch data from Eurostat are available, which are not aggregated quarterly but are yearly catch data per area. Table 1.3.6.1 gives an overview on the availability and format of data provided to the species coordinators. Missing sampling data are regarded to be problematic for France and Sweden in the case of Mackerel; Denmark, France, Lithuania all with considerable catches in the case of Horse Mackerel. Norwegian spring spawning herring and blue whiting are generally covered, countries not providing data constitute 0.8% and 4.5% of the total catch, respectively. However, under the EU directive for sampling of commercial catch the responsibility lies within the member state where the catch is landed. This would imply for instance that the Netherlands should be sampling French, UK and German mackerel and horse mackerel catches landed into the Netherlands.

The Working Group documents sampling coverage of the catches in two ways. National sampling effort is tabulated against official catches of the corresponding country (section 1.3.1). Furthermore tables 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. These tables are shown in section 1.3.1 as text tables under the species sections.

Transparency of data handling by the Working Group and archiving past data

The current practice of data handling by the working group has been the same for 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 varying formats. These are now stored in the original format, separately for each stock and catch year. It is the intention of the Working group that in the interim period until the proposed standard database is developed (see below) the previous year's 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/DVD. **The WG recommends that archives folder should be given access only to designated members of the WGWIDE**, 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 historical 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. This is particularly relevant given that for the 2005 mackerel assessment the time series had to be truncated due to poor data in the earliest years.

Table 1.3.6.1 Overview of the availability and format of data provided to the species coordinators for catch year 2008.

A. Mackerel

Stock Coordinator: Andrew Campbell

Country*	Data Supplied	Data Exchange Sheet	Aged Samples
Denmark	YES	YES	YES
England & Wales	YES	YES	YES
Faroes	YES	YES	YES
France	YES	YES	NO
Germany	YES	YES	YES
Iceland	YES	YES	YES
Ireland	YES	YES	YES
Netherlands	YES	YES	YES
Norway	YES	YES	YES
Portugal	YES	YES	YES
Russia	YES	YES	YES
Scotland	YES	YES	YES
Spain	YES	YES	YES
Sweden	YES	NO	NO

* Belgium,Jersey and Northern Ireland not listed (official catches below 100t)

B. Horse Mackerel

Stock Coordinators: Svein Iversen (Western & North Sea), Pablo Abaunza (Southern)

Country*	Data Supplied	Data Exchange Sheet	Aged Samples
Denmark	YES	YES	NO
Faroes	YES	YES	NO
France	NO	-	-
Germany	YES	YES	NO
Ireland	YES	YES	YES
Lithuania	NO	-	-
Netherlands	YES	YES	YES
Norway	YES	YES	YES
Portugal	YES	YES	YES
Scotland	YES	YES	NO
Spain	YES	YES	YES
Sweden	NO	-	-

* Belgium not listed (official catches below 100t)

C. Norwegian Spring Spawning Herring

Stock Coordinators: Asta Gudmundsdottir, Alexander Krysov

Country	Data Supplied	Data Exchange Sheet	Aged Samples
Denmark	YES	YES	YES
Faroes	YES	YES	YES
Germany	YES	YES	NO
Greenland	YES	NO	NO
Iceland	YES	YES	YES
Ireland	YES	YES	YES
Netherlands	YES	YES	YES
Norway	YES	YES	YES
Russia	YES	YES	YES
Scotland	YES	YES	YES

D. Blue Whiting

Stock Coordinators: Manolo Meixide

Country	Data Supplied	Data Exchange Sheet	Aged Samples
Denmark	YES	YES	YES
Faroes	YES	YES	YES
France	NO	-	-
Germany	YES	YES	NO
Iceland	YES	YES	YES
Ireland	YES	YES	YES
Lithuania	NO	-	-
Netherlands	YES	YES	YES
Norway	YES	YES	YES
Portugal	YES	YES	YES
Russia	YES	YES	YES
Scotland	NO	-	-
Spain	YES	YES	YES

1.3.7 Stock Data Problems Relevant to Data Collection

Stock	Data Problem	How to be addressed in DCR	By who
Stock name	***Data problem identification***	***Description of data problem and recommend solution***	***Who should take care of the recommended solution and who should be notified on this data issue.***
Blue Whiting	*No data provided by France, Sweden and Lithuania*	*Catch at age (or at least landings by quarter) should be provided to the WG.*	*National laboratories should provide data to stock coordinator*
NEA Mackerel	*Lack of samples during spawning season*	*There is often a lack of sampling in areas VIIb,j during spawning season (March, April, May). Targeted sampling is required in order that appropriate samples for deriving stock weights can be made available to the WG.*	*National laboratories should provide data to stock coordinator.*
NEA Mackerel	*Lack of samples for some area/quarter/fleet combinations*	*Sampling coverage could be improved by increased co-operation between national labs (especially those with similar fleets)..*	*National laboratories should provide data to stock coordinator.*
NEA Mackerel	*Incomplete and inconsistent discard data*	*Observers should be placed on vessels in those areas where discarding occurs and existing observer programmes should be continued. Sampling methods and raising procedures should be established.*	*National laboratories should provide data to stock coordinator. Intercessional work is required for the establishment of procedures.*
Horse Mackerel (all stocks)	*Most catch data is submitted on spreadsheets. None provided in the InterCatch format*	*Catch data should be provided in the InterCatch format. Catches by statistical rectangle and quarter should also be provided on spreadsheets.*	*ICES should inform all fishing countries/members to report catch data in the correct format (InterCatch and spreadsheet)*

1.3.8 InterCatch

Prior to the working group, ICES requested that all stock data be entered in InterCatch. Due to time constraints it was not possible to enter all relevant stocks. North East Atlantic Mackerel and Blue Whiting were both entered with allocations made and output generated. A comparison of the NEA Mackerel output with that from the sallocl application showed good agreement with discrepancies smaller than those reported last year. No comparison was made for Blue Whiting. The majority of Norwegian Spring Spawning Herring data was also uploaded.

The following general points were raised in relation to InterCatch during the meeting.

- InterCatch identifies a stock as a collection of species-area combinations and selects the appropriate data from that uploaded when the stock coordinator requests the information for a particular stock in any year. There is, at present, no way to distinguish between stocks of the same species that may originate from the same area. This causes problems for stocks such as Western Horse Mackerel and North Sea Horse Mackerel where catches in quarters 1 and 2 in area IVa are considered part of the North Sea Horse Mackerel stock and catches in quarters 3 and 4 are assigned to the Western Horse Mackerel stock. This issue could be resolved by the introduction of a temporal element to the InterCatch stock definition. However, this does not solve the problem where stocks of the same species are reported from the same area at the same time of the year (which affects the Norwegian Spring Spawning Herring stock). While there is a workaround available (which involves transforming (mapping) data to alternative area and country codes), the method is not readily understandable and would benefit from detailed attention in the user manual and ultimately, improved functionality in InterCatch.
- The development of tools to aid generation of the input files is a priority. This task would have to be undertaken at a national level since different nations maintain their catch and sampling data in different formats. It is a requirement that individual institute directors are made aware of this and that they assign appropriate resource to carry this out. It will be necessary for ICES to make representation to the national laboratories, highlighting the nature of the problem if this issue is to be resolved.
- It would be useful if the system could issue a warning to inputters if they attempt to upload data with a species/area combination for which there is no associated InterCatch stock.
- Internet Explorer is not an appropriate browser for the larger stocks, due to a software bug. Mozilla Firefox is a suitable alternative.
- It is important that countries continue to provide the data in this the current exchange format. This is useful as it provides for catches to be reported by statistical rectangle (separately to the catches by area), fleet information and length distributions. This additional data provides a valuable source of information which can also be used for quality control.

1.4 Comment on update and benchmark assessments

For this year, ICES had scheduled Norwegian an update assessment for Blue Whiting, Norwegian Spring Spawning Herring and, Southern and Western horse mackerel. A brief overview is given below; details are given in the respective sections.

NEA mackerel: Update: Catch and survey data were fit using FLICA which corresponds to ICA run with FLR.]

North Sea horse mackerel: As the advice for this stock is the same as last year's no data exploration was conducted.

Western horse mackerel: Update. The historic catch data are dominated by the very strong 1982 year class going through the fishery. Catch data was explored by means of a modified SAD assessment which accounts for the age structure in population in the relationship between the egg abundance and the SSB.

Southern horse mackerel*:* Update, based on an ASAP model (Legault and Restrepo, 1998).

Norwegian Spring Spawning herring: Update, the assessment was done with the recently developed toolbox TASACS (ICES 2008/ACOM: 13). TASACS has multiple options for assessment, this assessment was carried out using a VPA.

Blue Whiting: Update. Data exploration conducted using XSA, TSVPA and SMS. Final assessment presented using SMS.

A **benchmark** for blue whiting has been scheduled for spring 2011. However, given the state of the stock the WG has recommended that the benchmark is brought forward for 2010.

1.5 Reference points relevant for WGWIDE

No revisions of the reference points were considered at this meeting for blue whiting, Norwegian spring spawning herring, horse mackerel and mackerel stocks.

1.6 Special Requests to ICES

1.6.1 Request on Blue whiting

EC (DG MARE) asked ICES to clarify

> *The ICES WGWIDE 2008 simulations show a long-term yield of blue whiting of 400,000 tonnes, based on the recruitment estimated from the "low recruitment" period (1981-1996). This is significantly lower than the historical average yield of 591,000 tonnes in the same period.*
>
> *ICES are therefore requested to examine why the long-term yield in the 2008 simulations is almost 200,000 tonnes lower than the average yield in 1981-1996."*

ICES response was the following:

In order to compare the simulations made for the blue whiting with the yield during 1981-1996 four points should be observed, each of which suggests that the expected yield in the future under the management plan will be below the average 1981-1996 period. These are 1) the period 1981-1996 was fished with an average fishing mortality of 0.32 while the simulations are done for F=0.18 [the target agreed by management] and this together with a monotonic increasing yield per recruit curve implies lower yield in the future, 2) the recruitment 1981-1996 was better than expected which offset the expected decrease in SSB, 3) the average recruitment at full reproduction (plateau of the S-R curve) used in the simulations is lower than the average recruitment observed 1981-1996, and 4) the mean-weight-at-age has decreased after 1990 and the simulations are based on this more recent data.

Annex I provides some details pertaining to each of these points.

Annex I: Data and analysis

The projections are summarised in the graph below (WGWIDE 2008) suggesting a long-term yield around 400,000 t while the average yield 1981-1996 was 591,000 t. The simulations are done with a reference fishing mortality of 0.18 while the average fishing mortality 1981-1996 was 0.32. Blue whiting shall be managed based on recruitment considerations and it is on such basis that F=0.18 has been adopted by management.

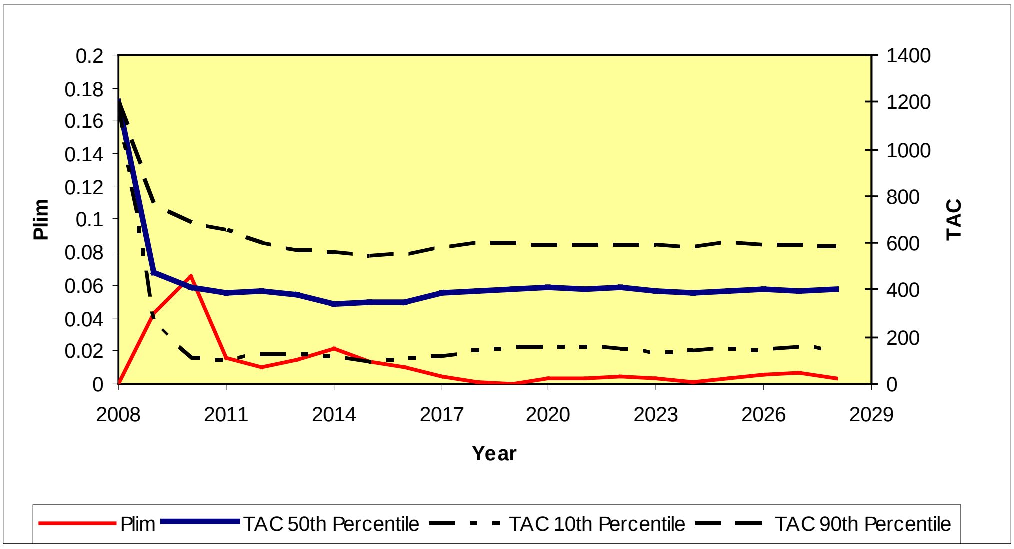
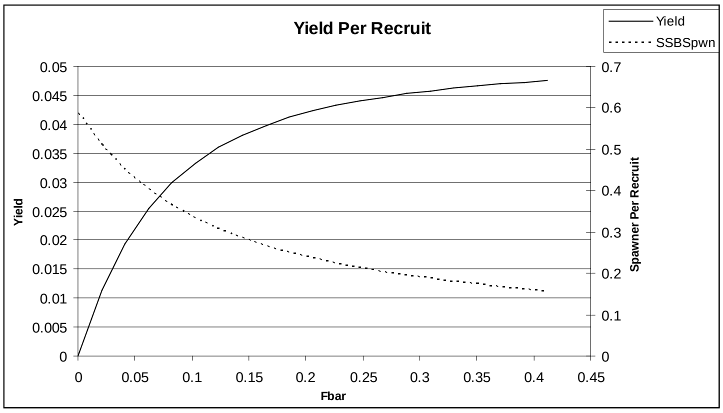


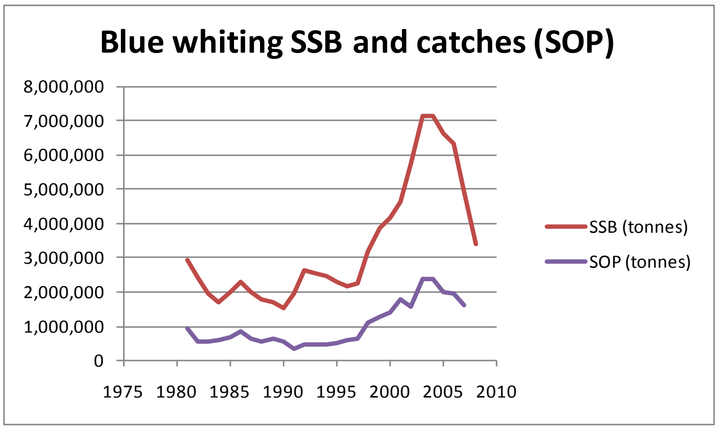
Figure 10.1.3.6. Risk to Blim and TAC (10, 50 and 90 percentiles) with Trigger biomass = 2500 thousand tonnes and the harvest rule with a target F=0.18 applied already in 2009 (no F reduction phase)

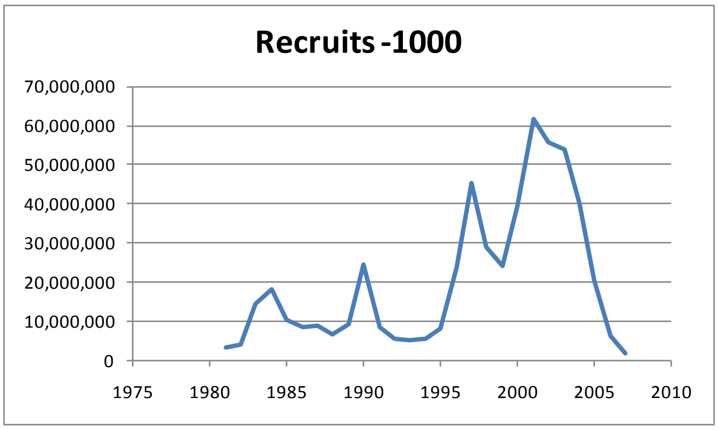
Below, please find some detailed comments for each of the four points.

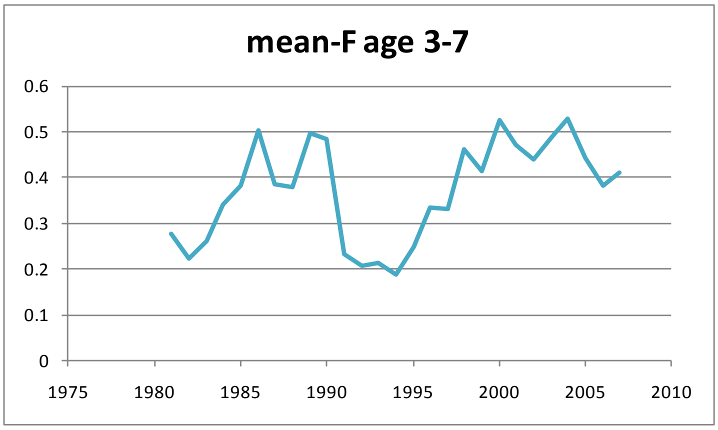
1) The yield per recruit curve for Blue whiting does not have an optimum; see Figure 10.7.1 (WGWIDE 2008). The average fishing mortality for the 1981-1996 period was 0.32 while the simulation with which this is compared is for F=0.18. Therefore the average yield in the period 1981-1996 will be higher than simulations suggest.



2) SSB remained fairly constant during 1981-1996 in spite of increasing fishing mortality during 1981-1990. This increase suggested a decrease in SSB but this was offset by some large year classes (age 1) 1983-84 and 1990 (see graphs below). The average stock 1981-1996 was therefore above the level in the simulations.

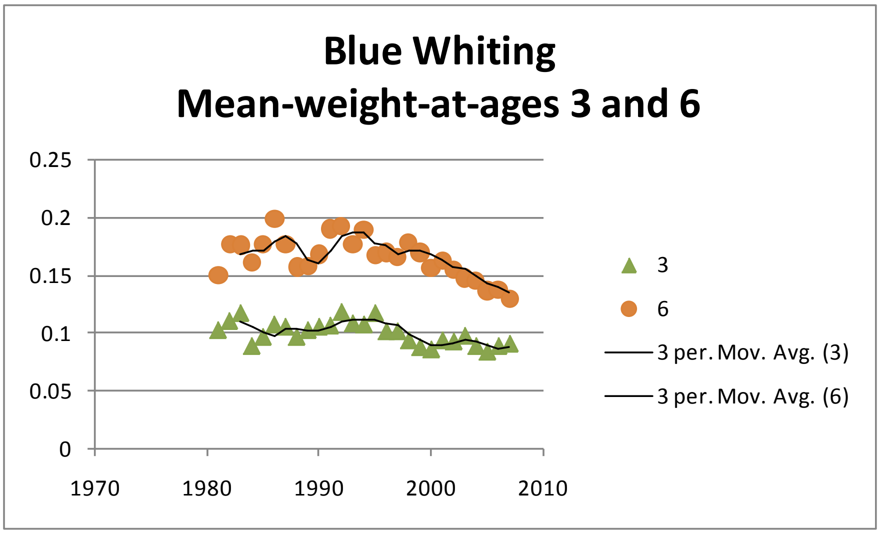


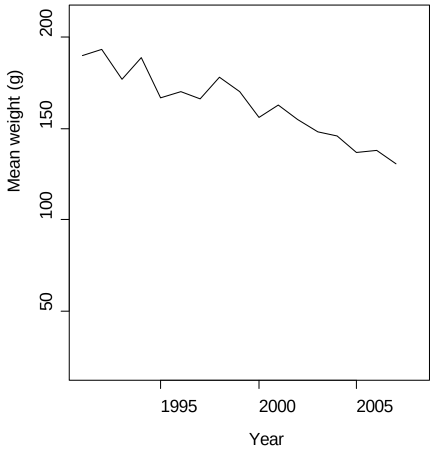




3) The recruitment model used in the simulations was, " A hockey-stick model with breakpoint at 1500, a plateau at 8792, and a log-normally random multiplier for each year with a CV = 0.58, truncated at 0.2 and 2.85." WGWIDE (2008), section 10.13. This model implies an arithmetic average recruitment at 9,296 at the plateau (because of the skewed log-normal distribution) while the arithmetic average recruitment for the period 1981-1996 was 10,407. The simulated yield will therefore be lower than for the period 1981-1996.

4) The mean weight by age in the catches has decreased since about 1990 while these mean weights were stable before, see WGWIDE 2008, section 10.15, Figure 10.4.3.1.2 and graph on mean weight in the catches for ages 3 and 6, below. Section 10.13 (WGWIDE 2008) notes "Weights and maturities at age were as the input to the short term prediction...." The simulations are done on the current smaller mean weights.




Mean weight (g)
200
150
100
50
1995
2000
2005
Year

Portugal, Spain, Scotland, Ireland, The Netherlands, Norway and Germany. The basis of the survey is to relate the number of freshly spawned eggs found in the water with the number of females having produced these eggs. Knowing the fecundity of the females provides an estimate for the spawning stock biomass. WGMEGS provided an estimate of SSB for the 2007 WGMHSA (ICES 2007c). This was based on an incomplete set of samples as the analysis could not be completed bythe time of the working group. Since the large number of samples have now been analysed, the group met again to evaluate the results and to assess the size of the mackerel population in the Northeast Atlantic, the southern horse mackerel stock and the egg production of horse mackerel in the western stock."

The Commission has proposed a long-term management plan for Western horse mackerel which is based to a large extent on the trends in egg abundance. Therefore, it is important to know whether the finalisation of the egg survey analysis as explained above had any impact on the estimation of horse mackerel eggs. ICES was asked to explain whether the finalisation of the egg survey analysis in 2008 had any impact on the estimation of horse mackerel eggs in Western Waters, and if not, why there has been an impact on the estimation of mackerel eggs, but not on the estimation of horse mackerel eggs.

ICES responded:

The question concerns data from 2007. The preliminary estimates available in the autumn of 2007 of mackerel and Western horse mackerel did not include all samples collected in March and April in the Galician and Cantabrian Sea areas. These areas are at the southern border of the investigation area for the Western stock of horse mackerel, and at the northern border of the Southern component of mackerel.

Mackerel had a peak of spawning in this area in March and April. The samples from the Galician and Cantabrian Sea areas therefore had a significant impact on the estimate of the total mackerel egg production. **Horse mackerel** showed low spawning activity in March and April. The peak of spawning for Western horse mackerel occurred in May and June in the Celtic Sea and the West of Ireland. The eggs sampled from Galician and Cantabrian Sea areas therefore contributed insignificantly to the overall estimate for horse mackerel.

In summary: when analysis of samples and compilation of results had been fully completed for the southern area in 2008, it became apparent that the impact on the preliminary estimate of horse mackerel egg production was negligible, whereas significant changes had to be made to the preliminary estimate of SSB for the southern mackerel component.

1.7 Mackerel survey request from NEAFC/Coastal

A group of scientists drawn from the NEAFC (EU, Norway, Iceland, Faroe Island, Russia) countries met at the Institute of Marine Research in Bergen, Norway, from 31 March to 2 April 2009, with the following terms of reference as agreed between member states in NEAFC: (i) Map and describe the seasonal distribution and migration of the NEA mackerel; (ii) Evaluate survey possibilities and define a suitable scientific survey programme including an appropriate survey protocol.

The group reviewed a wide range of surveys and methods currently used to investigate the biology, distribution, migration and abundance of Northeast Atlantic mackerel. A series of maps describing the distribution of mackerel at various stages (particular life history, time of the year and historical trends) were reproduced in the report.

The group could neither propose a new survey, nor a survey protocol, which would cover the entire distribution of mackerel in the Northeast Atlantic. Firstly, significant resources are already deployed towards the mackerel egg survey which maps the distribution of adults in the spawning period. Secondly - and more significantly - beyond the spawning period, mackerel behave in a variety of ways. For example, in mid-summer, they either: school close to the surface in the Norwegian Sea; or occur as dispersed individuals throughout the water column in the North Sea; or they may be close to the seabed (e.g. along the western continental shelf). There is currently no single method that will universally cover the whole distribution of mackerel at any time other than the spawning period, and combining the different methods which are tailored to any one of the different behaviours is presently impossible. The group would encourage appropriate consideration of possible solutions to these problems through a collaborative research project.

Notwithstanding the limitations described above, the group recognized that there is scope to coordinate and standardize existing surveys and methods to provide new and valuable information on the distribution and migration of mackerel. A number of surveys were examined which provide information on the ecology, distribution and abundance of mackerel at various stages of their life cycle. These ranged from directed surveys with specific objectives to determine the abundance of mackerel (e.g. egg surveys, Lidar, IBTS juvenile trawl survey); to surveys which target other species, but can easily provide information on the distribution of mackerel (e.g. pelagic acoustic surveys); to surveys for which additional data could be collected with some additional effort (e.g. by collecting and analysing acoustic data on the IBTS survey).

The group made some recommendations pertinent to the surveys identified above, which would allow for data on mackerel to be more comparable. The group considered the egg surveys as the most important survey since it is the basis for measuring the SSB and in addition provides fishery-independent information about distribution of eggs (i.e. spawning mackerel) during the spawning period. The group also recommended that tagging studies and stock identification methods should be investigated.

Recommendations

- WGWIDE recognized the need for additional fishery-independent methods providing information on biology, ecology, distribution, migration and abundance of NEA mackerel.

- WGWIDE recommends working on harmonization and coordination of national and international surveys that already are targeting mackerel, particularly the ongoing surveys in the mackerel feeding area during the summer, and other surveys that with minor adjustments can provide such information.
- WGWIDE recommend that a coordination group consisting of different experts on acoustics, pelagic trawling, survey design, biology and assessment should be established to improve and modify existing surveys targeting mackerel.

1.8 Ecosystem considerations for widely distributed and migratory pelagic fish species

It has been known for more than a century that ecosystem factors have a determinant effect on the productivity of fish stocks, and may therefore be a source of variation as important as exploitation by fisheries (Hjort, 1914). Various biological aspects of fish stocks such as recruitment, growth or natural mortality, are influenced by ecosystem factors (Skjoldal *et al*. 2004). Geographical distribution of stocks and species migration patterns may also vary according to environmental conditions (Sherman and Skjoldal 2002). Ecosystem factors influencing fish stocks include:

- Physical (temperature, salinity) conditions
- Hydrographical (turbulence, stratification) conditions
- Large scale circulation patterns
- Inter-species and intra-species relationships
- Bottom-up effect of zooplankton on pelagic fishes
- Competition for food or space between pelagic species
- Top-down control of pelagic species by predator abundance

An important challenge for the future meeting of this working group will be to take ecosystem considerations into account in stock assessment methods in order to reduce levels of uncertainty regarding the status and prediction of stocks. WGWIDE encourages further work to be carried out on ecosystem considerations linked to widely distributed fish stocks including NEA mackerel, Norwegian spring-spawning herring, blue whiting and horse mackerel. Emphasis should be on how ecosystem considerations from scientific studies and knowledge may be implemented and applied for management considerations.

ECOSYSTEM FACTORS AFFECTING THE STOCKS INCLUDED IN WGWIDE

Climate variability and climate change

Climate, in its wider sense, refers to the state of the atmosphere, for instance in terms of partitioned air masses (IPCC 2001). Climate variability, caused by the variations of atmospheric characteristics around the average climatic state, occurs via recurrent and persistent large-scale patterns of pressure and circulation anomalies. The North Atlantic Oscillation (NAO) is the recurrent pattern of variability in circulation of air masses over the North Atlantic region, corresponding to the alternation of periods of strong and weak differences between Azores high and Icelandic low pressure centers. Variations in the NAO influence winter weather over the North Atlantic (storm track, precipitations, strength of westerly winds) and hence have a strong impact on oceanic conditions (sea temperature and salinity, Gulf Stream intensity, wave height). Since 1996 the Hurrell winter NAO index has been fairly weak but mainly positive, except for during 2001, 2004 and 2006 (ICES, 2007). The Iceland Low and the Azores High were both weaker than normal in 2007 and 2008, and the centre of the Iceland Low was displaced towards the southwest to the entrances to the Labrador Sea (ICES 2007, 2008).

Accumulation of anthropogenic greenhouse gases in the atmosphere is currently effecting climate change (IPCC 2001). The classical measure of global warming is the Northern Hemisphere Temperature anomaly (NHT) (Jones and Moberg, 2003) which is computed as the anomaly in the annual mean of sea water and land air surface temperature over the northern hemisphere. Since the early 1900s, a warming of the northern hemisphere is evident. A first period of increasing temperature occurred from the early 1920s to about 1945. The period from the 1950s to the middle of the 1970s, corresponded to a light decrease of the NHT. During the last three decades, NHT anomalies have exhibited a strong warming trend. Many fish species are long-lived and therefore the effects of oceanographic conditions may be buffered at the population scale and integrated over time, even at the individual scale (Tasker *et al*. 2008).

Circulation pattern

Large-scale circulation patterns set the stage for important processes influencing fish species and ecosystems covered by WG WIDE. The circulation of the North Atlantic Ocean is characterized by two large gyres: the *subpolar* (SPG) and *subtropical* gyres (Rossby, 1999). When the SPG is strong it extends far eastwards bringing cold and fresh subarctic water masses to the NE Atlantic, while a weaker SPG allows warmer and more saline subtropical water to penetrate further northwards and westwards over the Rockall plateau area. Changes in the oceanic environment in the Porcupine/Rockall/Hatton areas have been shown to be linked to the strength of the subpolar gyre (Hátún *et al*., 2005). In recent years the area has been dominated by the warmer and saline Eastern North Atlantic Water (Hátún *et al*., 2007). The large oceanographic anomalies in the Rockall region spread directly into the Nordic Seas, regulating the living conditions there as well as further south. Such changes are likely to have an impact on the spatial distribution of spawning and feeding grounds and on migration patterns of certain pelagic species.

Temperature

Temperature is well known to affect many aspects of fish biology, such as recruitment, growth , or mortality rates.. Temperature affects fish both directly – through its effect on metabolic rates affecting growth and energy requirements - and indirectly – through its effect on the production of prey items and production and distribution of predators.

Feeding and spawning distributions and migration patterns of widely distributed species are also closely related to temperature: the timing of migration can be triggered by temperature and migration routes are related to temperature gradients (Harden Jones 1968; Leggett 1977). A better understanding of these effects could provide valuable information for both assessment and management of widely distributed stocks.

Time-series of sea surface temperature (SST) and salinity for the North Atlantic show recent generally rising trends. The trend from 1996-2008 has been warming and increasing salinity in the upper ocean (ICES 2008). In 2008 Atlantic Water surface temperatures were above the long term mean. The increase in SST at several of the stations in the NE Atlantic is up to 3^{o}C since the early 1980s. This rate of warming is very high relative to the rate of global warming (ICES 2007, 2008). The upper layers of the North Atlantic and Nordic Seas remained exceptionally warm and saline in 2006 and 2007 compared with the long-term average (ICES WGOH 2007, 2008). The largest anomalies were observed at high latitudes. The North Sea, Baltic Sea and Bay of Biscay had an unusually warm winter and spring. This was due to a combination of stored heat from the warm autumn in 2006, and high solar radiation in 2007 (ICES WGOH 2008).

Phytoplankton

Phytoplankton abundance in the NE Atlantic has increased in cooler regions (north of 55°N) and decreased in warmer regions (south of 50°N) (Tasker *et al*. 2008). These changes in the primary production are likely to have impacts on zooplankton because of tight trophic coupling (Richardson and Schoeman, 2004).

Zooplankton

Indicators of zooplankton communities which have been developed over recent years reveal important changes in the pelagic ecosystems of the North East Atlantic (Beaugrand, 2005). A northwards shift of 10° of latitude of the biogeographical boundaries of copepod species has, for instance, occurred during the past four decades (Beaugrand *et al*. 2002). One well-known example of these changes is the decline in the North Sea of the sub-arctic copepod *Calanus finmarchicus*, an important food item for a number of fish species, and its replacement by *Calanus helgolandicus*, a temperate water species. Progressive increases in abundance of warm water/sub-tropical phytoplankton species into more temperate areas of the northeast Atlantic (Beaugrand *et al*. 2005) have in turn influenced zooplankton communities. The average biomass of zooplankton in the Norwegian Sea has followed a decreasing trend since 2002, but increased in 2008 compared to 2007. Average biomass of zooplankton in May 2008 was lower than in 2006 and 2007, and was the lowest measured since 1997 (ICES 2008). Increased biomass was observed in the eastern region, while biomass in the western region decreased abruptly from 2007 to 2008. The overall distribution pattern of zooplankton biomass in 2008 resembles largely the distribution during previous years with the highest biomass in the cold water of the East Icelandic Current, where high aggregations of adult herring and mackerel were also observed. The biomass in the western region was much lower than any previous recordings; higher concentrations along the Arctic front further north were not obvious as opposed to in previous years. The average biomass of zooplankton in the Norwegian Sea in May reached in 2009 a record low level since the measurements started in 1997. A similar trend was found in July 2009 with low zooplankton concentrations in all areas of the Norwegian Sea. Areas of lowered plankton densities seem to have spread west and northwards in front of the feeding herring and up until 2009 there was a high density zooplankton area only in the circumference or outskirt of the herring feeding area. This area of higher plankton densities in the west and northwest disappeared in 2009, an observation done both during the May and July/August.

Species interactions

A central element in ecosystem considerations is how different species interact with each other (Rothschild 1986, Skjoldal *et al*. 2004). The distribution of species considered by WG WIDE can overlap to a large extend during some part of the year and according to life history stages. Since these species are mainly planktivorous, density dependent competition for food could be expected. All the species are potential predators on eggs and larvae and the larger species (mackerel and horse mackerel) are also potential predators of the juveniles. Consequently, cannibalism and interspecific interaction between pelagic species could play an important role in the dynamics of these pelagic stocks.

Various pelagic species (e.g. mackerel, horse mackerel, sardine, blue whiting) also represent an important food source for many top predators such as marine mammals, seabirds and other species of pelagic fish. Many pelagic ecosystems (particularly those in upwelling areas) are characterised by a wasp-waist control, where a few, but highly abundant fish species effectively regulate the populations of their prey (top down control) but also of their predators (bottom up control). This type of regulatory mechanism makes pelagic fish have a key role in ecosystem functioning (Skjoldal *et al*. 2004).

There is a large body of literature on the diet of predator species feeding on pelagic fish in the Northeast Atlantic: sardine, mackerel, horse mackerel, blue whiting and herring have all been found in the diet of several cetacean and seabirds species and are also part of the diet of other fish species (e.g. hake, tuna found with sardine and anchovy) (Anker Nilssen and Lorentzen, 2004; Nøttestad and Olsen 2004). Comparizon of population estimates of pelagic fish (TSB and SSB herring: 14.4 and 11.5 mill. tons, mackerel: 3.6 and 2.5 mill. tons and blue whiting: 5.761 and 4.918 mill. tons) (WGWIDE 2009)) with those of top predators (e.g. minke whale, fin whale, killer whales) it would appears that predation on pelagic fish by other pelagic fish has a much bigger potential for impact in regulating populations than that the predation by marine mammals and seabirds (Furness (2002) in the context of the North Sea). Nevertheless, top predators could play a bigger role in pelagic fish dynamics at regional or local scales particularly when fish biomass is low (Holst *et al*. 2004; Nøttestad *et al*. 2004).

Overview of the environmental conditions during the recent years in the NORTHEAST Atlantic ecosystems

North Sea

At the beginning of 2008, the temperatures in the North Sea were high and remained high until autumn. At the end of the year, they were about normal (Skogen *et al*. 2009). Model simulations indicate that the inflow of Atlantic water was very low, both from the north and through the English Channel (Skogen *et al*. 2009). The average annual modelled primary production in 2008 in the North Sea was well above the average for the period 1985-2007 (Naustvoll *et al*. 2009). Higher temperatures have extended the distribution of several zooplankton species northwards and more southern species have increased survival in the North Sea. The cold-water copepod *C.finmarchicus* is in retreat and is only partially replaced by the more southern *C. helgolandicus*. The population of the previously dominant zooplankton in the North Sea (*C.finmarchicus)* decreased in biomass by 70% between the 1960s and the 2000s. Species that prefer warmer waters have moved northwards, but their total biomass is not as great as the decrease in Calanus biomass (Edwards *et al*., 2008). A shift in the distribution of many plankton species by more than 10° latitude northwards has been recorded over the past 30 years (Beaugrand *et al*. 2002; Tasker *et al*. 2008).

Norwegian Sea

The Atlantic water in the Norwegian Sea has been extraordinarily warm and salt since 2002 with record-high temperature in 2007. Since then a cooling is observed, and in 2008 the temperature sunk to normal (Mork *et al*. 2009). In winter 2008 the NAO index was larger than the long-term average, with stronger southwesterlies than normal. After a record-high volume transport of Atlantic water in the Norwegian Sea during 2005-2006, the temperature fell, and has been normal in 2008. At the surface the temperatures in 2008 was warmer than the average for most of the Norwegian Sea (Mork *et al*. 2009). Arctic waters are separated from Atlantic waters by the Arctic Front. Surface waters in the northwestern part of the Norwegian Sea were considerably warmer compared to the last two decades, and coincided with increased presence and concentrations of large herring and mackerel in the area (Nøttestad *et al*. 2009). In 2008, the spring bloom in the water of the Norwegian Coastal Current in the Atlantic took place 2-4 weeks earlier than in 2007. This is much earlier than the average for the period 1991-2005 (Ellertsen and Melle 2009). The zooplankton biomass in the Norwegian Sea continues to drop, especially in the western part of the ocean. For the total Norwegian Sea the biomass is the lowest since the measurements started in 1997 (Ellertsen and Melle 2009). Plankton organisms uncommon to the Norwegian Sea are entering at an increasing rate. *Calanus helgolandicus*, the temperate sibling-species of the Norwegian Sea copepod *C. finmarchicus*, is at times dominating along the southwestern coast of Norway (Ellertsen and Melle 2009). Any increase in the *C. helgolandicus* population at the expense of *C. finmarchicus* might have a detrimental effect on pelagic planktivorous fish due to lack of suitable energy-rich food for e.g. mackerel, herring and blue whiting.

Barents Sea

The general circulation pattern in the Barents Sea is strongly influenced by topography. The coastal water is fresher than the Atlantic water, and has a stronger seasonal temperature signal. The water masses in the Barents Sea have been extraordinary warm since 2000. However, 2008 was slightly cooler than 2007. This is probably due to a strong reduction of the transport of Atlantic water into the Barents Sea. The amount of ice in the Barents Sea was low in 2008 (Ingvaldsen 2009). The seasonal distribution of phytoplankton was more or less similar in 2008 to what has been observed in earlier years. Considerably less zooplankton was observed in the Barents Sea in 2008 compared to 2007. This may be due to a lesser amount of Atlantic water being transported into the area, but an increasing capelin stock grazing on zooplankton, mainly copepods and krill, most probably contributed to the decrease (Knutsen and Dalpadado 2009). The highest zooplankton biomass were observed in the eastern part.

The capelin stock is increasing and estimated at about 4.4 mill. tonnes in the autumn 2008, The years classes 2005-2008 of the herring stock are smaller than previous years. A decreasing amount of blue whiting was recorded in 2008 and 2009.

Bay of Biscay to west of the British Isles

Hydrological and oceanographical data from the ICES Ocean Climate Report 2007 showed a cold winter and low sea surface temperatures, followed by an unusually warm summer and autumn, and correspondingly high SST (ICES 2007). This situation has recently influenced migration patterns and distribution of juvenile and adult NEA mackerel. Possible mechanisms involved are: earlier onset of spawning and migration to higher latitudes due to generally higher temperatures triggering spawning, and earlier spring blooms in the region important for some species such as mackerel and horse mackerel. No updates have been made due to lack of available data and results to WGWIDE.

STOCK SPECIFIC ECOSYSTEM CONSIDERATIONS

North East Atlantic Mackerel

In 2008-2009 new mackerel observations was made. This provides additional data for analysis that will eventually improve the understanding of the stocks dynamics of NEA mackerel. The present knowledge base is described in the Stock Annex.

New observations was especially made in relation to distribution and feeding in the area NW of the British Isles and in the Norwegian Sea:

In area NW of the British Isles covered by the blue whiting spawning survey in March-April, mackerel have in the years 2004–2008 sporadically been encountered along the shelf slope west of the Hebrides and further south as schools of medium to high density. However in 2009, mackerel were found to be distributed widely across the combined survey area and in high densities. Mackerel were taken in trawl samples from 60ºN north to as far south as 51ºN and west to 15ºW on the Hatton Bank. Ordinarily confined to the shelf slope, mackerel were encountered in open waters in depths of between 60–300m forming distinct schools occurring over large areas. Stomach contents revealed mackerel to be actively feeding on mesopelagic fish and were most frequently encountered within this layer. During daylight hours mackerel were discernible as single schools. At night mackerel schools dispersed through the mesopelagic layer (ICES 2009 PGNAPES).

One month later in May 2009 the international ecosystem survey in the Nordic Seas encountered mackerel off the Norwegian shelf between 62 and 68ºN and up to 64ºN in the Faroese area. Most of the mackerel were in maturity stages 4, 5 and 6 which means that they were most probably spawning in the area (ICES 2009 PGNAPES). This was also observed in 2008, but to a lesser extent (ICES 2008 PGNAPES). This is north and out of the area covered by the mackerel egg survey (WGMEGS 2008).

A major finding from an international ecosystem survey in the Norwegian Sea in July-August 2009, was that mackerel was caught and acoustically detected over vast areas, expanding further west and less north compared to previous years (Nøttestad and Jacobsen, WD 2009), illustrating the interannual dynamics of the fastmoving species. Repeated offshore catches of one and two year's old individuals indicate that the Norwegian Sea is an important nursery and feeding ground for immature mackerel. The mackerel was widely distributed, with highest trawl catches 3-400 km west of the Central Norwegian coast, 4-500 km northwest of Northern Norway and to the west and northwest of Iceland. The western boundary of the mackerel distribution was not found in July. The westernmost catch was just west of Iceland but no survey or catch data is available from further west. (ICES 2009 PGNAPES).

This distribution pattern coincided with considerably warmer surface waters in 2009 than in the earlier years in the western part of the Norwegian Sea in the Jan Mayen zone and in the northern part of the Icelandic zone. The northernmost areas in the Norwegian Sea were in contrast colder than previous years. During winter 2008 strong westerlies (high NAO index) resulted in an increased influence of Arctic water in the southern Norwegian Sea for 2008 compared to 2007. Also compared to the average 1995-2006 an increased Arctic influence was observed, especially in the western and southwestern part.

Together with temperature; feeding opportunities seems to affect the distribution. In summer 2009 the central parts of the Norwegian Sea had very low biomass levels and relatively rich areas was observed in the waters dominated by the East Icelandic current of the western Norwegian Sea. The distribution and biomass of zooplankton where *C. finmarchicus* dominates, likely influenced the feeding migration and distribution of adult mackerel (ICES PGNAPES 2009; Nøttestad and Jacobsen, WD 2009).

NEA mackerel and NSS herring had a pronounced overlap in spatial distribution particularly in the southwestern and western parts of the Norwegian Sea in 2008 and 2009. Mackerel were caught together with herring in the same trawl hauls, both in several commercial fisheries and in international surveys, suggesting that bycatch issues now represent increased challenges in the performance of this fishery by pelagic trawling and purse seine. Large mackerel ate adult capelin north of Iceland in 2009, which has never been reported before in this area. This illustrates the complex picture of interaction between species and confirms the opportunistic feeding behaviour as it has been shown in other areas (ICES 1989, ICES 1997, Mehl and Westgård 1983).

Due to the pronounced changes and dynamics in the distribution and migration pattern of both juvenile and adult mackerel observed in recent years (2006-2009), the ICES WGWIDE encourage future surveys to gain more coordinated information and to monitor these important changes. There is a general need for fishery-independent surveys on mackerel for abundance estimation, distribution and ecology, in order to increase our understanding of important mechanisms and processes underlying such observed dynamics and furthermore be able to improve our predictions for NEA mackerel. Currently the stock is subject to increased variability in recruitment and changes in distribution. This adds to uncertainty about the future.

Norwegian spring spawning herring

The herring distribution in May 2009 was similar to what was observed in May 2008. This is reflected in the center of gravity of the distribution. The smallest and youngest fish were found in the northeastern area and both size and age increased southwestward. Most of the oldest herring fed in the southwestern area during both 2008 and 2009. In 2009 the strong 2002, the average 2003 and the relatively strong 2004 year classes feeding in the Norwegian Sea were dominating the stock in numbers with about 50% of the total biomass.

The average biomass of zooplankton in the total area in May has, however, been on a decreasing trend since 2002, and reached in 2009 a record low level since the measurements started in 1997. A similar trend was found in July 2009 with low zooplankton concentrations in all areas of the Norwegian Sea. From a situation with relatively good feeding conditions throughout the Norwegian Sea, areas of lowered plankton densities seem to have spread west and northwards in front of the feeding herring and up until 2009 there was a high density zooplankton area only in the circumference or outskirt of the herring feeding area. This area of higher plankton densities in the west and northwest disappeared in 2009, an observation done both during the May and July/August survey as referred above. On its presently record high level the herring stock puts heavy pressure on its food resources. The very strong decrease in available plankton resources for all the pelagic fish stocks in the Norwegian must be regarded a major ecological factor at present and should be followed closely in the coming years.

Herring overlapped spatially in distribution with mackerel in several parts of its distribution area in 2008 and 2009, including the south-western and northern part of the distribution area, but was not present in the warmer southern part of the Atlantic water masses. This could have considerable consequences for fishing because of considerable spatiotemporal overlap and bycatch issues involved when fishing for herring as well as mackerel.

Norwegian spring spawning herring are a highly migratory and straddling stock carrying out extensive migrations in the NE Atlantic. This applies to the wintering, spawning and feeding area. Juveniles and adults of this stock form an important part of the ecosystems in the Barents Sea, the Norwegian Sea, and the Norwegian coast. Herring has an important role as food resource to higher trophic levels (e.g. cod, seabirds, and marine mammals). Recent changes in the herring migration have led to an increased proportion of the population feeding in Faroese and Icelandic waters. The growth of these herring is faster than those feeding further east and north. The size of the feeding area is influenced by the stock size. Additionally, ocean climate and current systems are obvious candidates affecting the feeding area with more northerly migrations in warming periods. Other factors could be the entrance of large year classes of young herring from the Barents Sea into the Norwegian Sea and asymmetrical plankton concentrations throughout the potential feeding area. Herring (as with previous years) had a somewhat more southerly distribution in 2008 than in 2007. This south-westward shift in feeding migration and distribution continued in 2004 through 2006, and especially in 2007 the fishery continued in the south-western areas throughout the summer, leading to some speculations of a change in their late autumn migrations of parts of the adult stock (see Fernö *et al*. 1998; Nøttestad *et al*. 2004).

Two main features of the circulation in the Norwegian Sea, where the herring stock is grazing, are the Norwegian Atlantic Current (NWAC) and the East Icelandic Current (EIC).

The inflow of Atlantic water into the Norwegian Sea and Barents Sea seems to influence the condition and hence fecundity of adult fish as well as the survival of larvae (Toresen and Østvedt, 2000, Fiksen and Slotte, 2002, Sætre *et al.*, 2002). Environmental conditions may also affect fish, which may result in reduced fecundity (Oskarson *et al.*, 2002). The strong year classes have occurred in periods of good condition and high temperatures.

Blue whiting

Very little new information has been provided to the working group in 2009. Blue whiting has an important role in the pelagic ecosystems of the NE Atlantic, both by consuming zooplankton and small fish, and by providing a food resource for larger fish and marine mammals.

During the spawning stock survey on blue whiting in 2009, large amounts of mackerel were observed throughout the spawning grounds. The mackerel was distributed from 60-300 meters and fed heavily on pearlsides (*Maurolicus mülleri*) (PGNAPES, ICES C.M 2009./RMC:06). The overlapping distribution of feeding mackerel with the blue whiting spawning grounds suggests a possible ecologic interaction between the two stocks, and predation from mackerel on blue whiting egg and larvae could be a contributing factor to the collapse in blue whiting recruitment observed. This interaction may have increased significantly both with the growth in the mackerel stock and with the changes observed in mackerel distribution in recent years. It is strongly suggested that investigations are carried out on this relationship in order to evaluate possible effects of mackerel on blue whiting recruitment.

In the last 15 years large changes have occurred in stock size, and during the last few years the stock has decreased rapidly; not only in terms of spawning stock biomass: recruitment has also been weak and lower than expected. This signal is reflected in changes in large-scale hydrographic systems in the north Atlantic (the subpolar gyre, SPG). Changes in the strength of the SPG have been shown to coincide with the recent large changes observed in the blue whiting recruitment (Hátún *et al.*, 2005). The strength of the SPG might affect the spawning distribution of the blue whiting as well as the main migration pattern into feeding areas in the north. In addition it might also influence the relative amounts of eggs and larvae drifting to northern and southern nursery areas; a certain spawning area may seed northern areas in one year and southern areas in another (Skogen *et al.*, 1999).

The recent large inflow of warm Atlantic water to the Barents Sea had a positive effect on abundance of blue whiting in the Barents Sea one year later (Heino *et al.*, 2003). The strength of year classes as 0-group in the North Sea is only weakly coupled to the strength of year classes in the main Atlantic stock. This suggests either local recruitment or variation in transportation of larvae into the North Sea. The recruitment of blue whiting the last few years has been very low, including the 2007 and 2008 year classes.

Blue whiting condition has decreased quite substantially the last 15 years. There are several possible explanations for this overall negative trend.

- Lower plankton concentrations in general.
- Lower plankton concentrations in particular areas and times occupied by blue whiting – an unfortunate match in time and space.
- Intra- or interspecific competition – too many fish competing for the same food resource.

Horse Mackerel.

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A major finding from an international ecosystem survey in the Norwegian Sea in July-August 2009, was that mackerel was caught and acoustically detected over vast areas, expanding further west and less north compared to previous years (Nøttestad and Jacobsen, WD 2009), illustrating the interannual dynamics of the fast moving species. Repeated offshore catches of one and two year's old individuals indicate that the Norwegian Sea is an important nursery and feeding ground for immature mackerel. The mackerel was widely distributed, with highest trawl catches 3-400 km west of the Central Norwegian coast, 4-500 km northwest of Northern Norway and to the west and northwest of Iceland. The western boundary of the mackerel distribution was not found in July. The westernmost catch was just west of Iceland but no survey or catch data is available from further west. (ICES 2009 PGNAPES).

This distribution pattern coincided with considerably warmer surface waters in 2009 than in the earlier years in the western part of the Norwegian Sea in the Jan Mayen zone and in the northern part of the Icelandic zone. The northernmost areas in the Norwegian Sea were in contrast colder than previous years. During winter 2008 strong westerlies (high NAO index) resulted in an increased influence of Arctic water in the southern Norwegian Sea for 2008 compared to 2007. Also compared to the average 1995-2006 an increased Arctic influence was observed, especially in the western and southwestern part.

Together with temperature; feeding opportunities seems to affect the distribution. In summer 2009 the central parts of the Norwegian Sea had very low biomass levels and relatively rich areas was observed in the waters dominated by the East Icelandic current of the western Norwegian Sea. The distribution and biomass of zooplankton where *C. finmarchicus* dominates, likely influenced the feeding migration and distribution of adult mackerel (ICES PGNAPES 2009; Nøttestad and Jacobsen, WD 2009).

NEA mackerel and NSS herring had a pronounced overlap in spatial distribution particularly in the southwestern and western parts of the Norwegian Sea in 2008 and 2009. Mackerel were caught together with herring in the same trawl hauls, both in several commercial fisheries and in international surveys, suggesting that bycatch issues now represent increased challenges in the performance of this fishery by pelagic trawling and purse seine. Large mackerel ate adult capelin north of Iceland in 2009, which has never been reported before in this area. This illustrates the complex picture of interaction between species and confirms the opportunistic feeding behaviour as it has been shown in other areas (ICES 1989, ICES 1997, Mehl and Westgård 1983).

Due to the pronounced changes and dynamics in the distribution and migration pattern of both juvenile and adult mackerel observed in recent years (2006-2009), future surveys to gain more coordinated information and to monitor these important changes are encouraged. There is a general need for fishery-independent surveys on mackerel for abundance estimation, distribution and ecology, in order to increase our understanding of important mechanisms and processes underlying such observed dynamics. Recent surveys suggest changes in distribution. This adds to uncertainty about the future.

2 Northeast Atlantic Mackerel

2.1 ICES advice and international management applicable to 2008 and 2009

The internationally agreed TACs 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, Va, 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 a part 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 TAC's agreed by the various management authorities (the Coastal States of mackerel and NEAFC) and the advice given by ACFM for 2008 and 2009, as well as the WG catch estimate for 2008 are given in the text table below.

<table>
<tr><th>Agreement</th><th>Areas and Divisions</th><th>TAC in 2008</th><th>TAC in 2009</th><th>Stock components</th><th>ICES advice 2008</th><th>ICES advice 2009</th><th>Areas used for allocations</th><th>Prediction basis</th><th>WG catch in 2008</th></tr>
<tr><td rowspan="2">Coastal states agreement (EU, Faroes, Norway)</td><td rowspan="2">IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV</td><td rowspan="2">385,366</td><td rowspan="2">511,287</td><td>North Sea</td><td>Lowest possible level</td><td>Lowest possible level</td><td rowspan="5">IIa, IIIa, IV, Va, b, VI, VII, VIIIa,b,d,e, XII, XIV</td><td rowspan="5">Northern</td><td rowspan="5">551,204</td></tr>
<tr><td rowspan="4">Western</td><td rowspan="5">Reduce F in the range 0.15 – 0.20</td><td rowspan="5">Reduce F in the range 0.15 – 0.20</td></tr>
<tr><td>NEAFC agreement</td><td>International waters of IIa, IV, Va, b, VI, VII, XII, XIV</td><td>43,629</td><td>57,884</td></tr>
<tr><td>Unilateral Norway-Faroes[4)]</td><td>IIa, IV, Vb</td><td>NA</td><td>35,819</td></tr>
<tr><td>EU-NO agreement[1)]</td><td>IIIa, IVa,b</td><td>1,865</td><td>1,865</td></tr>
<tr><td>EU autonomous[2)]</td><td>VIIIc, IXa</td><td>27,005</td><td>35,829</td><td>Southern</td><td>VIIIc, IXa</td><td>Southern[3)]</td><td>59,859</td></tr>
<tr><td>Total</td><td></td><td>457,865</td><td>642,684</td><td></td><td>349-456</td><td></td><td></td><td></td><td>611,063</td></tr>
</table>

1) Fixed quota to Sweden.

2) Includes 3,000 t of the Spanish quota that can be taken in Spanish waters VIIIb.

3) Does not include the 3,000 t of Spanish catches taken in Spanish waters of VIIIb under the southern TAC.

4) Unilateral Norway-Faroes declared quota in 2009.

Over recent years improved enforcement has detected some undeclared landings of mackerel from 2001 to 2004 in UK and Ireland. As a consequence the EU introduced a new regulation scheduling payback over the next few years (Commission Regulation 147/2007). For 2009 this figure was 18,222 tonnes and this amount of mackerel should be withdrawn from their national quotas in 2009. Thus, to arrive at an expected amount of mackerel in 2009 it is necessary to take the total TAC (606,865 tonnes) adding the estimated discards (26,766 tonnes, Table 2.2.1.1) and subtracting the UK/Ireland payback (18,222 tonnes), adding Icelandic catches (111,691 tonnes by end of August 2009), adding the estimated over catch (11.27% of the estimated total WG catch of 69,145 tonnes) giving an expected catch in 2009 of 832,275 tonnes.

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. However, these catches (3,000 t) have always been included by the Working Group in the provision of catch options for the Northern area.

In addition to the TACs and the national quotas, the following additional management measures are advised as stated by ACFM (2006). These measures are mainly designed to afford maximum protection to the North Sea spawning component while it remains in its 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. In detail these measures are: There should be no fishing for mackerel in Divisions IIIa and IVb,c at any time of the year, there should be no fishing for mackerel in Division IVa during the period 15 February – 31 July and the 30 cm minimum landing size at present in force in Subarea IV should be maintained.

However, according to the EU TAC regulation some small quotas are still assigned to IIIa and IVbc. In the same regulation is also stated that within the limits of the quota for the western component (VI, VII, VIIIabde, Vb(EU), IIa (non EU); XII, XIV), a certain quantity of this stock may be caught in IVa but only during the periods 1 January to 15 February and 1 October to 31 December. In all other areas than in the Subarea IV a minimum length of 20 cm is required. Various national measures such as closed seasons and boat quotas are also in operations in most of the major mackerel catching countries. Refer to Table 2.15 for an overview.

2.2 The Fishery in 2008

2.2.1 Catch Estimates

The total estimated working group catch for NEA Mackerel in 2008 was 611,063t, an increase of 31,684t over the 2007 figure and the largest catch recorded since 2004.

Catches reported in this and previous working group reports are considered to be best estimates. In some cases catch figures are available from processors, and where available discard estimates are included (see sections 1.3.4 and 2.2.2 for further discard information on mackerel). In most cases catch information comes only from official logbook records of catches. The table below gives a brief overview of the basis for the catch estimates.

Country	Official Log Book	Other Sources	Discard information made available to the WG[2]
Denmark	Y (landings)	Y (sale slips)	
Faroe[1]	Y (catches)	Y (coast guard)	
France	Y (landings)		
Germany	Y (landings)		Y
Iceland	Y (landings)		
Ireland	Y (landings)		
Netherlands	Y (landings)	Y	Y
Norway[1]	Y (catches)		
Portugal		Y (sale slips)	
Russia[1]	Y (catches)		
Spain		Y	
Sweden	Y (landings)		
UK	Y (landings)	Y	Y

[1]In the Russian, Norwegian and Faroese fleets discarding is illegal, which means officially landings are equal to catches.

[2]Note that this column represents the countries submitting information on discarding and not the occurrence of discarding itself. For other countries there is no information available.

From this table it can be seen that discard or slipping estimates are not available from many countries, and in most cases figures are only available from the logbooks. The working group considers that the best estimates of catch it can produce are likely to be an underestimate for the following reasons:

- Estimates of discarding due to high-grading or slipping are not available for most countries, and anecdotal information suggests that slipping may be widespread especially in the Q4 fishery in IVa and the Q1 fishery in VIa. For more details see stock annex.
- Confidential information suggests that substantial under reported landings occur, for which estimates are not available for most countries. Recent work has indicated considerable uncertainty in true catch figures (WD Simmonds 2007) and the situation is ongoing.
- In WGWIDE last report (ICES, 2008) estimates of the magnitude and precision of the unaccounted fishing mortality in the NEA mackerel given in a WD from Simmonds in 2007 were updated. This analysis suggested that, on average, total catch related removals were equivalent to1.6 - 3.4 times the catch, and the spawning stock biomass may on average be 1.7 - 2.7 times the ICA virtual population estimate (mean = 2.1 times).
- Reliance on logbook data from EU countries implies (even with 100% compliance) a precision of recorded landings of 89% from 2004 and 82% previous to this (Council Regulation (EC) No's 2807/83 & 2287/2003). Given that over reporting of mackerel landings is unlikely for economic reasons, the WG considers that where based on logbook figures, the reported landings may be an underestimate of up to 18% (11% from 2004). Where inspections were not carried out there is a possibility of a 56% under reporting, without there being an obvious illegal record in the logsheets. Without information on the percentage of the landings inspected it is not possible for the working group to evaluate the underestimate in its

figures due to this technicality. EU landings represent about 65% of the total estimated NEA mackerel catch.

- The precision in the logbook records from countries outside the EU has not been evaluated.

The total catch estimated by the Working Group to have been taken from the different ICES areas is shown in table 2.2.1.1 and illustrates the development of the fisheries since 1969.

Catches in 2008 in the Nordic Seas from Subareas II and V were 148,669t (see table 2.2.1.2) and were approximately double those of the previous year (72,882t). This increase is due to larger catches in Divisions Va and IIa, due to increased exploitation of the stock by Icelandic vessels which are responsible for 76% of the catches for this area. Norwegian catches have increased but remain low in comparison with the historical data. Russian catches remain at a similar level.

The time series of catches by country recorded from the North Sea, Skagerrak and Kattegat (Subarea IV and Division IIIa) is given in table 2.2.1.3. Catches in 2008 amounted to 230,237t, a decrease of 30kt on the 2007 tonnage and well below the catches seen in the early years of the decade. Misreporting of catches taken in this area into VIa was once again reported (2007 is the only year in which no misreported catch was recorded). The reported discards are within the range reported in recent years.

The catch taken in the western area (Subarea VI, VII and Divisions VIIIa,b,d,e) is given in table 2.2.1.4 and decreased by 12,154t to 172,298t with reduced catches reported by most nations. Approximately 24kt of this catch is comprised of discards, the highest in the time series. There is also an adjustment due to misreporting from Subarea IVa.

Catches in divisions VIIIc and IXa (Table 2.2.1.5) have decreased slightly to 59,859t but remain around the historical high reported in 2007. The "Prestige" oil spill in 2003 had caused a closure of the fishery in the first quarter of that year and resulted in the lowest catches in the area for the last 10 years. Following a reopening of the fishery, catches have increased and are now similar to levels recorded prior to the oil spill. Catches in VIIIc and IXa continue to substantially exceed the official TAC for the area (see section 2.1).

The quarterly distributions of the catches since 1990 are shown in the text table below.

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	36	9	28	27

YEAR	Q1	Q2	Q3	Q4
2000	41	4	21	33
2001	40	6	23	30
2002	37	5	29	28
2003	36	5	22	37
2004	37	6	28	29
2005	46	6	25	23
2006	41	5	18	36
2007	34	5	21	40
2008	34	4	35	27

These catches are shown per statistical rectangle in Figures 2.3.1.1 to 2.3.1.4. and are discussed in more detail in Section 2.3.1. It should be noted that these figures are a combination of official and WG catches but may not represent the location of the entire stock. Of the total catch, 34% was taken during the 1st quarter as the shoals migrated from Division IVa through Area VI to the main spawning areas in Area VII. Only a small proportion of the total catch was taken in quarter 2 (4%). The proportion of catch taken during quarter 3 has increased significantly compared to last year. A major component of this shift is due to the greatly increased Icelandic catches, 96% of which were taken in quarter 3. Additionally, the proportion of Norwegian catches taken in the third quarter increased from 17% to 46% with a corresponding decrease in the fourth quarter.

National catches

The national catches recorded by the various countries for the different areas are given in Tables 2.2.1.2 - 2.2.1.5. These estimates are not necessarily identical with the official landings statistics because they may include estimates of unreported landings and corrections for misallocation of catches by area and species.

The main mackerel catching countries are Denmark, Iceland, Ireland, Norway, Russia, Scotland and Spain. Iceland, Norway and Scotland all report catches in excess of 100kt and thus account for approximately one half of the total catch. England & Wales, the Faroe Islands, the Netherlands, France, Germany, Portugal and Sweden also have significant catches over 1,000t (combined catch 71,000t).

2.2.2 Discard Estimates

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 Subarea IV, mainly because of the very high prices paid for larger mackerel (>600g) 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. Anecdotal evidence from the fleet suggests that since 1994, discarding/slipping has 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 in the fourth quarter. The level of discards is influenced by the market price and by quotas. Data provided for discarding by the fleets operating in this fishery has been included in the WG catch estimates (see Table 2.2.1.1).

With a few exceptions, estimates of discards were provided to the Working Group for the Areas VI, VII/VIIIa,b,d,e and III/IV since 1978 (see Table 2.2.1.1). However, the Working Group considers the estimates for these areas as incomplete. In 2008 discard data for mackerel were provided by three nations: UK Scotland, the Netherlands and Germany. Total discards amount to approximately 27,000t from the three nations, the highest recorded figure for nearly 20 years. The majority of this (21,000t) relates to the quarter 1 fishery in Area VIa.

No discards are available for Areas I/II/Vb and VIIIc/IXa.

Countries providing discards estimates should be encouraged to also provide age based information in order that the total stock removal may be more accurately estimated.

The only specific discard age disaggregated data made available to the group is from Scotland from the fishery in Divisions IVa in the first and fourth quarters and VIa in the first quarter. The sampling indicates that 3 year olds (the 2005 year class) are the most commonly discarded, comprising 30-40% of the total number discarded. Over 75% of the discarded fish were accounted for by 2-5 year olds. The percentage length compositions of the Scottish discards for all areas with samples are shown in Table 2.4.4.2.

Several of the Dutch samples collected relate only to discarded catch. These include the samples collected in Subarea IVc quarter 3 (60% 2 year olds), Subarea VIIj quarter 2 (47% 6 year olds), Subarea IVa quarter 2 (50% 3 year olds) and Subarea VIa quarter 3 (88% 2 year olds).

2.2.3 Fleet Composition in 2008

Details about vessels operated by the different nations targeting mackerel are given in Table 2.2.3.1.

In the Norwegian Sea (subarea II) catches are taken by Russian freezer trawlers (55-80 m) that target mackerel, blue whiting and herring at the same time and Icelandic vessels targeting herring. In recent years, the Icelandic fleet has also taken significant catches of mackerel in a mixed fishery with Norwegian spring-spawning herring and also a targeted mackerel fishery.

The fishery in the North Sea, Skagerrak, and Kattegat (Subareas IV and III) is exploited by the Norwegian and Danish purse seine fleets and pelagic trawling fleets from Scotland, Ireland, Denmark, Faroes and England. A minor part of the Norwegian catches are taken by an *ad hoc* handline system. Large freezer trawlers (>85m) from the Netherlands, with some operating under the German and English flags, also fish in this area.

To the west of the British Isles (Subarea VI and Divisions VIIb,c) catches are predominantly taken by the Scottish and Irish pelagic trawl fleet, while Subdivisions VIId-j are also fished by the English fleet and Dutch, French and German freezer trawlers. The Spanish fleet operates in Divisions VIII (Bay of Biscay) and IX and consists of demersal trawlers, purse-seiners between 10-32 m and a large artisanal fleet with vessels between 2 and 34 m.

2.3 Data available

In this section the data available to the assessment are outlined. An overview is given in Sections 2.3.1 – 2.3.3. This includes catch data (Section 2.3.1) catch per unit effort data (Section 2.3.2) and survey data (Section 2.3.3).

Length composition of catch is outlined in Section 2.3.4. Available data on weights at age and maturity at age are indicated in sections 2.3.5 and 2.3.6 respectively. A description of tagging mortality estimates and available data is given in Section 2.3.7.

2.3.1 Catch data

The 2008 catches in numbers-at-age by quarter and area are given in Table 2.3.1.1. This catch in numbers relates to a tonnage of 611,063t which is the working group estimate for total catches from the stock in 2008. These figures have been added to the catch-at-age assessment input table (see Table 2.8.1).

Age distributions of commercial catches were provided by Denmark, England and Wales, Germany, Faroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. There remain gaps in the age sampling of catches, notably France (15,602t) and Sweden (3,663t). England and Wales sampled the handline fishery in Subareas VIIe and VIIf (which accounted for 37% of their reported catches).

Areas with low sampling include IIIa, VIIc, VIIk, VIIIa and VIIId and account for a catch of almost 10,000t. Catches for which there were no sampling data were converted into numbers-at-age using data from the most appropriate fleets. The sampling coverage is further discussed in section 1.3.

The percentage catch numbers-at-age by area are given in table 2.3.1.2.

Currently for this stock, the biomass is composed mainly of several year classes. The 2002 year class, identified as strongest in recent years on the basis of catch numbers at age data, has been replaced by the 2005 year class (3 year olds in 2008) as the most populous (23%), particularly in the heavily exploited Subareas (IIa,IVa,VIa). Ages 4-6 all contribute equally to the total catch by number (15-17%). In Subareas VIId,e,f,g young mackerel (1 and 2 year olds), taken as a by-catch in the directed juvenile horse mackerel fishery, account for over 50% of the percentage by numbers. In Subarea IXa, the catch is also dominated by juvenile fish, with 68% of the catch by number comprised of ages 0 and 1.

Distribution of Commercial Catches in 2008

The distribution of the NEA Mackerel catches taken in 2008 is shown by quarter and statistical rectangle in Figures 2.4.1.1 – 4. These data are based on catches reported by Denmark, Faroes, Germany, Ireland, Iceland, the Netherlands, Norway, Portugal, Russia, Spain, Sweden and the UK. The Spanish data are not based on official data and not all catches included in these data are official. The total catches reported by rectangle were approximately 595,000t including Spanish WG data. The total working group catches were 611,063t. This year, the bulk of the catch not recorded by statistical rectangle was from France.

First Quarter 2008 (206,143t - 34%)

The distribution of catches in quarter 1 is shown in figure 2.4.1.1. The tonnage and distribution remains close to that reported last year with the majority of catches taken along the shelf edge from the Celtic Sea up to the Shetland Isles.

Second Quarter 2008 (24,265t - 4%)

The distribution of catches in the second quarter is shown in Figure 2.4.1.2. Catches in this quarter represent only 4% of the total catch. As before, significant catches are taken along the North Iberian coast although there are now also catches recorded by the Icelandic fishery in Va and IIa.

Third Quarter 2008 (212,367t - 35%)

The third quarter distribution of catches is shown in Figure 2.4.1.3. The large increases in catch by the Icelandic fishery and earlier fishing by the Norwegian vessels means that this quarter has the highest recorded proportion of the catches (35%). Large catches are dispersed widely in Areas Va, IIa and also IVa, stretching from the Shetland Isles to the Norwegian coast.

Fourth Quarter 2008 (168,088t - 28%)

The fourth quarter distribution of catches is shown in Figure 2.4.1.4. Catches in this quarter have reduced by some 60,000t although the distribution remains similar with the majority of the catch in IVa and VIa. As noted last year, the large Icelandic catches and others north of 62ºN seen in quarter 3 do not extend into this quarter. As in all quarters, there are substantial catches recorded on the Iberian coast.

2.3.2 Effort and Catch per Unit Effort

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

Table 2.3.2.1 and Figure 2.3.2.1 show the fishing effort data from Spanish and Portuguese commercial fleets. The table includes Spanish effort of the hand-line fleets from Santoña and Santander (Subdivision VIIIc East) from 1989 to 2008 and from 1990 to 2008 respectively, for which mackerel is the target species from March to May. Figure 2.3.2.1 also shows the effort of the Aviles and La Coruña trawl fleets (Subdivision VIIIc East and VIIIc West) from 1983 to 2008. The effort of the Aviles trawl fleet has been unavailable since 2004. 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 2008 for which mackerel is a by-catch is also presented. In 2003, the effort of the Spanish fleets was lower due to the spatial and temporal closure during the first quarter imposed by the presence of oil in the water, due to the catastrophe of the *Prestige* oil spill. The effort of the hand-line fleet showed an increasing trend from 1993 to 1998. Since then, the trend has been variable. The effort of the trawl fleets is rather stable during all periods with a smooth decreasing trend especially since 1995. 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 occurs in Spain, mackerel is a by-catch. The effort for this fleet varied between the lowest value (38,719 fishing hours) in 1994 to the highest one (86,020 fishing hours) in 1998. 1992 and 2001 also showed high effort values. Since 2002 the effort data has not been available.

Table 2.3.2.2 and Figure 2.3.2.2 show the CPUE corresponding to the fleets referred to in Table 2.3.2.1. The CPUE trend of the Spanish hand-line fleets shows an increasing trend, with ups and downs through the whole series. Since 2005, the CPUEs of the handline fleets show the highest values of the two series, Santoña and Santander hand-line fleets. The CPUE of the trawl fleets, like the hand-line fleets, presents an increasing general trend. The CPUE for the Aviles trawl fleet has increased since 1995, in particular in 2000 and 2002, although this figure is unreliable because catches of this fleet are estimated since 1994 onwards. For the La Coruña trawl fleet CPUE is rather stable until 2004, increasing in 2005 and 2006 but decreasing greatly in 2007. The CPUE of the Portuguese trawl fleet is variable, with a decreasing trend, the maximum value in 1991 and the minimum in 1998. The CPUE of the purse-seine fleet shows fluctuations during the period 1983 to 1995 and since 1996 to 2002 the CPUE of this fleet shows an increasing trend. In 2003 a fall was seen in the CPUE of this fleet, increasing since 2004.

Catch-per-unit-effort, expressed as the numbers fish at each age group, for the hand-line and trawl fleets is shown in table 2.3.2.3.

2.3.3 Survey Data

No new egg survey data is available to the working group in 2009. The next survey for the western and southern components will take place in 2010. The next North Sea egg survey is scheduled for 2011.

2.3.4 Length Composition of Catch

The mean lengths-at-age in the catch per quarter and Area for 2008 are given in Table 2.3.4.1.

Sizes are similar to recent years except for age 0 fish for which the mean length has decreased by approximately 2cm. Variations of this order have been noted for this age class over recent years.

Length distributions of the 2008 catches were provided by England and Wales, Faroes, Iceland, Ireland, Germany, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. The length distributions were available from most of the fishing fleets and account for approximately 90% of the catches. These distributions are only intended to give an indication of the size of mackerel caught by the various fleets and do not reflect seasonal variations, which occur in many of the landings. More detailed information on a quarterly basis is available for most of the fleets in the working group files. The length distributions by country and fleet for 2008 catches and discards are given in Table 2.3.4.2.

2.3.5 Weights at Age in the Catch and Stock

The mean weights-at-age in the catch by quarter and area are given in Table 2.3.5.1. Weights are little changed except for age 0 which has reduced in accord with the decreased mean length, noted in section 2.3.4.

The working group used stock weights based on mean weights-at-age from Dutch, Irish, Portuguese and Spanish commercial catch data collected in Divisions VIa, VIIb, VIIj and VIIIb over the period March to May. For the 2008 western stock there were only a small number of samples of mean weight at age collected from the commercial fishery due to the low level of catch in that quarter. Mean weights-at-age for the North Sea component are based on the sample catches collected by the Dutch from Area IVa during 2nd quarter 2008. For the southern component, stock weights are based on samples taken in VIIIc and IXa in the 2nd quarter of the year. The weights for the total stock are combined based on the estimated size of the three areas. The contribution from each of the stock components and their relative weighting is detailed in the text table below. For 2008 the mean weight for age 1 fish was derived from an average of the three previous years due to lack of sample data. For a complete time series on mean weights-at-age in the three components and their relative weighting for the stock weights see the 2004 WHMHSA report (ICES CM 2005/ACFM:8).

Age	North Sea	Western Component	Southern Component	NEA Mackerel
0	-	-	-	0.000
1	-	-	0.107	0.071
2	0.173	0.161	0.135	0.157
3	0.247	0.198	0.187	0.198
4	0.269	0.281	0.224	0.269
5	-	0.327	0.306	0.308
6	0.327	0.340	0.338	0.339
7	-	0.406	0.443	0.396
8	-	0.438	0.400	0.431
9	-	0.462	0.438	0.457
10	-	0.465	0.454	0.463
11	-	0.507	0.501	0.506
12+	-	0.536	0.510	0.530
No of Samples	25	591	2241	
Component weighting	4.5%	75.9%	19.6%	

2.3.6 Maturity Ogive

The weighting for the maturity ogive for NEA mackerel is calculated as described above for the stock weights using the egg production from the 2007 international egg survey for the western and southern components and the 2008 North Sea egg survey for the North Sea component. The weighting factors are very slightly changed from last year's working group because of a small revision in the estimate of biomass in the North Sea, as estimated from the North Sea egg survey (2008). The ogives from the individual stock components and the ogive calculated for the stock as a whole are given in the text table below. For a complete time series on proportion mature at age (MATPROP) in the three components and their relative weighting in the stock see the 2004 WHMHSA report (ICES CM 2005/ACFM:8).

Age	North Sea	Western Component	Southern Component	NEA Mackerel
0	0.00	0.00	0.00	0.00
1	0.00	0.08	0.02	0.07
2	0.37	0.60	0.54	0.58
3	1.00	0.90	0.70	0.86
4	1.00	0.97	1.00	0.98
5	1.00	0.97	1.00	0.98
6	1.00	0.99	1.00	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
Component weighting	4.5%	75.9%	19.6%	

2.3.7 Estimates From Tag Recaptures

The Institute of Marine Research (IMR) in Bergen has used internal steel tags for tagging mackerel since 1966. The tagging has been carried out in the spawning area west of Ireland, where an average of 20 000 fish have been tagged each year. Since 1986 commercial catches of mackerel have been screened through metal detectors connected to conveyor belt systems located in four factories in Norway. Each year a total of 10,000-45,000 tons of mackerel are screened and the recaptured tagged fish are identified and sent to IMR for data collection. In the study the detector based tagging data were utilised to estimate the year class abundance of mackerel in the period 1986-2006, by using a model based on the Petersen's formula (N = numbers released * numbers screened / numbers recaptured) and by adding a tagging mortality estimate. These estimates of abundance are compared with the results from the ICA model runs in the assessment of the stock.

The estimated biomass from the tagging data for the years 1986 - 2006 varies between 2.8 and 9.9 million tons (Figure 2.3.7.1). The results show a decline in the biomass from the early 1990s until 1998 after which the biomass increases again. The tagging data give estimates that are between 1.1 and 3.8 times the ICES official estimate based on the ICA model. There are indications that the stock is being overexploited due to the high unaccounted mortality in the fishery. It has been estimated that the actual biomass is between 1.7 and 3.6 times the reported catches (Simmonds WD 2008). These estimates lie closer to our biomass estimates based on the tagging data. WGWIDE recommends to apply this time series as an additional fishery independent information for tuning the NEA mackerel stock assessment. It is also noteworthy that the historic stock development does not follow the same patterns as the ICES assessment (Figure 2.3.7.1).

2.4 Combined survey recruitment indices

Analysis carried out in 2008 (ICES 2008 ACOM:13) indicated that recruitment series from survey data continued to be ineffective as a means for estimating or predicting recruitment. The data series continues to be kept up but these data are not presented here and were not included in the stock assessment or short term predictions. See Stock Annex for additional information.

2.5 Acoustic Surveys

Acoustic studies on mackerel have increased over the last decade due to improvements in the acoustic instrumentation, multi-frequency approaches and improved software for scrutinizing acoustic data. Nevertheless, challenges still exist when it comes to reliable acoustic categorization of mackerel, due to the low backscattering strength (TS), unknown vessel avoidance and proper species identification. These challenges can result in errors in biomass estimation and thus skewed distribution maps, which is why the estimates are presently not included in the analytical assessment. However, WGWIDE acknowledge the significant improvement in the later years and encourage further work that could provide added fishery independent high resolution information on biomass and distribution in seasons where no such information currently exist.

2.5.1 Acoustic estimates of mackerel in the North Sea

Although mackerel is a species of high commercial interest, up to now the only available data on the stock abundance in the North Sea has come from the triennial egg survey. An annual abundance index for mackerel is a high priority for international fisheries management. To be able to get this information and to get more value out of an existing acoustic survey, the data from the Dutch part of the North Sea acoustic herring survey was used to identify mackerel resulting in a relative biomass index. Due to improvements in the field of acoustics, in terms of hardware and software, nowadays different approaches, single target and school detection methods, to detect mackerel on echograms exist. School detection was based on a modified algorithm developed by Fisheries Research Services in Scotland (now Marine Scotland – Science) using the software Echoview. An algorithm for single target detection was considered but proved impossible to be used for a mackerel biomass estimate. The final biomass estimation with a calculated stock of 130 000 tons was comparable to the results of the egg survey in 2008, 152 000 tons, showing only a variation of 14.6%, probably because of too conservative scrutinising. Single targets were proven to have no influence to the final result as only 7582 single targets, making up less than 0.001% of the total stock, that were believed to be mackerel could be detected. ICES WGWIDE recommends that acoustic data on mackerel from the North Sea herring cruise and related cruises are stored and made available for scrutinizing by acoustic experts.

2.5.2 Ecosystem surveys in the Nordic Seas in July–August 2009

2.5.2.1 Coordinated Norwegian-Faroese ecosystem survey in the Norwegian Sea

Three chartered fishing vessels performed a joint ecosystem survey in the Norwegian Sea and adjacent areas, two Norwegian M/V "Libas" and M/V "Eros" from 15 July to 6 August 2009, and one Faroese M/V "Finnur Frídi" from 15 to 25 July 2009 (Figure 2.5.2.1.1).

The abundances of Northeast Atlantic mackerel, Norwegian spring-spawning herring and blue whiting were measured acoustically. Estimated biomass of mackerel was calculated to 4.4 million tons in the Norwegian Sea (Figure 2.5.2.1.2). Mackerel was distributed over larger areas than previously documented in the Norwegian Sea in July. Furthermore, a northwestern distribution was more pronounced in July 2009 compared to previous years. Repeated offshore catches of one and two year's old individuals indicate that the Norwegian Sea is now also an important nursery and feeding ground for immature mackerel (Figure 2.5.2.1.3). The 2005- and 2006 year classes dominated in the catches with more than 50% (Figure 2.5.2.1.4). A small pelagic trawl with a narrow opening was generally applied during the ecosystem survey, and catch rates (kg/nmi) on mackerel are shown in Figure 2.5.2.1.5. Trawling did not confirm the northern hot-spot that was detected acoustically. Large mackerel caught in the area north of the Icelandic shelf had adult capelin in their stomachs, which has never been reported before (WD Nøttestad and Jacobsen 2009).

Surface waters in the northwestern part of the Norwegian Sea in the Jan Mayen zone and in the northern part of the Icelandic zone were considerably warmer compared to the last two decades, and coincided with increased presence and concentrations of large herring and mackerel in the area. The northernmost areas in the Norwegian Sea were in contrast colder than previous years, limiting the extent of northern migration by herring and mackerel compared to the last few years.

2.5.2.2 Ecosystem survey in Icelandic waters August 2009

Three vessels were used in the Icelandic ecosystem survey (Figure 2.5.2.2.1). The R/V Arni Fridriksson surveyed the area from west to northeast Iceland. The M/V Hoffell worked pre-determined trawl stations mainly off the north of Iceland. R/V Bjarni Saemundsson was doing hydrographic work north of Iceland at the same time as this cruise was taking place. The main objective was to study the abundance, spatial and temporal distribution and feeding ecology of the Northeast Atlantic mackerel (WD Sveinbjörnsson 2009).

Mackerel was caught in the majority of tows except for the area off western North Iceland (Figure 2.5.2.2.2). The mackerel caught in the survey ranged from 29-48 cm in length with the highest numbers ranging from 34-39 cm (Figure 2.5.2.2.3). The mean length was 36.58 cm. The weight distribution varied between 288 – 1071 g with a mean weight of 491 g.

Acoustic data have been collected but have not yet been processed.

2.6 Acoustic Estimates of Mackerel in the Iberian Peninsula and Bay of Biscay

2.6.1 Spring Acoustic Surveys

The IEO acoustic surveys (PELACUS 04) were carried out onboard R/V *Thalassa* in spring (March-April, see Table 2.6.1), with the main aim to assess the pelagic fish community off the North Iberian Peninsula (Divisions VIIIc and IXa) but focussed on sardine stock (Figure 2.6.1). Biomass estimates are obtained for the main pelagic fishes in the survey area, including sardine, mackerel, horse mackerel and, whenever it is present in sufficient fishing hauls, anchovy. In 2007 and 2009, the abundance and biomass of all the pelagic fish species detected in these are have been estimated (up to nine species). The methodology for the estimation of mackerel biomass by acoustic methods in the study area has been standardised (Iglesias *et al.*, WD 2005). The high abundance of this species in the Atlantic-Cantabrian Sea area during these months and their particular behaviour, with schools and aggregations close to the bottom, permits their relatively easy detection by means of scientific echosounder and fishing trawls for the purposes of identification. The TS/L relationship used was the same as in the North Sea and as recommended by PGAAM. The use of several frequencies, mainly 38 and 120 kHz, helps in the identification of the echotraces of this species, above all when they are masked by plankton or bubbles. In all of the surveys a reading threshold of echograms of -60 dB was chosen. In the last survey (Pelacus 2008) a plankton mask using several frequencies (18, 38 and 120 kHz) has been used to help the correct scrutinizing of the echograms.

Mackerel has been measured acoustically by Spain in March-April in the North and Northwest of Iberian Peninsula since 1999. Mackerel are abundant in this area in spring, when they come to the area to spawn. Details are available in the working document on acoustic surveys (Iglesias *et al*., 2005, WD to WGMHSA 2005). The results of the 2001 to 2009 surveys are presented, leaving the re-evaluation of the 1999 and 2000 surveys pending.

In all years, mackerel are distributed throughout the whole area surveyed (Figure 2.6.2), and the highest concentrations are found in Division VIIIc (Table 2.6.2), coinciding with the main spawning ground in the Southern Area (ICES 2008a). Mackerel abundance has varied considerably from 2001 to 2009, with higher values in 2002 and 2003 coinciding with a high abundance of juveniles (Table 2.6.3). Regarding biomass, a maximum was reached in 2002 (1,534,793 t) with a large reduction in 2005 (409,493 t) followed by a further large reduction in 2006 (146,572 t) and 2007 (198,801 t) with respect to 2003 and 2004 (907,814 t and 945,619 t respectively) values. The biomass estimated in 2008 (369,681 t) and 2009 (316,160) was at same level that in 2005. The fall in abundance and biomass registered in the last years (2005-2009), as Figure 2.6.3 shows, may be partly because the dates on which the survey was carried out were the latest of the whole series (April). Historically, the commercial catches of this species have usually come mainly in March and April, with a peak in the latter of the two months (Villamor *et al*., 1997). Nevertheless, the timing of the peak of catches has shifted forward in recent years (Punzón and Villamor, 2009) and this results point to the possibility that this shift may be due to a change in the timing of the spawning migration to the southern area of the NEA mackerel population. A forward shift in the timing of mackerel migration would mean that changes in the estimated abundance of this species by acoustic surveys would not be due to changes in its biomass, rather to changes in its migratory behaviour. This factor must be taken into account in future survey designs, in the use of indices deriving from them in the evaluation, and in the evaluation itself.

Also, as we see in biomass by length class distribution (Figure 2.6.4), years 2005-2009 show extremely low values. Biomass by age class (Figure 2.6.5) for the whole Spanish area (VIIIc and IXa North) reflect a strong year class in 2002 (age 1 in 2003) and also in 2001 (age 1 in 2002), albeit less than in 2002, a weak year class in 2000 (age 1 in 2001) and also in 2004 (age 1 in 2005). Age 1 to 7 predominate in the age structure of surveys.

In the years studied, 2001 to 2009, the mackerel abundance estimated from the acoustic surveys indicate that in spring the adult fish (> 2 years) were more abundant in the west of the Cantabrian Sea. However, juveniles were more abundant in the subdivision IXa North. When a year class is extremely abundant (as of 2002) the juvenile extending their distribution area. In this case it was observed that the juveniles were also distributed throughout the prospect area. (Figure 2.2.6)

The IPIMAR acoustic surveys (PELAGO) in Portuguese waters is targeted mainly sardine and the **IFREMER** annual survey (PELGAS) in the French Biscay area is targeted at all pelagic fish resources. In 2008 the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy (WGACEGG) in ICES Areas VIII and IX (ICES, 2008c) have produced, for the first time, estimates of most pelagic species detected in all areas (Figure 2.6.7), including Atlantic mackerel (Figure 2.6.8). In 2008 the mackerel abundance estimates was 820,000 t for the all area of the Iberian Peninsula and Bay of Biscay (Table 2.6.4). It can be observed the southern limit of distribution of this species (Figure 2.6.8).

The degree of coordination of the surveys achieved through the WGACEGG was considered satisfactory and the group endorses the continuity of such coordination which allows synoptic coverage of all areas IX and VIII (ICES, 2008c).

2.6.2 Autumn Acoustic Surveys

The IEO carry out a new acoustic survey (PELACUS 10) in autumn on board R/V *Thalassa* since 2006, with the aim to assess the abundance and spatial distribution of small pelagic fishes in the south of the Bay of Biscay (area within east 5ºW, south of 47º N) (Figure 2.6.1) in September-October. These surveys focusse particularly on the estimation of abundance/spattial distribution of anchovy juveniles and on the process of recruitment of young-of-the-year anchovy. The mackerel has also been measured acoustically in these surveys, but are currently studying and evaluating the abundance estimates of this species. This document presents only the distribution and mackerel size caught during the surveys 2006-2008.

The mackerel was located mainly in the French shelf (Figure 2.6.9). In the years studied, 2006 to 2008, the mackerel caught were mostly <34 cm in size (between 0 and 4 years of age in the age-length keys). The length interval was between 15-42 cm in 2006 (mode at 30 cm), between 11-38 cm in 2007 (mode at 28 cm) and between 16-39 cm in 2008 (detected 2 modes, at 26 and 31 cm) (Figure 2.6.10).

2.7 The international egg survey

2.7.1 Planning and coverage of the 2010 international egg survey

The ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) met in Hamburg on April 20-24, 2009, to plan the Mackerel and Horse Mackerel Egg Survey in 2010. For the first time the Faroe Islands will contribute to the triennial survey with their own vessel in addition to the participation of Portugal, Spain, Scotland, Ireland, The Netherlands, Norway and Germany. A description of the survey and its main aims are in the Stock Annex.

As in 2007, the 2010 survey has been based on six sampling periods, again commencing with the Portuguese DEPM survey for horse mackerel. As in 2007, there is no participation from UK (England and Wales) at a time when the spawning area of horse mackerel and particularly mackerel is expanding into new areas and this leads to an expansion of the potential survey area. This, combined with other ship-time restrictions, has already created difficulties with the 2007 survey with respect to defining egg distribution boundaries for both species. The recently observed expansion of the spawning area of mackerel to the north and northwest may result in the risk of missing coverage in 2010 although it is expected that the main spawning activity will remain along the 200m contour from the Cantabrian Sea to the northwest of Scotland. In this context, the working group welcomes the participation of the Faroese Islands in next year's survey.

It was anticipated that missing coverage might become more prominent in the future and it was stressed that in future triennial surveys only the participation of more states exploiting mackerel and horse mackerel will enable sufficient coverage of the spawning area over the complete reproductive periods of both species. More ship time is required in order to cover the spawning area of both species over the complete reproductive period.

WGWIDE is aware of the need of better coverage of the mackerel spawning area in the coming 2010 International Survey. In comparison to the 2007 mackerel egg production results, this particularly applies to the area north and northwest of the standard survey area in periods 4 and 5 (May - June). WGWIDE supported an initiative of a letter from ICES to the member states to draw their attention to their level of participation on the survey given their share of the mackerel total catch. In addition, it was suggested that mackerel egg samples should be taken during the Nordic Seas Ecosystem Survey 2010. Norway intends to sample 20 - 30 stations in the proposed area. This needs to be confirmed after checking existing ship time arrangements. It was also recommended to re-analyse the survey data under a survey design where the transects are spread out to allow covering a wider area but without increasing ship time. WGWIDE recommended a workshop for the due consideration of estimating the impact of such changes on bias and precision of both mackerel and horse mackerel estimates.

2.7.2 Quality assurance of the egg production index

Following a recommendation of WGWIDE, WGMEGS established a standard procedure in case all the samples could not be processed in time. In order to produce reliable preliminary egg production estimates, any participant unable to process samples to the required deadline will have to achieve an agreement about the selection of egg sample sub-sets in liaison with the survey data coordinator, WGMEGS chair and an independent referee.

In preparation of the 2010 survey a workshop dealing with egg identification and staging will be held in IJmuiden 5 – 9 October, 2009. Procedures for fecundity and atresia estimation will be standardized and training conducted on the fecundity workshop in San Sebastian in December. WGMEGS points out that these workshops are essential for quality assurance of the mackerel and horse mackerel egg surveys.

2.8 Stock Assessment

NEA Mackerel was classed as an update assessment this year, and the method used was the one defined by the 2007 benchmark (ICES 2007). The assessment model used is ICA, with a 12 year separable period, using the SSB estimates from the triennial Mackerel Egg survey as tuning index.

As no egg survey has been carried out this year (the next one will take place in 2010), the only new data used in the present assessment compared to last year is the 2008 catches at age. However, a slight revision in the North Sea egg survey estimate of SSB resulted in a small change in the maturity ogive used (see Section 2.3.6). Mean weights at age in the stock are routinely updated.

The assessment, including the yield per recruit analyses was implemented in R using the appropriate FLR packages. A description of the input data used for this assessment and of the model settings is given in the Stock Annex.

The input data are shown in Table 2.8.1 – Table 2.8.5. Table 2.8.6 and Figure 2.8.1 shows the stock summary. The estimated stock abundance and fishing mortality at age are shown in Table 2.8.7 and 2.8.8 respectively and the fitted selection pattern in Table 2.8.9. The diagnostics of the fit to the Mackerel egg survey data are presented in Tables 2.8.10 and 2.8.11 and Figure 2.8.2, and these don't show any obvious model specification. Diagnostics of the catch for the separable period are shown in Figure 2.8.3. and the estimated catch and residuals for the separable period are given in Table 2.8.12 and 2.8.13. Fitted parameters if the model with estimates of precision and confidence bounds are summarized in Table 2.8.14.

2.8.1 State of the Stock

The spawning stock at spawning time in 2008 is estimated at approximately 2.5 million tonnes, and appears to have been relatively stable since 2006. The stock reached a historic minimum in 2002 but has increased since then to a level above $B_{pa.}$ Fishing mortality in 2008 is estimated to be 0.237, just above F_{pa}. The 2002 year class is well above average. The subsequent year classes from 2004 to 2006 are estimated to be above the mean of the time-series. There is insufficient information to estimate accurately the size of the 2007 and 2008 year classes (see Table 2.8.14).

2.9 NE Mackerel Catch predictions for 2010

Table 2.9.1 lists the input data for the short term predictions. All procedures used this year follow those used in the benchmark of 2007. The ICA-estimated survivors ages 2 to 12+ in 1st of January 2009 in the assessment year are used as the starting populations in the prediction. The recruitment of age 0 (year class 2009) and the abundance at age 1 (year class 2008) are routinely revised.

Age 0–The geometric mean of the recruitments for the period 1972–2006, was used for the recruitment at age 0 for 2009 – 2011 in the predictions The value of 3859 million fish was used.

Age 1–As in previous years the WG has taken the abundance at age 1 to be the geometric mean recruitment at age 0 (3859 million fish) brought forward 1 year by the total mortality at age 0 in that year (2008). This corresponds to 3303 million fish.

As in previous years the exploitation pattern used in the predictions was the separable ICA F's, scaled to the F in the final year. As the model is fitted with 12 year separable period this is effectively the mean exploitation from 1997 to 2008 inclusive.

Maturity at age, weights at age in the catch and weights at age in the stock were all taken as 3 year averages (years 2006–2008). See Table 2.9.1.

The catch in the intermediate year (2009) is estimated using the agreed TAC. This is the standard practice for the NE Atlantic mackerel stock. The catch is calculated from the agreed TAC modified by quota reduction due to EU Commission Regulation (EC) No 147/2007 plus an assumed amount of discards of 26,766 t (see Table 2.2.1.1). In addition, three other sources of catch have been identified: an estimated over catch of Coastal States agreement taken mostly in the southern area (69,145 t); additional catches taken by Iceland outside the Coastal States agreement (111,691 t) and a new unilateral quota taken by Norway and the Faroes (35,819 t). The detailed calculations for intermediate year catch for the short term forecast (STF) are provided in the text table below.

	WG	Reported	Estimated catch	
Total of all areas TACs (NEAFC)	457,865		606,865	
UK Ireland payback	-18,222		-18,222	
Discards estimated from	8,616	26,766	26,766	
WG estimate of total declared	448,259	611,063	613,545	
Icelandic catches		112,286*	111,691**	
Catch reported by Coastal States		50,518#		
% Coastal States overcatch		11.27##		
Unilateral Norway Faroes TAC			35,819	
Estimated Coastal States			69,145	(11.27% of 613,545)
			832,275	

*** Icelandic catches have been zero or close to zero prior to 2007.**

**** Preliminary catch for January to August 2009 reported from Icelandic Fisheries Directorate.**

 # Difference between reported catch in 2008 and WG estimate of catch in 2008 (EU, Norway, Faroes). Not including 2008 Iceland catch

The percentage of the catch overshooting TAC in 2008 and assumed as the proportion underestimate in 2009. Not including 2008 Iceland catch

Short Term Predictions were calculated by the MFDP program. The short term forecast, estimates F at 0.31 and SSB at 2.59 Mt in 2009 (assuming catches for 2009 of 830 kt). A detailed single fleet management option table is presented: Table 2.9.2 with *catch constraint* fishing (Catch = 830 kt) in 2009. Table 2.9.3 provides multi options for 2010 to give a range of F options within the agreed management plan. Given the uncertainty in the recorded historic catch (Section 2.7.1), the most appropriate advice may not be the exact level of TAC. Therefore, advice is given on change in catch rather than on absolute values, a column giving the percentage change in catch associated with fishing mortality options has been included. Figure 2.9.1 shows results from the short term forecast.

2.10 Uncertainties in assessment and forecast

2.10.1 Uncertainties in assessment

Analytical retrospective plots (Figure 2.10.1) show fairly consistent stock trajectories. There is some revision associated with each new triennial egg survey, with periods of stability between surveys.

FLICA was used to investigate the precision of the assessment, using parametric bootstrap. Results are presented in an otolith plot showing the combined probability distribution of the 2008 estimate of SSB and Fbar4-8 (Figure 2.10.2). The 95% confidence interval of SSB and F are estimated as 2.194 and 2.863 Mt and 0.199 and 0.314 respectively, corresponding to a coefficient of variation of 6.5% and 11.3% respectively.

The uncertainty in the input parameters of the population at 1st January 2009 is relatively high for the age class above 3 (CV around 10% to 15%, Table 2.8.14) due to the time elapsed since the last survey point. For the younger ages the uncertainty is high (CV>25%), to very high for the recruits (CV=2275%). This high uncertainty on the recent recruitment is related to the absence of recruitment estimates from scientific surveys.

The main conclusions on the quality of assessments are:

- The terminal values of SSB and F are sensitive to the last egg survey value.
- Initial estimates of recent recruits are highly uncertain.
- Estimates of unaccounted mortality result in substantial uncertainty in total biomass (WD Simmonds 2007)

The WG considers the current use of the ICA model to be very sensitive to variability in the SSB estimates from egg surveys. However, it may be difficult to improve on this situation without additional resources.

2.10.2 Uncertainties in forecast

Deterministic forecasts are presented in section 2.9. The uncertainty in the ICA survivors estimates at 1st January 2009, discussed above, is a source of uncertainty in the results of the short term forecast.

Furthermore, the forecast relies on estimation of catches in 2009. There is increased uncertainty in the prediction of these catches over previous years. As last year, there are additional catches of mackerel in Icelandic waters in 2009. Preliminary estimates of catches from Icelandic waters (January to August 2009) contribute 18% to the estimated total for 2009 and there may be further catches in the remainder of the year. In addition catches reported to the WG from the TAC area have exceeded agreed catches by 11.3% in 2008. These are taken into account in the short term forecast presented in section 2.9. However, the values of catch used for both Icelandic waters and TAC overshoot are subject to some uncertainty.

2.11 Comparison with previous assessment and forecast

The addition of a new year of catch data for 2008 has not resulted in a revised perception of the stock. Changes in the TSB, SSB and Fbar4–8 for the year 2007 between the last two assessments are presented in the text table below.

	TSB (2007)	SSB (2007)	F 4–8 (2007)
2008 Assessment	**3.482 Mt**	**2.533 Mt**	**0.25**
2009 Assessment	**3.491 Mt**	**2.505 Mt**	**0.25**
% difference	**0.26%**	**-1.11%**	**0%**

A comparison of the fit of the model to the catch data between the 2008 assessment and the 2009 assessment is shown in Figure 2.11.1. The log residuals of the catch for the separable period from the 2009 assessment are similar to those from last year's assessment. The residual values are slightly higher this year, but are still low. The selection patterns are also very similar except for a slight increase in the selection at age 8 and a slight decrease for age 7 and 9. The fit of the model to the egg survey index from this year's assessment shows no difference with last year's assessment.

The uncertainty on the SSB and Fbar4-8 for the last year in the assessment has increased compared to the previous assessment. In the 2009 assessment, the estimates of SSB and Fbar in 2008 have CVs of 6.5% and 11.3% respectively, whereas in the 2008 assessment, the estimates of SSB and Fbar in 2007 had CVs of 4.4% and 9.8% respectively. This could be related to a further move away from the last egg survey year (2007).

The mackerel catch prediction for 2008 used for the short term forecast in the 2008 assessment is 1.8% lower than the catch reported in 2008 used in the present assessment. The estimate of SSB for 2008 from the new 2009 assessment is 12.4% lower than the value predicted in the short term forecast from the 2008 assessment (table below). The fishing mortality Fbar4–8 for 2008 estimated this year is 9.2% higher than the value predicted in the 2008 short term forecast.

	Catch (2008)	SSB (2008)	F 4–8 (2008)
Forecast from 2008 assessment	600 000	2.845 Mt	0.217
Observation/Estimate	611 063 t		
from 2009 assessment		2.492 Mt	0.237
% difference	1.8%	-12.4%	9.2%

2.12 Management plans and evaluations

The agreed management plan (October 2008) for NE Atlantic mackerel is shown in the Stock Annex. Evaluation of this management plan is also documented there.

2.13 Management Considerations

The spawning stock biomass (SSB) has risen from a low of 1.7Mt in 2002 to around an estimated 2.5 Mt in 2008, a level similar to that seen in the 1990s. Figure 2.13.1 indicates the current estimated stock level and recent stock development in relation to the agreed management plan.

Short term projections, assuming a catch of 830 kt in 2009 (see section 2.9) result in a relatively stable SSB of 2.6Mt in 2009. This increase is due to the following: a) increased contributions to SSB from the relatively good 2004 and 2005 year classes; and b) increased survival of the large 2002 year class due to a general reduction in fishing mortality in recent years. The fishing mortality in 2008 was approximately 0.24. Fishing mortality was reduced to 0.2 in 2006 and subsequently rose slightly in 2007 and 2008, mostly due to increased catches in Icelandic waters and the southern part of the current TAC area.

In 2008 the Coastal States agreed a Management Plan for NE Atlantic mackerel aiming at precautionary exploitation and stability of the catches. The TAC for 2009 has been set in accordance with the Management Plan. However, in 2008 and 2009 considerable additional catches have been taken outside the agreed TAC. The absence of clear international agreements on the exploitation of the stock (between all nations involved in the fishery) is a cause of concern and prevents control of the exploitation rate of the stock. According to the short term forecast (Section 2.9) the effect of the total catch in 2009 being well above the agreed TAC, results in an estimated F of 0.31, which is above that recommended by the agreed management plan.

Available information indicates that the distribution of the spawning area of mackerel has changed in recent years. Mackerel has been commercially fished in areas where it was previously not fished. It is possible that changes in distribution have lead to mackerel bycatch in fisheries in areas where it was not previously present and also new directed fisheries.

An evaluation of unaccounted mortality in the mackerel fishery (WD Simmonds 2007) showed that both biomass and removals were significantly greater than those estimated using the standard assessment model. These analyses also showed that the historic estimates of F provided by the standard assessment are not affected by unaccounted mortality.

There is increased uncertainty about the future productivity of the stock. Currently the stock appears to be subject to increased variability in recruitment.

2.14 Ecosystem considerations

In 2008-2009 new mackerel observations were made. Those provide additional data for analysis that will eventually improve the understanding of the stocks dynamics of NEA mackerel. The present knowledge base is described in the Stock Annex.

New observations were especially made in relation to distribution and feeding in the area NW of the British Isles and in the Norwegian Sea:

In area NW of the British Isles covered by the blue whiting spawning survey in March-April, mackerel have in the years 2004–2008 sporadically been encountered along the shelf slope west of the Hebrides and further south as schools of medium to high density. However in 2009, mackerel were found to be distributed widely across the combined survey area and in high densities. Mackerel were taken in trawl samples from 60ºN north to as far south as 51ºN and west to 15ºW on the Hatton Bank. Ordinarily confined to the shelf slope, mackerel were encountered in open waters in depths of between 60–300m forming distinct schools occurring over large areas. Stomach contents revealed mackerel to be actively feeding on mesopelagic fish and were most frequently encountered within this layer. During daylight hours mackerel were discernible as single schools. At night mackerel schools dispersed through the mesopelagic layer (ICES 2009 PGNAPES).

One month later in May 2009 the international ecosystem survey in the Nordic Seas encountered mackerel off the Norwegian shelf between 62 and 68ºN and up to 64ºN in the Faroese area. Most of the mackerel were in maturity stages 4, 5 and 6 which means that they were most probably spawning in the area (ICES 2009 PGNAPES). This was also observed in 2008, but to a lesser extent (ICES 2008 PGNAPES). This is north and out of the area covered by the mackerel egg survey (WGMEGS 2008).

A major finding from an international ecosystem survey in the Norwegian Sea in July-August 2009, was that mackerel was caught and acoustically detected over vast areas, expanding further west and less north compared to previous years (Nøttestad and Jacobsen, WD 2009), illustrating the interannual dynamics of the fastmoving species. Repeated offshore catches of one and two year's old individuals indicate that the Norwegian Sea is an important nursery and feeding ground for immature mackerel. The mackerel was widely distributed, with highest trawl catches 3-400 km west of the Central Norwegian coast, 4-500 km northwest of Northern Norway and to the west and northwest of Iceland. The western boundary of the mackerel distribution was not found in July. The westernmost catch was just west of Iceland but no survey or catch data is available from further west. (ICES 2009 PGNAPES).

This distribution pattern coincided with considerably warmer surface waters in 2009 than in the earlier years in the western part of the Norwegian Sea in the Jan Mayen zone and in the northern part of the Icelandic zone. The northernmost areas in the Norwegian Sea were in contrast colder than previous years. During winter 2008 strong westerlies (high NAO index) resulted in an increased influence of Arctic water in the southern Norwegian Sea for 2008 compared to 2007. Also compared to the average 1995-2006 an increased Arctic influence was observed, especially in the western and southwestern part.

Together with temperature; feeding opportunities seems to affect the distribution. In summer 2009 the central parts of the Norwegian Sea had very low biomass levels and relatively rich areas was observed in the waters dominated by the East Icelandic current of the western Norwegian Sea. The distribution and biomass of zooplankton where *C. finmarchicus* dominates, likely influenced the feeding migration and distribution of adult mackerel (ICES PGNAPES 2009; Nøttestad and Jacobsen, WD 2009).

NEA mackerel and NSS herring had a pronounced overlap in spatial distribution particularly in the southwestern and western parts of the Norwegian Sea in 2008 and 2009. Mackerel were caught together with herring in the same trawl hauls, both in several commercial fisheries and in international surveys, suggesting that bycatch issues now represent increased challenges in the performance of this fishery by pelagic trawling and purse seine. Large mackerel ate adult capelin north of Iceland in 2009, which has never been reported before in this area. This illustrates the complex picture of interaction between species and confirms the opportunistic feeding behaviour as it has been shown in other areas (ICES 1989, ICES 1997, Mehl and Westgård 1983).

Due to the pronounced changes and dynamics in the distribution and migration pattern of both juvenile and adult mackerel observed in recent years (2006-2009), future surveys to gain more coordinated information and to monitor these important changes are encouraged. There is a general need for fishery-independent surveys on mackerel for abundance estimation, distribution and ecology, in order to increase our understanding of important mechanisms and processes underlying such observed dynamics. Recent surveys suggest changes in distribution. This adds to uncertainty about the future.

2.15 Regulations and their effects

An overview of the major existing technical measures, TACs, effort control and management plans are given in Table 2.15. Note that **not** all existing international and national regulations are listed.

Management aimed at a fishing mortality in the range of 0.15–0.2 in the period 1998 - 2008. The current agreed management plan aims at a fishing mortality in the range 0.2-0.22. The fishing mortality realised during 1998-2008 was in the range of 0.22 to 0.45. The current assessment shows reduced F and increased biomass after the reductions in reported catches in 2003 and in subsequent years.

The measures advised by ICES to protect the North Sea spawning component aim at setting the conditions for making a recovery of this component possible. Before the late 1960s, the North Sea spawning biomass of mackerel was estimated at above 3 million tonnes. Due to overexploitation, recruitment has failed since 1969, leading to a decline in the stock. The North Sea spawning component has increased since 1999, but continued protection is needed as it is still very small.

The closure of the mackerel fishery in Divisions IVb,c and IIIa throughout the whole year is designed to protect the North Sea component in this area and also the juvenile western mackerel which are numerous, particularly in Division IVb,c during the second half of the year. This closure has unfortunately resulted in increased discards of mackerel in the non-directed fisheries (especially horse mackerel fisheries) in these areas as vessels at present are permitted to take only 10% of their catch as mackerel bycatch. No data on the actual amount of mackerel taken as bycatch are available, but the reported landings of mackerel in Divisions IIIa and IVb,c from 1997 onwards might seriously underestimate catches due to discarded bycatch.

The advised closure of Division IVa for fishing during the first half of the year is based on the perception that the western mackerel enter the North Sea in

July/August, and stay there until December before migrating back to their spawning areas. Updated observations taken in the late 1990s suggested that this return migration actually started in mid- to late February. This was believed to result in large-scale misreporting from the northern part of the North Sea (Division IVa) to Division VIa. It was recommended that the closure date for Division IVa be extended to the 15th of February[1]. This was adopted for the 1999/2000 fishing season onwards. However, misreporting from Division IVa to VIa continues to occur.

Within the area of the South West Mackerel Box off Cornwall in southern England only handliners are permitted to target mackerel. This area was set up at a time of high fishing effort in the area in 1981 by Council regulation to protect juvenile mackerel, as the area is a well known nursery. The area of the box was extended to its present size in 1989**.**

Additionally, there are various other national measures in operation in some of the mackerel catching countries.

2.16 Changes in fishing technology and fishing patterns

North East Atlantic mackerel, as a widely distributed species, is targeted by a number of different fishing métiers. Most of the fishing patterns of these métiers remained unchanged during the last years.

Recent changes can be noticed for two areas and métiers:

One part of the Northeast Atlantic mackerel population migrates towards the southern spawning area (Cantabrian Sea) at the end of winter. In this seasonal handline fishery, which is the most important fishery in this area that targets mackerel, the timing of the peak of catches has shifted forward since 2000 (WD Punzón and Villamor 2008). This approximately one month shift may be due to a change in the timing of the pre-spawning migration to the southern area of the Northeast Atlantic mackerel population. A shift on this scale has important consequences for the management of the resource, the fleets that exploit it and the resource evaluation survey designs. They will have to be adapted to this new scenario.

There has been a significant change in recent years in catch distribution in the 3rd quarter with large catches taken in Icelandic waters (Div. Va, see Sec. 2.3.1), due to increased effort and landings by Icelandic vessels. Figures from Icelandic landings records show an increase from 4222t in 2006, 36706t in 2007 to around 112 kt in 2008 and will be at similar level in 2009. The catch data from 2008, as well as information from the fishery in 2009, indicate that the fishery is over a wide area E, NE, and SE off Iceland and consist mainly of large and old mackerel. Results of a combined trawl and acoustic survey conducted in Icelandic waters in August 2009 show further that mackerel is distributed nearly all around Iceland and confirms the length/age composition according to the catch data (WD Sveinbjörnsson 2009). Information about the Icelandic mackerel fishing fleet are given in Table 2.2.3.1 and further description of the fishery in Section 2.3.1.

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[1] This is incorrectly stated as 1 February in the 2002 ICES Advice.

2.17 Changes in the environment

The working group WG WIDE has decided to merge this section into section 2.14 Ecosystem Considerations.

Table 2.2.1.1 NE Atlantic Mackerel catches by area (t). Discards not estimated prior to 1978 (Data submitted by Working Group members).

Year	Subarea VI			Subarea VII and Divisions VIIIa,b,d,e			Sub-area IV and III			Subarea I,II & Divs.V[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		833,912
1970	3,900		3,900	72,822		72,822	322,451		322,451	163	70,172	469,508		469,508
1971	10,200		10,200	89,745		89,745	243,673		243,673	358	32,942	376,918		376,918
1972	13,000		13,000	130,280		130,280	188,599		188,599	88	29,262	361,229		361,229
1973	52,200		52,200	144,807		144,807	326,519		326,519	21,600	25,967	571,093		571,093
1974	64,100		64,100	207,665		207,665	298,391		298,391	6,800	30,630	607,586		607,586
1975	64,800		64,800	395,995		395,995	263,062		263,062	34,700	25,457	784,014		784,014
1976	67,800		67,800	420,920		420,920	305,709		305,709	10,500	23,306	828,235		828,235
1977	74,800		74,800	259,100		259,100	259,531		259,531	1,400	25,416	620,247		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	50,600	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	60,600	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	21,600	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	45,516	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	25,350	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	11,396	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	12,302	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	8,191	614,275
1986	104,100		104,100	128,499		128,499	236,309	7,431	243,740	101,000	24,789	594,697	7,431	602,128
1987	183,700		183,700	100,300		100,300	290,829	10,789	301,618	47,000	22,187	644,016	10,789	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	35,566	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	7,090	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	15,600	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	30,700	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	25,000	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	18,180	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	5,370	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	7,721	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	11,415	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	18,864	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	8,012	666,664
1999[2,3]	116,362	§	116,362	94,290	§	94,290	313,014	§	313,014	72,848	43,796	640,311	§	640,311

Table 2.2.1.1 (Cont.)

Year	Subarea VI			Subarea VII and Divisions VIIIa,b,d,e			Subarea IV and III			Subarea I,II & Divs.V[1]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Landings	Landings	Discards	Catch
2000[2,3]	187,595	1	187,595	115,566	1,918	117,484	285,567	165	304,898	92,557	36,074	736,524	2,084	738,608
2001[2,3]	143,142	83	143,142	142,890	1,081	143,971	327,200	24	339,971	67,097	43,198	736,274	1,188	737,462
2002[2,3]	136,847	12,931	149,778	102,484	2,260	104,744	375,708	8,583	394,878	73,929	49,576	749,131	23,774	772,905
2003[3]	142,728	91	142,819	89,492		89,492	334,639	9,390	357,766	53,701	25,823	660,119	9,481	669,600
2004[3]	134,251	240	134,491	99,922	1,862	101,784	300,768	8,870	316,620	62,486	34,840	639,248	10,972	650,221
2005	79,960	11,400	91,361	90,278	5,878	96,156	249,740	2,482	252,223	54,129	49,618	523,726	19,760	543,486
2006	88,077	6,031	94,108	66,209	6,556	72,765	200,929	5,383	206,312	46,716	52,751	454,682	17,970	472,652
2007	110,788	405	111,193	71,235	2,024	73,259	253,013	6,187	259,200	72,891	62,834	570,761	8,616	579,379
2008	75,142	21,793	96,935	73,377	1,987	75,364	227,251	2,986	230,237	148,669	59,859	584,297	26,766	611,063

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

[2] Data revised for Northern Ireland

[3] data revised for unallocated catch

[§] Discards reported as part of unallocated catches

Table 2.2.1.2 NE Atlantic Mackerel catch (t) in the Norwegian Sea and Area V 1984–2008 (Data submitted by Working Group members).

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	11,787	7,610	1,653	3,133	4,265	6,433	6,800	1,098	251			4,746	3,198	37
Estonia									216		3,302	1,925	3,741	4,422
Faroe Islands	137				22	1,247	3,100	5,793	3,347	1,167	6,258	9,032	2,965	5,777[1]
France		16				11		23	6	6	5	5		270
Germany,			99		380									
Germany,			16	292		2,409							1	
Iceland													92	925
Ireland														
Latvia									100	4,700	1,508	389	233	
Lithuania														
Netherlands													561	
Norway	82,005	61,065	85,400	25,000	86,400	68,300	77,200	76,760	91,900	100,500	141,114	93,315	47,992	41,000
Poland														22
Sweden														
United King-			2,131	157	1,413		400	514	802		1,706	194	48	938
USSR (Russia	4,293	9,405	11,813	18,604	27,924	12,088	28,900	13,361	42,440	49,600	28,041	44,537	44,545	50,207
Misreported (IVa)											-109,625	-18,647		
Misreported (VIa)														
Misreported (Unknown)														
Unallocated														
Discards														
Total	98,222	78,096	101,112	47,186	120,404	90,488	118,700	97,819	139,062	165,973	72,309	135,496	103,376	103,598

Table 2.2.1.2 cont.

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	2,090	106	1,375	7	1						
Estonia	7,356	3,595	2,673	219							
Faroe Islands	2,716	3,011	5,546	3,272	4,730		650	30		278	123
France							2	1			
Germany, Fed. Rep.										7	
Germany, Dem. Rep.											
Iceland	357				53	122		363	4,222	36,706	112,286
Ireland		100				495	471				
Latvia											
Lithuania			2,085								
Netherlands		661			569		34	2,393			72
Norway	54,477	53,821	31,778	21,971	22,670	12,548	10,295	13,244	8,914	493	3,474
Poland											
Sweden				8							
United Kingdom	199	662		54	665	510	1,945				4
USSR (Russia from 1990)	67,201	51,002	49,100 [2]	41,566	45,811	40,026	49,489	40,491	33,580	35,408	32,728
Misreported (IVa)	-177	-40,01[illegible]									
Misreported (VIa)		-100									
Misreported (Unknown)					-570		-400				
Unallocated								-2,393		-10	-18
Discards											
Total	134,2[illegible]	72,84[illegible]	92,557	67,097	73,929	53,701	62,486	54,129	46,716	72,882	148,669

1- Faroese catch revised from previously reported 7,628t

2- includes small bycatches in subareas I and IIb

Table 2.2.1.3 NE Atlantic Mackerel catch (t) in the North Sea, Skagerrak and Kattegat (Sub-area IV and IIIa) 1988-2008 (Data submitted by Working Group members).

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	20	37		125	102	191	351	106	62	114	125	177	146	97
Denmark	32,588	26,831	29,000	38,834	41,719	42,502	47,852	30,891	24,057	21,934	25,326	29,353	27,720	21,680
Estonia					400									
Faroe Islands		2,685	5,900	5,338		11,408	11,027	17,883	13,886	3,288[2]	4,832	4,370	10,614	18,751
France	1,806	2,200	1,600	2,362	956	1,480	1,570	1,599	1,316	1,532	1,908	2,056	1,588	1,981
Germany, Fed. Rep.	177	6,312	3,500	4,173	4,610	4,940	1,497	712	542	213	423	473	78	4,514
Iceland												357		
Ireland		8,880	12,800	13,000	13,136	13,206	9,032	5,607	5,280	280	145	11,293	9,956	10,284
Latvia					211									
Netherlands	2,564	7,343	13,700	4,591	6,547	7,770	3,637	1,275	1,996	951	1,373	2,819	2,262	2,441
Norway	59,750	81,400	74,500	102,350	115,700	112,700	114,428	108,890	88,444	96,300	103,700	106,917	142,320	158,401
Poland														
Romania							2,903							
Sweden	1,003	6,601	6,400	4,227	5,100	5,934	7,099	6,285	5,307	4,714	5,146	5,233	4,994	5,090
United Kingdom	1,002	38,660	30,800	36,917	35,137	41,010	27,479	21,609	18,545	19,204	19,755	32,396[3]	58,282[3]	52,988[3]
USSR (Russia from										3,525	635	345	1,672	1
Misreported (IIa)							109,625	18,647				40,000		
Misreported (VIa)	180,000	92,000	126,000	130,000	127,000	146,697	134,765	106,987	51,781	73,523	98,432	59,882	8,591	39,024
Misreported (Unknown)														
Unallocated	29,630	6,461	-3,400	16,758	13,566			983	236	1,102	3,147	17,344[4]	34,761[4]	24,873[4]
Discards	29,776	2,190	4,300	7,200	2,980	2,720	1,150	730	1,387	2,807	4,753		1,912	24
Total	338,316	281,600	305,100	365,875	367,164	390,558	472,397	322,204	212,839	229,487	269,700	313,015	304,896	339,970

Table 2.2.1.3 cont.

Country	2002	2003	2004	2005	2006	2007[1]	2008[1]
Belgium	22	2	4	1	3	1	2
Denmark	34,375	27,508	25,665	23,212	24,219	25,217	26,716
Estonia							
Faroe Islands	12,548	11,754	11,705	9,739	12,008	11,818	7,627
France	2,152	1,467	1,538	1,004	285	7,549	490
Germany, Fed. Rep.	3,902	4,859	4,514	4,442	2,389	5,383	4,668
Iceland							
Ireland	20,715	17,145	18,901	15,605	4,125	13,337	11,628
Latvia							
Netherlands	11,044	6,784	6,366	3,915	4,093	5,973	1,980
Norway	161,62	150,85	147,06	106,43	113,07	131,19	114,10
Poland				109			
Romania							
Sweden	5,232	4,450	4,437	3,204	3,209	3,858	3,664
United Kingdom	61,781[3]	51,736	50,474	37,118	28,628	46,264	37,055
USSR (Russia from				4			
Misreported (IIa)							
Misreported (VIa)	49,918	46,407	18,480	37,911	8,719		17,280
Misreported							
Unallocated	22,985[4]	25,405[4]	18,597[4]	7,043	171	2,421	2,039
Discards	8,583	9,390	8,870	2,482	5,383	6,187	2,986
Total	394,87	357,76	316,62	252,22	206,31	259,19	230,23

1-includes small catches in IIIb and IIId

2-Faroese catches revised from previously reported 1,367t

3-catches revised for Northern Ireland

4-catches revised for unallocated catches

Table 2.2.1.4 NE Atlantic Mackerel catch (t) in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e) 1985–2008 (Data submitted by Working Group members).

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium														
Denmark	400	300	100		1,000		1,573	194		2,239	1,143	1,271		
Estonia											361			
Faroe Islands	9,900	1,400	7,100	2,600	1,100	1,000				4,283	4,284		2,448[1]	3,681
France	7,400	11,200	11,100	8,900	12,700	17,400	4,095		2,350	9,998	10,178	14,347	19,114	15,927
Germany, Fed. Rep.	11,800	7,700	13,300	15,900	16,200	18,100	10,364	9,109	8,296	25,011	23,703	15,685	15,161	20,989
Guernsey														
Ireland	91,400	74,500	89,500	85,800	61,100	61,500	17,138	21,952	23,776	79,996	72,927	49,033	52,849	66,505
Jersey														
Lithuania														
Netherlands	37,000	58,900	31,700	26,100	24,000	24,500	64,827	76,313	81,773	40,698	34,514	34,203	22,749	28,790
Norway	24,300	21,000	21,600	17,300	700		29,156	32,365	44,600	2,552			223	
Poland									600					
Spain				1,500	1,400	400	4,020	2,764	3,162	4,126	4,509	2,271	7,842	3,340
United Kingdom	205,90	156,30	200,70	208,40	149,10	162,70	162,58	196,89	215,26	208,65	190,34	127,61	128,83	165,99
Misreported (IVa)		-	-	-	-92,000	-	-	-	-	-	-	-51,781	-73,523	-
Misreported Unallocated	75,100	49,299	26,000	4,700	18,900	11,500	-3,802	1,472		4,632	28,245	10,603	4,577	8,351
Discards	4,500			5,800	4,900	11,300	23,550	22,020	15,660	4,220	6,991	10,028	16,057	3,277
Total	467,70	232,59	284,10	197,00	199,10	182,40	183,50	236,07	248,78	251,64	270,21	213,27	196,11	218,59

Table 2.2.1.4 cont.

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium						1				
Denmark	552	82	835		392				6	10
Estonia										
Faroe Islands	4,239	4,863	2,161	2,490	2,260	674		59	1,333	3,539
France	14,311	17,857	18,975	19,726	21,213	18,549	15,182	14,625	12,434	14,944
Germany, Fed. Rep.	19,476	22,901	20,793	22,630	19,202	18,730	14,598	14,219	12,831	10,834
Guernsey								10		
Ireland	48,282	61,277	60,168	51,457	49,715	41,730	30,082	36,539	35,923	33,131
Jersey							9	8	6	7
Lithuania								95	7	
Netherlands	25,141	30,123	33,654	21,831	23,640	21,132	18,819	20,064	18,261	17,920
Norway									7	3,948
Poland							461		978	
Spain	4,120	4,500	4,063	3,483	735	2,081	4,795	4,048	2,772	7,327
United Kingdom	127,09	126,62	139,58	131,59	130,76	122,31	115,68	67,187	87,424	75,090
Misreported (IVa)	-59,982	-3,775	-39,024	-43,339	-46,407	-18,049	-37,911	-8,719		-17,280
Misreported Unallocated	21,652[3]	31,564[3]	37,952[3]	27,558[3]	33,767[3]	27,999[3]	8,521	4,783	10,042	-952
Discards		1,920	1,164	15,191	91	2,102	17,278	12,587	2,428	23,780
Total	204,88	297,93	280,55	252,62	235,37	237,26	187,51	166,87	184,45	172,29

1 – Faroese catches revised from 2,158t

2 – catches revised for Northern Ireland

3 – catches revised for unallocated catches

Table 2.2.1.5 NE Atlantic Mackerel catch (t) in Divisions VIIIc and IXa, 1977–2008 (Data submitted by Working Group members).

Country	Div	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
France	VIIIc													
Poland	IXa	8												
Portugal	IXa	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	VIIIc	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
Spain	IXa	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
USSR	IXa	2,879	189	111										
Total	IXa	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

Country	Div	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
France	VIIIc													
Poland	IXa													
Portugal	IXa	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	VIIIc	16,086	16,940	12,043	16,675	21,246	23,631	28,386	35,015	36,174	37,631	30,061	38,205	38,703
Spain	IXa	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
USSR	IXa													
Total	IXa	5,225	3,840	6,003	3,042	3,899	3,918	5,737	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

Country	Div	2003	2004	2005	2006	2007	2008
France	VIIIc	226	177	151	43	55	168
Poland	IXa						
Portugal	IXa	2,749	2,289	1,509	2,620	2,605	2,381
Spain	VIIIc	17,381	28,428	42,851	43,063	53,401	50,455
Spain	IXa	5,646	3,946	5,107	7,025	6,773	6,855
USSR	IXa						
Total	IXa	8,395	6,234	6,616	9,645	9,378	9,236
Total		26,002	34,840	49,618	52,751	62,834	59,859

Table 2.2.3.1. NEA Mackerel. Pelagic fleet composition in 2008 of major mackerel catching nations.

Country	Details given	Length (metres)	Engine power (Horse Power)	Gear	Storage	Discard est	No vessels
Denmark	Y	39-57	1100-5200	Midwater Trawl	Tank	N	11
Denmark	Y	51-65	2400-5900	Purse Seine	Tank	N	6
Faroe Islands	Y	40-62	515-1540 kW	Trawl	219-906	N	3
Faroe Islands	Y	90	6468 kW	Trawl	RSW/Freezer	N	1
Faroe Islands	Y	53-76	2208-8000 kW	Purse Seine/Trawl		N	7
France	N			Pelagic Trawl	Dry Hold	N	9
France	N			Pelagic Trawl	Freezer	N	3
Germany	Y	95-140	4000-12000	Single Midwater Trawl	Freezer	Y	4
Iceland	Y	50-59	3000	Single Midwater Trawl	RSW	N	1
Iceland	Y	60-69	4012-6690	Single Midwater Trawl	RSW/Freezer	N	7
Iceland	Y	70-79	3308-10030	Single Midwater Trawl	RSW/Freezer	N	8
Ireland	Y	>100	6600	Midwater Trawl	RSW	N	1
Ireland	Y	60-80	2700-3000	Midwater Trawl	RSW	N	4
Ireland	Y	40-60	700-3500	Midwater Trawl	RSW	N	15
Ireland	Y	20-40	600-3000	Midwater Trawl	RSW	N	3
Ireland	Y	20-30	800-3000	Pair Midwater Trawl	Tank	N	2
Ireland	Y	20-30	800-3000	Dem/Pair Midwater Trawl	Dry Hold	N	13
Ireland	Y	10-20	300-600	Midwater Trawl	Dry Hold	N	2
Netherlands	Y	55	2890	Pair Midwater Trawl	Freezer	Y	2
Netherlands	Y	88-140	4400-1045	Single Midwater Trawl	Freezer	Y	14
Norway	Y	>27		Purse Seine		N	80
Norway	Y	21-27		Purse Seine		N	17
Norway	Y	<21		Purse Seine		N	164
Norway	Y			Trawler		N	21
Norway	Y			Handline/Gillnet		N	155
Russia	Y	55-80	1000-5000+	Single Midwater Trawl	Freezer	N	38
Spain	Y	20-35	200-800	Trawl	Dry hold, ice	N	122
Spain	Y	8-38	25-1100	Purse Seine	Dry hold, ice	N	306
Spain	Y	4–27	5–750	Artisanal: Hook	Dry hold, ice	N	370
Spain	Y	2-34	4-900	Artisanal: Others	Dry hold,ice	N	4587
Sweden	N					N	
UK (E&W)	Y	92.05	5053.5	Pair Midwater Trawl	Freezer	N	2
UK (E&W)	Y	47.3	1992	Midwater Trawl	RSW	N	3
UK (NI)	N					N	
Scotland	Y	45-76	2149-10728	Trawl	RSW	Y	24

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2008.

Quarters 1-4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	2.87	0.37			4798.47	1.89	32.26		0.01
2	11066.41	280.31	0.01	1.20	66700.88	1857.27	871.92	3332.52	93.54
3	50462.75	899.26	0.01	2.49	155441.89	407.20	196.12	21345.24	261.13
4	50168.61	555.31		1.05	112158.78	170.82	148.96	7305.86	225.89
5	41241.23	166.88		0.47	64156.21	41.19	81.39	13484.16	109.87
6	48853.99	216.53		0.37	68808.46	33.43	39.25	20827.94	103.85
7	27577.74	88.50		0.18	37069.94	18.43	64.64	9591.54	50.23
8	10147.79	21.31		0.10	19868.88	9.39	0.16	5640.21	12.35
9	7192.79	12.44		0.06	11315.78	5.49	0.10	2580.41	16.43
10	4124.35	22.48		0.04	9178.03	4.23	0.09	1054.18	3.61
11	448.31	1.50		0.02	3517.37	2.35	0.04		5.38
12	140.57	1.17		0.01	2107.07	1.31	0.02		2.71
13	33.58	2.42			1396.38	0.46	0.01		0.23
14	120.03	0.46		0.01	975.85	0.75	0.01		0.92
15	44.51	0.20			1062.70	0.58	0.01		0.85
SOP	110949.99	882.95	0.01	2.27	228649.58	529.55	286.08	38359.97	332.45
Catch	110801.27	882.60	0.01	2.28	228536.39	529.45	286.49	37535.00	332.45
SOP%	99.87	99.96	151.49	100.41	99.95	99.98	100.14	97.85	100.00

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	847.54	0.07			259.70	125.55	1.36	0.03	
1	2380.42	5.50	950.91		4880.93	2224.14	276.38	11.62	0.02
2	35682.48	15.07	4556.66	9.27	4240.87	2783.04	985.86	37.64	359.12
3	81667.05	7.47	8062.61	35.09	2104.38	1836.56	712.24	19.96	1941.33
4	44496.14	1.63	9810.30	45.07	1448.39	882.15	814.62	5.19	1214.23
5	49017.30	1.37	25070.57	94.97	1971.61	606.72	279.37	5.61	460.91
6	40098.29	0.35	10742.78	28.33	495.00	406.50	205.21	1.46	411.10
7	16153.82	0.12	4899.81	11.88	1549.31	183.29	61.82	0.56	219.46
8	10149.28	0.06	2183.59	5.34	293.57	44.21	5.06	0.26	143.04
9	5065.99	0.02	876.43	1.13	277.70	36.12	5.71	0.07	67.81
10	2570.51		255.87	0.46	11.81	18.88		0.02	12.03
11	1178.41		202.17	0.01	17.31	5.72	0.01		3.16
12	1126.20		355.67	0.15	1.69	5.39		0.01	2.96
13	407.61				0.02				
14	229.15		188.91		0.03				
15	267.37								
SOP	97470.35	6.02	26587.85	93.77	4301.30	2242.46	667.13	16.92	1403.24
Catch	96934.52	6.01	26568.99	93.73	4294.58	2240.07	667.32	16.91	1415.40
SOP%	99.45	99.85	99.93	99.95	99.84	99.89	100.03	99.93	100.87

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	67.14	68.12	9.33		3141.27		20672.94	545.19	25738.25
1	1199.69	1223.35	449.89	3837.70	3730.38	12.52	14473.46	1532.79	42025.57
2	5847.92	3735.19	2194.71	2618.10	1954.45	333.09	3707.91	3425.34	156690.75
3	19321.09	7302.09	5405.53	13964.88	6173.07	1711.02	4136.75	2456.36	385873.63
4	15937.00	4986.15	4122.78	16958.65	3021.83	1100.72	2404.51	515.11	278499.66
5	11793.05	2701.38	5371.80	31836.98	4020.53	502.55	2725.55	281.50	256023.17
6	9669.75	1909.74	5712.62	36692.60	4456.90	359.38	2705.18	356.44	253135.39
7	3611.53	1508.61	2201.18	14901.23	1928.12	296.14	758.80	265.70	123012.60
8	2076.95	674.74	541.15	3780.49	684.29	138.36	119.01	98.60	56638.18
9	996.36	269.09	417.64	2276.92	315.27	73.17	55.50	127.83	31986.28
10	143.29	32.84	99.06	1128.41	308.05	10.26	42.77	120.58	19141.84
11	232.32	13.26	107.35	624.19	140.37	3.87	13.15	244.05	6760.33
12	128.94	7.04	69.18	351.60	102.06	2.64	9.08		4415.47
13			66.73	276.41	42.01		3.13		2228.98
14				13.25	7.96		0.13		1537.45
15				1.66					1377.88
SOP	22959.75	7113.93	8422.63	42601.05	7172.55	1335.26	6854.65	2380.79	611646.86
Catch	22995.84	7134.20	8585.08	43463.21	7159.35	1346.00	6855.10	2381.10	611063.38
SOP%	100.16	100.29	101.93	102.02	99.82	100.80	100.01	100.01	99.90

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2008 (cont.).

Quarter 1

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0.01	0.05			64.95	0.09			0.01
2	0.61	2.17		0.05	2838.67	4.04	12.82		0.34
3	1.53	5.42		0.13	7811.53	10.17	38.56		0.84
4	1.43	5.07		0.12	7037.60	10.42	102.97		0.79
5	1.55	5.48		0.13	7472.05	10.62	64.31		0.85
6	2.16	7.64		0.18	9994.63	14.11	38.56		1.19
7	1.35	4.78		0.11	6185.80	9.37	64.31		0.74
8	0.68	2.41		0.06	3132.24	4.28			0.37
9	0.41	1.46		0.04	1881.29	2.60			0.23
10	0.35	1.22		0.03	1616.84	2.18			0.19
11	0.20	0.71		0.02	918.50	1.26			0.11
12	0.11	0.38		0.01	509.28	0.68			0.06
13	0.04	0.13			176.98	0.23			0.02
14	0.06	0.22		0.01	279.00	0.38			0.03
15	0.06	0.20			258.04	0.36			0.03
SOP	3.98	14.06		0.34	18793.27	26.01	73.81		2.18
Catch	3.97	14.06		0.34	18792.81	26.01	74.00		2.18
SOP%	99.81	99.99		100.01	100.00	100.00	100.25		99.99

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	1971.78				249.33	10.51	0.77	0.01	
2	27500.48		1060.59	6.59	210.27	9.79	1.86	0.05	359.09
3	63514.30		6036.89	32.06	249.33	12.30	3.40	0.23	1941.31
4	36423.95	0.01	9228.94	43.71	306.40	16.76	2.82	0.14	1214.23
5	47287.73	0.01	24516.09	94.07	192.25	15.68	1.78	0.16	460.91
6	38053.66		10576.03	27.80	267.35	20.49	2.83	0.07	411.10
7	15115.95		4838.14	11.73	231.30	14.29	1.14	0.02	219.46
8	9408.87		2155.96	5.27	114.15	5.33	0.36	0.01	143.04
9	4631.87		867.11	1.09	96.13	4.70	0.29	0.01	67.81
10	2281.15		249.65	0.41		0.20			12.03
11	1040.94		200.80						3.16
12	1045.03		354.47	0.14		0.32			2.96
13	347.21								
14	194.57		188.91						
15	215.10								
SOP	83931.78	0.01	24843.35	90.77	539.93	32.08	3.71	0.23	1403.22
Catch	83410.75	0.01	24826.21	90.73	540.71	32.12	3.72	0.23	1415.38
SOP%	99.38	148.33	99.93	99.96	100.14	100.12	100.04	100.28	100.87

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1			244.62	3215.45	1362.26		3266.73	6.71	10393.25
2	4933.57	2064.27	1740.96	1812.73	1392.30	312.29	567.24	25.43	44856.21
3	19017.59	6125.78	4134.64	10524.90	4599.44	1686.19	2390.64	390.80	128528.00
4	15768.91	4363.13	3299.42	12822.56	2122.53	1055.98	1571.90	100.92	95500.70
5	11496.41	1980.58	4468.50	24161.17	2952.29	382.98	2063.24	46.38	127675.20
6	9586.75	1729.89	4961.92	27904.53	3322.47	355.22	2117.35	52.37	109448.31
7	3414.90	1082.92	1873.42	11300.14	1445.83	192.72	555.00	32.14	46595.56
8	2046.81	607.19	457.97	2852.29	514.73	125.34	62.84	8.92	21649.12
9	965.55	205.18	374.83	1721.75	244.03	59.49	24.84	7.52	11158.22
10	142.65	20.69	96.62	838.11	230.13	10.23	20.49	10.77	5533.96
11	230.10	5.54	104.06	478.91	112.96	2.74	6.35	28.19	3134.54
12	128.87	5.33	68.00	266.88	77.97	2.63	4.26		2467.38
13			65.58	214.53	37.15		1.57		843.44
14				11.26	5.43		0.06		679.92
15				1.66					475.45
SOP	22262.16	5401.88	7128.11	32205.32	4925.25	1210.35	2690.01	197.67	205772.50
Catch	22299.99	5423.22	7224.21	32929.27	4924.60	1221.00	2690.08	197.68	206143.28
SOP%	100.17	100.40	101.35	102.25	99.99	100.88	100.00	100.01	100.18

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2008 (cont.).

Quarter 2

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0.03	0.02			0.48	0.05			
2	962.92	62.93		0.09	215.80	1696.69	615.93	73.38	60.15
3	852.65	160.25		0.17	1050.31	160.21	57.70	286.17	60.30
4	810.45	82.49		0.06	795.51	82.26	28.62	286.17	21.75
5	2532.74	21.89		0.01	263.04	5.95	0.39	447.59	53.98
6	3356.53	23.34			397.07	8.29	0.41	520.97	36.99
7	1078.52	9.36			163.86	5.19	0.26	315.52	15.77
8	322.91	2.09			41.00	2.61	0.13	124.74	2.89
9	641.66	1.22			24.06	1.59	0.08	73.38	5.13
10	146.90	2.38			41.70	1.33	0.07	51.36	0.74
11	36.85	0.09			3.65	0.77	0.04		2.26
12	30.52	0.09			2.59	0.41	0.02		1.87
13	0.35	0.26			4.49	0.14	0.01		0.06
14	0.04	0.03			1.11	0.23	0.01		0.01
15	9.09				0.66	0.22	0.01		0.55
SOP	4731.42	140.39		0.12	1174.70	327.10	114.99	1052.15	100.29
Catch	4731.43	140.31		0.13	1174.69	327.11	114.96	1050.00	100.27
SOP%	100.00	99.94		102.07	100.00	100.00	99.98	99.80	99.99

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	0.02				154.51	33.40	32.63		
2	0.29	0.06	25.15		244.63	82.34	445.60	0.30	
3	38.43	0.29	122.41		282.34	88.37	309.59	1.45	
4	14.39	0.41	166.89		541.23	98.48	182.36	1.99	
5	6.13	0.92	359.20		1467.81	115.51	72.06	4.35	
6	3.20	0.34	106.16		46.90	74.46	113.97	1.39	
7	1.20	0.11	44.78		1274.67	77.53	31.76	0.54	
8	0.83	0.06	20.13		160.02	8.37	0.98	0.25	
9	0.41	0.02	4.16		168.30	9.45	0.61	0.06	
10	0.19		1.58			0.58		0.02	
11	0.08				13.80	0.50	0.01		
12	0.06		0.55			1.58		0.01	
13	0.02								
14	0.01								
15	0.01								
SOP	16.30	0.90	346.61		1519.87	145.91	247.75	4.21	
Catch	16.24	0.90	346.45		1519.33	146.14	247.76	4.21	
SOP%	99.67	100.14	99.95		99.96	100.16	100.00	99.92	

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1	22.91	46.23	15.92	23.30	117.56	12.52	2655.51	1.43	3116.52
2	36.73	70.16	234.78	404.27	154.49	19.01	483.68	156.54	6045.91
3	52.87	84.20	893.11	3045.30	1303.09	22.81	782.20	1063.60	10717.83
4	91.85	161.79	421.71	3893.36	738.53	43.83	373.30	289.90	9127.33
5	269.94	439.14	533.79	7490.56	977.78	118.97	451.48	64.99	15698.23
6	69.55	14.03	453.63	8658.58	1082.61	3.80	487.97	110.32	15570.52
7	194.74	381.36	155.22	3516.46	448.05	103.32	149.19	96.50	8063.91
8	29.31	47.88	26.31	873.20	152.03	12.97	29.58	81.63	1939.91
9	30.24	50.35	19.77	517.19	57.70	13.64	12.08	62.23	1693.31
10	0.13		2.20	268.11	70.34		12.04	56.27	655.94
11	2.07	4.13	3.22	137.66	24.87	1.12	3.95	134.72	369.77
12			1.15	80.95	22.38		3.11		145.28
13			1.15	59.99	3.97		0.65		71.10
14				1.95	2.54		0.06		5.97
15									10.55
SOP	282.95	454.17	742.95	9816.30	1460.99	123.04	935.32	560.95	24299.18
Catch	282.67	454.00	758.37	9969.98	1460.90	123.00	935.24	561.15	24465.23
SOP%	99.90	99.96	102.08	101.57	99.99	99.97	99.99	100.03	100.68

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2008 (cont.).

Quarter 3

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	2.83	0.16			38.35	1.59	27.84		
2	10082.03	212.15	0.01	0.89	13993.73	146.49	208.76	3259.14	33.05
3	49585.02	728.58	0.01	1.71	57795.64	208.43	85.01	21059.08	199.99
4	49346.16	464.68		0.59	40910.14	62.16	14.44	7019.69	203.35
5	38699.98	137.66		0.11	12735.14	12.12	14.02	13036.57	55.04
6	45491.16	184.28			18315.86			20306.97	65.67
7	26496.71	73.92			7342.83			9276.02	33.72
8	9823.69	16.54			1654.06			5515.47	9.09
9	6550.37	9.62			961.54			2507.03	11.07
10	3976.79	18.80			1865.60			1002.81	2.68
11	411.16	0.68			69.09				3.02
12	109.90	0.68			68.35				0.78
13	33.19	2.03			201.04				0.15
14	119.93	0.20			21.06				0.88
15	35.36								0.26
SOP	106192.69	722.13	0.01	1.23	61185.95	141.94	82.75	37306.17	229.98
Catch	106042.58	721.99	0.01	1.23	61155.58	141.81	82.95	36485.00	230.00
SOP%	99.86	99.98	151.49	100.17	99.95	99.91	100.24	97.80	100.01

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	4.87	0.07			259.70	121.60	0.47	0.03	
1	6.00	5.50	31.48		4477.07	2107.32	203.28	10.56	0.02
2	150.39	14.99	104.80		3015.36	1452.25	510.92	33.80	0.01
3	72.01	7.16	51.60		699.02	371.34	386.07	16.55	
4	22.95	1.22	8.60		207.90	139.61	611.25	2.77	
5	7.31	0.43	3.09		52.03	55.27	198.03	0.99	
6	1.36	0.01			25.90	45.99	82.31		
7						14.28	27.71		
8						0.66	3.31		
9						1.24	3.95		
10						0.22			
11									
12						0.50			
13									
14									
15									
SOP	56.17	5.10	34.96		1375.85	696.41	394.33	11.31	0.00
Catch	56.74	5.10	34.93		1368.57	693.11	394.57	11.31	0.01
SOP%	101.02	99.88	99.94		99.47	99.53	100.06	99.96	113.15

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	67.14	68.12	9.11		2972.41		14060.69	0.91	17565.14
1	1171.76	1174.42	157.72	344.24	1331.24		6829.65	1101.36	19022.38
2	826.90	790.99	113.41	217.02	349.50		1803.68	2273.83	39594.11
3	204.01	183.37	51.31	207.42	211.35		559.82	656.25	133340.73
4	57.63	54.54	27.14	95.35	126.99		233.27	60.06	99670.49
5	14.85	13.65	20.45	58.01	71.61		96.26	77.38	65359.98
6	6.70	6.79	14.95	39.61	42.33		40.70	103.18	84773.78
7			5.69	20.71	29.89		21.60	82.97	43426.07
8			1.28	12.82	15.96		11.84	5.32	17070.02
9			0.39	9.94	12.62		10.18	32.52	10110.46
10				6.13	7.12		6.12	36.41	6922.70
11				2.20	2.39		2.05	52.60	543.18
12				1.38	1.65		1.42		184.66
13				0.69	0.86		0.76		238.72
14				0.04			0.01		142.12
15									35.63
SOP	371.53	360.91	72.06	239.47	614.54		2247.43	1043.78	213388.82
Catch	369.61	359.00	72.86	234.53	614.86		2246.64	1043.94	212366.92
SOP%	99.48	99.47	101.11	97.94	100.05		99.96	100.01	99.52

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2008 (cont.).

Quarter 4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1		0.14			4694.68	0.15	4.42		
2	20.85	3.06		0.17	49652.69	10.05	34.42		
3	23.54	5.01		0.48	88784.41	28.39	14.84		
4	10.57	3.06		0.27	63415.52	15.99	2.92		
5	6.97	1.85		0.21	43685.99	12.51	2.68		
6	4.14	1.27		0.19	40100.90	11.02	0.28		
7	1.15	0.45		0.07	23377.45	3.87	0.08		
8	0.51	0.27		0.04	15041.59	2.50	0.03		
9	0.35	0.13		0.02	8448.89	1.30	0.02		
10	0.32	0.08		0.01	5653.89	0.73	0.02		
11	0.09	0.03		0.01	2526.13	0.33	0.01		
12	0.04	0.02			1526.85	0.22			
13		0.01			1013.87	0.08			
14		0.01			674.68	0.13			
15					804.00				
SOP	23.28	6.32		0.58	147508.38	34.52	14.53		
Catch	23.30	6.24		0.59	147413.31	34.52	14.57		
SOP%	100.08	98.73		101.43	99.94	100.02	100.27		

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	842.67					3.95	0.89		
1	402.62	0.01	919.43		0.03	72.92	39.71	1.05	
2	8031.32	0.02	3366.11	2.68	770.60	1238.65	27.49	3.50	0.01
3	18042.31	0.01	1851.71	3.03	873.69	1364.55	13.19	1.72	0.02
4	8034.86		405.87	1.36	392.87	627.30	18.19	0.29	0.01
5	1716.14		192.19	0.90	259.51	420.26	7.50	0.10	
6	2040.07		60.59	0.53	154.85	265.55	6.10		
7	1036.67		16.89	0.15	43.34	77.20	1.21		
8	739.58		7.50	0.07	19.39	29.86	0.40		
9	433.71		5.17	0.05	13.28	20.73	0.87		
10	289.16		4.63	0.04	11.81	17.87			
11	137.40		1.37	0.01	3.51	5.22			
12	81.11		0.65	0.01	1.69	2.99			
13	60.38				0.02				
14	34.58				0.03				
15	52.26								
SOP	13463.01	0.01	1361.97	3.00	865.60	1368.23	21.31	1.17	0.01
Catch	13450.79	0.01	1361.40	3.00	865.98	1368.69	21.27	1.17	0.02
SOP%	99.91	92.17	99.96	99.86	100.04	100.03	99.81	100.06	128.80

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0			0.22		168.85		6612.25	544.27	8173.11
1	5.02	2.70	31.64	254.72	919.32		1721.57	423.29	9493.43
2	50.73	809.77	105.55	184.08	58.15	1.79	853.32	969.54	66194.55
3	46.63	908.75	326.47	187.26	59.19	2.02	404.10	345.71	113287.03
4	18.61	406.69	374.52	147.38	33.79	0.91	226.04	64.23	74201.25
5	11.86	268.02	349.06	127.24	18.84	0.60	114.57	92.75	47289.73
6	6.75	159.02	282.12	89.87	9.48	0.36	59.17	90.56	43342.83
7	1.88	44.34	166.84	63.92	4.34	0.10	33.01	54.09	24927.05
8	0.84	19.68	55.59	42.19	1.56	0.04	14.74	2.73	15979.12
9	0.58	13.56	22.66	28.05	0.92	0.03	8.40	25.56	9024.28
10	0.52	12.15	0.23	16.06	0.46	0.03	4.12	17.13	6029.25
11	0.15	3.59	0.07	5.43	0.15	0.01	0.79	28.55	2712.84
12	0.07	1.71	0.03	2.39	0.07		0.28		1618.15
13				1.19	0.03		0.14		1075.72
14									709.43
15									856.26
SOP	43.56	897.63	479.41	337.32	172.35	2.00	983.08	578.32	168156.04
Catch	43.58	897.98	529.64	329.43	159.00	2.00	983.14	578.33	168087.95
SOP%	100.03	100.04	110.48	97.66	92.25	99.92	100.01	100.00	99.96

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2008. Zeros represent values <1%.

Quarters 1-4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0%	0%			0%	0%	2%		0%
2	4%	12%	50%	20%	12%	73%	61%	4%	11%
3	20%	40%	50%	42%	28%	16%	14%	25%	29%
4	20%	24%		18%	20%	7%	10%	9%	25%
5	16%	7%		8%	11%	2%	6%	16%	12%
6	19%	10%		6%	12%	1%	3%	24%	12%
7	11%	4%		3%	7%	0%	5%	11%	6%
8	4%	0%		2%	4%	0%	0%	7%	1%
9	3%	0%		1%	2%	0%	0%	3%	2%
10	2%	0%		0%	2%	0%	0%	1%	0%
11	0%	0%		0%	0%	0%	0%		0%
12	0%	0%		0%	0%	0%	0%		0%
13	0%	0%			0%	0%	0%		0%
14	0%	0%		0%	0%	0%	0%		0%
15	0%	0%			0%	0%	0%		0%

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	0%	0%			1%	1%	0%	0%	
1	0%	17%	1%		28%	24%	8%	14%	0%
2	12%	48%	7%	4%	24%	30%	29%	46%	7%
3	28%	24%	12%	15%	12%	20%	21%	24%	40%
4	15%	5%	14%	19%	8%	10%	24%	6%	25%
5	17%	4%	37%	41%	11%	7%	8%	7%	10%
6	14%	1%	16%	12%	3%	4%	6%	2%	9%
7	6%	0%	7%	5%	9%	2%	2%	0%	5%
8	3%	0%	3%	2%	2%	0%	0%	0%	3%
9	2%	0%	1%	0%	2%	0%	0%	0%	1%
10	0%		0%	0%	0%	0%		0%	0%
11	0%		0%	0%	0%	0%	0%		0%
12	0%		0%	0%	0%	0%		0%	0%
13	0%				0%				
14	0%		0%		0%				
15	0%								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	0%	0%	0%		10%		40%	5%	2%
1	2%	5%	2%	3%	12%	0%	28%	15%	3%
2	8%	15%	8%	2%	7%	7%	7%	34%	10%
3	27%	30%	20%	11%	21%	38%	8%	25%	23%
4	22%	20%	15%	13%	10%	24%	5%	5%	17%
5	17%	11%	20%	25%	13%	11%	5%	3%	16%
6	14%	8%	21%	28%	15%	8%	5%	4%	15%
7	5%	6%	8%	12%	6%	7%	1%	3%	7%
8	3%	3%	2%	3%	2%	3%	0%	0%	3%
9	1%	1%	2%	2%	1%	2%	0%	1%	2%
10	0%	0%	0%	0%	1%	0%	0%	1%	1%
11	0%	0%	0%	0%	0%	0%	0%	2%	0%
12	0%	0%	0%	0%	0%	0%	0%		0%
13			0%	0%	0%		0%		0%
14				0%	0%		0%		0%
15				0%					0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2008. Zeros represent values <1% (cont.).

Quarter 1

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0%	0%			0%	0%			0%
2	6%	6%		6%	6%	6%	4%		6%
3	15%	15%		15%	16%	14%	12%		14%
4	14%	14%		13%	14%	15%	32%		14%
5	15%	15%		15%	15%	15%	20%		15%
6	20%	20%		20%	20%	20%	12%		21%
7	13%	13%		12%	12%	13%	20%		13%
8	6%	6%		7%	6%	6%			6%
9	4%	4%		4%	4%	4%			4%
10	3%	3%		3%	3%	3%			3%
11	2%	2%		2%	2%	2%			2%
12	1%	1%		1%	1%	0%			1%
13	0%	0%			0%	0%			0%
14	0%	0%		1%	0%	0%			0%
15	0%	0%			0%	0%			0%

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	0%				13%	10%	5%	1%	
2	11%		2%	3%	11%	9%	12%	7%	7%
3	26%		10%	14%	13%	11%	22%	33%	40%
4	15%	50%	15%	20%	16%	15%	18%	20%	25%
5	19%	50%	41%	42%	10%	14%	12%	23%	10%
6	15%		18%	12%	14%	19%	19%	10%	9%
7	6%		8%	5%	12%	13%	7%	3%	5%
8	4%		4%	2%	6%	5%	2%	1%	3%
9	2%		1%	0%	5%	4%	2%	1%	1%
10	0%		0%	0%		0%			0%
11	0%		0%						0%
12	0%		0%	0%		0%			0%
13	0%								
14	0%		0%						
15	0%								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1			1%	3%	7%		26%	0%	2%
2	7%	11%	8%	2%	8%	7%	4%	4%	7%
3	28%	34%	19%	11%	25%	40%	19%	55%	21%
4	23%	24%	15%	13%	12%	25%	12%	14%	16%
5	17%	11%	20%	25%	16%	9%	16%	7%	21%
6	14%	10%	23%	28%	18%	8%	17%	7%	18%
7	5%	6%	9%	12%	8%	5%	4%	5%	8%
8	3%	3%	2%	3%	3%	3%	0%	1%	4%
9	1%	1%	2%	2%	1%	1%	0%	1%	2%
10	0%	0%	0%	0%	1%	0%	0%	2%	0%
11	0%	0%	0%	0%	0%	0%	0%	4%	0%
12	0%	0%	0%	0%	0%	0%	0%		0%
13			0%	0%	0%		0%		0%
14				0%	0%		0%		0%
15				0%					0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2008. Zeros represent values <1% (cont.).

Quarter 2

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0%	0%			0%	0%			
2	9%	17%		27%	7%	86%	88%	3%	23%
3	8%	44%		52%	35%	8%	8%	13%	23%
4	8%	23%		18%	26%	4%	4%	13%	8%
5	23%	6%		3%	9%	0%	0%	21%	21%
6	31%	6%			13%	0%	0%	24%	14%
7	10%	3%			5%	0%	0%	14%	6%
8	3%	0%			1%	0%	0%	6%	1%
9	6%	0%			0%	0%	0%	3%	2%
10	1%	0%			1%	0%	0%	2%	0%
11	0%	0%			0%	0%	0%		0%
12	0%	0%			0%	0%	0%		0%
13	0%	0%			0%	0%	0%		0%
14	0%	0%			0%	0%	0%		0%
15	0%				0%	0%	0%		0%

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	0%				4%	6%	3%		
2	0%	3%	3%		6%	14%	37%	3%	
3	59%	13%	14%		6%	15%	26%	14%	
4	22%	19%	20%		12%	17%	15%	19%	
5	9%	42%	42%		34%	20%	6%	42%	
6	5%	15%	12%		1%	13%	10%	13%	
7	2%	5%	5%		29%	13%	3%	5%	
8	1%	3%	2%		4%	1%	0%	2%	
9	0%	0%	0%		4%	2%	0%	0%	
10	0%		0%			0%		0%	
11	0%				0%	0%	0%		
12	0%		0%			0%		0%	
13	0%								
14	0%								
15	0%								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1	3%	4%	0%	0%	2%	4%	49%	0%	4%
2	5%	5%	9%	1%	3%	5%	9%	7%	8%
3	7%	6%	32%	11%	25%	6%	14%	50%	15%
4	11%	12%	15%	13%	14%	12%	7%	14%	12%
5	34%	34%	19%	26%	19%	34%	8%	3%	21%
6	9%	1%	16%	30%	21%	1%	9%	5%	21%
7	24%	29%	6%	12%	9%	29%	3%	5%	11%
8	4%	4%	0%	3%	3%	4%	0%	4%	3%
9	4%	4%	0%	2%	1%	4%	0%	3%	2%
10	0%		0%	0%	1%		0%	3%	0%
11	0%	0%	0%	0%	0%	0%	0%	6%	0%
12			0%	0%	0%		0%		0%
13			0%	0%	0%		0%		0%
14				0%	0%		0%		0%
15									0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2008. Zeros represent values <1% (cont.).

Quarter 3

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0%	0%			0%	0%	8%		
2	4%	11%	50%	27%	9%	34%	60%	4%	5%
3	21%	39%	50%	52%	37%	48%	24%	25%	32%
4	20%	25%		18%	26%	14%	4%	8%	33%
5	16%	7%		3%	8%	3%	4%	16%	9%
6	19%	10%			12%			24%	11%
7	11%	4%			5%			11%	5%
8	4%	0%			1%			7%	1%
9	3%	0%			0%			3%	2%
10	2%	1%			1%			1%	0%
11	0%	0%			0%				0%
12	0%	0%			0%				0%
13	0%	0%			0%				0%
14	0%	0%			0%				0%
15	0%								0%

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	2%	0%			3%	3%	0%	0%	
1	2%	19%	16%		51%	49%	10%	16%	67%
2	57%	51%	53%		35%	34%	25%	52%	33%
3	27%	24%	26%		8%	9%	19%	26%	
4	9%	4%	4%		2%	3%	30%	4%	
5	3%	1%	2%		0%	1%	10%	2%	
6	0%	0%			0%	1%	4%		
7						0%	1%		
8						0%	0%		
9						0%	0%		
10						0%			
11									
12						0%			
13									
14									
15									

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	3%	3%	2%		57%		59%	0%	3%
1	50%	51%	39%	34%	26%		29%	25%	4%
2	35%	35%	28%	21%	7%		8%	51%	7%
3	9%	8%	13%	20%	4%		2%	15%	25%
4	2%	2%	7%	9%	2%		0%	1%	19%
5	0%	0%	5%	6%	1%		0%	2%	12%
6	0%	0%	4%	4%	0%		0%	2%	16%
7			1%	2%	0%		0%	2%	8%
8			0%	1%	0%		0%	0%	3%
9			0%	0%	0%		0%	0%	2%
10				0%	0%		0%	0%	1%
11				0%	0%		0%	1%	0%
12				0%	0%		0%		0%
13				0%	0%		0%		0%
14				0%			0%		0%
15									0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2008. Zeros represent values <1% (cont.).

Quarter 4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1		0%			1%	0%	7%		
2	30%	20%		12%	14%	12%	58%		
3	34%	33%		33%	25%	33%	25%		
4	15%	20%		18%	18%	18%	5%		
5	10%	12%		14%	13%	14%	4%		
6	6%	8%		13%	11%	13%	0%		
7	2%	3%		5%	7%	4%	0%		
8	0%	2%		3%	4%	3%	0%		
9	0%	0%		1%	2%	1%	0%		
10	0%	0%		0%	2%	0%	0%		
11	0%	0%		0%	0%	0%	0%		
12	0%	0%			0%	0%			
13		0%			0%	0%			
14		0%			0%	0%			
15					0%				

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	2%					0%	0%		
1	0%	25%	13%		0%	2%	34%	16%	
2	19%	50%	49%	30%	30%	30%	24%	53%	25%
3	43%	25%	27%	34%	34%	33%	11%	26%	50%
4	19%		6%	15%	15%	15%	16%	4%	25%
5	4%		3%	10%	10%	10%	6%	2%	
6	5%		0%	6%	6%	6%	5%		
7	2%		0%	2%	2%	2%	1%		
8	2%		0%	0%	0%	0%	0%		
9	1%		0%	0%	0%	0%	0%		
10	0%		0%	0%	0%	0%			
11	0%		0%	0%	0%	0%			
12	0%		0%	0%	0%	0%			
13	0%				0%				
14	0%				0%				
15	0%								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0			0%		13%		66%	20%	2%
1	3%	0%	2%	22%	72%		17%	16%	2%
2	35%	31%	6%	16%	5%	30%	8%	36%	16%
3	32%	34%	19%	16%	5%	34%	4%	13%	27%
4	13%	15%	22%	13%	3%	15%	2%	2%	17%
5	8%	10%	20%	11%	1%	10%	1%	3%	11%
6	5%	6%	16%	8%	0%	6%	0%	3%	10%
7	1%	2%	10%	6%	0%	2%	0%	2%	6%
8	0%	0%	3%	4%	0%	0%	0%	0%	4%
9	0%	0%	1%	2%	0%	0%	0%	0%	2%
10	0%	0%	0%	1%	0%	0%	0%	0%	1%
11	0%	0%	0%	0%	0%	0%	0%	1%	0%
12	0%	0%	0%	0%	0%		0%		0%
13				0%	0%		0%		0%
14									0%
15									0%

Table 2.3.2.1 NEA Mackerel (Southern component). Effort data by fleets.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Days * 100 CV)	LA CORUÑA (Subdiv.VIIIc West) (Days * 100 CV)	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	51017	-	-	20	-
1984	10815	48655	-	-	700	-
1985	9856	45358	-	-	215	-
1986	10845	39829	-	-	157	-
1987	8309	34658	-	-	92	-
1988	9047	41498	-	-	374	55178
1989	8063	44401	-	605	153	52514
1990	8492	44411	322	509	161	49968
1991	7677	40435	209	724	66	44061
1992	12693	38896	70	698	286	74666
1993	7635	44479	151	1216	-	47822
1994	9620	39602	130	1926	392	38719
1995	6146	41476	217	1696	677	42090
1996	4525	35709	560	2007	777	43633
1997	4699	35191	736	2095	304	42043
1998	5929	35191	754	3022	631	86020
1999	6829	30131	739	2602	546	55311
2000	4453	30073	719	1709	413	67112
2001	2385	29923	700	2479	88	74684
2002	2748	21823	1282	2672	541	-
2003	2526	12328	265	759	544	-
2004	-	19198	626	2151	186	-
2005	-	20663	553	1504	-	-
2006	-	12866	845	1933	530	-
2007	-	21202	1031	1895	337	-
2008	-	20212	1143	1350	-	-

\- Not available

Table 2.3.2.2 NEA mackerel (Southern component). CPUE series in commercial fisheries.

	SPAIN					PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		PURSE SEINE	TRAWL
	AVILES (Subdiv.VIIIc East) (Kg * 100 CV)	LA CORUÑA (Subdiv.VIIIc West) (Kg * 100 CV)	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	22.8	-	-	1.3	-
1984	24.1	26.7	-	-	5.6	-
1985	17.6	25.4	-	-	4.2	-
1986	41.1	22.8	-	-	5.0	-
1987	13.0	24.4	-	-	2.1	-
1988	15.9	32.5	-	-	3.7	36.4
1989	19.0	28.7	-	1427.5	2.1	26.8
1990	82.7	39.5	739.6	1924.4	2.7	39.2
1991	68.2	36.3	632.9	1394.4	2.0	39.9
1992	35.1	13.3	905.6	856.4	3.9	21.2
1993	12.8	12.8	613.3	1790.9	-	16.9
1994	57.2	44.0	2388.5	1590.6	1.1	20.9
1995	94.9	36.1	3136.1	1987.9	0.3	24.5
1996	124.5	32.9	1165.7	1508.9	0.8	23.8
1997	133.2	38.6	2137.9	1867.8	1.7	18.5
1998	142.1	80.1	2361.5	2128.0	3.3	15.4
1999	136.4	43.9	2438.0	2084.7	3.6	23.9
2000	311.6	65.2	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	-
2003	357.0	51.9	1868.2	1413.5	1.0	-
2004	-	18.7	2046.2	1312.6	1.5	-
2005	-	143.0	3617.7	2424.8	-	-
2006	-	442.4	2907.9	2741.8	2.9	-
2007	-	21.9	2675.6	2888.9	1.7	-
2008		12.4	1921.5	2831.7	-	-

- Not available

Table 2.3.2.3 NEA Mackerel (Southern component). CPUE at age from fleets.

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
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
2003	759	0	1	62	151	481	605	589	318	329	116	64	36	14	5	3	1
2004	2151	0	2	124	1776	858	1503	1265	950	419	287	107	74	39	8	0	6
2005	1504	0	31	255	1886	2375	891	1673	1203	566	363	109	70	80	45	5	10
2006	1933	0	0	109	1722	6933	3416	1400	1124	414	290	227	57	57	10	0	0
2007	1895	0	1	64	614	3562	6109	2878	896	687	327	201	72	44	2	11	0
2008		0	4	64	709	1591	3087	3516	1374	326	196	95	51	29	24	3	1

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
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
2003	265	0	3	51	80	297	332	304	133	122	32	17	9	3	1	0	0
2004	626	0	83	197	1034	586	920	557	335	98	58	12	5	2	0	0	0
2005	553	0	0	7	586	1562	579	1049	680	268	162	31	19	19	15	0	2
2006	845	0	0	28	391	2408	1908	836	616	208	151	109	27	16	0	0	0
2007	1031	0	0	0	223	1774	3221	1486	414	339	139	87	27	9	0	2	0
2008		0	12	11	122	634	1603	1947	918	249	150	79	42	24	18	0	0

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
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
2003	2526	0	13	7	39	216	519	548	332	330	83	45	30	10	0	0	0
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3.2.3. (Cont.)

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

Year	Effort	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
1988	41498	0	6095	584	625	594	167	239	444	195	53	12	8	21	26	0	7
1989	44401	462	482	719	345	289	541	231	355	444	117	63	24	22	22	6	15
1990	44411	27	4535	939	175	235	370	624	184	409	405	145	45	69	5	9	5
1991	40435	1	39	454	573	839	551	445	504	165	165	266	53	4	10	11	23
1992	38896	1	154	102	298	251	355	128	61	84	25	32	38	14	6	0	2
1993	44479	0	307	440	118	528	188	265	98	41	33	21	11	3	4	2	3
1994	39602	0	237	1531	1085	821	1156	575	264	63	40	17	6	1	1	1	0
1995	41476	735	249	400	624	324	251	381	376	402	175	116	104	44	17	19	20
1996	35709	54	5865	104	562	695	148	77	127	65	59	27	20	8	1	2	2
1997	35191	13	626	1347	531	1234	493	136	140	114	88	49	32	25	6	3	6
1998	35191	3	6745	2965	2547	641	678	451	144	80	72	49	36	38	13	8	18
1999	30131	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
2003	12328	0	51	410	149	368	310	277	130	144	63	36	19	8	5	3	14
2004	19198	0	112	452	363	75	124	94	61	25	21	6	7	2	1	0	1
2005	20663	113	33	159	389	176	39	46	29	13	7	3	2	1	1	0	1
2006	12866	81	130	123	339	748	140	39	31	13	7	3	2	1	0	0	0
2007	21202	0	554	283	87	146	216	152	98	59	45	46	20	28	16	13	0
2008	20212	0	75	94	212	99	124	137	75	32	14	14	7	5	2	0	0

IXa trawl fleet (Portugal) (Catch thousands)

Year	Effort (	Catch age 0	Catch age 1	Catch age 2	Catch age 3	Catch age 4	Catch age 5	Catch age 6	Catch age 7	Catch age 8	Catch age 9	Catch age 10	Catch age 11	Catch age 12	Catch age 13	Catch age 14	Catch age 15+
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			
2001***	74684	3030	5539	1665	382	195	149	65	42	24	3	2	0	0			

*** preliminary

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2008.

Quarters 1-4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	24.0	25.8		26.1	27.7	23.7	26.5		22.5
2	30.4	31.7	32.3	32.0	31.3	27.3	27.7	29.5	28.9
3	32.1	33.0	34.0	33.7	33.1	31.5	30.9	32.0	31.4
4	33.5	34.6	36.8	35.9	35.0	37.3	32.9	34.0	32.9
5	35.6	36.4	38.2	36.7	36.7	36.4	33.8	35.5	35.2
6	36.9	36.0		36.6	36.6	36.4	31.6	37.1	36.7
7	38.3	37.4		37.1	37.7	36.8	33.7	38.7	37.9
8	39.1	39.1		38.9	39.3	38.9	38.9	39.0	38.7
9	39.8	39.7		38.8	39.9	38.7	39.1	40.0	39.5
10	40.7	40.0		39.3	40.7	39.2	39.3	41.9	40.5
11	40.1	41.4		39.7	40.8	39.7	40.0		40.3
12	40.4	42.0		40.2	42.3	40.0	40.1		41.6
13	41.9	40.2		41.2	41.8	41.1	41.0		42.1
14	43.7	42.8		41.3	41.9	41.4	41.5		43.6
15	44.2	40.8		40.8	43.6	40.8	40.8		44.5

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	19.7	20.5			20.5	20.5	20.5	20.5	20.5
1	21.9	25.7	25.7		25.7	25.7	25.8	25.7	25.7
2	28.1	28.5	28.5	28.7	29.0	29.4	28.3	28.5	28.5
3	31.0	31.1	32.7	33.6	31.5	32.0	30.1	31.2	31.3
4	34.1	33.7	35.7	36.2	33.8	33.7	30.3	34.2	33.7
5	36.1	36.3	36.7	37.1	36.2	35.7	31.1	36.6	36.4
6	36.7	38.2	37.3	38.5	35.7	35.4	32.5	38.4	36.8
7	37.7	39.4	38.5	39.2	39.3	37.1	32.0	39.2	39.2
8	39.1	40.3	39.6	40.0	39.8	39.2	35.4	40.1	39.5
9	39.4	43.3	40.8	42.4	39.5	39.2	38.8	42.5	40.2
10	40.5	43.0	42.4	42.7	39.8	39.6		42.7	40.3
11	40.4		39.6	42.2	42.0	42.2	42.0	45.5	41.6
12	41.7	42.5	41.3	42.5	42.5	39.6		42.5	40.5
13	41.6				41.7				
14	41.6		39.5		41.0				
15	42.0								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	20.5	20.5	20.5		21.3		18.7	21.9	19.1
1	25.7	25.8	25.9	22.9	25.4	27.5	25.8	28.0	25.5
2	29.9	29.5	27.9	28.4	27.8	28.6	28.1	29.8	29.8
3	31.8	31.7	30.6	31.0	29.7	31.3	30.1	30.5	32.1
4	34.7	34.1	34.8	35.0	32.8	33.7	32.6	33.2	34.5
5	36.5	36.6	36.5	36.5	35.4	36.3	34.2	35.5	36.2
6	37.0	37.2	37.1	36.9	36.0	36.7	34.6	36.3	36.8
7	39.0	39.7	38.6	38.4	38.0	39.3	35.7	37.3	38.1
8	40.0	40.3	38.7	39.7	40.4	39.7	38.6	37.7	39.3
9	39.5	41.2	39.9	40.1	40.6	40.1	39.1	38.9	39.8
10	41.1	40.1	41.3	40.2	40.7	40.3	39.6	40.1	40.7
11	40.8	41.8	41.5	41.8	41.7	41.6	41.4	42.7	40.9
12	42.0	41.0	41.9	41.9	42.2	40.5	41.9		42.0
13			42.0	42.0	43.2		42.8		41.8
14				45.0	44.6		44.5		41.8
15				46.5					43.3

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2008 (cont.).

Quarter 1

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	21.0	21.0		21.0	21.0	21.0			21.0
2	27.0	27.0		27.0	27.1	27.1	28.5		27.0
3	31.2	31.2		31.2	31.3	31.2	30.5		31.2
4	33.4	33.4		33.4	33.4	33.1	31.1		33.4
5	35.6	35.6		35.6	35.6	35.4	33.3		35.6
6	36.1	36.1		36.1	36.1	35.9	31.5		36.1
7	36.7	36.7		36.7	36.7	36.4	33.7		36.7
8	38.9	38.9		38.9	38.9	38.9			38.9
9	38.7	38.7		38.7	38.7	38.7			38.7
10	39.1	39.1		39.1	39.1	39.1			39.1
11	39.6	39.6		39.6	39.6	39.6			39.6
12	39.7	39.7		39.7	39.6	39.7			39.7
13	41.0	41.0		41.0	40.9	41.0			41.0
14	41.5	41.5		41.5	41.5	41.5			41.5
15	40.8	40.8		40.8	40.8	40.8			40.8

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	21.0				24.1	24.1	24.1	24.1	
2	27.3	28.2	28.2	28.2	27.9	28.2	28.0	30.5	28.5
3	30.6	33.7	33.1	33.7	30.9	31.1	31.0	32.4	31.3
4	33.9	36.3	35.8	36.3	32.5	32.7	31.8	35.3	33.7
5	36.1	37.1	36.7	37.1	35.2	34.7	33.5	37.1	36.4
6	36.7	38.6	37.2	38.6	35.4	35.0	33.9	38.1	36.8
7	37.7	39.2	38.5	39.2	37.1	36.4	35.4	38.9	39.2
8	39.0	40.0	39.6	40.0	37.8	37.8	37.8	40.3	39.5
9	39.3	42.4	40.7	42.4	39.1	38.5	39.1	39.9	40.2
10	40.3	43.0	42.4	43.0		36.5		40.6	40.3
11	40.3		39.6					45.5	41.6
12	41.6	42.5	41.3	42.5		36.9			40.5
13	41.5								
14	41.5		39.5						
15	41.4								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1			25.7	22.1	25.6		24.0	23.6	23.1
2	30.1	29.5	27.6	28.1	27.4	28.5	27.0	27.7	27.8
3	31.9	31.6	30.5	31.0	29.5	31.3	30.4	31.0	31.0
4	34.7	34.1	35.0	35.1	32.8	33.6	33.0	33.4	34.3
5	36.5	36.6	36.9	36.5	35.5	36.3	34.3	35.4	36.3
6	37.0	37.2	37.3	36.9	36.1	36.7	34.6	36.4	36.7
7	39.0	39.7	39.0	38.4	38.1	39.1	35.5	37.4	38.0
8	40.0	40.2	39.1	39.7	40.5	39.5	38.6	38.5	39.3
9	39.4	41.7	40.2	40.2	40.7	40.2	39.1	39.3	39.6
10	41.1	40.3	41.3	40.2	40.7	40.3	39.2	40.3	40.1
11	40.8	41.5	41.5	41.9	41.8	41.5	41.4	42.5	40.4
12	42.0	40.5	42.0	42.0	42.3	40.5	41.9		41.2
13			42.0	42.1	43.1		42.6		41.6
14				45.1	44.7		44.5		41.0
15				46.5					41.1

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2008 (cont.).

Quarter 2

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	25.0	25.0			23.7	21.0	21.0		25.0
2	28.7	32.0		32.3	30.3	27.0	27.0	31.7	28.8
3	31.8	33.4		34.0	32.3	29.1	29.1	33.2	31.9
4	34.1	35.2		36.8	34.0	39.1	39.4	34.6	34.5
5	35.3	36.7		38.2	36.1	35.6	36.2	35.8	35.9
6	36.6	36.0			36.0	36.1	36.1	37.0	36.7
7	38.0	37.4			37.3	36.7	36.7	38.5	38.6
8	38.6	39.1			39.1	38.9	38.9	39.2	39.1
9	40.0	39.8			39.6	38.7	38.7	39.9	40.0
10	41.0	40.0			39.9	39.1	39.1	40.7	40.9
11	40.6	43.1			40.9	39.6	39.6		40.6
12	42.4	43.1			41.5	39.7	39.7		42.4
13	40.1	40.1			40.2	41.0	41.0		40.1
14	44.2	44.2			42.5	41.5	41.5		44.2
15	45.0				40.8	40.8	40.8		45.0

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	21.1				27.5	27.5	23.9		27.5
2	28.1	28.2	28.2		29.8	28.9	27.9	28.2	29.9
3	31.0	33.7	33.7		31.0	30.1	30.2	33.7	31.0
4	32.8	36.2	36.3		34.1	31.2	30.8	36.3	34.1
5	36.0	37.2	37.1		36.3	34.3	32.5	37.2	36.3
6	37.5	38.3	38.6		34.5	33.1	32.8	38.5	34.5
7	38.7	39.4	39.2		39.7	36.9	32.6	39.2	39.7
8	39.6	40.3	40.0		41.4	40.9	38.1	40.1	41.4
9	40.3	43.3	42.4		39.7	38.2	39.5	42.8	39.7
10	41.2	43.0	43.0			36.5		43.0	
11	41.3				42.0	42.0	42.0		42.0
12	40.4	42.5	42.5			37.1		42.5	
13	41.7								
14	41.0								
15	41.4								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1	27.5	27.5	27.4	25.9	26.0	27.5	24.8	24.2	25.1
2	30.0	29.9	28.4	28.5	27.7	29.9	26.6	26.6	27.9
3	31.3	31.0	30.3	31.0	30.4	31.0	29.4	29.6	30.9
4	34.0	34.1	33.7	35.1	32.9	34.1	32.6	32.6	34.3
5	36.6	36.3	35.4	36.5	35.2	36.3	34.6	34.3	36.1
6	37.2	34.5	35.7	36.9	35.7	34.5	34.9	35.5	36.6
7	39.8	39.7	38.3	38.4	37.8	39.7	36.5	36.4	38.5
8	41.6	41.4	38.4	39.6	40.3	41.4	39.7	37.5	39.6
9	40.5	39.7	39.1	40.1	40.3	39.7	39.7	38.2	39.9
10	40.6		40.6	40.2	40.6		40.0	39.2	40.3
11	42.0	42.0	41.1	41.7	41.4	42.0	41.3	42.1	41.7
12			41.6	41.7	41.9		41.8		41.8
13			41.6	41.8	43.8		42.8		41.8
14				44.5	44.5		44.5		44.0
15									44.6

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2008 (cont.).

Quarter 3

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	24.0	25.0			24.6	23.5	26.5		
2	30.5	31.7	32.3	32.3	31.2	30.6	29.6	29.5	29.2
3	32.1	32.9	34.0	34.0	32.6	33.2	32.0	32.0	31.3
4	33.5	34.5	36.8	36.8	34.2	36.2	32.7	34.0	32.7
5	35.6	36.3	38.2	38.2	36.2	37.5	35.5	35.5	34.6
6	36.9	36.0			36.0			37.2	36.6
7	38.3	37.4			37.4			38.7	37.6
8	39.1	39.1			39.1			39.0	38.6
9	39.8	39.8			39.8			40.0	39.3
10	40.7	40.0			40.0			42.0	40.5
11	40.1	43.1			43.0				40.1
12	39.9	43.1			43.1				39.8
13	41.9	40.1			40.1				43.0
14	43.7	44.2			44.1				43.7
15	44.0								44.0

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	19.7	20.5			20.5	20.5	20.5	20.5	20.5
1	23.7	25.7	25.7		25.7	25.7	26.1	25.7	25.7
2	28.4	28.5	28.5		28.7	28.7	28.6	28.5	28.7
3	32.0	31.0	31.0		30.6	30.6	30.0	31.0	30.6
4	32.7	32.8	32.8		33.9	32.8	30.1	32.8	33.9
5	34.0	34.2	34.3		33.0	32.5	30.5	34.3	33.0
6	35.2	31.5			31.5	32.3	31.9	31.5	31.5
7						32.5	31.1		
8						38.4	34.5		
9						35.2	38.5		
10						36.5			
11									
12						37.1			
13									
14									
15									

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	20.5	20.5	20.5		21.2		18.7	20.5	19.2
1	25.7	25.7	25.7	27.0	25.5		26.6	28.1	26.2
2	28.7	28.7	28.9	29.6	29.4		28.4	29.9	30.2
3	30.7	30.6	31.4	31.3	30.6		29.6	31.2	32.3
4	33.8	33.9	33.1	32.6	32.0		30.6	34.3	33.8
5	33.1	33.0	33.0	33.9	33.3		32.0	36.1	35.7
6	31.5	31.5	33.5	34.8	35.4		34.6	36.8	36.7
7			33.6	37.2	36.8		37.1	37.9	38.2
8			35.0	37.9	37.9		38.3	38.5	39.1
9			36.5	38.9	38.7		38.8	39.5	39.8
10				40.0	39.9		39.9	41.0	40.7
11				41.6	41.7		41.8	43.8	40.8
12				42.3	42.3		42.3		41.1
13				43.1	43.0		43.0		40.4
14				44.5			44.5		43.7
15									44.0

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2008 (cont.).

Quarter 4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1		28.5		28.4	27.8	28.4	26.5		
2	30.2	32.1		31.6	31.5	31.5	29.6		
3	32.5	34.3		33.1	33.6	33.1	32.1		
4	34.5	36.2		34.7	35.7	34.7	33.0		
5	36.9	37.8		36.5	37.1	36.5	35.7		
6	37.2	38.4		37.1	37.0	37.1	37.2		
7	39.2	39.3		37.8	38.0	37.8	39.2		
8	39.0	39.0		38.9	39.4	38.9	39.0		
9	40.3	38.8		38.9	40.2	38.9	40.3		
10	39.8	40.4		39.9	41.4	39.9	39.8		
11	42.2	40.1		40.0	41.2	40.0	42.2		
12	42.5	41.9		41.3	43.2	41.3	42.5		
13		41.7		41.7	42.3	41.7	41.7		
14		41.0		41.0	42.0	41.0	41.0		
15					44.5				

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	19.7					20.5	20.5		
1	26.1	25.7	25.7		28.4	25.8	25.7	25.7	
2	30.9	28.5	28.7	30.2	30.2	30.1	28.3	28.5	30.2
3	32.4	31.0	31.3	32.5	32.5	32.5	30.5	31.0	32.5
4	35.1	32.8	33.4	34.5	34.5	34.3	30.7	32.8	34.5
5	35.5	34.3	35.7	36.9	36.9	36.6	32.3	34.3	36.9
6	37.1		37.2	37.2	37.2	36.6	33.1		37.2
7	37.6		39.2	39.2	39.2	38.2	32.2		39.2
8	39.5		39.0	39.0	39.0	39.0	34.5		39.0
9	40.5		40.3	40.3	40.3	40.1	39.5		40.3
10	41.6		39.8	39.8	39.8	39.8			39.8
11	41.4		42.2	42.2	42.2	42.2			42.2
12	43.5		42.5	42.5	42.5	41.6			42.5
13	42.3				41.7				
14	42.3				41.0				
15	44.5								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0			22.5		23.1		18.7	21.9	19.1
1	25.7	25.7	27.8	27.3	24.8		27.2	27.8	27.1
2	29.6	30.2	30.6	29.7	30.0	30.2	28.9	30.2	31.2
3	32.2	32.5	32.5	31.8	31.1	32.5	30.4	31.6	33.3
4	34.3	34.5	33.7	34.1	31.9	34.5	31.6	34.6	35.6
5	36.8	36.9	34.3	35.1	32.4	36.9	32.7	35.9	36.9
6	37.2	37.2	34.8	36.1	33.4	37.2	34.3	36.7	37.0
7	39.2	39.2	34.8	37.1	35.0	39.2	35.6	37.9	38.0
8	39.0	39.0	35.7	37.4	36.7	39.0	36.7	38.5	39.4
9	40.3	40.3	37.4	38.7	38.4	40.3	38.2	39.5	40.2
10	39.8	39.8	39.8	39.9	39.8	39.8	39.5	41.0	41.3
11	42.2	42.2	42.2	41.3	41.3	42.2	41.1	43.6	41.2
12	42.5	42.5	42.5	42.3	42.3	42.5	42.3		43.2
13				43.0	43.0		43.0		42.3
14									42.0
15									44.5

Table 2.3.4.2 NE Atlantic Mackerel. Percentage length composition in catches by country and gear, 2008. Zeros represent values <1%.

Len (cm)	NL – PTF	PT – ALL	RU – PT	IE – PTF	NO – PS IVa	NO – PS IIa	NO – PS VIa	UKS – all IVa	UKS – all VIa	UKS – all VIIb	UKS – all VIIj	UKS – IVa Discards	UKS – VIa Discards	FO – PS	DE – PTF IVa	DE – PTF VIa	DE – PTF VIIj	ES – PS	ES – Trawl	ES – Artisanal	UKE – Lines VIIe	UKE – Lines VIIf	IC – All
16																							
17																0		2					
18	0			0												0		10					
19	0	0		0									0			0		5	0				
20	0	0		0				0	0			0	0			0		0	0			0	
21	0	3		0				0				0	0			0		3	0	0		0	
22	0	2		0						0	0		0			0		0	0	0		0	
23	0	0		0				0	0				0			0		1	0			0	
24	0	0	0	0	0		0	0	0			0	0			2	0	2	1	0	0	1	
25	0	2	0	0	0	0	0	0	0	0	0	0	3		0	4	0	3	2	0	0	3	
26	0	3	0	0	0	0	0	0	0	0		0	6		0	6	0	4	4	0	3	4	
27	2	6	0	1	0	0	0	0	0			0	8		1	5	2	2	7	0	8	10	0
28	3	12	2	1	0	0	1	0	0	0	0	1	10		5	6	4	2	7	2	10	18	0
29	6	17	4	3	1	1	1	1	1	1	0	8	12	0	11	7	9	2	10	2	15	21	0
30	7	14	11	5	4	5	3	5	2	1	2	15	14	0	12	9	13	2	7	2	16	23	3
31	10	10	13	7	7	9	5	9	3	1	5	15	12	1	14	9	17	2	8	3	14	8	4
32	9	7	17	7	10	13	7	13	5	1	7	19	11	2	15	8	15	2	10	4	12	6	6
33	12	4	14	7	13	17	9	15	8	6	8	12	7	10	11	6	10	3	8	5	8	2	7
34	11	2	9	9	12	16	9	12	9	11	15	8	4	9	8	7	7	5	7	8	5	1	10
35	8	3	7	9	11	13	9	10	13	16	14	5	3	9	5	6	6	7	5	11	4	0	11
36	6	3	5	11	9	9	9	10	16	21	20	6	3	16	5	7	5	9	6	13	2	0	13
37	7	3	6	12	8	7	10	9	16	18	12	4	2	13	5	6	3	11	5	15	2	0	15
38	6	1	5	10	7	5	10	7	11	11	9	2	2	12	3	4	2	8	4	13	0	0	11
39	4	1	3	7	6	3	8	4	7	8	4	1	0	10	2	3	3	6	4	9	0	0	9
40	5	0	2	4	4	2	7	2	3	0	1	0	0	9	0	2	1	3	3	6	0	0	4
41	2	0	0	2	2	0	4	1	2	2	1	0	0	5	0	0	0	2	1	3	0	0	3
42	1	0	0	0	2	0	3	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0
43	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0		0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0			0			0	0		0	0	0	0		0
45		0	0	0	0	0	0									0			0	0			
46	0	0	0	0	0		0		0						0		0			0			
47		0	0	0																			
48		0																					
49		0																					
50		0																					
51		0																		0			

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2008.

Quarters 1-4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0.105	0.143		0.161	0.169	0.101	0.150		0.088
2	0.281	0.288	0.300	0.292	0.272	0.157	0.169	0.256	0.239
3	0.331	0.342	0.360	0.349	0.338	0.272	0.233	0.335	0.304
4	0.381	0.409	0.479	0.436	0.409	0.426	0.257	0.409	0.354
5	0.450	0.480	0.551	0.461	0.471	0.442	0.276	0.449	0.429
6	0.505	0.470		0.444	0.467	0.427	0.207	0.506	0.488
7	0.558	0.525		0.457	0.510	0.437	0.294	0.548	0.530
8	0.588	0.608		0.534	0.576	0.526	0.527	0.566	0.586
9	0.584	0.639		0.528	0.603	0.519	0.539	0.624	0.599
10	0.656	0.647		0.550	0.633	0.539	0.549	0.685	0.665
11	0.629	0.612		0.562	0.611	0.554	0.577		0.630
12	0.686	0.651		0.589	0.674	0.573	0.583		0.684
13	0.678	0.591		0.635	0.668	0.622	0.606		0.687
14	0.773	0.726		0.644	0.674	0.640	0.635		0.768
15	0.828	0.597		0.597	0.775	0.597	0.597		0.833

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	0.047	0.063			0.063	0.063	0.063	0.063	0.063
1	0.076	0.114	0.109		0.128	0.130	0.131	0.110	0.129
2	0.176	0.162	0.168	0.186	0.192	0.206	0.174	0.161	0.161
3	0.243	0.223	0.276	0.303	0.254	0.281	0.209	0.226	0.224
4	0.337	0.299	0.375	0.388	0.307	0.340	0.211	0.316	0.290
5	0.402	0.387	0.413	0.422	0.356	0.413	0.230	0.400	0.379
6	0.428	0.447	0.441	0.483	0.384	0.400	0.264	0.469	0.389
7	0.472	0.508	0.491	0.512	0.447	0.438	0.253	0.509	0.489
8	0.524	0.545	0.537	0.548	0.463	0.533	0.339	0.546	0.500
9	0.545	0.641	0.598	0.679	0.461	0.542	0.443	0.647	0.532
10	0.589	0.713	0.678	0.705	0.625	0.608		0.691	0.560
11	0.588		0.541	0.782	0.595	0.761	0.548	0.793	0.623
12	0.651	0.678	0.628	0.683	0.795	0.569		0.678	0.568
13	0.647				0.702				
14	0.649		0.537		0.664				
15	0.670								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	0.063	0.063	0.063		0.072		0.047	0.070	0.051
1	0.129	0.130	0.124	0.089	0.123	0.142	0.131	0.168	0.128
2	0.186	0.189	0.152	0.165	0.157	0.162	0.172	0.208	0.227
3	0.236	0.234	0.207	0.213	0.187	0.223	0.199	0.219	0.295
4	0.323	0.301	0.311	0.305	0.254	0.288	0.251	0.283	0.371
5	0.381	0.379	0.359	0.342	0.316	0.368	0.284	0.366	0.418
6	0.404	0.394	0.375	0.354	0.331	0.386	0.294	0.392	0.444
7	0.477	0.487	0.429	0.398	0.388	0.475	0.327	0.428	0.497
8	0.518	0.509	0.440	0.439	0.463	0.496	0.422	0.418	0.550
9	0.505	0.555	0.479	0.455	0.471	0.510	0.448	0.488	0.572
10	0.580	0.585	0.530	0.456	0.473	0.561	0.458	0.542	0.621
11	0.577	0.641	0.535	0.512	0.509	0.598	0.522	0.664	0.594
12	0.641	0.624	0.552	0.515	0.526	0.568	0.538		0.645
13			0.551	0.519	0.565		0.585		0.640
14				0.635	0.619		0.623		0.661
15				0.700					0.756

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2008 (cont.).

Quarter 1

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0.067	0.067		0.067	0.067	0.067			0.067
2	0.155	0.155		0.155	0.157	0.155	0.167		0.155
3	0.252	0.252		0.252	0.254	0.249	0.200		0.252
4	0.312	0.312		0.312	0.311	0.298	0.206		0.312
5	0.385	0.385		0.385	0.387	0.374	0.250		0.385
6	0.405	0.405		0.405	0.404	0.397	0.203		0.405
7	0.424	0.424		0.424	0.425	0.412	0.293		0.424
8	0.513	0.513		0.513	0.512	0.513			0.513
9	0.504	0.504		0.504	0.505	0.504			0.504
10	0.524	0.524		0.524	0.523	0.524			0.524
11	0.543	0.543		0.543	0.544	0.543			0.543
12	0.551	0.551		0.551	0.548	0.551			0.551
13	0.605	0.605		0.605	0.601	0.605			0.605
14	0.635	0.635		0.635	0.635	0.635			0.635
15	0.597	0.597		0.597	0.597	0.597			0.597

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	0.063				0.097	0.097	0.097	0.097	
2	0.160	0.165	0.168	0.165	0.148	0.157	0.153	0.201	0.161
3	0.233	0.302	0.289	0.302	0.217	0.224	0.211	0.246	0.224
4	0.326	0.388	0.378	0.388	0.263	0.269	0.232	0.332	0.290
5	0.402	0.421	0.413	0.421	0.342	0.329	0.276	0.392	0.379
6	0.425	0.483	0.441	0.483	0.346	0.335	0.284	0.437	0.389
7	0.469	0.511	0.491	0.511	0.400	0.380	0.340	0.471	0.489
8	0.519	0.548	0.537	0.548	0.435	0.434	0.428	0.532	0.500
9	0.536	0.680	0.597	0.680	0.515	0.490	0.512	0.525	0.532
10	0.579	0.713	0.678	0.713		0.379		0.537	0.560
11	0.582		0.539					0.793	0.623
12	0.645	0.678	0.628	0.678		0.391			0.568
13	0.638								
14	0.642		0.537						
15	0.631								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1			0.116	0.076	0.117		0.097	0.091	0.087
2	0.186	0.172	0.145	0.155	0.143	0.159	0.138	0.156	0.162
3	0.236	0.224	0.205	0.211	0.181	0.223	0.198	0.221	0.232
4	0.323	0.295	0.319	0.305	0.253	0.289	0.253	0.282	0.321
5	0.382	0.375	0.368	0.342	0.318	0.377	0.283	0.339	0.384
6	0.405	0.386	0.383	0.354	0.333	0.387	0.290	0.371	0.396
7	0.478	0.496	0.442	0.398	0.390	0.489	0.315	0.402	0.444
8	0.519	0.510	0.455	0.439	0.465	0.499	0.404	0.444	0.505
9	0.507	0.583	0.488	0.455	0.472	0.532	0.421	0.473	0.518
10	0.580	0.561	0.530	0.455	0.471	0.561	0.422	0.515	0.542
11	0.577	0.618	0.535	0.513	0.510	0.618	0.496	0.615	0.553
12	0.641	0.568	0.552	0.515	0.527	0.568	0.513		0.602
13			0.551	0.520	0.560		0.538		0.590
14				0.638	0.622		0.613		0.610
15				0.700					0.613

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2008 (cont.).

Quarter 2

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0.125	0.125			0.106	0.067	0.067		0.125
2	0.232	0.293		0.300	0.254	0.148	0.148	0.321	0.233
3	0.309	0.349		0.360	0.327	0.184	0.186	0.371	0.312
4	0.395	0.428		0.479	0.388	0.424	0.432	0.423	0.392
5	0.425	0.495		0.551	0.466	0.385	0.425	0.459	0.440
6	0.474	0.472			0.467	0.405	0.405	0.512	0.482
7	0.513	0.531			0.521	0.424	0.424	0.568	0.550
8	0.558	0.621			0.601	0.513	0.513	0.588	0.581
9	0.585	0.658			0.628	0.504	0.504	0.582	0.628
10	0.662	0.654			0.641	0.524	0.524	0.654	0.668
11	0.636	0.675			0.592	0.543	0.543		0.636
12	0.688	0.700			0.629	0.551	0.551		0.688
13	0.590	0.590			0.591	0.605	0.605		0.590
14	0.815	0.815			0.701	0.635	0.635		0.815
15	0.851				0.597	0.597	0.597		0.851

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0									
1	0.065				0.142	0.144	0.107		0.142
2	0.175	0.165	0.165		0.193	0.169	0.170	0.165	0.195
3	0.195	0.302	0.302		0.225	0.192	0.216	0.302	0.226
4	0.242	0.385	0.388		0.281	0.216	0.228	0.387	0.281
5	0.382	0.419	0.421		0.337	0.286	0.268	0.420	0.337
6	0.450	0.452	0.483		0.312	0.254	0.276	0.471	0.312
7	0.500	0.508	0.511		0.450	0.370	0.273	0.510	0.450
8	0.539	0.545	0.548		0.468	0.459	0.420	0.547	0.468
9	0.581	0.640	0.680		0.415	0.377	0.462	0.662	0.415
10	0.618	0.713	0.713			0.336		0.713	
11	0.624				0.548	0.548	0.548		0.548
12	0.581	0.678	0.678			0.354		0.678	
13	0.647								
14	0.607								
15	0.630								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0									
1	0.142	0.142	0.141	0.123	0.122	0.142	0.106	0.098	0.110
2	0.195	0.195	0.161	0.162	0.150	0.195	0.131	0.135	0.174
3	0.230	0.226	0.197	0.211	0.196	0.226	0.180	0.192	0.231
4	0.281	0.281	0.279	0.307	0.254	0.281	0.246	0.259	0.315
5	0.347	0.337	0.322	0.343	0.310	0.337	0.292	0.305	0.358
6	0.354	0.312	0.333	0.355	0.324	0.312	0.300	0.341	0.384
7	0.450	0.450	0.413	0.397	0.381	0.450	0.344	0.370	0.433
8	0.479	0.468	0.406	0.437	0.458	0.468	0.437	0.407	0.476
9	0.444	0.415	0.423	0.451	0.459	0.415	0.437	0.434	0.505
10	0.537		0.496	0.453	0.468		0.447	0.472	0.532
11	0.550	0.548	0.515	0.506	0.495	0.548	0.490	0.600	0.556
12			0.536	0.507	0.513		0.507		0.550
13			0.536	0.510	0.586		0.545		0.521
14				0.613	0.613		0.614		0.633
15									0.829

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2008 (cont.).

Quarter 3

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1	0.105	0.125			0.118	0.094	0.150		
2	0.286	0.288	0.300	0.300	0.277	0.255	0.221	0.254	0.250
3	0.331	0.341	0.360	0.360	0.335	0.334	0.274	0.335	0.302
4	0.381	0.407	0.479	0.479	0.397	0.459	0.272	0.408	0.350
5	0.452	0.480	0.551	0.551	0.474	0.516	0.371	0.449	0.420
6	0.508	0.472			0.472			0.506	0.493
7	0.560	0.531			0.531			0.547	0.524
8	0.589	0.621			0.621			0.565	0.591
9	0.584	0.658			0.657			0.626	0.588
10	0.656	0.654			0.654			0.686	0.675
11	0.629	0.675			0.673				0.628
12	0.686	0.700			0.700				0.685
13	0.679	0.590			0.590				0.734
14	0.773	0.815			0.808				0.773
15	0.822								0.822

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	0.047	0.063			0.063	0.063	0.063	0.063	0.063
1	0.104	0.114	0.109		0.129	0.130	0.136	0.110	0.129
2	0.184	0.162	0.161		0.183	0.184	0.177	0.161	0.183
3	0.254	0.220	0.220		0.208	0.209	0.204	0.220	0.208
4	0.276	0.270	0.269		0.296	0.276	0.206	0.269	0.296
5	0.351	0.319	0.319		0.308	0.287	0.214	0.319	0.308
6	0.352	0.201			0.201	0.263	0.246	0.201	0.201
7						0.284	0.228		
8						0.460	0.309		
9						0.353	0.429		
10						0.393			
11									
12						0.412			
13									
14									
15									

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0	0.063	0.063	0.063		0.071		0.047	0.056	0.052
1	0.129	0.129	0.130	0.158	0.131		0.148	0.169	0.139
2	0.182	0.183	0.186	0.211	0.204		0.183	0.210	0.251
3	0.209	0.208	0.221	0.251	0.234		0.209	0.244	0.330
4	0.294	0.296	0.264	0.290	0.274		0.236	0.335	0.388
5	0.309	0.308	0.263	0.328	0.315		0.275	0.402	0.454
6	0.201	0.201	0.269	0.362	0.382		0.355	0.429	0.498
7			0.272	0.441	0.428		0.439	0.477	0.551
8			0.309	0.469	0.467		0.482	0.501	0.584
9			0.352	0.507	0.499		0.504	0.548	0.601
10				0.551	0.549		0.550	0.622	0.659
11				0.627	0.632		0.633	0.793	0.651
12				0.660	0.658		0.660		0.690
13				0.700	0.695		0.696		0.604
14				0.776			0.776		0.778
15									0.822

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2008 (cont.).

Quarter 4

Ages	IIa	IIIa	IIIb	IIId	IVa	IVb	IVc	Va	Vb
0									
1		0.193		0.203	0.171	0.203	0.150		
2	0.238	0.296		0.284	0.277	0.283	0.222		
3	0.310	0.367		0.330	0.348	0.329	0.276		
4	0.384	0.443		0.388	0.427	0.388	0.293		
5	0.484	0.504		0.455	0.484	0.456	0.390		
6	0.501	0.535		0.483	0.481	0.483	0.501		
7	0.601	0.579		0.514	0.527	0.515	0.600		
8	0.578	0.560		0.561	0.585	0.561	0.578		
9	0.656	0.555		0.566	0.619	0.567	0.655		
10	0.625	0.629		0.609	0.658	0.609	0.625		
11	0.782	0.613		0.617	0.634	0.618	0.780		
12	0.798	0.708		0.679	0.715	0.680	0.796		
13		0.702		0.702	0.696	0.702	0.702		
14		0.664		0.664	0.686	0.664	0.664		
15					0.832				

Ages	VIa	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh
0	0.047					0.063	0.063		
1	0.134	0.109	0.109		0.203	0.132	0.129	0.109	
2	0.230	0.161	0.168	0.238	0.238	0.235	0.174	0.161	0.238
3	0.279	0.220	0.237	0.310	0.310	0.307	0.214	0.220	0.310
4	0.386	0.269	0.313	0.384	0.384	0.376	0.223	0.269	0.384
5	0.413	0.319	0.406	0.484	0.483	0.467	0.261	0.319	0.484
6	0.489		0.501	0.501	0.501	0.470	0.277		0.501
7	0.510		0.601	0.601	0.599	0.547	0.254		0.601
8	0.590		0.578	0.578	0.577	0.574	0.312		0.578
9	0.633		0.656	0.656	0.654	0.640	0.470		0.656
10	0.669		0.625	0.625	0.625	0.622			0.625
11	0.636		0.782	0.782	0.779	0.782			0.782
12	0.718		0.798	0.798	0.795	0.728			0.798
13	0.695				0.702				
14	0.693				0.664				
15	0.832								

Ages	VIIj	VIIIa	VIIIb	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	Total
0			0.076		0.093		0.047	0.070	0.050
1	0.109	0.109	0.150	0.164	0.119		0.160	0.165	0.155
2	0.213	0.237	0.210	0.212	0.217	0.238	0.194	0.218	0.262
3	0.294	0.310	0.250	0.264	0.246	0.310	0.228	0.256	0.332
4	0.376	0.384	0.277	0.334	0.266	0.384	0.263	0.347	0.420
5	0.477	0.484	0.294	0.367	0.282	0.484	0.292	0.394	0.478
6	0.501	0.501	0.306	0.403	0.314	0.501	0.342	0.423	0.480
7	0.601	0.601	0.304	0.436	0.363	0.601	0.384	0.473	0.524
8	0.578	0.578	0.332	0.449	0.423	0.578	0.421	0.501	0.584
9	0.656	0.656	0.383	0.498	0.485	0.656	0.476	0.548	0.619
10	0.625	0.625	0.625	0.545	0.543	0.625	0.527	0.622	0.658
11	0.782	0.782	0.782	0.609	0.612	0.782	0.603	0.774	0.636
12	0.798	0.798	0.798	0.657	0.657	0.798	0.657		0.716
13				0.695	0.695		0.695		0.696
14									0.687
15									0.832

Table 2.6.1. Spring Spanish acoustic surveys (PELACUS 04) carried out in the North-western and North Atlantic waters off the Iberian Peninsula, in the years 2001-2008. Dates of beginning and end of the surveys.

Survey	Start	End	Month
Pelacus 2001	30/03/2001	21/04/2001	April
Pelacus 2002	10/03/2002	31/03/2002	March
Pelacus 2003	20/03/2003	10/04/2003	March/April
Pelacus 2004	30/03/2004	23/04/2004	April
Pelacus 2005	06/04/2005	28/04/2005	April
Pelacus 2006	03/04/2006	25/04/2006	April
Pelacus 2007	29/03/2007	20/04/2007	April
Pelacus 2008	28/03/2008	21/04/2008	April

Table 2.6.2- Spring Spanish acoustic surveys from 2001 to 2009. Mackerel Abundance in number of individuals (millions) and Biomass in tons by ICES Subdivisions, only for the Spanish area.

	ICES IXa-N		ICES VIIIc-W		VIIIc-EW		VIIIc-EE		TOTAL	
	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass
2001	19	7,384	311	120,096	1,232	489,058	362	119,111	1,926	735,650
2002			822	333,748	3,804	1,191,051	37	9,993	4,668	1,534,793
2003	4,584	376,561	1,070	184,428	876	202,487	540	144,340	7,138	907,815
2004	609	118,570	1,030	304,335	1,502	515,729	30	6,986	3,173	945,619
2005	156	45,566	233	12,983	602	228,628	164	32,314	1,061	409,493
2006	8	673	385	100,475	149	41,463	16	3,962	557	146,572
2007	159	11,216	223	77,378	361	108,412	5	1,794	749	198,801
2008	160	21,415	377	109,035	835	235,040	51	4,191	1423	369,681
2009	59	11,784	40	10,052	568	220,223	325	74,102	992	316,160

Table 2.6.3. Spanish acoustic surveys. Biomass (in number and weight), mean length and mean weight at age of mackerel from the acoustics surveys from 2001 to 2008 in ICES Subdivision IXa North and Division VIIIc.

	2001				2002				2003				2004			
AGE	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)
1	29.03	25.94	126.21	3.66	621.44	23.33	80.54	50.05	5678.55	23.15	81.57	463.18	195.23	25.03	114.60	22.37
2	47.63	30.95	213.70	10.18	94.80	32.02	221.87	21.03	324.50	28.89	165.14	53.59	952.36	28.29	164.48	156.64
3	184.31	33.68	277.31	51.11	378.11	34.25	277.14	104.79	108.96	33.47	261.33	28.47	599.27	32.80	258.15	154.70
4	386.61	36.06	340.29	131.56	706.78	35.80	317.92	224.70	229.00	35.00	299.70	68.63	227.54	37.46	377.85	85.97
5	382.12	37.52	383.02	146.36	1065.88	36.85	348.00	370.93	265.16	37.09	359.09	95.22	425.56	38.05	395.53	168.32
6	393.57	37.98	397.69	156.52	604.56	38.24	390.93	236.34	230.14	37.95	385.71	88.77	336.69	39.13	428.35	144.22
7	202.67	39.50	446.73	90.54	674.54	39.07	419.19	282.76	94.25	39.76	443.38	41.79	181.46	40.15	461.71	83.78
8	143.52	40.01	464.48	66.66	191.43	39.88	447.20	85.61	88.53	40.11	454.61	40.25	106.11	40.78	483.18	51.27
9	83.71	40.51	481.74	40.33	158.39	40.30	461.39	73.08	19.55	41.47	505.14	9.88	76.46	41.03	492.49	37.66
10	17.00	40.16	469.27	7.98	100.16	41.04	490.19	49.10	10.00	41.93	519.88	5.20	31.07	42.33	538.03	16.72
11	26.28	42.12	541.39	14.23	53.95	41.41	503.95	27.19	13.98	42.61	549.62	7.69	18.90	42.22	533.89	10.09
12	12.26	41.90	533.82	6.54	12.38	43.50	586.72	7.26	3.80	41.50	503.13	1.91	13.49	43.27	573.84	7.74
13	1.88	41.50	517.12	0.97	0.00	0.00	0.00	0.00	3.69	43.11	566.94	2.09	3.21	43.95	599.81	1.92
14	6.14	43.50	596.47	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15+	9.41	42.76	568.10	5.35	2.90	45.46	676.91	1.96	2.00	43.34	578.06	1.15	5.92	46.45	710.52	4.21
TOTAL	1926.15	37.30	381.93	735.65	4665.31	35.49	328.98	1534.79	7072.12	25.53	128.37	907.82	3173.25	33.80	298.00	945.62

	2005				2006				2007				2008			
AGE	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)
1	43.44	24.79	112.12	4.64	83.70	20.77	58.51	4.90	182.24	21.49	64.07	11.68	407.07	24.41	100.35	40.90
2	106.50	29.24	181.77	18.96	9.31	29.69	177.18	1.65	34.63	25.63	110.51	3.83	100.49	27.06	135.24	13.59
3	229.10	32.25	245.43	56.14	57.33	31.94	223.13	12.79	22.08	33.41	254.45	5.62	327.43	29.75	180.70	59.07
4	259.58	36.50	349.40	92.36	230.74	33.54	262.72	60.62	129.60	34.87	291.68	37.80	125.84	33.48	261.93	32.92
5	82.56	38.33	403.43	34.21	104.71	36.68	345.04	36.13	189.44	36.08	323.95	61.37	233.60	36.24	328.24	76.54
6	163.83	38.76	417.58	70.42	34.20	38.46	398.15	13.62	117.54	38.07	379.72	44.63	277.51	36.30	328.50	91.02
7	114.88	39.45	438.44	51.98	22.18	39.18	420.53	9.33	31.94	39.79	435.86	13.92	131.04	37.90	374.13	48.92
8	63.83	39.80	451.67	29.82	7.55	40.94	483.34	3.65	20.47	39.73	431.55	8.83	25.21	39.52	423.45	10.64
9	33.55	41.02	493.88	17.23	1.97	41.85	513.64	1.01	4.76	41.24	483.97	2.31	20.13	39.51	422.69	8.48
10	15.28	42.29	535.41	8.54	3.44	41.34	495.11	1.70	6.06	40.73	464.70	2.81	20.45	40.15	443.58	9.04
11	13.66	41.81	518.75	7.38	1.43	42.68	545.72	0.78	1.53	41.39	490.27	0.75	9.20	41.11	474.75	4.35
12	6.59	42.00	526.61	3.62	0.53	42.82	551.13	0.29	4.68	44.47	608.62	2.85	7.32	41.81	499.99	3.65
13	11.31	42.47	544.07	6.43	0.13	43.79	590.73	0.08	0.72	43.50	567.62	0.41	2.39	43.44	561.40	1.34
14	5.10	43.77	592.63	3.17	0.00	0.00	0.00	0.00	2.60	44.04	591.48	1.54	1.08	44.58	607.07	0.66
15+	7.34	43.72	594.87	4.59	0.03	44.50	620.97	0.02	0.65	46.50	697.93	0.46	0.38	46.54	690.30	0.27
TOTAL	1156.55	35.91	346.65	409.49	557.28	32.72	263.01	146.57	748.94	32.51	265.44	198.80	1689.15	31.72	237.98	401.39

Table 2.6.4. Biomass estimates calculated for main species during spring acoustic surveys in 2008 in the Iberian Peninsula and Bay of Biscay, carried out by IPIMAR (PELAGO 08), IEO (PELACUS 08) and IFREMER (PELGAS 08). Coding of the species: PIL-*Sardina pilchardus*, ANE-*Engraulis encrasicolus*, MAC-*Scomber scombrus*, HOM-*Trachurus trachurus*, MAS-*Scomber colias*, SPR-*Spratus spratus*, BOG-*Boops boops*, HMM- *Trachurus mediterraneus*, JAA- *Trachurus picturatus*. (From WGACEGG 2008)

	PIL	ANE	MAC	HOM	MAS	SPR	BOG	HMM	JAA
PELGAS08	460 727	37 574	340 619	98 153	1 833	49 117	0	0	0
PELACUS08	140 287	3 225	365 490	37 102	3 617	0	28 982	0	8 477
PELAGO08	244 000	39 700	114 690	17 950	67 811	0	20 530	8 884	57 241
Total	845 014	80 499	820 799	153 205	73 261	49 117	49 512	8 884	65 718

Table 2.8.1. Catch Number at age

Units : Thousands

year

age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	10707	16997	29277	36171	62510	6077	34623	114529	33101	56682
1	34979	46267	108077	62908	282818	175220	34513	360698	411327	276229
2	51652	74544	47410	92385	249293	328732	560738	62909	393025	502365
3	194461	109015	155390	84509	374245	226560	449338	609522	64549	231814
4	650980	415015	148543	265129	176793	236116	279236	385578	328206	32814
5	0	814518	424462	164673	314261	67758	282158	250755	254172	184867
6	0	0	673317	251420	133822	186619	78877	248099	142978	173349
7	0	0	0	991632	379790	105004	172213	92655	145385	116328
8	0	0	0	0	478925	229803	73933	169605	54778	125548
9	0	0	0	0	0	236966	127975	73900	130771	41186
10	0	0	0	0	0	0	243333	102363	39920	146186
11	0	0	0	0	0	0	0	204291	56210	31639
12	0	0	0	0	0	0	0	0	104927	199615

year

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	11180	7333	287287	81799	49983	7403	57644	65400	24246	10007
1	213936	47914	31901	268960	58126	40126	152656	64263	140534	58459
2	432867	668909	86064	20893	424563	156670	137635	312739	209848	212521
3	472457	433744	682491	58346	38387	663378	190403	207689	410751	206421
4	184581	373262	387582	445357	76545	56680	538394	167588	208146	375451
5	26544	126533	251503	252217	364119	89003	72914	362469	156742	188623
6	138970	20175	98063	165219	208021	244570	87323	48696	254015	129145
7	112476	90151	22086	62363	126174	150588	201021	58116	42549	197888
8	89672	72031	61813	19562	42569	85863	122496	111251	49698	51077
9	88726	48668	47925	47560	13533	34795	55913	68240	85447	43415
10	27552	49252	37482	37607	32786	19658	20710	32228	33041	70839
11	91743	19745	30105	26965	22971	25747	13178	13904	16587	29743
12	156121	132040	69183	97652	81153	63146	57494	35814	27905	52986

year

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	43447	19354	25368	14759	37956	36012	61127	67003	36345	26034
1	83583	128144	147315	81529	119852	144390	99352	73597	102407	40315
2	156292	210319	221489	340898	168882	186481	229767	132994	142898	158943
3	356209	266677	306979	340215	333365	238426	264566	223639	275376	234186
4	266591	398240	267420	275031	279182	378881	323186	261778	390858	297206
5	306143	244285	301346	186855	177667	246781	361945	281041	295516	309937
6	156070	255472	184925	197856	96303	135059	207619	244212	241550	231804
7	113899	149932	189847	142342	119831	84378	118388	159019	175608	195250
8	138458	97746	106108	113413	55812	66504	72745	86739	106291	120241
9	51208	121400	80054	69191	59801	39450	47353	50613	52394	72205
10	36612	38794	57622	42441	25803	26735	24386	30363	31280	42529
11	40956	29067	20407	37960	18353	13950	16551	17048	18918	20546
12	68205	68217	57551	39753	30648	24974	22932	32446	34202	40706

year

age	2002	2003	2004	2005	2006	2007	2008
0	70409	14409	5168	5014	58294	15374	25738
1	222214	182121	24617	44235	69303	79398	42026
2	69728	265153	425834	131909	165134	189765	156691
3	366981	88950	499455	661629	156631	227859	385874
4	349853	290227	142792	289505	468403	204001	278500
5	262485	230568	244885	118453	194147	448612	256023
6	236927	180479	137998	119907	96817	200620	253135
7	151241	132355	83997	63297	73749	75312	123012
8	118814	93165	61426	38025	33234	58619	56638
9	79919	74779	37614	23744	18785	28301	31986
10	43776	45793	32816	18703	13951	16451	19142
11	21606	25691	15385	7863	8313	11796	6760
12	40260	30887	18151	10558	10071	13548	9560

Table 2.8.2. Weights at age in the catch

Units : Kg

year														
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0.052	0.05	0.051	0.05	0.059	0.056	0.036	0.016	0.057	0.06	0.053	0.05	0.031	0.055
1	0.135	0.145	0.136	0.148	0.137	0.136	0.135	0.137	0.131	0.132	0.131	0.168	0.102	0.144
2	0.277	0.194	0.229	0.177	0.207	0.169	0.161	0.161	0.249	0.248	0.249	0.219	0.184	0.262
3	0.341	0.285	0.261	0.259	0.263	0.275	0.25	0.243	0.285	0.287	0.285	0.276	0.295	0.357
4	0.423	0.368	0.334	0.323	0.32	0.333	0.325	0.318	0.345	0.344	0.345	0.31	0.326	0.418
5		0.448	0.392	0.348	0.346	0.352	0.345	0.348	0.378	0.377	0.378	0.386	0.344	0.417
6			0.481	0.43	0.406	0.407	0.403	0.401	0.454	0.454	0.454	0.425	0.431	0.436
7				0.488	0.443	0.446	0.421	0.416	0.498	0.499	0.496	0.435	0.542	0.521
8					0.518	0.546	0.518	0.506	0.52	0.513	0.513	0.498	0.48	0.555
9						0.537	0.536	0.513	0.542	0.543	0.541	0.545	0.569	0.564
10							0.529	0.537	0.574	0.573	0.574	0.606	0.628	0.629
11								0.522	0.59	0.576	0.574	0.608	0.636	0.679
12									0.58	0.584	0.582	0.614	0.663	0.71

year														
age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.039	0.076	0.055	0.049	0.085	0.068	0.051	0.061	0.046	0.072	0.058	0.076	0.065	0.062
1	0.146	0.179	0.133	0.136	0.156	0.156	0.167	0.134	0.136	0.143	0.143	0.143	0.157	0.176
2	0.245	0.223	0.259	0.237	0.233	0.253	0.239	0.24	0.255	0.234	0.226	0.23	0.227	0.235
3	0.335	0.318	0.323	0.32	0.336	0.327	0.333	0.317	0.339	0.333	0.313	0.295	0.31	0.306
4	0.423	0.399	0.388	0.377	0.379	0.394	0.397	0.376	0.39	0.39	0.377	0.359	0.354	0.361
5	0.471	0.474	0.456	0.433	0.423	0.423	0.46	0.436	0.448	0.452	0.425	0.415	0.408	0.404
6	0.444	0.512	0.524	0.456	0.467	0.469	0.495	0.483	0.512	0.501	0.484	0.453	0.452	0.452
7	0.457	0.493	0.555	0.543	0.528	0.506	0.532	0.527	0.543	0.539	0.518	0.481	0.462	0.5
8	0.543	0.498	0.555	0.592	0.552	0.554	0.555	0.548	0.59	0.577	0.551	0.524	0.518	0.536
9	0.591	0.58	0.562	0.578	0.606	0.609	0.597	0.583	0.583	0.594	0.576	0.553	0.55	0.569
10	0.552	0.634	0.613	0.581	0.606	0.63	0.651	0.595	0.627	0.606	0.596	0.577	0.573	0.586
11	0.694	0.635	0.624	0.648	0.591	0.649	0.663	0.647	0.678	0.631	0.603	0.591	0.591	0.607
12	0.688	0.718	0.697	0.739	0.713	0.708	0.669	0.679	0.713	0.672	0.67	0.636	0.631	0.687

year									
age	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.063	0.069	0.052	0.081	0.086	0.067	0.042	0.093	0.051
1	0.135	0.172	0.16	0.171	0.16	0.149	0.099	0.121	0.128
2	0.227	0.224	0.256	0.271	0.267	0.27	0.196	0.218	0.227
3	0.306	0.305	0.307	0.338	0.326	0.307	0.307	0.295	0.295
4	0.363	0.376	0.367	0.387	0.402	0.366	0.357	0.369	0.371
5	0.427	0.424	0.425	0.439	0.422	0.434	0.428	0.408	0.418
6	0.463	0.474	0.46	0.477	0.488	0.44	0.48	0.453	0.444
7	0.501	0.496	0.512	0.523	0.523	0.495	0.494	0.505	0.497
8	0.534	0.54	0.537	0.572	0.557	0.539	0.543	0.529	0.55
9	0.567	0.577	0.58	0.612	0.575	0.556	0.584	0.569	0.57
10	0.586	0.603	0.601	0.631	0.598	0.582	0.625	0.575	0.621
11	0.594	0.611	0.629	0.648	0.633	0.635	0.635	0.587	0.594
12	0.644	0.666	0.665	0.715	0.686	0.657	0.69	0.668	0.663

Table 2.8.3. Weights at age in the stock

Units : Kg

year														
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0	0
1	0.132	0.132	0.13	0.129	0.128	0.127	0.111	0.11	0.109	0.087	0.086	0.086	0.081	0.085
2	0.178	0.177	0.173	0.171	0.17	0.167	0.175	0.174	0.173	0.186	0.135	0.172	0.194	0.165
3	0.243	0.242	0.238	0.236	0.236	0.233	0.238	0.237	0.236	0.252	0.221	0.235	0.253	0.293
4	0.411	0.301	0.296	0.294	0.293	0.289	0.3	0.299	0.297	0.313	0.28	0.28	0.295	0.306
5	0	0.438	0.322	0.318	0.318	0.313	0.346	0.345	0.343	0.323	0.385	0.339	0.324	0.341
6	0	0	0.469	0.365	0.365	0.361	0.382	0.38	0.379	0.378	0.353	0.377	0.393	0.384
7	0	0	0	0.497	0.419	0.416	0.41	0.408	0.407	0.419	0.408	0.404	0.436	0.43
8	0	0	0	0	0.512	0.446	0.432	0.43	0.429	0.434	0.437	0.439	0.441	0.459
9	0	0	0	0	0	0.53	0.451	0.449	0.448	0.449	0.446	0.503	0.479	0.468
10	0	0	0	0	0	0	0.514	0.504	0.503	0.443	0.479	0.473	0.52	0.559
11	0	0	0	0	0	0	0	0.516	0.508	0.523	0.526	0.555	0.51	0.579
12	0	0	0	0	0	0	0	0	0.518	0.531	0.534	0.563	0.55	0.607

year														
age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.077	0.078	0.072	0.076	0.074	0.075	0.078	0.078	0.079	0.081	0.076	0.076	0.077	0.081
2	0.179	0.148	0.156	0.177	0.138	0.155	0.212	0.197	0.178	0.164	0.133	0.186	0.149	0.194
3	0.267	0.24	0.237	0.244	0.222	0.23	0.259	0.268	0.237	0.267	0.251	0.228	0.223	0.242
4	0.304	0.286	0.301	0.306	0.287	0.307	0.31	0.315	0.301	0.326	0.317	0.296	0.285	0.301
5	0.356	0.374	0.329	0.352	0.339	0.357	0.362	0.36	0.361	0.398	0.366	0.361	0.342	0.353
6	0.351	0.386	0.423	0.38	0.373	0.409	0.402	0.416	0.413	0.448	0.444	0.402	0.4	0.396
7	0.416	0.411	0.445	0.429	0.414	0.432	0.424	0.454	0.466	0.491	0.462	0.445	0.426	0.423
8	0.473	0.429	0.432	0.474	0.409	0.502	0.462	0.465	0.47	0.508	0.501	0.478	0.466	0.44
9	0.443	0.482	0.455	0.457	0.437	0.541	0.487	0.484	0.483	0.546	0.565	0.519	0.502	0.485
10	0.468	0.499	0.522	0.466	0.514	0.566	0.522	0.511	0.55	0.514	0.573	0.537	0.549	0.498
11	0.497	0.47	0.589	0.51	0.523	0.566	0.552	0.585	0.608	0.619	0.611	0.532	0.524	0.465
12	0.575	0.549	0.632	0.595	0.529	0.594	0.583	0.577	0.584	0.639	0.632	0.585	0.58	0.565

year									
age	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0	0	0	0	0	0	0	0	0
1	0.074	0.078	0.078	0.074	0.059	0.074	0.076	0.064	0.071
2	0.185	0.164	0.181	0.181	0.138	0.168	0.178	0.169	0.157
3	0.235	0.241	0.239	0.273	0.246	0.238	0.228	0.224	0.198
4	0.289	0.342	0.311	0.316	0.313	0.336	0.297	0.278	0.269
5	0.35	0.39	0.364	0.371	0.355	0.381	0.345	0.309	0.308
6	0.39	0.446	0.411	0.446	0.412	0.401	0.391	0.363	0.339
7	0.426	0.459	0.436	0.446	0.463	0.481	0.436	0.439	0.396
8	0.447	0.499	0.462	0.475	0.462	0.501	0.458	0.448	0.431
9	0.485	0.529	0.5	0.584	0.508	0.55	0.517	0.498	0.457
10	0.492	0.576	0.522	0.527	0.52	0.55	0.523	0.517	0.463
11	0.532	0.603	0.533	0.599	0.538	0.576	0.578	0.542	0.506
12	0.544	0.586	0.565	0.61	0.59	0.59	0.614	0.565	0.53

Table 2.8.4. Proportion mature at age

Units : proportion

year age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
2	0.53	0.54	0.54	0.55	0.55	0.55	0.56	0.56	0.57	0.57	0.57	0.58	0.58	0.58
3	0.9	0.9	0.9	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88
4	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97
5	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97
6	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
7	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
9	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
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1

year age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
2	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
3	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.86	0.86
4	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98
5	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98	0.98
6	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
7	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
9	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
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1

year age	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0	0	0	0	0	0	0	0	0
1	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
2	0.58	0.59	0.59	0.59	0.59	0.58	0.57	0.58	0.58
3	0.86	0.88	0.88	0.88	0.88	0.89	0.89	0.86	0.87
4	0.98	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98
5	0.98	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98
6	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
7	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1

Table 2.8.5. Survey index

Triennal Mackerel Egg Sruvey
Units :10^3 tonnes

year													
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
SSB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
year													
age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
SSB	NA	NA	NA	NA	NA	NA	NA	3370	NA	NA	2840	NA	NA
year													
age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007			
SSB	3750	NA	NA	2900	NA	NA	2750	NA	NA	3260			

Table 2.8.6. Stock summary

Year	Recruitment Age 0 (Thousands)	TSB (Tonnes)	SSB (Tonnes)	Fbar age 4-8	Catchs (Tonnes)
1972	2107710	5268805	3910445	0.019	361262
1973	4740947	5163444	3972952	0.183	570719
1974	3972009	5041355	3797838	0.210	607473
1975	4898680	4855543	3526017	0.220	784329
1976	4921339	4570718	3195872	0.253	828434
1977	959498	4266770	3023937	0.196	620016
1978	3224330	3917625	2978773	0.193	736519
1979	5293791	3486657	2523841	0.256	842739
1980	5545867	3170793	2109885	0.248	734950
1981	7223223	3294253	2137584	0.231	754045
1982	2025972	3227927	2061195	0.224	716987
1983	1564509	3348280	2357237	0.214	672283
1984	7381492	3123975	2377858	0.224	641928
1985	3304438	3310145	2325294	0.219	614371
1986	3431405	3316289	2348414	0.232	602201
1987	5119691	3183050	2342935	0.218	654992
1988	3570179	3261221	2352917	0.240	680491
1989	4397057	3342866	2432299	0.181	585920
1990	3176776	3130777	2299116	0.182	626107
1991	3706513	3423846	2559251	0.225	675665
1992	4716451	3536234	2577894	0.254	760690
1993	5562702	3466635	2413766	0.318	824568
1994	4745812	3339450	2233526	0.355	819087
1995	4275449	3542342	2423915	0.345	756277
1996	4050038	3369042	2447523	0.239	563472
1997	3014543	3514795	2560826	0.249	573029
1998	3014644	3337419	2470494	0.290	666316
1999	3452126	3375918	2486482	0.301	640309
2000	1980116	3098108	2222260	0.352	738606
2001	5064315	2983811	2158363	0.397	737463
2002	8427720	2664323	1765975	0.443	772905
2003	3330106	2958967	1775602	0.427	669600
2004	4204636	2825813	1909235	0.376	650221
2005	5655568	3256519	2378330	0.267	543486
2006	4703184	3441403	2476318	0.220	472652
2007	2740833	3491284	2505033	0.252	579379
2008	3858779	3324007	2491963	0.237	611063

Table 2.8.7. Estimated stock numbers at age

Units : thousands

year									
age	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	2107710	4740947	3972009	4898680	4921339	959498	3224330	5293791	5545867
1	5166699	1804199	4064818	3391607	4182810	4177906	820216	2743120	4450285
2	2093262	4414601	1510020	3398483	2860890	3338288	3433644	673995	2027339
3	4138145	1753829	3730605	1255762	2839504	2231611	2569024	2436881	521882
4	7765863	3381611	1408579	3067017	1002589	2097767	1711076	1795779	1534687
5	0	6081475	2526591	1074901	2394364	699500	1587067	1214542	1189425
6	0	0	4480882	1782210	772887	1770120	539348	1105167	813672
7	0	0	0	3234020	1301406	541512	1350844	391268	722058
8	0	0	0	0	1868974	769753	369041	1003356	251201
9	0	0	0	0	0	1166511	450553	249317	706786
10	0	0	0	0	0	0	785060	269713	146418
11	0	0	0	0	0	0	0	451299	137878
12	0	0	0	0	0	0	0	0	257377
year									
age	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	7223223	2025972	1564509	7381492	3304438	3431405	5119691	3570179	4397057
1	4742694	6164554	1733408	1339789	6087172	2768365	2907119	4399698	3019465
2	3449646	3826252	5107684	1447565	1123609	4990137	2328893	2464996	3645429
3	1381721	2504496	2892722	3777403	1166226	947739	3902006	1859420	1994170
4	389465	974928	1718967	2088643	2620357	949738	780166	2745165	1424195
5	1017699	304837	668529	1134704	1439466	1843610	746580	619013	1865231
6	788926	705057	237803	458460	744325	1005794	1250319	560234	465322
7	568157	518900	478422	186002	304004	488028	673488	850139	401445
8	487136	381529	342714	328458	139657	204035	303574	440577	546079
9	165607	303383	245571	228425	225575	102109	136283	182062	266169
10	487463	104512	179270	166390	152328	150213	75367	85177	105135
11	89181	284719	64523	108847	108592	96387	99002	46723	54189
12	562657	484513	431482	250136	393259	340519	242807	203846	139581
year									
age	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	3176776	3706513	4716451	5562702	4745812	4275449	4050038	3014543	3014644
1	3723976	2711806	3180950	4019223	4769924	4061247	3666234	3450724	2579913
2	2539331	3075066	2279905	2660426	3340655	3969027	3420001	3044519	2909600
3	2848130	1991346	2449944	1817608	2095127	2670226	3100586	2787197	2483002
4	1524182	2071493	1522923	1779225	1317782	1519369	1983527	2360185	2151376
5	1070745	1119332	1435894	1064337	1163536	887119	1053501	1449000	1714072
6	1270435	776629	789023	953047	690458	723285	590912	742492	1005672
7	355438	858742	549043	534891	584502	423602	439941	419556	492261
8	291774	266559	556357	367327	322034	328055	233394	268069	271380
9	367215	205185	182223	351024	225941	179360	177842	149344	168747
10	166097	237150	136493	109589	190251	120708	90667	97949	94686
11	60767	112428	138772	83689	58579	110603	64787	54230	60194
12	102230	200286	231101	196408	165202	115827	108189	97085	78449
year									
age	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	3452126	1980116	5064315	8427720	3330106	4204636	5655568	4703184	2740833
1	2577587	2950888	1690640	4319505	7180758	2838382	3588034	4838200	4027805
2	2168004	2164045	2467054	1408189	3584323	5966155	2368413	3020951	4089452
3	2352049	1748316	1725999	1948590	1101325	2812581	4734462	1924199	2479555
4	1882568	1774557	1289995	1248680	1381855	786277	2054133	3626191	1504536
5	1519407	1319433	1201264	846820	794578	888583	523833	1473867	2687031
6	1148299	1008073	837700	733553	497116	472681	552863	358035	1049345
7	638750	720818	599902	475523	396958	273377	274477	359791	244826
8	303804	389173	414251	327396	246282	209246	152948	173964	240733
9	162270	179116	215227	216490	161567	123906	112369	94158	113643
10	101745	96503	100065	113771	108205	82291	67262	69709	61899

11	55054	58268	51586	50328	53796	52239	42619	40355	44583
12	107574	99935	108239	98567	77653	50412	38723	43633	52059

year		
age	2008	2009
0	3858779[1]	3858779[1]
1	2345482	3303337[2]
2	3395226	1979643
3	3332743	2776243
4	1911048	2586043
5	1090111	1399324
6	1859408	764493
7	693207	1248402
8	157739	454616
9	150888	100807
10	71749	97088
11	37863	44816
12	38770	48512

[1] Geometric mean of recruitment over the period 1972-2006

[2] Calculated from abundance, fishing and natural mortality at age 0 in 2008

Table 2.8.8. Estimated fishing mortality at age

year age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01
1	0.01	0.03	0.03	0.02	0.08	0.05	0.05	0.15	0.11	0.07	0.04	0.03
2	0.03	0.02	0.03	0.03	0.10	0.11	0.19	0.11	0.23	0.17	0.13	0.15
3	0.05	0.07	0.05	0.08	0.15	0.12	0.21	0.31	0.14	0.20	0.23	0.18
4	0.09	0.14	0.12	0.10	0.21	0.13	0.19	0.26	0.26	0.10	0.23	0.27
5	0.00	0.16	0.20	0.18	0.15	0.11	0.21	0.25	0.26	0.22	0.10	0.23
6	0.00	0.19	0.18	0.16	0.21	0.12	0.17	0.28	0.21	0.27	0.24	0.10
7	0.00	0.21	0.26	0.40	0.38	0.23	0.15	0.29	0.24	0.25	0.27	0.23
8	0.00	0.23	0.29	0.26	0.32	0.39	0.24	0.20	0.27	0.32	0.29	0.26
9	0.00	0.22	0.28	0.26	0.22	0.25	0.36	0.38	0.22	0.31	0.38	0.24
10	0.00	0.24	0.31	0.28	0.24	0.17	0.40	0.52	0.35	0.39	0.33	0.35
11	0.00	0.23	0.30	0.27	0.23	0.17	0.32	0.66	0.57	0.48	0.42	0.40
12	0.00	0.23	0.30	0.27	0.23	0.17	0.32	0.66	0.57	0.48	0.42	0.40

year age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.04	0.03	0.02	0.00	0.02	0.02	0.01	0.00	0.01	0.00	0.01	0.00
1	0.03	0.05	0.02	0.02	0.04	0.02	0.04	0.02	0.03	0.04	0.03	0.02
2	0.07	0.02	0.10	0.08	0.06	0.10	0.09	0.08	0.08	0.09	0.07	0.10
3	0.22	0.06	0.05	0.20	0.12	0.12	0.17	0.12	0.17	0.17	0.17	0.15
4	0.22	0.20	0.09	0.08	0.24	0.14	0.16	0.22	0.21	0.28	0.25	0.22
5	0.27	0.21	0.24	0.14	0.14	0.23	0.17	0.20	0.26	0.28	0.33	0.26
6	0.26	0.27	0.25	0.24	0.18	0.12	0.24	0.20	0.24	0.34	0.34	0.35
7	0.14	0.25	0.33	0.27	0.29	0.17	0.14	0.28	0.25	0.36	0.43	0.45
8	0.23	0.16	0.25	0.36	0.35	0.25	0.20	0.23	0.31	0.34	0.44	0.46
9	0.26	0.26	0.15	0.32	0.40	0.32	0.29	0.26	0.36	0.46	0.48	0.53
10	0.28	0.31	0.27	0.33	0.30	0.40	0.24	0.39	0.34	0.48	0.39	0.47
11	0.35	0.31	0.30	0.33	0.36	0.32	0.35	0.33	0.38	0.47	0.47	0.46
12	0.35	0.31	0.30	0.33	0.36	0.32	0.35	0.33	0.38	0.47	0.47	0.46

year age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1	0.04	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.02	0.02	0.02
2	0.06	0.05	0.06	0.07	0.08	0.09	0.10	0.09	0.08	0.06	0.05	0.06
3	0.12	0.11	0.13	0.13	0.15	0.17	0.19	0.19	0.16	0.12	0.10	0.11
4	0.16	0.17	0.20	0.21	0.24	0.27	0.30	0.29	0.26	0.18	0.15	0.17
5	0.20	0.22	0.25	0.26	0.30	0.34	0.38	0.37	0.33	0.23	0.19	0.22
6	0.19	0.26	0.30	0.32	0.37	0.42	0.46	0.45	0.39	0.28	0.23	0.27
7	0.35	0.29	0.33	0.35	0.40	0.46	0.51	0.49	0.43	0.31	0.25	0.29
8	0.30	0.31	0.36	0.38	0.44	0.50	0.56	0.54	0.47	0.34	0.28	0.32
9	0.45	0.31	0.36	0.37	0.43	0.49	0.54	0.53	0.46	0.33	0.27	0.31
10	0.36	0.34	0.39	0.41	0.48	0.54	0.60	0.58	0.51	0.36	0.30	0.34
11	0.36	0.32	0.38	0.39	0.46	0.52	0.57	0.55	0.49	0.35	0.29	0.33
12	0.36	0.32	0.38	0.39	0.46	0.52	0.57	0.55	0.49	0.35	0.29	0.33

year age	2008
0	0.01
1	0.02
2	0.05
3	0.10
4	0.16
5	0.21
6	0.25
7	0.27
8	0.30
9	0.29
10	0.32
11	0.31
12	0.31

Table 2.8.9. Fitted selection pattern

year age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
1	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
4	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21
7	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
8	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
9	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
10	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
11	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
12	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50

Table 2.8.10. Predicted index values

year age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
all	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

year age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
all	NA	NA	NA	NA	NA	NA	3461003	NA	NA	3253934	NA	NA	3317002

year age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	NA	NA	2897736	NA	NA	2563193	NA	NA	3363032	NA

Table 2.8.11. Index residuals

year age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
all	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

year age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
all	NA	NA	NA	NA	NA	NA	-0.027	NA	NA	-0.136	NA	NA	0.123

year age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
all	NA	NA	0.00	NA	NA	0.07	NA	NA	-0.03	NA

Table 2.8.12. Predicted catch in number

Units : Thousands

year

age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	10707	16997	29277	36171	62510	6077	34623	114529	33101	56682
1	34979	46267	108077	62908	282818	175220	34513	360698	411327	276229
2	51652	74544	47410	92385	249293	328732	560738	62909	393025	502365
3	194461	109015	155390	84509	374245	226560	449338	609522	64549	231814
4	650980	415015	148543	265129	176793	236116	279236	385578	328206	32814
5	0	814518	424462	164673	314261	67758	282158	250755	254172	184867
6	0	0	673317	251420	133822	186619	78877	248099	142978	173349
7	0	0	0	991632	379790	105004	172213	92655	145385	116328
8	0	0	0	0	478925	229803	73933	169605	54778	125548
9	0	0	0	0	0	236966	127975	73900	130771	41186
10	0	0	0	0	0	0	243333	102363	39920	146186
11	0	0	0	0	0	0	0	204291	56210	31639
12	0	0	0	0	0	0	0	0	104927	199615

year

age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	11180	7333	287287	81799	49983	7403	57644	65400	24246	10007
1	213936	47914	31901	268960	58126	40126	152656	64263	140534	58459
2	432867	668909	86064	20893	424563	156670	137635	312739	209848	212521
3	472457	433744	682491	58346	38387	663378	190403	207689	410751	206421
4	184581	373262	387582	445357	76545	56680	538394	167588	208146	375451
5	26544	126533	251503	252217	364119	89003	72914	362469	156742	188623
6	138970	20175	98063	165219	208021	244570	87323	48696	254015	129145
7	112476	90151	22086	62363	126174	150588	201021	58116	42549	197888
8	89672	72031	61813	19562	42569	85863	122496	111251	49698	51077
9	88726	48668	47925	47560	13533	34795	55913	68240	85447	43415
10	27552	49252	37482	37607	32786	19658	20710	32228	33041	70839
11	91743	19745	30105	26965	22971	25747	13178	13904	16587	29743
12	156121	132040	69183	97652	81153	63146	57494	35814	27905	52986

year

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	43447	19354	25368	14759	37956	15891	18495	21995	14741	42505
1	83583	128144	147315	81529	119852	65252	56710	58824	78571	50683
2	156292	210319	221489	340898	168882	148382	164409	127093	147530	188818
3	356209	266677	306979	340215	333365	267484	275092	270027	232186	256147
4	266591	398240	267420	275031	279182	343123	359401	325482	352896	285239
5	306143	244285	301346	186855	177667	261248	353921	324388	322674	325471
6	156070	255472	184925	197856	96303	158906	245665	289776	290210	266235
7	113899	149932	189847	142342	119831	97160	129885	174022	223550	205008
8	138458	97746	106108	113413	55812	67134	77285	89288	129897	152048
9	51208	121400	80054	69191	59801	36666	47137	46784	58684	77584
10	36612	38794	57622	42441	25803	26123	28669	31777	34159	38881
11	40956	29067	20407	37960	18353	13950	17596	16605	19942	19400
12	68205	68217	57551	39753	30648	24974	22932	32446	34202	40706

year

age	2002	2003	2004	2005	2006	2007	2008
0	78821	30070	33374	31929	21863	14646	25738
1	144108	231397	80522	72628	80747	77202	42230
2	119592	294312	432704	123421	130193	201979	157679
3	319381	174802	396419	484912	163797	241060	305156
4	303415	325703	165515	318069	469181	221493	265437
5	251226	228933	229595	100445	237080	490441	187964
6	254374	167614	143507	125657	68531	227287	380955
7	176978	143739	89324	67451	74615	57371	153759
8	130609	95654	73504	40612	39071	60996	37858
9	84865	61651	42736	29257	20724	28230	35497
10	47963	44438	30628	19006	16694	16700	18348
11	20557	21398	18809	11620	9314	11603	9336
12	40260	30887	18151	10558	10071	13548	9560

Table 2.8.13. Catch residuals

year												
age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
0	0.82	1.20	1.11	0.90	-0.49	-0.11	-0.74	-1.87	-1.85	0.98	0.05	0.00
1	0.79	0.56	0.22	0.27	-0.23	0.43	-0.24	-1.19	-0.50	-0.15	0.03	-0.01
2	0.23	0.34	0.05	-0.03	-0.17	-0.54	-0.10	-0.02	0.07	0.24	-0.06	-0.01
3	-0.12	-0.04	-0.19	0.17	-0.09	0.14	-0.68	0.23	0.31	-0.05	-0.06	0.24
4	0.10	-0.11	-0.22	0.10	0.04	0.14	-0.12	-0.15	-0.09	0.00	-0.08	0.05
5	-0.06	0.02	-0.14	-0.09	-0.05	0.04	0.01	0.06	0.17	-0.20	-0.09	0.31
6	-0.16	-0.17	-0.17	-0.18	-0.14	-0.07	0.07	-0.04	-0.05	0.35	-0.13	-0.41
7	-0.14	-0.09	-0.09	-0.24	-0.05	-0.16	-0.08	-0.06	-0.06	-0.01	0.27	-0.22
8	-0.01	-0.06	-0.03	-0.20	-0.24	-0.10	-0.03	-0.18	-0.07	-0.16	-0.04	0.40
9	0.07	0.01	0.08	-0.11	-0.07	-0.06	0.19	-0.13	-0.21	-0.10	0.00	-0.10
10	0.02	-0.16	-0.05	-0.09	0.09	-0.09	0.03	0.07	-0.02	-0.18	-0.02	0.04
11	0.00	-0.06	0.03	-0.05	0.06	0.05	0.18	-0.20	-0.39	-0.11	0.02	-0.32
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2.8.14. Fit parameters

Parameter	Value	CV	Lower 95%	Upper 95%
F,1997	0.22	9%	0.18	0.26
F,1998	0.25	9%	0.21	0.30
F,1999	0.26	9%	0.22	0.31
F,2000	0.30	9%	0.26	0.36
F,2001	0.34	9%	0.29	0.41
F,2002	0.38	9%	0.32	0.46
F,2003	0.37	9%	0.31	0.44
F,2004	0.32	10%	0.27	0.39
F,2005	0.23	10%	0.19	0.28
F,2006	0.19	9%	0.16	0.23
F,2007	0.22	10%	0.18	0.27
F,2008	0.20	13%	0.16	0.26
Selectivity at age 0	0.03	77%	0.01	0.10
Selectivity at age 1	0.10	23%	0.06	0.15
Selectivity at age 2	0.25	9%	0.21	0.30
Selectivity at age 3	0.51	10%	0.42	0.61
Selectivity at age 4	0.79	9%	0.66	0.94
Selectivity at age 6	1.21	9%	1.02	1.44
Selectivity at age 7	1.33	8%	1.13	1.56
Selectivity at age 8	1.45	8%	1.25	1.70
Selectivity at age 9	1.42	8%	1.22	1.65
Selectivity at age 10	1.57	8%	1.35	1.82
Terminal year pop, age 0	5129702	2275%	57503	457607291
Terminal year pop, age 1	2345482	94%	596893	9216539
Terminal year pop, age 2	3395225	25%	2129675	5412823
Terminal year pop, age 3	3332742	15%	2486005	4467877
Terminal year pop, age 4	1911047	12%	1500914	2433252
Terminal year pop, age 5	1090110	12%	869856	1366133
Terminal year pop, age 6	1859407	9%	1556845	2220770
Terminal year pop, age 7	693206	10%	573532	837852
Terminal year pop, age 8	157738	11%	127507	195137
Terminal year pop, age 9	150887	11%	121677	187111
Terminal year pop, age 10	71748	12%	57278	89873
Terminal year pop, age 11	37862	13%	29654	48343
Last true age pop, 1997	54229	24%	34301	85734
Last true age pop, 1998	60193	18%	42744	84764
Last true age pop, 1999	55053	15%	40993	73937
Last true age pop, 2000	58267	14%	44640	76055
Last true age pop, 2001	51585	13%	40191	66210
Last true age pop, 2002	50327	12%	39521	64089
Last true age pop, 2003	53795	13%	41898	69071
Last true age pop, 2004	52238	13%	40710	67030
Last true age pop, 2005	42618	13%	33232	54655
Last true age pop, 2006	40354	12%	31732	51320
Last true age pop, 2007	44582	12%	35228	56421
Index biomass, Q	1.34	2%	1.28	1.41

Table 2.9.1 North East Atlantic Mackerel. Short term prediction: INPUT DATA

2009	Stock	Natural	Maturity	Prop. Of F	Prop. Of M	Stock	Exploitation	Catch
0	3858779	0.15	0	0.421	0.35	0.000	0.005	0.062
1	3303337	0.15	0.05	0.421	0.35	0.070	0.020	0.116
2	1979643	0.15	0.53	0.421	0.35	0.168	0.051	0.214
3	2776243	0.15	0.9	0.421	0.35	0.217	0.103	0.299
4	2586043	0.15	0.98	0.421	0.35	0.281	0.161	0.366
5	1399324	0.15	0.98	0.421	0.35	0.321	0.204	0.418
6	764493	0.15	0.99	0.421	0.35	0.364	0.248	0.459
7	1248402	0.15	1.00	0.421	0.35	0.424	0.271	0.499
8	454616	0.15	1.00	0.421	0.35	0.446	0.297	0.541
9	100807	0.15	1.00	0.421	0.35	0.491	0.290	0.574
10	97088	0.15	1.00	0.421	0.35	0.501	0.320	0.607
11	44816	0.15	1.00	0.421	0.35	0.542	0.306	0.605
12	48512	0.15	1.00	0.421	0.35	0.570	0.306	0.674

2010	Stock	Natural	Maturity	Prop. Of F	Prop. Of M	Stock	Exploitation	Catch
0	3858779	0.15	0	0.421	0.35	0.000	0.005	0.062
1	-	0.15	0.05	0.421	0.35	0.070	0.020	0.116
2	-	0.15	0.53	0.421	0.35	0.168	0.051	0.214
3	-	0.15	0.9	0.421	0.35	0.217	0.103	0.299
4	-	0.15	0.98	0.421	0.35	0.281	0.161	0.366
5	-	0.15	0.98	0.421	0.35	0.321	0.204	0.418
6	-	0.15	0.99	0.421	0.35	0.364	0.248	0.459
7	-	0.15	1.00	0.421	0.35	0.424	0.271	0.499
8	-	0.15	1.00	0.421	0.35	0.446	0.297	0.541
9	-	0.15	1.00	0.421	0.35	0.491	0.290	0.574
10	-	0.15	1.00	0.421	0.35	0.501	0.320	0.607
11	-	0.15	1.00	0.421	0.35	0.542	0.306	0.605
12	-	0.15	1.00	0.421	0.35	0.570	0.306	0.674

2011	Stock	Natural	Maturity	Prop. Of F	Prop. Of M	Stock	Exploitation	Catch
0	3858779	0.15	0	0.421	0.35	0.000	0.005	0.062
1	-	0.15	0.05	0.421	0.35	0.070	0.020	0.116
2	-	0.15	0.53	0.421	0.35	0.168	0.051	0.214
3	-	0.15	0.9	0.421	0.35	0.217	0.103	0.299
4	-	0.15	0.98	0.421	0.35	0.281	0.161	0.366
5	-	0.15	0.98	0.421	0.35	0.321	0.204	0.418
6	-	0.15	0.99	0.421	0.35	0.364	0.248	0.459
7	-	0.15	1.00	0.421	0.35	0.424	0.271	0.499
8	-	0.15	1.00	0.421	0.35	0.446	0.297	0.541
9	-	0.15	1.00	0.421	0.35	0.491	0.290	0.574
10	-	0.15	1.00	0.421	0.35	0.501	0.320	0.607
11	-	0.15	1.00	0.421	0.35	0.542	0.306	0.605
12	-	0.15	1.00	0.421	0.35	0.570	0.306	0.674

Input units are thousands and kg - output in tonnes

Table 2.9.2 North East Atlantic Mackerel Short term prediction single option table. Catch constraint of 830 Kt in 2009 and F status quo for 2010 and 2011

Year: 2009		F multiplier: 1.3253		Fbar: 0.3131					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.007	25565	1585	3858779	0	0	0	0	0
1	0.026	78360	9090	3303337	232335	165167	11617	155022	10903
2	0.068	120535	25754	1979643	332580	1049211	176267	967551	162549
3	0.137	330630	98858	2776243	601519	2498619	541367	2237953	484890
4	0.214	463178	169369	2586043	727540	2534322	712989	2197858	618331
5	0.271	309186	129240	1399324	448717	1371338	439742	1161058	372312
6	0.328	199466	91555	764493	278530	756848	275745	625446	227871
7	0.359	351474	175268	1248402	528906	1248402	528906	1018268	431406
8	0.394	137997	74610	454616	202607	454616	202607	365515	162898
9	0.385	30022	17243	100807	49463	100807	49463	81357	39919
10	0.424	31302	19001	97088	48641	97088	48641	77073	38613
11	0.406	13958	8449	44816	24290	44816	24290	35843	19427
12	0.406	15109	10178	48512	27636	48512	27636	38798	22102
Total		2106781	830200	18662104	3502764	10369746	3039272	8961740	2591221

Year: 2010		F multiplier 1		Fbar: 0.2362					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0054	19306	1197	3858779	0	0	0	0	0
1	0.0195	59206	6868	3297589	231930	164879	11597	155166	10913
2	0.0511	128315	27417	2770602	465461	1468419	246694	1363646	229093
3	0.1034	145400	43475	1592268	344991	1433041	310492	1301840	282065
4	0.1612	288647	105548	2083606	586188	2041934	574464	1810368	509317
5	0.2042	309170	129233	1797663	576450	1761709	564921	1533878	491863
6	0.2477	187771	86187	918799	334749	909611	331401	777621	283313
7	0.2711	104850	52285	473880	200767	473880	200767	401143	169951
8	0.2969	179611	97110	750192	334335	750192	334335	628187	279962
9	0.2901	61958	35584	264011	129542	264011	129542	221708	108785
10	0.3197	15070	9147	59072	29595	59072	29595	48992	24545
11	0.3064	13456	8145	54704	29649	54704	29649	45625	24729
12	0.3064	13165	8869	53523	30490	53523	30490	44640	25430
Total		1525927	611066	17974686	3294149	9434974	2793949	8332815	2439966

Year: 2011		F multiplier 1		Fbar: 0.2362					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.0054	19306	1197	3858779	0	0	0	0	0
1	0.0195	59310	6880	3303388	232338	165169	11617	155439	10933
2	0.0511	128908	27543	2783398	467611	1475201	247834	1369944	230151
3	0.1034	206907	61865	2265823	490928	2039241	441836	1852540	401384
4	0.1612	171210	62606	1235884	347695	1211166	340741	1073814	302100
5	0.2042	262513	109730	1526375	489458	1495847	479668	1302398	417636
6	0.2477	257794	118327	1261430	459581	1248816	454985	1067606	388964
7	0.2711	136586	68111	617314	261535	617314	261535	522561	221392
8	0.2969	74464	40260	311017	138610	311017	138610	260436	116068
9	0.2901	112607	64674	479834	235438	479834	235438	402949	197714
10	0.3197	43373	26328	170017	85178	170017	85178	141006	70644
11	0.3064	9084	5499	36931	20017	36931	20017	30802	16695
12	0.3064	16867	11363	68571	39062	68571	39062	57190	32579
Total		1498929	604383	17918760	3267452	9319123	2756522	8236685	2406258

Input units are thousands and kg - output in tonnes

Table 2.9.3 North East Atlantic Mackerel. . Short term prediction; single area management option table. OPTION: Catch constraint 830 Kt in 2009.

2009				
Biomass	SSB	FMult	FBar	Landings
3502764	2591221	1.3253	0.3131	830000

2010					2011		
TSB	SSB	FMult	FBar	Landings	TSB	SSB	Implied change
3294149	2651050	0.00	0.00	0	3779569	3090442	-100.0%
-	2629019	0.10	0.02	67082	3723270	3011942	-91.9%
-	2607199	0.20	0.05	132750	3668176	2935892	-84.0%
-	2585587	0.30	0.07	197040	3614256	2862209	-76.3%
-	2564182	0.40	0.09	259982	3561484	2790811	-68.7%
-	2542981	0.50	0.12	321608	3509831	2721622	-61.3%
-	2521982	0.60	0.14	381950	3459271	2654565	-54.0%
-	2501183	0.70	0.17	441038	3409779	2589569	-46.9%
-	2485920	0.77	0.18	483973	3373826	2542757	-41.7%
-	2480582	0.80	0.19	498901	3361328	2526563	-39.9%
-	2470355	0.85	0.20	527382	3337485	2495786	-36.5%
-	2462209	0.89	0.21	549954	3318592	2471505	-33.8%
-	2454094	0.93	0.22	572339	3299858	2447522	-31.1%
-	2442180	0.99	0.23	605018	3272513	2412683	-27.1%
-	2439966	1.00	0.24	611066	3267452	2406258	-26.4%
-	2420346	1.10	0.26	664348	3222881	2349961	-20.0%
-	2419947	1.10	0.26	665424	3221981	2348830	-19.8%
-	2400118	1.20	0.28	718667	3177456	2293138	-13.4%
-	2397357	1.21	0.29	726034	3171296	2285476	-12.5%
-	2380477	1.30	0.31	770822	3133855	2239123	-7.2%
-	2361022	1.40	0.33	821913	3091156	2186729	-1.0%
-	2341751	1.50	0.35	871966	3049339	2135902	5.0%
-	2322663	1.60	0.38	921005	3008383	2086590	10.9%
-	2303754	1.70	0.40	969053	2968267	2038743	16.7%
-	2293057	1.76	0.42	996005	2945769	2012106	20.0%
-	2285025	1.80	0.43	1016132	2928972	1992311	22.4%
-	2266472	1.90	0.45	1062266	2890478	1947247	28.0%
-	2248094	2.00	0.47	1107475	2852768	1903508	33.4%

Input units are thousands and kg - output in tonnes

Table 2.15: Overview of major existing regulations on mackerel catches

Technical measure	National/European level	Specification	Note
Catch limitation	European (EU, Norway,	TAC 2007: 501.000t	
Catch limitation	Unilateral	TAC: 35,819t	
Management plan	European (EU, Norway,	F=0.20 to 0.22, SSB	
Minimum size	European (EU, Norway,	30cm in the North	
Minimum size (all	European (EU, Faroes)	20cm in all areas	10% undersized allowed
Minimum size	National (Nor)	30cm in all areas	
Catch limitation	European (EU, Norway,	Within the limits of	
Area closure	National (UK)	South-West	except where the weight of
Quota adaptation	European (EU)	Reducing of UK and	
Discard	National (Nor)	All discarding is	

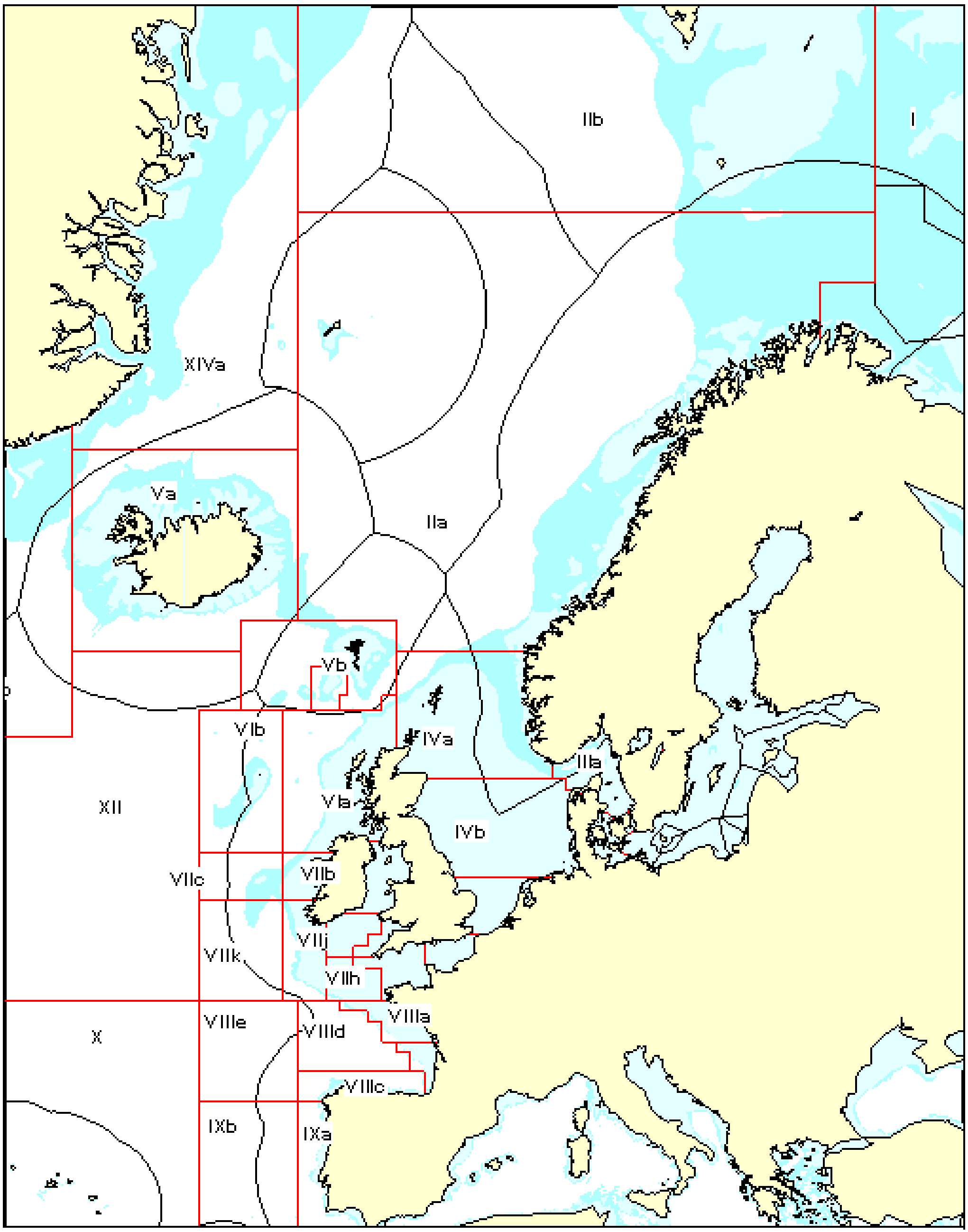


Figure 2.1.1. Map of approximate national zones and ICES Divisions and Subareas. Note that EU region is considered as one zone in this map. The 200 and 500 m depth contour is shown on the map.

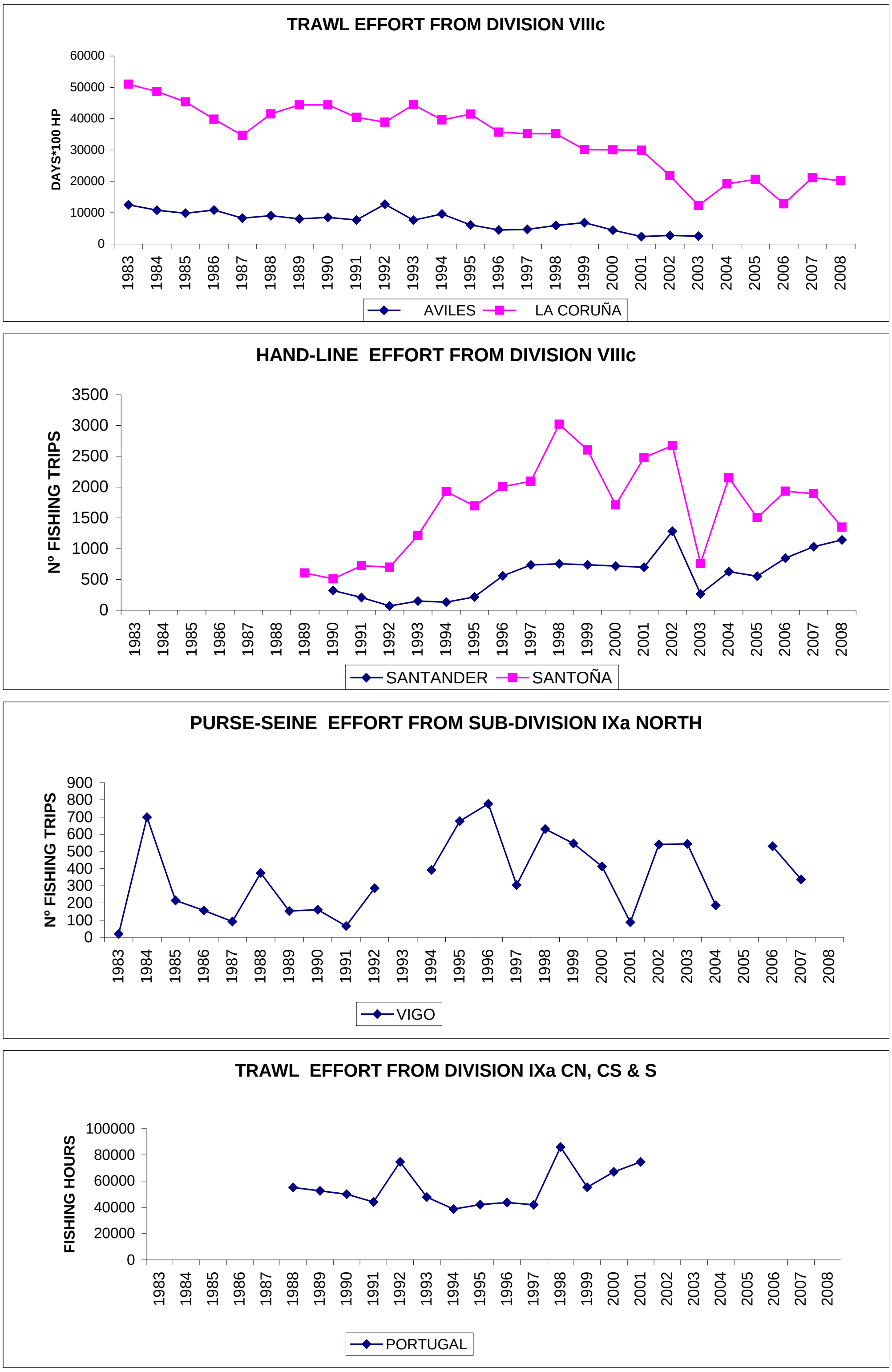


Figure 2.3.2.1. NEA mackerel (Southern component). Effort data by fleets and area .

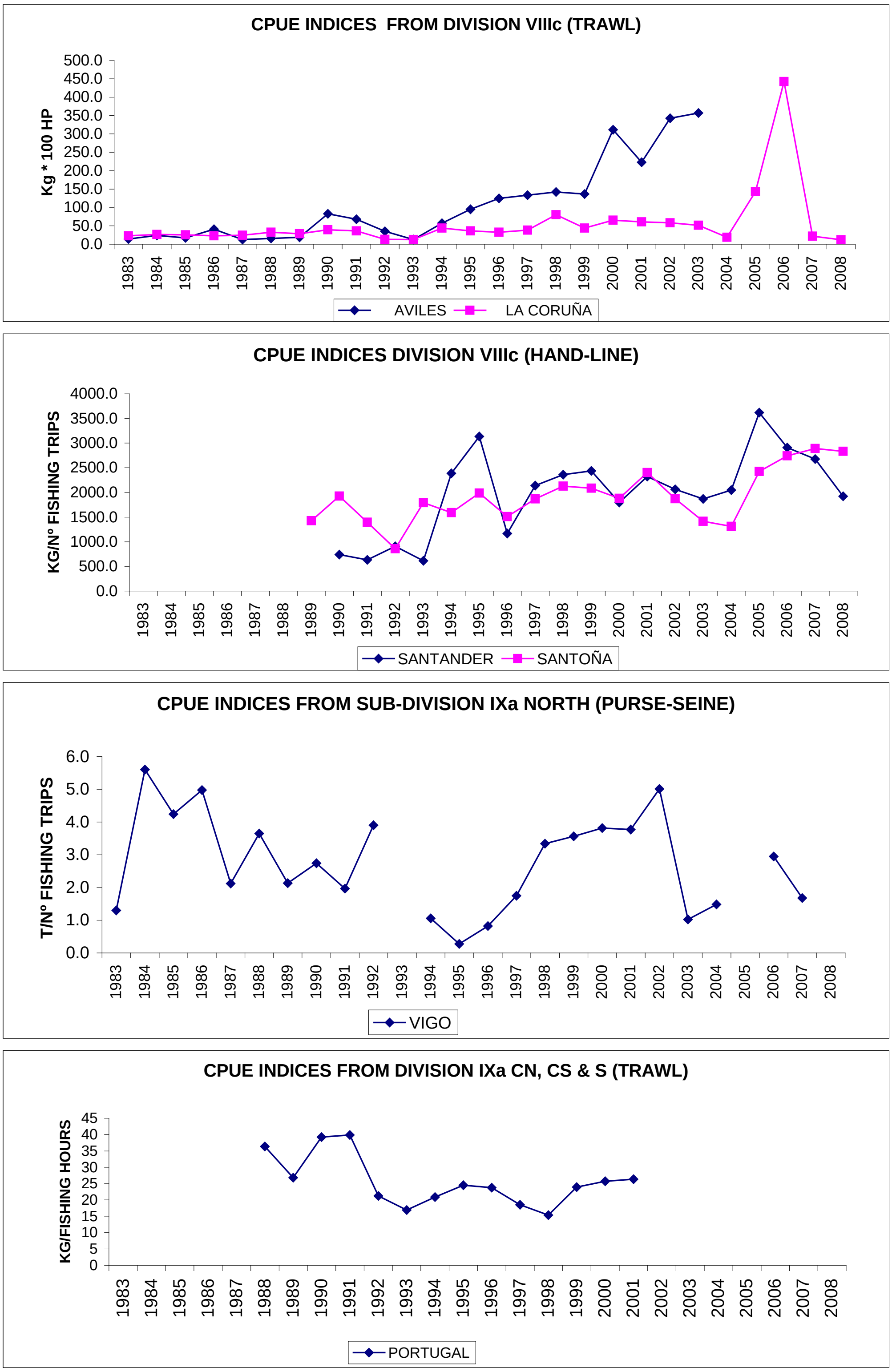


Figure 2.3.2.2. NEA mackerel (Southern component). CPUE indices by fleets and area

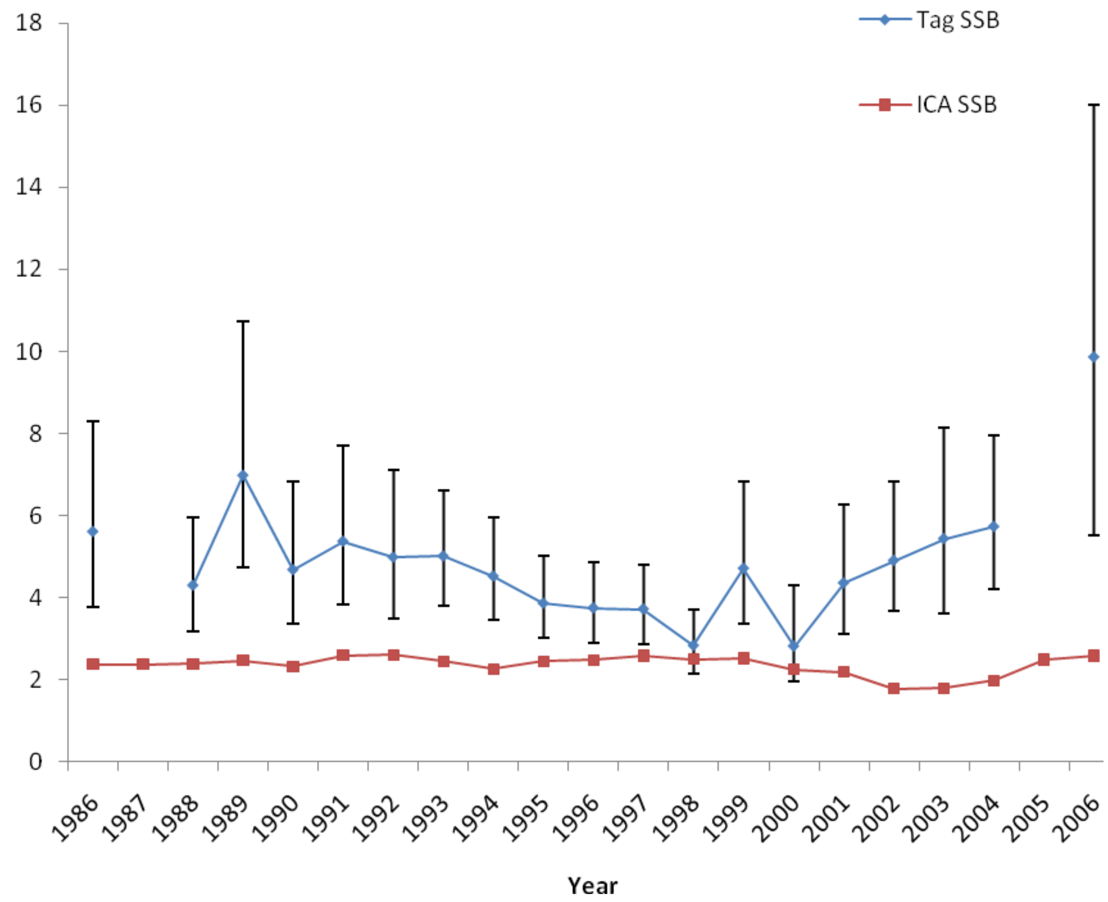


Figure. 2.3.7.1. Stock biomass estimated from the tagging data (ages 2-12) compared with the ICA spawning stock biomass estimate. A 40% tagging mortality is assumed and the tagged population biomass is shown as median values from bootstrap runs with 25th and 75th percentiles

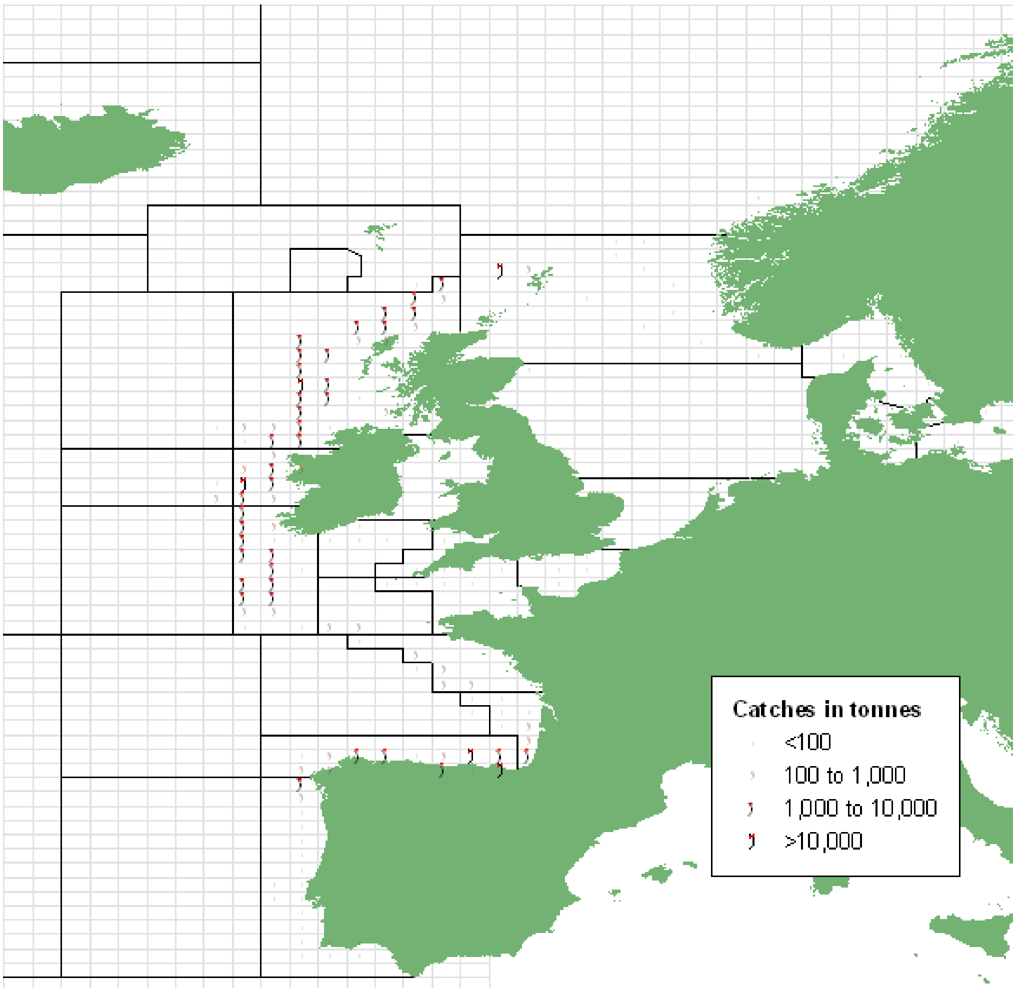


Figure 2.4.1.1 NEA Mackerel, commercial catches in quarter 1, 2008.

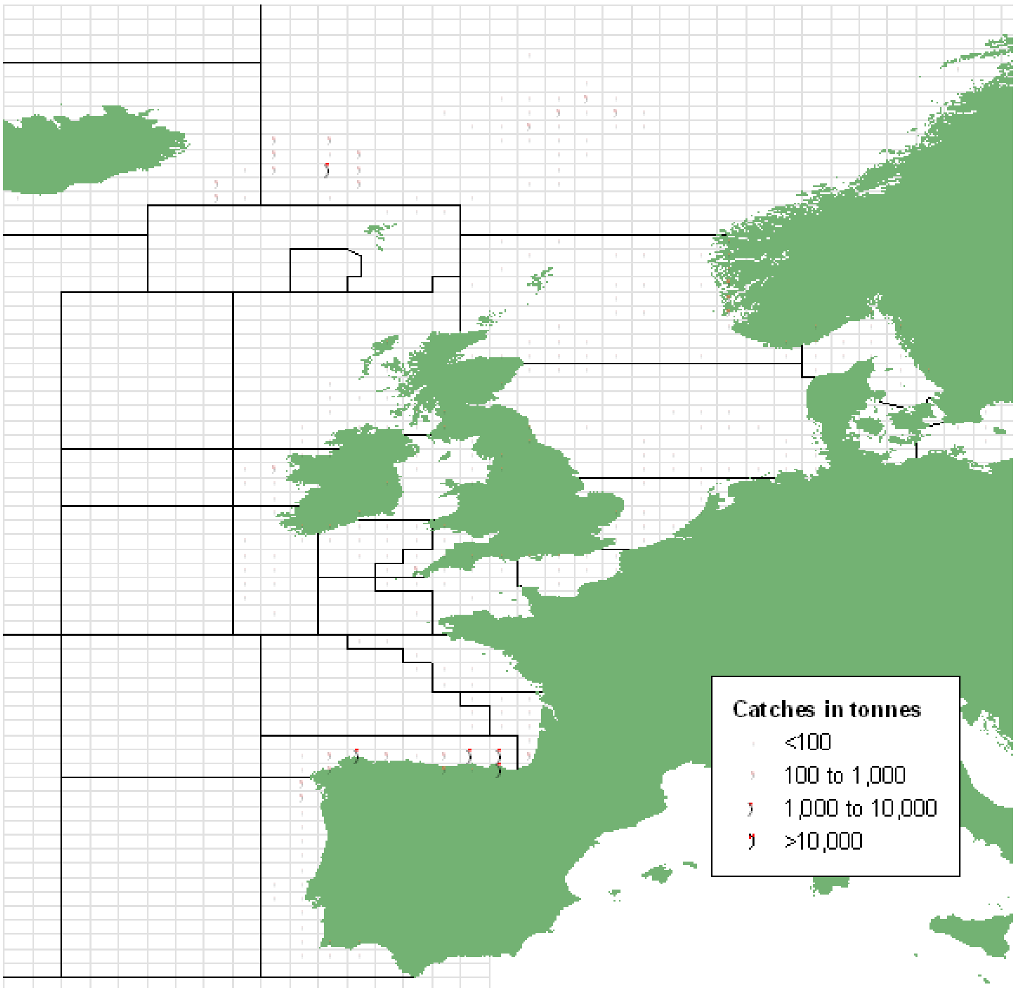


Figure 2.4.1.2 NEA Mackerel, commercial catches in quarter 2, 2008.

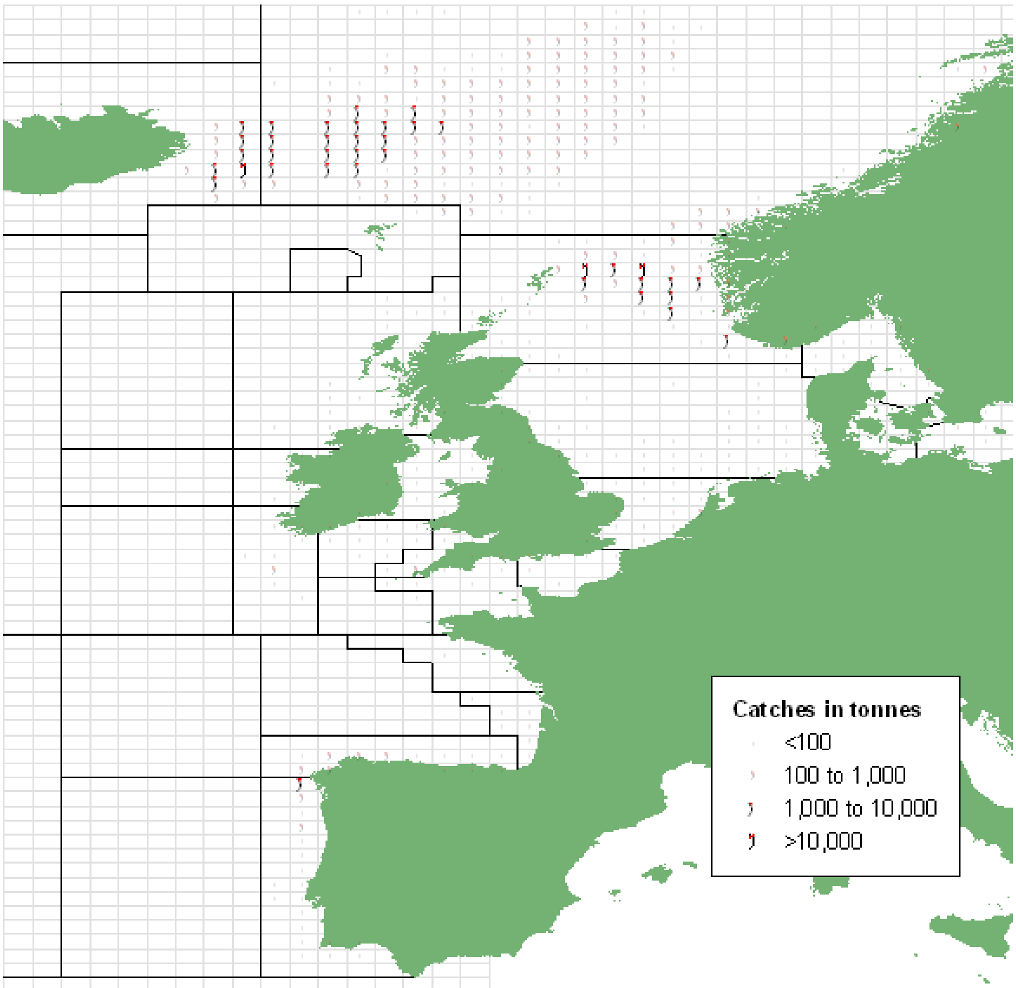


Figure 2.4.1.3 NEA Mackerel, commercial catches in quarter 3, 2008.

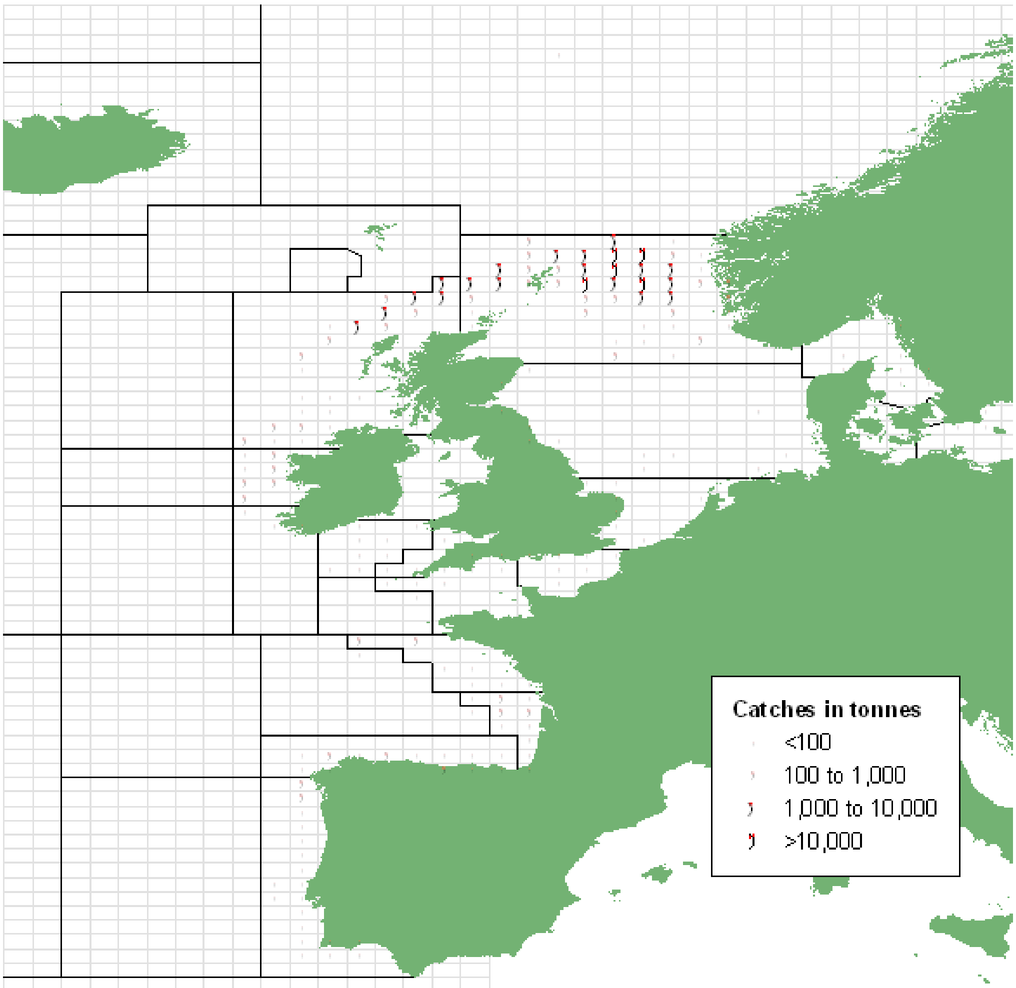


Figure 2.4.1.4 NEA Mackerel, commercial catches in quarter 4, 2008.

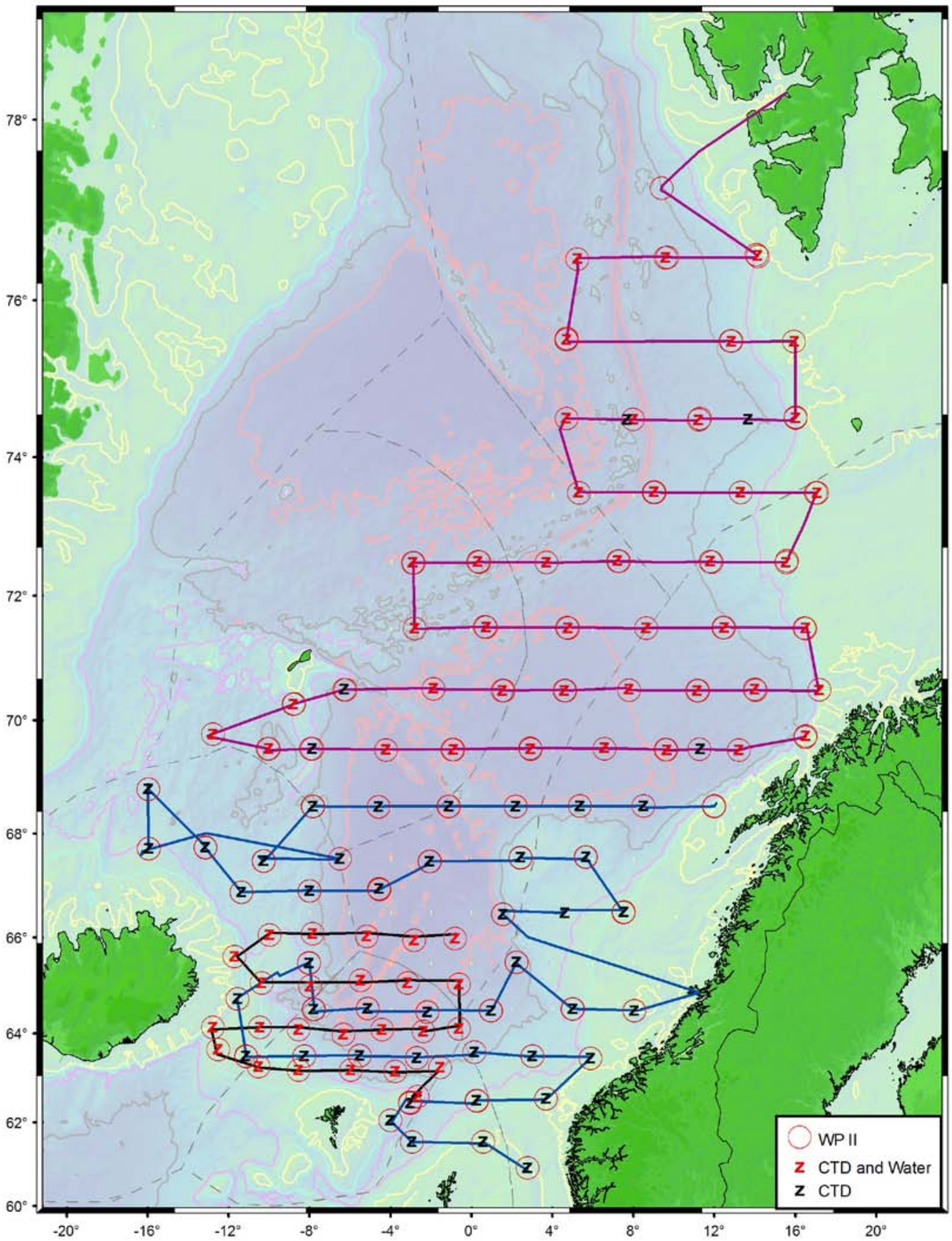


Figure 2.5.2.1.1. Survey lines along the cruise tracks with pre-defined CTD stations (0-500 m) and WP2 samples (0-200 m) for M/V"Libas", "Eros", and "Finnur Fríði", 15 July – 6 August 2009. This large ocean area included the following Economical Exclusive Zones (EEZ): Norwegian EEZ, United Kingdom EEZ, Faeroe Island EEZ, Iceland EEZ, Jan Mayen fishery protection zone, Spitzbergen protected area and International waters.

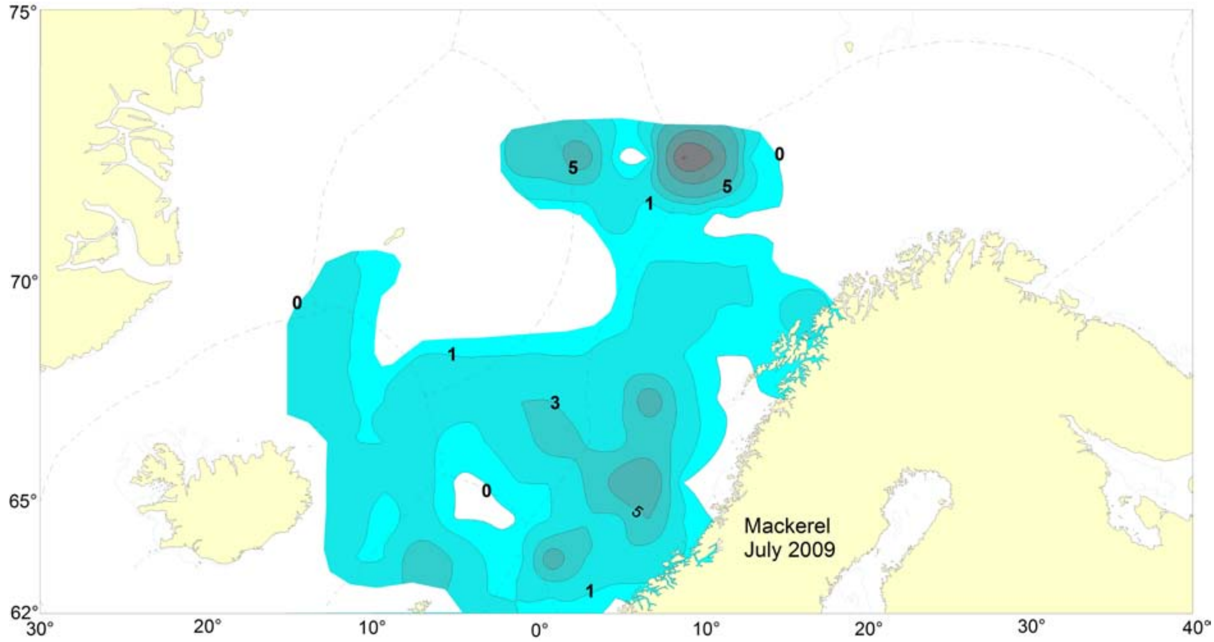


Figure 2.5.2.1.2. Sa or Nautical Area Scattering Coefficient (NASC) values of mackerel along the cruise track.

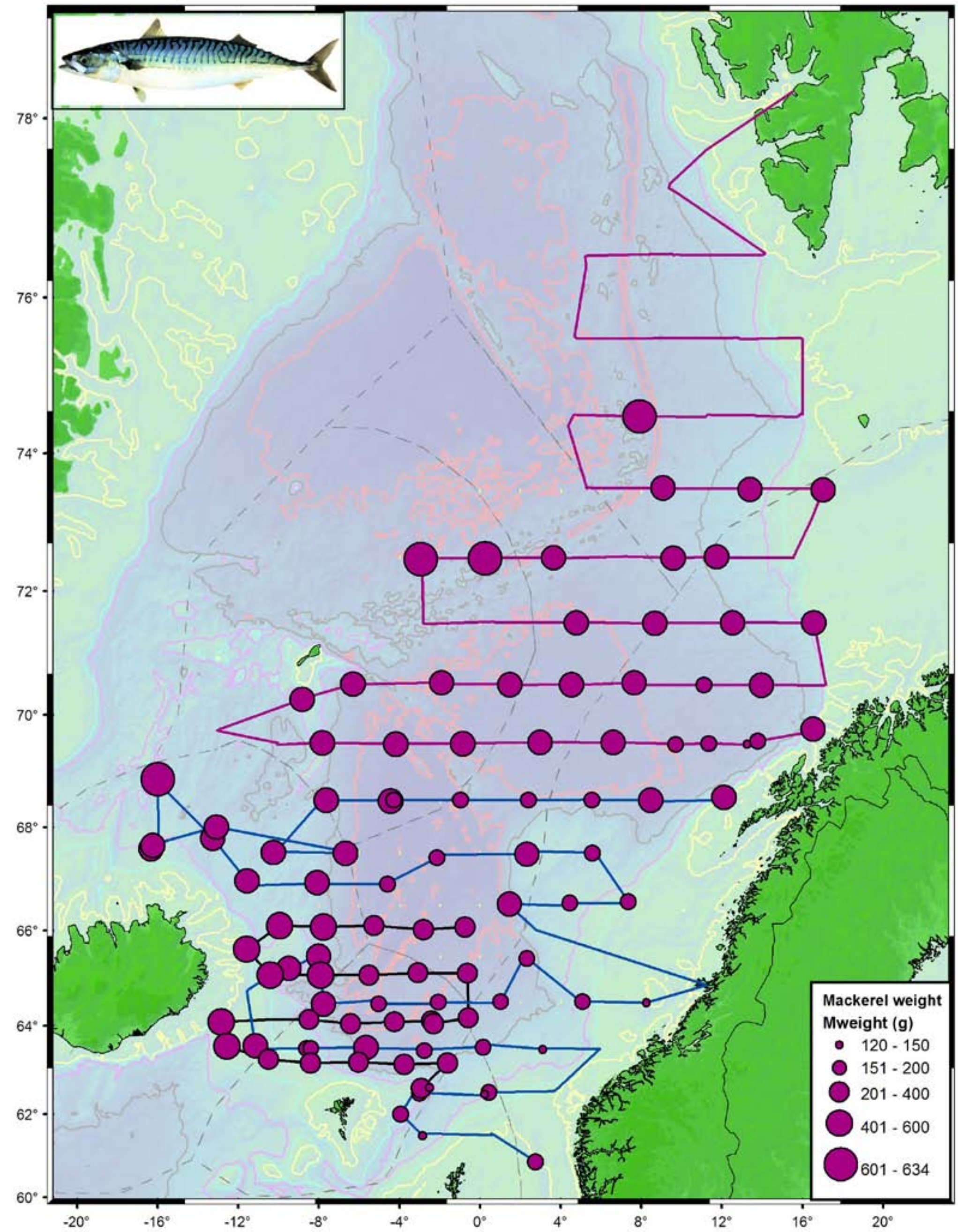


Figure 2.5.2.1.3. Mean mackerel weight (g) represented for each station within the categories shown. No catch of mackerel is indicated as a blank along the cruise track.

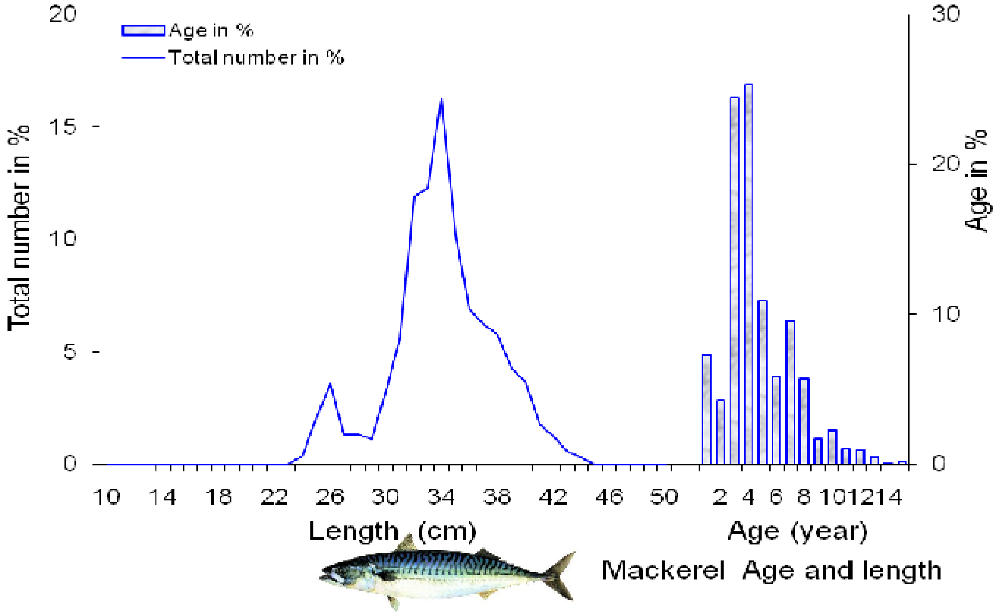


Figure 2.5.2.1.4. Age and length distribution in percent (%) of Atlantic mackerel in the Norwegian Sea

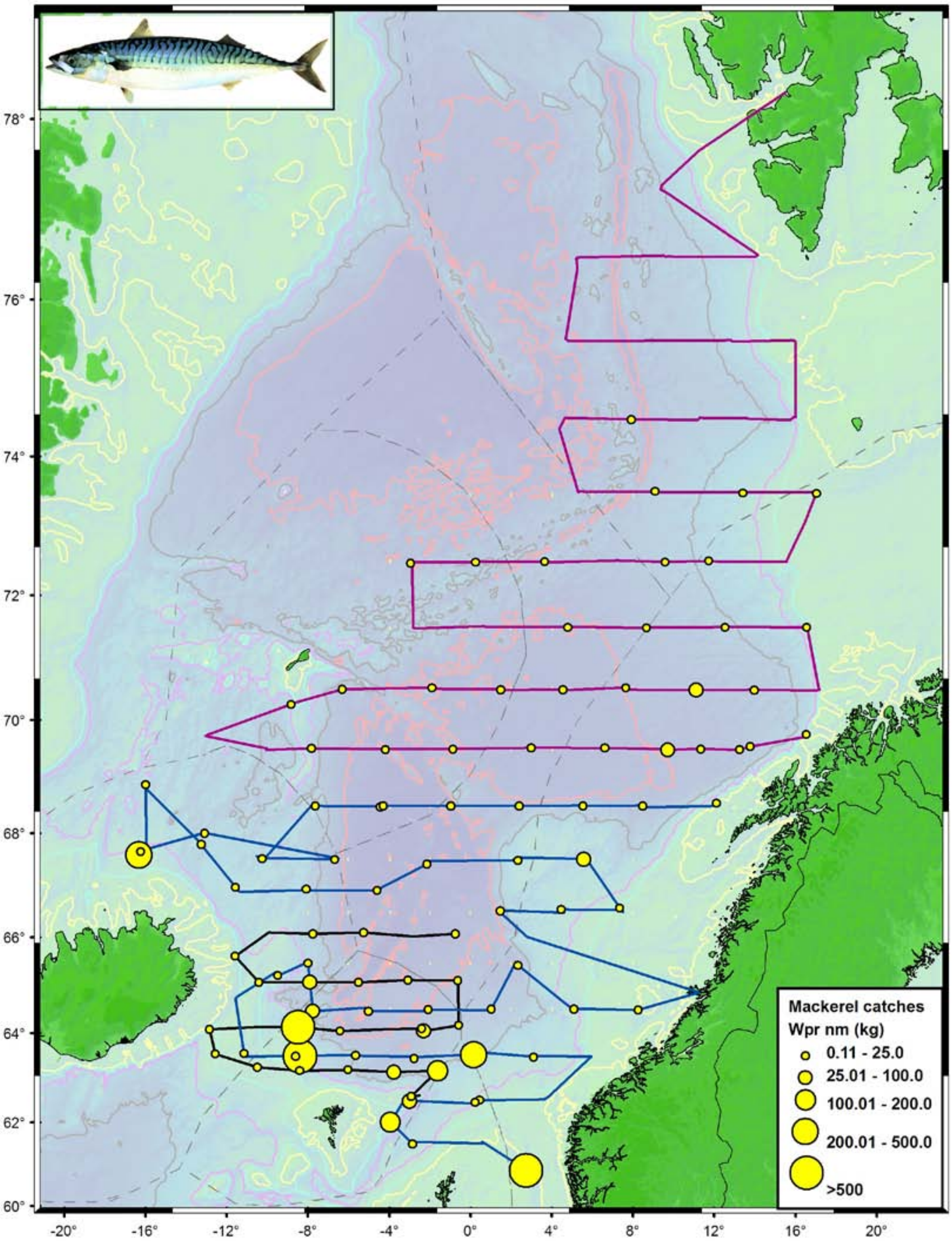


Figure 2.5.2.1.5 Mackerel catches (kg/nmi) using a small pelagic trawl with narrow opening from Libas , Eros and Finnur Fríði combined in the Norwegian Sea, 15 July- 6 August 2009.

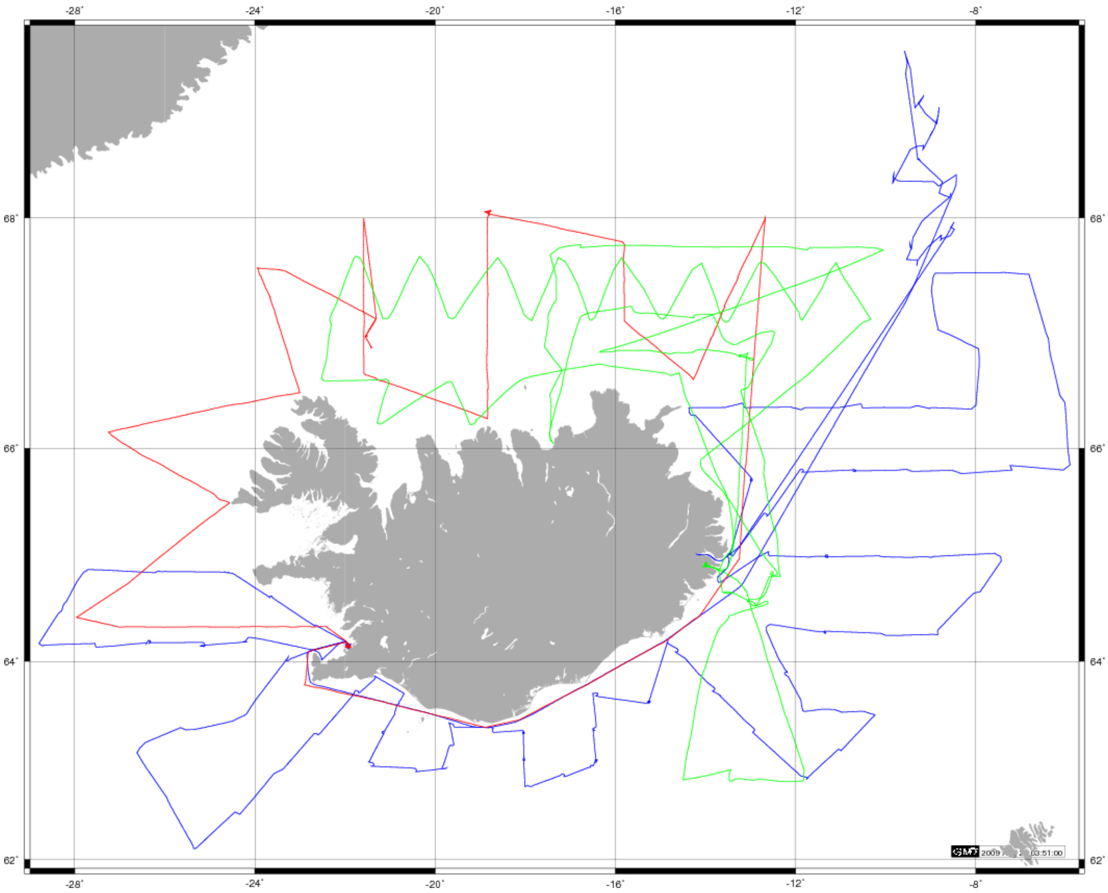


Figure 2.5.2.2.1. Cruise tracks of Icelandic vessels, 4-24 August 2009

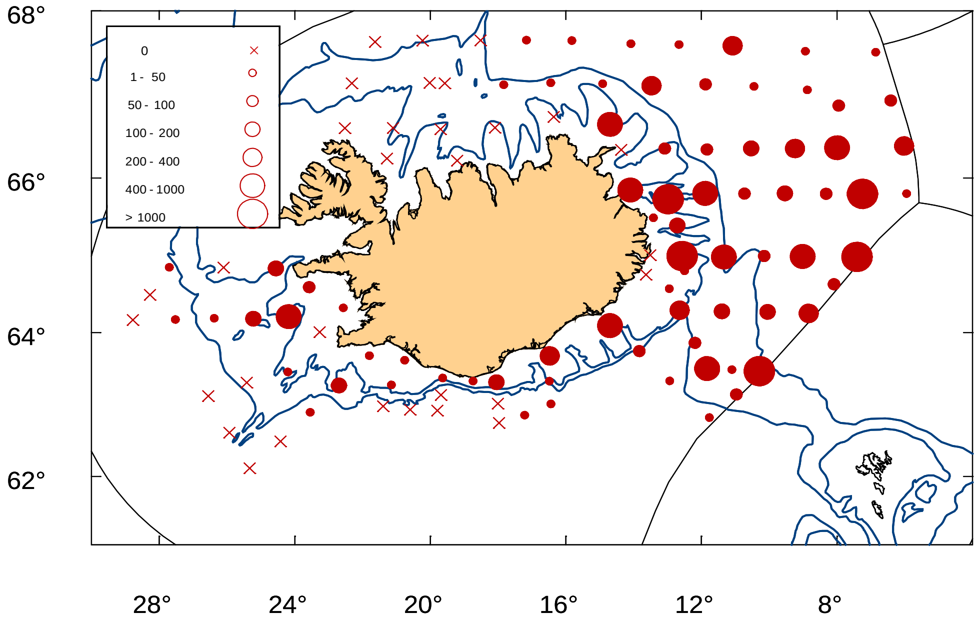


Figure 2.5.2.2.2. The catch (kg/hour) of mackerel in August 2009 on RV Arni Friðriksson and FV Hoffell. The data are not standardized according to trawl size.

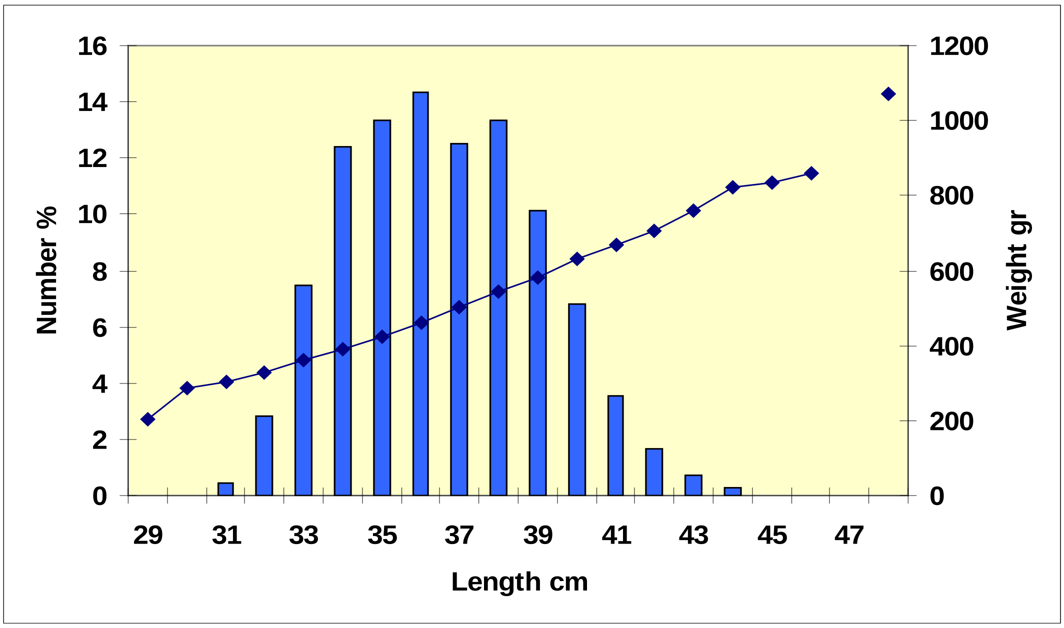


Figure 2.5.2.2.3. Total weight (g) and length (cm) distribution of mackerel

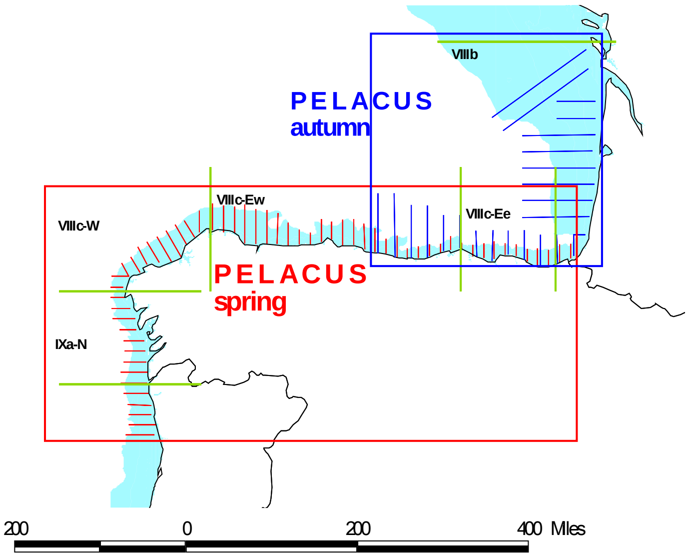


Figure 2.6.1. Sampling design of the acoustic surveys carred out by the IEO in the waters of Galicia and Cantabrian Sea in March-April (2001-2008) and in the southern Bay of Biscay in September-October (2006-2008). It identifies the tracks and the ICES areas, IXa North (IXa-N), VIIIc West (VIIIc-W), VIIIc East (VIIIc-VIIIc-Ew and Ee) and VIIIb.

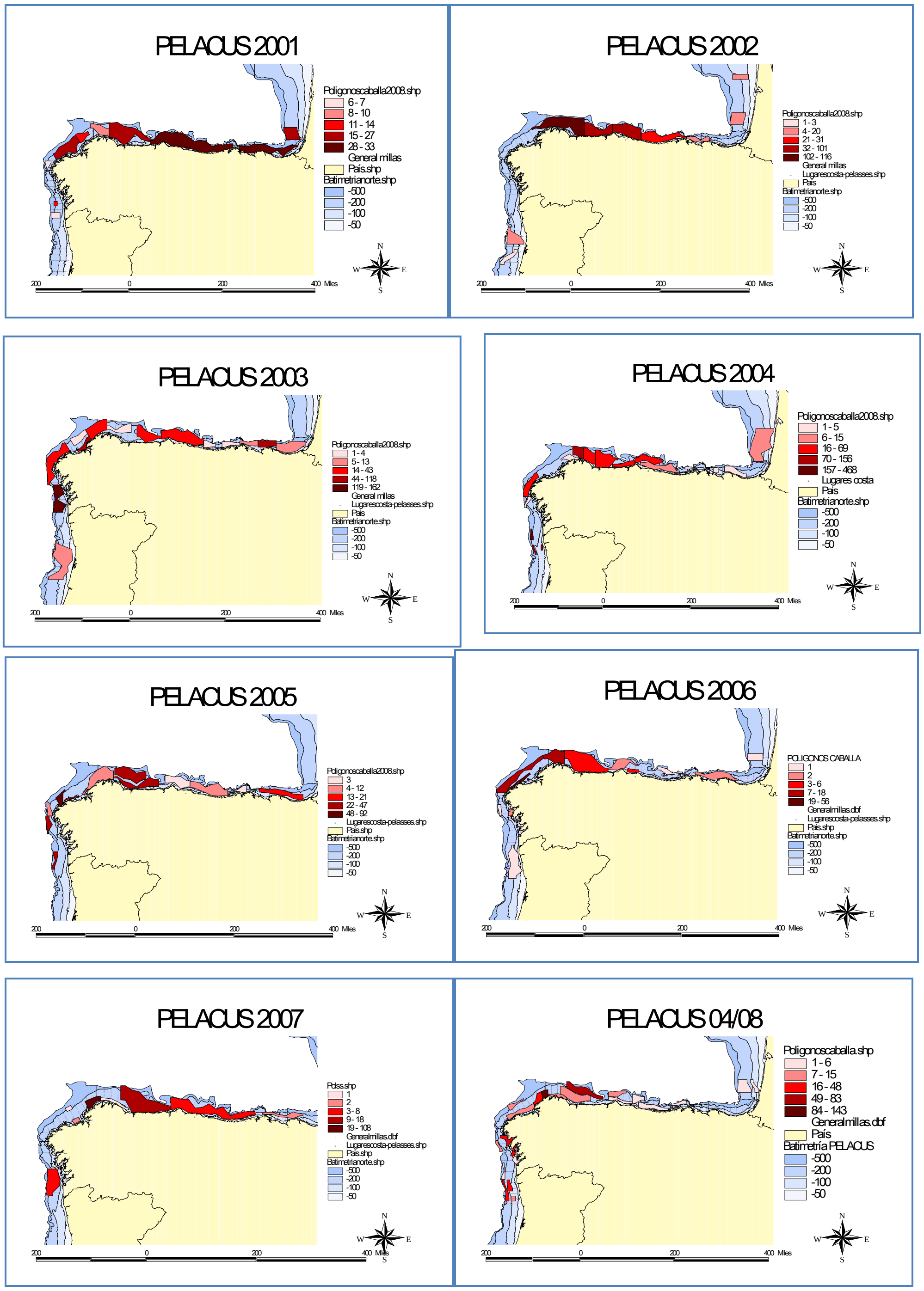


Figure 2.6.2a. Mackerel distribution from Spanish acoustic surveys in spring (PELACUS 04) 2001-2008. Survey polygons are drawn to encompass the observed echoes, and polygon colour indicates the average of values of integrated energy in m²/mn²(sA, NASC) within each polygon.

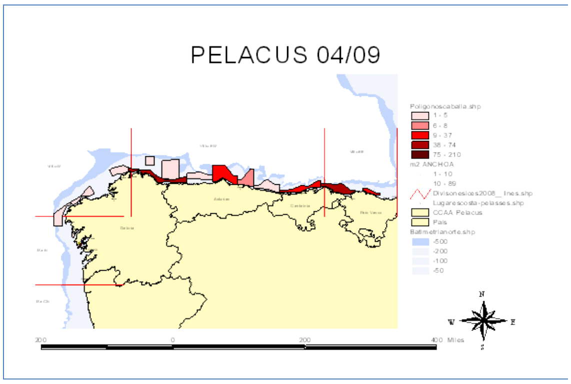
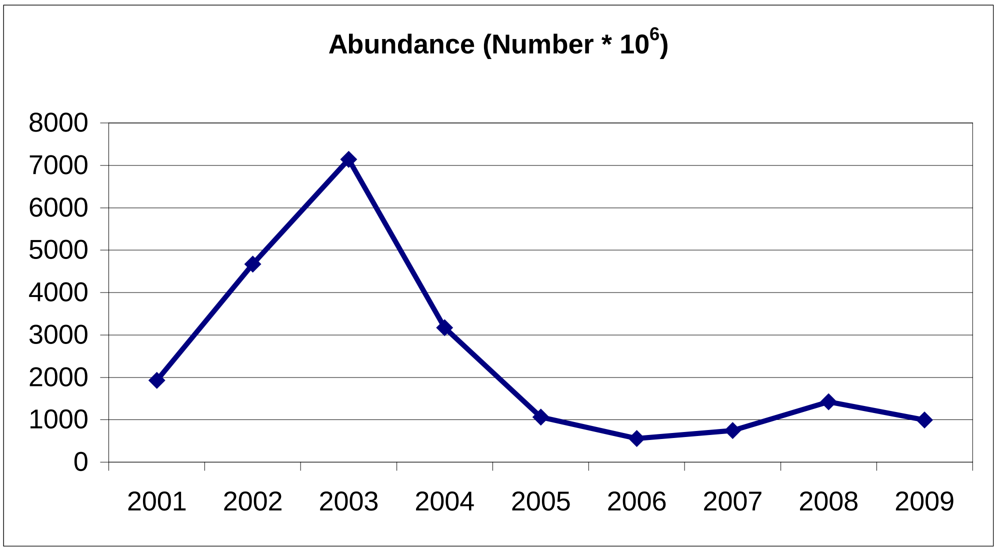


Figure 2.6.2b. Mackerel distribution from Spanish acoustic surveys in spring (PELACUS 04) 2009. Survey polygons are drawn to encompass the observed echoes, and polygon colour indicates the average of values of integrated energy in m²/mn²(sA, NASC) within each polygon.



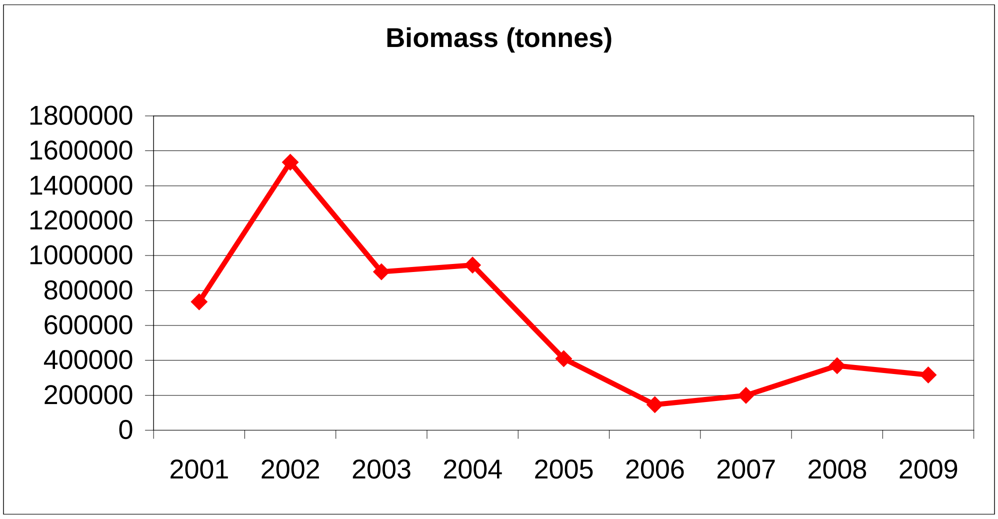


Figure 2.6.3. Spring Spanish acoustic surveys from 2001 to 2009. Mackerel abundance in number of individuals (millions) and Biomass in tons.

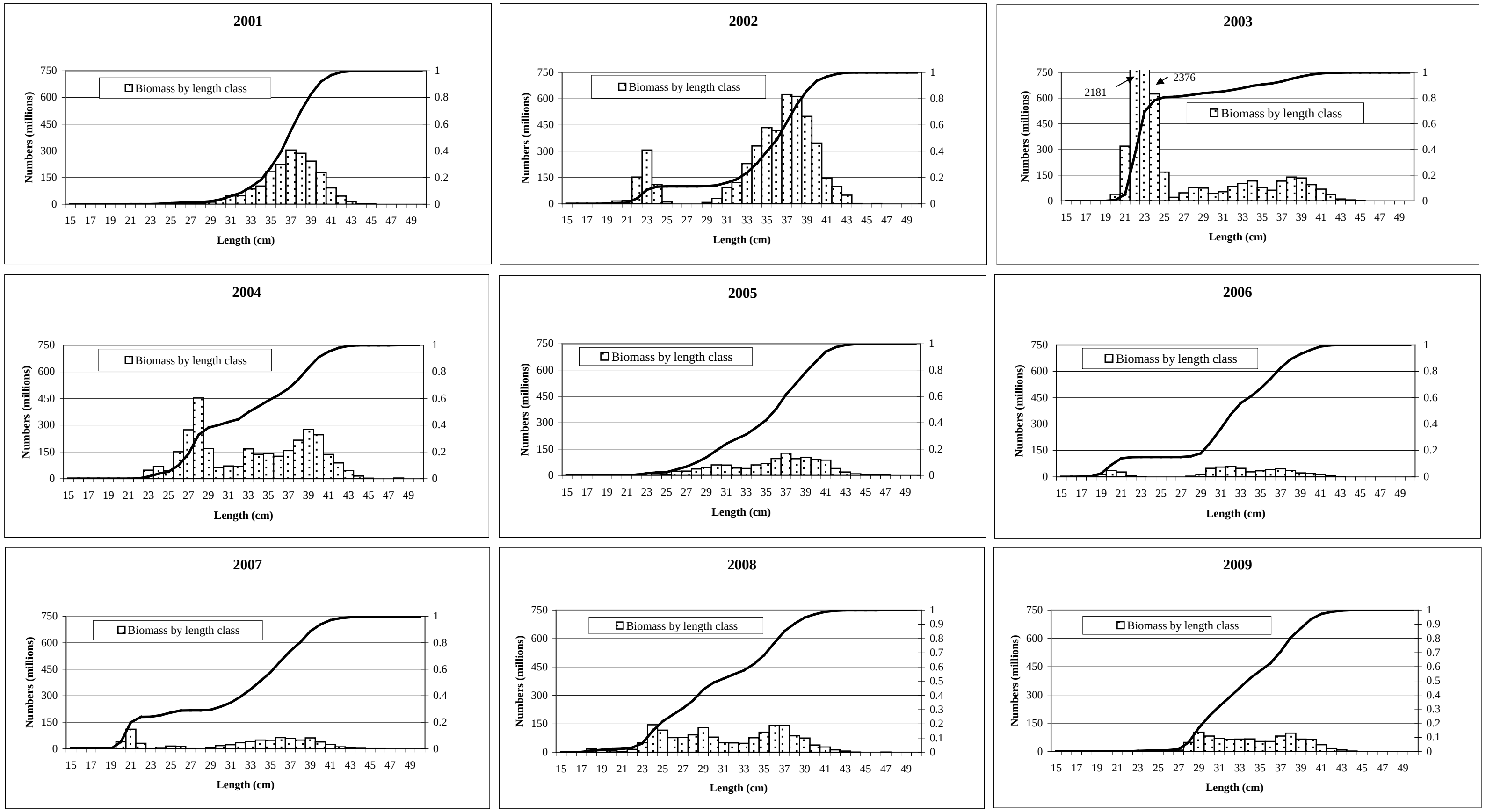


Figure 2.6.4. Mackerel length distribution for the spring Spanish acoustic survey from 2001 to 2009 in Subdivision IXa North and Division VIIIc (Spanish waters). The line denotes the cumulative frequency.

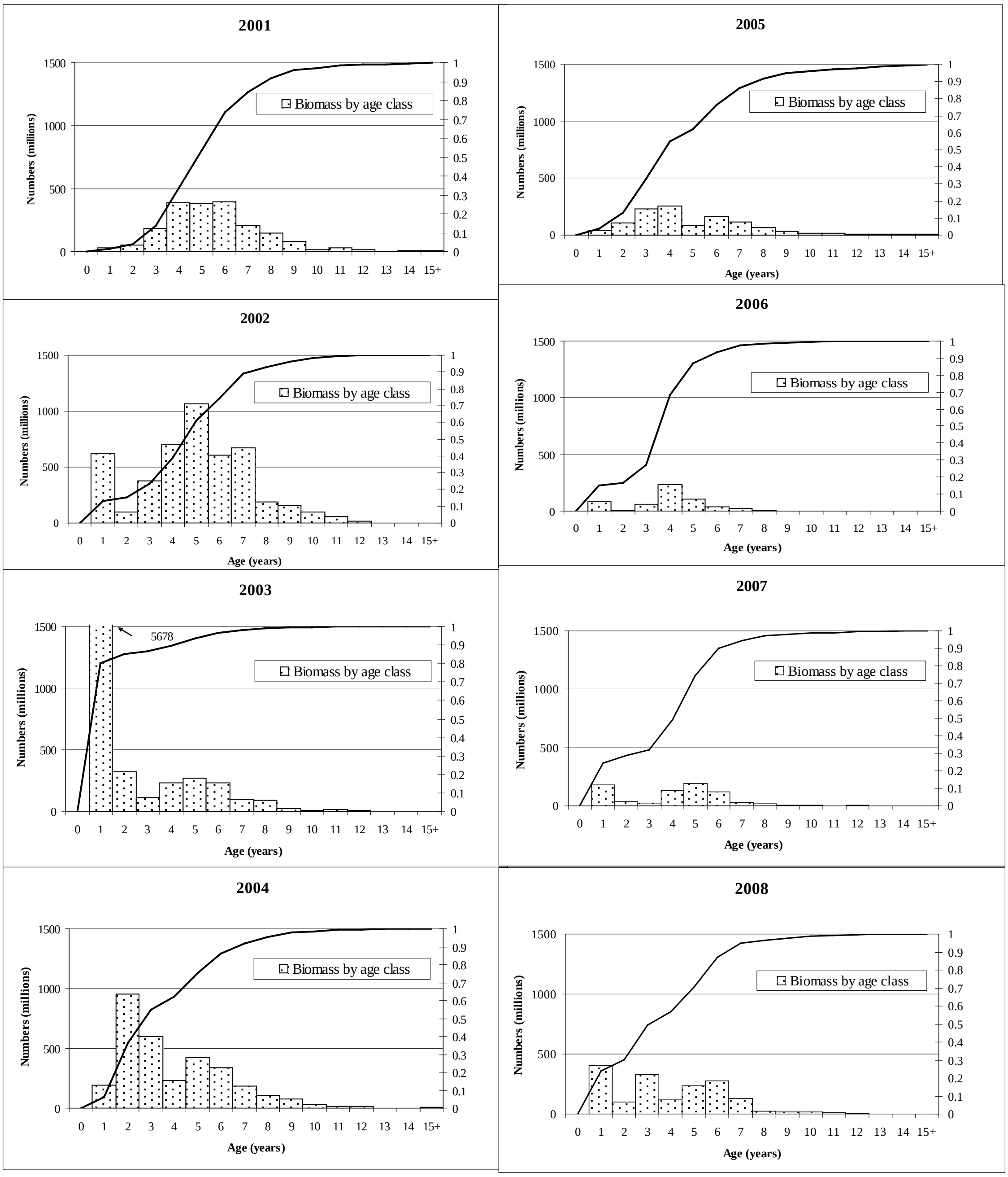


Figure 2.6.5. Mackerel age distribution for the spring Spanish acoustic survey from 2001 to 2008 in Subdivision IXa North and Division VIIIc (Spanish waters). The line denotes the cumulative frequency.

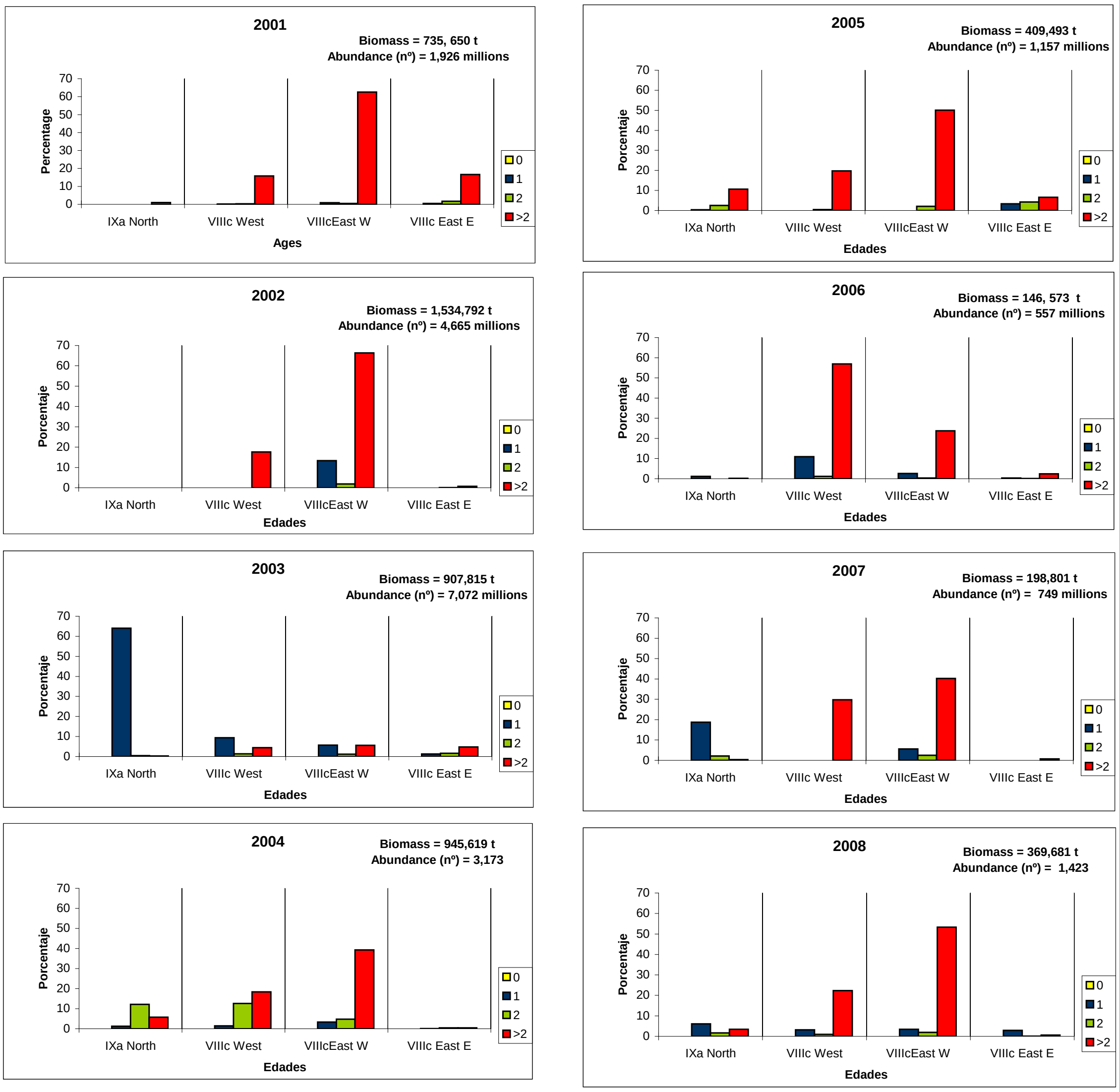


Figure 2.6.6. Abundance of mackerel (in percentage) by age group and ICES Subdivision from the acoustic surveys (2001-2008). For each year shows the abundance (number) and biomass (t) for the whole Spanish area.

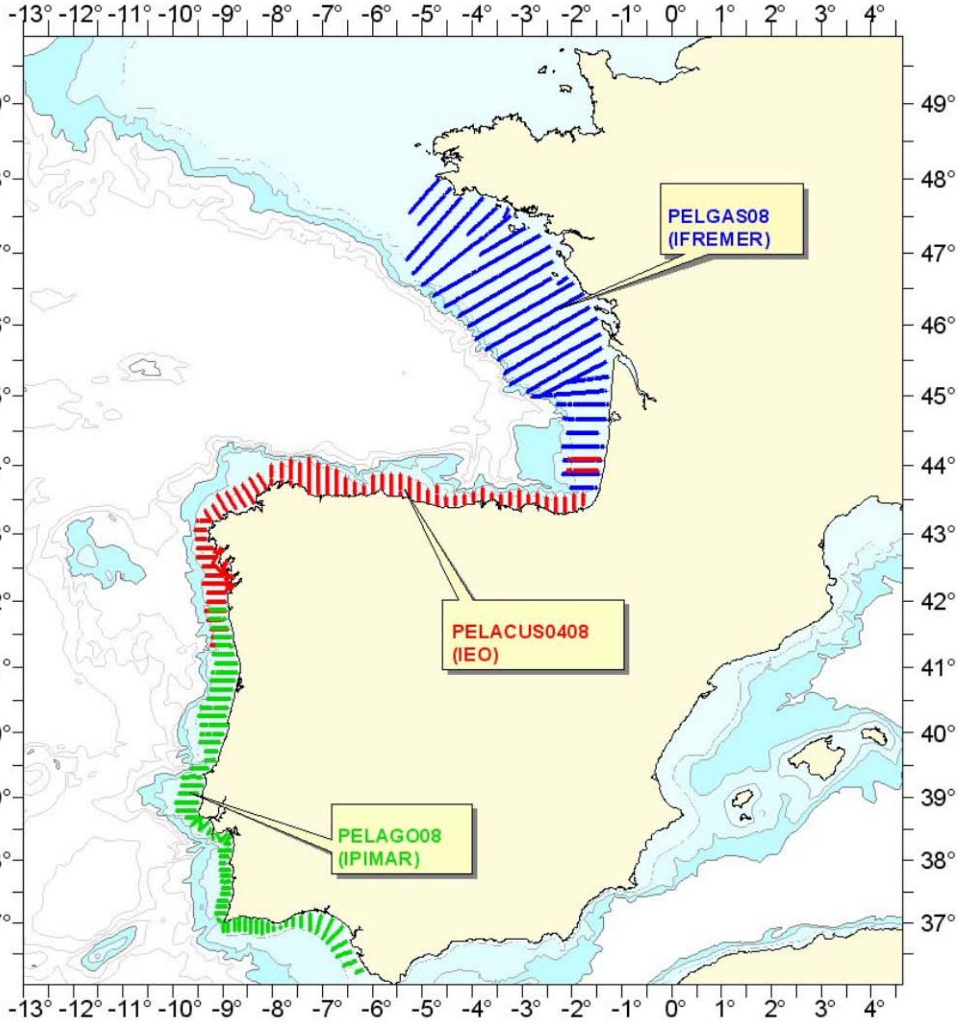


Figure 2.6.7. Tracks surveyed by PELAGO (Portuguese acoustic survey), PELACUS (Spanish acoustic survey) and PELGAS (French acoustic survey) during spring 2008.

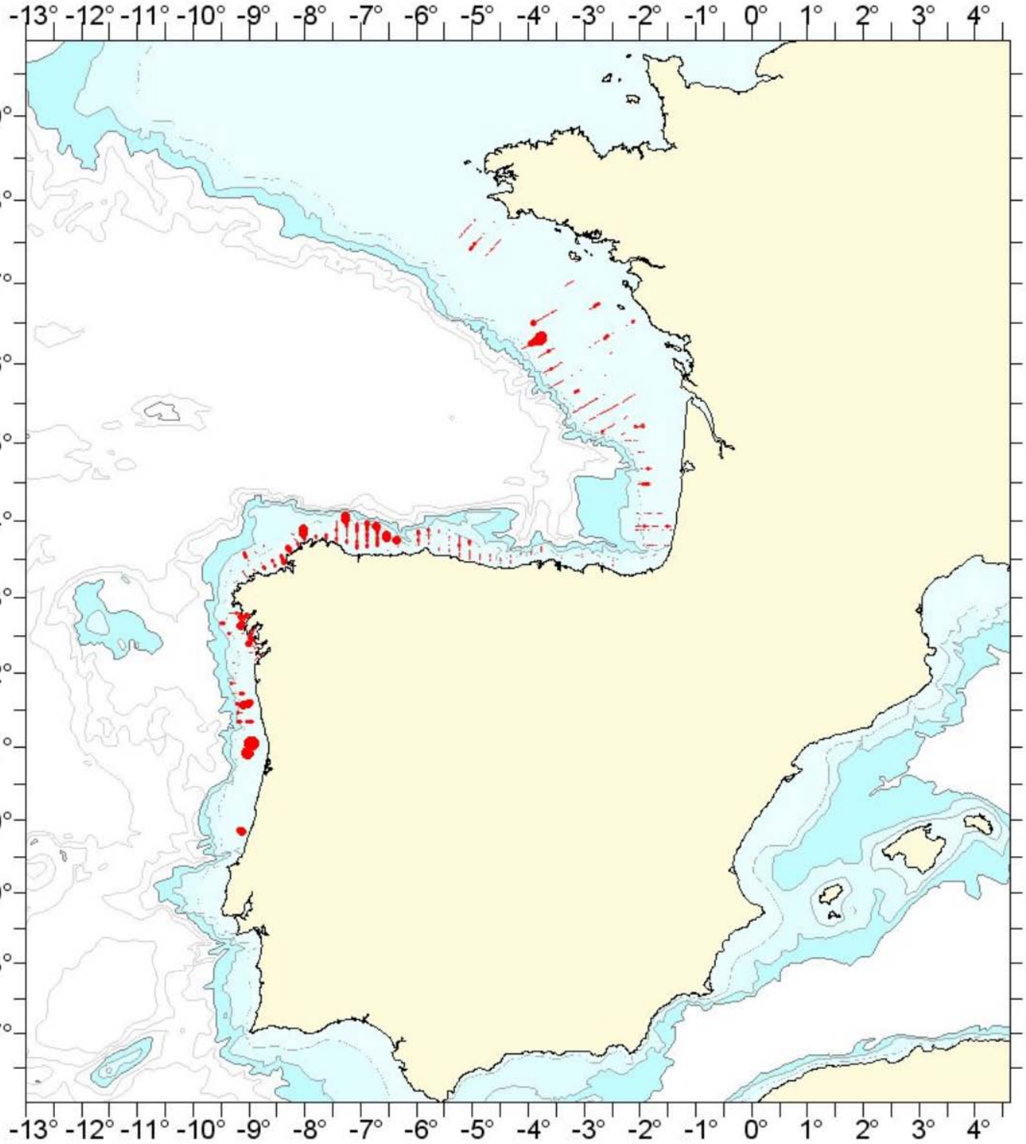


Figure 2.6.8. Acoustic energies (sA in m²/nm²) per EDSU attributed to mackerel (*Scomber scombrus*).

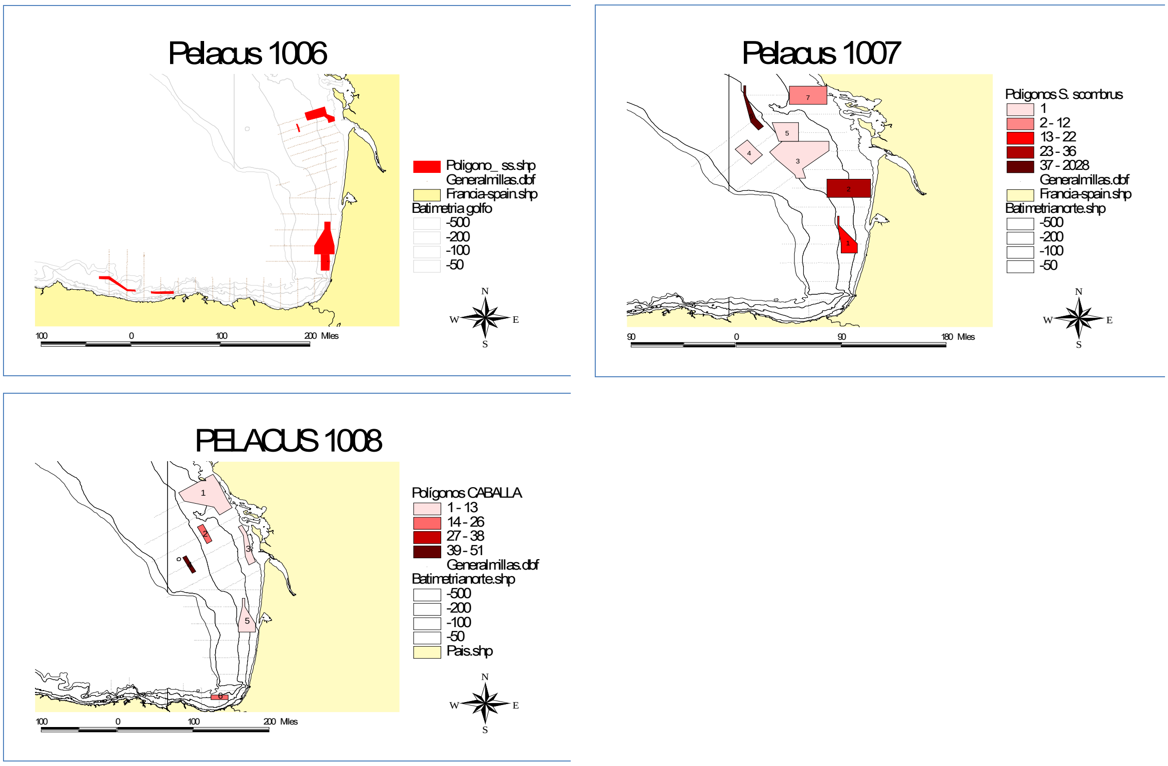


Figure 2.6.9. Mackerel distribution from Spanish acoustic surveys in autumn (PELACUS 10) 2006-2008. Survey polygons are drawn to encompass the observed echoes, and polygon colour indicates the average of values of integrated energy in m²/mn² (sA, NASC) within each polygon.

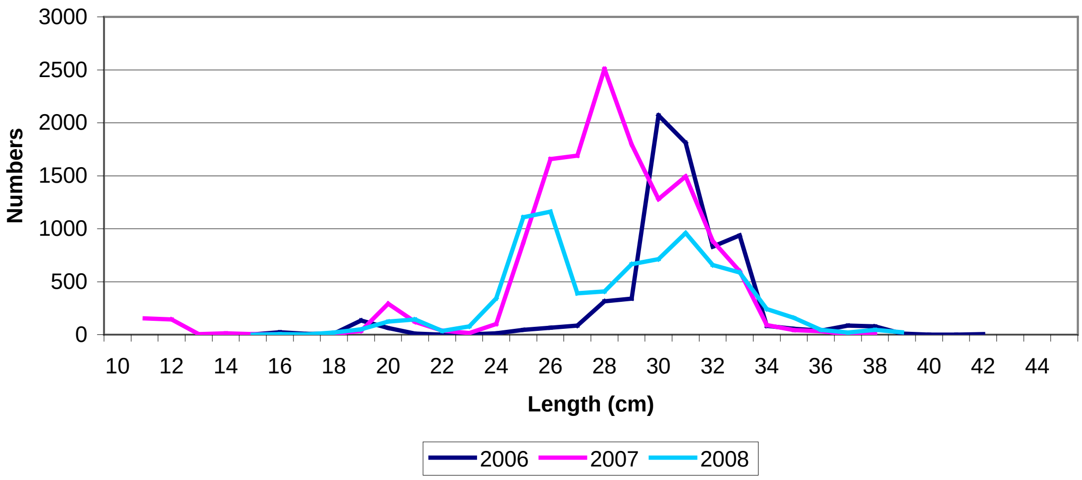


Figure 2.6.10. Mackerel length frequency distribution from the fishing trawls carried out during Spanish acoustic surveys in autumn (PELACUS 10), 2006-2008.

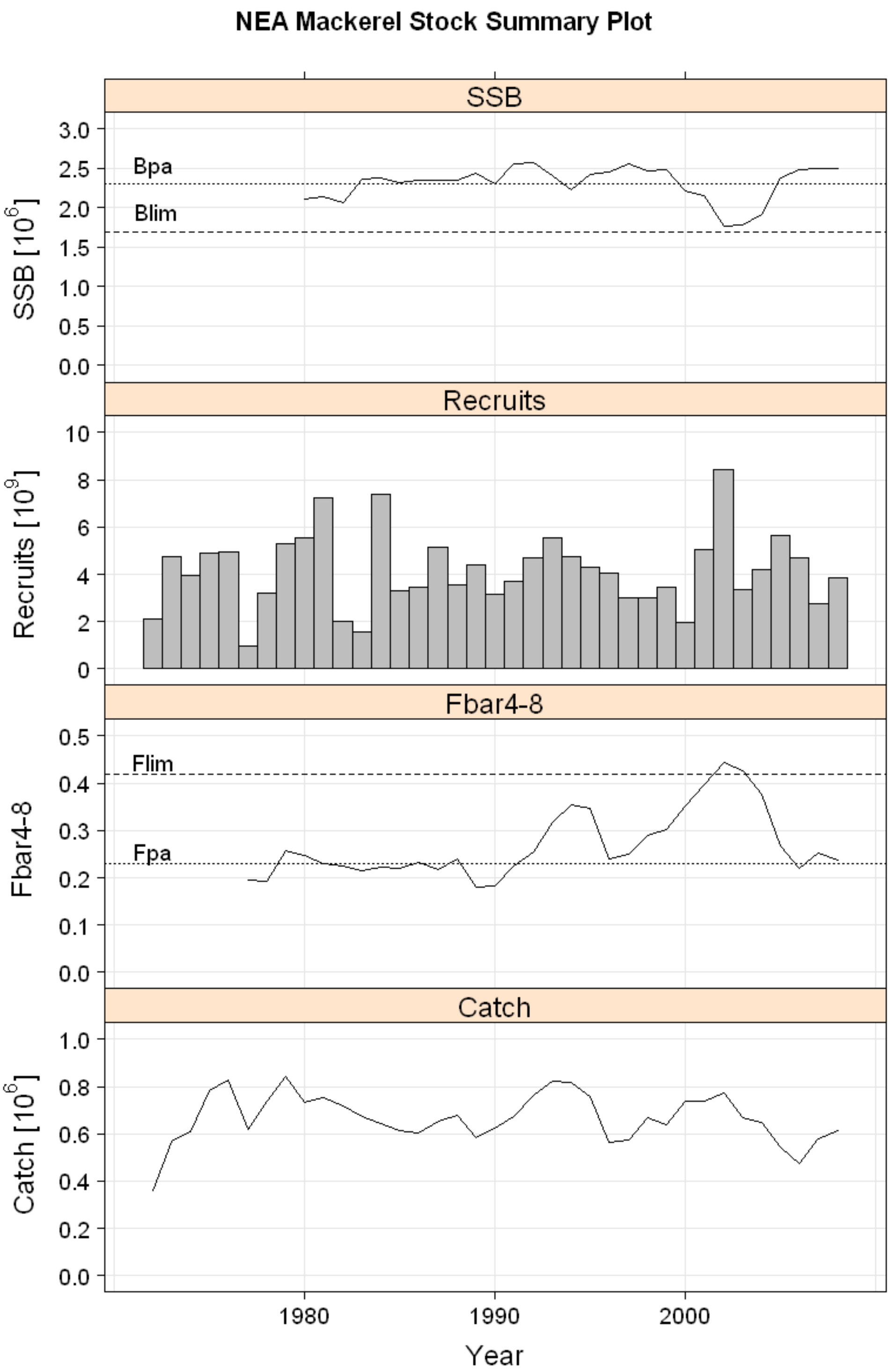


Figure 2.8.1 NE Atlantic Mackerel stock summary (spawning stock biomass, 1980 to 2008, recruitment from 1972-2008, catches from 1972 to 2008 and Fbar4-8 from 1977 to 2008.

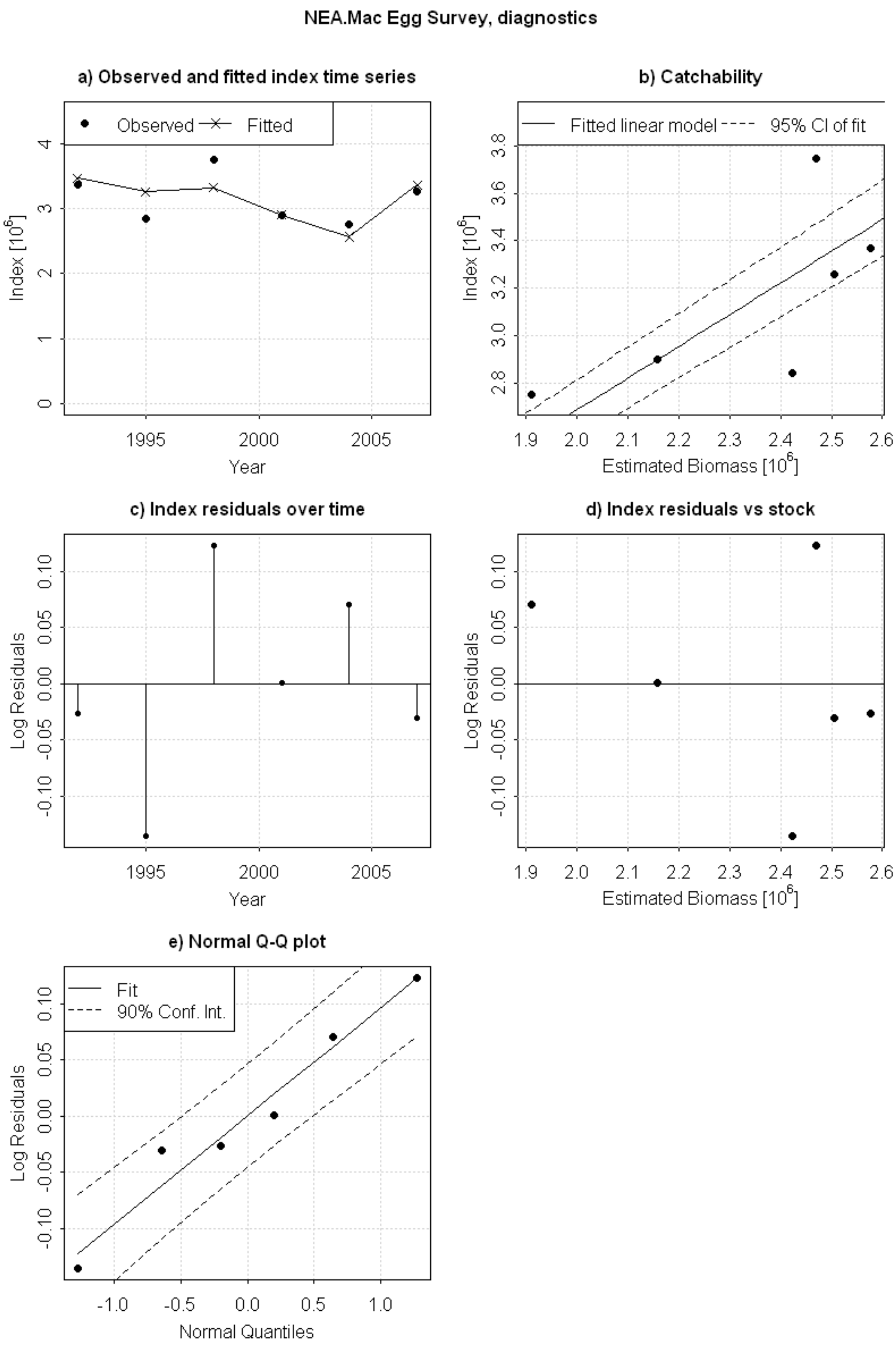


Figure 2.8.2. NE Atlantic mackerel final assessment FLICA diagnostics for fit to mackerel egg survey.

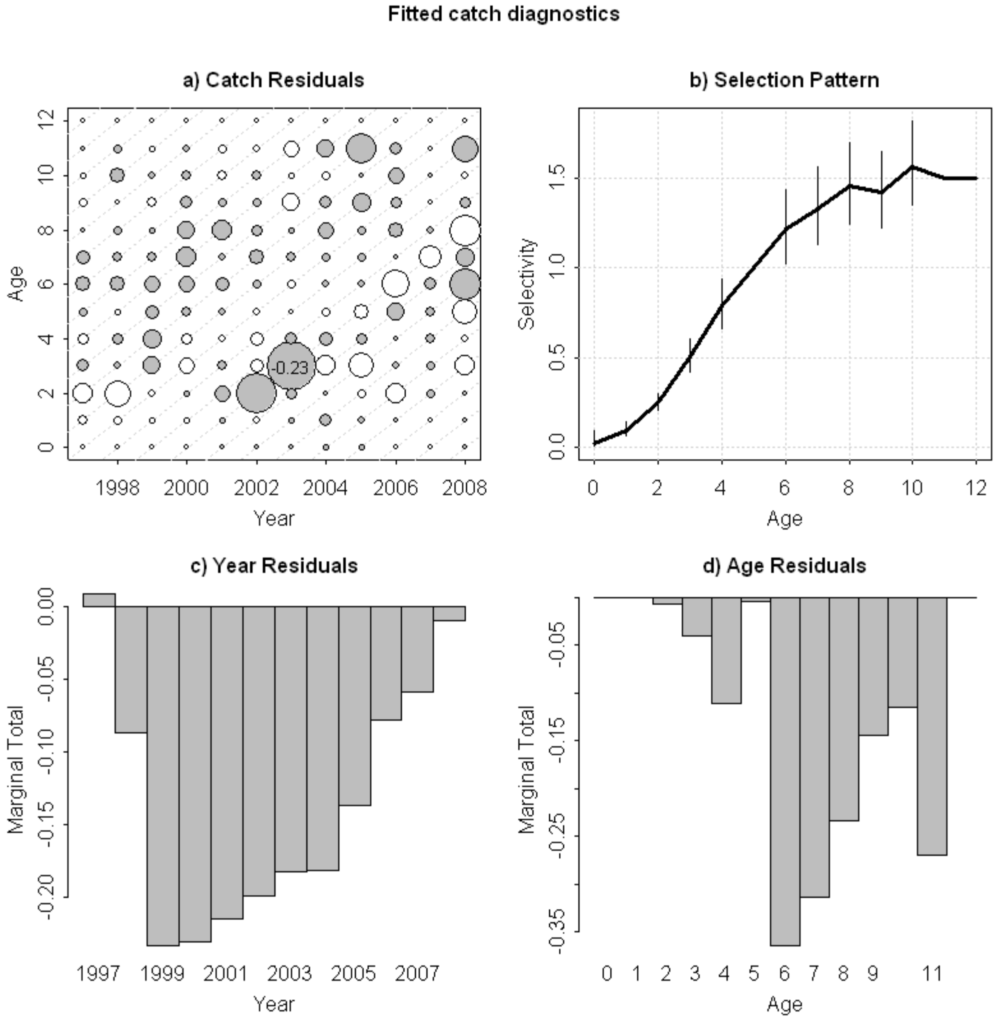


Figure 2.8.3. NE Atlantic mackerel final assessment FLICA diagnostics for fit of catch to the separable period, a) log residuals by year (age, 0 and 1 down weighted). b) fitted selection pattern, sum of the residuals c) by year, d) by age.

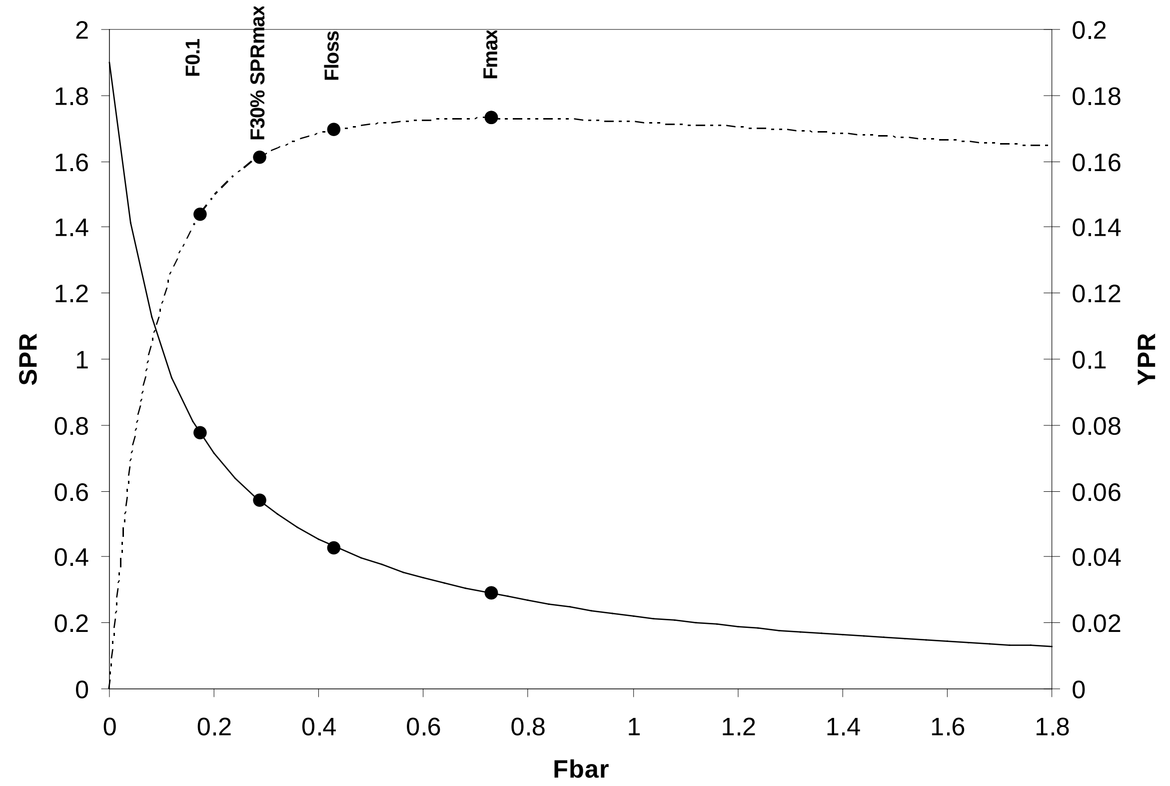


Figure 2.8.4. NEA mackerel. Spawner biomass per recruit and yield per recruit analysis

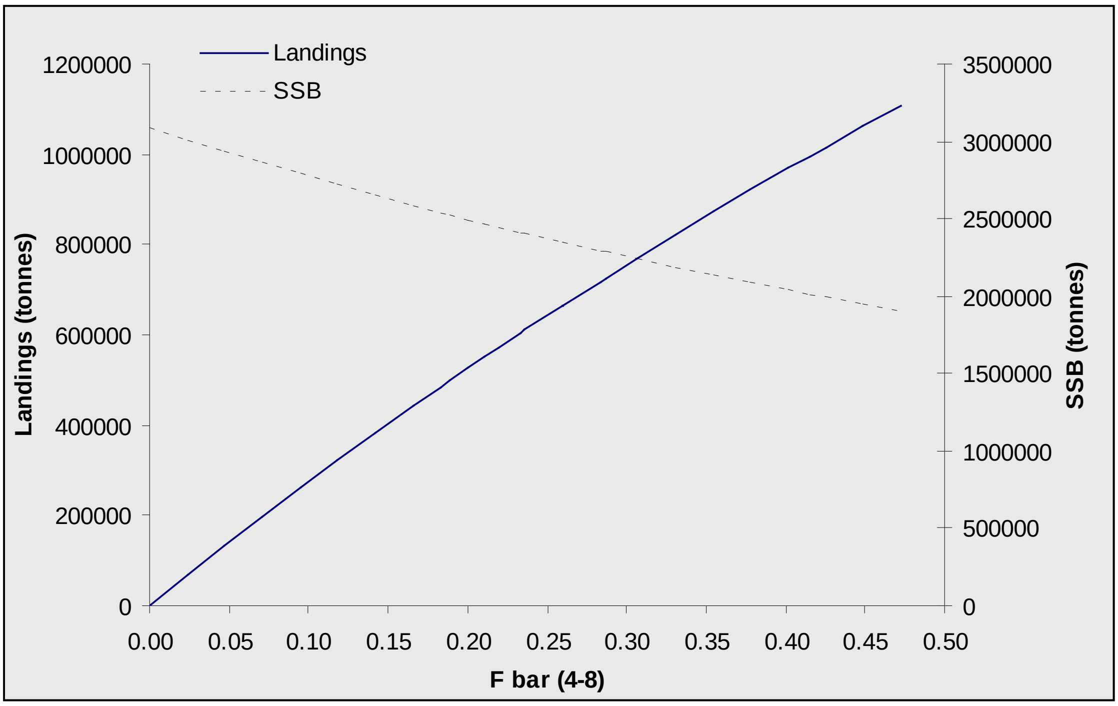


Figure 2.9.1. NEA mackerel short term forecast. Output produced using MFDP.

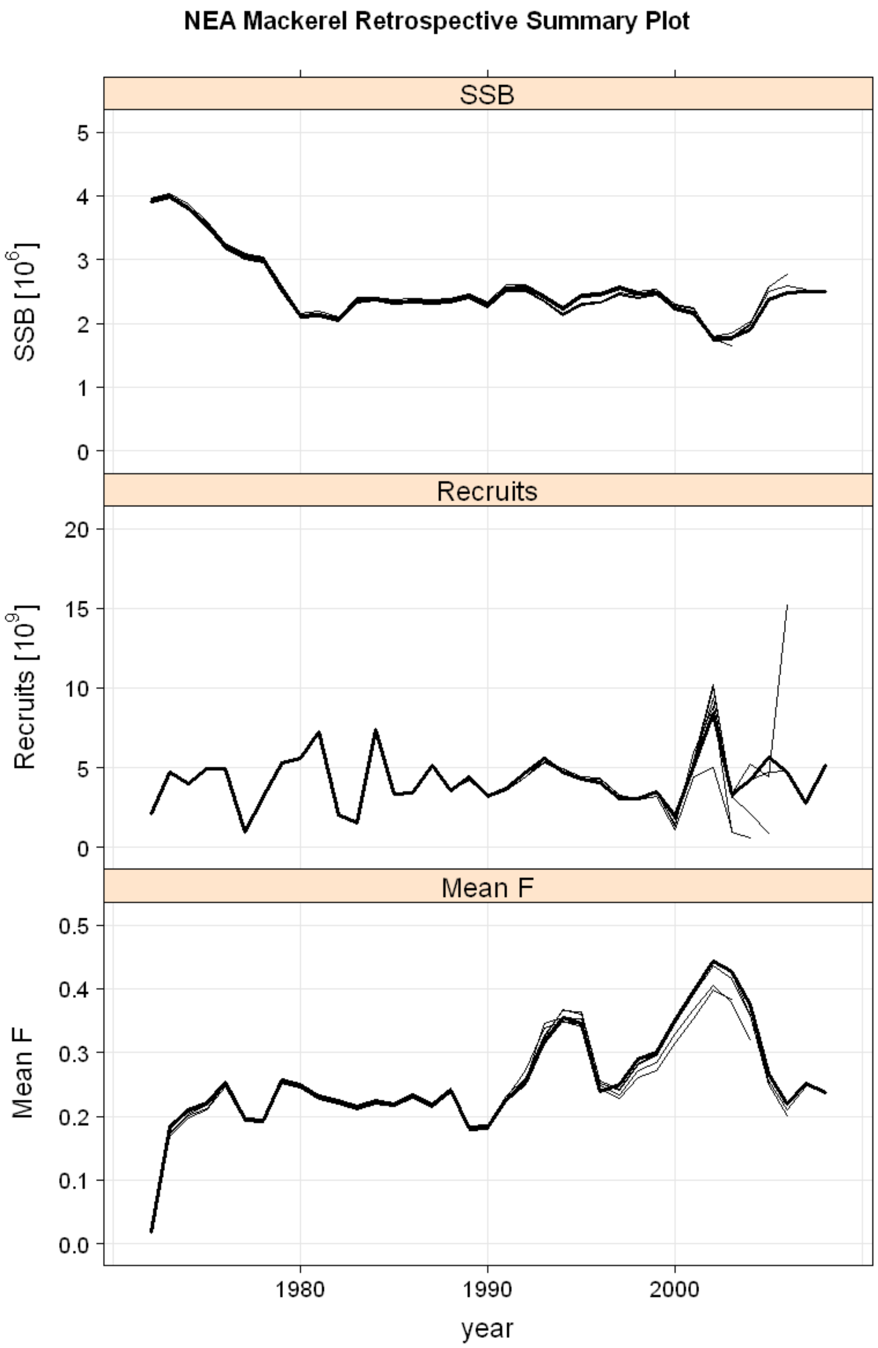


Figure 2.10.1 NE Atlantic mackerel final ICA assessment analytical retrospective of Spawning Stock Biomass (SSB), recruitment age 0 and mean F ages 4 – 8.

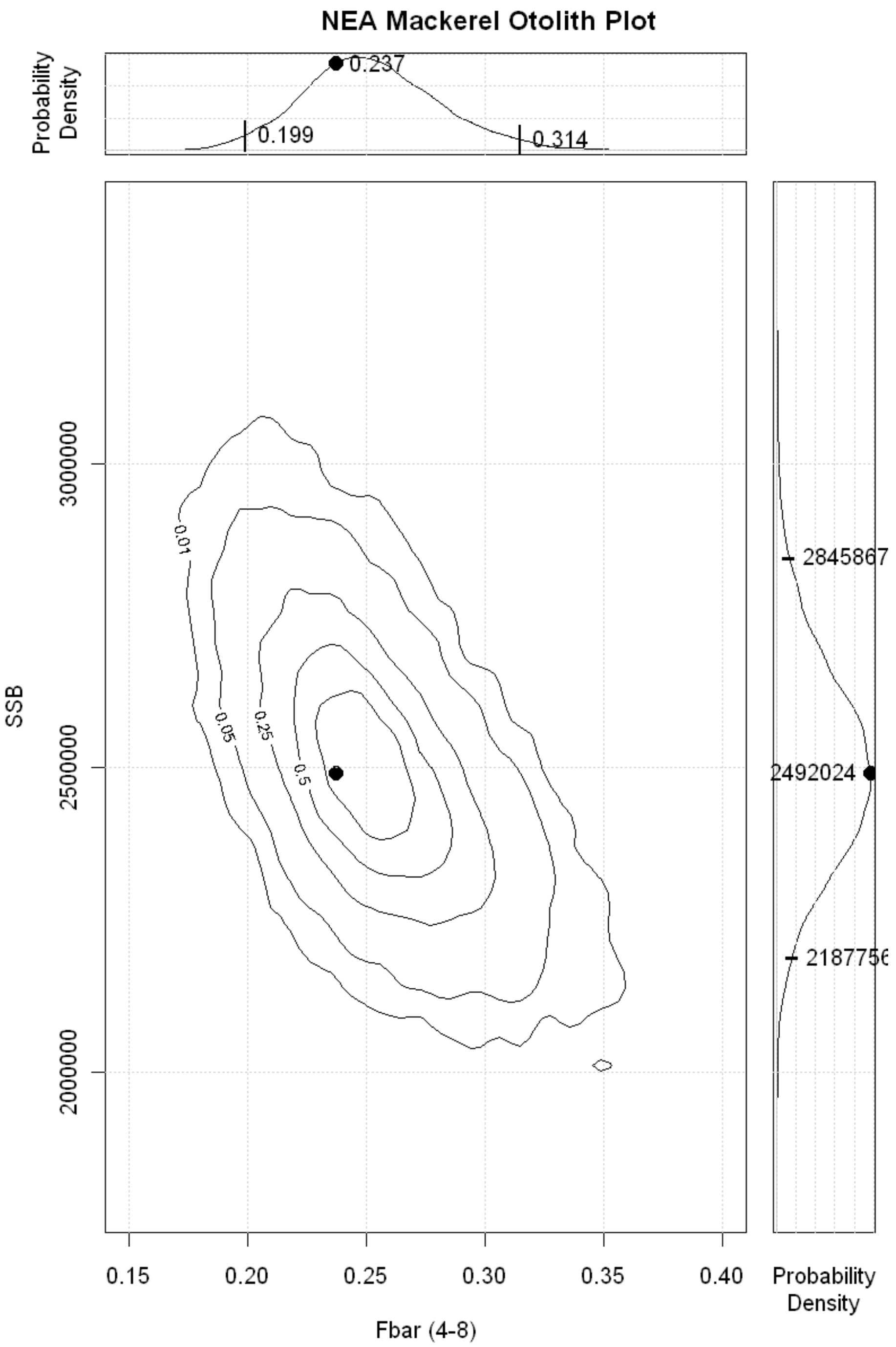


Figure 2.10.2. NE Atlantic mackerel, precision of ICA estimates of SSB and Fbar4–8 in 2008 from bootstrap of parameter residuals in FLICA. Showing percentile contours from 10000 realisations and the point estimates.

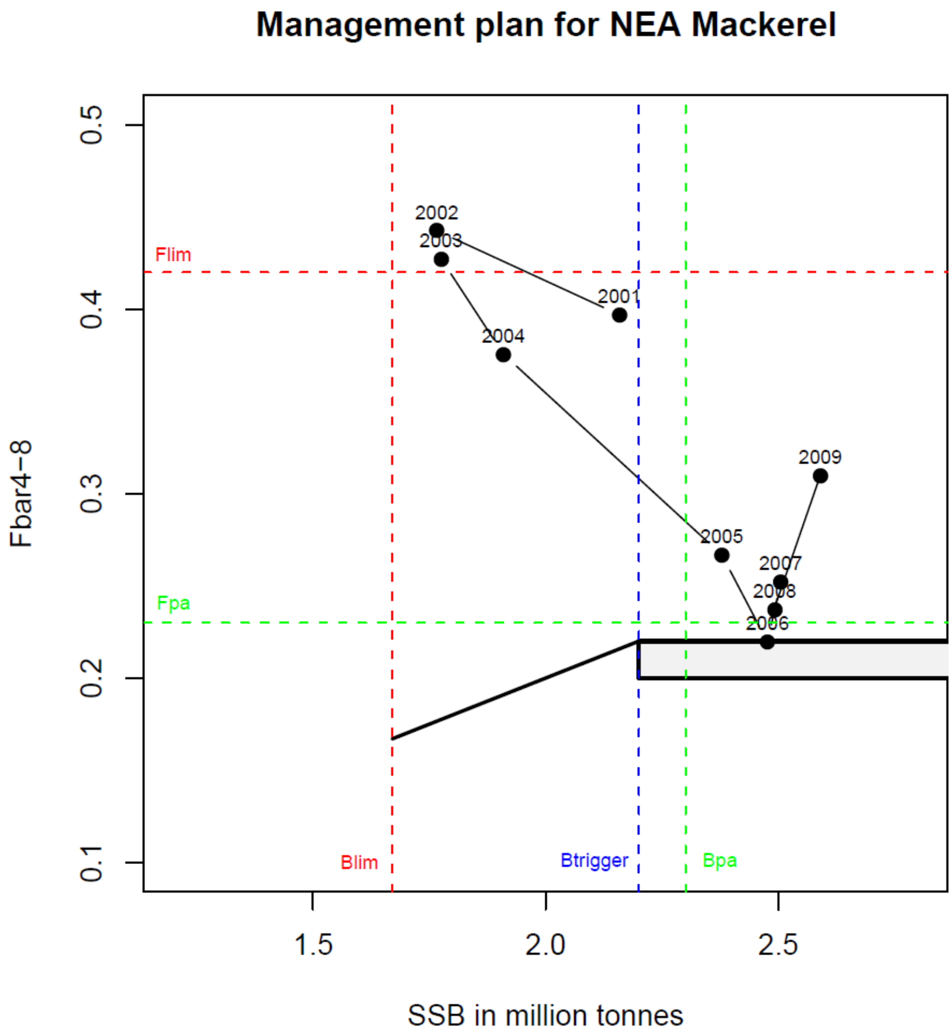


Figure 2.13.1. Recent history of the stock in relation to the management plan. Black dots represent the estimated fishing mortality (Fbar4-8) in relation to the estimated SSB for the years 2001 to 2008. The 2009 point is estimated from the short term forecast (see section 2.9). The grey area represents the range for Fbar in agreement with the management plan if $SSB>B_{trigger}$. If $B_{lim}<SSB<B_{trigger}$, Fbar should be on the black line of equation Fbar = 0.22 SSB/ 2 2000 000. A maximum TAC variation constraint of 20% also apply when $SSB>B_{trigger}$.

3 Horse Mackerel

3.1 Fisheries in 2008

The total international catches of horse mackerel in the North East Atlantic are shown in Table 3.1.1 and Figure 3.3.1. The total catch from all areas in 2008 was 198,085 tons which is 10,000 tons more than in 2007 and the second lowest since 1986. Ireland, Denmark, Scotland, England and Wales (no catches reported for 2008), France, Germany and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have both directed and mixed trawl and purse seine fisheries. In earlier years most of the catches were used for meal and oil while in later years most of the catches have been used for human consumption.

The quarterly catches of horse mackerel by Division and Subdivision in 2008 are given in Table 3.1.2 and the distribution of the fisheries are given in Figure 3.1.1.a–d. The figures are based on data provided by Denmark Faroe Islands, Germany, Ireland, Netherlands, Norway, Scotland, Portugal and Spain representing 85 % of the total catches. The distribution of the fishery is similar to the later years.

The Dutch and German fleets operated mainly west of the Channel, in the Channel area, north and west of Ireland and in the southern North Sea. Ireland fished mainly north and west of Ireland and Norway in the north eastern part of the North Sea. The Spanish and Portuguese fleets operated mainly in their respective waters. For the third time Lithuania reported catches of horse mackerel, 5,550 tons which is 200 tons less than they reported for 2007. Their catches were mainly reported from the area west and south west of Ireland.

First quarter: 47,100 tons, which is the same as in 2007. The fishery was mainly carried out west and south of Ireland, in the Channel, along the Spanish and Portuguese coasts (Figure 3.1.1.a).

Second quarter: 19,600 tons. This is 900 tons more than in 2007. As usual, rather low catches were taken during the second quarter, which is the main spawning period. Most of the catches were taken south of Ireland, along the Spanish and Portuguese coasts and in the northern part of the Bay of Biscay. Only very low catches were taken in the south eastern part of the North Sea (Figure 3.1.1.b).

Third quarter: 30,400 tons. This is 10,000 tons more than in 2007. Most of the catches were south of Ireland and in Portuguese and Spanish. As usual also some small catches were reported from the northern part of the North Sea (Figure 3.1.1.c).

Fourth quarter: This the main fishing season with a catch of 101,000 tons which is the same as in 2007. The catches were distributed in four main areas (Figure 3.1.1.d):

- Portuguese and Spanish waters,
- Irish waters
- in the Channel
- in the northern part of the North Sea/southern part of the Norwegian Sea.

3.2 Stock Units

For many years the Working Group has considered the horse mackerel in the north east Atlantic as separated into three stocks: the North Sea, the Southern and the Western stocks (ICES 1990/Assess: 24, ICES 1991/Assess: 22). For further information see Stock Annex Western Horse Mackerel. The boundaries for the different stocks are given in Figure 3.2.1.

3.3 Allocation of Catches to Stocks

The distribution areas for the three stocks are given in the Stock Annex Western Horse Mackerel. The catches in 2008 were allocated to the three stocks as follows:

Western stock: 3 and 4 quarter: Divisions IIIa and IVa. 1-4 quarter: IIa, Vb, VIa, VIIa–c,e–k and VIIIa-e.

North Sea stock: 1-2 quarter: Divisions IIIa, IVa. 1-4 quarter: IVb,c and VIId. The catches 1-2 quarters of Divisions IVa and IIIa and 1-4 quarters from Divisions IVb,c and VIId were allocated to the North Sea stock.

Southern stock: Division IXa. All catches from these areas were allocated to the southern stock. The catches by stock are given in Table 3.3.1, Figure 3.3.1. and by stock and country for 2008 in Table 3.3.2.

3.4 Estimates of discards

Over the years only Netherlands has provided data on discards and in some few years also Germany has provided such data. Therefore the amount of discards given in Table 3.1.1 are not representative for the total fishery. During the last year only the Netherlands provided discard data. No data about discard were provided during 1998-2001. Based on the limited data available it is impossible to estimate the amount of discard in the horse mackerel fisheries (see section 1.3.3).

3.5 *Trachurus* Species Mixing

The catches of *T. mediterraneus* (1989-2008) and *T. picturatus* (1986-2005) are given in Table 3.5.1 (see Stock Annex Western Horse Mackerel).

3.6 Length Distribution by Fleet and by Country:

Ireland, Netherlands, Norway, Portugal and Spain provided length distribution for their catches in 2008. These length distributions covered 78 % of the total landings and are shown in Table 3.6.1.

Table 3.1.1 HORSE MACKEREL general. Catches (t) by Sub-area. Data as submitted by Working Group members. Data of limited discard information are only available for some years.

Sub-area	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

Sub-area	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

Sub-area	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

Sub-area	1998	1999	2000	2001	2002	2003	2004
II + Vb	2,538	2,557	1,169	60	1,324	24	47
IV + IIIa	31,295	58,746	31,583	19,839	49,691	34,226	30,540
VI	35,073	40,381	20,657	24,636	14,190	23,254	21,929
VII	250,656	186,604	137,716	138,790	97,906	123,046	116,139
VIII	38,562	47,012	54,211	75,120	54,560	41,711	24,125
IX	41,574	27,733	27,160	24,912	23,665	19,570	23,581
Total	399,698	363,033	272,496	283,357	241,335	241,831	216,361

Sub-area	2005	2006	2007	2008[1]
II + Vb	176	30	366	572
IV + IIIa	40,564	38,911	16,407	15,377
VI	22,055	15,751	26,279	25,902
VII	107,475	101,912	93,132	98,746
VIII	41,495	34,122	28,387	33,892
IX	23,111	24,557	23,423	23,596
Total	234,876	215,283	187,994	198,085

[1]Preliminary.

Table 3.1.2 HORSE MACKEREL general. Quarterly catches (1000 t) by Division and Sub-division in 2008.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb				0.6	0.6
III	+		+	+	+
IVa	0.9	0.1	0.1	11.9	13.0
IVbc	0.2	+	0.1	2.0	2.3
VIId	9.5	+	+	21.8	31.4
VIa,b	5.1	+	0.8	20.0	25.9
VIIa–c,e–k	23.8	5.0	11.0	27.5	67.3
VIIIa,b,d,e	1.8	6.4	2.4	3.8	14.5
VIIIc	1.9	3.2	6.9	7.4	19.4
IXa	3.8	4.7	9	6.1	23.6
Sum	47.1	19.6	30.4	101.0	198.1

+ less than 50 t

Table 3.3.1 HORSE MACKEREL general. Landings and discards (t) by year and Division, for the North Sea, Western, and Southern horse mackerel stocks. (Data submitted by Working Group members.)

Year	IIIa	IVa	IVb,c	Discards	VIId	**North Sea Stock**	IIa Vb	IIIa	IVa	VIa,b	VIIa-c,e-k	VIIIa,b,d,e	VIIIc	Disc	**Western Stock**	**Southern Stock** (IXa)	All stocks
1982	2,788[1]		-		1,247	4,035	-		-	6,283	32,231	3,073	19,610	-	61,197	39,726	104,958
1983	4,420[1]		-		3,600	8,020	412		-	24,881	36,926	2,643	25,580	-	90,442	48,733	147,195
1984	25,893[1]		-		3,585	29,478	23		94	31,716	38,782	2,510	23,119	500	96,744	23,178	149,400
1985	-		22,897		2,715	26,750	79		203	33,025	35,296	4,448	23,292	7,500	103,843	20,237	150,830
1986	-		19,496		4,756	24,648	214		776	20,343	72,761	3,071	40,334	8,500	145,999	31,159	201,806
1987	1,138		9,477		1,721	11,634	3,311		11,185	35,197	99,942	7,605	30,098	-	187,338	24,540	223,512
1988	396		18,290		3,120	23,671	6,818		42,174	45,842	81,978	7,548	26,629	3,740	214,729	29,763	268,163
1989	436		25,830		6,522	33,265	4,809		85,304[2]	34,870	131,218	11,516	27,170	1,150	296,037	29,231	358,533
1990	2,261		17,437		1,325	18,762	11,414	14,878	112,753[2]	20,794	182,580	21,120	25,182	9,930	398,645	24,023	441,430
1991	913		11,400		600	12,000	4,487	2,725	63,869[2]	34,415	196,926	25,693	23,733	5,440	357,288	21,778	391,066
1992			13,955	400	688	15,043	13,457	2,374	101,752	40,881	180,937	29,329	24,243	1,820	394,793	26,713	436,548
1993			3,895	930	8,792	13,617	3,168	850	134,908	53,782	204,318	27,519	25,483	8,600	458,628	31,945	504,190
1994			2,496	630	2,503	5,689	759	2,492	106,911	69,546	194,188	11,044	24,147	3,935	413,022	28,442	447,153
1995	112		7,948	30	8,666	16,756	13,133	128	90,527	83,486	320,102	1,175	27,534	2,046	538,131	25,147	580,034
1996	1,657		7,558	212	9,416	18,843	3,366		18,356	81,259	252,823	23,978	24,290	16,870	420,942	20,400	460,185
1997			14,078	10	5,452	19,540	2,617	2,037	65,073[3]	40,145	318,101	11,677	29,129	2,921	471,700	27,642	518,882
1998	3,693		10,530	83	16,194	30,500	2,540[4]		17,011	35,043	232,451	15,662	22,906	830	326,443	41,574	398,523
1999			9,335		27,889	37,224	2,557[5]	2,095	47,316	40,381	158,715	22,824	24,188		298,076	27,733	363,033
2000			25,954		22,471	48,425	1,169[6]	1,105	4,524	20,657	115,245	32,227	21,984		196,911	27,160	272,496
2001	85	69	8,157		38,114	46,356	60	72	11,456	24,636	100,676	54,293	20,828		212,090	24,911	283,357
2002			12,636	20	10,723	23,379	1,324	179	36,855	14,190	86,878	32,450	22,110	305	194,292	23,665	241,336
2003	48	623	10,309		21,098	32,078	24	1,974	21,272	23,254	101,948	21,732	19,979		190,183	19,570	241,831
2004	351		18,348		16,455	35,154	47		11,841	21,929	98,984	8,353	15,772	701	157,627	23,581	216,361
2005	357		13,892	62	15,460	29,711	176		26,315	22,054	91,431	26,483	14,775	760	181,994	23,111	234,876
2006	1,099	2,661	7,998	78	23,790	35,626	30		27,152	15,722	77,970	20,651	13,470	99	155,094	24,557	215,277
2007	63	2,056	9,118	139	29,788	41,164	366[7]	110	4,940	26,279	63,223	14,428	13,960	102	123,408	23,423	187,994
2008	27	1,003	2,330		31,389	34,749	572	3	12,014	25,902	67,325	14,537	19,345	43	139,741	23,596	198,085

[1]Divisions IIIa and IVb,c combined.
[2]Norwegian catches in IVb included in Western horse mackerel.
[3] Includes Norwegian catches in IVb (1,426 t).
[4]Includes 1,937 t from Vb.
[5]Includes 132 t from Vb.
[6]Includes 250 t from Vb.
[7] all fom Vb

Table 3.3.2 HORSE MACKEREL general. Catches by country and stock in 2008

(Data submitted by Working Group members)

Country	North Sea stock	Western stock	Southern stock	Total
Belgium	3	-	-	3
Denmark	57	5,261	-	5,318
Faroese Island	-	841	-	841
France	2,246	12,626	-	14,872
Germany	1,174	11,708	-	12,882
Ireland	897	35,612	-	36,510
Lithuania	-	5,548	-	5,548
Netherland	19,439	43,648	-	63,087
Norway	21	12,223	-	12,244
Portugal	-	-	9,278	9,278
Spain	-	19,851	14,318	34,169
Sweden	35	9	-	44
UK E&W	-	-	-	-
UK Northern Ireland	-	-	-	-
UK Scotland	6	1,077	-	1,083
Discard	-	43	-	43
Unallocated	10,870	-8,706	-	2,164
Tot	34,749	139,740	23,596	198,085

Table 3.5.1 Catches (t) of Trachurus mediterraneus in Divisions VIIIab, VIIIc and IXa and Sub-area VII in the period 1989-2008 and Trachurus picturatus in División IXa, Subarea X and in CECAF Division 34.1.1 in the period 1986-2005.

Species	Divisions	Sub-Divisions	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
T. mediterraneus	VII		-	-	-	0	0	0	0	0	0	0	0	0	0	0	59	1	1	0	0	1	1	0	0
	VIIIab		-	-	-	23	298	2122	1123	649	1573	2271	1175	557	740	1100	988	525	525	340	53	155	168	126	66
	VIIIc	VIIIc East	-	-	-	3903	2943	5020	4804	5576	3344	4585	3443	3264	3755	1592	808	1293	1198	1699	841	1005	794	326	97
		VIIIc west	-	-	-	0	0	0	0	0	0	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	1699	841	1005	794	326	97
	IXa	IXa North	-	-	-	0	0	0	0	0	0	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	0	0	0	0	0	0
		Total	-	-	-	0	0	0	0	0	0	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	2039	894	1162	963	452	163
T. picturatus	IXa		367	181	2370	2394	2012	1700	1035	1028	1045	728	1009	834.01	526	320	464	420	663	773	508				
	X Azorean Area		3331	3020	3079	2866	2510	1274	1255	1732	1778	1822	1715	1920	1473	690	563	1089	4999.6	1509.01	1244.2				
	34.1.1 Madeira's area		2006	1533	1687	1564	1863	1161	792	530	297	206	393	762	657	344	646	385	358	572	653				
	TOTAL		5704	4734	7136	6824	6385	4135	3082	3290	3120	2756	3117	3516	2657	1354	1672	1894	6021	2854	2405	0	0	0	0

(-) Not available

Table 3.6.1 Horse mackerel general. Length distributions (%) catches by fleet and country in 2008. (0.0= <0.05%)

	Neth	Ireland	Norway	Spain			Portugal
	P.trawl	Trawl	P.seine	P.seine	Dem.trawl	Artisanal	All
cm	All	All	IVa	All	All	All	IXa
5							
6							
7							
8				0.2			
9				1.0			
10				2.9			0.3
11				3.9			3.5
12				2.2			4.1
13				1.1	0.0		3.3
14				1.6	0.2		4.2
15				12.0	0.2		7.1
16				16.2	1.2		8.7
17	0.0			9.0	2.2	0.6	7.1
18	0.2			8.6	1.4	0.9	6.6
19	0.4			4.9	0.3	3.7	5.9
20	0.9			2.9	0.1	10.7	7.5
21	2.3			2.0	0.0	7.5	9.4
22	7.9			2.6	0.4	5.0	7.8
23	11.8			2.2	1.3	5.2	6.1
24	11.9	0.4		2.3	2.4	3.8	3.9
25	13.1	2.9		2.9	3.1	3.4	2.9
26	13.3	10.8		3.4	3.2	4.1	2.0
27	10.3	20.8	0.4	4.1	2.6	4.0	1.8
28	7.3	21.6	0.5	4.1	5.6	2.6	1.8
29	5.3	16.6	0.9	3.0	4.6	3.2	1.5
30	4.2	10.9	2.2	2.3	5.7	3.3	0.9
31	3.8	6.3	7.0	1.6	5.7	3.7	0.6
32	3.4	3.2	11.1	1.1	9.0	3.7	0.5
33	1.9	2.3	14.8	0.6	9.4	4.7	0.3
34	0.9	1.4	15.2	0.5	9.2	4.6	0.3
35	0.3	0.9	12.4	0.3	8.3	4.6	0.2
36	0.3	0.6	11.3	0.3	7.2	5.7	0.2
37	0.1	0.4	9.8	0.1	6.5	6.8	0.3
38	0.1	0.3	6.2	0.1	4.6	3.9	0.3
39	0.1	0.2	3.1	0.0	3.7	2.8	0.3
40	0.1	0.2	2.0	0.0	1.1	0.9	0.3
41		0.1	1.1	0.0	0.6	0.2	0.1
42+		0.0	1.9	0.0	0.2	0.3	0.1

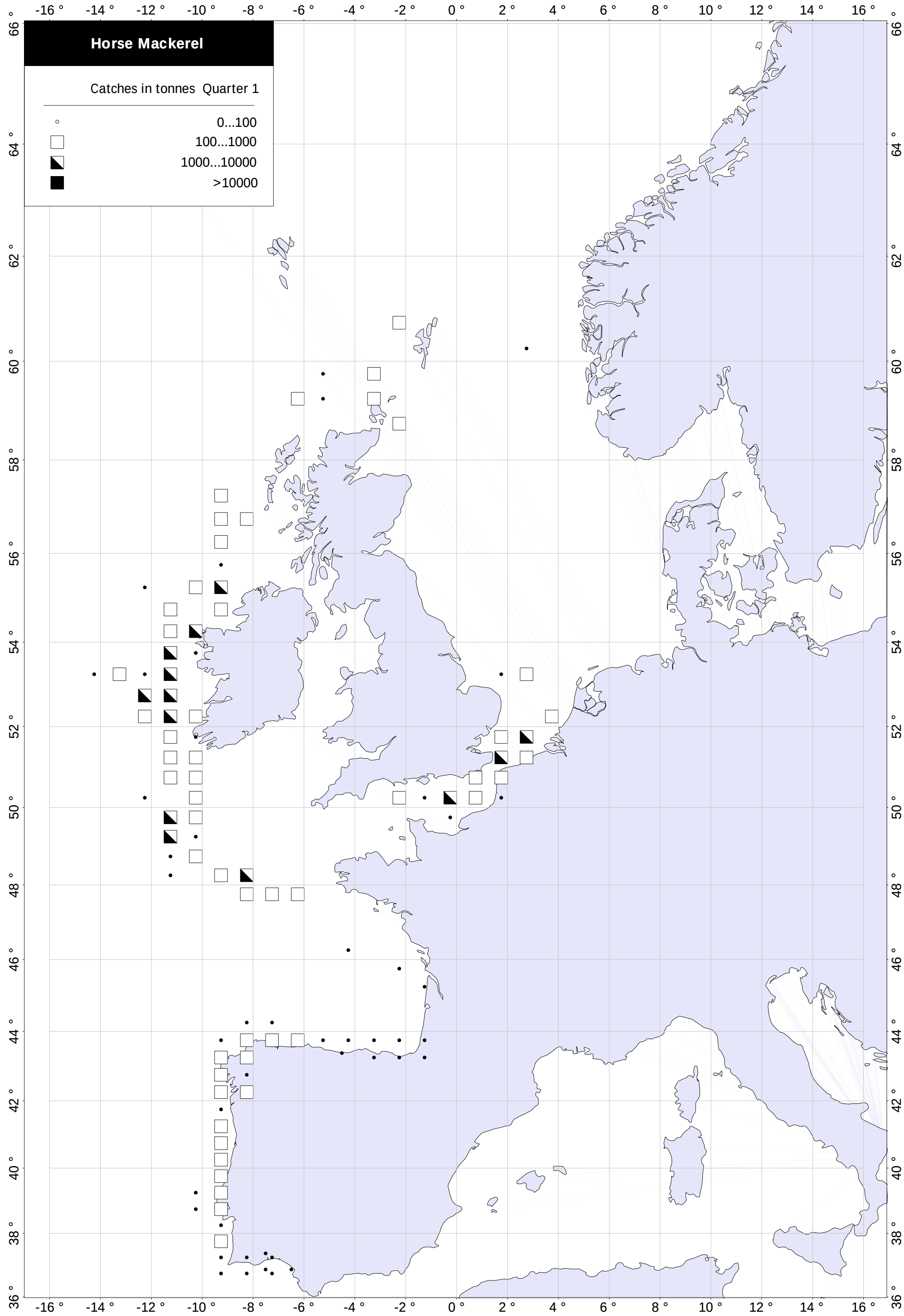


Figure 3.1.1a Horse mackerel catches 1 quarter 2008

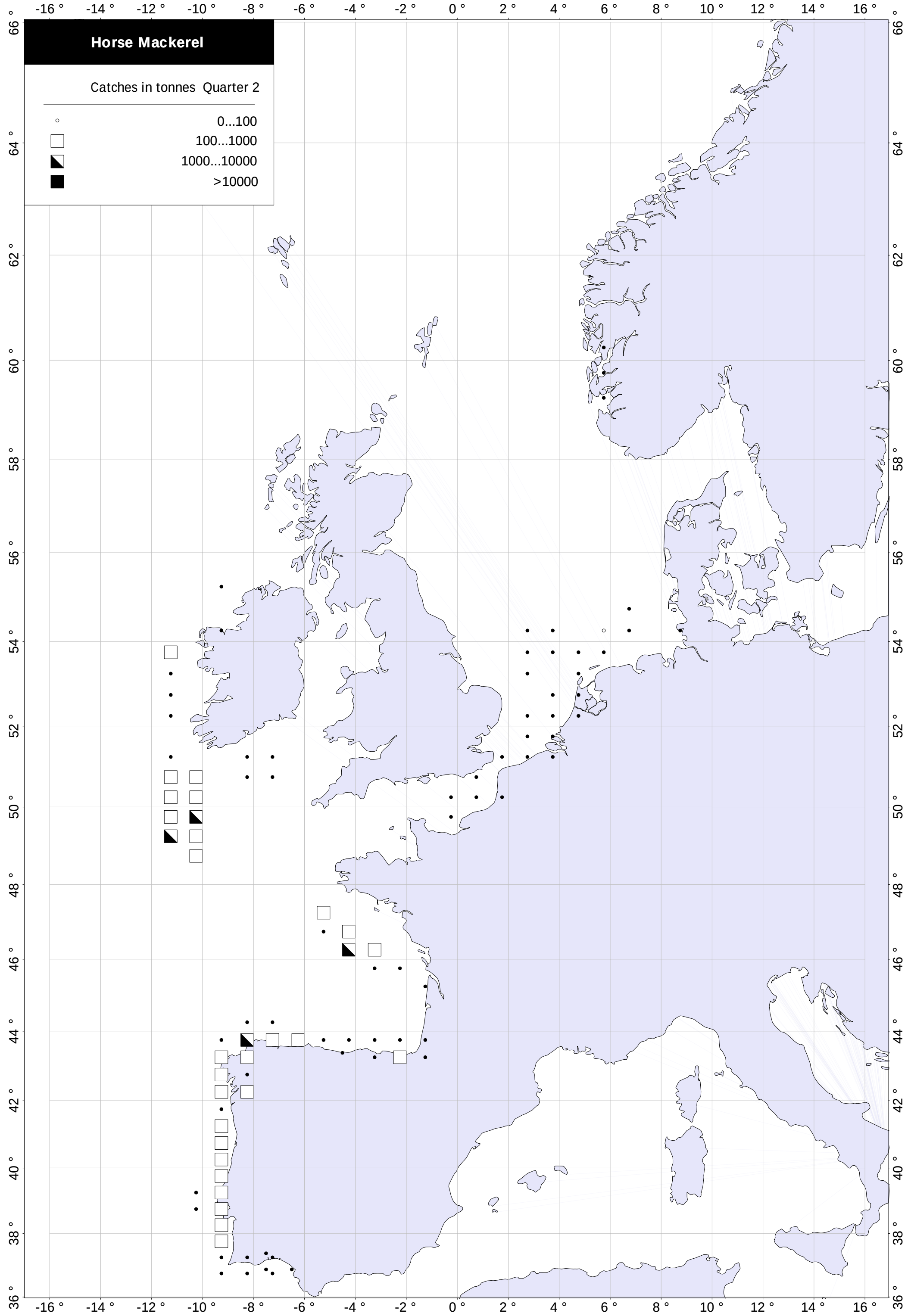


Figure 3.1.1b Horse mackerel catches 2 quarter 2008

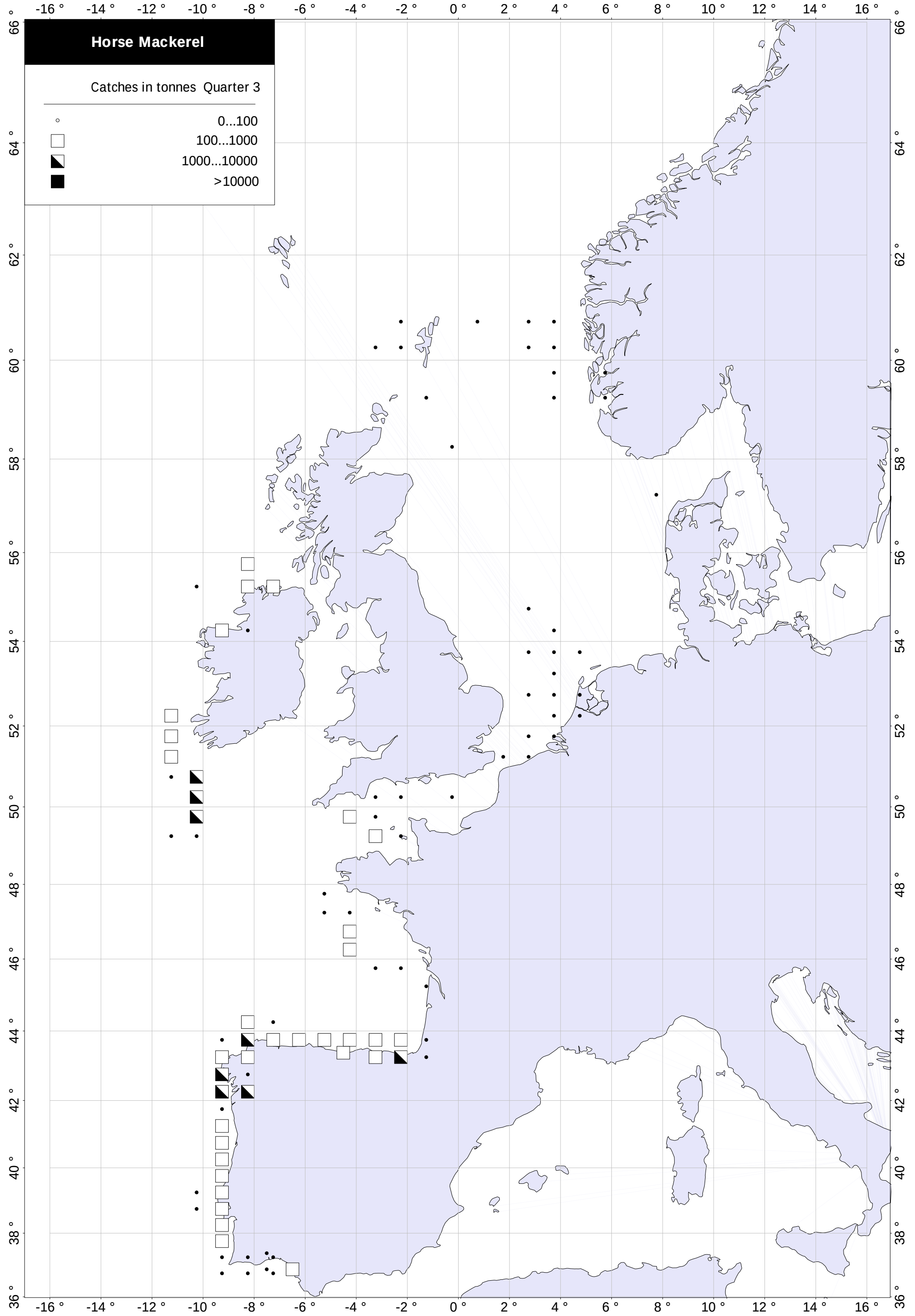


Figure 3.1.1c Horse mackerel catches 3 quarter 2008

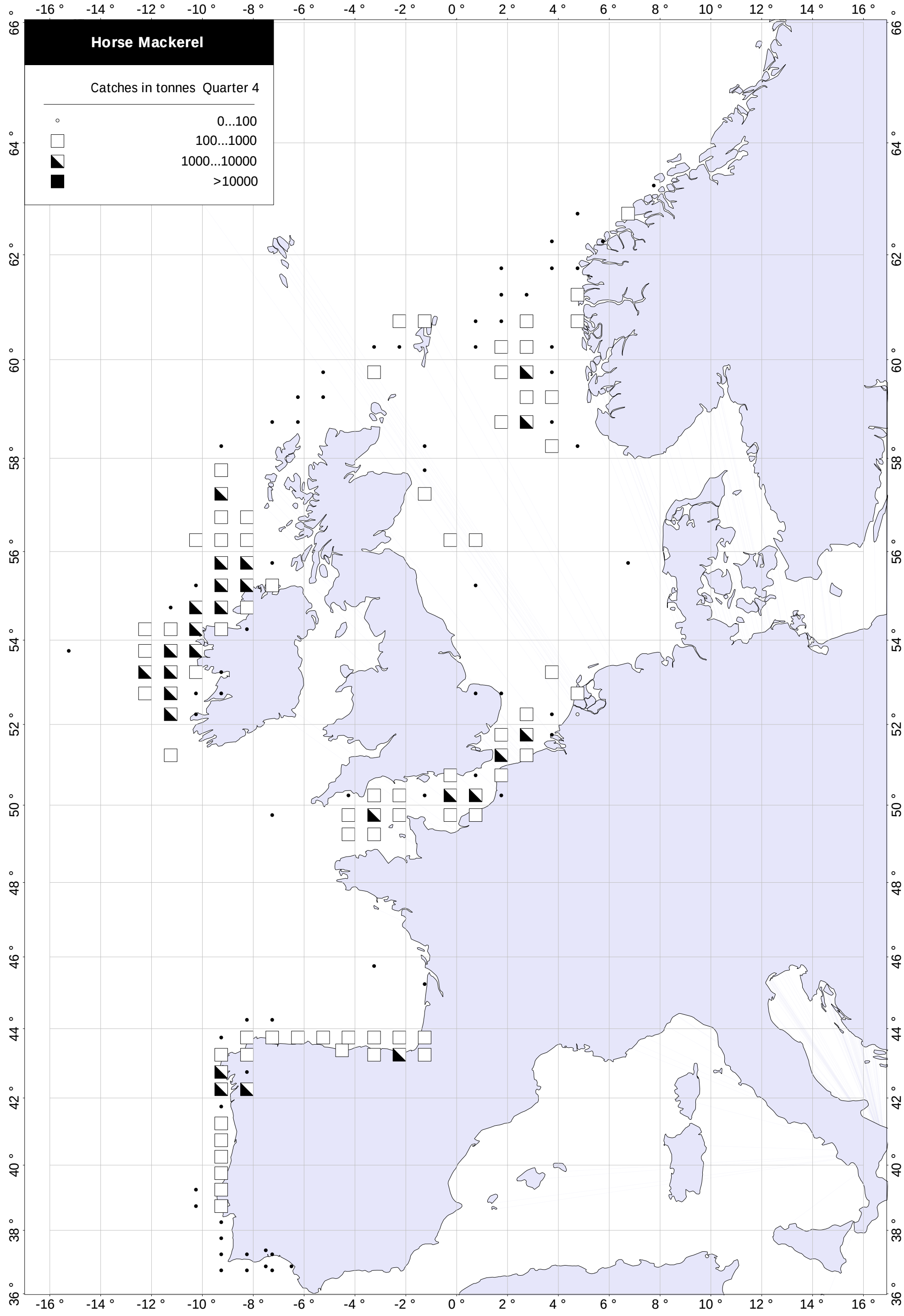


Figure 3.1.1d Horse mackerel catches 4 quarter 2008

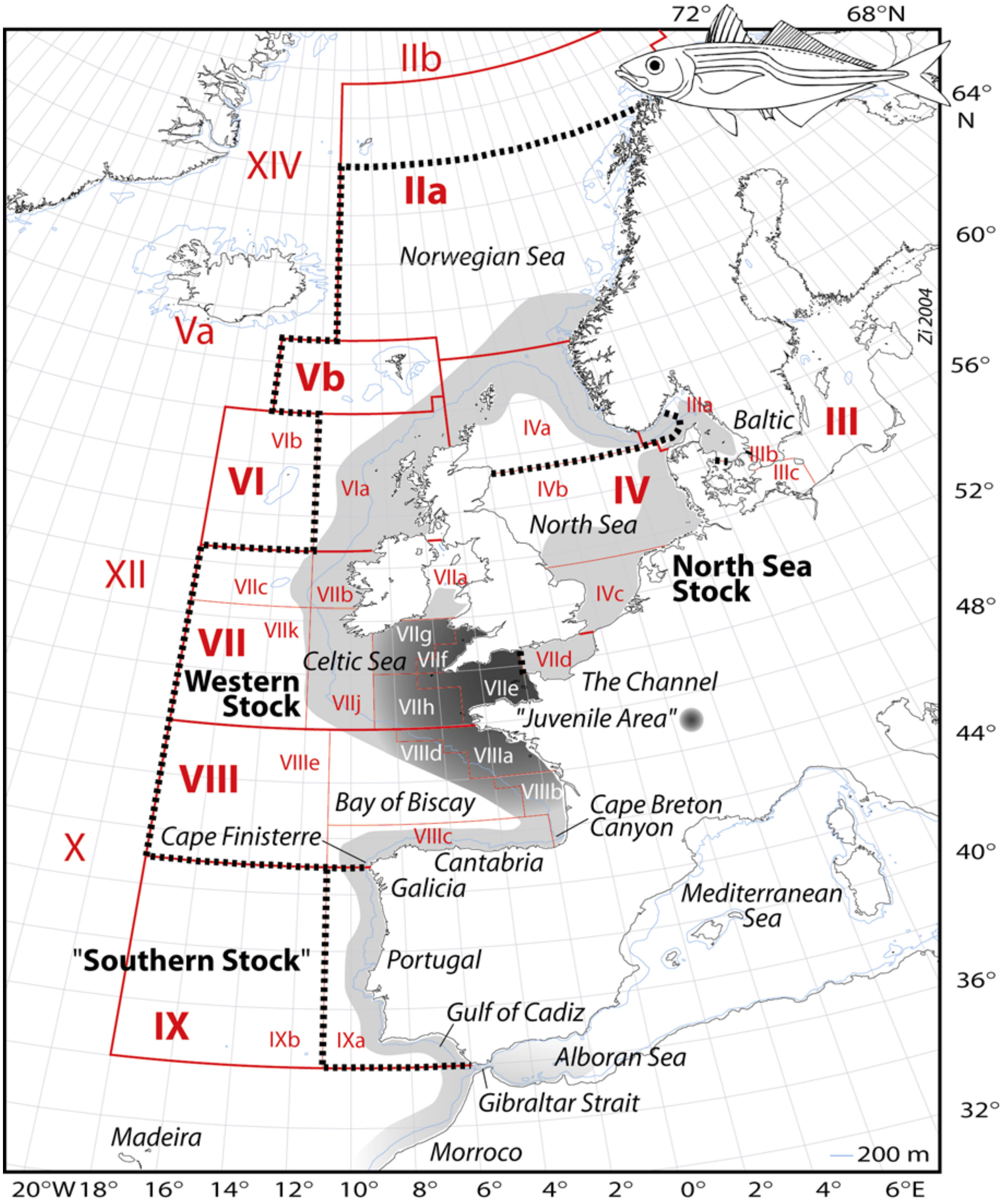


Figure 3.2.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by the 2004 WG MHSA. Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar projection, 200 m depth contour drawn.

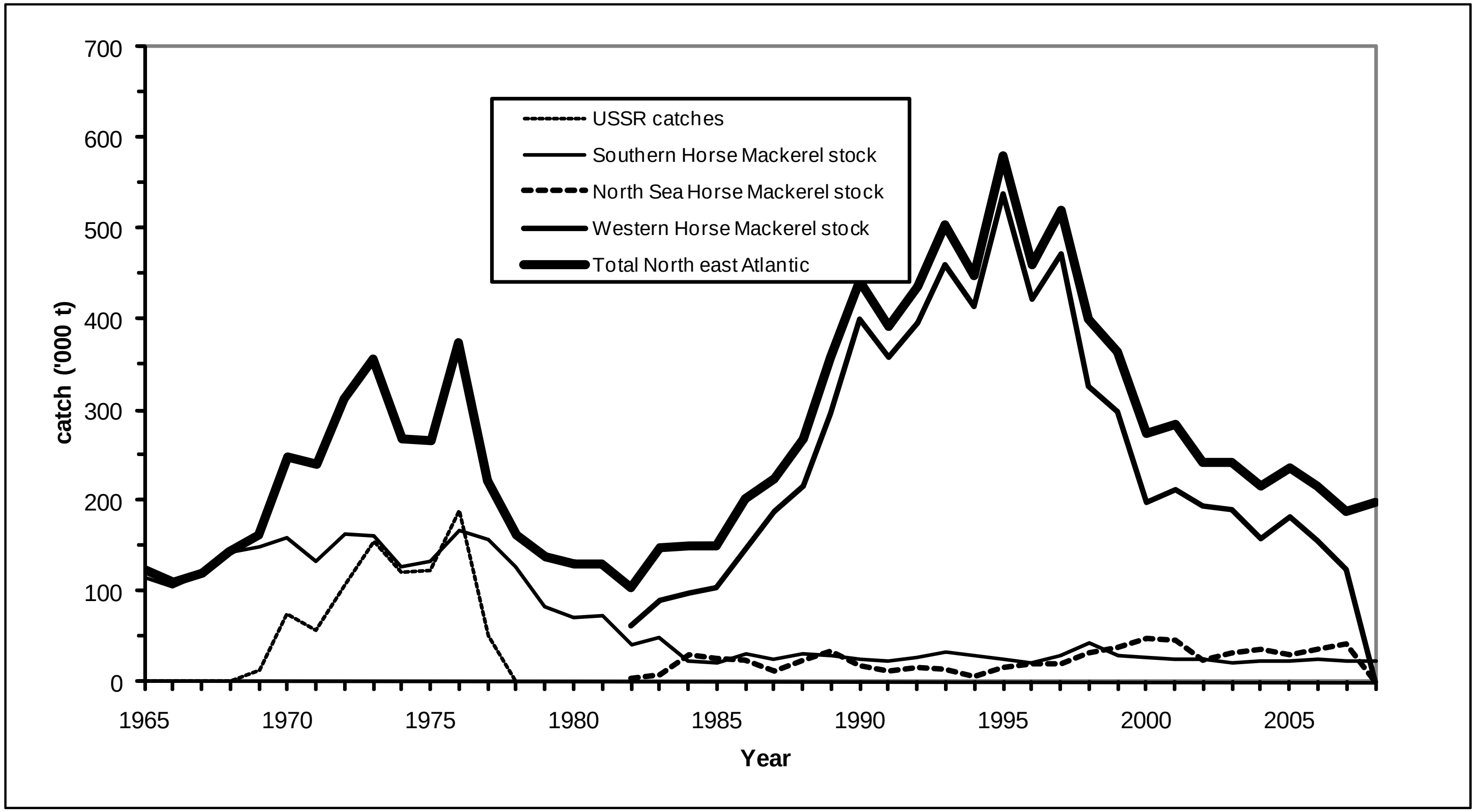


Figure 3.3.1 Horse mackerel general. Total catches in the northeast Atlantic during the period 1965 - 2008. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic. Caches from Div. VIIIc are transferred from southern stock to western stock from 1982 onwards.

4 North Sea Horse Mackerel: Divisions IVa (first and second quarters), IIIa (excluding Western Skagerrak in third and fourth quarter), IVb, IVc and VIId

4.1 ICES advice Applicable to 2008

The ICES advice has been the same since 2002. Also in 2008 ICES recommended that catches should not be more than the 1982-1997 average of 18 000 t, in order to avoid an expansion of the fishery until there is more information about the structure of horse mackerel stocks, and sufficient information to facilitate an adequate assessment. The TAC for this stock should apply to all areas in which North Sea horse mackerel are fished, i.e., Divisions IIIa, (eastern part), IVb, IVc and VIId.

EU has since 1987 set three TACs for horse mackerel in different EU waters. Two of these TACs cover part of the North Sea stock and thereby do not correspond to the distribution areas of neither the North Sea stock, nor the western and southern stocks.

4.2 The Fishery in 2008 on the North Sea stock

Catches taken in Divisions IV a and IIIa during the two first quarters and all year in Divisions IVb, IVc and VIId are regarded as belonging to the North Sea horse mackerel. Catches from the eastern part of Division IIIa during the third and fourth quarters are regarded as belonging to the North Sea stock. Table 3.3.1 shows the reported catches of this stock from 1982–2008. The catches were relatively low during the period 1982-1997 with an average of 18,000 tons. The catches increased from 1998 (30,500 tons) until record high in 2000 (48,400 tons). In 2005 the catch was reduced to 29,200 tons but increased to 41,100 tons in 2007. In 2008 the catches declined to 34,700 tons

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 larger parts of the catches have been taken in a directed horse mackerel fishery for human consumption.

4.3 Fishery-independent Information

4.3.1 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. Horse mackerel is now considered an indeterminate spawner, where fecundity is not determined prior to spawning. Therefore it is not possible currently to provide a realistic estimate of the spawning biomass. The mackerel egg surveys in the North Sea do not cover the spawning area of horse mackerel.

4.4 Biological Data

4.4.1 Catch in Numbers at Age

Catch in numbers at age for 2008 were calculated according to Dutch samples from Division VIId (1Q and 2Q) , and Irish samples from Divison IVa (1Q). Table 4.4.1.1 shows catch number by quarter and by area in 2008. Annual catch numbers at age for

1995-2008 are given in Table 4.4.1.2. 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 4.4.1.1).

At present the sampling intensity is relatively high (89%) due to the Dutch data and catches from Divison VIId. However the quality of the catch at age data may be questionable and involve large uncertainties. If a dependable analytical assessment is to be done in the future, the sampling needs to be improved considerably.

4.4.2 Mean weight at age and mean length at age

Table 4.4.2.1-2 show weight and length by quarter and by area in 2008. The annual average values are shown in Table 4.4.1.2.

4.4.3 Maturity at age

No data has been made available for this Working Group.

4.4.4 Natural mortality

There is no specific information available about natural mortality of this stock.

Table 4.4.1.1 North Sea Horse Mackerel stock. Catch in numbers (1000)
Mean length (Cm) at age by quarter and area in 2008

Ages	IIIa	IVa	IVb	IVc	VIId	Total
1Q						
0	0.00	0.00		0.00	0.00	0.00
1	0.00	0.00		0.00	0.00	0.00
2	0.00	0.00		15.64	247.62	263.27
3	0.00	0.00		289.00	4574.88	4863.89
4	0.00	0.00		137.15	2171.01	2308.16
5	0.93	31.19		1165.52	18450.11	19647.75
6	0.46	15.59		526.20	8329.73	8872.00
7	108.83	3660.95		572.79	9067.15	13409.72
8	2.25	75.75		242.06	3831.80	4151.86
9	6.94	233.57		232.31	3677.37	4150.19
10	1.59	53.39		43.34	686.01	784.33
11	1.73	58.22		10.43	165.12	235.50
12	1.00	33.79		22.48	355.78	413.05
13	1.72	57.92		17.26	273.27	350.18
14	1.51	50.79		39.74	629.16	721.21
15+	2.83	95.35		55.39	876.89	1030.47
Sum	129.79	4366.51		3369.31	53335.90	61201.58
2Q						
0		0.00	0.00	0.00	0.00	0.00
1		0.00	3.75	5.05	0.00	8.80
2		0.00	13.37	18.02	0.09	31.48
3		0.00	8.85	11.93	1.65	22.42
4		0.00	7.19	9.70	0.78	17.67
5		0.41	22.12	29.83	6.64	59.00
6		0.20	13.38	18.04	3.00	34.62
7		48.10	8.18	11.03	3.26	70.58
8		1.00	2.63	3.55	1.38	8.55
9		3.07	2.53	3.41	1.32	10.32
10		0.70	0.47	0.64	0.25	2.05
11		0.76	0.11	0.15	0.06	1.09
12		0.44	0.24	0.33	0.13	1.15
13		0.76	0.19	0.25	0.10	1.30
14		0.67	0.43	0.58	0.23	1.91
15+		1.25	0.60	0.81	0.32	2.98
Sum		57.36	84.04	113.32	19.21	273.92
3Q						
0			0.00	0.00	0.00	0.00
1			5.35	33.69	2.56	41.61
2			18.85	118.67	9.01	146.53
3			8.15	51.28	3.89	63.32
4			8.15	51.28	3.89	63.32
5			13.50	84.97	6.45	104.92
6			10.94	68.85	5.23	85.02
7			2.79	17.58	1.34	21.71
8			0.00	0.00	0.00	0.00
9			0.00	0.00	0.00	0.00
10			0.00	0.00	0.00	0.00
11			0.00	0.00	0.00	0.00
12			0.00	0.00	0.00	0.00
13			0.00	0.00	0.00	0.00
14			0.00	0.00	0.00	0.00
15+			0.00	0.00	0.00	0.00
Sum			67.73	426.32	32.37	526.43
4Q						
0			0.00	0.00	0.00	0.00
1			24.91	88.03	1514.83	1627.77
2			124.53	440.16	7574.15	8138.84
3			460.77	1628.59	28024.45	30113.82
4			211.71	748.27	12876.16	13836.14
5			236.61	836.31	14390.99	15463.91
6			398.50	1408.51	24237.27	26044.28
7			199.25	704.25	12118.64	13022.14
8			261.52	924.34	15905.82	17091.68
9			87.17	308.12	5302.01	5697.30
10			99.63	352.13	6059.32	6511.07
11			24.91	88.03	1514.83	1627.77
12			24.91	88.03	1514.83	1627.77
13			0.00	0.00	0.00	0.00
14			24.91	88.03	1514.83	1627.77
15+			0.00	0.00	0.00	0.00
Sum			2179.33	7702.80	132548.13	142430.26
1Q-4Q						
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	34.01	126.78	1517.39	1678.17
2	0.00	0.00	156.75	592.49	7830.87	8580.11
3	0.00	0.00	477.76	1980.79	32604.88	35063.43
4	0.00	0.00	227.05	946.40	15051.85	16225.29
5	0.93	31.60	272.24	2116.63	32854.19	35275.59
6	0.46	15.80	422.82	2021.60	32575.23	35035.92
7	108.83	3709.05	210.23	1305.65	21190.39	26524.14
8	2.25	76.74	264.15	1169.95	19739.00	21252.09
9	6.94	236.64	89.70	543.83	8980.70	9857.82
10	1.59	54.09	100.10	396.10	6745.58	7297.46
11	1.73	58.98	25.02	98.62	1680.01	1864.36
12	1.00	34.23	25.15	110.84	1870.74	2041.96
13	1.72	58.68	0.19	17.52	273.37	351.48
14	1.51	51.46	25.34	128.36	2144.21	2350.88
15+	2.83	96.60	0.60	56.21	877.20	1033.45
Sum	129.79	4423.87	2331.11	11611.77	185935.61	204432.15

Table 4.4.1.2 Catch in numbers at age (millions), weight at age (kg) and length at age (cm) for the North Sea horse mackerel stock 1995-2007

millions	Catch number													
Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	1.76	4.58	12.56	2.30	12.42	70.23	12.81	60.42	13.81	15.65	52.4	5.0	3.4	1.7
2	3.12	13.78	27.24	22.13	31.45	77.98	36.36	16.82	56.15	17.54	29.8	23.7	15.5	8.6
3	7.19	11.04	14.07	36.69	23.13	28.41	174.34	19.27	23.44	34.38	27.8	61.5	22.8	35.1
4	10.32	11.87	14.93	38.82	17.59	21.42	87.81	11.90	33.21	14.51	12.6	40.9	82.6	16.2
5	12.08	9.64	14.58	20.79	23.12	31.27	18.51	5.61	26.93	27.77	16.7	72.9	71.2	35.3
6	13.16	12.49	12.38	12.10	26.19	19.64	11.49	5.83	10.59	20.17	5.2	23.4	30.5	35.0
7	11.43	7.96	10.12	13.99	20.64	19.47	18.25	5.54	6.33	10.58	2.9	13.7	23.9	26.5
8	12.64	6.60	8.64	10.79	21.75	9.00	14.70	10.48	9.56	3.82	2.4	5.9	17.3	21.3
9	7.25	1.48	2.45	8.26	12.91	11.50	10.22	6.33	10.90	5.37	3.8	1.6	7.9	9.9
10	5.87	5.31	0.75	4.01	8.21	8.96	9.98	6.75	1.51	10.95	5.8	1.4	1.7	7.3
11	0.01	0.29	0.34	2.72	2.14	6.98	9.58	5.12	3.43	6.22	2.3	0.2	0.6	1.9
12	8.84	1.28	0.25	0.71	0.43	3.07	5.35	3.02	3.29	4.47	4.1	1.7	0.2	2.0
13	0.20	8.92	0.00	1.81	1.40	1.61	3.73	2.17	2.25	6.16	2.5	0.6	0.7	0.4
14	4.37	8.01	1.38	0.31	3.78	0.00	1.95	1.29	3.40	2.25	9.9	1.0	0.6	2.4
15+	0.00	0.00	0.00	5.11	4.03	12.22	5.81	2.71	4.70	8.52	9.6	0.8	0.0	1.0

kg	weight													
Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.076	0.107	0.063	0.063	0.063	0.075	0.055	0.066	0.073	0.076	0.079	0.069	0.073	0.063
2	0.126	0.123	0.102	0.102	0.102	0.101	0.072	0.095	0.105	0.104	0.077	0.095	0.082	0.096
3	0.125	0.143	0.126	0.126	0.126	0.136	0.071	0.129	0.123	0.120	0.103	0.116	0.105	0.109
4	0.133	0.156	0.142	0.142	0.142	0.152	0.082	0.154	0.137	0.147	0.132	0.124	0.115	0.125
5	0.146	0.177	0.160	0.160	0.160	0.166	0.120	0.172	0.166	0.174	0.158	0.141	0.130	0.145
6	0.164	0.187	0.175	0.175	0.175	0.194	0.183	0.195	0.181	0.198	0.196	0.177	0.164	0.161
7	0.161	0.203	0.199	0.199	0.199	0.198	0.197	0.216	0.195	0.225	0.251	0.210	0.191	0.194
8	0.178	0.195	0.231	0.231	0.231	0.213	0.201	0.227	0.212	0.229	0.270	0.244	0.197	0.221
9	0.165	0.218	0.250	0.250	0.250	0.247	0.235	0.228	0.238	0.256	0.280	0.231	0.256	0.286
10	0.173	0.241	0.259	0.259	0.259	0.280	0.246	0.251	0.259	0.291	0.291	0.284	0.258	0.296
11	0.317	0.307	0.300	0.300	0.300	0.279	0.260	0.302	0.245	0.301	0.344	0.237	0.517	0.273
12	0.233	0.211	0.329	0.329	0.329	0.342	0.286	0.292	0.295	0.300	0.361	0.257	0.279	0.309
13	0.241	0.258	0.367	0.367	0.367	0.318	0.287	0.318	0.356	0.302	0.332	0.268	0.338	0.375
14	0.348	0.277	0.299	0.299	0.299	0.325	0.295	0.319	0.319	0.338	0.376	0.291	0.414	0.277
15+	0.348	0.277	0.360	0.360	0.360	0.332	0.336	0.390	0.380	0.401	0.367	0.402		0.389

cm	length													
Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	19.2	19.2	19.2	19.2	19.2	19.0	18.7	17.1	20.2	19.8	20.54	19.89	20.05	20.00
2	22.0	22.0	22.0	22.0	22.0	21.5	20.4	21.4	22.4	22.2	21.49	21.94	20.83	21.62
3	23.5	23.5	23.5	23.5	23.5	23.9	20.6	22.9	23.8	23.6	23.00	23.38	22.59	23.20
4	24.8	24.8	24.8	24.8	24.8	24.9	21.3	24.9	24.6	25.2	24.69	24.13	23.64	24.11
5	25.5	25.5	25.5	25.5	25.5	26.0	25.0	26.2	26.2	26.6	25.53	25.42	24.37	25.61
6	26.4	26.4	26.4	26.4	26.4	27.8	27.4	26.6	27.3	27.5	27.77	27.01	26.58	26.33
7	27.2	27.2	27.2	27.2	27.2	28.3	28.0	27.4	28.2	28.9	30.42	28.53	27.80	28.07
8	29.2	29.2	29.2	29.2	29.2	28.6	28.4	28.2	29.0	29.2	31.19	29.84	28.12	28.77
9	29.5	29.5	29.5	29.5	29.5	30.0	29.7	29.2	29.9	30.5	31.82	30.63	30.05	31.16
10	29.5	29.5	29.5	29.5	29.5	31.3	30.2	30.8	30.8	31.5	32.32	31.55	31.15	31.79
11	30.6	30.6	30.6	30.6	30.6	31.4	30.7	32.5	30.8	32.0	34.41	31.18	39.50	31.60
12	32.1	32.1	32.1	32.1	32.1	33.7	32.0	33.8	31.9	31.8	36.16	30.75	31.50	32.24
13	33.3	33.3	33.3	33.3	33.3	33.5	31.7	33.8	32.9	32.0	34.20	32.13	33.40	33.90
14	31.1	31.1	31.1	31.1	31.1	33.4	32.1	32.4	32.7	33.0	34.90	32.15	34.50	32.33
15+	32.5	32.5	32.5	32.5	32.5	33.4	33.4	34.4	34.6	34.8	35.39	35.42		35.12

Table 4.4.2.1 North Sea Horse Mackerel stock.
Mean weight (kg) in catch at age by
quarter and area in 2008

Ages	IIIa	IVa	IVb	IVc	VIId	Mean
1Q						
0						
1						
2				0.080	0.080	0.080
3				0.098	0.098	0.098
4				0.135	0.135	0.135
5	0.126	0.126		0.147	0.147	0.147
6	0.134	0.134		0.168	0.168	0.168
7	0.192	0.192		0.201	0.201	0.199
8	0.238	0.238		0.227	0.227	0.227
9	0.208	0.208		0.256	0.256	0.254
10	0.298	0.298		0.291	0.291	0.291
11	0.291	0.291		0.312	0.312	0.307
12	0.368	0.368		0.312	0.312	0.316
13	0.385	0.385		0.373	0.373	0.375
14	0.329	0.329		0.271	0.271	0.275
15	0.419	0.419		0.386	0.386	0.389
Mean	0.206	0.206		0.178	0.178	0.180
2Q						
0						
1			0.077	0.077		0.077
2			0.098	0.098	0.080	0.098
3			0.109	0.109	0.098	0.108
4			0.140	0.140	0.135	0.140
5		0.126	0.151	0.151	0.147	0.151
6		0.134	0.172	0.172	0.168	0.171
7		0.192	0.205	0.205	0.201	0.196
8		0.238	0.227	0.227	0.227	0.228
9		0.208	0.256	0.256	0.256	0.242
10		0.298	0.291	0.291	0.291	0.293
11		0.291	0.312	0.312	0.312	0.297
12		0.368	0.312	0.312	0.312	0.334
13		0.385	0.373	0.373	0.373	0.380
14		0.329	0.271	0.271	0.271	0.291
15		0.419	0.386	0.386	0.386	0.400
Mean		0.206	0.152	0.152	0.178	0.165
3Q						
0						
1			0.077	0.077	0.077	0.077
2			0.116	0.116	0.116	0.116
3			0.120	0.120	0.120	0.120
4			0.145	0.145	0.145	0.145
5			0.155	0.155	0.155	0.155
6			0.176	0.176	0.176	0.176
7			0.208	0.208	0.208	0.208
8						
9						
10						
11						
12						
13						
14						
15						
Mean			0.138	0.138	0.138	0.138
4Q						
0						
1			0.062	0.062	0.062	0.062
2			0.096	0.096	0.096	0.096
3			0.111	0.111	0.111	0.111
4			0.123	0.123	0.123	0.123
5			0.143	0.143	0.143	0.143
6			0.158	0.158	0.158	0.158
7			0.188	0.188	0.188	0.188
8			0.219	0.219	0.219	0.219
9			0.310	0.310	0.310	0.310
10			0.296	0.296	0.296	0.296
11			0.268	0.268	0.268	0.268
12			0.307	0.307	0.307	0.307
13						
14			0.278	0.278	0.278	0.278
15						
Mean			0.165	0.165	0.165	0.165
1Q-4Q						
0						
1			0.066	0.067	0.062	0.063
2			0.099	0.100	0.096	0.096
3			0.111	0.109	0.109	0.109
4			0.124	0.126	0.125	0.125
5	0.126	0.126	0.144	0.146	0.145	0.145
6	0.134	0.134	0.159	0.161	0.161	0.161
7	0.192	0.192	0.189	0.194	0.194	0.194
8	0.238	0.238	0.219	0.221	0.221	0.221
9	0.208	0.208	0.309	0.287	0.288	0.286
10	0.298	0.298	0.296	0.295	0.296	0.296
11	0.291	0.291	0.268	0.273	0.272	0.273
12	0.368	0.368	0.307	0.308	0.308	0.309
13	0.385	0.385	0.373	0.373	0.373	0.375
14	0.329	0.329	0.278	0.276	0.276	0.277
15	0.419	0.419	0.386	0.386	0.386	0.389
Mean	0.206	0.206	0.164	0.168	0.169	0.170

Table 4.4.2.2 North sea Horse Mackerel stock. Mean length (Cm) in catch at age by quarter and area in 2008

1Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1						
2				21.50	21.50	21.50
3				23.01	23.01	23.01
4				24.95	24.95	24.95
5	26.00	26.00		25.90	25.90	25.90
6	26.50	26.50		27.03	27.03	27.03
7	29.29	29.29		28.44	28.44	28.68
8	31.21	31.21		29.66	29.66	29.69
9	29.94	29.94		30.73	30.73	30.69
10	33.34	33.34		32.06	32.06	32.15
11	33.12	33.12		32.00	32.00	32.29
12	35.35	35.35		32.96	32.96	33.16
13	35.85	35.85		33.50	33.50	33.90
14	34.25	34.25		31.76	31.76	31.94
15+	36.50	36.50		34.97	34.97	35.12
Mean	29.77	29.77		27.21	27.21	27.40
2Q						
0						
1			20.00	20.00		20.00
2			22.22	22.22	21.50	22.21
3			23.25	23.25	23.01	23.24
4			24.73	24.73	24.95	24.74
5		26.00	25.70	25.70	25.90	25.72
6		26.50	26.64	26.64	27.03	26.67
7		29.29	27.97	27.97	28.44	28.89
8		31.21	29.66	29.66	29.66	29.84
9		29.94	30.73	30.73	30.73	30.50
10		33.34	32.06	32.06	32.06	32.49
11		33.12	32.00	32.00	32.00	32.79
12		35.35	32.96	32.96	32.96	33.89
13		35.85	33.50	33.50	33.50	34.88
14		34.25	31.76	31.76	31.76	32.63
15+		36.50	34.97	34.97	34.97	35.61
Mean		29.77	25.38	25.38	27.21	26.43
3Q						
0						
1			20.00	20.00	20.00	20.00
2			22.93	22.93	22.93	22.93
3			23.50	23.50	23.50	23.50
4			24.50	24.50	24.50	24.50
5			25.50	25.50	25.50	25.50
6			26.25	26.25	26.25	26.25
7			27.50	27.50	27.50	27.50
8						
9						
10						
11						
12						
13						
14						
15+						
Mean			24.19	24.19	24.19	24.19
4Q						
0						
1			20.00	20.00	20.00	20.00
2			21.60	21.60	21.60	21.60
3			23.23	23.23	23.23	23.23
4			23.97	23.97	23.97	23.97
5			25.24	25.24	25.24	25.24
6			26.09	26.09	26.09	26.09
7			27.44	27.44	27.44	27.44
8			28.55	28.55	28.55	28.55
9			31.50	31.50	31.50	31.50
10			31.75	31.75	31.75	31.75
11			31.50	31.50	31.50	31.50
12			32.00	32.00	32.00	32.00
13						
14			32.50	32.50	32.50	32.50
15+						
Mean			25.96	25.96	25.96	25.96
1Q-4Q						
0						
1			20.00	20.00	20.00	20.00
2			21.81	21.88	21.60	21.62
3			23.24	23.21	23.20	23.20
4			24.01	24.15	24.11	24.11
5	26.00	26.00	25.29	25.62	25.61	25.61
6	26.50	26.50	26.11	26.35	26.33	26.33
7	29.29	29.29	27.46	27.89	27.87	28.07
8	31.21	31.21	28.56	28.78	28.77	28.77
9	29.94	29.94	31.48	31.17	31.19	31.16
10	33.34	33.34	31.75	31.78	31.78	31.79
11	33.12	33.12	31.50	31.55	31.55	31.60
12	35.35	35.35	32.01	32.20	32.18	32.24
13	35.85	35.85	33.50	33.50	33.50	33.90
14	34.25	34.25	32.49	32.27	32.28	32.33
15+	36.50	36.50	34.97	34.97	34.97	35.12
Mean	29.77	29.77	25.89	26.25	26.32	26.38

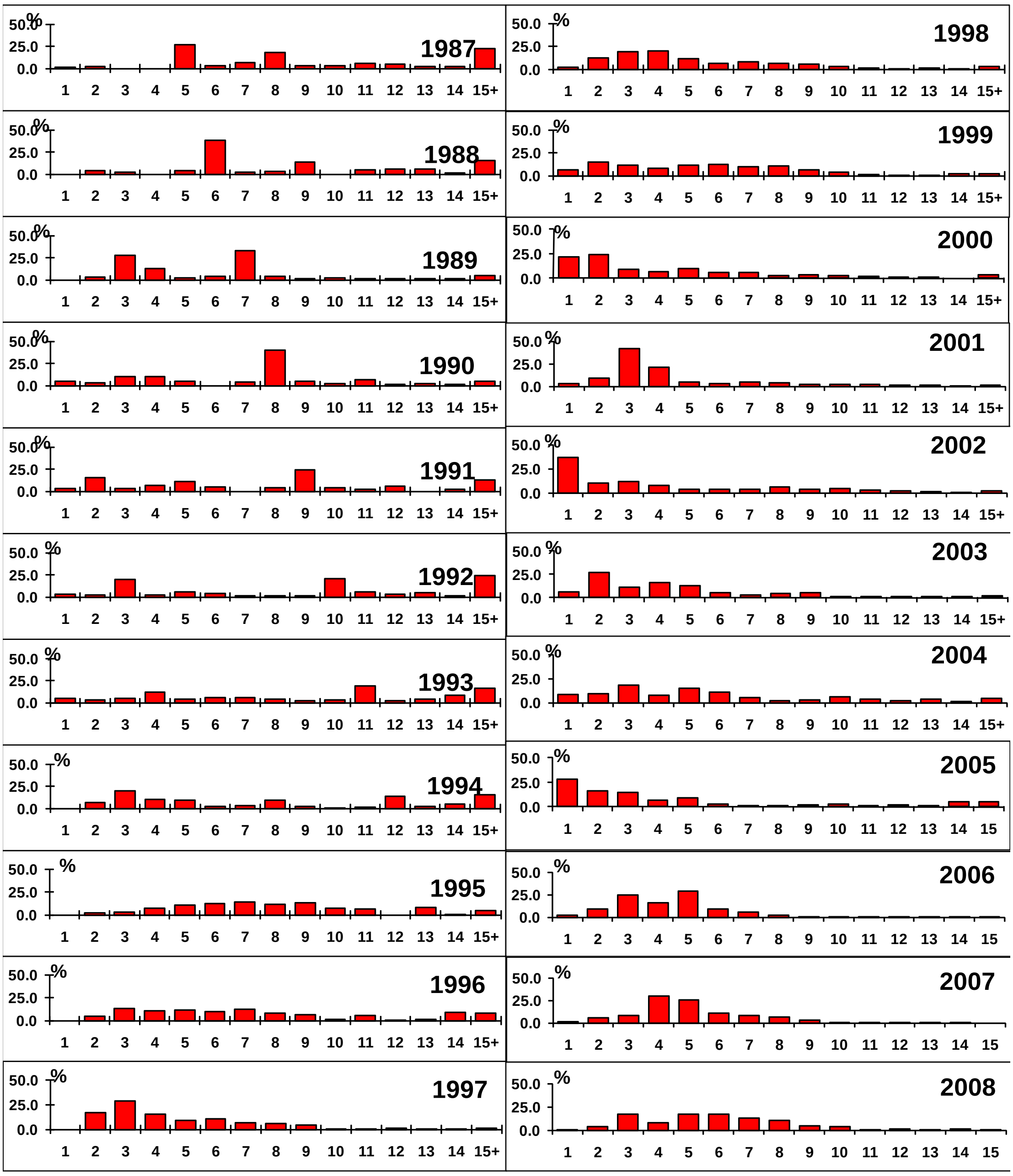


Figure 4.4.1.1 Age distribution in the catches of North Sea horse mackerel 1987-2008

5 Western Horse Mackerel - Divisions IIa, IIIa (Western Part), IVa, Vb, VIa, VIIa-c, VIIe-k, AND VIIIa-e

5.1 ICES advice applicable to 2008 and 2009

EU has set TACs for western horse mackerel in EU waters since 1987. However, these TACs cover a mixture of western, North Sea and southern horse mackerel areas. For 2008 and 2009, the TACs can be summarised as follows (EC 40/2008, EC 43/2009):

Areas in EU waters	TAC 2008	TAC 2009	Stocks fished in this area
Div Vb, Subareas VI and VII, Div VIIIa,b,d,e	170 000 t	170 000 t	Western & North Sea stocks
Div IIa and Subarea IV	39 309 t	39 309 t	Western & North Sea stocks
Division VIIIc and Subarea IX	57 750 t	57 750 t	Southern & Western stocks

The TAC for the western stock should apply to the distribution area of western horse mackerel as follows:

All Quarters: IIa, Vb, VIa, VIIa-c, VIIe-k, VIIIa-e

Quarters 3&4: IIIa (west), IVa

The TAC for the North Sea stock should apply to the distribution area of North Sea horse mackerel as follows:

All Quarters: IIIa (east), IVb-c, VIId

Quarters 1&2: IIIa (west), IVa

The TAC for the southern stock should apply to the distribution area of southern horse mackerel as follows:

All Quarters: IXa

In 2007 ICES evaluated the proposed management plan for western horse mackerel to be in accordance with the precautionary approach and advised a TAC of 180,000 tons for each of the years 2008, 2009 and 2010. The TAC should apply to the total distribution area of this stock. The EU horse mackerel catches in Division IIIa in 2008 were taken outside the horse mackerel TACs.

5.1.1 Stock description and management units

The western horse mackerel stock spawns in the Bay of Biscay, and in UK an Irish waters. After spawning, parts of the stock migrate northwards into the Norwegian Sea and North Sea, where they are fished in the third and fourth quarter. The stock is distributed in Divisions IIa, Vb, IIIa, IVa, VIa, VIIa-c, VIIe-k and VIIIa-e. The stock is caught in these areas in the total or parts of the year as described in Section 3.3 and the stock annex. The western stock is considered a management unit and advised accordingly. At present there are no international agreed management and TAC of western horse mackerel. EU regulates their fishery by TAC, but the TAC is not set in accordance with the distribution of the stock.

Based on various biological examinations undertaken in the last decade, an EU non-paper outlines the proposed updates to the management and assessment area. A summary of the existing structure is presented in the following text table:

ICES Division concerned	Allocation to existing TAC area	Biological observation as reviewed by ICES and ICES working groups	Allocation in the ICES advice
VIIIc North and Northwest Spain	Southern area (VIIIc, IXa)	Inhabited by the Western stock, exchange between stocks not specified	Western stock (IIa, IVa, Vb, VI, VIIa-c, VIIe-k, VIIIa-e)
VIId Eastern English Channel	Western area (VI, VII, VIIIab, VIIIde, Vb, XII, XIV)	Inhabited by the North Sea stock for overwintering, overlap with the Western stock possible	North Sea stock (IIIa Eastern part, IVbc, VIId)
IIa Norwegian Sea and IVa Northern North Sea	Northern area (IIa, IV)	Inhabited by the Western stock in autumn, in first and second quarter presence of North Sea stock possible	Western stock (IIa, IVa, Vb, VIa, VIIa-c, VIIe-k, VIIIa-e)
IIIa Skagerrak and Kattegat	none	Presence of the Western stock in autumn; catches in winter/ spring in the Western part and catches in the Eastern part likely attributable to the North Sea stock	Eastern part to the North Sea stock, Western part to the Western stock

5.2 Scientific data

5.2.1 The fishery in 2008

Information on the development of the fisheries by quarter and division is shown in Table 3.1.2 and in Figures 3.1.1.a–d. The total catch allocated to western horse mackerel (including Division VIIIc) in 2008 was approximately 139,700 t (Table 3.3.1) which is 16,300 tons more than in 2007 and the second lowest reported catch since 1986. The catches of horse mackerel by country and area are shown in Tables 5.2.1.1-5.

5.2.2 Egg survey estimates

There is no new total egg production estimate for 2009. The next mackerel and horse mackerel egg survey takes place in 2010. More information on the egg surveys can be found in the stock annex and in the most recent WGMEGS reports (ICES 2008/LRC:09, 2009/LRC:09). The egg survey estimates used in the assessment are shown in Table 5.2.2.1.

5.2.3 Other surveys for western horse mackerel

Bottom trawl surveys

No new information was presented on bottom trawl surveys. These surveys could be considered in future to provide indices of recruitment or abundance for western horse mackerel. Further information can be found in the stock annex, and in ICES (2008/ACOM:13) and ICES (2009/RMC:04).

Acoustic surveys

No new information was presented on acoustic surveys. Further information can be found in in the stock annex and in ICES (2008/ACOM:13) and ICES (2006/LRC:18).

5.2.4 Effort and catch per unit effort

No new information was presented on effort and catch per unit effort. Further information can be found in the stock annex.

5.2.5 Catch in numbers

In 2008 the Netherlands (VIIb,e,h,j, VIIIa,b,d), Norway (IVa), Ireland (IVa, VIa, and VIIb,j), and Spain (VIIIb,c) provided catch in numbers at age. The catch sampled for age readings in 2008 covered 70% of the total catch.

The total annual and quarterly catches in numbers for western horse mackerel in 2008 are shown in Table 5.2.5.1. The sampling intensity is discussed in Section 1.3.

The catch at age matrix, as used in the assessment, is given in Table 5.2.5.2, and illustrated in Figure 5.2.5.1. It shows the dominance of the 1982 year class in the catches since 1984 until it entered the plus group in 1996. Since 2002 the 2001 year class of horse mackerel has been caught in considerable numbers.

5.2.6 Mean length at age and mean weight at age

Mean length at age and mean weight at age in the catches

The mean weight and mean length at age in the catches by year, and by quarter in 2008 are shown in Tables 5.2.6.1 and 5.2.6.2.

Mean weight at age in the stock

Mean weights-at-age in the stock, as used in the assessment, are presented in Table 5.2.6.3. Further information can be found in the stock annex.

5.2.7 Maturity ogive

Maturity-at-age, as used in the assessment, is presented in Table 5.2.7.1. Further information can be found in the stock annex.

5.2.8 Natural mortality

A fixed natural mortality of $0.15.\text{year}^{-1}$ is assumed for all ages and years in the assessment. Further information can be found in the stock annex.

5.2.9 Fecundity data

The potential fecundity data used in the assessment is listed in Table 5.2.9.1. The basis for specifying the realised fecundity 'prior', as used in the assessment (mean=1 847 eggs per gram spawning female, CV=0.287), is given in the stock annex.

5.3 Methods

5.3.1 Data exploration

Within-cohort consistency of the catch-at-age matrix is investigated in Figure 5.3.1.1, and demonstrates that the catch-at-age data contains information on year class strength that could form the basis for an age-structured model.

Log-catch curves are shown in Figure 5.3.1.2, along with the negative of the gradients fitted to ages 1-3 (bottom left plot), and ages 4-8 (bottom right plot). The general pattern of log-catches is increasing log-catch with age for the earlier years, indicating cohorts are not fully selected until they have reached an advanced age, and the more usual decreasing log-catch for a wider range of ages in the most recent years (compared to earlier years), indicating selection has shifted towards younger fish over time. A requirement for interpreting the negative gradient as a proxy for total mortality is that catchability and selectivity-at-age remains stable within a cohort, so that any changes in the catch of a cohort are explained by changes in total mortality. The prevalence of negative values for the proxy (bottom plots of Figure 5.3.1.2) indicates that this requirement has not always been met for western horse mackerel catch data, and also indicates that a separable model with constant selectivity-at-age for the earliest data would not be appropriate.

5.3.2 Assessment model

The SAD (linked Separable-ADAPT VPA) model is used for the assessment of western horse mackerel. A description of the model can be found in the stock annex. The western horse mackerel assessment is presented as an update assessment.

The updated assessment could be conducted either by keeping the window 5 years long but shifting it one year along (2004-2008), or by keeping the first year fixed and extending it by one year to 6 years (2003-2008). The decision to proceed with a 6-year window instead of a 5-year one was based on increased precision of model estimates for the former compared to the latter (improvement in CVs of 13-22% for selection-at-age parameters, 1-4% for the most recent 5 years of SSB estimates, 3-6% for separable period F-estimates, and 13-17% for the most recent 5 years of recruitment estimates; slight improvement in AIC_c of 0.2%), and the fact that residual patterns for the separable period log-catches were well-behaved in both cases, indicating a lack of evidence for the breakdown of the separable assumption. The update assessment is therefore presented as the same as the 2008 assessment, but with the addition of one more year of data and the extension of the separable window to 6 years (2003-2008).

Fits to the available data are given in Figure 5.3.2.1, and model estimates with associated precision in Figures 5.3.2.2-3. Model estimates and residual patterns are similar to those presented in 2008 (ICES 2008/ACOM:13). A comparison with the 2008 assessment is discussed in Section 5.8.

Sensitivity to the length of the separable window is shown in Figure 5.3.2.4. This figure indicates that SSB, recruitment and F trajectories are relatively insensitive to the length of the separable period (although the precision of these estimates are affected, as discussed above), but selectivity-at-age is affected most probably because of the known increased targeting of younger fish in recent years.

Retrospective plots are shown for two cases. In the first case, 5-year retrospective plots were constructed for SSB, recruitment and F trajectories, and for selectivity-at-age, where the length of the separable window is kept at six years. For this case, Figure 5.3.2.5 indicates substantial retrospective bias both in the recent period and historically, with changes in the bias from one direction to the other and back again. This behaviour is likely due to the changes in selectivity-at-age for the separable period as the window is moved back in time, but the availability of egg production estimates may also have an effect (not only for this set of retrospective plots, but for the one discussed below). The changes in selectivity-at-age indicate increased selection of younger fish in recent years (also evident in Figure 5.3.2.4).

For the second case, 3-year retrospective plots were constructed as before, but this time the starting year of the separable window (2003) was kept constant, thus resulting in the separable window reducing in length as years were dropped. The reduced length of the separable window only allowed 3 years for the analysis, because a window any shorter than 4 years in length resulted in a large deterioration in the precision of model estimates. Results for the second set of retrospective plots are shown in Figure 5.3.2.6, giving little indication of the retrospective bias problems previously shown in Figure 5.3.2.5. However, estimates of selectivity-at-age in Figure 5.3.2.6 were different for the 2003-2006 window compared to the other window options shown, but in this case precision of the selectivity-at-age estimates was worse than the other cases shown (14% and 16.5% worse, on average, than the 2003-2007 and 2003-2008 windows, respectively), and these estimates remain within the confidence bounds of both the 2003-2007 and 2003-2008 window options (see Figure 5.3.2.1a for the latter).

5.4 Reference points

No new calculations have taken place this year (see stock annex for details).

5.5 State of the Stock

5.5.1 Stock assessment

The SAD model with a separable window of 2003-2008 is presented as the final assessment model. Stock numbers-at-age and Fishing mortality-at-age are given in Tables 5.5.1.1 and 5.5.1.2, and a stock-summary is provided in Table 5.5.1.3, and illustrated in Figure 5.5.1.1. SSB peaked in 1988 following the very strong 1982 year class and has since declined and shown two further smaller increases following moderate year classes in the early- to mid-90s and the moderate-to-strong year class of 2001 (a third the size of the 1982 year class). Year classes following 2001 have been weak, although these year classes are estimated with poorer precision than previous ones. Fishing mortality on the older ages (4-8) is low compared to levels in the 1990s.

5.5.2 Reliability of the assessment

Fishery-independent data for this stock is extremely limited, with only a single data point for egg production every three years. The reliability of this assessment depends on the reliability of the input data, and the extent to which model assumptions are violated. For example, simulation testing has shown that if there is an increasing trend in the realised fecundity parameter that is not accounted for, then the model over-estimates SSB and recruitment, and underestimates fishing mortality and realised fecundity (ICES 2008/ACOM:13).

The model relies on a ‘prior’ distribution for realised fecundity (based on published values), which it uses for scaling, and the inclusion of any additional information on realised fecundity would help improve the reliability of the assessment. Estimates of F are considerably lower than the assumed value for natural mortality (M=0.15). Reviewers have commented that the assumed value for M should be investigated. However, there is no data available (such as tagging) that could assist in estimating M more accurately. Nevertheless, total mortality appears to be low, given the persistence of the 1982 year class in the catch data.

Decisions on the length of the separable window need to balance the precision of model estimates (windows that are too short result in less precise model estimates) with considerations of whether the separability assumption continues to hold (by considering information from the fishery and patterns in the log-catch residual plots).

Although some estimates for the uncertainty of the egg input data are available, they are not currently available in a form that can be included in the assessment model. This is one area that might need addressing in the future if a systematic estimation of likely error in the model is to be evaluated. The inclusion of independent estimates of the uncertainty of the egg production would improve the reliability of the assessment

The precision of recruitment estimates for the most recent years is poor, with CVs of 33-55% for the most recent 5 years. This result is expected given the negligible input the first three age classes make to SSB, and the limited catch data for recruits. This uncertainty increases as the assessment is updated without additional egg production survey data. The estimate for the 2001 year class at age 0 is the largest since 1982, with a CV of 25%.

The assessment could be improved by the inclusion of information such as survey tuning indices. However, obtaining a reliable tuning series is likely to be hampered by the large geographic area in which the stock occurs and the strong migration patterns. It does not seem that changes to the modelling methodology alone will fundamentally solve this problem.

5.6 Short-term forecast

A short-term forecast is not conducted for western horse mackerel because a management plan is in place. The management plan provides for a constant TAC set for 3 years. This TAC (180 000t) was last set for 2008 based on the egg survey estimate in that year. This value will remain unchanged for 2009 and 2010. The 2007 survey estimate has not been revised in 2008 or 2009, so that the TAC should remain the same.

5.7 Uncertainties in the assessment and forecast

See Section 5.5.2 on reliability of assessment.

5.8 Comparison with previous assessment and forecast

A comparison with the update assessment with the 2008 assessment is shown in Figure 5.8.1. SSB, recruitment and F trajectories are similar, but there are differences in the selectivity-at-age curve, although these differences occur within the confidence bounds for these estimates, as shown in Figure 5.3.2.2a.

5.9 Management plans and evaluations

In 2007 the Pelagic RAC, in collaboration with a group of scientists, developed and proposed a management plan for the Western Horse Mackerel stock. The plan sets a multiannual TAC using a harvest rule that comprises a fixed TAC component and one that varies with the trend in egg production as recorded during the previous 3 egg surveys. The TAC is set according to the following rule:

$$TAC_{y+1\text{ to }y+3} = 1.07\left[\frac{TAC_{ref}}{2} + \frac{TAC_{y-2\text{ to }y}sl}{2}\right]$$

where y is the year an egg survey becomes available, TAC_{ref} = 150kt and sl is a function of the slope of the most recent three egg abundance estimates from surveys such that

	slope	≤ -1.5	$sl = 0$
-1.5 <	slope	< 0	$sl = 1-((1/-1.5)*slope)$
0 ≤	slope	≤ 0.5	$sl = 1+((0.4/0.5)*slope)$
0.5 <	slope		$sl = 1.4$

Upon evaluation, ICES considered the plan to be precautionary only in the short term (3 years). The plan was used in the setting of the TAC for the three year period 2008-2010 at 180kt, using the egg survey result of 2007. There are however, several issues related to the implementation of the management plan. The mismatch between the assessment and management areas for this stock has been highlighted for several years as problematic in terms of the management of the fishery. Also, the plan was developed with the proviso that all catches of western horse mackerel should be included against the TAC. This is not the case at present.

Although in use, the management plan as described above has not been officially placed into EC regulations. At present the EC is in the process of consulting with EU member states regarding the alignment of the assessment and management areas with a view to reaching agreement prior to the setting of fishing opportunities for 2010 (see Section 5.1). The completion of this exercise is a necessary prerequisite for the management plan to be officially adopted, as outlined in the draft EC regulation. The draft regulation contains the following important points:

1. The harvest rule is as set out in the original management plan text (ICES Advice 2007, Book 9, albeit the parameters have been assigned revised names)
2. The new regulation will replace the existing plan in 2010
3. The harvest rule will be applied once again for 2010, using the 2007 egg survey result. The 2010 egg survey result will then be used to set the TAC for 2011-2013.
4. A formal review of the plan will take place in 2014.
5. The TAC will be reduced each year to account for discarding and slipping in the previous year (as estimated by STECF). If no estimate is available, the highest value recorded in the previous 15 years will be used as a basis for the calculated reduction.

As described, the draft regulation states that the first review of the management plan will take place in 2014. However, the original plan scheduled a review for 2009 (timely as the ICES evaluation resulted in the plan being considered precautionary only for 3 years). The results of the 2009 review were presented to the working group (WD by Campbell and Kelly). The review explored many of the concerns detailed by ICES during its evaluation and investigated means by which the harvest rule could be modified to account for them. Revised simulations were also conducted on the basis of additional stock and assessment data being available since the initial runs. These investigations will inform the work of the formal review in 2014.

5.10 Management considerations

The 2001 year class is now well established in the fishery. It is around a third the size of the 1982 year class and well above those in the early to mid-90s. This year, there is no new egg survey data and the only additional information available to the assessment is the catch data from 2008. SSB in 2009 was estimated at 2.6Mt, which is well above the 1982 SSB of 1.4Mt which has been adopted as B_{lim}. A B_{pa} consistent with this is 1.8Mt and was proposed in 2008. It is not recommended to use B_{pa} as a management target but rather follow the precautionary rule in the agreed management plan.

The TAC has only been given for parts of the distribution and fishing areas (EU waters). The Working Group advises that the TAC should apply to all areas where western horse mackerel are caught (see Section 5.1). Note that subarea VIIIc is now included in the Western stock distribution area. If (as planned) the management area limits are revised, measures should be taken to ensure that misreporting of juvenile catch taken in subareas VIIe,h and VIId (the latter then belonging to the North Sea stock management area) is effectively hindered. The mismatch between TAC and fishing areas and the fact that the TAC is only applied to EU waters has resulted in the catch prior to 2007 exceeding those advised by ICES.

The management plan proposed by the Pelagic RAC in 2007 was evaluated by ICES and considered to be precautionary in the short term. It was subsequently used to set the TAC for 2008-2010. This plan makes use of the information available in the egg production surveys, and bases triennial TACs on the slope of the three previous egg production estimates. It should be noted that the management plan assumes that all catches are taken against the TAC and, should the management and assessment areas be combined in the future, the TAC as set by the EU will not cover all fisheries.

5.11 Ecosystem considerations

Knowledge about the distribution of the western horse mackerel stock is gained from the egg surveys and the seasonal changes in the fishery. However, based on these observations it is not possible to infer a similar changing trend in the distribution of western horse mackerel as for NEA mackerel.

5.12 Regulations and their effects

There are no horse mackerel management agreements between EU and non EU countries. The TAC set by EU therefore only apply to EU waters and the EU fleet in international waters. The minimum landing size of horse mackerel by the EU fleet is 15cm (10% undersized allowed in the catches).

The stock allocations were changed in 2005 following the results of the HOMSIR project (Abaunza *et al*. 2003) and VIIIc is now belonging to the western stock. In view of the front loading of the Fishing Opportunities Regulation for 2009, alterations based on the findings of the HOMSIR project were applied to the TAC management areas.

In Norwegian waters there is no quota for horse mackerel but existing regulations on bycatch proportions as well as a general discard prohibition (for all species) apply to horse mackerel.

5.13 Changes in fishing technology and fishing patterns

The description of the fishery is given in Sections 3.1 and 5.2.1 and no big changes in fishing areas or patterns have taken place. However, there has been a gradual shift from an industrial fishery for meal and oil towards a human consumption fishery.

5.14 Changes in the environment

Migrations are closely associated with the slope current, and horse mackerel migrations are known to be modulated by temperature. Continued warming of the slope current is likely to affect the timing and spatial extent of this migration.

Since the strong 1982 year class of the western stock started to appear in the North Sea in 1987 a good correspondence between the modelled influx of Atlantic water to the North Sea in the first quarter and the horse mackerel catches taken by Norwegian purse seiners in the Norwegian EEZ (NEZ) later (October-November) the same year (Iversen *et al*. 2002, Iversen WD presented in ICES 2007/ACFM:31) has been noted in most years.

Table 5.2.1.1 Horse mackerel general. Catches (t) 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	-	-	9643	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	2003
Faroe Islands	1,598	799[3]	188[3]	132[3]	250[3]	-		
Denmark	-	-	1,755[3]			-		
France	-	-	-			-		
Germany	-	-	-			-		
Norway	887	1,170	234	2,304	841	44	1,321	22
Russia	881	648	345	121	84[3]	16	3	2
UK (England + Wales)	-	-	-			-		
Estonia	-	-	22					
Total	3,366	2,617	2,544	2557	1175	60	1,324	24

	2004	2005	2006	2007	2008[1]
Faroe Islands	-	-	3	-	-
Denmark	-	-	-	-	-
France	-	-	-	-	-
Germany	-	-	-	-	-
Ireland	-	-	-	366[4]	-
Norway	42	176	27	-	572
Russia					
UK (England + Wales)	-	-	-	-	-
Estonia	-	-	-	-	-
Total	42	176	30	366	572

[1]Preliminary.

[2]Included in Subarea IV.

[3]Includes catches in Div. Vb.

[4]Taken in Div. Vb

Table 5.2.1.2. Horse mackerel general. Catches (t) in North Sea Subarea IV and Skagerrak Division IIIa by country. (Data submitted by Working Group members). Catches partly concern the North Sea horse mackerel.

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	2003	2004	2005	2006[1]
Belgium	19	21	19	19	1,004	5	4	6	3
Denmark	2,048	8,006	4,409	2,288	1,393	3,774	8,735	4,258	1,343
Estonia	22	-	-						
Faroe Islands	28	908	24	-	699	809		35	
France	379	60	49	48	-	392	174	3,876	2,380
Germany	4,620	4,071	3,115	230	2,671	3,048	4,905	1,811	965
Ireland	-	404	103	375	72	93	379	753	2,077
Lithuania									2,354
Netherlands	3,811	3,610	3,382	4,685	6,612	17,354	21,418	24,679	20,984
Norway	13,129	44,344	1,246	7,948	35,368	20,493	10,709	24,937	27,200
Russia	-	-	2	-	-	-			
Sweden	3,411	1,957	1,141	119	575	1,074	665	239	491
UK (Engl. + Wales)	2	11	15	317	1,191	1,192	2,552	1,778	423
UK (Scotland)	3,041	1,658	3,465	3,161	255	1	1	22	
Unallocated+discards	737	-325	14613	649	-149	-14,009	-19,103	-21,830	314
									-19,623
Total	31,247	64,725	31583	19,839	49,691	34,226	30,435	40,564	38,911

[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 5.2.1.2 cont. Horse mackerel general. Catches (t) in North Sea Subarea IV and Skagerrak Division IIIa by country. (Data submitted by Working Group members). Catches partly concern the North Sea horse mackerel.

Country	2007	2008[1]
Belgium	5	2
Denmark	329	59
Faroe Islands	3	55
France	457	943
Germany, Fed.Rep.	93	1,167
Ireland	652	1,186
Netherlands	20,027	9,400
Lithuania	98	- 11,652
Norway	5.423	45
Sweden	130	-
UK (Engl. + Wales)	2,966	20
UK (Scotland)	626	-9,151
Unallocated +discards	-14,403	
Total	16,407	15,377

[1]-**Preliminary.**

Table 5.2.1.3 Horse mackerel general. Catches (t) 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	2003	2004	2005	2006
Denmark	-	-	-	-	-	-	-	-	-
Faroe Islands	-	-	-	-	-	-	-	-	-
France	221	25,007	-	428	55	209	172	41	411
Germany	414	1,031	209	265	149	1,337	1,413	1,958	1,025
Ireland	21,608	31,736	15,843	20,162	12,341	20,915	15,702	12,395	9,780
Lithuania									2,822
Netherlands	885	1,139	687	600	450	847	3,701	6,039	1,892
Spain	-	-	-	-	-	-	-	-	-
UK (Engl.+Wales)	10	344	41	91	-	46	5	52	-
UK (N.Ireland)	1,132	-	-			453		210	82
UK (Scotland)	10,447	4,544	1,839	3,111	1,192		377	62	43
Unallocated+disc.	98	1,507	2,038	-21	3	-553	559	1,298	-304
Total	34,815	65,308	20,657	24,636	14,190	23,254	21,929	22,055	15,751

Country	2007	2008[1]
Denmark	-	-
Faroe Islands	-	573
France	-	74
Germany	1,835	5,097
Ireland	20,341	18,786
Lithuania	80	641
Netherlands	2,177	3,904
Norway	2	20
Russia	-	-
Spain	-	-
UK (Engl. + Wales)	232	-
UK (Scotland)	38	588
Unallocated+discards	1,474	-3,781
Total	26,279	25,902

[1]Preliminary. [2]Included in Subarea VII.,

[3]Includes Divisions IIIa, IVa,b and VIb. [4]Includes a negative unallocated catch of -7000 t.

Table 5.2.1.4 Horse mackerel general . Catches (t) 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	2003	2004	2005	2006
Faroe Islands	-	-	550	-	-	-	-	3,660	1,201
Belgium	18	-	-	-	1	-	+	+	+
Denmark	25,492	19,223	13,946	20,574	10,094	10,867	11,529	9,939	6,838
France	24,223	-	20,401	11,049	6,466	7,199	8,083	8,469	7,928
Germany	25,414	15,247	9,692	8,320	10,812	13,873	16,352	10,437	7,139
Ireland	51,720	25,843	32,999	30,192	23,366	13,533	8,470	20,406	16,841
Lithuania									3,569
Netherlands	91,946	56,223	50,120	46,196	37,605	48.222	41,123	31,156	35,467
Spain	-	-	50	7	0	1	27	12	60
UK (Engl. + Wales)	12,832	8,885	2,972	8,901	5,525	4,186	7,178	4,752	2,935
UK (N.Ireland)	-	-	-	-	-			217	142
UK (Scotland)	5,095	4,994	5,152	1,757	1,461	268	1,146	59	413
Unallocated+discards	12,706	31,239	1,884	11,046	2,576	24,897	18,485	18,368	19,379
Total	249,446	161,654	137,766	138,042	97,906	123,046	112,393	107,475	101,912

Country	2007	2008[1]
Faroe Islands	475	212
Belgium	+	+
Denmark	4,806	1,970
France	6,844	11,008
Germany	3.943	5,700
Ireland	8,039	16,293
Lithuania	5,585	4,907
Netherlands	38,034	43,514
Spain	-	11
Sweden	55	-
UK (Engl. + Wales)	9,105	-
UK (Scotland)	738	476
Unallocated+discards	15,460	14,656
Total	93,084	98,746

[1]Preliminary

Table 5.2.1.5 Horse mackerel general. Catches (t) 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	2003	2004	2005	2006
Denmark	1,728	4,818	2,584	582	-	-		-	1,513
France	1,844	74	7	5,316	13,676	-	2,161	3,540	3,944
Germany	3,268	3,197	3,760	3,645	2,249	4,908	72	4,776	3,325
Ireland	-	-	6,485	1,483	704	504	1,882	1,808	158
Lithuania									401
Netherlands	6,604	22,479	11,768	36,106	12,538	1,314	1,047	6,607	6,073
Russia	-	-	-	-	-	6,620			-
Spain	23,599	24,190	24,154	23,531	22,110	24,598	16,245	16,624	13,874
UK (Engl. + Wales)	9	29	112	1,092	157	982	516	838	821
UK (Scotland)	-	-	249	-	-	-		-	-
Unallocated+discards	1,884	-8658	5,093	4,365	1,705	2,785	2,202	7,302	4,013
Total	38,936	46,129	54,212	76,120	54,560	41,711	24,125	41,495	34,122

Country	2007	2008[1]
Denmark	2,687	3,289
France	10,741	2,848
Germany	-	918
Ireland	694	246
Lithuania	-	-
Netherlands	-	6,269
Russia	-	-
Spain	13,853	19,840
UK (Engl. + Wales)	-	-
UK (Scotland)	-	-
Unallocated+discards	412	482
Total	28,387	33,892

[1]Preliminary.

[2]Included in Subarea VII.

Table 5.2.2.1 Western horse mackerel. The time series of egg production estimates (10^{-12} eggs).

Year	Total egg production
1983	513
1989	1762
1992	1712
1995	1265
1998	1136
2001	821
2004	889
2007	1427

Table 5.2.5.1 Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2008

Ages	IIIa	IIa	IVa	VIa	VIb	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	VIIIc west	VIIIc east	VIIId	Sum
1Q																				
0				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	971.17	64.77	0.14	2.11		1038.19
2				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	537.34	35.92	4.28	9.22		586.76
3				0.00	0.00	0.00	0.00	1465.93	21.39	0.00	0.00	0.00	0.00	0.00	2.69	0.48	17.35	30.23		1538.07
4				28.11	0.19	0.00	11.21	488.58	7.13	0.08	1545.17	230.67	2.01	499.12	0.99	1.20	87.04	114.42		3015.92
5				184.66	1.24	787.73	75.90	9088.78	132.62	0.46	9270.23	3001.98	25.76	2994.45	1.14	1.53	193.83	146.78		25907.09
6				163.90	1.10	317.94	5.29	3342.28	48.77	0.00	0.00	392.25	2.37	0.00	0.83	1.38	260.39	133.42		4669.92
7				13063.49	87.72	28661.27	518.57	4300.20	62.75	1.16	23175.96	33081.23	238.94	7486.24	0.80	1.42	403.08	138.29		111221.12
8				1180.94	7.93	1248.03	44.02	1446.50	21.11	0.00	0.00	4322.09	26.42	0.00	1.26	1.92	540.79	185.49		9026.50
9				1507.47	10.12	1956.44	42.13	1876.35	27.38	0.08	1545.17	2723.43	17.97	499.12	1.29	1.99	521.76	191.58		10922.28
10				1130.53	7.59	699.60	23.60	0.00	0.00	0.08	1545.17	996.05	6.02	499.12	1.67	2.58	730.39	248.65		5891.05
11				404.31	2.71	353.19	2.90	0.00	0.00	0.00	0.00	461.34	4.03	0.00	1.22	2.01	720.97	194.45		2147.13
12				405.14	2.72	94.91	1.36	0.00	0.00	0.00	0.00	461.34	4.03	0.00	1.31	2.13	851.36	206.05		2030.35
13				307.32	2.06	189.81	1.79	0.00	0.00	0.00	0.00	158.71	1.23	0.00	1.06	1.68	651.62	162.28		1477.56
14				624.60	4.19	711.80	16.21	0.00	0.00	0.08	1545.17	440.64	3.70	499.12	0.79	1.33	590.39	129.20		4567.22
15				1741.10	11.69	379.63	5.09	1935.07	28.24	0.00	0.00	1188.85	10.08	0.00	0.69	1.29	662.48	125.06		6089.27
SUM				20741.57	139.26	35400.35	748.07	23943.69	349.39	1.94	38626.87	47458.58	342.56	12477.17	1524.25	121.63	6235.87	2017.23		190128.43
2Q																				
0				0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1				0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	309.93	258.72	51.37	0.49	77.37	0.00	697.88
2				0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	1239.89	271.37	53.33	15.91	25.69	0.00	1606.19
3				0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	4184.49	953.11	2.45	69.41	53.29	731.37	5994.12
4				0.47	0.00	0.00	0.00	0.00	0.00			259.73	0.00	10538.83	2595.89	2.70	356.83	232.66	1736.95	15724.06
5				0.56	0.00	76.51	0.00	0.00	0.00			779.56	0.00	7284.14	474.30	3.79	573.70	330.22	3108.17	12630.95
6				0.22	0.00	30.88	0.00	0.00	0.00			1819.22	0.00	2479.78	3.84	5.27	787.50	460.59	457.07	6044.37
7				4.15	0.00	2783.96	0.00	0.00	0.00			19230.76	0.00	2169.69	474.67	4.82	945.29	427.57	548.51	26589.42
8				0.15	0.00	121.22	0.00	0.00	0.00			1299.39	0.00	619.87	3.40	4.89	1254.41	430.99	182.87	3917.19
9				0.19	0.00	190.04	0.00	0.00	0.00			779.56	0.00	929.96	238.05	3.68	1056.09	328.96	0.00	3526.53
10				0.14	0.00	67.95	0.00	0.00	0.00			519.83	0.00	309.93	238.04	4.12	1266.68	374.79	0.00	2781.48
11				0.05	0.00	34.31	0.00	0.00	0.00			0.00	0.00	309.93	238.43	3.45	1197.50	298.79	0.00	2082.46
12				0.05	0.00	9.22	0.00	0.00	0.00			0.00	0.00	619.87	4.09	3.46	1468.52	271.17	0.00	2376.38
13				0.04	0.00	18.44	0.00	0.00	0.00			519.83	0.00	464.98	3.98	2.76	1026.39	202.28	0.00	2238.70
14				0.08	0.00	69.14	0.00	0.00	0.00			259.73	0.00	1704.87	241.47	2.60	761.69	150.53	91.43	3281.54
15				0.22	0.00	36.87	0.00	0.00	0.00			519.83	0.00	1704.87	479.88	3.01	706.85	139.59	0.00	3591.12
SUM				6.32	0.00	3438.54	0.00	0.00	0.00			25987.44	0.00	34871.03	6479.24	151.70	11487.26	3804.49	6856.37	93082.39
3Q																				
0	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	11.63	74.56	8350.49	8929.20	0.00	17365.88
1	0.00		0.00	0.00	0.00	0.00	0.00	36.76	0.00			0.00	0.00	2612.56	91.55	209.39	27446.14	21270.98	0.00	51667.38
2	0.00		0.00	0.00	0.00	0.00	0.00	515.35	4.58			0.00	0.00	4934.95	0.32	14.41	3310.44	109.76	35.76	8925.57
3	0.02		2.99	0.00	0.00	0.00	0.00	1537.16	24.86			1002.94	0.00	8708.60	0.10	2.30	382.43	156.25	142.93	11960.58
4	0.03		4.40	619.50	0.00	6.10	0.00	1570.65	16.48			3008.99	0.00	2902.83	0.34	2.87	129.06	526.22	160.81	8948.28
5	0.03		3.17	712.95	0.00	29.14	0.00	1616.18	16.57			6017.97	0.00	580.54	0.69	6.42	54.55	1402.97	35.76	10476.94
6	0.17		21.63	263.03	0.00	29.10	0.00	585.48	11.54			14543.30	0.00	870.82	0.88	8.57	30.31	1911.76	17.88	18294.47
7	1.02		128.89	3319.02	0.00	357.43	0.00	622.24	8.01			18555.22	0.00	0.00	0.97	9.36	14.88	2105.46	0.00	25122.50
8	0.35		44.24	0.00	0.00	203.80	0.00	50.76	4.85			2507.52	0.00	290.27	0.70	6.86	133.87	1425.79	17.88	4686.89
9	0.40		50.73	0.00	0.00	62.49	0.00	36.76	0.00			1755.14	0.00	0.00	0.71	9.57	889.81	1320.17	0.00	4125.78
10	0.43		54.44	0.00	0.00	41.49	0.00	0.00	1.24			2006.05	0.00	0.00	0.36	3.79	307.73	565.74	0.00	2981.27
11	0.14		17.34	0.00	0.00	20.50	0.00	0.00	0.00			752.20	0.00	580.54	0.49	7.16	811.01	848.21	0.00	3037.59
12	0.29		36.71	0.00	0.00	11.68	0.00	73.66	0.00			1002.94	0.00	0.00	0.29	4.33	515.79	490.30	0.00	2135.99
13	0.11		14.34	0.00	0.00	15.48	0.00	0.00	0.00			752.20	0.00	0.00	0.20	3.37	511.33	277.17	0.00	1574.20
14	0.24		30.44	0.00	0.00	11.83	0.00	0.00	0.00			250.73	0.00	0.00	0.14	1.65	237.70	146.90	0.00	679.63
15	0.31		39.14	0.00	0.00	30.28	0.00	0.00	0.00			3008.99	0.00	290.27	0.16	3.77	667.28	217.34	17.88	4275.42
SUM	3.54	0.00	448.46	4914.50	0.00	819.32	0.00	6645.00	88.13			55164.19	0.00	21771.38	109.53	368.38	43792.82	41704.22	428.90	176258.37
4Q																				
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	4.38	70.00	7195.00	5276.76	0.00	12546.14
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	120.62	157.05	19718.28	2958.58	0.00	22954.53
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2798.01	40.83		51.08	0.00	0.00	213.93	711.50	23.28	2534.03	1402.97	324.56	8100.19
3	0.02	9.00	187.72	0.00	0.00	0.00	0.00	15190.12	221.64		277.30	0.00	0.00	1161.40	1107.05	9.88	341.82	2419.13	1297.12	22222.20
4	0.03	13.00	276.42	1184.71	0.00	823.80	0.00	10070.93	146.94		183.85	0.00	0.00	770.00	1117.56	10.22	108.18	3109.65	1459.41	19274.70
5	0.03	10.00	199.06	4312.19	0.00	3651.53	0.00	10126.82	147.76		184.87	0.00	0.00	774.27	955.78	13.49	33.90	4375.60	324.56	25109.86
6	0.17	65.00	1360.42	1450.48	0.00	3156.28	121.97	7050.60	102.87		128.71	0.00	0.00	539.07	516.79	12.37	15.77	4048.94	162.28	18731.72
7	1.02	389.00	8104.77	67561.32	0.00	46343.13	81.28	4896.67	71.45		89.39	0.00	0.00	374.39	235.45	10.89	22.31	3545.18	0.00	131726.25
8	0.35	134.00	2781.69	4241.80	0.00	15107.77	1423.29	2964.85	43.26		233.24	2078.80	0.00	976.89	259.98	8.22	97.58	2476.01	162.28	32990.01
9	0.40	153.00	3190.13	4625.88	0.00	5112.31	935.30	0.00	0.00		84.30	978.32	0.00	353.06	106.65	9.84	338.92	2410.04	0.00	18298.15
10	0.43	164.00	3423.23	2745.93	0.00	3428.18	447.30	755.03	11.02		98.08	978.32	0.00	410.79	98.11	5.57	227.62	1277.41	0.00	14071.02
11	0.14	52.00	1090.19	715.26	0.00	1716.10	325.33	0.00	0.00		73.76	855.99	0.00	308.91	81.21	8.82	460.77	1770.73	0.00	7459.21
12	0.29	111.00	2308.28	730.75	0.00	1015.80	121.97	0.00	0.00		21.07	244.49	0.00	88.23	28.63	5.67	326.62	1064.51	0.00	6067.31
13	0.11	43.00	901.45	736.45	0.00	1108.39	40.69	0.00	0.00		21.07	244.49	0.00	88.23	22.09	3.48	230.70	577.38	0.00	4017.53
14	0.24	92.00	1914.28	1159.63	0.00	1036.09	0.00	0.00	0.00		21.07	244.49	0.00	88.23	20.33	1.86	129.55	294.10	0.00	5001.87
15	0.31	118.00	2460.93	2894.91	0.00	2405.72	569.27	0.00	0.00		42.15	489.16	0.00	176.53	39.54	2.59	243.95	250.58	162.28	9855.92
SUM	3.54	1353.00	28198.57	92359.31	0.00	84905.10	4066.40	53853.03	785.77		1509.94	6114.06	0.00	6323.93	5425.67	353.23	32025.00	37257.57	3892.50	358426.62
1Q-4Q																				
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.01	144.56	15545.48	14205.96	0.00	29912.01
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.76	0.00	0.00	0.00	0.00	0.00	2922.49	1442.07	482.57	47165.05	24309.04	0.00	76357.98
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3313.36	45.40	0.00	51.08	0.00	0.00	6388.77	1520.52	126.93	5864.66	1547.64	360.33	19218.69
3	0.05	9.00	190.70	0.00	0.00	0.00	0.00	18193.21	267.89	0.00	277.30	1002.94	0.00	14054.49	2062.95	15.11	811.01	2658.90	2171.42	41714.97
4	0.07	13.00	280.81	1832.80	0.19	829.90	11.21	12130.16	170.56	0.08	1729.01	3499.39	2.01	14710.78	3714.78	16.99	681.10	3982.95	3357.16	46962.95
5	0.05	10.00	202.23	5210.35	1.24	4544.91	75.90	20831.78	296.95	0.46	9455.10	9799.52	25.76	11633.40	1431.92	25.24	855.98	6255.57	3468.49	74124.85
6	0.34	65.00	1382.06	1877.63	1.10	3534.20	127.26	10978.37	163.18	0.00	128.71	16754.77	2.37	3889.67	522.34	27.58	1093.98	6554.70	637.23	47740.49
7	2.04	389.00	8233.66	83947.98	87.72	78145.79	599.85	9819.12	142.21	1.16	23265.35	70867.22	238.94	10030.31	711.89	26.49	1385.56	6216.51	548.51	294659.31
8	0.70	134.00	2825.93	5422.89	7.93	16680.82	1467.31	4462.11	69.22	0.00	233.24	10207.80	26.42	1887.03	265.33	21.89	2026.65	4518.28	363.03	50620.58
9	0.80	153.00	3240.86	6133.54	10.12	7321.28	977.42	1913.12	27.38	0.08	1629.46	6236.46	17.97	1782.13	346.71	25.07	2806.58	4250.75	0.00	36872.73
10	0.86	164.00	3477.67	3876.60	7.59	4237.22	470.90	755.03	12.25	0.08	1643.25	4500.25	6.02	1219.83	338.18	16.07	2532.43	2466.60	0.00	25724.83
11	0.27	52.00	1107.53	1119.62	2.71	2124.10	328.23	0.00	0.00	0.00	73.76	2069.53	4.03	1199.39	321.35	21.44	3190.25	3112.19	0.00	14726.40
12	0.58	111.00	2344.99	1135.95	2.72	1131.61	123.33	73.66	0.00	0.00	21.07	1708.77	4.03	708.10	34.32	15.60	3162.29	2032.03	0.00	12610.05
13	0.23	43.00	915.78	1043.81	2.06	1332.12	42.49	0.00	0.00	0.00	21.07	1675.24	1.23	553.21	27.33	11.30	2420.04	1219.11	0.00	9308.02
14	0.48	92.00	1944.73	1784.31	4.19	1828.87	16.21	0.00	0.00	0.08	1566.23	1195.60	3.70	2292.22	262.73	7.44	1719.34	720.73	91.43	13530.29
15	0.62	118.00	2500.06	4636.23	11.69	2852.51	574.36	1935.07	28.24	0.00	42.15	5206.83	10.08	2171.67	520.26	10.66	2280.56	732.57	180.16	23811.72
SUM	7.09	1353.00	28647.01	118021.71	139.26	124563.33	4814.47	84441.75	1223.28	1.94	40136.78	134724.32	342.56	75443.49	13538.69	994.94	93540.96	84783.53	11177.77	817895.88

Table 5.2.5.2 Western horse mackerel. Catch-at-age (thousands of fish).

	0	1	2	3	4	5	6	7	8	9	10	11+
1982	0	3713	21072	134743	11515	13197	11741	8848	1651	414	1651	81385
1983	0	7903	2269	32900	53508	15345	44539	52673	17923	3291	5505	129139
1984	0	0	241360	4439	36294	149798	22350	38244	34020	14756	4101	58370
1985	0	1633	4901	602992	4463	41822	100376	12644	16172	6200	9224	40976
1986	0	0	0	1548	676208	8727	65147	109747	25712	21179	15271	56824
1987	0	99	493	0	2950	891660	2061	41564	90814	11740	9549	62776
1988	876	27369	6112	2099	4402	18968	941725	12115	39913	67869	9739	76096
1989	0	0	0	20766	18282	5308	14500	1276731	12046	59357	83125	78951
1990	0	20406	45036	138929	61442	33298	10549	20607	1384850	37011	70512	226294
1991	20632	33560	89715	23034	207751	143072	73730	25369	25584	1219646	23987	137131
1992	14887	229703	36331	80552	56275	256085	127048	49020	19053	23449	1103480	152305
1993	46	109152	94500	16738	62714	94711	317337	144610	70717	32693	4822	1309609
1994	3686	60759	911713	115729	53132	44692	38769	221970	106512	40799	42302	998180
1995	2702	165382	470498	424563	215468	59035	90832	35654	245230	119117	99495	1362342
1996	10729	19774	658727	860992	186306	85508	51365	55229	53379	57131	56962	729283
1997	4860	110145	465350	735919	410638	244328	119062	127658	134488	109962	109165	601196
1998	744	91505	184443	488662	360116	219650	157396	122583	81499	68264	50555	389594
1999	14822	97561	83714	176919	265820	254516	212225	187250	147328	77691	35635	252044
2000	637	78856	131112	52716	71779	150869	170393	177995	133290	61578	18010	168770
2001	58685	69430	246525	151707	98454	101344	116952	234832	203823	103968	36076	132706
2002	13707	461055	120106	164977	126329	64449	69828	94429	130285	85325	45798	150103
2003	1843	303721	585700	165666	152117	88944	57445	45596	49476	92758	50503	109994
2004	21246	140299	110976	474273	76136	103011	69844	43981	31618	49188	56109	63823
2005	1260	71508	170936	310085	531221	68559	74392	61641	43454	22304	27127	99898
2006	1901	49396	39439	41585	73860	501168	57299	39424	43667	17148	12274	102329
2007	4583	37208	39743	46218	63337	105042	336626	48066	27637	20155	8801	59268
2008	29912	76358	19219	41715	46963	74125	47740	294659	50621	36873	25725	73986

Table 5.2.6.1 Western Horse Mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2008

1Q Ages	IIIa	IIa	IVa	VIa	VIb	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	VIIIc west	VIIIc east	VIIId	Mean
0																				
1															0.042	0.045	0.078	0.047		0.043
2															0.050	0.068	0.095	0.086		0.052
3								0.109	0.109						0.067	0.088	0.108	0.108		0.109
4				0.162	0.162	0.000	0.121	0.134	0.134	0.121	0.121	0.117	0.117	0.121	0.123	0.124	0.134	0.125		0.124
5				0.151	0.151	0.152	0.143	0.145	0.145	0.125	0.125	0.141	0.145	0.125	0.145	0.146	0.164	0.147		0.135
6				0.173	0.173	0.142	0.140	0.154	0.154	0.000	0.000	0.137	0.137	0.000	0.158	0.158	0.168	0.158		0.153
7				0.199	0.199	0.170	0.154	0.181	0.181	0.139	0.139	0.150	0.150	0.139	0.173	0.173	0.181	0.173		0.159
8				0.247	0.247	0.194	0.184	0.213	0.213			0.178	0.193		0.188	0.187	0.192	0.187		0.196
9				0.270	0.270	0.211	0.195	0.207	0.207	0.186	0.186	0.184	0.177	0.186	0.199	0.200	0.206	0.200		0.206
10				0.312	0.312	0.249	0.230			0.172	0.172	0.269	0.269	0.172	0.208	0.208	0.213	0.208		0.232
11				0.369	0.369	0.245	0.228					0.155	0.155		0.218	0.220	0.232	0.221		0.242
12				0.317	0.317	0.320	0.267					0.155	0.155		0.243	0.243	0.251	0.243		0.245
13				0.328	0.328	0.266	0.242					0.203	0.206		0.248	0.249	0.271	0.249		0.272
14				0.352	0.352	0.245	0.202			0.191	0.191	0.171	0.172	0.191	0.270	0.271	0.286	0.271		0.234
15+				0.429	0.429	0.343	0.254	0.300	0.300	0.000	0.000	0.179	0.184		0.283	0.290	0.342	0.297		0.321
Mean				0.244	0.244	0.179	0.161	0.172	0.172	0.140	0.140	0.157	0.157	0.140	0.046	0.079	0.238	0.206		0.170
2Q																				
0																				
1														0.055	0.045	0.038	0.077	0.031		0.047
2														0.071	0.055	0.065	0.095	0.074		0.068
3														0.084	0.078	0.086	0.109	0.105	0.085	0.084
4				0.160								0.128		0.104	0.096	0.129	0.129	0.129	0.097	0.103
5				0.161		0.152						0.138		0.116	0.117	0.144	0.153	0.146	0.107	0.118
6				0.175		0.142						0.158		0.139	0.152	0.152	0.159	0.153	0.107	0.146
7				0.187		0.170						0.170		0.115	0.159	0.166	0.173	0.165	0.125	0.164
8				0.247		0.194						0.161		0.199	0.192	0.185	0.187	0.178	0.122	0.177
9				0.270		0.211						0.165		0.221	0.188	0.199	0.201	0.193		0.197
10				0.312		0.249						0.246		0.201	0.232	0.205	0.209	0.202		0.217
11				0.369		0.245						0.000		0.248	0.244	0.223	0.226	0.212		0.230
12				0.317		0.320						0.000		0.217	0.275	0.252	0.250	0.230		0.240
13				0.328		0.266						0.249		0.242	0.299	0.268	0.252	0.236		0.248
14				0.352		0.245						0.159		0.302	0.383	0.307	0.269	0.268	0.164	0.282
15+				0.429		0.343						0.228		0.304	0.268	0.328	0.290	0.299	0.000	0.286
Mean				0.202		0.179						0.171		0.136	0.133	0.097	0.213	0.184	0.105	0.156
3Q																				
0															0.033	0.035	0.035	0.035		0.035
1								0.086						0.054	0.037	0.043	0.047	0.040		0.044
2								0.095	0.101					0.086	0.052	0.082	0.081	0.083	0.082	0.085
3	0.174		0.174					0.116	0.111			0.127		0.095	0.118	0.112	0.108	0.116	0.092	0.101
4	0.230		0.230	0.158		0.149		0.123	0.124			0.128		0.107	0.136	0.130	0.121	0.139	0.105	0.123
5	0.271		0.271	0.170		0.158		0.129	0.150			0.143		0.132	0.152	0.148	0.142	0.154	0.108	0.143
6	0.309		0.309	0.176		0.166		0.139	0.158			0.157		0.135	0.165	0.160	0.155	0.164	0.121	0.157
7	0.329		0.329	0.174		0.183		0.144	0.156			0.171			0.182	0.179	0.179	0.179		0.172
8	0.414		0.414			0.217		0.164	0.211			0.190		0.217	0.204	0.268	0.338	0.199	0.188	0.202
9	0.444		0.444			0.225		0.187				0.256			0.254	0.321	0.405	0.237		0.283
10	0.468		0.468			0.247			0.216			0.244			0.252	0.294	0.346	0.242		0.258
11	0.471		0.471			0.246						0.221			0.269	0.306	0.362	0.250		0.226
12	0.491		0.491			0.245		0.223				0.220			0.276	0.314	0.369	0.259		0.270
13	0.487		0.487			0.218						0.269			0.316	0.345	0.394	0.297		0.316
14	0.500		0.500			0.252						0.320			0.306	0.340	0.383	0.297		0.344
15+	0.597		0.597			0.288						0.351		0.382	0.403	0.416	0.448	0.385	0.422	0.372
Mean	0.423		0.423	0.172		0.204		0.126	0.137			0.181		0.095	0.046	0.082	0.080	0.083	0.116	0.120
4Q																				
0															0.042	0.028	0.035	0.022		0.029
1															0.062	0.045	0.045	0.045		0.045
2								0.101	0.101		0.101			0.101	0.099	0.092	0.084	0.100	0.082	0.094
3	0.174	0.174	0.174	0.000		0.000		0.111	0.111		0.111			0.111	0.113	0.111	0.108	0.114	0.092	0.110
4	0.230	0.230	0.230	0.167		0.149		0.124	0.124		0.124			0.124	0.127	0.125	0.120	0.131	0.105	0.129
5	0.271	0.271	0.271	0.174		0.162		0.150	0.150		0.150			0.150	0.142	0.148	0.148	0.148	0.108	0.155
6	0.309	0.309	0.309	0.190		0.168	0.175	0.158	0.158		0.158			0.158	0.155	0.166	0.170	0.161	0.121	0.174
7	0.329	0.329	0.329	0.205		0.182	0.254	0.156	0.156		0.156			0.156	0.166	0.186	0.193	0.179		0.202
8	0.414	0.414	0.414	0.241		0.215	0.228	0.211	0.211		0.212	0.214		0.212	0.208	0.247	0.292	0.201	0.188	0.235
9	0.444	0.444	0.444	0.257		0.225	0.241				0.241	0.241		0.241	0.228	0.287	0.352	0.222		0.277
10	0.468	0.468	0.468	0.285		0.247	0.241	0.216	0.216		0.248	0.280		0.248	0.244	0.276	0.310	0.243		0.312
11	0.471	0.471	0.471	0.268		0.246	0.273				0.287	0.287		0.287	0.272	0.292	0.337	0.248		0.297
12	0.491	0.491	0.491	0.287		0.244	0.286				0.313	0.313		0.313	0.271	0.293	0.328	0.257		0.359
13	0.487	0.487	0.487	0.263		0.230	0.218				0.222	0.222		0.222	0.221	0.319	0.355	0.283		0.311
14	0.500	0.500	0.500	0.306		0.252	0.000				0.300	0.300		0.300	0.297	0.310	0.347	0.273		0.371
15+	0.597	0.597	0.597	0.331		0.286	0.297				0.331	0.331		0.331	0.330	0.364	0.409	0.319	0.422	0.391
Mean	0.423	0.423	0.423	0.216		0.198	0.246	0.137	0.137		0.177	0.256		0.177	0.139	0.093	0.066	0.144	0.116	0.194
1Q-4Q																				
0															0.035	0.032	0.035	0.030	0.000	0.033
1														0.054	0.044	0.044	0.046	0.041	0.000	0.044
2														0.084	0.074	0.073	0.083	0.098	0.082	0.069
3	0.174	0.174	0.174					0.111	0.110		0.111	0.127		0.093	0.097	0.106	0.108	0.114	0.086	0.104
4	0.230	0.230	0.230	0.164	0.162	0.149	0.121	0.125	0.125	0.121	0.121	0.127	0.117	0.106	0.105	0.127	0.127	0.132	0.098	0.119
5	0.271	0.271	0.271	0.173	0.151	0.160	0.143	0.146	0.147	0.125	0.126	0.142	0.145	0.121	0.134	0.147	0.155	0.149	0.107	0.140
6	0.309	0.309	0.309	0.187	0.173	0.165	0.174	0.156	0.157	0.000	0.158	0.157	0.137	0.141	0.155	0.161	0.161	0.161	0.107	0.162
7	0.329	0.329	0.329	0.203	0.199	0.177	0.168	0.166	0.167	0.139	0.139	0.161	0.150	0.134	0.161	0.179	0.176	0.178	0.125	0.180
8	0.414	0.414	0.414	0.242	0.247	0.213	0.227	0.211	0.211	0.000	0.212	0.186	0.193	0.209	0.208	0.234	0.204	0.198	0.127	0.220
9	0.444	0.444	0.444	0.260	0.270	0.221	0.239	0.207	0.207	0.186	0.189	0.211	0.177	0.215	0.201	0.280	0.285	0.223	0.000	0.249
10	0.468	0.468	0.468	0.293	0.312	0.247	0.240	0.216	0.216	0.172	0.177	0.258	0.269	0.205	0.235	0.251	0.236	0.233	0.000	0.277
11	0.471	0.471	0.471	0.305	0.369	0.245	0.273				0.287	0.234	0.155	0.238	0.251	0.279	0.278	0.243	0.000	0.273
12	0.491	0.491	0.491	0.298	0.317	0.251	0.286	0.223			0.313	0.216	0.155	0.229	0.271	0.283	0.278	0.252	0.000	0.303
13	0.487	0.487	0.487	0.282	0.328	0.236	0.219				0.222	0.250	0.206	0.239	0.234	0.304	0.297	0.274	0.000	0.290
14	0.500	0.500	0.500	0.322	0.352	0.249	0.202			0.191	0.193	0.226	0.172	0.278	0.376	0.309	0.296	0.277	0.164	0.302
15+	0.597	0.597	0.597	0.368	0.429	0.294	0.297	0.300	0.300		0.331	0.298	0.184	0.317	0.272	0.363	0.364	0.331	0.422	0.354
Mean	0.423	0.423	0.423	0.219	0.244	0.192	0.233	0.142	0.143	0.140	0.141	0.174	0.157	0.130	0.125	0.088	0.102	0.117	0.106	0.168

Table 5.2.6.2 Western Horse Mackerel stock. Mean length (Cm) in catch at age by quarter and area in 2008

Ages	IIIa	IIa	IVa	VIa	VIb	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	VIIIc west	VIIIc east	VIIId	Mean
1Q																				
0																				0.00
1															17.00	17.20	21.07	17.39		17.02
2															18.03	19.83	22.57	21.64		18.23
3								23.50	23.50						19.97	21.79	23.65	23.61		23.50
4				27.50	27.50	0.00	24.50	25.50	25.50	24.50	24.50	24.50	24.50	24.50	24.71	24.80	25.42	24.89		24.73
5				26.91	26.91	27.10	26.67	26.08	26.08	25.17	25.17	26.51	26.93	25.17	26.12	26.18	27.26	26.25		25.75
6				27.96	27.96	26.50	26.57	26.93	26.93			26.64	26.64		26.95	26.95	27.51	26.96		26.95
7				29.17	29.17	28.05	27.31	27.95	27.95	26.23	26.23	27.31	27.24	26.23	27.80	27.81	28.27	27.82		27.45
8				31.09	31.09	29.21	33.50	28.84	28.84			36.84	34.74		28.67	28.63	28.83	28.59		33.05
9				31.87	31.87	30.01	32.22	29.00	29.00	28.50	28.50	35.59	33.28	28.50	29.28	29.29	29.58	29.31		31.18
10				33.32	33.32	31.73	30.58			27.50	27.50	32.50	32.50	27.50	29.72	29.73	29.99	29.73		30.39
11				34.95	34.95	31.59	30.83					27.50	27.50		30.20	30.26	30.84	30.32		30.97
12				33.40	33.40	34.50	32.26					27.50	27.50		31.34	31.34	31.72	31.33		31.18
13				33.83	33.83	32.50	31.81					30.39	30.50		31.53	31.54	32.41	31.56		32.41
14				34.35	34.35	31.23	32.56			28.50	28.50	31.59	33.50	28.50	32.44	32.48	33.09	32.52		30.76
15+				36.61	36.61	35.00	31.94	35.02	35.02	0.00	0.00	29.14	29.40		33.03	33.29	35.06	33.55		34.29
Mean				30.71	30.71	28.45	28.12	27.48	27.48	26.15	26.14	28.79	28.33	26.14	17.48	20.06	30.89	29.39		28.03
2Q																				
0																				
1														19.00	17.34	16.29	20.99	15.24	0.00	17.77
2														20.88	18.64	19.61	22.57	20.58	0.00	20.47
3														22.35	21.98	21.66	23.68	23.39	22.38	22.32
4				27.04		0.00						26.50		23.94	23.68	25.11	25.14	25.17	23.45	23.93
5				27.16		27.10						26.50		24.73	25.01	26.11	26.66	26.20	24.29	24.88
6				27.88		26.50						27.36		25.94	26.62	26.67	27.07	26.71	24.30	26.45
7				28.43		28.05						27.78		24.86	26.51	27.41	27.85	27.38	25.50	27.50
8				31.09		29.21						27.30		29.25	28.80	28.48	28.62	28.17	25.00	28.08
9				31.87		30.01						27.83		29.67	29.50	29.22	29.34	28.96	0.00	29.10
10				33.32		31.73						31.00		30.00	30.49	29.55	29.75	29.43	0.00	30.08
11				34.95		31.59								31.00	31.49	30.36	30.56	29.89	0.00	30.65
12				33.40		34.50								30.50	32.68	31.71	31.68	30.73	0.00	31.28
13				33.83		32.50						31.00		30.17	33.66	32.32	31.74	30.98	0.00	31.19
14				34.35		31.23						27.50		32.86	39.40	33.89	32.43	32.32	27.50	32.61
15+				36.61		35.00						31.00		32.86	31.58	34.73	33.28	33.58	0.00	32.55
Mean				28.95		28.45						27.87		25.40	25.21	21.36	29.81	28.19	24.03	26.74
3Q																				
0															15.59	15.92	15.96	15.88		15.92
1								21.50						18.64	16.16	17.10	17.51	16.68		17.23
2								21.86	21.75					22.32	18.24	21.34	21.35	21.33	22.00	21.92
3	27.40		27.40			0.00		23.53	23.12			24.75		23.00	24.44	23.95	23.67	24.23	23.00	23.25
4	29.50		29.50	26.58		26.60		24.26	24.22			25.42		24.30	25.64	25.22	24.63	25.81	23.83	24.92
5	31.20		31.20	27.41		27.24		24.55	25.71			26.08		26.00	26.64	26.39	26.03	26.74	24.00	26.02
6	31.70		31.70	27.79		27.48		25.13	26.61			26.83		25.50	27.44	27.11	26.84	27.37	25.50	26.79
7	32.40		32.40	27.68		28.42		25.68	26.64			27.77			28.38	28.24	28.23	28.25		27.78
8	34.30		34.30			30.04		27.50	29.03			28.90		29.50	29.48	32.21	35.17	29.25	29.50	29.32
9	35.40		35.40			30.37		28.50				32.07			31.61	34.21	37.53	30.88		32.86
10	35.40		35.40			31.29			28.50			31.00			31.70	33.36	35.48	31.24		31.59
11	36.00		36.00			31.11						30.17		29.50	32.32	33.79	36.08	31.50		32.04
12	36.20		36.20			31.49		29.50				30.50			32.58	34.07	36.28	31.86		32.28
13	36.30		36.30			29.97		0.00				31.83			34.15	35.24	37.12	33.35		33.85
14	36.40		36.40			31.51		0.00				34.50			33.87	35.12	36.75	33.49		35.10
15+	38.30		38.30			32.99		0.00				35.00		35.50	37.19	37.67	38.81	36.53	37.50	35.74
Mean	34.56		34.55	27.51		29.38		24.28	24.92			28.02		23.10	16.85	19.68	19.41	19.91	24.29	23.19
4Q																				
0															16.85	14.61	15.87	13.34		14.80
1															19.19	17.27	17.27	17.27		17.28
2								21.75	21.75		21.75			21.75	22.80	22.28	21.58	22.98	22.00	22.02
3	27.40	27.40	27.40					23.12	23.12		23.12			23.12	23.85	23.88	23.67	24.09	23.00	23.30
4	29.50	29.50	29.50	27.28		26.60		24.22	24.22		24.22			24.22	24.94	24.91	24.56	25.27	23.83	24.78
5	31.20	31.20	31.20	27.63		27.40		25.71	25.71		25.71			25.71	25.87	26.36	26.35	26.37	24.00	26.43
6	31.70	31.70	31.70	28.45		27.63	28.17	26.61	26.61		26.61			26.61	26.75	27.42	27.65	27.20	25.50	27.44
7	32.40	32.40	32.40	29.23		28.40	32.00	26.64	26.64		26.64			26.64	27.37	28.61	29.00	28.22	0.00	29.01
8	34.30	34.30	34.30	30.88		29.93	30.61	29.03	29.03		29.44	29.85		29.44	29.33	31.32	33.27	29.38	29.50	30.32
9	35.40	35.40	35.40	31.53		30.38	31.20				31.13	31.13		31.13	30.53	32.96	35.58	30.34		31.78
10	35.40	35.40	35.40	32.66		31.29	31.14	28.50	28.50		30.31	32.12		30.31	30.25	32.72	34.11	31.34		32.51
11	36.00	36.00	36.00	32.04		31.11	32.38				32.79	32.79		32.79	32.19	33.31	35.15	31.47		32.63
12	36.20	36.20	36.20	32.76		31.42	33.50				33.50	33.50		33.50	31.87	33.33	34.82	31.84		33.91
13	36.30	36.30	36.30	31.89		30.45	29.50				30.50	30.50		30.50	30.43	34.32	35.76	32.88		32.74
14	36.40	36.40	36.40	33.44		31.52	0.00				33.50	33.50		33.50	33.38	34.03	35.50	32.56		34.24
15+	38.30	38.30	38.30	34.39		32.94	33.21				34.25	34.25		34.25	34.19	35.89	37.56	34.22	37.50	35.11
Mean	34.56	34.55	34.55	29.70		29.11	31.34	24.92	24.92		27.10	31.50		27.10	25.43	20.59	18.57	24.93	24.29	27.60
1Q-4Q																				
0															15.94	15.28	15.92	14.94		15.45
1								21.50						18.68	17.20	17.08	17.41	16.75		17.25
2								21.77	21.75		21.75			22.02	20.37	20.36	21.45	22.82	22.00	21.73
3	27.40	27.40	27.40					23.19	23.15		23.12	24.75		22.82	22.98	23.46	23.67	24.08	23.00	23.16
4	29.50	29.50	29.50	27.05	27.50	26.60	24.50	24.28	24.28	24.50	24.47	25.44	24.50	24.05	24.06	24.99	24.99	25.32	23.83	24.53
5	31.20	31.20	31.20	27.57	26.91	27.34	26.67	25.78	25.88	25.17	25.18	26.24	26.93	24.97	25.59	26.32	26.74	26.44	24.00	25.86
6	31.70	31.70	31.70	28.31	27.96	27.52	28.10	26.63	26.70		26.61	26.88	26.64	25.93	26.75	27.16	27.17	27.21	25.50	27.03
7	32.40	32.40	32.40	29.16	29.17	28.26	27.94	27.15	27.22	26.23	26.23	27.56	27.24	25.95	26.80	28.22	27.99	28.16		28.13
8	34.30	34.30	34.30	30.93	31.09	29.87	30.70	28.95	28.97	0.00	29.44	32.25	34.74	29.39	29.32	30.73	29.33	29.19	29.50	30.56
9	35.40	35.40	35.40	31.61	31.87	30.27	31.24	28.99	29.00	28.50	28.64	32.93	33.28	29.63	29.82	32.60	32.74	30.35		31.47
10	35.40	35.40	35.40	32.85	33.32	31.37	31.11	28.50	28.50	27.50	27.67	31.58	32.50	29.08	30.42	31.58	30.91	30.86		31.66
11	36.00	36.00	36.00	33.09	34.95	31.20	32.37	0.00			32.79	30.66	27.50	30.74	31.67	32.71	32.69	31.25		31.99
12	36.20	36.20	36.20	32.99	33.40	31.71	33.49	29.50			33.50	30.12	27.50	30.87	31.95	32.90	32.77	31.64		32.70
13	36.30	36.30	36.30	32.46	33.83	30.77	29.60				30.50	31.24	30.50	30.22	30.97	33.69	33.44	32.50		32.50
14	36.40	36.40	36.40	33.76	34.35	31.40	32.56			28.50	28.57	31.70	33.50	31.94	38.91	33.94	33.49	32.69		32.53
15+	38.30	38.30	38.30	35.22	36.61	33.24	33.20	35.02	35.02		34.25	33.19	29.40	33.33	31.78	35.88	35.88	34.67	37.50	34.62
Mean	34.55	34.55	34.55	29.78	30.71	28.90	30.84	25.60	25.65	26.15	26.17	28.42	28.33	25.00	24.36	20.31	21.17	22.71	22.80	26.63

Table 5.2.6.3 Western horse mackerel. Stock weights-at-age (kg).

	0	1	2	3	**4**	**5**	**6**	7	8	9	10	11+
1982	0.000	0.000	0.050	0.080	**0.207**	**0.232**	**0.269**	0.280	0.292	0.305	0.369	0.352
1983	0.000	0.000	0.050	0.080	**0.171**	**0.227**	**0.257**	0.276	0.270	0.243	0.390	0.311
1984	0.000	0.000	0.050	0.077	**0.122**	**0.155**	**0.201**	0.223	0.253	0.246	0.338	0.287
1985	0.000	0.000	0.050	0.081	**0.148**	**0.140**	**0.193**	0.236	0.242	0.289	0.247	0.306
1986	0.000	0.000	0.050	0.080	**0.105**	**0.134**	**0.169**	0.195	0.242	0.292	0.262	0.342
1987	0.000	0.000	0.050	0.080	**0.105**	**0.126**	**0.150**	0.171	0.218	0.254	0.281	0.317
1988	0.000	0.000	0.050	0.080	**0.105**	**0.126**	**0.141**	0.143	0.217	0.274	0.305	0.366
1989	0.000	0.000	0.050	0.080	**0.105**	**0.103**	**0.131**	0.159	0.127	0.210	0.252	0.336
1990	0.000	0.000	0.050	0.080	**0.105**	**0.127**	**0.135**	0.124	0.154	0.174	0.282	0.345
1991	0.000	0.000	0.050	0.080	**0.121**	**0.137**	**0.143**	0.144	0.150	0.182	0.189	0.333
1992	0.000	0.000	0.050	0.080	**0.105**	**0.133**	**0.151**	0.150	0.158	0.160	0.182	0.287
1993	0.000	0.000	0.050	0.080	**0.105**	**0.153**	**0.166**	0.173	0.172	0.170	0.206	0.222
1994	0.000	0.000	0.050	0.080	**0.105**	**0.147**	**0.185**	0.169	0.191	0.191	0.190	0.235
1995	0.000	0.000	0.050	0.066	**0.119**	**0.096**	**0.152**	0.166	0.178	0.187	0.197	0.233
1996	0.000	0.000	0.050	0.095	**0.118**	**0.129**	**0.148**	0.172	0.183	0.185	0.202	0.238
1997	0.000	0.000	0.050	0.080	**0.112**	**0.124**	**0.162**	0.169	0.184	0.188	0.208	0.238
1998	0.000	0.000	0.050	0.090	**0.108**	**0.129**	**0.142**	0.151	0.162	0.174	0.191	0.215
1999	0.000	0.000	0.050	0.110	**0.120**	**0.130**	**0.160**	0.170	0.180	0.190	0.210	0.222
2000	0.000	0.000	0.050	0.087	**0.108**	**0.148**	**0.170**	0.173	0.193	0.202	0.257	0.260
2001	0.000	0.000	0.070	0.074	**0.082**	**0.100**	**0.121**	0.131	0.142	0.161	0.187	0.268
2002	0.000	0.000	0.050	0.109	**0.120**	**0.135**	**0.146**	0.153	0.177	0.206	0.216	0.275
2003	0.000	0.000	0.050	0.110	**0.142**	**0.139**	**0.161**	0.169	0.169	0.176	0.176	0.206
2004	0.000	0.000	0.050	0.104	**0.114**	**0.127**	**0.142**	0.157	0.168	0.166	0.178	0.213
2005	0.000	0.000	0.085	0.095	**0.110**	**0.141**	**0.163**	0.182	0.197	0.181	0.209	0.243
2006	0.000	0.000	0.085	0.098	**0.095**	**0.113**	**0.167**	0.157	0.164	0.205	0.195	0.229
2007	0.000	0.000	0.085	0.098	**0.095**	**0.118**	**0.128**	0.137	0.168	0.180	0.173	0.181
2008	0.000	0.000	0.085	0.107	**0.128**	**0.142**	**0.153**	0.160	0.169	0.188	0.263	0.217

Table 5.2.7.1 Western horse mackerel. Maturity-at-age.

	0	1	2	3	4	5	6	7	8	9	10	11+
1982	0	0	0.40	0.80	1	1	1	1	1	1	1	1
1983	0	0	0.30	0.70	1	1	1	1	1	1	1	1
1984	0	0	0.10	0.60	0.85	1	1	1	1	1	1	1
1985	0	0	0.10	0.40	0.80	0.95	1	1	1	1	1	1
1986	0	0	0.10	0.40	0.60	0.90	1	1	1	1	1	1
1987	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1988	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1989	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1990	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1991	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1992	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1993	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1994	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1995	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1996	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1997	0	0	0.10	0.40	0.60	0.80	1	1	1	1	1	1
1998	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
1999	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2000	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2001	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2002	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2003	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2004	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2005	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2006	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2007	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2008	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1

Table 5.2.9.1 Western horse mackerel. Potential fecundity (10^6 eggs) per kg spawning female vs. weight in kg.

	1987		1992		1995		1998		2000		2001		2001 (contd)	
	w	pfec.	w	pfec.	w	pfec.	w	pfec.	w	pfec.	w	pfec.	w	pfec.
1	0.168	1.524	0.105	1.317	0.13	1.307	0.172	1.318	0.258	0.841	0.086	0.688	0.165	1.382
2	0.179	0.916	0.109	2.056	0.157	1.246	0.104	0.867	0.268	0.747	0.08	0.812	0.166	1.579
3	0.192	2.083	0.11	1.869	0.168	1.699	0.112	1.312	0.304	1.188	0.081	0.535	0.167	1.479
4	0.233	1.644	0.112	1.772	0.179	1.135	0.206	0.382	0.311	1.411	0.095	0.88	0.113	0.527
5	0.213	1.066	0.115	1.188	0.189	1.529	0.207	0.78	0.337	0.613	0.11	1.164	0.14	0.876
6	0.217	2.392	0.119	1.317	0.168	1.1	0.109	1.133	0.339	1.571	0.113	1.106	0.122	0.589
7	0.277	1.617	0.12	1.413	0.209	1.497	0.132	1.02	0.341	1.522	0.095	0.823	0.12	0.68
8	0.279	1.018	0.123	1.293	0.215	1.524	0.2	1.088	0.355	1.056	0.11	0.883	0.121	0.578
9	0.274	1.62	0.123	1.991	0.218	1.616	0.152	1.417	0.357	0.604	0.108	0.823	0.139	0.723
10	0.3	1.513	0.131	1.617	0.226	1.883	0.149	1.004	0.367	1.15	0.097	0.741	0.144	1.213
11	0.32	1.647	0.135	0.793	0.22	1.324			0.393	1.279	0.101	0.853	0.144	1.265
12	0.273	1.956	0.131	1.039	0.236	1.221			0.393	0.668	0.106	1.133	0.171	0.956
13	0.212	2.83	0.136	1.06	0.261	1.21			0.413	0.694	0.107	0.935	0.121	0.607
14	0.268	1.687	0.138	1.489	0.245	1.445			0.421	1.339	0.107	0.494	0.122	0.689
15	0.32	1.088	0.147	1.214	0.306	1.693			0.423	0.798	0.11	0.85	0.139	0.915
16	0.318	1.208	0.151	1.158	0.314	1.312			0.445	1.03	0.111	0.67	0.153	0.943
17	0.343	1.933	0.16	1.349	0.46	1.575			0.446	1.208	0.103	0.632	0.154	0.709
18	0.378	1.429	0.165	1.359	0.449	1.43			0.152	0.643	0.111	0.547	0.156	0.773
19	0.404	1.849	0.165	0.945					0.165	0.579	0.118	0.88	0.162	1.158
20	0.428	2.236	0.167	1					0.175	0.596	0.107	0.944	0.174	1.389
21	0.398	1.538	0.168	1.545					0.179	0.997	0.104	0.724	0.175	1.426
22	0.431	1.223	0.18	1.299					0.19	0.744	0.111	0.86	0.179	1.248
23	0.432	1.465	0.174	1.487					0.197	0.613	0.11	0.728	0.179	1.236
24	0.421	1.843	0.178	1.594					0.203	0.702	0.111	0.544	0.18	2.353
25	0.481	1.757	0.185	1.475					0.219	0.472	0.129	0.935	0.184	2.255
26	0.494	1.611	0.195	1.41					0.223	0.806	0.114	0.901	0.139	0.931
27	0.54	1.754	0.203	1.937					0.227	0.606	0.114	0.557	0.161	1.037
28	0.564	2.255	0.205	1.534					0.289	1.273	0.151	1.377	0.162	0.893
29	0.585	1.221	0.213	1.577					0.294	1.395	0.153	1.596	0.169	0.691
30			0.222	0.958					0.3	1.305	0.154	1.699	0.18	1.609
31			0.275	2.444							0.103	0.679	0.185	1.776
32											0.12	1.14	0.211	2.102
33											0.12	0.631	0.224	1.466
34											0.121	0.834	0.162	0.849
35											0.144	0.626	0.17	0.668
36											0.116	0.668	0.187	1.453
37											0.118	1.194	0.198	1.371
38											0.112	0.779	0.219	1.847
39											0.126	0.782	0.22	1.578
40											0.139	1.244	0.201	0.878
41											0.119	1.212	0.206	1.196
42											0.109	0.755	0.223	1.115
43											0.122	0.841	0.225	1.43
44											0.131	0.929	0.233	1.724
45											0.135	0.862	0.241	1.131
46											0.142	1.834	0.219	0.96
47											0.146	1.689	0.237	1.33
48											0.148	1.357	0.241	0.918
49											0.151	1.817	0.34	0.605
50											0.164	1.631	0.407	1.189
51											0.164	1.052		

Table 5.5.1.1 Western horse mackerel. Final assessment. Numbers-at-age (thousands).

	0	1	2	3	4	5	6	7	8	9	10	11+
1982	75431700	745743	1851730	3376420	487530	439864	351019	260930	40495.4	43785.3	47992.5	2365760
1983	509655	64924600	638422	1574250	2781110	408938	366351	291232	216376	33323	37302.2	2000610
1984	1477600	438664	55873800	547390	1324440	2344080	337740	274000	201799	169608	25628.2	1475890
1985	2727880	1271780	377562	47867100	467025	1106290	1878590	269961	200353	142128	132293	1070190
1986	3951630	2347910	1093120	320424	40640200	397832	913390	1523800	220627	157442	116579	957351
1987	5327120	3401200	2020860	940856	274355	34352000	334320	725723	1209730	166041	115863	794196
1988	2166740	4585100	2927340	1738920	809803	233403	28739800	285840	586075	956970	132021	713857
1989	2306470	1864120	3921040	2513920	1494750	692920	183294	23862900	234785	467410	760706	670278
1990	2151520	1985200	1604460	3374870	2144480	1269580	591477	144311	19354500	190906	347236	1086950
1991	4217490	1851830	1689750	1339190	2775880	1788770	1061850	499302	105091	15373800	129978	965304
1992	8219460	3610880	1562750	1371150	1131280	2196490	1406880	845539	406217	66717.5	12100800	755883
1993	12126700	7060740	2894810	1311360	1105420	921495	1652950	1093040	682284	331958	35669.6	9980600
1994	13934500	10437500	5975970	2403920	1113170	893265	705270	1128300	806629	521640	255388	7368500
1995	7090560	11990100	8927280	4297730	1961700	908824	727377	571064	765207	595456	411129	5394340
1996	3820390	6100390	10166500	7247280	3305200	1488550	727463	541791	458442	431109	402004	3699470
1997	3447860	3278290	5232310	8139280	5439010	2671970	1201880	578479	415085	345062	318056	2992620
1998	5022280	2963090	2719460	4071770	6322800	4300430	2073110	924009	379468	232497	194981	1802290
1999	5306040	4322030	2465460	2169550	3051250	5107990	3497640	1638320	681576	251001	136780	1241030
2000	4778090	4553200	3629490	2044380	1703210	2379620	4160360	2813550	1236400	449956	143961	854538
2001	25938300	4111950	3845820	3002290	1710700	1399370	1908190	3422780	2256510	940518	330152	743844
2002	6287890	22270900	3474780	3081410	2443350	1381080	1110430	1533890	2728150	1753100	713056	815791
2003	4061850	5399320	18741000	2879340	2499140	1985810	1128910	890974	1232630	2227270	1429750	1224960
2004	2294610	3494360	4404020	15472100	2350740	2043130	1608310	921412	724350	1002750	1826910	2198060
2005	1978740	1955280	2876950	3662270	12748100	1939060	1672310	1324860	756554	595063	829410	3355120
2006	1111590	1701940	1595980	2376440	2992000	10429000	1571700	1365880	1077900	615916	488407	3466490
2007	2347570	954992	1416150	1338110	1978540	2493180	8639150	1308320	1134180	895403	514302	3321980
2008		2016320	793666	1186230	1112730	1646760	2062450	7182800	1084980	940954	746866	3219530
2009			1664730	661427	980078	920332	1352160	1703670	5915230	893949	780253	3312990

Table 5.5.1.2 Western horse mackerel. Final assessment. Fishing mortality-at-age.

	0	1	2	3	4	5	6	7	8	9	10	11+
1982	0.000	0.005	0.012	0.044	0.026	0.033	0.037	0.037	0.045	0.010	0.038	0.038
1983	0.000	0.000	0.004	0.023	0.021	0.041	0.140	0.217	0.094	0.113	0.173	0.173
1984	0.000	0.000	0.005	0.009	0.030	0.071	0.074	0.163	0.201	0.098	0.189	0.189
1985	0.000	0.001	0.014	0.014	0.010	0.042	0.059	0.052	0.091	0.048	0.078	0.078
1986	0.000	0.000	0.000	0.005	0.018	0.024	0.080	0.081	0.134	0.157	0.152	0.152
1987	0.000	0.000	0.000	0.000	0.012	0.028	0.007	0.064	0.084	0.079	0.093	0.093
1988	0.000	0.006	0.002	0.001	0.006	0.092	0.036	0.047	0.076	0.080	0.083	0.083
1989	0.000	0.000	0.000	0.009	0.013	0.008	0.089	0.059	0.057	0.147	0.125	0.125
1990	0.000	0.011	0.031	0.045	0.031	0.029	0.019	0.167	0.080	0.234	0.246	0.246
1991	0.005	0.020	0.059	0.019	0.084	0.090	0.078	0.056	0.304	0.089	0.221	0.221
1992	0.002	0.071	0.025	0.065	0.055	0.134	0.102	0.065	0.052	0.476	0.103	0.103
1993	0.000	0.017	0.036	0.014	0.063	0.117	0.232	0.154	0.118	0.112	0.157	0.157
1994	0.000	0.006	0.180	0.053	0.053	0.055	0.061	0.238	0.154	0.088	0.196	0.196
1995	0.000	0.015	0.058	0.113	0.126	0.073	0.145	0.070	0.424	0.243	0.301	0.301
1996	0.003	0.004	0.072	0.137	0.063	0.064	0.079	0.116	0.134	0.154	0.165	0.165
1997	0.002	0.037	0.101	0.103	0.085	0.104	0.113	0.272	0.430	0.421	0.458	0.458
1998	0.000	0.034	0.076	0.139	0.063	0.057	0.085	0.154	0.263	0.381	0.326	0.326
1999	0.003	0.025	0.037	0.092	0.099	0.055	0.068	0.131	0.265	0.406	0.328	0.328
2000	0.000	0.019	0.040	0.028	0.046	0.071	0.045	0.071	0.124	0.160	0.144	0.144
2001	0.002	0.018	0.072	0.056	0.064	0.081	0.068	0.077	0.102	0.127	0.125	0.125
2002	0.002	0.023	0.038	0.059	0.057	0.052	0.070	0.069	0.053	0.054	0.072	0.072
2003	0.000	0.054	0.042	0.053	0.051	0.061	0.053	0.057	0.056	0.048	0.039	0.039
2004	0.010	0.044	0.034	0.044	0.043	0.050	0.044	0.047	0.047	0.040	0.032	0.032
2005	0.001	0.053	0.041	0.052	0.051	0.060	0.052	0.056	0.056	0.048	0.038	0.038
2006	0.002	0.034	0.026	0.033	0.032	0.038	0.033	0.036	0.035	0.030	0.024	0.024
2007	0.002	0.035	0.027	0.034	0.034	0.040	0.035	0.037	0.037	0.031	0.025	0.025
2008	0.000	0.042	0.032	0.041	0.040	0.047	0.041	0.044	0.044	0.037	0.030	0.030

Table 5.5.1.3 Western horse mackerel. Final assessment. Stock summary table.

	R (age 0) (thousands)	SSB (tons)	TSB (tons)	Catch (tons)	Yield/SSB	F (1-3)	F(4-8)
1982	75431700	1378480	1608788	61197	0.044	0.021	0.036
1983	509655	1377030	1604049	90442	0.066	0.009	0.103
1984	1477600	1306190	4014762	96744	0.074	0.004	0.108
1985	2727880	2423220	4996107	103843	0.043	0.010	0.051
1986	3951630	3239390	5309647	145999	0.045	0.002	0.067
1987	5327120	3938960	5297931	187338	0.048	0.000	0.039
1988	2166740	4521640	5184032	214729	0.047	0.003	0.051
1989	2306470	4189870	4988583	296037	0.071	0.003	0.045
1990	2151520	3550240	4321093	398645	0.112	0.029	0.065
1991	4217490	3425280	4156117	357288	0.104	0.032	0.123
1992	8219460	2847860	3432158	394793	0.139	0.054	0.082
1993	12126700	2701920	3367020	458628	0.170	0.022	0.137
1994	13934500	2281920	3094283	413022	0.181	0.080	0.112
1995	7090560	1801860	2841492	538131	0.299	0.062	0.167
1996	3820390	1797850	3105034	420942	0.234	0.071	0.091
1997	3447860	1776060	3065365	471700	0.266	0.080	0.201
1998	5022280	1813300	2700619	326443	0.180	0.083	0.125
1999	5306040	2000630	2704855	298076	0.149	0.051	0.124
2000	4778090	2075790	2678166	196911	0.095	0.029	0.071
2001	25938300	1536350	2183803	212090	0.138	0.049	0.079
2002	6287890	1905330	2608452	194292	0.102	0.040	0.060
2003	4061850	1895020	3321304	190183	0.100	0.049	0.056
2004	2294610	2112990	3811327	157627	0.075	0.041	0.046
2005	1978740	2835100	4027254	181994	0.064	0.049	0.055
2006	1111590	2811690	3500287	155094	0.055	0.031	0.035
2007	2347570	2557530	3060683	123408	0.048	0.032	0.036
2008		2825790	3291671	139741	0.049	0.038	0.043
2009		2579550					

Note: the final estimate of SSB assumes the same F-at-age as in the preceding year

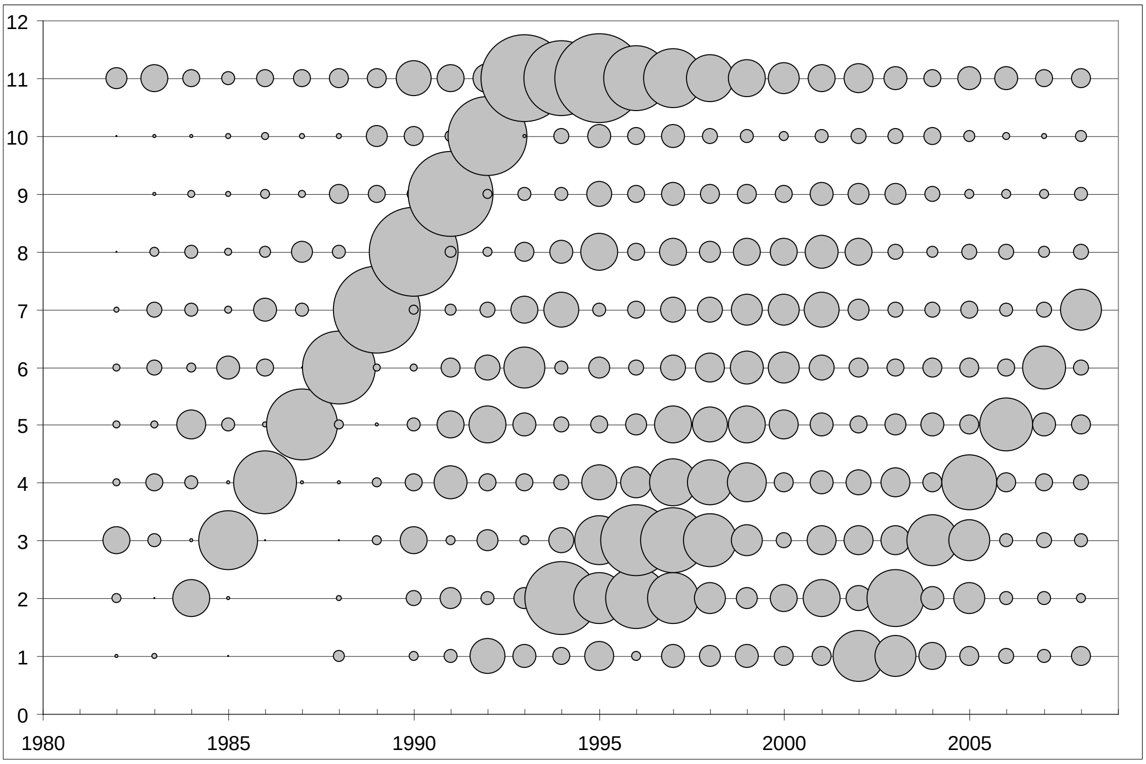


Figure 5.2.5.1. Western horse mackerel. Catch-at-age matrix, expressed as numbers (thousands). The area of bubbles is proportional to the catch number. Note that age 11 is a plusgroup.

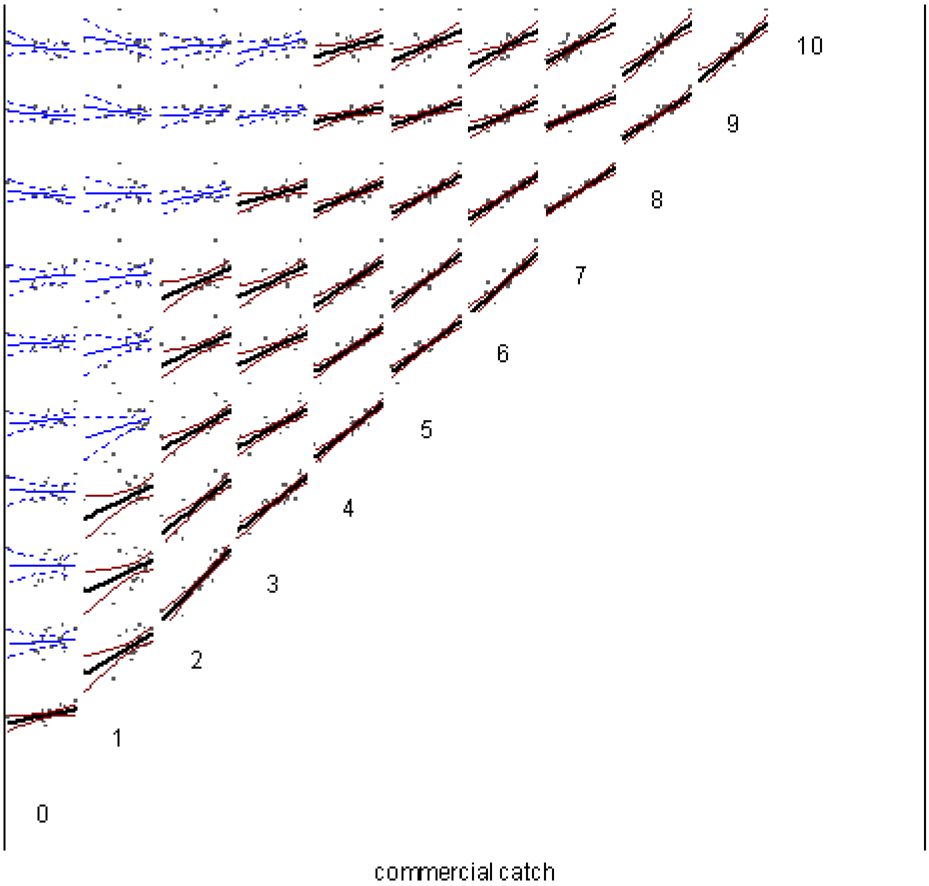
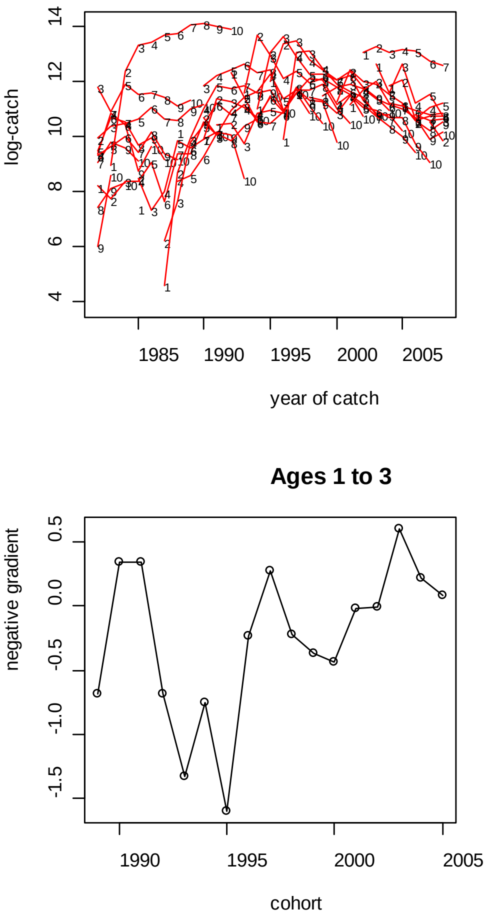


Figure 5.3.1.1. Western horse mackerel. Data exploration. Within-cohort consistency in the catch-at-age matrix, shown by plotting the log-catch of a cohort at a particular age against the log-catch of the same cohort at subsequent ages. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.


log-catch
year of catch
log-catch
year of catch
Ages 1 to 3
negative gradient
cohort

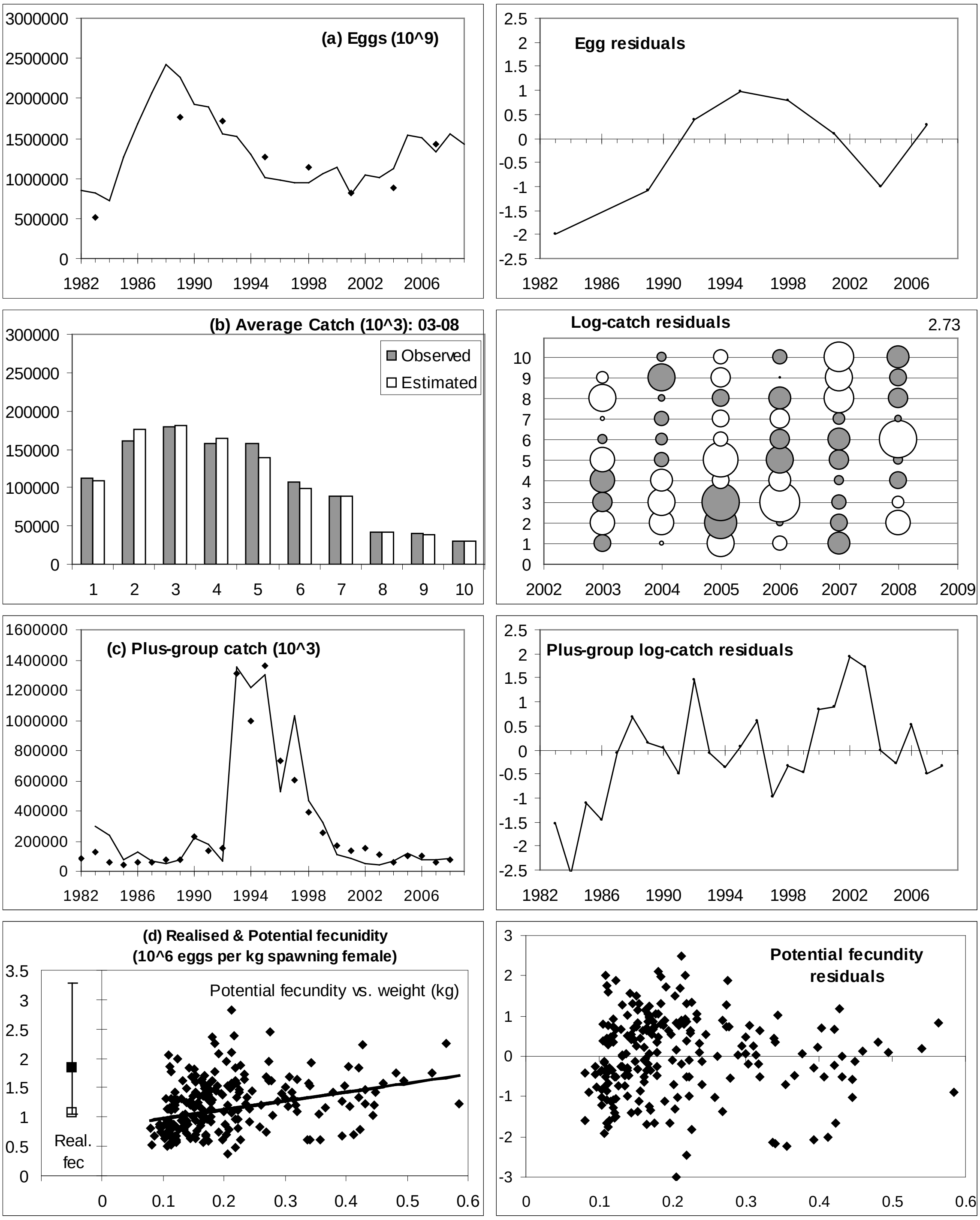


Figure 5.3.2.1. Western horse mackerel. SAD model with 2003-2008 separable window. Model fits to data for the five components of the likelihood, corresponding to (a) the egg estimates, (b) the catches in the separable period, (c) to the catches in the plus-group, and (d) population-mean realised fecundity (left of y-axis) and potential fecundity (right of y-axis). The left-hand column of plots shows the actual fit to the data (average catches are shown in (b) for ease of presentation), and the right-hand column normalised residuals, of the form: $(\ln X - \ln \hat{X})/\sigma$. In the residual plot for (b), the area of a bubble reflects the size of the residual, with the maximum absolute size given in the top right of the plot. In the residual plot for (d), only the potential fecundity residuals are shown (there is only one residual for the population-mean realised fecundity). The final SSB estimate assumes the same fishing mortality as in the previous year.

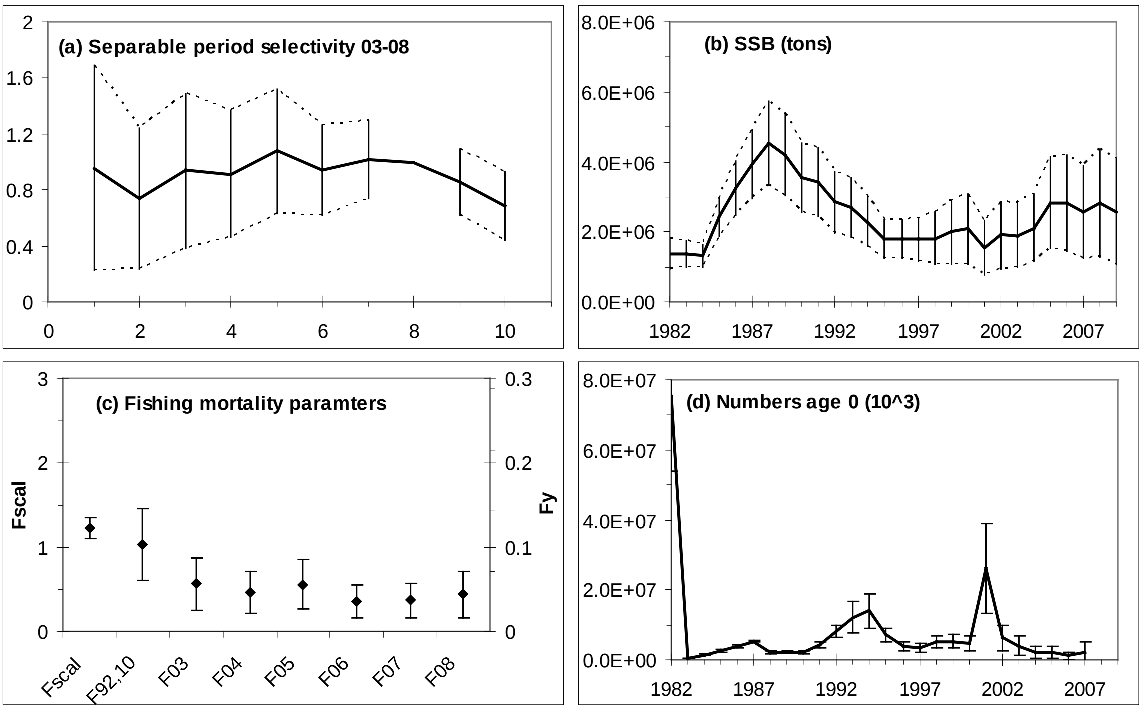


Figure 5.3.2.2. Western horse mackerel. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) fishing mortality parameters (the scaling parameter , fishing mortality at age 10 in 1992, 92,10, and the fishing mortality year effects for the separable period,), and (d) numbers at age 0. The error bars are 2 standard deviations (indicating roughly 95% confidence bounds). The final SSB estimate assumes the same fishing mortality as in the previous year.

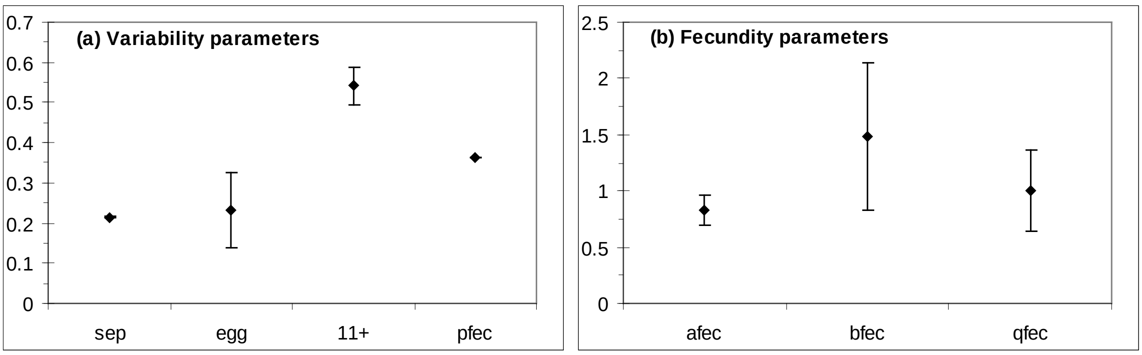


Figure 5.3.2.3. Western horse mackerel. Estimates for some key parameters, with (a) corresponding to variability parameters, plotted as standard deviations, for four components of the likelihood (σ , σ , and σ_{11+} and σ), and (b) the fecundity parameters , and . The error bars are 2 standard deviations (indicating roughly 95% confidence bounds).

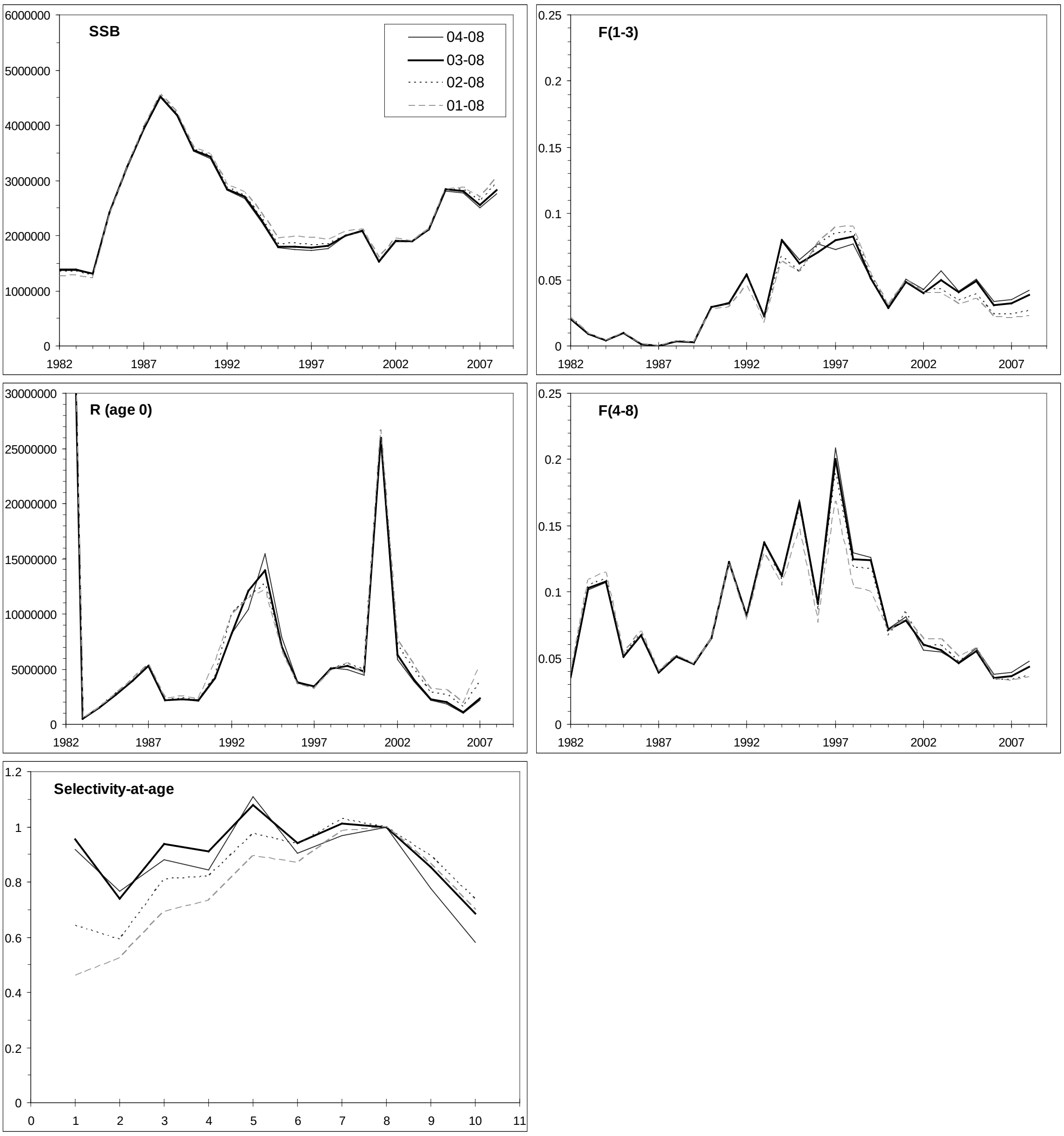


Figure 5.3.2.4. Western horse mackerel. Sensitivity of the SAD model to the length of the separable window. Trajectories of SSB, recruitment (age 0), F (1-3) and F (4-8) are shown in the top four plots, while the bottom plot shows selectivity-at-age.

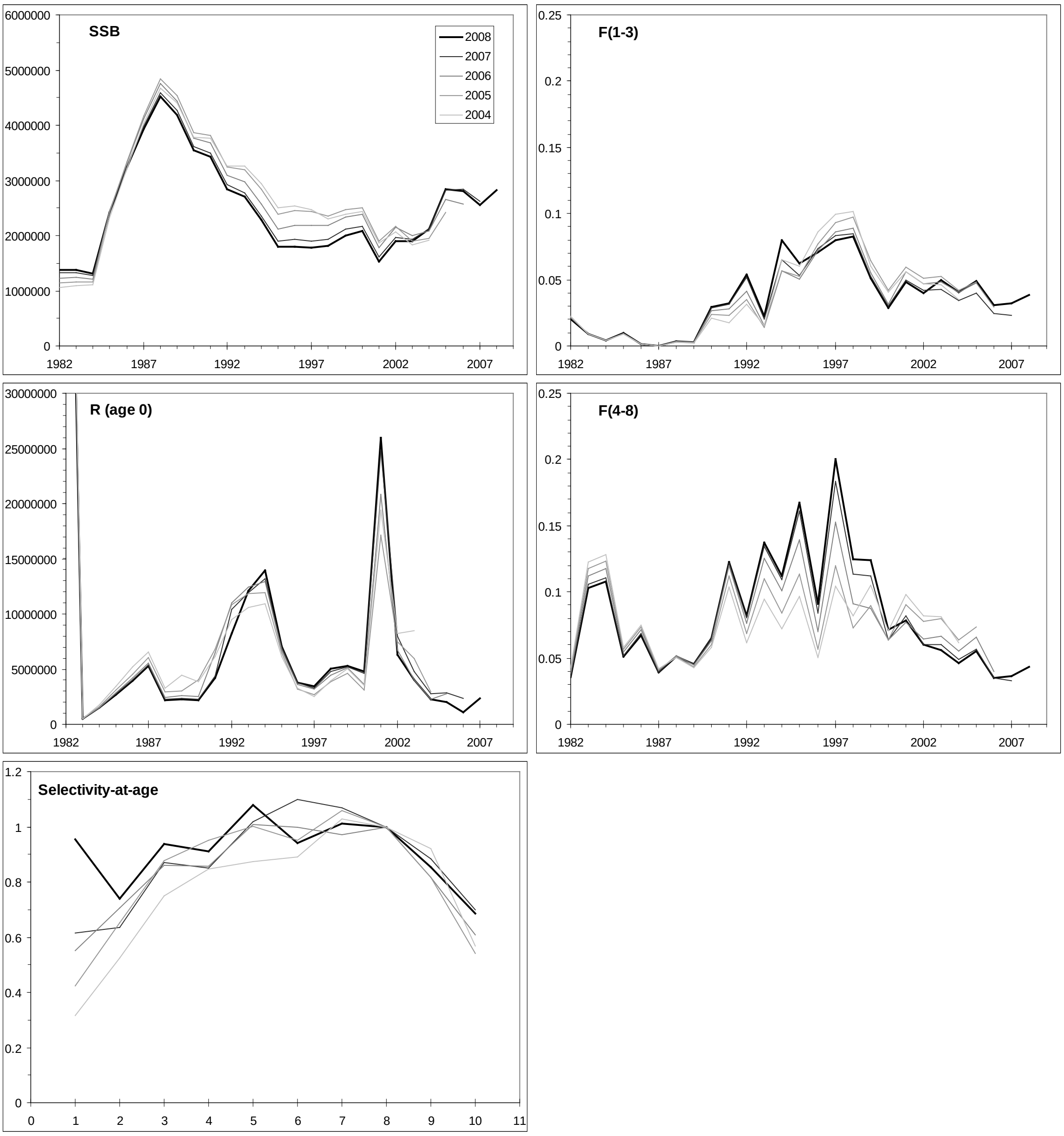


Figure 5.3.2.5. Western horse mackerel. 5-year retrospective bias for the case where the length of the separable window is kept at 6 years (the year shown is the final year of the window). Trajectories of SSB, recruitment (age 0), F (1-3) and F (4-8) are shown in the top four plots, while the bottom plot shows selectivity-at-age.

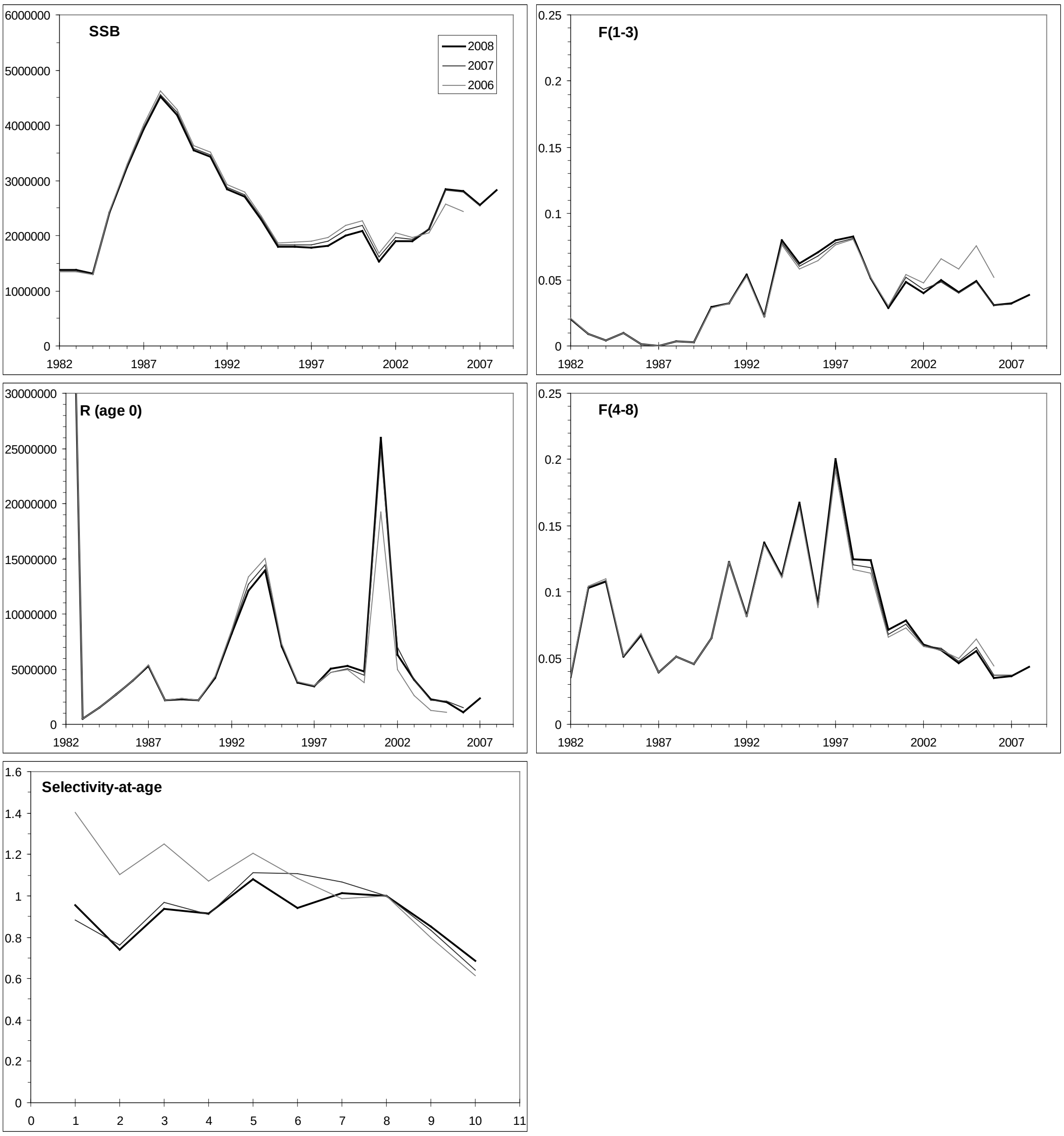


Figure 5.3.2.6. Western horse mackerel. 3-year retrospective bias for the case where the starting year of the separable window is kept at 2003, so that the window decreases in length as more years are dropped (the year shown is the final year of the window). Trajectories of SSB, recruitment (age 0), F (1-3) and F (4-8) are shown in the top four plots, while the bottom plot shows selectivity-at-age.

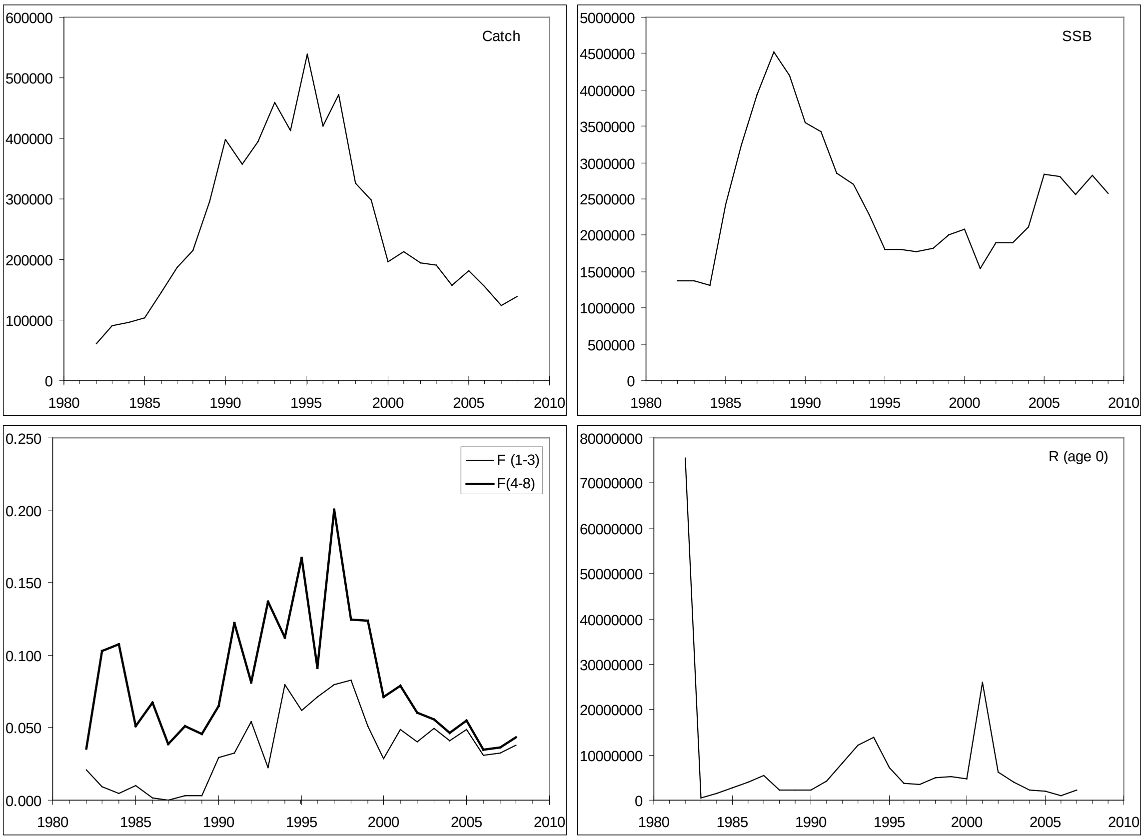


Figure 5.5.1.1. Western horse mackerel. Final assessment. Stock summary. Plots of catch, SSB, recruitment (age 0) and fishing mortality (average for ages 1-3 and 4-8). SSB and catch are in tons, and recruitment in thousands. The final SSB estimate assumes the same fishing mortality as in the previous year.

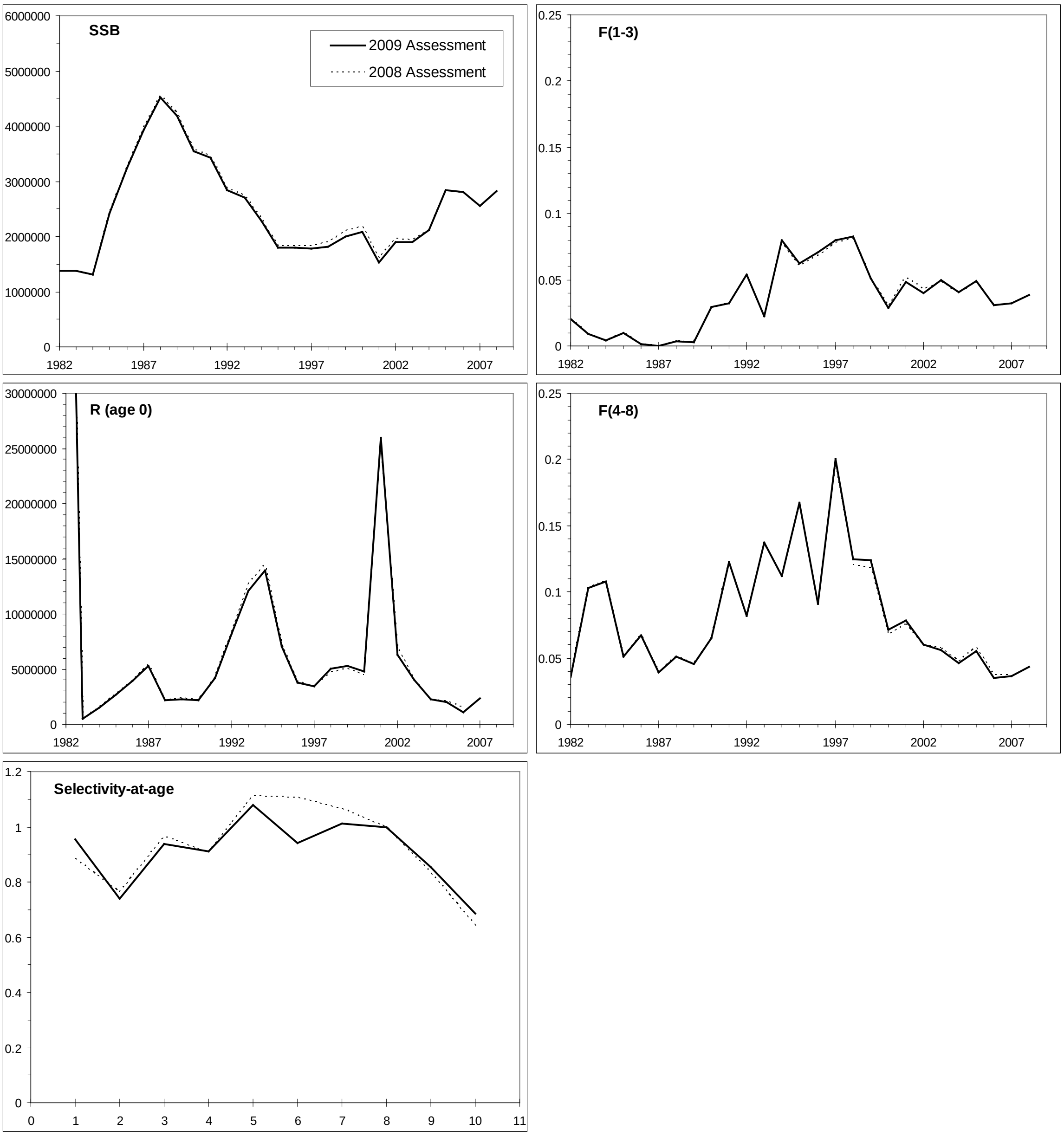


Figure 5.8.1. Western horse mackerel. Comparison of the final assessment this year with that of last year. Plots of SSB, recruitment (age 0), fishing mortality (average for ages 1-3 and 4-8) and selectivity-at-age for the separable period (2003-2007 for the 2008 assessment, and 2003-2008 for the 2009 assessment). SSB values are in tons, and recruitment in thousands.

6 Southern Horse Mackerel (Division IXa)

6.1 ICES advice applicable to 2008 and 2009

In 2008 ICES considered that in the absence of defined reference points, the state of this stock cannot be evaluated with regard to these. Catches decreased from the early 1960s but have been relatively stable since the early 1990s. SSB has increased since 2003 and fishing mortality has been stable between 0.3 and 0.4 since 1999. The 2004 year class has been above average which may have driven an increase in SSB.

ICES further stated that the recent level of catches does not seem to be detrimental to the stock. ICES therefore recommends that catches in 2009 should not exceed the recent average catch of 25 000 t (2000–2004; 2003 is excluded because of the reduced effort following the Prestige oil spill).

ICES also recommended that the TAC for this stock should only apply to *Trachurus trachurus*.

6.2 Stock description and management units

The definition of horse mackerel stocks and management units in the ICES area is discussed in sections 3.2 and 3.3 and in the Stock Annex.

6.3 Scientific data

6.3.1 The fishery in 2008

Catch allocation between Subdivisions for this stock is described in the Stock Annex. These catches were already removed in 2004 to obtain the historical series of stock catches (Table 6.3.1.1 and Figure 6.3.1.1). However, the definition of the Subdivisions was set quite recently (ICES, 1992) and some of the previous catch statistics came from an area that comprises more than one Subdivision. This is the case of the Galician coasts where the Subdivisions VIIIc West and Subdivision IXa North are located. Further work is necessary to collect the catches by port and to distribute them by Subdivision. At the moment it has been collected the required information for the period 1992−2008, and it is expected to go back in time until 1939 (Portuguese catches are available since 1927) during the next years.

The Portuguese catches range from 40% of the total catch of the stoc k in 2008 to 85% in 1992 (Table 6.3.1.1). Therefore in 2008 the Portuguese catches were the lowest of the time series with a decrease of more than 1,000 tonnes comparing with catches in 2007. On the contrary Spanish catches in 2007 increased in more than 1,300 t. The catch time series during the assessment period shows a decreasing trend since the peak reached in 1998 until 2003, when the lowest level of the time series was reached (Figure 6.3.1.1). This low catch level was mainly due to the markedly decrease (-21%) observed in Portuguese catches as compared to the catch reported in 2002. The catches in 2008 showed a slight decrease of 200 t in relation to 2007. In the assessment period the level of catches (excluding the catches from the Gulf of Cádiz) for this stock is about 26,000 t (s.d. = 5,200t). The Spanish catches increased markedly from 1991 until 1998, whereas the Portuguese ones are more stable showing a smooth decreasing trend since the peak obtained in 1992 (with a secondary peak in 1998).

A historical evolution of catches is detailed in the Stock Annex, in Figures 6.3.1.1 and 6.3.1.2, and in Table 6.3.1.2. The different fleets targeting Southern horse mackerel are described in the Stock Annex.

6.3.2 Fishery independent information

6.3.2.1 Bottom trawl surveys

The CPUE matrices from these surveys are shown in Table 6.3.2.1.1 In the Spanish September/October survey, the ages from 1 to 5 are almost absent (except in 1993 and 2004), whereas in the Portuguese survey the oldest adults are not well represented. The total number per haul is dominated by the catch of the incoming year classes in the two time series of surveys. In the Spanish survey appeared an outstanding year class in 2005 but its strength has not been confirmed at age 1 in 2006 (Table 6.3.2.1.1). Figure 6.3.2.1.1 shows the evolution of several year-classes in the combined data set. The patterns in the combined data show a coherent decreasing pattern for each year class. Table 6.3.2.1.2 shows the combined abundance indices used in the assessment (see the Stock Annex for details).

6.3.2.2 Egg surveys

See the Stock Annex for details in the calculation of SSB by the Daily Egg Production Method (DEPM). The SSB estimates of the Daily Egg Production Method, and corresponding CV used in the stock assessment are shown below.

Year	SSB (ton.)	CV
2002	172577	0.76
2005	284951	0.54
2007	346983	0.75

6.3.3 Effort and catch per unit of effort

Useful statistics of Portuguese bottom trawl fleet were collected to monitor the state of the stock with a historic perspective. The time series of number of vessels and number of trips from this fleet are now available from 1937 to 1998 and 1991 respectively. The time series of the specific catch from this fleet is available from 1963 to 1998. During the period 1969–1978 there were outstanding high catches which were not in relation with the small increase in effort, suggesting an increase in the abundance of horse mackerel in that period. However, the effort showed an increasing trend since 60' until 1987 (Figure 6.3.3.1). In the future, it is expected to use this information with appropriate models (e.g. biomass dynamic models) to examine the dynamics of this stock through a large time series.

Looking at the historical series of the catches from Portugal and Spain (available since 1930 until now), it can be observed periods with significant higher catches (Figures 6.3.3.2 and 6.3.3.3). However, it is clear that the current catch level is not abnormally low when compared with the catches of the first half of the 20th century. Instead, the catches from 1962–1978, appear exceptionally high when looking to the whole time series. Many hypotheses have been proposed to explain this pattern and are under investigation with the analysis of the catch and effort data from the Portuguese bottom trawl fleet available since 1963.

Recently it has been prepared a new CPUE at age series for southern horse mackerel stock, still too short to be used in the assessment, corresponding th the Marín bottom trawl fleet, one of the fleets that operates mainly in Subdivision IXa North (Galicia, NW Spain). The effort series for this fleet is available from 1994 to 2006 and it has not been possible to update the information for 2007 and 2008. Taking into consideration that the Horse Power of each vessel is now under revision, we have considered provisionally the number of fishing trips as the unit of effort. The number of vessels and the number of fishing trips showed a clear decreasing trend since 1997 until 2002, remaining at relatively low level since then. Length distributions of horse mackerel catches from this fleet by month are available from 1999 to 2005. It is expected to retrieve other years back in time in the future and the years 2006 - 2008 in a short period of time. Age–length keys estimated by semester were applied to quarterly length distributions to obtain the catches at age. The CPUE data was obtained dividing the catch at age data by the number of fishing trips (Table 6.3.3.1). The figures of the CPUE at age (in logarithms) by cohort showed that the juvenile ages are very variable and the trend in young adult ages (from 3 to age 8) is null or even slightly positive indicating a possible immigration of those ages from other areas (Figure 6.3.3.4) (Murta *et al.*, 2008). Another explanation that could be proposed is that the fishing fleet target these intermediate ages. For the older ages (greater than 8 years old) the slopes are negative showing that the fishing fleet could be useful in obtaining information on mortality for those ages. In any case, the time series is at the moment quite short and the analysis of the complete cohorts is not possible.

6.3.4 Mean length at age and mean weight at age

Detailed information on the way to calculate mean weight and mean length at age values is included in the Stock Annex.

Table 6.3.4.1 and Table 6.3.4.2 show the mean weight at age in the catch, and the mean length at age in catch respectively. The mean weight at age in the catch increased significantly in 2004 for the ages above 3 years old, being for some of these ages the highest of the historical series (Figure 6.3.4.1). In 2008, the majority of the ages showed a decrease in mean weigh at age. The mean length at age showed a smooth increase trend for those ages since 2002 with a decrease in 2005 and 2006 (table 6.3.5.2).

6.3.5 Maturity at age

Maturity ogive estimation procedures are detailed in Stock Annex.

The proportion of maturity at age used in the assessment period is:

Age	0	1	2	3	4	5	6	7	8	9	10
Maturity (92–06)	0.04	0.31	0.83	0.98	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Maturity (07-08)	0.04	0.54	0.77	0.9	0.96	0.99	1.0	1.0	1.0	1.0	1.0

6.3.6 Catch in numbers at age

The procedure to estimate numbers at age in the catch is described in the Stock Annex. In the time series of the catch in numbers at age, the 1994 year class showed high catches at ages 11 and 12 and the 1996 year class appears to be conspicuous at juvenile ages (0, 1 and 2) and reappearing again at ages 8 and 10. (Table 6.3.6.1.) In general, catches are dominated by juveniles and young adults (ages 0 to 4), although in recent years there is an increment of catch of older ages.

To know more in depth the exploitation history of the southern horse mackerel a new series of catch in numbers at age by fishing fleet is provided (Table 6.3.6.2 and Figures

6.3.1.2 and 6.3.6.1). Six fishing fleets are considered defined by the gear type (bottom trawl, purse seine and artisanal) and country (Portugal and Spain). The new time series starts in 1992 although it is expected to be extended back in time in the future.

The following fleets: Portuguese bottom trawl fleet, Portuguese purse seine fleet and Spanish purse seine fleet show a similar exploitation pattern (see Figure 6.3.6.1) with a great presence of juveniles and lower abundance of adults. On the other hand the Portuguese artisanal fleet, and the Spanish bottom trawl and artisanal fleets show the opposite: a significant presence of adults and low presence of juveniles. The catch of Spanish artisanal fishery is negligible.

6.3.7 Natural mortality

The natural mortality rate used in the assessment is the same value as used in previous years (see Stock Annex).

6.4 Information from the fishing industry

There is no any information in relation with this subsection

6.5 Methods

6.5.1 The ASAP model

See Stock Annex.

6.5.2 Model and data exploration

The detailed parameterisation of the model can be seen in the final input file (see Table 6.5.2.1), and the parameter estimates and diagnostics are detailed in the output report file in Table 6.5.2.2. The model used is the same as in last year's assessment; however a slight change in parameterisation was made to improve the pattern of the residuals of one of the fleets (fleet 4 – Spanish bottom-trawl). Therefore, instead of estimating one selectivity parameter for each age, a double logistic function was used, which also helped to reduce the number of parameters to be estimated (less 20 than in the previous parameterisation). This option improved the pattern and general magnitude of the Spanish bottom trawl residuals, and contributed to avoid overparameterisation of the model. The overall fitting of the model to the total catch data of every fleet is very good (log residuals ranging from -0.01 to 0.02). The fitting to the catch proportions at age by fleet also shows mostly small residuals, however the residuals of the plus-group (age 11+) of the Spanish bottom-trawl fish are all positive and some as high as 0.6, which is due to higher catches in those ages than would be expected by the fitted selectivity vector (Figure 6.5.2.1). The residuals of the fit to the survey data (Figure 6.5.2.2) show clear year-effects, which may be due to several causes (different availability of the fish in different years, fishing experience of the different skippers, etc). There are no clear patterns across ages, which means that the catchabilities vector shown in Figure 6.5.2.3 is well fitted. Figure 6.5.2.4 also shows the residuals of the fit to the survey data, by plotting the observed (dashed lines) and the fitted (solid lines) indices. Given the variability in the survey data, the fitted values behave as smoothers that describe the overall trends, but do not fit to the extreme fluctuations of the abundance indices. Regarding the three observations of the egg surveys, the fitting is also very good, with log residuals ranging from -0.27 to 0.30. The estimated catchability is of 4.95.

6.6 Reference points

Reference points have not been defined for this stock

6.7 State of the stock

6.7.1 Stock assessment

The numbers at age in the stock, estimated in the assessment, are shown in Table 6.7.1.1. Figure 6.7.1.1 shows the SSB and recruitment, and fishing mortality estimates in each year, along with the respective retrospective pattern. Those figures show a strong recruitment in 1996, followed by another one in 2004. This recent strong recruitment is likely responsible for the increase in SSB that is shown in Figure 6.7.1.1. Estimates of SSB, recruitment, and the average fishing mortality from ages 1 to 11+ are shown in the stock summary table (Table 6.7.1.2).

Figure 6.7.1.2 shows the average fishing mortality rate from ages 1 to 11+, both total (dashed line) and by fleet (solid lines). The apparent overall stability in the exploitation rate is not reflected in the individual fleet's exploitation rates, but rather due to an inverse trend in fishing mortality between the two most important fleets (the Portuguese and Spanish bottom-trawl fleets). The Portuguese purse-seine fleet also presents a decreasing trend in fishing mortality, while the artisanal fleet has a stable exploitation rate at relatively low levels. The Spanish purse-seiners, after an increase in the late 1990s due to a shortage in their main target species (sardine), which was followed by a decrease from 1998 to 2004, showed in 2008 an increase in fishing mortality. The Spanish artisanal fleet also had an increase in fishing mortality in 2008, although the overall level is still low.

The three vectors of selectivity estimates are shown in Figure 6.7.1.3. Block 1 corresponds to the selectivity of the Portuguese bottom-trawl fleet and both purse-seine fleets, Block 2 corresponds to the selectivity of both artisanal fleets, and Block 3 corresponds to the selectivity of the Spanish bottom-trawl fleet. Blocks 2 and 3 correspond to fleets mainly targeting older age classes, while Block 1 corresponds to fleets targeting mainly young fish, but also catching a wide range of age classes.

6.8 Short term forecast

As it was noted in the previous year report, the short term forecast considering increments of the status quo catch is considered a misleading concept for this stock since the forecast should be made taking into account the effects of the particular selection pattern of each fleet could have on the horse mackerel population (see section on Management Considerations).

To analyse the possible effects of the increasing trend in fishing mortality of the Spanish fleets, a short-term forecast was carried out by fixing the catches by fleet for the whole period (2009-2010) under different assumptions: 1) status quo (i.e. same catches as in 2008); 2) mean catches of the last 10 years; 3) catches derived if the fleets continue the historical trend; and 4) same total catches, but distributed between fleets following the historical catch percentage trend (see Figure 6.8.1). Furthermore, in 2008, we assume the same F value estimated by the assessment model. The recruitment for each of the years was assumed to be stochastic (around the geometric mean of the estimated recruitments from 1992 to 2007 with the same variability observed in the series). To perform the multi-fleet deterministic forecast with catch constraints it has been designed an *ad hoc* function in the R programming language (for more details see Stock Annex). With these assumptions, the SSB would increase to 86,500 ton. in 2009 to around 87,000 ton. in 2010 and around 90,000 ton. in 2011, depending on the assumption about catches selected. In summary it would be an increment of about 3.3% in SSB at the end of the period, in the status quo cases.

Table 6.8.1 shows the forecast for different catch options. In all the scenarios considered, SSB has a slight increase along the forecast period. This means that following the current catch trends in all fleets, or having each fleet to fish at their historical catch level, it has similar effects in the short-term, assuming a constant recruitment.

6.9 Uncertainties in assessment and forecast

There are typically several source of uncertainty in a fish stock assessment, e.g.:

(1) Unsatisfactory fitting of the assessment model;
(2) Inaccurate catch data (due to black landings or discards);
(3) Doubts in aging criteria;
(4) Noisy abundance indices;
(5) Ignorance on stock identity.

Regarding the first source of uncertainty, all diagnostics (residuals, retrospective patterns) indicate an appropriate fit of the model to the available data. Even the survey indices, which are the noisiest data source, could be fitted in a way that, although not adjusting for extreme variations, allowed to describe the main overall trends in the data

Although horse mackerel is usually labelled as a pelagic species, the fact is that most of the catches in Iberian waters are taken by bottom-trawl. The association of this species with the sea floor (e.g. Lloris and Moreno, 1995) is much higher than that of other typically pelagic fish, such as scombrids or tunnids. Therefore, abundance data from bottom-trawl surveys, although variable over the years, seem to provide estimates reliable enough to be used in the assessment. That is also supported by the signal along the year classes shown in Figure 6.3.2.1.1.

The catch data used in the assessment is believed to be accurate, given the large number of samples, the good spatial and temporal coverage of the landings and the lack of discards and black landings (horse mackerel usually has a market price good enough to avoid discarding but not so high as to motivate black landings). The aging data for this stock is produced by experienced technicians who have participated more than once on otolith exchange programmes and age reading workshops. Age reading criteria were validated by using an otolith reference collection from the 1982 year-class, which was preponderant for many years in the western horse mackerel stock and therefore allowed to know with little doubt the actual age of the sampled fish.

The stock identity of the north-east Atlantic horse mackerel has recently been the subject of an international research project, which defined the boundaries of several stocks (including the southern one), using a multidisciplinary approach. The main findings of that project are published in several papers in the special issue of *Fisheries Research* (2008, vol. 89, issue 2) on the stock identification of horse mackerel.

Finally, the main uncertainties in the forecast are related to the assumptions on the stability of catches, recruitment and exploitation patterns.

6.10 Management considerations

This stock has supported a stable exploitation level for a long time period. The fleet-disaggregated assessment carried out allows evaluating the historical series of fishing mortality by fleet, and their corresponding exploitation pattern. It is clear that the apparent stability in the overall exploitation level is due to a decrease in fishing mortality in some fleets and an increase in others. The one with the highest increase is the Spanish bottom-trawl fleet operating in subdivision IXa North, which accounted less than 20% of the total catches until 2003 and has reached to a maximum level of 35% of the total catches in 2007. There was also a slight increase in the fishing mortality of the rest of the Spanish fleets (see Table 6.10.1), while the Portuguese fishing fleets had a decrease in fishing mortality. This overall stability can change drastically if there is a change in the fishing mortality trend of any of the Portuguese fleets or a faster rise in the Spanish fleets. Such change in fishing mortality has been observed in the late 1990s due to a decrease in sardine abundance, which made many purse-seiners to start targeting horse mackerel. Such a drastic change, in the current conditions, could lead to a decline of the reproductive potential of the stock.

The traditional exploitation pattern across fleets has been, for a long time, the targeting of juvenile age classes. This targeting of juveniles at a moderate level of exploitation does not seem to have been detrimental to the dynamics of this stock, which has been stable along the years. However, both artisanal fleets and the Spanish bottom-trawl fleet target adult fish, especially above 6 years old. There are studies on the migratory pattern of southern horse mackerel that suggest that age classes are not evenly distributed along the stock area, with old fish mostly present in the waters of Galicia and northern Portugal (Murta et al., 2008). Therefore, a high fishing mortality focused on those areas may deplete the spawning stock in a faster way than if the fish were homogeneously distributed, which would reduce the reproductive capacity of the stock. The effect of the ongoing changes in the overall exploitation pattern of the stock can only be investigated in the medium-term, by simulating how the increased depletion of the older ages may affect the renewal capacity of the stock.

The abundance information indicates no change in the stock abundance. Following the EU Commission consultation paper on TACs for 2010 (COM(2009) 224, 12 May 2009), this corresponds to an unchanged TAC. ICES has not evaluated the proposed option in relation to the precautionary approach.

6.11 Comparison with previous assessment and forecast

Although this year's and last year's assessments provide an identical view of the stock structure and dynamics, there are two differences that can be noticed in the evolution of the estimated SSB: it has a decreasing trend from 2007 to 2008, while it increased from 2006 to 2007, and the overall level of SSB was revised to a lower level (2007 SSB was estimated last year at 132000 t and this year at 90000 t.). These two differences have different causes. On one hand, the change in the trend of SSB is caused by the inclusion of the 2008 data in the assessment, which has a higher fishing mortality in older ages and in which the strong 1996 year class stopped contributing for SSB. On the other hand, the re-scaling of the overall SSB level is caused by the re-parameterisation of the model in order to improve the residuals of the plus-group of the Spanish bottom-trawl fleet. This change, which resulted in the removal of 20 parameters from the model, implied a change in the weights that the different data sources have on the objective function of the model, causing a decrease in the overall level of the SSB estimates. Still, both assessments agree on the overall pattern of stability in the fishing mortality and SSB across the years, and on the trends of fishing mortality across the different fleets. This is the first year in that multi-fleet stochastic short-term forecasts were carried out, nevertheless, the predicted trends for the near future are in line with those indicated by last year's assessment and forecast.

6.12 Management plan evaluations

There is no management plan for this stock

6.13 Ecosystem considerations

See section 1.9 in relation with horse mackerel species.

6.14 Regulations and their effects

There is no specific regulations that can affect significantly to the fishery and/or dynamics of southern horse mackerel stock.

6.15 Changes in fishing technology and fishing patterns

Traditionally this fishery is characterized by the high proportion of juveniles in catches. Recently the importance of the Spanish bottom trawl fleet in the catches of the stock is increasing. This fleet is targeting mainly adult fish.

6.16 Changes in the environment

No information. See also section 1.9.

Table 6.3.1.1 Time series of southern horse mackerel historical catches by country (in tonnes).

	Country		
Year	Portugal (Subdivisions: IX a central north; IXa central south and IXa south)	Spain (Subdivisions IXa North and IXa south*)	Total Catch
1991	17,497	4,275	21,772
1992	22,654	4,059[1]	28,411[1]
1993	25,747	6,198	31,945
1994	19,061	9,380[1]	28,441[1]
1995	17,698	7,449	25,147
1996	14,053	6,347[1]	20,400[1]
1997	16,736	10,906	27,642
1998	21,334	20,230	41,564
1999	14,420	13,313	27,733
2000	15,348	11,812	27,160
2001	13,760	11,152	24,910
2002	14,270	8,236 // (9,393)*	22,506 // (23,663)*
2003	11,242	7,645 // (8,324)*	18,887 // (19,566)*
2004	11,875	11,377 // (11,702)*	23,252 // (23,577)*
2005	13,307	9,388 // (9,804)*	22,695 // (23,111)*
2006	14,607	9,295 // (9,951)*	23,902 // (24,558)*
2007	10,381	12,409 // (13,043)*	22,790 // (23,424)*
2008	9290	13,703 // (14,303)*	22,993 // (23,593)*

(*) In parenthesis: the Spanish catches from Subdivision IXa south are also included. These catches are only available since 2002 and they will not be considered in the assessment data until the rest of the time series be completed.

([1]) These figures have been revised in 2008.

Table 6.3.1.2. Southern horse mackerel. Landings by gear and by country with and indication (in parenthesis) of the percentage that represent those landings in each country.

Gear	Bottom trawl		Purse seine		Artisanal	
Year	Portugal	Spain	Portugal	Spain	Portugal	Spain
1992	13,000 (54.7)	1,651 (40.7)	7,354 (30.9)	2,409 (59.3)	3,445 (14.5)	-
1993	16,783 (66.3)	3,877 (62.6)	4,683 (18.5)	2,321 (37.4)	3,841 (15.2)	-
1994	10,466 (55.0)	2,655 (28.3)	5,369 (28.2)	6,724 (71.7)	3,202 (16.8)	-
1995	12601 (71.3)	3,010 (40.4)	2,947 (16.7)	4,440 (59.6)	2,137 (12.1)	-
1996	10,674 (76.3)	2,705 (42.6)	2,085 (14.9)	3,642 (57.4)	1,228 (8.8)	-
1997	12,446 (66.8)	2,130 (19.5)	4,385 (23.5)	8,776 (80.5)	1,800 (9.7)	-
1998	13,170 (61.7)	3,773 (18.6)	5,901 (27.6)	16,458 (81.4)	2,287 (10.7)	-
1999	6,868 (47.6)	3,238 (24.3)	5,707 (39.5)	10,074 (75.7)	1,855 (12.9)	-
2000	7,970 (55.5)	4,727 (40.0)	4,210 (29.3)	7,027 (59.5)	2,169 (15.1)	58 (0.5)
2001	7,690 (55.9)	4,536 (40.7)	4,788 (34.8)	6,260 (56.1)	1,281 (9.3)	356 (3.2)
2002	8,126 (56.9)	4,181 (50.8)	4,271 (29.9)	3,959 (48.1)	1,873 (13.1)	96 (1.2)
2003	6,887 (61.3)	3,229 (42.2)	2,112 (18.8)	4,411 (57.7)	2,243 (20.0)	5 (0.1)
2004	8,625 (65.8)	7,501 (65.9)	2,042 (15.6)	3,658 (32.2)	2,441 (18.6)	217 (1.9)
2005	8,319 (62.5)	5,710 (60.9)	2,444 (18.4)	3,596 (38.3)	2,545 (19.1)	76 (0.8)
2006	9,485 (64.9)	5,534 (59.6)	1,754 (12.0)	3,676 (39.6)	3,368 (23.1)	77 (0.8)
2007	5,706 (55.0)	7,999 (64.5)	2,683 (25.8)	4,092 (33.0)	1,992 (19.2)	316 (2.5)
2008	5,790 (62.0)	6,590 (48.0)	1,090 (12.0)	6,580 (48.0)	2,410 (26.0)	539 (4.0)

Table 6.3.1.3. Description of the Portuguese fishing fleets that catch horse mackerel in Division IXa (only trawlers and purse seiners). Note that horse mackerel is also caught in all polyvalent and most small scale fisheries.

Gear	Length	Storage	Number of boats
Trawl	10-20	Freezer	2
Trawl	20-30	Freezer	7
Trawl	30-40	Freezer	5
Trawl	0-10	Other	259
Trawl	10-20	Other	68
Trawl	20-30	Other	60
Trawl	30-40	Other	29
Purse seine	0-10	Other	79
Purse seine	10-20	Other	103
Purse seine	20-30	Other	79

Table 6.3.1.4. Description of the Spanish fishing fleets that catch horse mackerel in Division IXa including the Gulf of Cádiz (Southern horse mackerel stock) and in Division VIIIc (Western horse mackerel stock). It is indicated the range and the arithmetic mean (in parenthesis). Data from official census (Hernández 2008). Note that horse mackerel in the Spanish area is mainly fished by bottom trawlers and purse seiners.

Gear	Bottom trawl	Purse seine	Lgline Bottom	Lgline surface	Gillnet (big mesh size)	Gillnet	Other artisanal
Number	282	410	100	67	35	57	5379
Construction year (mean)	1996	1992	1990	1995	1990	1993	1982
Length	9-35 (22.9)	8-38 (21)	6-28 (15.1)	18-38 (27.6)	4-28.6 (14)	12-27 (17.2)	3-27 (7)
Power	66-800 (322.3)	24-1100 (302.5)	12-476 (150.3)	175-780 (418.9)	10-500 (141.8)	50-408 (164.9)	2-450 (32.6)
Tonnage	6-228 (81.2)	4-221 (56.6)	2-118 (26)	37-206 (116)	1-110 (23.7)	10-99 (27.6)	0.3-83 (3.5)

Table 6.3.2.1.1. Sourthern horse mackerel. CPUE at age from bottom trawl surveys

Portuguese October Survey

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	319.270	35.750	20.580	21.330	25.070	11.790	6.560	3.540	4.080	3.070	1.340	0.990	0.590	0.040	0.000	0.080
1992	522.240	568.290	182.260	63.540	28.300	11.010	7.420	7.750	4.120	3.460	4.720	0.770	1.000	0.300	0.160	0.120
1993	2065.440	277.910	279.050	171.660	40.690	5.350	3.110	1.940	1.110	1.270	0.780	1.870	0.520	0.360	0.080	0.090
1994	4.070	10.210	70.590	64.570	26.870	6.640	3.000	2.050	1.000	0.550	0.350	0.120	0.040	0.010	0.000	0.010
1995	22.900	90.500	129.630	78.560	34.980	6.640	1.370	1.600	0.500	0.240	0.240	0.370	0.310	0.570	0.150	0.210
1996*	1613.260	11.340	18.460	29.820	29.970	5.680	2.290	0.910	0.330	0.180	0.060	0.120	0.090	0.060	0.010	0.010
1997	1306.610	92.160	152.190	45.400	73.850	42.740	8.650	6.880	2.740	3.110	1.130	0.140	0.040	0.160	0.100	0.070
1998	115.750	48.910	137.450	19.900	7.390	4.100	2.200	2.190	0.340	0.070	0.030	0.010	0.030	0.000	0.000	0.010
1999*	147.220	31.310	58.860	69.360	5.820	2.000	1.050	0.250	0.060	0.100	0.030	0.000	0.010	0.010	0.000	0.000
2000	3.510	22.700	30.540	34.320	16.700	9.320	4.810	1.470	0.750	0.100	0.050	0.070	0.040	0.020	0.000	0.000
2001	726.800	1.150	4.710	3.700	5.110	7.260	8.800	13.960	7.610	2.470	1.370	0.400	0.180	0.230	0.050	0.000
2002 [1]	41.580	2.630	8.850	14.570	11.590	5.970	1.880	1.260	0.860	0.520	1.020	0.350	0.240	0.120	0.060	0.030
2003*	82.460	10.470	10.510	20.340	18.090	5.170	2.810	1.720	1.100	0.630	0.270	0.010	0.010	0.010	0.000	0.000
2004	63.080	39.330	140.660	55.220	11.570	4.980	2.360	5.900	7.710	1.220	0.250	0.030	0.000	0.000	0.000	0.000
2005	383.510	1475.200	237.210	81.050	39.830	17.230	20.270	20.600	15.780	8.200	5.000	5.990	5.440	1.020	1.270	0.350
2006	93.110	95.230	253.400	63.140	3.760	12.110	8.750	7.190	2.930	1.600	0.730	0.160	0.040	0.000	0.000	0.000
2007	40.790	0.870	28.190	45.660	34.270	8.580	2.880	1.700	0.170	0.570	1.620	1.470	0.660	0.330	0.330	0.590
2008	51.700	26.650	41.070	23.660	30.400	21.060	2.920	0.980	1.430	2.010	1.370	1.010	0.530	0.940	0.630	2

Spanish October Survey (only Subdivision IXa North)

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	0.146	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.878	1.860	0.782	0.829	2.734	1.438	1.699	1.812
1992	6.575	0.000	0.000	0.000	0.092	0.000	0.011	0.200	0.181	0.300	3.386	1.553	1.919	1.086	0.302	2.246
1993	92.068	1.652	5.164	3.945	0.354	0.000	1.152	5.175	5.724	8.721	5.228	10.801	2.235	1.646	0.415	0.958
1994	0.148	0.000	0.477	0.000	0.000	0.000	0.000	0.191	0.574	1.432	2.631	0.191	16.133	12.757	1.255	6.413
1995	0.092	0.000	0.000	0.001	0.000	0.003	0.018	0.018	0.339	0.175	0.761	2.534	3.967	8.751	2.450	2.203
1996	33.649	0.000	0.000	0.000	0.000	0.026	0.260	0.348	0.903	2.708	0.564	0.447	1.838	2.561	1.001	4.410
1997**	2.033	0.007	0.000	0.000	0.016	0.126	0.248	0.980	1.158	1.711	0.779	0.235	0.259	0.800	1.098	2.617
1998	0.976	0.000	0.000	0.000	0.000	0.000	0.134	0.926	0.540	0.253	0.146	0.043	0.078	0.126	0.041	0.163
1999	0.041	0.000	0.000	0.000	0.000	0.000	0.170	0.270	0.630	2.175	3.168	2.597	4.653	1.939	1.633	0.286
2000	0.478	0.000	0.000	0.000	0.000	0.005	0.374	2.792	3.686	3.241	0.721	0.578	0.427	0.537	0.294	0.719
2001	12.742	2.857	0.000	0.000	0.000	0.190	0.411	2.544	4.412	4.127	3.151	1.793	0.998	0.930	0.122	0.312
2002	0.143	0.000	0.000	0.000	0.000	0.000	0.594	1.240	7.291	7.091	8.949	10.386	3.540	4.463	1.336	2.295
2003	8.775	0.000	0.000	0.000	0.000	0.026	0.061	0.194	0.110	0.810	0.880	0.348	0.222	0.119	0.067	0.917
2004	89.967	1.191	2.500	16.218	5.390	4.599	1.710	1.306	0.653	0.290	0.797	0.100	0.350	0.044	0.056	0.070
2005	3520.441	0.045	0.000	0.000	0.348	0.409	0.259	0.252	0.515	0.479	0.140	0.637	0.288	0.194	0.099	0.045
2006	28.401	0.096	0.035	0.114	0.061	0.072	0.044	0.027	0.041	0.075	0.155	0.192	0.256	0.159	0.030	0.218
2007	1.388	0.000	0.000	0.007	0.091	0.210	0.965	1.256	1.634	0.756	0.618	0.641	0.177	0.239	0.190	0.162
2008	17.980	0.000	0.003	0.026	0.026	0.003	0.058	0.081	0.225	0.373	0.372	0.264	0.065	0.041	0.057	0.384

*****The surveys were carried out with a different vessel
******Since 1997 another stratification design was applied in the Spanish surveys
1 In 2002 started a new series in which the duration of the trawling per haul has changed from one hour to thirty minutes

Table 6.3.2.1.2. Time series of CPUE at age from Portuguese and Spanish combined bottom trawl survey. It is showed with the period and the age plus considered in the assessment.

	AGES											
YEAR	0	1	2	3	4	5	6	7	8	9	10	11+
1992	392.79	425.96	138.3	47.03	20.88	10.04	6.29	5.89	3.32	2.87	4.36	2.61
1993	1329.25	240.47	245.72	132.1	33.44	6.74	3.51	2.73	2.26	2.32	2.17	4.8
1994	21.84	241.46	82.96	74.62	36.15	8.71	2.65	1.74	1.04	0.78	1.36	4.61
1995	17.02	60.09	86.9	60.77	29.77	7.33	1.68	1.39	0.65	0.31	0.55	3.43
1996	1051.82	25.84	26.21	40.63	32	8.26	2.95	1.08	0.84	0.61	0.28	1.42
1997	843.59	245.4	100.34	31.69	50.69	30.68	6.4	4.79	2	2.23	0.89	0.93
1998	80.56	176.3	104.78	29.47	9.75	10.58	5.99	2.44	1.08	0.45	0.61	0.36
1999	98.68	35.52	46.37	60.6	6.82	2.58	1.33	0.58	0.43	0.37	0.45	1.27
2000	2.64	30.62	23.19	28.68	18.79	7.5	4.86	2.26	1.26	0.65	0.34	0.49
2001	465.33	2.38	6.96	6.84	7.54	6.64	6.8	9.93	5.74	2.46	1.8	1.05
2002	28.75	80.26	7.98	11.71	8.33	4.65	2.23	2	2.98	2.06	2.03	3.4
2003	61.96	26.09	13.15	15.24	13.7	4.81	3.08	2.16	1	0.76	0.47	0.76
2004	363.82	59.34	99.68	42.38	11.98	7.78	4.44	5.9	6.06	1.46	1.85	0.18
2005	660.78	975.76	162.13	67.06	32.89	13.29	14.33	13.75	10.94	6.19	3.38	9.2
2006	62.74	170.47	323.14	69.11	11.93	12.29	7.62	6.8	4.14	2.9	1.75	1.29
2007	34.88	21.41	38.21	82.96	35.28	6.29	4.52	3.09	1.82	1.07	1.45	2.48
2008	46.64	22.65	34.91	20.11	25.84	17.9	2.49	0.85	1.25	1.76	1.22	0.9

Table 6.3.3.1. Southern horse mackerel. Marín bottom trawl fleet. CPUE at age time series.

	Age															
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**
1999	0.001	1.360	6.300	23.553	28.662	29.119	27.787	18.919	12.381	17.313	10.097	7.069	9.688	4.362	2.676	4.503
2000	0.000	0.002	0.436	3.970	10.715	9.484	36.772	89.936	79.794	60.716	12.658	11.002	7.062	6.660	2.929	4.620
2001	1.034	1.071	8.334	15.324	14.187	57.378	114.489	181.163	158.618	111.662	81.657	47.366	28.695	19.487	1.326	3.477
2002	0.000	54.004	35.769	20.005	7.158	8.001	46.143	86.064	177.139	111.396	57.724	45.110	11.976	17.099	3.744	5.998
2003	0.000	0.003	0.171	0.186	0.628	13.429	29.377	77.771	94.658	100.433	85.274	25.255	14.039	5.972	0.159	25.156
2004	6.364	49.687	17.695	110.186	52.609	55.791	47.621	67.870	52.579	18.749	41.416	3.948	11.387	1.749	0.859	10.115
2005	1.302	40.004	29.336	36.787	36.736	24.976	29.493	39.253	67.946	58.202	41.397	41.823	11.668	9.765	3.349	2.366

Table 6.3.4.1. Southern horse mackerel. Mean weight at age in the catch

	AGES															
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	0.026	0.036	0.073	0.101	0.122	0.153	0.170	0.179	0.210	0.217	0.221	0.215	0.256	0.296	0.398	0.374
1992	0.032	0.034	0.044	0.067	0.104	0.131	0.148	0.172	0.187	0.200	0.232	0.258	0.280	0.324	0.331	0.416
1993	0.023	0.029	0.038	0.066	0.089	0.130	0.166	0.208	0.243	0.243	0.253	0.269	0.319	0.341	0.369	0.413
1994	0.040	0.036	0.063	0.069	0.091	0.131	0.157	0.193	0.225	0.248	0.272	0.286	0.343	0.336	0.325	0.380
1995	0.036	0.035	0.060	0.083	0.097	0.124	0.164	0.168	0.200	0.222	0.230	0.255	0.284	0.292	0.331	0.391
1996	0.022	0.049	0.070	0.087	0.112	0.140	0.172	0.186	0.216	0.239	0.258	0.264	0.293	0.275	0.362	0.380
1997	0.028	0.031	0.051	0.073	0.112	0.138	0.166	0.200	0.236	0.264	0.255	0.288	0.324	0.332	0.348	0.443
1998	0.028	0.031	0.039	0.067	0.102	0.127	0.169	0.212	0.170	0.245	0.251	0.270	0.290	0.315	0.364	0.447
1999	0.022	0.040	0.060	0.084	0.108	0.140	0.163	0.191	0.217	0.249	0.271	0.284	0.300	0.321	0.397	0.474
2000	0.024	0.035	0.053	0.087	0.111	0.134	0.160	0.188	0.220	0.235	0.252	0.275	0.283	0.321	0.324	0.339
2001	0.024	0.029	0.067	0.083	0.087	0.131	0.157	0.183	0.199	0.232	0.241	0.281	0.279	0.306	0.330	0.428
2002	0.027	0.030	0.044	0.069	0.097	0.124	0.147	0.168	0.196	0.226	0.246	0.270	0.311	0.322	0.341	0.409
2003	0.022	0.033	0.045	0.063	0.088	0.124	0.146	0.179	0.204	0.235	0.254	0.280	0.299	0.318	0.440	0.344
2004	0.039	0.028	0.047	0.084	0.120	0.159	0.184	0.209	0.228	0.254	0.266	0.268	0.284	0.274	0.370	0.361
2005	0.02	0.03	0.04	0.07	0.12	0.15	0.17	0.18	0.22	0.24	0.25	0.28	0.28	0.31	0.29	0.41
2006	0.029	0.029	0.045	0.063	0.093	0.125	0.140	0.167	0.194	0.225	0.249	0.290	0.309	0.363	0.386	0.399
2007	0.028	0.048	0.057	0.070	0.093	0.113	0.162	0.193	0.232	0.223	0.237	0.260	0.294	0.266	0.323	0.363
2008	0.019	0.047	0.062	0.082	0.104	0.133	0.152	0.172	0.195	0.215	0.234	0.247	0.264	0.306	0.353	0.407

Table 6.3.4.2. Southern horse mackerel mean length at age in the catch

	AGES															
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1991	13.31	13.57	20.56	23.62	25.14	26.93	28.13	28.37	29.58	29.67	30.17	29.67	31.50	31.83	36.12	35.68
1992	14.93	15.59	17.47	19.84	23.18	25.79	27.38	28.65	29.60	31.15	31.53	32.64	33.28	33.93	34.70	36.81
1993	13.96	15.54	17.41	18.89	21.28	28.23	29.56	31.09	31.70	31.66	32.05	32.45	34.08	34.72	35.81	37.18
1994	13.37	14.58	18.11	21.08	22.66	24.76	27.01	29.53	31.15	31.71	32.38	32.19	33.27	34.17	34.37	36.46
1995	16.04	15.44	19.88	21.77	23.12	24.49	28.64	26.54	30.14	30.90	31.61	32.61	33.95	33.99	35.23	36.94
1996	13.29	18.99	19.68	21.82	24.68	26.32	28.02	28.56	30.34	30.74	31.47	31.95	33.42	32.54	36.15	37.00
1997	13.36	15.81	18.89	20.72	24.27	26.30	27.62	29.46	31.15	32.40	31.88	33.05	34.64	34.82	35.45	38.54
1998	14.49	13.92	15.92	20.45	23.51	25.52	28.31	30.31	26.86	31.69	31.98	32.73	33.44	34.54	36.45	39.08
1999	13.41	16.39	18.97	22.27	24.48	26.20	27.51	28.98	30.29	31.70	32.69	33.26	33.88	34.74	37.31	39.59
2000	13.61	16.37	18.43	21.68	24.76	26.00	27.23	28.57	30.22	30.80	31.52	32.28	32.66	34.23	34.49	34.99
2001	14.11	15.62	20.24	21.85	22.46	25.44	27.36	28.73	29.59	30.85	31.18	32.98	32.84	33.99	34.73	38.23
2002	15.05	15.69	17.51	20.34	23.06	25.38	26.60	28.01	29.58	30.86	31.76	32.60	34.20	34.68	35.43	36.88
2003	13.00	15.72	18.75	20.70	23.14	26.08	26.73	29.19	30.00	31.21	31.96	32.90	33.55	33.93	38.86	35.31
2004	16.17	14.43	17.23	21.17	24.04	26.67	28.08	29.40	30.47	31.62	32.29	32.23	33.05	32.25	36.37	35.88
2005	12.50	13.93	16.62	20.08	23.54	25.92	27.12	28.09	30.02	31.14	31.64	32.79	32.58	33.55	32.59	37.22
2006	14.61	14.66	17.04	19.21	22.21	24.62	25.63	27.21	28.72	30.33	31.48	33.22	34.00	35.86	36.70	37.00
2007	14.60	17.49	18.53	20.02	22.09	23.64	26.90	28.72	30.64	30.33	30.92	31.83	33.42	32.16	34.49	35.74
2008	12.96	17.26	20.48	22.25	23.97	25.42	26.54	27.66	28.78	29.64	30.48	31.28	32.23	33.53	35.58	37.23

Table 6.3.6.1. Southern horse mackerel. Time series of catch at age data

	AGES															
YEAR	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**
1991	13914	72287	15701	7725	7182	10684	7133	8453	8333	19754	12079	9346	5765	4015	1763	522
1992	11966	102521	160026	43207	12516	10030	5615	7672	5633	4902	13783	4700	3409	1924	1213	1846
1993	5121	73007	154366	98963	34999	13410	13128	10972	6080	4317	3878	9537	1286	565	436	1741
1994	11943	54418	76970	95856	30476	8115	4567	3213	4646	3176	5534	2234	1579	1763	1266	3436
1995	6241	58241	28682	52856	28399	11225	4068	3124	2536	3496	2490	5251	6852	9705	3704	5677
1996	40207	12439	12449	27937	37498	11584	8353	5834	4148	10065	4481	4170	4808	3253	1109	4049
1997	3770	304637	115808	25895	17418	12323	7532	5259	4131	3393	2013	1957	1560	2065	2225	3042
1998	19023	54319	328147	84414	18308	11144	9281	21127	16389	7877	6562	3136	2624	3377	1849	4560
1999	39363	30615	26945	62894	42044	16994	16382	7464	4093	6772	3751	2874	3221	1429	847	3305
2000	9821	56973	31437	37675	35549	17438	20611	14007	7868	6323	4353	966	1497	1499	1261	2675
2001	107632	76414	28214	32098	27406	16641	14151	13436	8513	3488	4887	3062	1591	2053	272	1492
2002	17826	86185	95747	27782	12360	10982	9151	9996	8897	8910	5199	3103	1452	1673	1061	1071
2003	37403	5268	34426	33693	23880	13535	11363	10853	9847	7403	4994	1696	1485	491	69	2134
2004	6689	111702	51898	20474	10655	15629	12927	15350	10223	3582	5132	591	1508	214	438	2505
2005	27753	104789	46912	23480	18274	12407	11641	8217	8729	6514	4920	5062	2145	1417	1485	1700
2006	2892	84591	99525	23228	7139	12800	11318	6552	7632	8118	8852	4914	3779	2071	1834	2263
2007	2881	13666	21668	41343	20290	8238	4868	4076	6483	5133	5243	4755	5636	2997	5772	11172
2008	50159	53317	27463	29982	17067	7260	4932	3689	4573	3939	4472	3454	1644	6632	3862	9295

Table 6.3.6.2. Southern horse mackerel. Catch in number by gear and country (Pt = Portugal; Sp = Spain)

Pt. Bottom trawl

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11+
1992	4707	43326	72194	19567	7253	6331	3538	4288	3046	2495	6593	5676
1993	98	8737	40080	77980	28618	10722	9734	6540	3471	1342	1383	3356
1994	3413	16252	37679	55074	16278	3862	1945	900	1263	914	691	1136
1995	3917	12983	18291	22796	11429	5351	2395	2195	2036	2378	1691	17550
1996	30763	10329	10084	19186	23285	6293	4295	2813	2181	1779	1195	3638
1997	2819	180143	67538	14756	7630	4251	1825	779	296	175	172	806
1998	4444	36543	205035	32093	7077	3347	2155	2045	1844	1041	1225	2539
1999	28176	11489	16041	23580	8295	2527	2701	1581	863	932	767	1309
2000	1106	35946	13682	17867	9887	5749	5723	4046	2301	1568	950	769
2001	39825	25156	10755	9140	7377	4284	5419	5757	3687	1331	774	666
2002	3572	58462	49165	11953	4456	3560	3600	4563	2847	1891	775	821
2003	14581	2077	18044	12035	12655	7100	5807	4606	3117	1629	831	347
2004	1335	77202	44073	10862	3388	4640	3772	4340	2829	807	229	125
2005	2943	50534	30346	14960	10564	5227	5228	3751	2836	1720	1180	2200
2006	1223	55455	60260	14803	3643	9412	8894	3068	2630	1797	1218	624
2007	19	2374	14842	31466	10961	2909	1595	632	411	534	772	4181
2008	5512	12786	21009	21454	9703	2290	1172	727	901	623	702	1856

Pt. Purse seine

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11+
1992	6188	36983	47773	12060	3322	2414	1344	1952	1278	1186	2537	2363
1993	2143	44611	72760	9606	2792	477	174	200	73	96	92	175
1994	2378	8351	21613	26189	7060	1706	816	466	580	440	392	452
1995	0	121	2649	15853	8111	1863	354	265	52	299	162	1223
1996	5933	210	1032	3839	3675	244	108	91	256	1522	560	2111
1997	132	80144	25732	5035	2512	920	242	70	44	22	65	0
1998	8511	10500	56107	23166	3661	994	225	69	179	0	0	0
1999	879	1757	5691	27514	19477	4308	1953	361	67	23	11	2
2000	1180	3147	3833	13482	14000	4449	1824	455	150	11	1	2
2001	49834	28340	2185	7538	10979	5726	2627	1048	269	39	17	7
2002	8107	14724	27433	11274	5473	3771	1833	876	291	58	125	0
2003	8945	1558	9762	13652	5428	1574	644	66	10	2	1	0
2004	432	11782	8860	3419	1648	1675	1543	1043	102	15	0	0
2005	9441	35137	12717	4993	1840	1193	863	381	214	76	29	8
2006	589	14848	22692	3355	78	17	0	0	0	0	0	0
2007	65	5327	8411	8935	6005	3106	111	0	0	0	0	0
2008	9397	8038	2893	1930	2025	178	86	82	102	127	152	100

Pt. Artisanal

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11+
1992	0	0	1	5	45	76	93	553	731	935	4393	5818
1993	89	6135	13760	5902	2402	1668	2025	1501	886	766	511	3187
1994	1666	1549	3052	1939	1171	863	882	839	1039	943	1290	3511
1995	2	286	516	2193	1929	1410	608	415	258	252	175	3485
1996	0	11	97	692	1651	618	465	331	370	255	205	1330
1997	17	602	972	1384	2915	2575	1313	653	420	235	278	814
1998	180	181	2726	1051	1726	1861	1387	1684	740	647	728	2056
1999	2	67	731	1927	2836	2102	2420	1151	433	394	98	564
2000	73	1129	1028	998	1385	1081	2154	2137	1463	717	386	787
2001	420	1011	129	489	841	1194	1482	1557	888	359	228	382
2002	1212	3166	459	588	467	883	1330	1656	1580	1114	533	1095
2003	2537	143	1581	663	1434	1313	2145	2855	2031	1079	601	547
2004	491	7154	1551	431	877	1364	1328	2510	2606	986	357	265
2005	203	738	295	305	323	1306	1607	917	1138	1018	1170	3611
2006	26	5785	1859	590	777	1079	853	1009	1763	1931	1961	3753
2007	0	5	211	1458	1349	1395	415	250	287	307	382	4193
2008	0	312	800	1290	2305	1831	814	480	506	362	405	3751

Table 6.3.6.2. (Cont.)

Sp. Bottom trawl

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11+
1992	0	0	0	2	12	18	25	51	79	128	416	458
1993	0	2	14	37	42	182	667	1634	1695	2581	1936	6056
1994	0	0	0	5	44	65	193	658	1267	1286	1516	4087
1995	0	0	1	11	18	24	146	85	263	360	447	8060
1996	0	11	39	59	46	33	228	250	590	1466	1015	4973
1997	10	400	792	299	216	286	262	438	516	627	436	3555
1998	0	1	574	901	74	81	332	1518	1256	1377	1498	4686
1999	0	2	18	164	358	388	942	989	787	1000	846	4215
2000	0	0	3	219	876	2141	3457	3611	3245	2578	1594	1747
2001	47	89	106	261	915	2045	3267	4504	3957	1300	782	1940
2002	0	579	237	335	340	901	1500	2718	3220	3306	1896	2336
2003	0	0	35	521	370	426	1603	2334	2928	2337	1424	1179
2004	17	327	98	1787	1370	4474	4014	5276	4046	1559	3594	3834
2005	13	109	43	140	1682	1409	1768	2439	4211	3826	2530	4505
2006	443	4022	915	112	156	411	598	694	1242	2505	3690	9357
2007	0	70	11	4	6	23	388	829	2270	2110	2364	17195
2008	0	1	69	374	705	694	523	439	1017	1055	1671	15025

Sp. Purse seine

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11+
1992	790	14877	25764	9102	1538	263	18	21	20	18	35	39
1993	4150	6727	10476	6990	1564	317	339	619	472	766	575	1667
1994	5256	37078	24375	13047	4207	1133	563	570	1061	1251	2158	3079
1995	3311	41990	9807	11177	6712	2361	501	180	110	62	55	1024
1996	32956	3237	2769	4350	5279	2672	1514	1016	766	481	331	2190
1997	2079	34040	17176	4762	3895	4855	4138	5230	2663	2809	1473	3672
1998	9782	48725	56279	11227	6232	5034	5613	15313	8741	3621	2760	2041
1999	22602	16480	3749	13518	11994	6377	5824	3473	2025	2442	752	1326
2000	9888	32714	4999	9027	9779	5196	4066	1836	726	327	171	229
2001	15634	22765	18074	6626	3414	3294	2408	1959	901	251	210	637
2002	5553	17461	7083	2330	2421	2270	1971	2634	2145	1083	233	116
2003	13970	3051	7331	1686	2036	2370	4544	3719	2544	1446	674	260
2004	4826	30332	3471	1717	1025	1367	1057	1560	856	474	979	928
2005	8416	21553	5795	3889	3432	2172	1676	418	689	772	571	1018
2006	1048	12448	7154	3779	2024	2192	1506	1225	1638	1804	2037	1514
2007	2798	8476	4006	2296	2014	693	1801	1712	2799	1667	1323	2179
2008	33471	33012	6873	2743	1704	2045	2053	1837	1960	1750	1555	3554

Sp. Artisanal

YEAR	AGES 0	1	2	3	4	5	6	7	8	9	10	11+
1992												
1993												
1994												
1995												
1996												
1997												
1998												
1999												
2000	0	0	2	26	40	27	30	33	31	25	22	22
2001	0	3	11	50	195	251	189	138	94	31	11	357
2002	0	10	3	3	3	12	29	55	74	73	45	66
2003	0	0	0	3	9	8	7	2	1	0	0	0
2004	0	0	1	25	20	66	121	149	103	35	98	167
2005	0	0	1	3	36	26	36	21	35	33	22	78
2006	0	5	16	27	60	64	41	32	30	33	41	73
2007	3	168	187	198	199	61	149	139	209	130	103	246
2008	0	18	308	268	174	156	134	95	93	58	50	813

Table 6.7.1.1. Southern horse mackerel. Numbers at age from ASAP assessment.

Year	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+
1992	8.40E+008	6.50E+008	3.04E+008	1.10E+008	7.89E+007	4.52E+007	2.49E+007	2.06E+007	1.74E+007	9.94E+006	1.37E+007	6.15E+007
1993	6.66E+008	6.31E+008	3.71E+008	1.45E+008	5.59E+007	4.50E+007	2.80E+007	1.58E+007	1.24E+007	9.10E+006	4.95E+006	5.61E+007
1994	5.09E+008	4.93E+008	3.45E+008	1.66E+008	6.92E+007	3.02E+007	2.62E+007	1.61E+007	7.73E+006	4.59E+006	3.25E+006	4.29E+007
1995	5.29E+008	3.88E+008	2.96E+008	1.76E+008	8.93E+007	4.08E+007	1.87E+007	1.57E+007	8.15E+006	2.96E+006	1.65E+006	3.28E+007
1996	1.79E+009	4.07E+008	2.39E+008	1.56E+008	9.77E+007	5.38E+007	2.56E+007	1.11E+007	7.59E+006	2.86E+006	1.03E+006	2.42E+007
1997	9.87E+008	1.43E+009	2.82E+008	1.50E+008	1.01E+008	6.67E+007	3.75E+007	1.70E+007	6.24E+006	3.33E+006	1.29E+006	1.87E+007
1998	4.46E+008	7.71E+008	9.25E+008	1.60E+008	8.87E+007	6.47E+007	4.45E+007	2.46E+007	9.88E+006	2.98E+006	1.58E+006	1.50E+007
1999	5.85E+008	3.35E+008	4.42E+008	4.42E+008	8.11E+007	5.01E+007	3.88E+007	2.59E+007	1.18E+007	3.52E+006	1.08E+006	1.15E+007
2000	2.69E+008	4.65E+008	2.27E+008	2.69E+008	2.78E+008	5.41E+007	3.44E+007	2.55E+007	1.45E+007	5.18E+006	1.56E+006	9.26E+006
2001	6.11E+008	2.14E+008	3.17E+008	1.39E+008	1.70E+008	1.86E+008	3.68E+007	2.19E+007	1.31E+007	5.51E+006	2.03E+006	7.60E+006
2002	3.34E+008	4.84E+008	1.44E+008	1.90E+008	8.68E+007	1.13E+008	1.26E+008	2.38E+007	1.17E+007	5.40E+006	2.37E+006	6.80E+006
2003	6.74E+008	2.62E+008	3.16E+008	8.29E+007	1.14E+008	5.60E+007	7.57E+007	8.23E+007	1.33E+007	5.26E+006	2.48E+006	6.54E+006
2004	9.57E+008	5.35E+008	1.77E+008	1.92E+008	5.21E+007	7.67E+007	3.92E+007	5.25E+007	5.23E+007	7.33E+006	2.88E+006	6.78E+006
2005	6.92E+008	7.70E+008	3.77E+008	1.14E+008	1.27E+008	3.63E+007	5.47E+007	2.70E+007	3.16E+007	2.58E+007	3.71E+006	7.05E+006
2006	2.24E+008	5.57E+008	5.43E+008	2.43E+008	7.56E+007	8.85E+007	2.59E+007	3.77E+007	1.62E+007	1.55E+007	1.30E+007	7.77E+006
2007	1.64E+008	1.81E+008	3.96E+008	3.54E+008	1.62E+008	5.26E+007	6.19E+007	1.69E+007	1.98E+007	6.29E+006	6.04E+006	1.29E+007
2008	3.25E+008	1.35E+008	1.34E+008	2.73E+008	2.48E+008	1.16E+008	3.68E+007	3.82E+007	7.46E+006	5.66E+006	1.94E+006	1.18E+007

Table 6.7.1.2. Southern horse mackerel. Summary table from the ASAP assessment.

year	Recruits ('000)	Tot. Biomass (t.)	SSB (t.)	Landings (t.)	Yield/SSB	Mean F (ages 1-11)	SOP
1992	840355	112458	72591	27860	0.38	0.4	100
1993	666372	99427	70822	31520	0.45	0.54	100
1994	508996	108194	71244	28450	0.4	0.48	100
1995	528839	96956	65349	25140	0.38	0.49	100
1996	1792120	121786	70265	20360	0.29	0.34	100
1997	987362	136764	76193	29490	0.39	0.36	100
1998	446384	122762	87417	41660	0.48	0.52	100
1999	584847	121952	96280	27780	0.29	0.36	100
2000	268981	110546	93308	26168	0.28	0.4	100
2001	611267	107991	87921	24916	0.28	0.38	100
2002	334046	95069	74213	22506	0.3	0.37	100
2003	673910	91780	70651	18885	0.27	0.28	100
2004	957136	132022	82372	24487	0.3	0.29	100
2005	691536	111031	79077	22686	0.29	0.3	100
2006	224086	105961	83028	23897	0.29	0.37	100
2007	164469	107248	89803	22786	0.25	0.44	100
2008	325183	101927	87452	22999	0.26	0.49	100

Table 6.8.1. Sourthern horse mackerel. Short-term forecast (2009-2011) for different catch options and 95% confidence intervals.

Rationale	Year	Recruitment (thousands)	Landings (t)	SSB (t)	% SSB change[1]	% catch change[2]
Status quo catch by fleet	2008	546,526 (253,252;1,177,725)	22,993	87,629		
	2009	546,109 (184,761;1,619,563)	22,993	86,468 (86,234;86,973)	-1.32%	0%
	2010	547,205 (144,084;2,057,65)	22,993	87,234 (79,449;104,035)	-0.45%	0%
	2011	-	-	90,544 (70,241;137,923)	3.33%	-
Mean of last 10 years catch by fleet	2008	545,664 (254,187;1,170,579)	22,993	87,629		
	2009	546,874 (183,916;1,614,121)	23,708	86,468 (86,235;86,968)	-1.33%	3.11%
	2010	546,284 (144,767;2,059,855)	23,708	86,456 (78,717;103,041)	-1.34%	3.11%
	2011	-	-	88,682 (68,305;136,154)	1.2%	-
Historical trend by fleet	2008	547,174 (255,001;1,174,49)	22,993	87,629		
	2009	548,785 (185,753;1,618,21)	22,504	86,469 (86,235;86,971)	-1.32%	-5.85%
	2010	549,356 (144,651;2,060,593)	22,215	88,670 (80,900;105,347)	1.19%	-7.94%
	2011	-	-	94,129 (73,810;141,498)	7.42%	-
Status quo catch + historical trends by fleet	2008	546,064 (252,152;1,184,852)	22,993	87,629		
	2009	546,244 (183,864;1,617,985)	22,993	86,468 (86,233;86,979)	-1.32%	0%
	2010	547,803 (145,227;2,058,009)	22,993	87,230 (79,415;104,241)	-0.45%	0%
	2011	-	-	90,530 (70,163;138,485)	3.31%	-

[1]SSB relative to SSB 2008

[2]Catch relative to assumed catch 2008

Table 6.10.1. Southern horse mackerel. Yearly percentages of catches for each fleet. Note that the values for 2009 and 2010 are estimated (following the historical trend).

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Pt trawl	46,66%	53,30%	36,91%	50,13%	52,55%	42,05%	31,68%	24,73%	30,47%
Pt seine	26,40%	14,86%	18,87%	11,72%	10,24%	14,87%	14,16%	20,55%	16,09%
Pt artisanal	12,37%	12,19%	11,26%	8,50%	6,03%	6,10%	5,49%	6,68%	8,29%
Sp trawl	5,93%	12,30%	9,33%	11,97%	13,28%	7,22%	9,06%	11,66%	18,07%
Sp seine	8,65%	7,36%	23,64%	17,66%	17,89%	29,76%	39,61%	36,37%	26,86%
Sp artisanal	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,22%

Table 6.10.1(cont.). Sourthern horse mackerel. Yearly percentages of catches for each fleet. Note that the values for 2009 and 2010 are estimated (following the historical trend).

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Pt trawl	30,87%	36,11%	36,47%	35,23%	36,66%	39,70%	25,04%	25,17%	26,44%	25,23%
Pt seine	19,22%	18,98%	11,18%	8,34%	10,77%	7,34%	11,78%	4,72%	7,96%	7,28%
Pt artisanal	5,14%	8,32%	11,88%	9,97%	11,21%	14,10%	8,74%	10,46%	9,85%	9,92%
Sp trawl	18,21%	18,58%	17,10%	30,64%	25,17%	23,16%	35,10%	28,68%	30,95%	32,46%
Sp seine	25,13%	17,59%	23,36%	14,94%	15,85%	15,39%	17,96%	28,62%	23,53%	23,75%
Sp artisanal	1,43%	0,43%	0,02%	0,89%	0,33%	0,32%	1,39%	2,34%	1,27%	1,36%

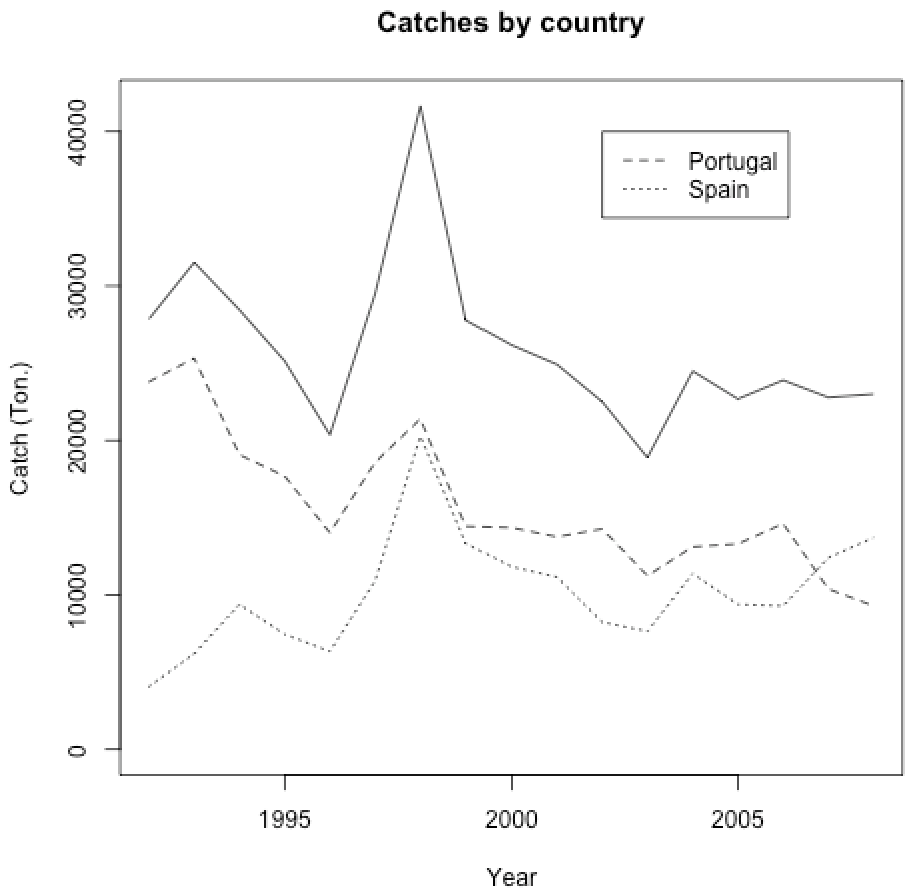


Figure 6.3.1.1. Southern horse mackerel. Historical series of the the stock landings including the landings by country.

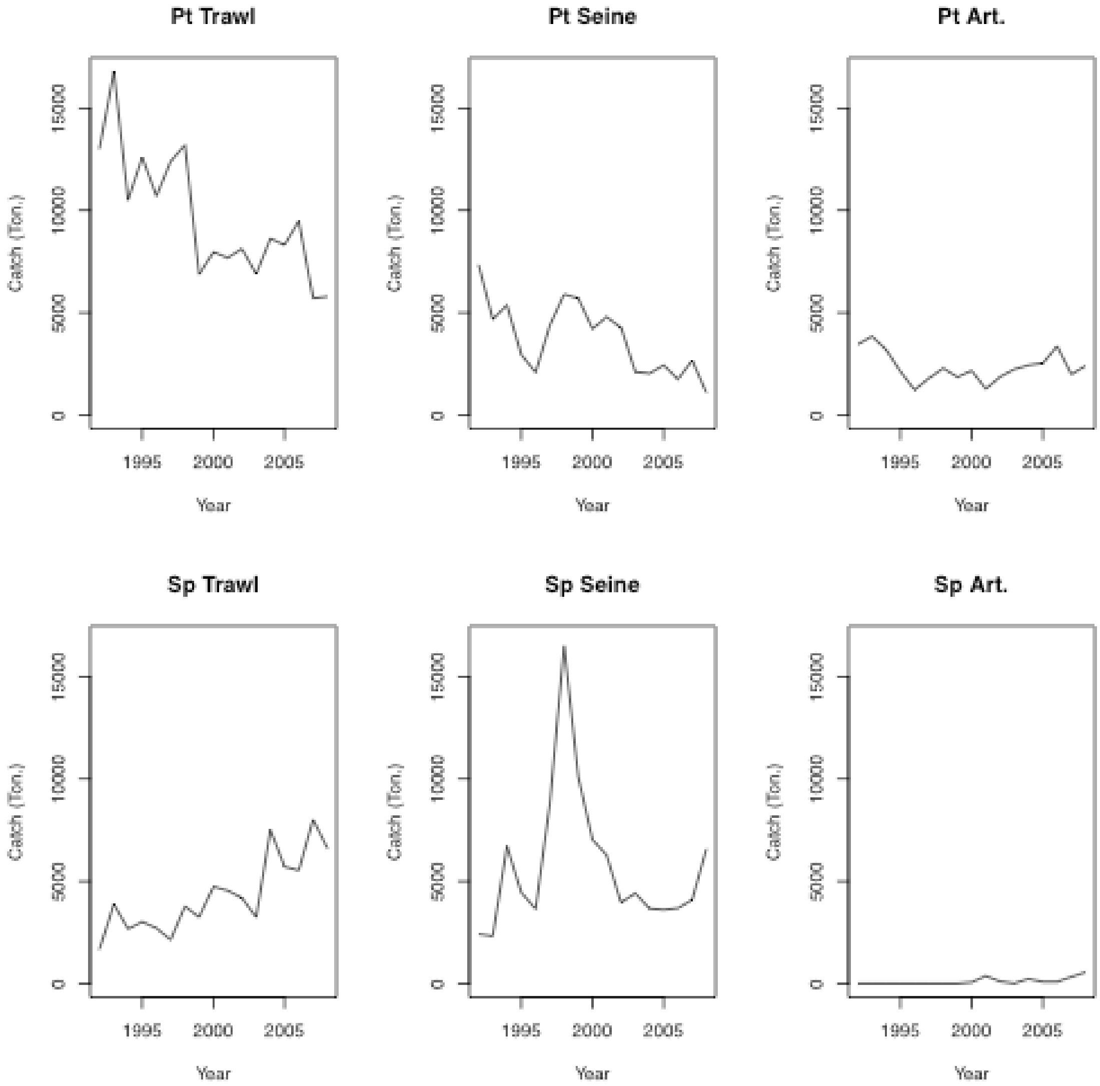


Figure 6.3.1.2. Southern horse mackerel. Historical series of catches by gear and country (Pt = Portugal; Sp = Spain)

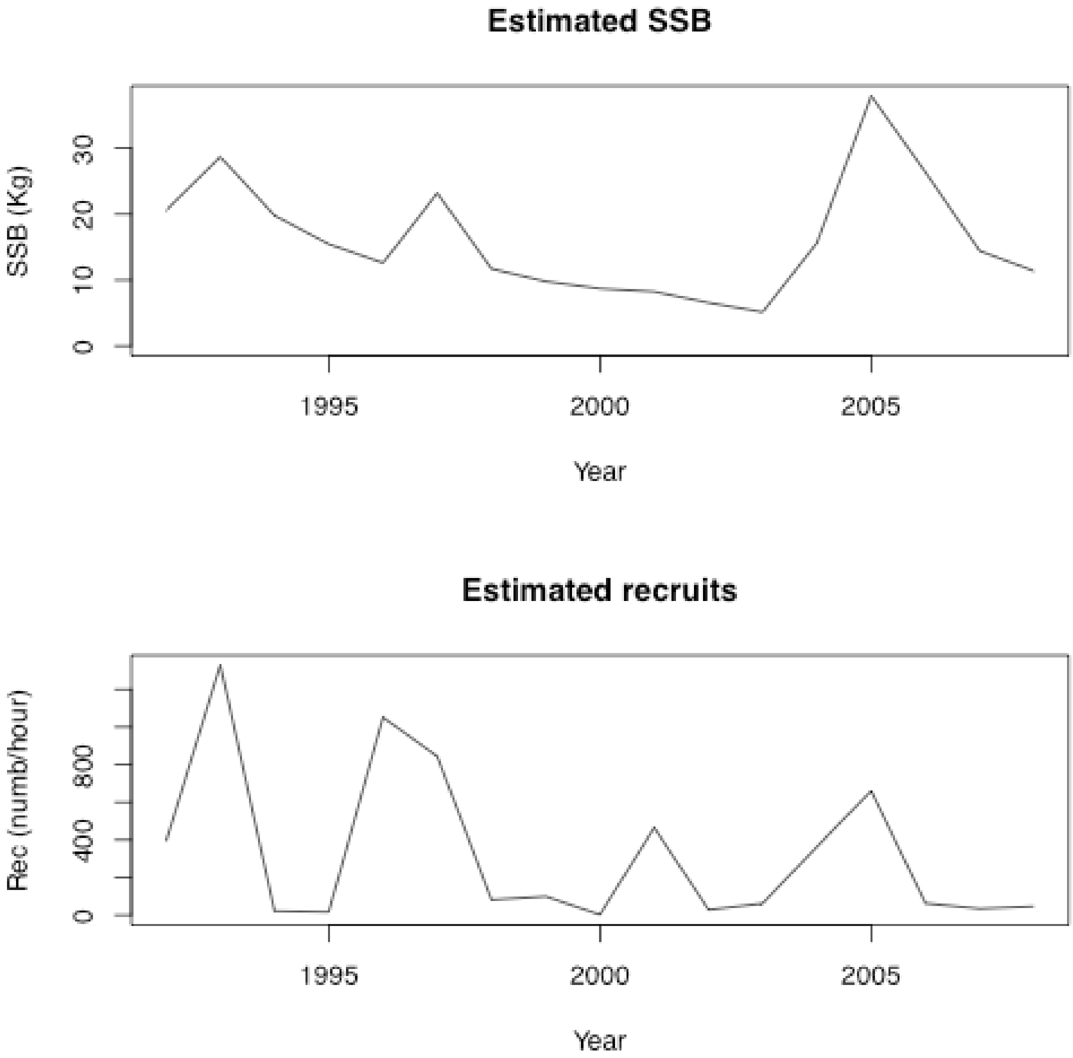


Figure 6.3.2.1.1. Southern horse mackerel. Historical series of biomass and recruitment index estimates from combined bottom trawl survey.

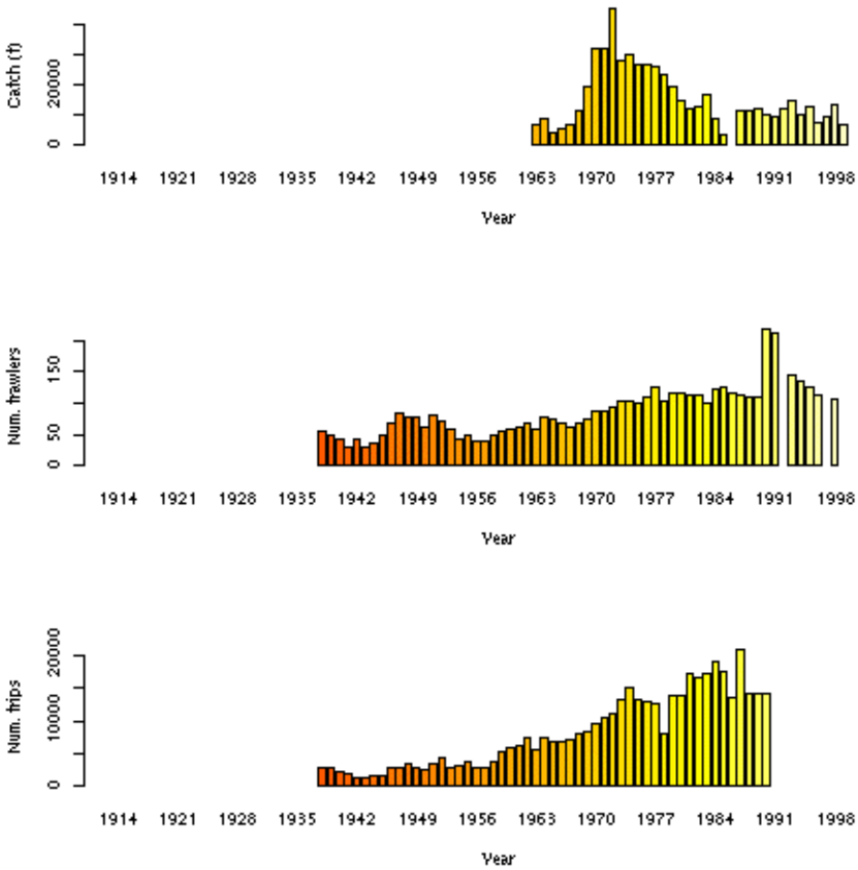


Figure 6.3.3.1. Southern horse mackerel. Time series of catch and effort from Portuguese bottom trawlers operating in Division IXa.

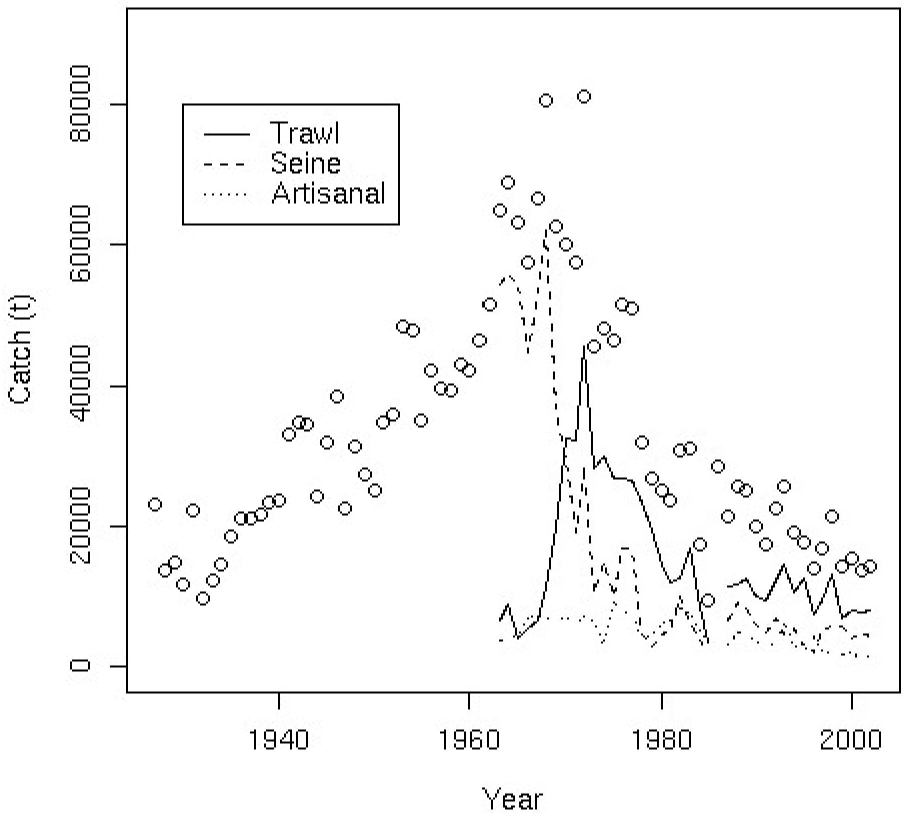


Figure 6.3.3.2. Southern horse mackerel. Time series of the Portuguese catches of horse mackerel in Division IXa: total and by fishing gear

Figure 6.3.3.3. Southern horse mackerel. Time series of the Spanish catches of horse mackerel in Division IXa (Southern stock) and in Division VIIIc (Western stock): total and by fishing gear.

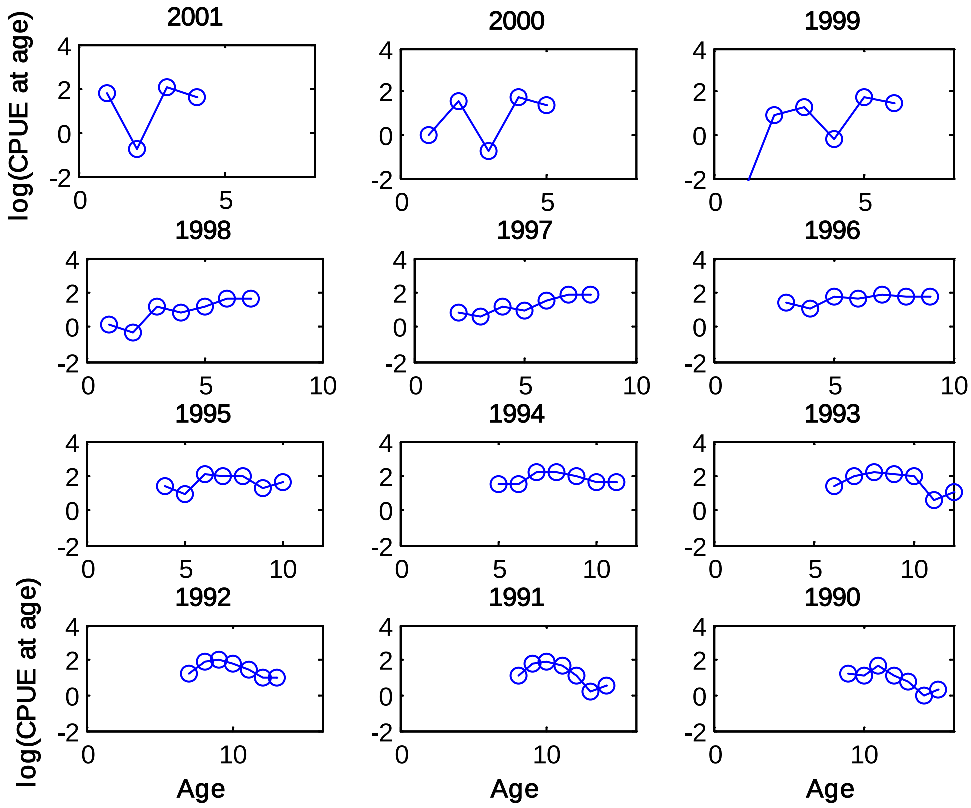


Figure 6.3.3.4. Southern horse mackerel. Marín bottom trawl fleet. Evolution of the index of abundance of several year classes (1990-2001).

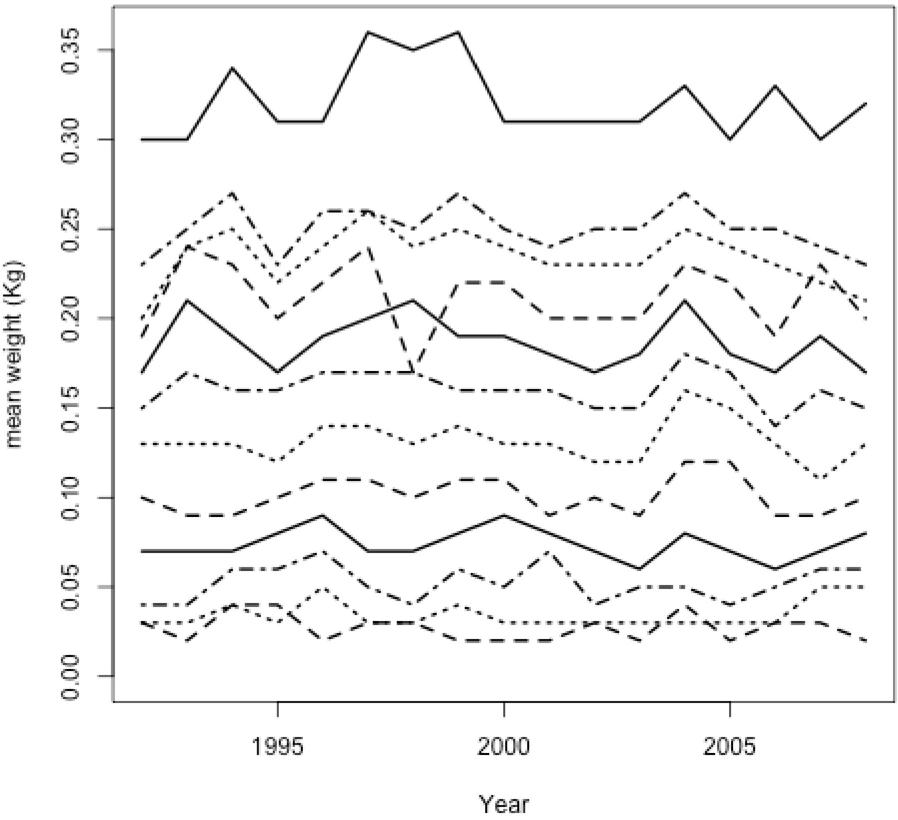


Figure 6.3.4.1. Southern horse mackerel. Time series of mean weight at age in the catch (from age 1 to 11)

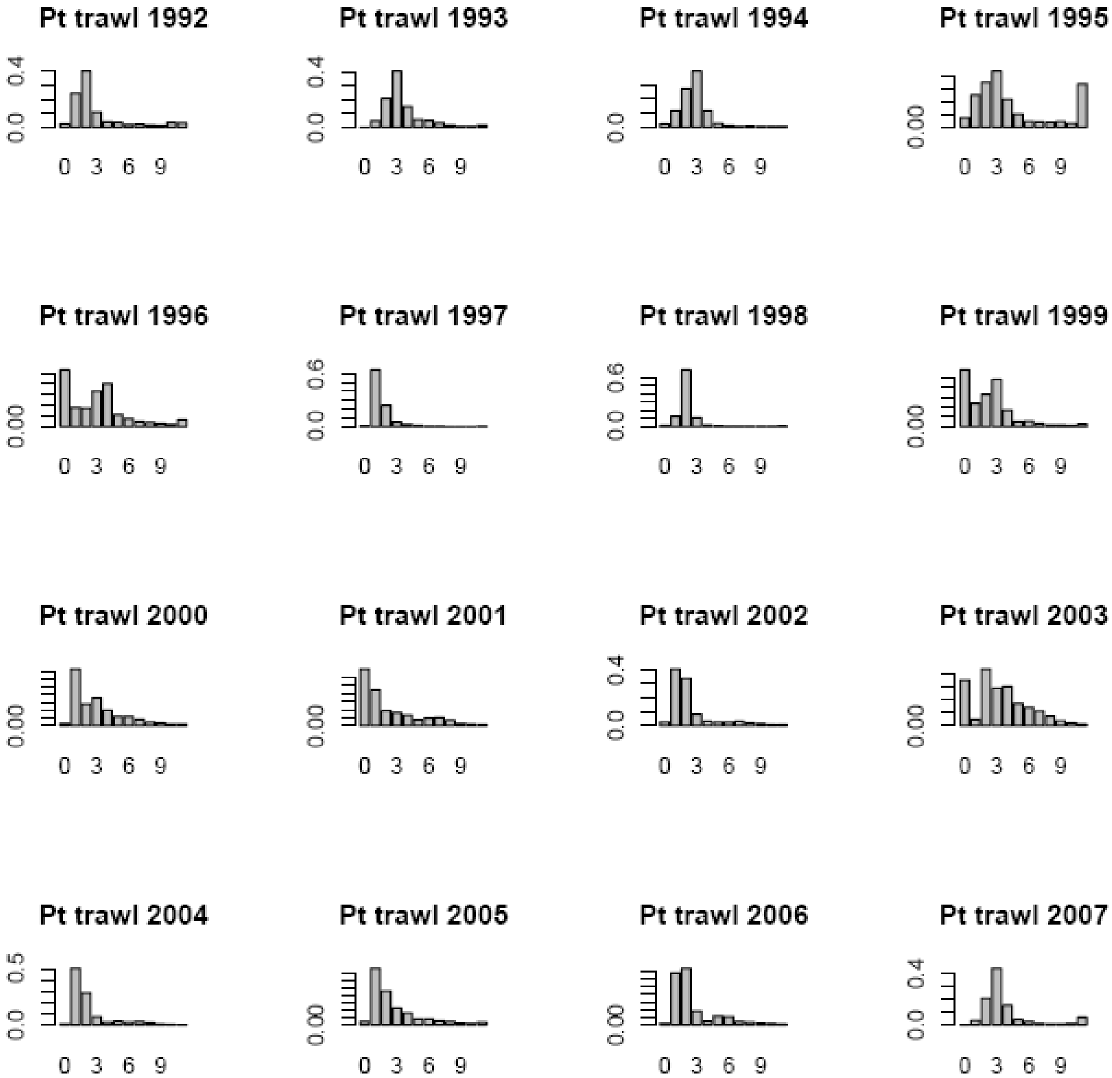


Figure 6.3.6.1. Southern horse mackerel. Historical series of proportions of catches at age by fishing fleet and country (Pt = Potugal; Sp = Spain; art. = artisanal)

Figure 6.3.6.1. (Cont.)

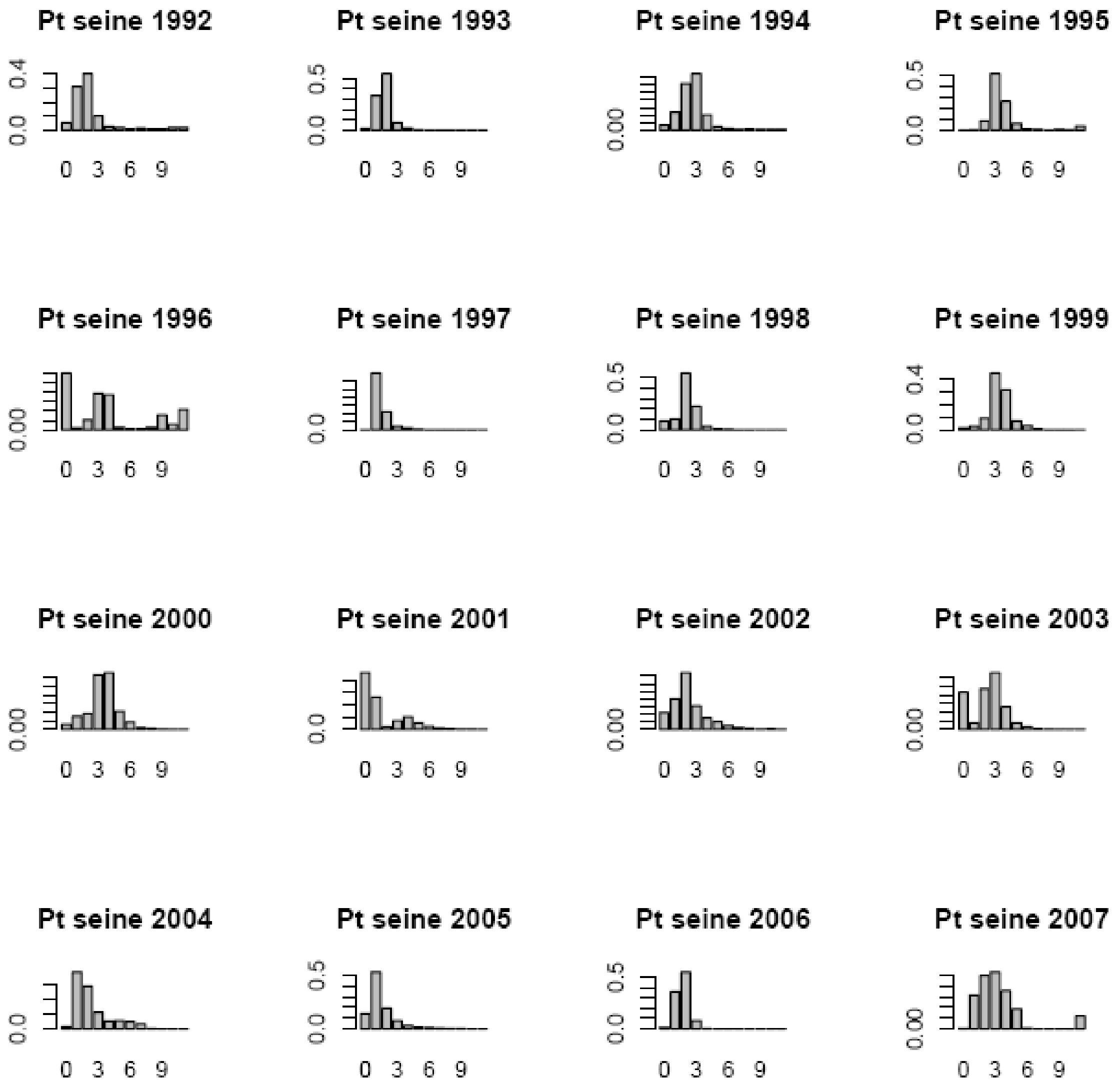
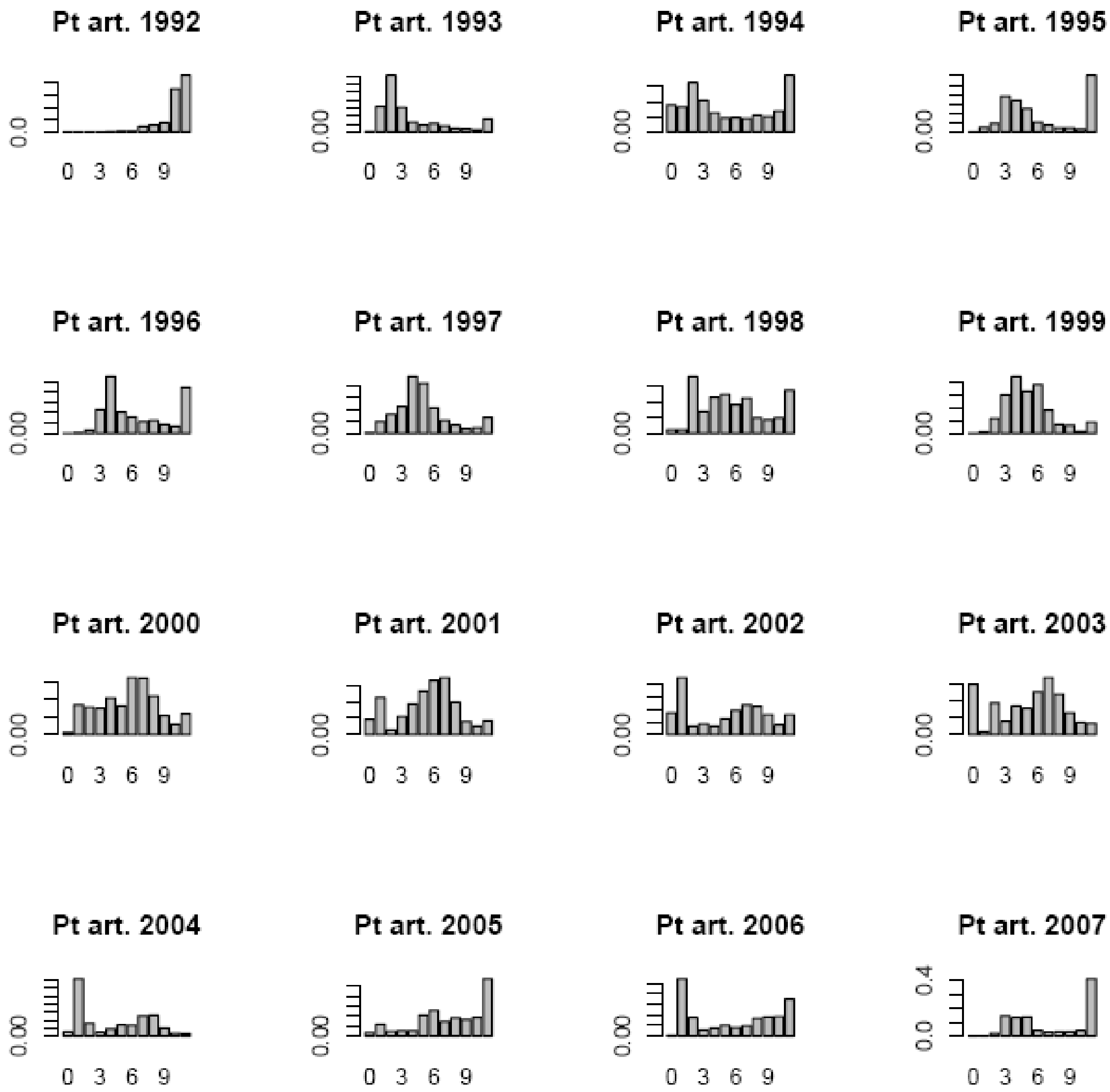


Figure 6.3.6.1. (Cont.)



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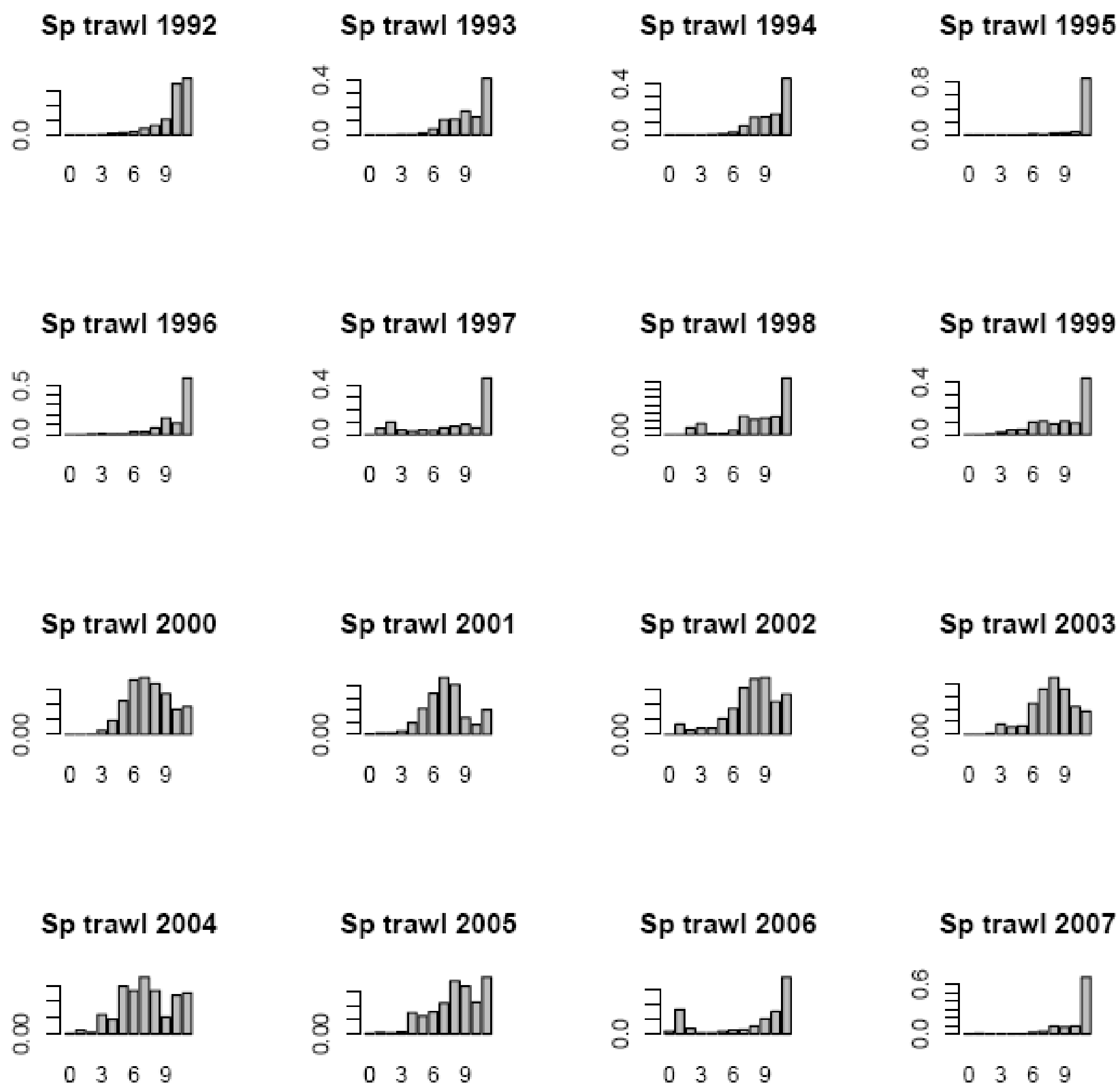


Figure 6.3.6.1. (Cont.)

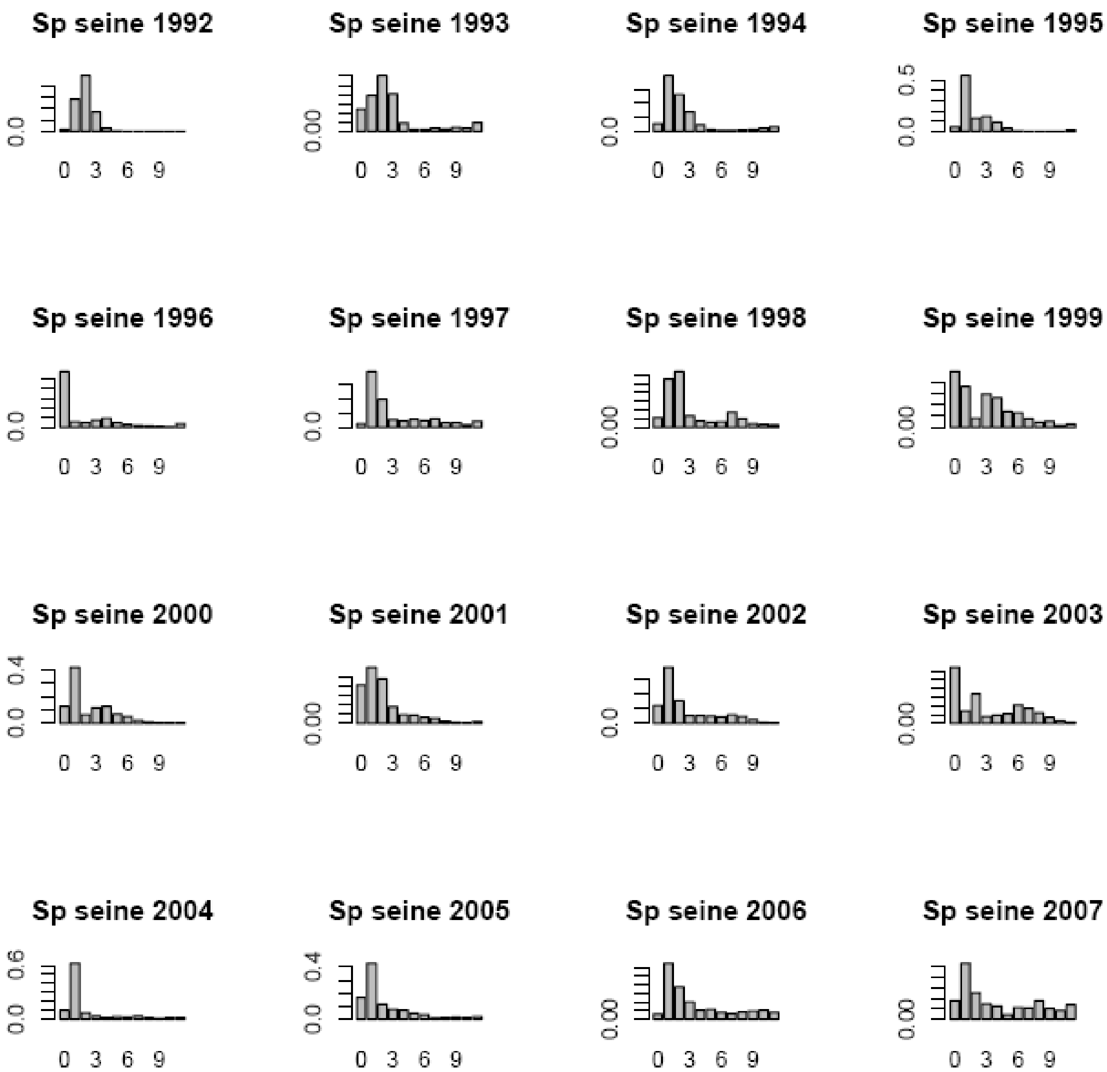
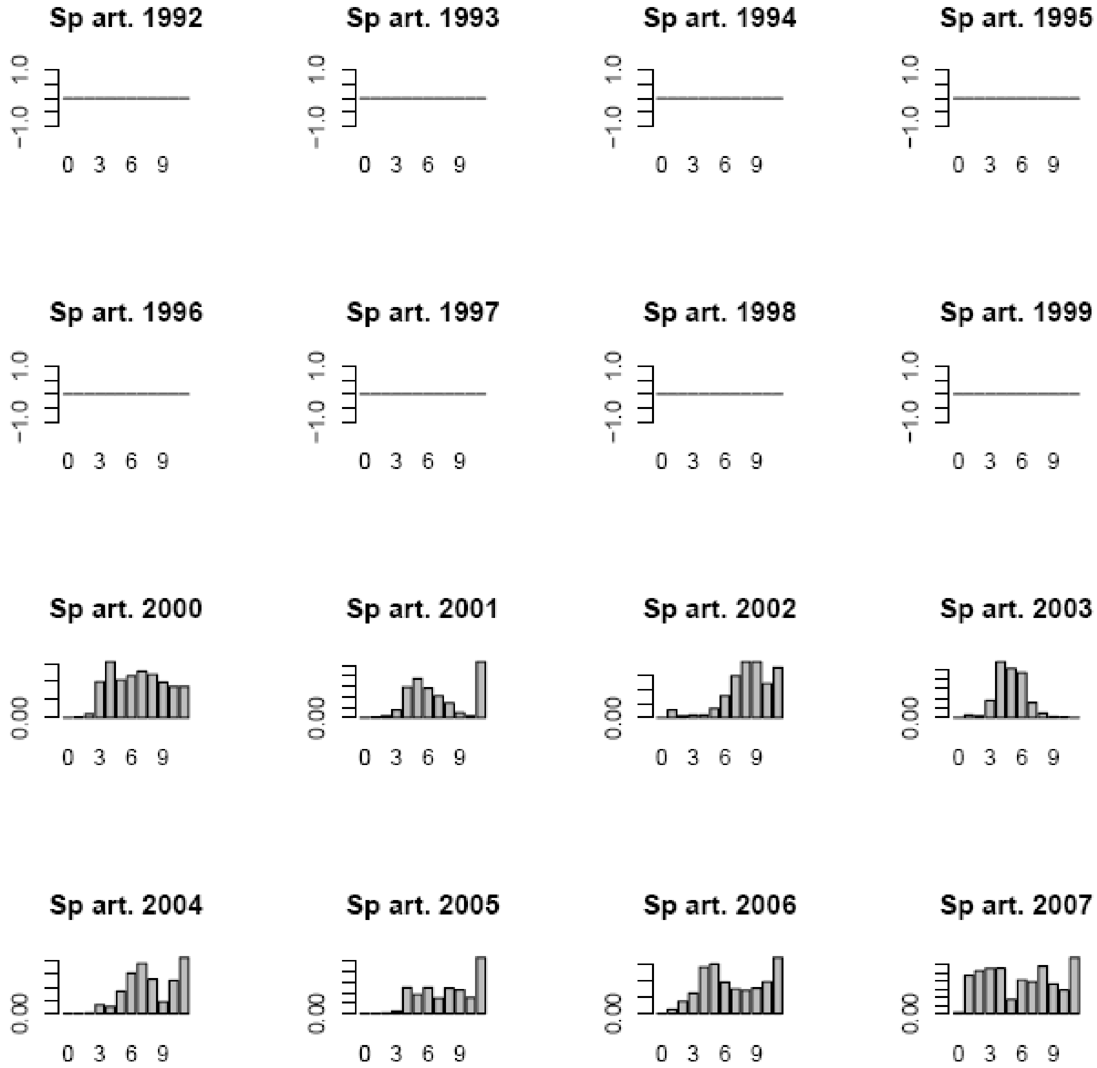


Figure 6.3.6.1. (Cont.)



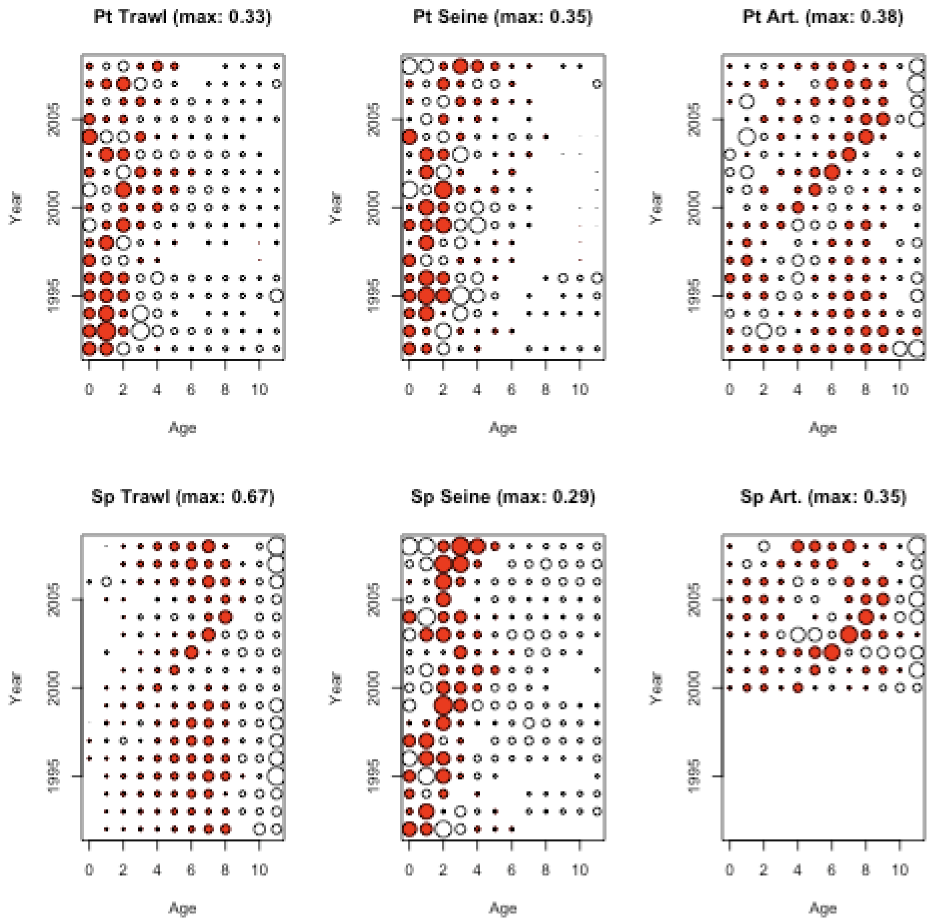


Figure 6.5.2.1. Southern horse mackerel. Catch proportion at age residuals from the ASAP assessment (Pt = Portuguese, Sp = Spanish)

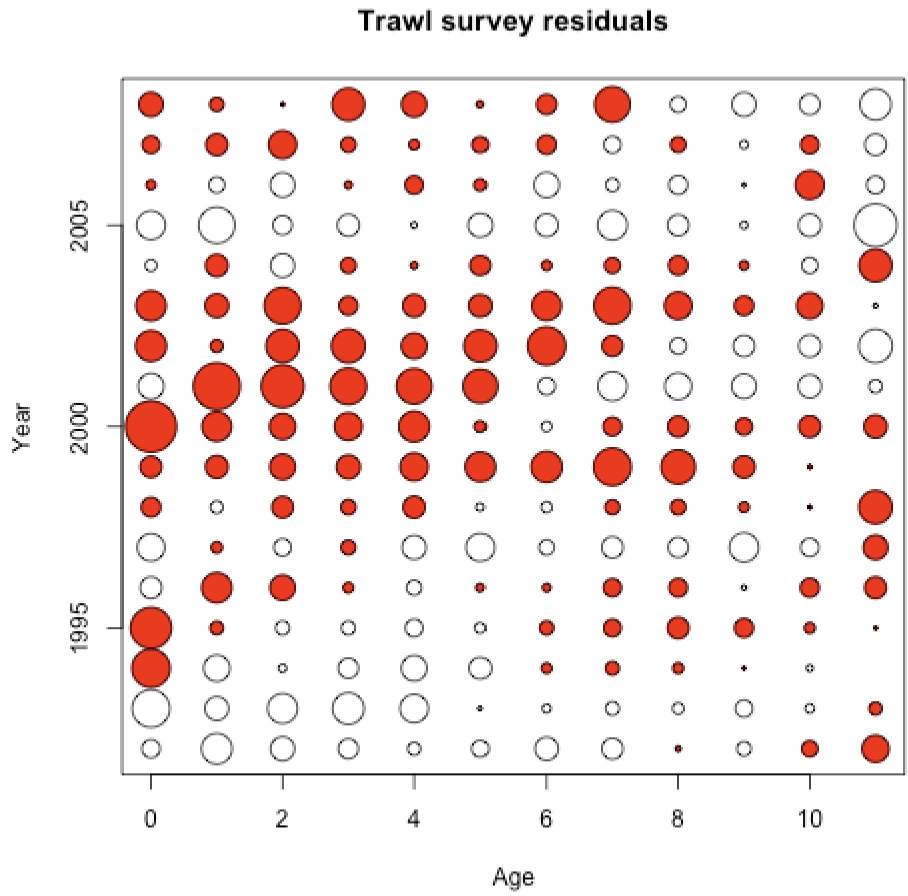


Figure 6.5.2.2. Southern horse mackerel. Bubble plot of bottom trawl survey residuals (raw) from the ASAP assessment.

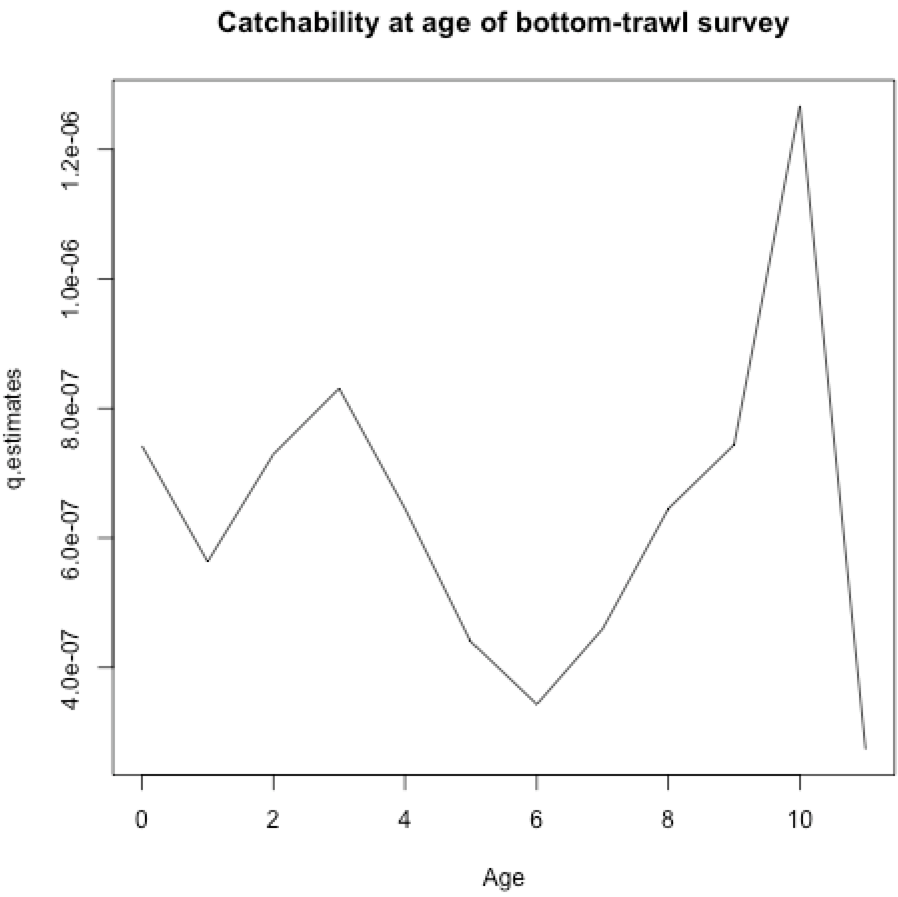


Figure 6.5.2.3. Southern horse mackerel. Catchability at age of bottom trawl survey

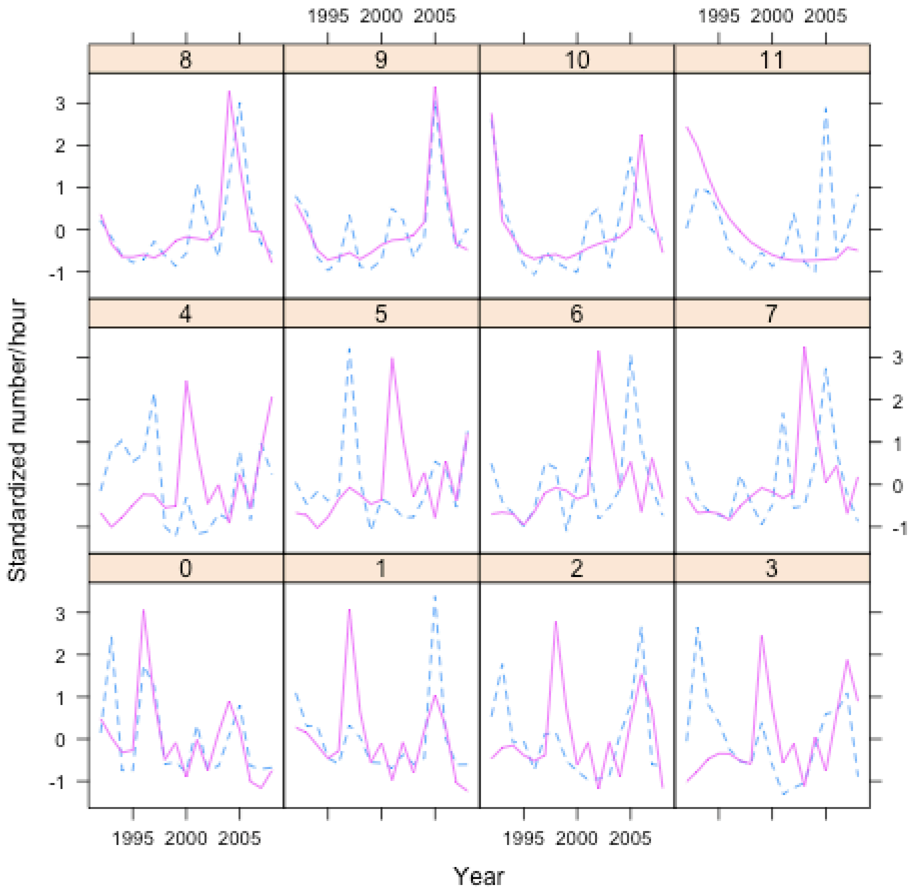


Figure 6.5.2.4. Southern horse mackerel. Comparison of observed bottom trawl survey values by age and those fitted by the ASAP model. Observed values = dashed lines; fitted values = solid lines.

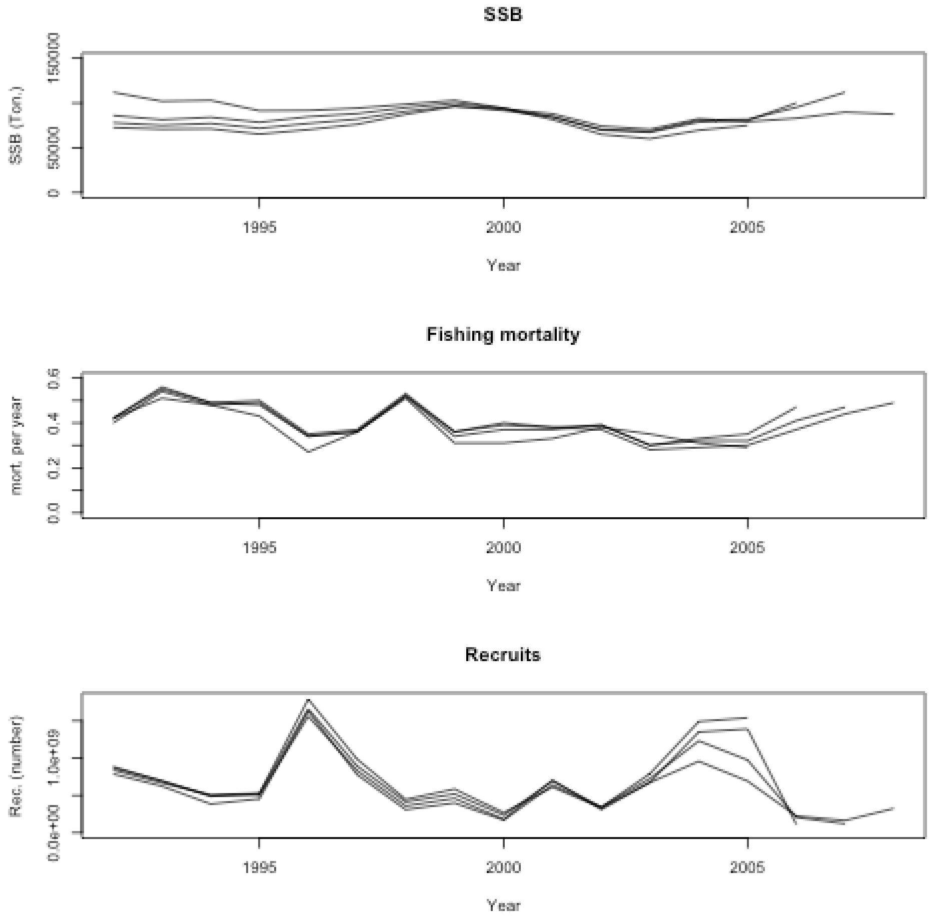


Figure 6.7.1.1. Southern horse mackerel. Retrospective analysis from the ASAP model (four years backwards were included).

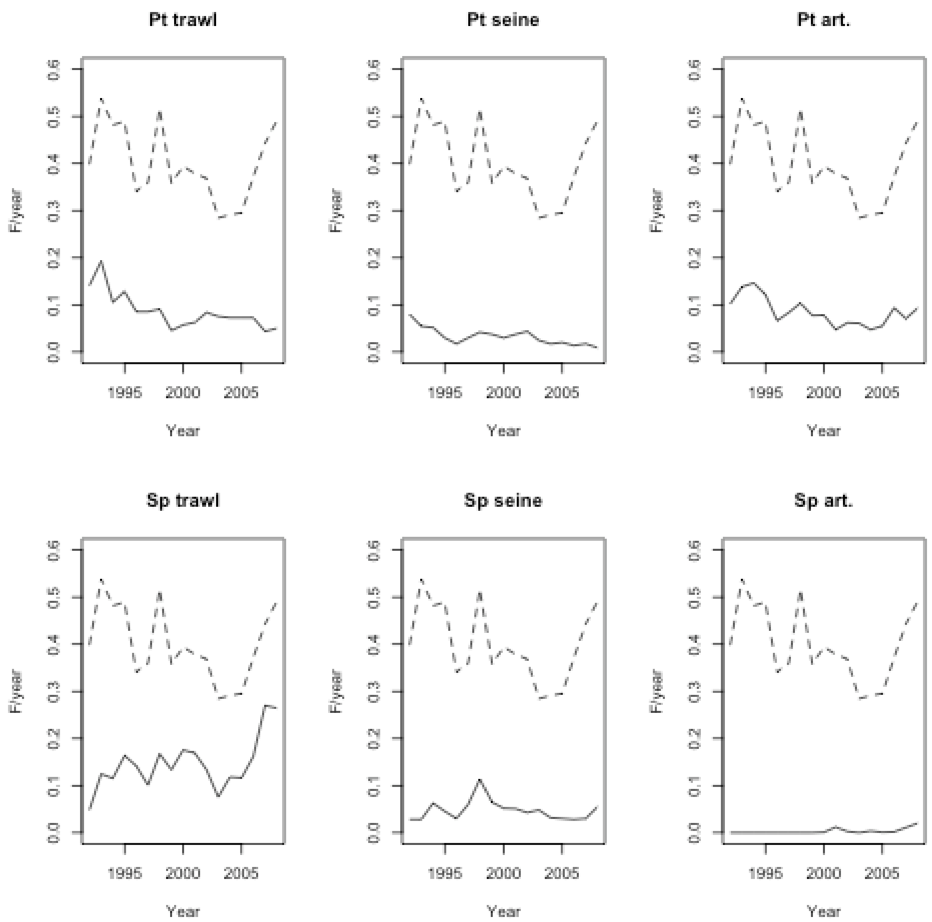


Figure 6.7.1.2. Southern horse mackerel. Mean Fishing mortality (1-11), overall (dashed line) and by fishing fleet (solid line), estimated by the ASAP model. (Pt = Portuguese; Sp = Spanish; art = artisanal).

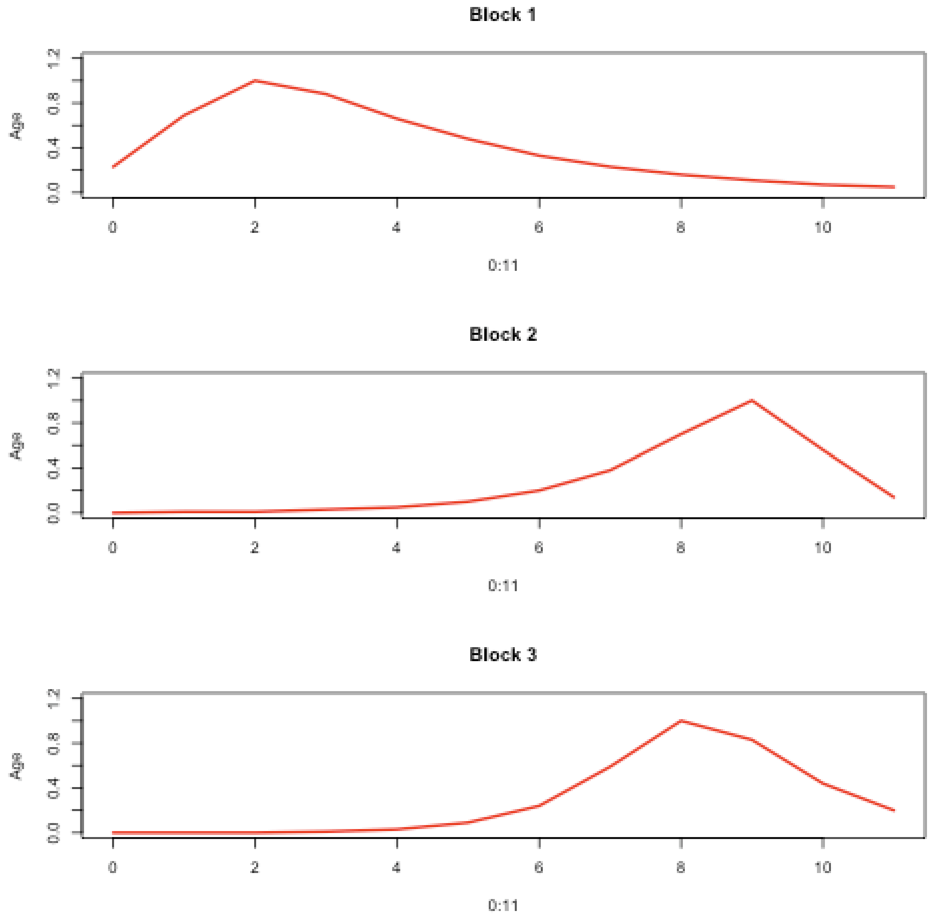


Figure 6.7.1.3. Southern horse mackerel. Retrospective analysis of the selectivity patterns from the ASAP model. Three blocks are defined: Block 1: Portuguese bottom trawl and purse seine fleets and Spanish purse seine fleet; Block 2: Portuguese and Spanish artisanal fleets; Block 3: Spanish bottom trawl fleet.

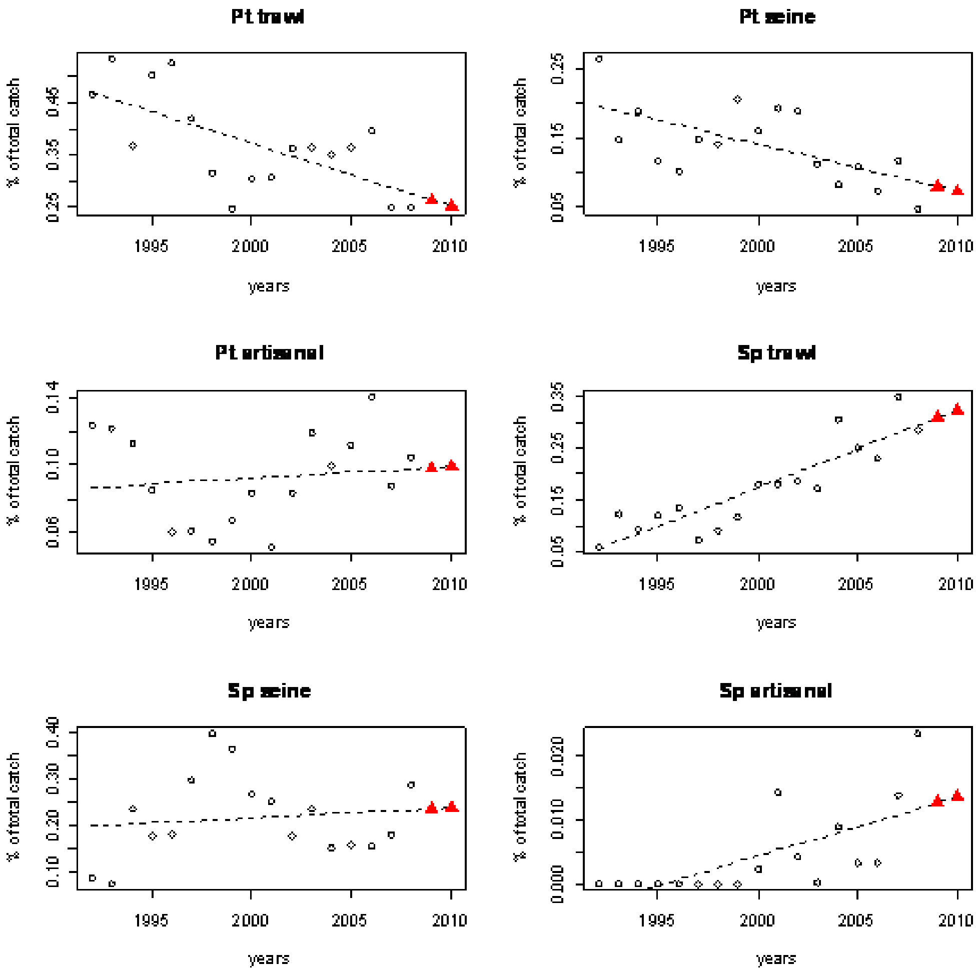


Figure 6.8.1. Southern horse mackerel short predictions input data. Trends of the percentage of total catch by fleet, and assumed values for the 2 years in the short-term forecasting (2009 and 2010) based on a linear regression.

7 Norwegian spring spawning herring

7.1 ICES advice in 2008

In 2008 ICES stated that "Based on the most recent estimates of SSB and fishing mortality, ICES classifies the stock as having full reproductive capacity and being harvested sustainably. The estimate of the spawning-stock biomass is well above B_{pa} in 2008 and near the highest in the recent time-series. Fishing mortality is well below F_{pa}. The productivity of the stock presently is high. In the last 10 years, four large year classes have been produced (1998, 1999, 2002, and 2004). The 2004 year class has not been fully recruited yet; consequently, catches and SSB are expected to increase in the near future".

A management plan, agreed by the Coastal States is operational. The management plan implies maximum catches of 1 643 000 t in 2009, which is expected to leave a spawning stock of 11.5 million tonnes in 2010. ICES considers that the target defined in the management plan is consistent with high long-term yield and has a low risk of depleting the production potential. ICES considers that the current long-term management plan is consistent with the precautionary approach.

7.2 Management in 2008 and 2009

EU, Faroe Islands, Iceland, Norway, and Russia agreed in 1996 to implement a long-term management plan for Norwegian spring-spawning herring. The management plan was part of the international agreement on total quota setting and sharing of the quota during the years 1997–2002. In the years 2003–2006 there was also no agreement between the Coastal States regarding the allocation of the quota. In this period quotas were set unilaterally and in some countries quota were raised during the year. In the years 2007-2008 the Coastal States have agreed to set a TAC in accordance with the Management Plan. The management plan in use contains the following elements:

1) Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level (B_{lim}) of 2 500 000 t.

2) For the year 2001 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of less than 0.125 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of this fishing mortality rate.

3) Should the SSB fall below a reference point of 5 000 000 t (B_{pa}), the fishing mortality rate, referred under Paragraph 2, shall be adapted in the light of scientific estimates of the conditions to ensure a safe and rapid recovery of the SSB to a level in excess of 5 000 000 t. The basis for such an adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at B_{pa} (5 000 000 t) to 0.05 at B_{lim} (2 500 000 t).

4) The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

The agreed TAC for 2008[1] was 1 518 000 tonnes. The agreed shares of the Parties are 98 822 tonnes for the European Community, 78 329 tonnes for Faroe Islands, 220 262 tonnes for Iceland, 925 980 tonnes for Norway and 194 607 tonnes for the Russian Federation.

The agreed TAC for 2009[2] was 1 643 000 tonnes. The agreed shares of the Parties are 106 959 tonnes for the European Community, 84 779 tonnes for Faroe Islands, 238 399 tonnes for Iceland, 1 002 230 tonnes for Norway and 210 633 tonnes for the Russian Federation.

Each Party may transfer unutilised quantities of up to 10% of the quota allocated to the Party to the following year. Such transfer shall be an addition to the quota allocated to the Party in that year. Also each Party may authorise fishing by its vessels of up to 10% of the quota allocated. All quantities fished beyond the allocated quota shall be deducted from the Party's allocation in the following year. Further arrangements, including arrangements for access and other conditions for fishing in the respective zones of fisheries jurisdiction of the Parties, are regulated by bilateral arrangements.

7.3 The fishery in 2008

7.3.1 Description and development of the fisheries

Like in earlier years the fishing pattern in 2008 followed the clockwise migration pattern of the herring, now also including the catches in the Jan Mayen area in the Norwegian Sea. As last year, the westerly trend in the southwest area continued with high catches taken in the Icelandic ‐ Faroe zone during the summer fishery targeting the largest and oldest fish.

The distribution of the fisheries of Norwegian spring ‐ spawning herring by all countries in 2008 by ICES rectangles is shown in Figure 7.3.1.1 (total whole year) and in Figure 7.3.1.2 (by quarter). In 2008 the data provided as catch by rectangle represented more than 99.7% of the total WG catch.

Due to limitations by some countries to enter the EEZs of other countries in 2008 the fisheries do not necessarily depict the distribution of herring in the Nordic Seas neither the preferred fishing pattern of the fleets given free access to any zone. A special feature of the summer fishery in recent years was the prolonged fishery in the Icelandic and Faroese zones during summer, where the oldest age groups were present (second and especially third quarter).

The migration pattern, together with environmental factors, was mapped in 2008 during the ICES PGNAPES (Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys) investigations (ICES 2009/RMC:06).

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[1] Agreed record of conclusions of fisheries consultations on the management of the Norwegian spring-spawning (Atlanto-scandian) herring stock in the north-east Atlantic for 2008 (London, 25 October 2007)

[2] Agreed record of conclusions of fisheries consultations on the management of the Norwegian mpring-mpawning (Atlanto-scandian) herring stock in the north-east Atlantic for 2009 (London, 13 November 2008)

7.3.1.1 Denmark

The Danish fishery of Norwegian spring spawning herring in 2008 carried out by purse seiners and trawlers was 31 128 t. The fishery took place in the first quarter (25 529 t) and fourth quarter (5 599 t). 85% of the landings were landed in Denmark.

7.3.1.2 Germany

The vessels targeting Norwegian spring spawning herring are belonging to the pelagic freezer trawler fleet owned by a Dutch company and operating under the German flag. Depending on season and the economic situation these vessels are targeting other pelagic species in European and international waters. This fleet consist of four large pelagic freezer-trawlers of lengths between 90 m and 140 m with power ratings between 4 200 and 12 000 hp. The crew consists of about 35 to 40 men. The vessels are purpose built for pelagic fisheries. The catch is pumped into large storage tanks filled with cool water to keep the catch fresh until it is processed.

7.3.1.3 Greenland

No information is available.

7.3.1.4 Faroe Islands

As in recent years the summer fishery has lasted for an extended period (May to August) in the Faroese, Icelandic, and Jan Mayen zones (Divisions Vb, Va and IIa). The catches mostly consisted of large (old) herring, however with increasing proportions of young herring in the northern (Jan Mayen) areas. The general pattern was that the fishery gradually moved northwards towards the Jan Mayen zone in June, but in August a large fishery was also in the Faroese zone north of the Faroes, Icelandic and Jan Mayen zones. Thus the herring seem to use the south-western and western bordering areas more extensively during their oceanic feeding phase then previously. In the last quarter the fisheries moved further north and eastwards into the International zone and Norwegian zone, and the rest of the quota was taken in the Norwegian zone in November and December. There has been a change the last years towards using pair trawling instead of single trawling, and about one third of the catches were taken pelagic pair trawling, 50% by single pelagic trawl and the rest by purse-seine.

7.3.1.5 Iceland

The Icelandic catch quota for Norwegian spring-spawning herring in 2008 was set at 220 000 tonnes. The Icelandic fishery started in May in the Icelandic zone and lasted there through August. The fishery gradually moved then to the international zone and also to the Norwegian EEZ and ceased in early November. The total catch in the Icelandic EEZ came to 130 000 t, which is the highest annual catch there since the 1960s. About 4 000 t were taken in Faroese waters, 18 000 t in the International zone, 22 000 t in the Jan Mayen zone and about 43 000 t in the Norwegian zone.

In 2008, as well as 2007, the entire fishery of the Icelandic summer-spawning herring was west off Iceland and therefore Norwegian spring-spawning herring was not caught in that fishery, different from the east coast fishery during 2004-2005.

The total catch was 217 602 tonnes of which 95.5% were caught in mid-water trawl and 4.5% in purse-seine. A total of 22 trawlers/purse-seiners participated in the herring fishery, or the same number as in 2007. The length range of the vessels was 54 – 79 meters with a mean length of 69 meters. The engine power range of the fleet was 2 399 – 11 257 HP with a mean of 5 429 HP.

7.3.1.6 Ireland

The Irish fishery for Norwegian spring spawning herring took place in February off the Norwegian coast and recorded landings of 7 900 tonnes. The fleet is comprised of 7 pelagic licensed trawlers with RSW tanks. Norwegian spring spawning herring from the Irish fleet is landed primarily for reduction to fishmeal and processed for human consumption. Fishing took place on spawning aggregations in ICES Area IIa and was concentrated on the shelf.

7.3.1.7 Netherlands

The fishery for Norwegian spring spawning herring by the Netherlands in 2008 was conducted by 7 freezer trawlers using large pelagic trawls. The fishery took place in the third and fourth quarter in ICES Division IIa between 70-74 degrees North and 2-17 degrees west. The total catch was 28 747 tonnes was taken in 10 trips. Three trips were carried out with a scientific observer on board. Discards of herring in these trips were estimated to be very low and estimated between 0.2 and 2.0% in weight. There are also records of small amounts of mackerel present in the catches from this fisheries.

7.3.1.8 Norway

The Norwegian quota is shared with 50% to the large oceanic purse seiners, 10% to trawlers and 40% to smaller coastal purse seiners.

The change from a fjordic to an oceanic wintering area of the Norwegian spring spawning herring has led to large consequences for the fishing pattern of the Norwegian fleet during recent years. For the larger vessels the new distribution means longer trips in terms of distance and lower availability because of strongly reduced concentrations in the oceanic as compared to fjordic wintering areas. Weather has also become a more important factor to the fishery in the wintering areas. For the smaller vessels the availability of herring has been grossly reduced and many vessels find difficulties in taking their quotas. This has led to a shift in the fisheries towards the Norwegian coastal/fjordic herring stocks, which are herring of smaller size and lower lengths at maturity. This herring is often found in mixed concentrations with immature Norwegian spring spawning herring and there is a new and clear challenge to science and management in how to deal with this new situation. Due to the reduced availability of herring to the coastal fleet in the wintering area, the fishery on the spawning migration and in the spawning areas has increased. This lead to a strong increase in the fisheries during the first quarter from 2006 to 2007 with catches up from 202 649 tonnes to 296 762 tonnes and a further increase to 447 433 tonnes in 2008.

The Norwegian fleet hardly fish herring in the oceanic feeding area during the second quarter. There are some catches reported from the coastal areas during this period, amounting to 2 501 tonnes in 2008. This herring mainly consists of local fjordic herring stocks which have so far been allocated to the Norwegian spring spawning herring quota for practical reasons.

The Norwegian fisheries after the feeding period in Quarter 3 started in the areas west of Lofoten, about 100 – 200 nautical miles from land, and then moved towards the new oceanic wintering area north of Vesterålen. A total of 78 392 tonnes were caught in this quarter. The Norwegian catch in quarter 4 was 433 243 tonnes in 2008.

7.3.1.9 Russia

The Russian fishery started within the wintering area of the Norwegian spring spawning herring (approximately 12 – 15°E) in the Vesteralen (Norwegian EEZ) at the middle of January, then progressed in the south-western direction along the Norwegian coast in February and finished in the area of Budgrunnen Bank (approximately 62°N) at the end of March. In January-March the total catch was 14 256 t.

In the II quarter, the commercial vessels conducted fishing in the southern and western parts of the international area in the Norwegian Sea, northern part of Faroes Islands and landed 1 885 t.

In July, the vessels caught herring in the northern part of the international water. In August, the fishery expanded into the Norwegian EEZ and areas of Spitsbergen and Jan-Mayen. In September, the main fishery focused in the Norwegian EEZ to the north from Lofoten. 124 788 t of the herring was taken in the III quarter.

In IV quarter, the fishery was continued in the northern part of Norwegian EEZ and was finished in the beginning of December. 52 190 t was taken in that period.

The Russian fishery is carried out by different types of trawl vessels. Total Russian catch of Norwegian spring spawning herring was 193 119 t. The entire Russian catch was utilized for human consumption.

7.3.2 UK (Scotland)

No information on the fishery by the UK was provided.

7.3.3 Information on by-catch

With the exception of the Faroes and Iceland, no information was provided to the Working Group on by-catches in the fishery for herring. Since 2006 the Faroese summer fishery for Norwegian spring spawning herring north of the Faroes has been hampered by large amounts of mackerel present in the same area mixed within the herring schools in the upper layers. As a result the vessels had to move northwards out of the Faroese area, to the Jan Mayen area, but there the herring was smaller than further south, unfortunately. The reason they avoid the by-catch was the low marketing value of mackerel in the summer months, the mackerel is too soft in the early phase of its "fattening" season. The by-catch of mackerel was subtracted from the individual vessel quotas, and was thus a result of legal activity.

Mackerel was highly mixed in the Icelandic fishery of Norwegian spring-spawning herring in the summer 2008 off east Iceland.

7.4 Stock Description and management units

7.4.1 Stock description

The Norwegian spring spawning herring (*Clupea harengus*) is the largest herring stock in the world. It is widely distributed and highly migratory throughout large parts of the NE Atlantic during its lifespan. Management units are not defined. ICES advice applies to all areas where the stock occurs. A detailed description of the stock is given in the stock annex.

7.4.2 Changes in migration

A characteristic feature of this herring stock is a very flexible and varying migration pattern. A detailed description of the migration pattern is given in the stock annex.

During the last several years, a temperature reduction has been observed in the western part while a temperature increase has been observed in the eastern part of the Norwegian Sea. This could explain the slight north-eastward displacement of the centre of gravity of the herring distribution observed in May 2009, beside the fact that the feeding migration is still ongoing during the survey period. Additionally, the plankton situation in the Norwegian Sea was this year at a very low level, particularly in the western area.

Anomalously high sea surface temperature was observed in north Icelandic waters in July 2009 and herring was observed feeding in the eastern part of that area. The western boundary of the herring distribution was not found in July. A western trend, where the oldest and largest herring has been migrating further west in recent years. The plasticity of the herring migration could be regarded an adaptive trait enabling the stock to optimally exploiting the ever varying climate and planktonic resources of its potential range in the NE Atlantic. There was a slight northeastward shift of the center of gravity (Figure 7.4.2.1) of the distribution in 2009 compared to 2008.

7.5 Data available

7.5.1 Catch data

Data-delivery sheets from Denmark, Faroe Islands, Germany, Greenland, Iceland, Ireland, The Netherlands, Norway, Russia and Scotland were available with data from 2008. They contain total catch in tons by quarter of the year and ICES area. Catch in tonnes by ICES rectangles and quarters are also reported. The French, the Swedish and the Polish fleet did not catch this stock in 2008.

The total catch in 2008 was 1 545 656 t (Table 7.5.1.1). For 2008 ICES had recommended a catch of 1 518 000 t. corresponding to the Management Plan. The majority of the catches were taken in area IIa (95%).

Samples were provided by Denmark, Faroe Islands, Iceland, Ireland, Norway, The Netherlands, Russia and Scotland. Sampled catches accounted for 95% of the total catches. The sampling levels of the catch in 2008 by country is shown in Table 7.5.1.3. The positions, mean weights and mean lengths from the sampled catches were plotted (WD, Gudmundsdottir[3]). On the basis of them allocations were done. The program SALLOC was used to provide catches in numbers (Table 7.5.1.2)

7.5.2 Discards

Last year, the Working Group noted that in this fishery an unaccounted mortality caused by fishing operations and underreporting probably exists. Now it was not possible to assess the magnitude of these extra removals from the stock, and taking into account the large catches taken in recent years, the relative importance of such additional mortality is probably low. Therefore, no extra amount to account for these

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[3]Gudmundsdottir. A. 2009. Norwegian spring spawning herring Total international catch in numbers in 2008. Working document to WGWIDE available at SharePoint/WGWIDE 2009/Working Documents

factors has been added in 1994 and later years. In previous years, when the stock and the quotas were much smaller, an estimated amount of fish was added to the catches.

The Working Group has no comprehensive data to estimate discards of the herring. Although discarding may occur on this stock, it is considered to be very low and a minor problem to the assessment. This is confirmed by recent estimates from sampling programmes carried out by some EU countries in the DCR framework. Estimates on discarding in 2008 were provided by the Netherlands only.

7.5.3 Length and age composition of the catch

The year class 2002 accounts for 43% in numbers and 44% in weight, around 5% and 7% higher than predicted. The year classes 1999, 2003 and 2004 account for 10-13% in numbers each and 7-13% in weight, around 3% higher than expected. The 1998 year class was expected to be 15% in numbers and 18% in weight, but was only half of it. The catch from 15+ became also less than half of what it was expected to be. An unexpected high catches in numbers of ages 1 and 2 were observed. They were taken in area IIa and quarter IV. So high catches have not been observed since the 1983 year class was fished at age 2 in 1985.

Length at age data are not used in the assessment.

7.5.4 Weight at age in catch and in the stock

The weight-at-age in the catches in 2008 was taken from the total international weight-at-age (Table 7.5.4.1), which were produced using the computer programme SALLOC, standard ICES software. Trends in weight-at-age are presented in Figure 7.5.4.1. The mean weight at age for age groups 3 to 7 is lower in 2008 than in 2007. There has been a slight increase in weight at age for the younger age groups in the last few years. The mean weight at age for older age groups are at a similar levels in 2008 as in the last few years.

A similar pattern is observed in weight-at-age in the stock which is presented in Figure 7.5.4.2. These data have been taken from the survey in the wintering area until the year 2008. The mean weight at age in the stock in the year 2009 is derived from samples taken in the fishery in the same area and at the same time as the wintering surveys were conducted in. The general pattern here is a slight increase since 1996 for all age groups with a slight decrease for the younger ages during 2006-2008. The mean weights are at a similar level in 2009 as in 2008 for most age groups.

Weight-at-age in the stock by year classes is shown in Figure 7.5.4.1 and Table 7.5.4.2. The strong year classes 1991 and 1992 had a slow growth which is normal for strong year classes due to density dependent effects in the nursery areas. On the other hand, the even stronger 2002 year class had a relatively higher growth. This emphasises what has been previously assumed that a large part of this year class used the Norwegian Sea as a nursery area favouring higher growth compared to year classes using the Barents Sea as nursery area. This also explains the slight decrease in weight-at-age both in the stock and in the catch for the young ages during the last years. The year classes following the 2002 year class have used the Barents Sea as nursery area and have therefore had a comparably slower growth.

7.5.5 Maturity at age

Except for the year class 2002, the proportion mature at age used in assessment has generally been the same during the last ten years. During the benchmark last year, WGWIDE recommended that effort should be put into updating estimates on proportion mature at age for NSSH using back-calculation techniques and compare with direct measurements on proportion mature at age from the May survey. This work is ongoing and it was not possible to have the back-calculated values ready in time for the working groups. Alternative values of proportion mature at age from the May survey in 2009 were presented to the WG. Numbers of fish at age considered to be mature (maturity stages 3-8) and immature (stages 1-2) from the three different areas (Barents Sea, northeast Norwegian Sea and southwest Norwegian Sea) were weighted by the total estimate of fish at age in the respective areas and then combined to calculate proportion mature at age from the whole distribution area of NSSH. The WG discussed this approach and considered it to be interesting. However, a problem was identified regarding the sample size, particularly of the young age-classes (age 3). The number of samples of this age class in the survey was relatively low and the WG decided to use the same proportion mature at age as last year. However, the WG recommended exploring this further and in future surveys stratified sampling of the catch could be done in order to obtain acceptable sample sizes for all age classes. In addition, it was recommended that the work on maturity ogive is of such importance that it should be evaluated by an expert group outside the WG. The historical time series of the maturity ogive used in the assessment is given in the stock annex. The values used for 2009 are given in the text table below:

AGE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1

7.5.6 Natural mortality

In this year's (2009) assessment, the natural mortality M=0.15 was used for ages 3 and older and M=0.9 was used for ages 0–2. These levels of M are in accordance to previous years and their justification is provided in the stock annex. Information about deviations from these levels in the time series, e.g. due to diseases, are also provided in the stock annex.

WGWIDE is aware of that an outbreak of *Ichthyophonus* was observed in the Icelandic summer-spawning herring in the autumn 2008, where around 32% of the fishable stock was estimated to be infected (ICES 2009, NWWG[4]) with the corresponding increase in M. This outbreak continued in the summer 2009, according to a survey on the spawning grounds. The stock is believed to get infected through its diet on the feeding grounds (Óskarsson and Pálsson 2009[5]). The part of the stock that feeds on the continental shelf off eastern Iceland prior to and following the spawning in July, is mixed with Norwegian spring-spawning herring feeding there also. Neither of the stocks caught there mixed in June 2009 were infected and there is still no indication for an infection in the spring spawning stock during the summer fishery there in 2009. Catch samples from the area will be inspected for possible infection through the fishing season. Accordingly, there is no indication for increased M in the Norwegian

[4] ICES. 2009. Report of the North Western Working Group (NWWG), 29 April - 5 May 2009, ICES Headquarters, Copenhagen. ICES CM 2009\ACOM:04. 655 pp.

[5] Óskarsson, G.J. and J. Pálsson 2009. Plausible causes for the *Ichthyophonus* outbreak in the Icelandic summer-spawning herring. Marine Research Institute, Iceland, Report 145: 48-53.

spring spawning stock and *Ichthyophonus* infection is therefore not an issue at the moment. Observation of 3 *Ichthyophonus* infected out of total around 1000 Norwegian spring spawning individuals investigated at RV Dana in the Norwegian Sea in May 2009 is not considered to change that conclusion because this prevalence of infection (few ‰) is possibly the normal level in herring stocks according to researches of Icelandic summer-spawning herring during 1992-2000 (Óskarsson and Pálsson 2009[6]).

7.5.7 Survey data

7.5.7.1 Survey 1 Norwegian acoustic survey on spawning grounds in February/March

No new infornation (see stock annex 4)

7.5.7.2 Survey 2 Norwegian acoustic survey in November/December

No new infornation (see stock annex 4)

7.5.7.3 Survey 3 Norwegian acoustic survey in January

No new infornation (see stock annex 4)

7.5.7.4 Survey 4 and 5 International ecosystem survey in the Nordic Seas and Barents Sea

The international ecosystem survey in the Nordic Seas and the Barents Sea is aimed at observing the pelagic ecosystem, focusing herring, blue whiting, zooplankton and hydrography. The planned area has been completely covered in 2009.

From the area west of 20°E the age groups 4 and older are used for the assessment, whereas the Barents Sea area east of 20°E supplies the recruitment age groups 1 and 2 for the assessment. The part of the survey covering the Barents Sea has been used in the final assessment from 2005 onwards.

During the ecosystem survey in the Norwegian Sea and Barents Sea in May 2009, the coverage of Norwegian spring spawning herring was considered adequate.

Herring was recorded throughout the survey area with highest values observed in the central part of the Norwegian Sea at the edge of the cold waters of the East Iceland Current (Figure 7.5.7.4.1). The distribution was similar to what was observed in May 2008 (Figure 7.5.7.4.1). This is reflected in the center of gravity of the distribution, which has been calculated since 1996. Since 2003 there has been a southwestward shift in the center of gravity of herring, but this did not continue in 2009 when a slight northeastward shift was observed. As in previous years, the smallest and youngest fish were found in the northeastern area and both size and age increased southwestward. The stock is now dominated by the 2002 and 2004 year classes while the 2003 year class also seems to be above average ((Figure 7.5.7.4.2). No strong year classes were found in the Barents Sea, indicating weak recruitment since 2004. The time series of abundance (both in numbers and biomass) of Norwegian spring spawning herring in May is shown in Table B.3.4.2 in the stock annex. The total bio-

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[6] Óskarsson, G.J. and J. Pálsson 2009. Plausible causes for the *Ichthyophonus* outbreak in the Icelandic summer-spawning herring. Marine Research Institute, Iceland, Report 145: 48-53.

mass of Norwegian spring spawning herring was estimated to 10.7 million tonnes which is higher than the 2008 estimate of 10 million tonnes.

The age-disaggregated time-series of abundance for the Barents (Table 7.5.7.4.1) and Norwegian Sea is presented in Table 7.5.7.4.2.

7.5.7.5 Survey 6 and 7 Joined Russian-Norwegian ecosystem autumn survey in the Barents Sea

The age groups 1 and 2 are used in the assessment. The log index of 0–group herring has been used in the assessment up to 2004 and then replaced by a new abundance index, which was included in the assessment since 2006.

The results from these surveys on 0–group herring are given in Table 7.5.7.5.1; those of the 1 to 3 age groups are given in Table 7.5.7.5.2. The youngest age groups (0+ to 3+) of the Norwegian spring spawning herring stock are found in the Barents Sea at irregular intervals. It is difficult to access the stock size during autumn, due to various reasons. The age groups 1 to 3 are found mixed with 0–group herring and are difficult to catch in the sampling trawl used in this survey. The stock size estimates of herring are therefore considered less reliable than those for capelin and polar cod. The distribution of young herring is shown in Figure 7.5.7.5.1. Distribution of 0–group herring is presented in Figure 7.5.7.5.2.

7.5.7.6 Survey 8 Norwegian herring larvae survey on the Norwegian shelf

A description of this survey is given in stock annex 4. Two indices are available from this survey (Table 7.5.7.6.1). The "Index 1" is used in the assessment as representative for the size of the spawning stock for the exception 2003 and 2009.

In 2008 the survey was carried out from 5-19 April. In 2009, the survey started in Ålesund on 12 April.

The number of herring larvae found this year was very low and the total number was estimated to be $8.4*10^{12}$, resulting in a low Larvae Production Index (LPI) of 53.8. This is the lowest number of larvae recorded since 2003 when the survey was severely hampered by bad weather (Table 7.5.7.6.1). The mean size of the larvae was 13.6 mm which is the highest mean size since 2003.

The low numbers of larvae could have been due to an excessive mortality of eggs on the spawning grounds either due to adverse physical conditions or exceptionally high predation mortality. Alternatively, the early stage larvae could have been subject to very high mortality rates.

Alternatively, the relatively large mean size of the larvae caught in the survey could suggest that spawning was particularly early in 2009 and the survey was not able to catch the larger larvae.

Herring larvae were observed throughout the sampling area (Figure 7.5.7.6.1). Zero values were found both on the northernmost and on the southernmost section.

7.5.7.7 Survey 9 Norwegian ecosystem survey and SALSEA salmon project in the Norwegian Sea in July-August

A Norwegian ecosystem survey and SALSEA salmon project in the Norwegian Sea in July-August has been carried out on the Norwegian shelf since 2004 for the exception 2007. The objectives of the survey study abundance, spatiotemporal distribution, aggregation and feeding ecology of Northeast Atlantic mackerel, Norwegian spring-spawning herring, blue whiting and Atlantic salmon in relation to oceanographic conditions, prey communities and marine mammals.

The survey has not been used in the assessment due to non-standard covering areas but the herring results of the 2009 were presented to the WG. The survey was carried out from 15 July-6 August 2009. The herring population within the covered cruise tracks (Figure 7.5.7.7.1) and areas was estimated to be 13.6 million tons consisting of 47 billion individuals. The distribution of the herring is given in Figure 7.5.7.7.2. The average weight of herring was 286.9 gram and mean length was 31.8 cm. Altogether 14 different year classes were present in the catches, whereas only five year classes constituted more than 5% of the catches.

7.6 Methods

7.6.1 TASAC stock assessment

This year's assessment was classified as an update assessment and was run according to the benchmark in 2008 using the VPA population model in the TASACS toolbox with the same model options as the benchmark (see stock annex 4). The information used in the assessment is catch data and survey data from eight surveys. The analysis was restricted to the years 1988 – 2009, which is regarded as the period representative of the present production and exploitation regimes, and is presumed to be of main interest for the management.

There were no data to support the estimate of the terminal stock numbers for some small year classes in the VPA (before 1982, 1984 – 1988, 1995 and 2000 – 2001). For those of these year classes that had reached oldest true age, terminal fishing mortalities were derived from the terminal F the year before and fishing mortalities at younger ages, with the standard procedure in TASACS. For the year classes that still are younger than the oldest true age, survivor numbers were fixed at arbitrarily selected small values during last year's benchmark. Since these year classes are now one year older, the survivor numbers for these year classes this year were reduced to allow the modelled values one year back to fit with the values fixed last year.

The model was run with catch data 1988 – 2008, and projected forwards through 2009 assuming Fs in 2009 equal to those in 2008, to include survey data from 2009.

7.6.2 Short-term forecast

A detailed description of the short term forecast procedure is given in the stock annex. Since the standard software cannot cope with Management Option Tables based on average fishing mortality weighted over stock numbers, calculations are carried out using a spread sheet.

7.7 Data Exploration

7.7.1 Catch curve analyses

7.7.2 Data exploration with TISVPA

7.7.3 TASACS assessment following benchmark

This year's assessment was classified as an update assessment and was run according to the benchmark in 2008 using the VPA population model in the TASACS toolbox with the same model options as the benchmark (see stock annex 4). The input data and the performance of the assessment were scrutinized to check for potential problems.

During the benchmark in 2008, exploration of the survey data was carried out in order to investigate whether the survey contributes information to the assessment or whether there is no or little information in the survey data. Within TASACS, the development of the individual cohorts (year classes) was explored for each survey separately. This was done cohort by cohort by translating each survey index into population numbers. This allows comparing what each survey indicates that the population numbers should be, and thus identify conflicting signals between surveys and outliers in the survey data. This was done year class by year class. Included in this analysis was also catch data at age, translated into N-values assuming a separable model for the fishing mortalities. Such comparisons allow identification of outliers in the surveys, contradicting signals, or may indicate that the survey provides mostly noise.

This year, new information was available for surveys 4, 5, 6 and 7. It was noted that there was a conflict between the assessment and survey 5 (feeding survey in the Norwegian Sea in May) for the strong 1998 year class (Figure 7.7.3.1). This year class seems to have a more pronounced downward trend in the survey than in the assessment. The reason for this could be due to problems of obtaining correct ages for old age classes in May when there are two consecutive strong year classes. The 1999 year class was also a strong year class and there is no similar conflict for this year class. During the survey in May, the growth season has just started and it is possible that some of the fish from the 1998 year class was aged to 10 years (1999 year class) instead of 11.

The data finally used in further exploration with TASACS are shown in Figure 7.7.3.2. Data not used still remain on the input files. Exclusion of data is done by giving them zero weight in the analysis.

Figure 7.7.3.3 shows the residual SSQ for the surveys separately from both the assessments made in 2008 and 2009. In 2008 survey 5 contributed most to the SSQ. The survey 5 is on the feeding area and contributes most of the survey data to the assessment. In 2009, however, both survey 5 and survey 7 contribute almost equal to the SSQ and the contribution from survey 6 has also increased a lot. The surveys 6 and 7 are on the juvenile herring and 0-group and are considered more noisy. In Figure 7.7.3.4 weighted residuals for the surveys are shown. In survey 5 there is no clear pattern in the residuals except for some relatively small year effects. In survey 6 there is a large residual at age 1 in 2008.

The final results of the assessment are presented in Tables 7.7.3.1 (stock in numbers) and 7.7.3.2 (fishing mortality) and Figure 7.7.3.5. Table 7.7.3.4 is the summary table of the assessment.

The assessment indicates that the fishing mortality ($F_{5-14weighted}$ weighted by stock numbers) in recent years has fluctuated between 0.10 and 0.15 and is estimated in 2008 at 0.125. A number of large year classes have appeared in recent years of which two year classes 2002 and 2004 are the most recent ones. The 2002 year class is now fully recruited to the spawning stock while the 2004 year class is close to fully recruited. As a result of these large year classes and the high survival due to low fishing mortality, the SSB has increased in recent years and is estimated near 13.3 million tonnes in 2009. However, the data available for the year classes after 2004 indicates that they are small year classes and SSB are therefore expected to be reduced in the coming years.

7.7.4 Bootstrap

The uncertainty of the assessments was examined by bootstrap (1000 replicas). For the data where residuals are generated by the modelling, the bootstrap was made by adding randomly drawn residuals from the same source of data to the modelled observations. For catches at age in the VPA, lognormally distributed random noise with a CV of 0.1 was added to the observations. The results are shown in Figure 7.7.4.1.

7.7.5 Retrospective analyses

The retrospective analyses are shown in Figure 7.7.5.1. They generally show weak retrospective pattern in the most recent years except for some underestimation of SSB and overestimation of fishing mortality for the 2006 retrospective. The main reason for this is the amount of information on the size of the 2002 year class. Estimates of this large year class have increased considerably in successive years as more information (from surveys and catches) became available, leading to higher estimates of the stock in successive years.

7.8 NSSH reference points

The presently used reference points for the stock originate from an analysis carried out in 1998, as detailed in the stock annex. According to it, ICES considers the precautionary reference points B_{lim}=2.5 million t and proposes that B_{pa}=5.0 million t. F_{pa}=0.150. The Coastal States have then agreed a target reference point defined at F_{target}=0.125.

7.9 State of the stock

The stock is considered to be within safe biological limits. Fishing mortality is lower than F_{pa}. SSB in 2009 is well above all reference points and is estimated as one of the highest in the time-series. In the past decade, the productivity of the stock has been high. The stock contains a number of good year classes. In the last 10 years, four large year classes have been produced (1998, 1999, 2002 and 2004). However, the available information indicates that year classes born after 2004 have been small.

7.10 NSSH Catch predictions for 2010

7.10.1 Input data for the forecast

Input stock numbers in 2009 at age 4 and older are taken from the final assessment. Stock numbers at age 0 to 3 were estimated separately. In the absence of external information on the year classes 2009 and later, the Working Group decided to use geometric mean over the years 1988–2005 for these year classes at age 0. This choice does not affect the estimates of catch, spawning biomass and fishing mortality in the short term prediction. To derive estimates for ages 1, 2 and 3 in 2009 (year classess 2008, 2007 and 2006) the RCT3 program was used. Input data for the RCT3 program (Table 7.10.1.1) were VPA values at age 2 and available survey indices. Results from the RCT3 are shown in Table 7.10.1.2. The year classes estimates used in the prediction are indicated (underlined) in the text table below:

year class	age	VPA	RCT	GM
2006	3	4 158	6000	4 800
2007	2	1 040	5 000	12 800
2008	1	-		38 000
2009	0	-		103 000
2010	0	-		103 000
2011	0	-		103 000

As last year, Working Group adopted the RCT3 values for age 2 and 3 to be used in the forecast. For age 1 (year class 2008) only information is available from 0- and 1-group surveys in the Barents Sea. The results of these surveys for estimating 1-year-olds by RCT3 were not considered in last years benchmark. The surveys indicate year class 2008 to be weak but the estimates are still uncertain as they include no information from the Norwegian Sea. The Working Group adopted the GM estimate at age 1.

The catch weight-at-age, used in the forecast, is the average of the observed catch weights over the last 3 years (2006–2008). For the weight-at-age in the stock, the values for 2009 were obtained from the commercial fisheries in the wintering areas (Table 7.5.3.1). For the other years the average of the last 3 years (2007–2009) was used.

Standard values of maturity at age and natural mortality were used.

The exploitation pattern used in the forecast was taken as the average of the last 3 years (2006–2008). The average fishing mortality is the average over the ages 5 to 14 and is weighted over the population numbers in the relevant year.

$$\overline{F}_y = \sum_{a=5}^{a=14} F_{y,a} N_{y,a} / \sum_{a=5}^{a=14} N_{y,a}$$

Where $F_{y,a}$ and $N_{y,a}$ are fishing mortalities and numbers by year and age

This procedure is the same as applied in previous years for this stock.

Input data for the short term forecast are given in Table 7.10.1.3.

7.10.2 Results of the forecast

The Management Options Table with the results of the forecast is presented in Table 7.10.2.1. Detailed output of the forecast, corresponding to the management plan is given in Table 7.10.2.2. Assuming that the TAC of 1 643 000 tonnes is taken in 2009, it is expected that the SSB will decline from 13.3 million tonnes in 2009 to 12.2 million tonnes in 2010. The TAC in 2010, corresponding with the fishing mortality of 0.125 in the agreed Management Plan ($F_{management\ plan} = F_{(5-14)weighted} = 0.125$), is 1 483 000 tonnes. The expected remaining SSB in 2011 is about 11.0 million tonnes.

7.11 Uncertainties in assessment and forecast

7.11.1 Uncertainty in the assessment

Last year, the bench mark assessment concluded that the choice of the assessment model had a minor impact on the results. The assessment appeared to be more sensitive to the choice of the data used than to the choice of the model. A major source of uncertainty is caused by conflicting signals from survey information on the youngest ages. The benchmark assessment is carried out in the TASACS framework. This years assessment is carried out using the same procedures and settings as in the benchmark and the results are consistent with last year.

Exploration of the available data using TISVPA picked up signals in the catch of relatively high catch numbers of 1 and 2 year olds in 2008 (year classes 2007 and 2006). However, the available surveys do not indicate that these year classes are strong.

7.11.2 Uncertainty in the forecast

The spawning stock in recent years has increased due to a number good year classes and a moderate exploitation. However, the forecast indicates that the (spawning) stock is expected to decrease in the near future. This can be expected since the last strong year class was born 2004 and year classes born thereafter were much lower. The contributions of these lower year classes to the spawning stock in the next years will be much less.

Recruitment estimates of the most recent year classes are uncertain because they are based on little, incomplete or no information. However, the assumptions made for these year classes have little impact on the short term prediction of landings and SSB in the projected years.

7.12 Comparison with previous assessment and forecast

The assessment in 2008 was a benchmark assessment. The final assessment then was made with a VPA type of model carried out in the TASACS framework. A comparison between the assessments 2006-2009 is shown in Figure 7.12.1. In principle, the same data sources have been used in all these assessments, but the weight of some data points given in the assessment in 2008 and 2009 was changed in some cases, following an evaluation in the benchmark (section 9.5 in the working group report, ICES CM 2008/ACOM:13). The assessments for Norwegian spring spawning herring in 2006-2007 were carried out with a different model than presently used. This model (Seastar) is also a VPA type model.

The results from this year's assessment are in accordance with the results from last year.

The SSB in 2008 was estimated at 12.4 million tonnes in the present assessment compared to 11.9 million tonnes last year. Weighted F 5-14 in 2007 is estimated at 0.0.098 compared to 0.101 last year.

7.13 Management plans and evaluations

The present management plan dates from 1996 and is described in section 7.2. A brief history of it is in the stock annex. The management plan aims for exploitation at a target fishing mortality below F_{pa} and is considered by ICES in accordance with the precautionary approach. In general, management has achieved to manage to stock in compliance with the management plan. The Working Group did not consider new evaluation of the existing management plan and there were also no requests to do so.

7.14 Management considerations

Historically, the size of the stock has shown large variations and dependency on the irregular occurrence of very strong year classes. In recent years, the stock has produced a number strong year classes which lead to an increase in SSB. The stock is estimated in 2009 at its highest level in the last 20 years. In recent years catches have also increased and are regulated through an agreed Management Plan. The Management Plan is considered precautionary.

In the absence of strong year classes after 2004, the stock is expected to decline in the near future even when fishing according to the management plan. This is a normal behaviour of stocks which show spasmodic recruitment dynamics. The decline of the stock will also affect the projected catches. The short term prognoses indicate a decline of the stock from 12.4 million tonnes in 2009 to 10 million tonnes in 2011 assuming exploitation in 2010 is according the Management Plan.

Catches, taken from the stock in recent years, have been taken with a low fishing mortality close to the agreed target fishing mortality in the Management Plan. If management will continue to comply with it, then the decline in the catches will be gradual.

In recent years the distribution area of mackerel has expanded to the north and west and overlaps the distribution area of the herring. As consequence mackerel catches are taken in that area.

In recent years, the migration behaviour of the stock has changed significantly, particularly in geographical locations of the wintering and feeding areas. These, in turn, have affected the distribution of the fisheries.

7.15 Ecosystem considerations

The Norwegian spring spawning herring is characterized by large dynamics with regard to migration pattern. This applies to the wintering, spawning and feeding area. Juveniles and adults of this stock form an important part of the ecosystems in the Barents Sea, the Norwegian Sea, and the Norwegian coast. Herring has an important role as food resource to higher trophic levels (e.g. cod, saithe, seabirds, and marine mammals). Recent changes in the herring migration have led to an increased proportion of the population feeding in Faroese and Icelandic waters in early summer. The growth of these herring is faster than those feeding further east and north. An increased spatial overlap between herring and mackerel was evident in several areas of the Norwegian Sea in July 2009. The following discussion will in particular concentrate on the situation in the feeding areas (ICES PGNAPES 2009).

The herring distribution in May 2009 was similar to what was observed in May 2008. This is reflected in the center of gravity of the distribution (Figure 7.4.2.1). The smallest and youngest fish were found in the northeastern area and both size and age increased southwestward. The stock is now dominated by the 2002 and 2004 year classes while the 2003 year class also seems to be above average. No strong year classes were found in the Barents Sea, indicating weak recruitment since 2004. In 2009 the strong 2002, the average 2003 and the relatively strong 2004 year classes feeding in the Norwegian Sea were dominating the stock in numbers with about 50% of the total biomass. The 2002 year class completed to recruit to the spawning stock in 2008. The 2004 year class began to recruit to the spawning stock in 2008. The Barents Sea component now consists of quite weak 2005-2008 year classes.

In July 2009, the Norwegian spring spawning herring had moved out of the central part of the Norwegian Sea and was observed feeding in a wide area around the fringes of the survey area. Highest values were found in the northern and western region, while there were very low concentrations in the central area. This is a typical distribution which has been observed this time of the year during the last few years. Similarly to May, the biggest and oldest fish were found in the western and southwestern parts of the survey area. The herring was predominantly distributed in small schools and aggregations. The low number of marine mammals sighted in the Norwegian Sea in summer 2009, could be due to low and unfavourable densities of herring providing less cost efficient feeding opportunities for marine mammals such as humpback whale, fin whale and minke whale.

The recent southwestern extension of the herring feeding area started in 2003. The concentration of herring in the southwestern area in May increased somewhat in 2004 but showed a more significant increase after 2005. The increased concentrations are reflected both in the surveys and through a significant fishery in the southwestern area during the 2007. As seen from the fishery pattern from 2005 there is a split in a southwestern and northern fishing area, which can be explained by the division of the larger fish in the southwestern and northern area as observed during the May and July survey. Most of the oldest herring fed in the southwestern area during 2008 and 2009.

The average biomass of zooplankton in the total area in May has, however, been on a decreasing trend since 2002, and reached in 2009 a record low level since the measurements started in 1997. A similar trend was found in July 2009 with low zooplankton concentrations in all areas of the Norwegian Sea. From a situation with relatively good feeding conditions throughout the Norwegian Sea, areas of lowered plankton densities seem to have spread west and northwards in front of the feeding herring and up until 2009 there was a high density zooplankton area only in the circumference or outskirt of the herring feeding area. This area of higher plankton densities in the west and northwest disappeared in 2009, an observation done both during the May and July/August survey as referred above. The strong decrease in available plankton resources for all the pelagic fish stocks in the Norwegian must be regarded a major ecological factor at present and should be followed closely in the coming years.

7.16 Regulations and their effects

The NSSH has been fished moderately for the last six years with a mean F of 0.125. This is in accordance with the international management plan and below F_{pa}. Thus the stock is moderately harvested as compared to most other stocks. The moderate harvest combined with a number of large year classes in the period 1998-2004 has been the main contributors to the high stock levels observed in 2008 and 2009. These stock levels are not significantly different from those estimated before the 1960's stock collapse and the rebuilding of this stock has come to its conclusion.

7.17 Changes in fishing patterns

The NSSH changed wintering areas from fjordic to oceanic during the years 2002-2006. The new wintering pattern caused a large change in fishing pattern as more catches were taken during the spawning migration and spawning instead of during the wintering period. The changes apply mostly to the Norwegian fleet and are discussed in section 7.3.1.8.

7.18 Changes in the environment

In the Norwegian Sea, where the herring stock is grazing the two main features of the circulation are the Norwegian Atlantic Current (NWAC) and the East Icelandic Current (EIC). The NWAC with its offshoots forms the northern limb of the North Atlantic current system and carries relatively warm and salty water from the North Atlantic into the Nordic Seas. The EIC, on the other hand, carries Arctic waters.

The Arctic front is a central feeding area for Norwegian spring-spawning herring. During periods when the Arctic front is shifted westwards it is likely that the part of the stock feeding in the western Norwegian Sea will also be shifted westward. The position of the Arctic front is correlated with large-scale environmental events which are detected by the winter index of the NAO.

After two years with strong westerlies (high NAO index) during 2007–2008, with an increased influence of Arctic water in the southern Norwegian Sea, the strength of the westerlies was in winter 2009 about normal. However, the increased Arctic influence in the western areas of the Norwegian Sea is still observed in 2009. After several years with large westerly extension of Atlantic water and additional warm Atlantic water in the Norwegian Sea, especially in 2003 and 2004, a temperature reduction in the western Norwegian Sea had been observed over the last several years. This is due to a lower extension of Atlantic water and the occurrence of an increased transport of Arctic water to the area. Thus, the temperature in the western Norwegian Sea in 2009 is close to and in some areas less than the 1995–2009 average. In the central and eastern parts, however, the Atlantic water is still warmer than the 1995–2009 average, about 0–1°C dependent on the area and depths. The main reason for this is that the inflowing Atlantic water is significantly warmer and more saline than normal, and in particular the Atlantic water that flows northward through the Faroe-Shetland Channel is observed to be considerable warmer and saltier than normal.

The anomalously high sea surface temperature in north-western Icelandic waters in summer 2009 were probably a consequence of strong atmospheric warming of the surface layers further south and subsequent advection to that area.

7.19 Recommendations

We suggest that each Expert Group collate and list their recommendations (if any) in a separate annex to the report. It has not always been clear to whom recommendations are addressed. Most often, we have seen that recommendations are addressed to:

- Another Expert Group under the Advisory or the Science Programme;
- The ICES Data Centre;
- Generally addressed to ICES;
- One or more members of the Expert Group itself.

RECOMMENDATION	FOR FOLLOW UP BY:
1. Increase sampling of weight at age in the 1st quarter for Norwegian spring spawning herring	countries fishing on this stock
2. Workshop on maturity at ag for Norwegian spring spawning herring	ICES
3.	
4.	
5.	
6.	

After submission of the report, the ICES Secretariat will follow up on the recommendations, which will also include communication of proposed terms of reference to other ICES Expert Group Chairs. The "Action" column is optional, but in some cases, it would be helpful for ICES if you would specify to whom the recommendation is addressed.

Recommendation 1

WGWIDE recommends an increase in sampling for weight at age in the 1st quarter in the commercial fisheries order to derive an increase in precision of the weight at age in the stock.

rationale:

Previously weight at age in the stock was derived from a Norwegian survey in the overwintering areas. The survey has stopped in 2008 and will not be continued. For 2009, commercial data have been used from the fishery in the 1st quarter from the same area where the survey had been carried out. For some age groups there were no or only few observations. It is recommended increase the sampling to obtain estimates for all age groups. It is also recommended to carry out some statistical analyses in order to obtain an indication of how many observations are required to achieve sufficient precision for the weight estimates. In order to cover all age groups in the sampling it may be required to stratify sampling to ensure that also less abundant year classes are well represented in the samples.

Recommendation 2

WGWIDE recommends to held a Workshop before it next meeting to evaluate maturity at age information from back-calculation analyses and to provide guidance on the way future maturity at age sampling should be carried out.

rationale

The assumption on the maturity at age used in the assessment can have big impact on the estimate of the spawning stock biomass. Different assumptions made on the maturation of the abundant 2002 year class lead to SSB estimates which differed up to 1 million tonnes. There is no documentation for the values used in recent years. Maturity estimates from a back calculation analyses, would allow to update the o-gives used in the assessment for the historical period. An evaluation of the maturity at age information was planned for the benchmark assessment in 2008. However, no data were made available to carry such an analyses. Also in 2009, the data were not available. A discussion on the subject revealed that such an evaluation would require much more time, than can be made available in an assessment working group.

However, data from back calculation studies do not provide information of maturation in recent years and these have to be derived from sampling programmes. Previously, maturity at age was sampled in two surveys: the survey on the overwintering ground (pre-spawning information) and the May survey on the feeding grounds (post-spawning information). The first survey has stopped in 2008. Guidance is required to set up an appropriate protocol for sampling this information.

Table 7.5.1.1 Total catch of Norwegian spring-spawning herring (tons) since 1972. Data provided by Working Group members.

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Netherlands	Greenland	UK (Scotland)	Germany	France	Poland	Sweden	Total
1972	13161	-	-	-	-	-	-	-	-	-	-	-	-	13161
1973	7017	-	-	-	-	-	-	-	-	-	-	-	-	7017
1974	7619	-	-	-	-	-	-	-	-	-	-	-	-	7619
1975	13713	-	-	-	-	-	-	-	-	-	-	-	-	13713
1976	10436	-	-	-	-	-	-	-	-	-	-	-	-	10436
1977	22706	-	-	-	-	-	-	-	-	-	-	-	-	22706
1978	19824	-	-	-	-	-	-	-	-	-	-	-	-	19824
1979	12864	-	-	-	-	-	-	-	-	-	-	-	-	12864
1980	18577	-	-	-	-	-	-	-	-	-	-	-	-	18577
1981	13736	-	-	-	-	-	-	-	-	-	-	-	-	13736
1982	16655	-	-	-	-	-	-	-	-	-	-	-	-	16655
1983	23054	-	-	-	-	-	-	-	-	-	-	-	-	23054
1984	53532	-	-	-	-	-	-	-	-	-	-	-	-	53532
1985	167272	2600	-	-	-	-	-	-	-	-	-	-	-	169872
1986	199256	26000	-	-	-	-	-	-	-	-	-	-	-	225256
1987	108417	18889	-	-	-	-	-	-	-	-	-	-	-	127306
1988	115076	20225	-	-	-	-	-	-	-	-	-	-	-	135301
1989	88707	15123	-	-	-	-	-	-	-	-	-	-	-	103830
1990	74604	11807	-	-	-	-	-	-	-	-	-	-	-	86411
1991	73683	11000	-	-	-	-	-	-	-	-	-	-	-	84683
1992	91111	13337	-	-	-	-	-	-	-	-	-	-	-	104448
1993	199771	32645	-	-	-	-	-	-	-	-	-	-	-	232457
1994	380771	74400	-	2911	21146	-	-	-	-	-	-	-	-	479228
1995	529838	101987	30577	57084	174109	-	7969	2500	881	556	-	-	-	905501
1996	699161	119290	60681	52788	164957	19541	19664	-	46131	11978	-	-	22424	1220283
1997	860963	168900	44292	59987	220154	11179	8694	-	25149	6190	1500	-	19499	1426507
1998	743925	124049	35519	68136	197789	2437	12827	-	15971	7003	605	-	14863	1223131
1999	740640	157328	37010	55527	203381	2412	5871	-	19207	-	-	-	14057	1235433
2000	713500	163261	34968	68625	186035	8939	-	-	14096	3298	-	-	14749	1207201
2001	495036	109054	24038	34170	77693	6070	6439	-	12230	1588	-	-	9818	766136
2002	487233	113763	18998	32302	127197	1699	9392	-	3482	3017	-	1226	9486	807795
2003*	477573	122846	14144	27943	117910	1400	8678	-	9214	3371	-	-	6431	789510

***In 2003 the Norwegian catches were raised of 39433 to account for changes in percentages of water content.**

Table 7.5.1.1, cont. Total catch of Norwegian spring-spawning herring (tons) since 1972. Data provided by Working Group members.

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Netherlands	Greenland	UK (Scotland)	Germany	France	Poland	Sweden	Total
2004	477076	115876	23111	42771	102787	11	17369	-	1869	4810	400	-	7986	794066
2005**	580804	132099	28368	65071	156467	-	21517	-	-	17676	0	561	680	1003243
2006***	567237	120836	18449	63137	157474	4693	11625	-	12523	9958	80	-	2946	968958
2007	779089	162434	22911	64251	173621	6411	29764	4897	13244	6038	0	4333	0	1266993
2008	961603	193119	31128	74261	217602	7903	28155	3810	19737	8338	0	0	0	1545656

****Preliminary, as provided by Working Group members.**

*****Scotland and Northern Irland combined.**

Table 7.5.1.2. Norwegian spring spawning herring. Output from SALLOC for 2008 data.

Summary of Sampling by Country

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	31128.00	31128.00	12	1520	1504	99.85
Faroe Islands	63177.00	71171.00	6	380	114	99.98
Germany	0.00	8338.00	0	0	0	0.00
Greenland	0.00	2302.00	0	0	0	0.00
Iceland	129385.00	176863.00	63	2842	5334	99.98
Ireland	7903.00	7903.00	1	86	86	99.93
Norway	955920.00	955920.00	377	38583	17084	100.06
Russia	176402.00	176402.00	100	21147	1398	99.98
Scotland	19737.00	19737.00	5	617	204	99.91
The Netherlands	16122.00	23852.00	40	4549	1000	100.05
Total IIa	1399774.00	1473616.00	604	69724	26724	100.03

Sum of Offical Catches : 1473616.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 1473616.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	1788.00	1788.00	1	90	39	100.07
Iceland	0.00	219.00	0	0	0	0.00
Russia	16633.00	16633.00	10	2100	150	100.03
The Netherlands	0.00	4303.00	0	0	0	0.00
Total IIb	18421.00	22943.00	11	2190	189	100.03

Sum of Offical Catches : 22943.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 22943.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	2721.00	2721.00	60	6610	2632	99.92
Total IVa	2721.00	2721.00	60	6610	2632	99.92

Sum of Offical Catches : 2721.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 2721.00

AREA : Ib

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	2962.00	2962.00	14	1370	584	100.07
Total Ib	2962.00	2962.00	14	1370	584	100.07

Sum of Offical Catches : 2962.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 2962.00

Table 7.5.1.2 (Cont'd)

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	458.00	458.00	3	200	135	100.14
Iceland	36323.00	40520.00	26	1225	1000	100.02
Total Va	36781.00	40978.00	29	1425	1135	100.02

Sum of Offical Catches : 40978.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 40978.00

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	803.00	803.00	3	200	135	99.98
Greenland	0.00	1508.00	0	0	0	0.00
Russia	0.00	84.00	0	0	0	0.00
Total Vb	803.00	2395.00	3	200	135	99.98

Sum of Offical Catches : 2395.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 2395.00

AREA : XIVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	41.00	41.00	1	90	39	99.22
Total XIVa	41.00	41.00	1	90	39	99.22

Sum of Offical Catches : 41.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 41.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	25529.00	25529.00	11	1384	1380	99.80
Faroe Islands	0.00	544.00	0	0	0	0.00
Ireland	7903.00	7903.00	1	86	86	99.93
Norway	447433.00	447433.00	240	21652	11040	100.06
Russia	14256.00	14256.00	22	4650	300	100.04
Scotland	19737.00	19737.00	5	617	204	99.91
Period Total	514858.00	515402.00	279	28389	13010	100.04

Sum of Offical Catches : 515402.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 515402.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	1261.00	8711.00	6	400	270	100.04
Iceland	29898.00	34314.00	13	581	2667	100.09
Norway	2535.00	2535.00	37	3979	1678	100.00
Russia	1808.00	1885.00	5	345	116	99.85
Period Total	35502.00	47445.00	61	5305	4731	100.07

Sum of Offical Catches : 47445.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 47445.00

Table 7.5.1.2 (Cont'd)

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	42902.00	42902.00	5	370	135	99.98
Germany	0.00	6190.00	0	0	0	0.00
Greenland	0.00	3810.00	0	0	0	0.00
Iceland	135810.00	135810.00	76	3486	3667	99.97
Norway	78392.00	78392.00	49	5450	3968	100.07
Russia	124781.00	124788.00	74	16350	1024	99.98
The Netherlands	16122.00	20425.00	40	4549	1000	100.05
Period Total	398007.00	412317.00	244	30205	9794	100.01

Sum of Offical Catches : 412317.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 412317.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	5599.00	5599.00	1	136	124	100.10
Faroe Islands	22104.00	22104.00	3	190	57	99.98
Germany	0.00	2148.00	0	0	0	0.00
Iceland	0.00	47478.00	0	0	0	0.00
Norway	433243.00	433243.00	125	15482	3614	100.06
Russia	52190.00	52190.00	9	1902	108	100.01
The Netherlands	0.00	7730.00	0	0	0	0.00
Period Total	513136.00	570492.00	138	17710	3903	100.05

Sum of Offical Catches : 570492.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 570492.00

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	31128.00	31128.00	12	1520	1504	99.85
Faroe Islands	66267.00	74261.00	14	960	462	99.98
Germany	0.00	8338.00	0	0	0	0.00
Greenland	0.00	3810.00	0	0	0	0.00
Iceland	165708.00	217602.00	89	4067	6334	99.99
Ireland	7903.00	7903.00	1	86	86	99.93
Norway	961603.00	961603.00	451	46563	20300	100.06
Russia	193035.00	193119.00	110	23247	1548	99.99
Scotland	19737.00	19737.00	5	617	204	99.91
The Netherlands	16122.00	28155.00	40	4549	1000	100.05
Total for Stock	1461503.00	1545656.00	722	81609	31438	100.03

Sum of Offical Catches : 1545656.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 1545656.00

DETAILS OF DATA FILLING-IN

```
  Filling-in for record : (  3)   Iceland                4 IIa
Mean Weighted by Number of Samples of:
  >>  ( 10)  Russia                 4 IIa
  >>  ( 23)  Faroe Islands          4 IIa
  >>  ( 32)  Norway                 4 IIa
  >>  ( 39)  Denmark                4 IIa

  Filling-in for record : (  4)   Iceland                2 IIb
Using Only
  >>  (  1)  Iceland                2 IIa

  Filling-in for record : (  5)   Iceland                2 Va
Using Only
  >>  (  1)  Iceland                2 IIa

  Filling-in for record : ( 12)   Russia                 2 Vb
Using Only
  >>  (  8)  Russia                 2 IIa

  Filling-in for record : ( 13)   Russia                 3 Vb
Using Only
  >>  (  9)  Russia                 3 IIa
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Table 7.5.1.2 (Cont'd)

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  Filling-in for record : ( 15)   Greenland              3 IIa
Using Only
  >>  (  2)  Iceland                3 IIa

  Filling-in for record : ( 16)   Greenland              3 Vb
Using Only
  >>  (  9)  Russia                 3 IIa

  Filling-in for record : ( 17)   Germany                3 IIa
Using Only
  >>  ( 35)  The Netherlands        3 IIa

  Filling-in for record : ( 18)   Germany                4 IIa
Mean Weighted by Number of Samples of:
  >>  ( 10)  Russia                 4 IIa
  >>  ( 23)  Faroe Islands          4 IIa
  >>  ( 32)  Norway                 4 IIa
  >>  ( 39)  Denmark                4 IIa

  Filling-in for record : ( 20)   Faroe Islands          1 IIa
Using Only
  >>  ( 38)  Denmark                1 IIa

  Filling-in for record : ( 21)   Faroe Islands          2 IIa
Using Only
  >>  (  1)  Iceland                2 IIa

  Filling-in for record : ( 36)   The Netherlands        4 IIa
Mean Weighted by Number of Samples of:
  >>  ( 10)  Russia                 4 IIa
  >>  ( 23)  Faroe Islands          4 IIa
  >>  ( 32)  Norway                 4 IIa
  >>  ( 39)  Denmark                4 IIa

  Filling-in for record : ( 37)   The Netherlands        3 IIb
Using Only
  >>  ( 11)  Russia                 3 IIb
```

Table 7.5.1.2 (Cont'd)

Catch Numbers at Age by Area

For Periods 1 to 4

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	39547.88	0.00	0.00	285.00	0.00	65.20	0.00	39898.07
2	115890.25	6921.61	0.00	748.00	0.00	389.30	0.00	123949.16
3	35301.12	901.83	0.00	72.00	173.52	181.09	0.00	36629.54
4	507787.34	25833.78	143.00	13220.00	1905.90	1372.81	11.00	550273.88
5	638367.94	21749.92	441.00	1384.00	7378.17	1334.19	26.00	670681.19
6	2196469.00	29940.96	5490.00	563.00	60680.00	2720.57	48.00	2295911.50
7	187345.00	1274.38	176.00	0.00	10011.68	767.06	18.00	199592.14
8	239924.02	3354.69	212.00	0.00	12226.59	401.58	13.00	256131.91
9	561012.19	1995.97	1608.00	0.00	21497.17	467.28	2.00	586582.69
10	357182.28	525.82	546.00	0.00	11167.90	194.84	3.00	369619.88
11	28830.76	7.98	0.00	0.00	754.87	39.42	0.00	29633.03
12	35155.84	2.74	298.00	0.00	509.50	59.39	0.00	36025.46
13	23439.07	1.97	30.00	0.00	283.76	20.19	0.00	23775.00
14	24297.02	4.15	0.00	0.00	881.59	12.69	0.00	25195.46
15	61307.20	3.04	196.00	0.00	1665.26	4.43	0.00	63175.92

Mean Weight at Age by Area (Kg)

For Periods 1 to 4

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0255	0.0000	0.0000	0.0420	0.0000	0.0366	0.0000	0.0257
2	0.1048	0.1210	0.0000	0.1030	0.0000	0.1198	0.0000	0.1057
3	0.1442	0.1552	0.0000	0.2300	0.2522	0.1949	0.0000	0.1454
4	0.2091	0.2120	0.2060	0.1820	0.2659	0.1982	0.3100	0.2088
5	0.2536	0.2551	0.2200	0.2280	0.2871	0.2752	0.3300	0.2539
6	0.2959	0.2883	0.2800	0.2430	0.2997	0.3258	0.3340	0.2958
7	0.3174	0.3249	0.3130	0.0000	0.3213	0.4106	0.3340	0.3180
8	0.3411	0.3201	0.3380	0.0000	0.3375	0.4044	0.3680	0.3408
9	0.3536	0.3114	0.3340	0.0000	0.3412	0.3736	0.3600	0.3530
10	0.3636	0.3773	0.3480	0.0000	0.3496	0.3847	0.3810	0.3631
11	0.3675	0.3270	0.0000	0.0000	0.3388	0.4090	0.0000	0.3668
12	0.3950	0.3390	0.3690	0.0000	0.3972	0.4178	0.0000	0.3949
13	0.3959	0.3430	0.4420	0.0000	0.3481	0.4680	0.0000	0.3955
14	0.3864	0.3440	0.0000	0.0000	0.3795	0.4100	0.0000	0.3862
15	0.4132	0.3510	0.3980	0.0000	0.3973	0.3910	0.0000	0.4128

Mean Length at Age by Area (cm)

For Periods 1 to 4

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	15.2718	0.0000	0.0000	18.0000	0.0000	13.8221	0.0000	15.2890
2	22.5209	21.5000	0.0000	23.1000	0.0000	21.7518	0.0000	22.4650
3	26.0884	26.4078	0.0000	29.0000	29.9833	28.0620	0.0000	26.1302
4	29.1048	31.8681	28.8000	26.9000	30.6835	30.4866	30.3000	29.1904
5	30.6119	32.8169	29.4000	28.7000	31.6614	32.1193	31.4000	30.6932
6	31.8007	33.5288	31.6000	29.7000	32.2669	32.9324	31.6000	31.8359
7	32.6234	32.6750	32.9000	0.0000	33.1051	35.3721	31.6000	32.6586
8	33.6445	35.2550	34.6000	0.0000	33.8021	35.3875	33.4000	33.6766
9	33.9292	36.3029	33.6000	0.0000	33.9925	35.3312	33.0000	33.9398
10	34.0990	36.4374	33.4000	0.0000	34.2860	35.7501	34.0000	34.1078
11	34.9653	34.6000	0.0000	0.0000	33.9986	36.8138	0.0000	34.9430
12	35.6248	35.1000	35.5000	0.0000	36.1020	36.6635	0.0000	35.6322
13	35.7563	35.3000	37.0000	0.0000	34.2808	38.1897	0.0000	35.7423
14	35.4953	35.4000	0.0000	0.0000	35.4910	37.7000	0.0000	35.4962
15	36.5298	35.6000	35.9010	0.0000	36.0825	39.4000	0.0000	36.5162

Table 7.5.1.2 (Cont'd)

Catch Numbers at Age by Area

For Period 1

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1014.00	0.00	0.00	0.00	0.00	0.00	0.00	1014.00
3	9717.00	0.00	0.00	0.00	0.00	0.00	0.00	9717.00
4	85560.16	0.00	141.00	0.00	0.00	0.00	0.00	85701.16
5	227332.00	0.00	435.00	0.00	0.00	0.00	0.00	227767.00
6	925710.75	0.00	5421.00	0.00	0.00	0.00	0.00	931131.75
7	62693.30	0.00	174.00	0.00	0.00	0.00	0.00	62867.30
8	80882.17	0.00	209.00	0.00	0.00	0.00	0.00	81091.17
9	228609.52	0.00	1588.00	0.00	0.00	0.00	0.00	230197.52
10	165795.56	0.00	539.00	0.00	0.00	0.00	0.00	166334.56
11	14319.10	0.00	0.00	0.00	0.00	0.00	0.00	14319.10
12	16117.00	0.00	294.00	0.00	0.00	0.00	0.00	16411.00
13	11702.00	0.00	30.00	0.00	0.00	0.00	0.00	11732.00
14	9724.00	0.00	0.00	0.00	0.00	0.00	0.00	9724.00
15	25409.00	0.00	194.00	0.00	0.00	0.00	0.00	25603.00

Mean Weight at Age by Area (Kg)

For Period 1

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0580	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0580
3	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1000
4	0.1614	0.0000	0.2060	0.0000	0.0000	0.0000	0.0000	0.1615
5	0.2112	0.0000	0.2200	0.0000	0.0000	0.0000	0.0000	0.2112
6	0.2637	0.0000	0.2800	0.0000	0.0000	0.0000	0.0000	0.2638
7	0.2947	0.0000	0.3130	0.0000	0.0000	0.0000	0.0000	0.2947
8	0.3167	0.0000	0.3380	0.0000	0.0000	0.0000	0.0000	0.3167
9	0.3299	0.0000	0.3340	0.0000	0.0000	0.0000	0.0000	0.3299
10	0.3442	0.0000	0.3480	0.0000	0.0000	0.0000	0.0000	0.3442
11	0.3530	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3530
12	0.3711	0.0000	0.3690	0.0000	0.0000	0.0000	0.0000	0.3710
13	0.3824	0.0000	0.4420	0.0000	0.0000	0.0000	0.0000	0.3826
14	0.3786	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3786
15	0.4006	0.0000	0.3980	0.0000	0.0000	0.0000	0.0000	0.4005

Mean Length at Age by Area (cm)

For Period 1

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	22.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	22.2000
3	24.8000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	24.8000
4	27.4062	0.0000	28.8000	0.0000	0.0000	0.0000	0.0000	27.4085
5	29.5611	0.0000	29.4000	0.0000	0.0000	0.0000	0.0000	29.5608
6	31.1821	0.0000	31.6000	0.0000	0.0000	0.0000	0.0000	31.1845
7	32.1815	0.0000	32.9000	0.0000	0.0000	0.0000	0.0000	32.1835
8	33.3833	0.0000	34.6000	0.0000	0.0000	0.0000	0.0000	33.3865
9	33.5165	0.0000	33.6000	0.0000	0.0000	0.0000	0.0000	33.5171
10	33.7532	0.0000	33.4000	0.0000	0.0000	0.0000	0.0000	33.7520
11	34.6981	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	34.6981
12	35.6302	0.0000	35.5000	0.0000	0.0000	0.0000	0.0000	35.6279
13	35.8439	0.0000	37.0000	0.0000	0.0000	0.0000	0.0000	35.8469
14	35.6456	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	35.6456
15	36.4651	0.0000	35.9000	0.0000	0.0000	0.0000	0.0000	36.4609

Table 7.5.1.2 (Cont'd)

Catch Numbers at Age by Area

For Period 2

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1098.00	0.00	0.00	0.00	0.00	46.76	0.00	1144.76
2	1129.00	0.00	0.00	0.00	0.00	48.08	0.00	1177.08
3	909.04	1.85	0.00	0.00	60.52	69.25	0.00	1040.67
4	11077.02	15.49	2.00	0.00	316.90	395.23	0.00	11806.64
5	12964.69	65.34	6.00	0.00	1396.17	321.93	0.00	14754.12
6	69516.94	398.34	69.00	0.00	7987.00	662.42	0.00	78633.70
7	13147.98	58.32	2.00	0.00	1467.68	614.85	0.00	15290.83
8	13874.64	65.78	3.00	0.00	1381.59	213.68	0.00	15538.69
9	18032.75	105.00	20.00	0.00	2092.17	145.41	0.00	20395.33
10	6957.94	40.80	7.00	0.00	822.90	72.00	0.00	7900.64
11	1360.36	7.98	0.00	0.00	158.87	11.00	0.00	1538.21
12	516.19	2.74	4.00	0.00	65.50	24.09	0.00	612.52
13	336.03	1.97	0.00	0.00	43.76	11.00	0.00	392.76
14	1114.29	4.15	0.00	0.00	79.59	0.00	0.00	1198.03
15	698.41	3.04	2.00	0.00	58.26	0.00	0.00	761.71

Mean Weight at Age by Area (Kg)

For Period 2

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0140	0.0000	0.0000	0.0000	0.0000	0.0140	0.0000	0.0140
2	0.0690	0.0000	0.0000	0.0000	0.0000	0.0690	0.0000	0.0690
3	0.1512	0.2380	0.0000	0.0000	0.2508	0.2092	0.0000	0.1610
4	0.1582	0.2450	0.2060	0.0000	0.2504	0.1492	0.0000	0.1605
5	0.2475	0.2600	0.2200	0.0000	0.2703	0.3168	0.0000	0.2512
6	0.2731	0.2740	0.2800	0.0000	0.2777	0.3470	0.0000	0.2742
7	0.2931	0.2800	0.3130	0.0000	0.3174	0.4361	0.0000	0.3012
8	0.3209	0.3060	0.3380	0.0000	0.3183	0.4435	0.0000	0.3223
9	0.3115	0.3120	0.3340	0.0000	0.3152	0.3904	0.0000	0.3125
10	0.3160	0.3160	0.3480	0.0000	0.3197	0.3910	0.0000	0.3171
11	0.3270	0.3270	0.0000	0.0000	0.3343	0.5200	0.0000	0.3291
12	0.3370	0.3390	0.3690	0.0000	0.3644	0.4541	0.0000	0.3448
13	0.3430	0.3430	0.0000	0.0000	0.3706	0.5440	0.0000	0.3517
14	0.3571	0.3440	0.0000	0.0000	0.3440	0.0000	0.0000	0.3562
15	0.3678	0.3510	0.4000	0.0000	0.3510	0.0000	0.0000	0.3665

Mean Length at Age by Area (cm)

For Period 2

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	13.2000	0.0000	0.0000	0.0000	0.0000	13.2000	0.0000	13.2000
2	20.7000	0.0000	0.0000	0.0000	0.0000	20.7000	0.0000	20.7000
3	27.5254	30.2000	0.0000	0.0000	29.9521	28.3237	0.0000	27.7244
4	29.5101	30.5000	28.8000	0.0000	30.6010	29.4641	0.0000	29.5390
5	31.2946	31.3000	29.4000	0.0000	31.4960	32.8090	0.0000	31.3460
6	31.9937	32.0000	31.6000	0.0000	32.0486	33.0329	0.0000	32.0077
7	32.3741	32.3000	32.9000	0.0000	33.1346	35.7861	0.0000	32.5841
8	33.7537	33.6000	34.6000	0.0000	33.8190	36.0799	0.0000	33.7910
9	33.9070	33.9000	33.6000	0.0000	33.9229	34.5149	0.0000	33.9127
10	34.1000	34.1000	33.4000	0.0000	34.1100	34.3000	0.0000	34.1022
11	34.6000	34.6000	0.0000	0.0000	34.7435	38.4000	0.0000	34.6420
12	35.2139	35.1000	35.5000	0.0000	35.4374	36.7567	0.0000	35.2998
13	35.3000	35.3000	0.0000	0.0000	35.8210	39.1000	0.0000	35.4645
14	35.6186	35.4000	0.0000	0.0000	35.4000	0.0000	0.0000	35.6033
15	35.9866	35.6000	36.0000	0.0000	35.6000	0.0000	0.0000	35.9555

Table 7.5.1.2 (Cont'd)

Catch Numbers at Age by Area

For Period 3

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1316.00	0.00	0.00	285.00	0.00	18.44	0.00	1619.44
2	24358.00	6921.61	0.00	748.00	0.00	341.22	0.00	32368.83
3	9136.89	899.97	0.00	72.00	113.00	111.83	0.00	10333.70
4	110794.28	25818.29	0.00	13220.00	1589.00	977.57	11.00	152410.14
5	193726.00	21684.58	0.00	1384.00	5982.00	1012.26	26.00	223814.83
6	513437.69	29542.61	0.00	563.00	52693.00	2058.15	48.00	598342.44
7	61008.92	1216.06	0.00	0.00	8544.00	152.20	18.00	70939.19
8	61666.97	3288.92	0.00	0.00	10845.00	187.90	13.00	76001.79
9	96094.07	1890.98	0.00	0.00	19405.00	321.88	2.00	117713.92
10	41838.91	485.02	0.00	0.00	10345.00	122.84	3.00	52794.77
11	7484.52	0.00	0.00	0.00	596.00	28.42	0.00	8108.94
12	6113.97	0.00	0.00	0.00	444.00	35.30	0.00	6593.28
13	1859.21	0.00	0.00	0.00	240.00	9.19	0.00	2108.40
14	4806.26	0.00	0.00	0.00	802.00	12.69	0.00	5620.95
15	2433.28	0.00	0.00	0.00	1607.00	4.43	0.00	4044.70

Mean Weight at Age by Area (Kg)

For Period 3

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0940	0.0000	0.0000	0.0420	0.0000	0.0940	0.0000	0.0848
2	0.1270	0.1210	0.0000	0.1030	0.0000	0.1270	0.0000	0.1252
3	0.1909	0.1550	0.0000	0.2300	0.2530	0.1860	0.0000	0.1887
4	0.2350	0.2119	0.0000	0.1820	0.2690	0.2180	0.3100	0.2268
5	0.2766	0.2551	0.0000	0.2280	0.2910	0.2620	0.3300	0.2745
6	0.3202	0.2885	0.0000	0.2430	0.3030	0.3190	0.3340	0.3170
7	0.3241	0.3271	0.0000	0.0000	0.3220	0.3080	0.3340	0.3238
8	0.3509	0.3204	0.0000	0.0000	0.3400	0.3600	0.3680	0.3480
9	0.3570	0.3113	0.0000	0.0000	0.3440	0.3660	0.3600	0.3541
10	0.3670	0.3825	0.0000	0.0000	0.3520	0.3810	0.3810	0.3642
11	0.3680	0.0000	0.0000	0.0000	0.3400	0.3660	0.0000	0.3659
12	0.3982	0.0000	0.0000	0.0000	0.4020	0.3930	0.0000	0.3984
13	0.3789	0.0000	0.0000	0.0000	0.3440	0.3770	0.0000	0.3750
14	0.3882	0.0000	0.0000	0.0000	0.3830	0.4100	0.0000	0.3875
15	0.3865	0.0000	0.0000	0.0000	0.3990	0.3910	0.0000	0.3915

Mean Length at Age by Area (cm)

For Period 3

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	15.4000	0.0000	0.0000	18.0000	0.0000	15.4000	0.0000	15.8576
2	21.9000	21.5000	0.0000	23.1000	0.0000	21.9000	0.0000	21.8422
3	27.9688	26.4000	0.0000	29.0000	30.0000	27.9000	0.0000	27.8608
4	30.5614	31.8689	0.0000	26.9000	30.7000	30.9000	30.3000	30.4689
5	31.3660	32.8215	0.0000	28.7000	31.7000	31.9000	31.4000	31.5019
6	32.3457	33.5494	0.0000	29.7000	32.3000	32.9000	31.6000	32.4004
7	32.6461	32.6930	0.0000	0.0000	33.1000	33.7000	31.6000	32.7036
8	33.7594	35.2881	0.0000	0.0000	33.8000	34.6000	33.4000	33.8334
9	34.3756	36.4363	0.0000	0.0000	34.0000	35.7000	33.0000	34.3504
10	34.6501	36.6341	0.0000	0.0000	34.3000	36.6000	34.0000	34.6042
11	35.2139	0.0000	0.0000	0.0000	33.8000	36.2000	0.0000	35.1134
12	35.8985	0.0000	0.0000	0.0000	36.2000	36.6000	0.0000	35.9225
13	36.1293	0.0000	0.0000	0.0000	34.0000	37.1000	0.0000	35.8911
14	36.0541	0.0000	0.0000	0.0000	35.5000	37.7000	0.0000	35.9787
15	36.4158	0.0000	0.0000	0.0000	36.1000	39.4000	0.0000	36.2936

Table 7.5.1.2 (Cont'd)

Catch Numbers at Age by Area

For Period 4

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	37133.88	0.00	0.00	0.00	0.00	0.00	0.00	37133.88
2	89389.25	0.00	0.00	0.00	0.00	0.00	0.00	89389.25
3	15538.18	0.00	0.00	0.00	0.00	0.00	0.00	15538.18
4	300355.91	0.00	0.00	0.00	0.00	0.00	0.00	300355.91
5	204345.17	0.00	0.00	0.00	0.00	0.00	0.00	204345.17
6	687803.56	0.00	0.00	0.00	0.00	0.00	0.00	687803.56
7	50494.79	0.00	0.00	0.00	0.00	0.00	0.00	50494.79
8	83500.23	0.00	0.00	0.00	0.00	0.00	0.00	83500.23
9	218275.91	0.00	0.00	0.00	0.00	0.00	0.00	218275.91
10	142589.88	0.00	0.00	0.00	0.00	0.00	0.00	142589.88
11	5666.78	0.00	0.00	0.00	0.00	0.00	0.00	5666.78
12	12408.67	0.00	0.00	0.00	0.00	0.00	0.00	12408.67
13	9541.83	0.00	0.00	0.00	0.00	0.00	0.00	9541.83
14	8652.47	0.00	0.00	0.00	0.00	0.00	0.00	8652.47
15	32766.51	0.00	0.00	0.00	0.00	0.00	0.00	32766.51

Mean Weight at Age by Area (Kg)

For Period 4

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0235	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0235
2	0.0997	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0997
3	0.1440	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1440
4	0.2150	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2150
5	0.2792	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2792
6	0.3232	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3232
7	0.3438	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3438
8	0.3609	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3609
9	0.3804	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3804
10	0.3874	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3874
11	0.4130	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4130
12	0.4270	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4270
13	0.4176	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4176
14	0.3980	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3980
15	0.4260	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4260

Mean Length at Age by Area (cm)

For Period 4

Ages	IIa	IIb	IVa	Ib	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	15.3286	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	15.3286
2	22.7168	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	22.7168
3	25.7043	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	25.7043
4	29.0364	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	29.0364
5	31.0226	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	31.0226
6	32.2071	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	32.2071
7	33.2094	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	33.2094
8	33.7944	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	33.7944
9	34.1667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	34.1667
10	34.3394	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	34.3394
11	35.4000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	35.4000
12	35.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	35.5000
13	35.5923	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	35.5923
14	35.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	35.0000
15	36.6000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	36.6000

Table 7.5.1.3. Norwegian Spring Spawning Herring; summary of sampling data of the catches in 2008.

Total over all Areas and Periods 2008

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	31128	31128	12	1520	1504	99.85
Faroe Islands	66267	74261	14	960	462	99.98
Germany	0	8338	0	0	0	0
Greenland	0	3810	0	0	0	0
Iceland	165708	217602	89	4067	6334	99.99
Ireland	7903	7903	1	86	86	99.93
Norway	961603	961603	451	46563	20300	100.06
Russia	193035	193119	110	23247	1548	99.99
Scotland	19737	19737	5	617	204	99.91
The Netherlands	16122	28155	40	4549	1000	100.05
Total for the stock	1461503	1545656	722	81609	31438	100.03

Table 7.5.1.4. Norwegian spring spawning herring. Catch in numbers (thousands).

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1950	5112600	2000000	600000	276200	184800	185500	547000	628600	79500	88600	109500	86900	194500	368300	66400	344300
1951	1635500	7607700	400000	6600	383800	172400	164400	515600	602000	77100	82700	103100	107600	253500	348000	352500
1952	13721600	9149700	1232900	39300	60500	602300	136300	204500	380200	377900	79200	85700	107700	106800	186500	564400
1953	5697200	5055000	581300	740100	46600	100900	355600	81900	110900	314100	394900	61700	91200	94100	98800	730400
1954	10675990	7071090	855400	266300	1435500	142900	236000	490300	128100	199800	440400	460700	88400	100600	133000	803200
1955	5175600	2871100	510100	93000	276400	2045100	114300	189600	274700	85300	193400	295600	203200	58700	84600	580600
1956	5363900	2023700	627100	116500	251600	314200	2555100	110000	203900	264200	130700	198300	272800	163300	63000	565100
1957	5001900	3290800	219500	23300	373300	153800	228500	1985300	72000	127300	182500	88400	121200	149300	131600	281400
1958	9666990	2798100	666400	17500	17900	110900	89300	194400	973500	70700	123000	200900	98700	77400	70900	255600
1959	17896280	198530	325500	15100	26800	25900	146600	114800	240700	1103800	88600	124300	198000	88500	77400	235900
1960	12884310	13580790	392500	121700	18200	28100	24400	96200	73300	203900	1163000	85200	129700	153500	56700	168900
1961	6207500	16075600	2884800	31200	8100	4100	15000	19400	61600	49200	136100	728100	49700	45000	63000	60100
1962	3693200	4081100	1041300	1843800	8000	3100	7200	20200	11900	59100	52600	117000	813500	44200	54700	152300
1963	4807000	2119200	2045300	760400	835800	5300	1800	3600	18300	9300	107700	92500	174100	923700	79600	185300
1964	3613000	2728300	220300	114600	399000	2045800	13700	1500	3000	24900	29300	95600	82400	153000	772800	336800
1965	2303000	3780900	2853600	89900	256200	571100	2199700	19500	14900	7400	19100	40000	100500	107800	138700	883100
1966	3926500	662800	1678000	2048700	26900	466600	1306000	2884500	37900	14300	17400	26200	11000	69100	72100	556700
1967	426800	9877100	70400	1392300	3254000	26600	421300	1132000	1720800	8900	5700	3500	8500	8900	17500	104400
1968	1783600	437000	388300	99100	1880500	1387400	14220	94000	134100	345100	2000	1100	830	2500	2600	17000
1969	561200	507100	141900	188200	800	8800	4700	700	11700	33600	36000	300	200	200	200	2400
1970	119300	529400	33200	6300	18600	600	3300	3300	1000	13400	26200	28100	300	100	200	2000
1971	30500	42900	85100	1820	1020	1240	360	1110	1130	360	4410	6910	5450	0	20	120
1972	347100	41000	20400	35376	3476	3583	2481	694	1486	198	0	494	593	593	0	0
1973	29300	3500	1700	2389	25200	651	1506	278	178	0	0	0	0	0	180	0
1974	65900	7800	3900	100	241	24505	257	196	0	0	0	0	0	0	0	0
1975	30600	3600	1800	3268	132	910	30667	5	2	0	0	0	0	0	0	0
1976	20100	2400	1200	23248	5436	0	0	13086	0	0	0	0	0	0	0	0
1977	43000	6200	3100	22103	23595	336	0	419	10766	0	0	0	0	0	0	0
1978	20100	2400	1200	3019	12164	20315	870	0	620	5027	0	0	0	0	0	0
1979	32600	3800	1900	6352	1866	6865	11216	326	0	0	2534	0	0	0	0	0
1980	6900	800	400	6407	5814	2278	8165	15838	441	8	0	2688	0	0	0	0
1981	8300	1100	11900	4166	4591	8596	2200	4512	8280	345	103	114	964	0	0	0
1982	22600	1100	200	13817	7892	4507	6258	1960	5075	6047	121	37	37	121	0	0

Table 7.5.1.4. cont. Norwegian spring spawning herring. Catch in numbers (thousands).

	Age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	127000	4680	1670	3183	21191	9521	6181	6823	1293	4598	7329	143	40	143	860	0
1984	33860	1700	2490	4483	5388	61543	18202	12638	15608	7215	16338	6478	0	0	0	1650
1985	28570	13150	207220	21500	15500	16500	130000	59000	55000	63000	10000	31000	50000	0	0	2640
1986	13810	1380	3090	539785	17594	14500	15500	105000	75000	42000	77000	19469	66000	80000	0	2470
1987	13850	6330	35770	19776	501393	18672	3502	7058	28000	12000	9500	4500	7834	6500	7000	450
1988	15490	2790	9110	62923	25059	550367	9452	3679	5964	14583	8872	2818	3356	2682	1560	540
1989	7120	1930	25200	2890	3623	5650	324290	3469	800	679	3297	1375	679	321	260	0
1990	1020	400	15540	18633	2658	11875	10854	226280	1289	1519	2036	2415	646	179	590	480
1991	100	3370	3330	8438	2780	1410	14698	8867	218851	2499	461	87	690	103	260	540
1992	1630	150	1340	12586	33100	4980	1193	11981	5748	225677	2483	639	247	1236	0	0
1993	6570	130	7240	28408	106866	87269	8625	3648	29603	18631	410110	0	0	0	0	0
1994	430	20	8100	32500	110090	363920	164800	15580	8140	37330	35660	645410	2830	460	100	2070
1995	0	0	1130	57590	346460	622810	637840	231090	15510	15850	69750	83740	911880	4070	250	450
1996	0	0	30140	34360	713620	1571000	940580	406280	103410	5680	7370	66090	17570	836550	0	0
1997	0	0	21820	130450	270950	1795780	1993620	761210	326490	60870	20020	32400	90520	19120	370330	300
1998	0	0	82891	70323	242365	368310	1760319	1263750	381482	129971	42502	25343	3478	112604	5633	108514
1999	0	0	5029	137626	35820	134813	429433	1604959	1164263	291394	106005	14524	40040	7202	88598	63983
2000	0	0	14395	84016	560379	34933	110719	404460	1299253	1045001	216980	71589	16260	22701	23321	71811
2001	0	0	2076	102293	160678	426822	38749	95991	296460	839136	507106	73673	23722	3505	3356	22164
2002	0	0	62031	198360	643161	255516	326495	29843	93530	264675	663059	339326	52922	12437	7000	10087
2003	0	3461	4524	75243	323958	730468	175878	167776	22866	74494	217108	567253	219097	38555	8111	6192
2004	125	1846	43800	24299	92300	429510	714433	111022	137940	26656	52467	169196	401564	210547	28028	11883
2005	0	442	20411	447788	94206	170547	643600	930309	121856	123291	37967	65289	139331	344822	126879	15697
2006	0	1968	45438	75824	729898	82107	171370	726041	772217	88701	77115	30339	57882	133665	142240	49128
2007	0	4475	8450	224636	366983	1804495	152916	242923	728836	511664	47215	25384	15316	24488	64755	58465
2008	0	39898	123949	36630	550274	670681	2295912	199592	256132	586583	369620	29633	36025	23775	25195	63176

Table 7.5.4.1. Norwegian spring spawning herring. Weight at age in the catch (kg).

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1950	0.007	0.025	0.058	0.110	0.188	0.211	0.234	0.253	0.266	0.280	0.294	0.303	0.312	0.32	0.323	0.334
1951	0.009	0.029	0.068	0.130	0.222	0.249	0.276	0.298	0.314	0.330	0.346	0.357	0.368	0.377	0.381	0.394
1952	0.008	0.026	0.061	0.115	0.197	0.221	0.245	0.265	0.279	0.293	0.308	0.317	0.327	0.335	0.339	0.349
1953	0.008	0.027	0.063	0.120	0.205	0.230	0.255	0.275	0.290	0.305	0.320	0.330	0.34	0.347	0.351	0.363
1954	0.008	0.026	0.062	0.117	0.201	0.225	0.250	0.269	0.284	0.299	0.313	0.323	0.333	0.341	0.345	0.356
1955	0.008	0.027	0.063	0.119	0.204	0.229	0.254	0.274	0.289	0.304	0.318	0.328	0.338	0.346	0.350	0.362
1956	0.008	0.028	0.066	0.126	0.215	0.241	0.268	0.289	0.304	0.320	0.336	0.346	0.357	0.365	0.369	0.382
1957	0.008	0.028	0.066	0.127	0.216	0.243	0.269	0.290	0.306	0.322	0.338	0.348	0.359	0.367	0.371	0.384
1958	0.009	0.030	0.070	0.133	0.227	0.255	0.283	0.305	0.321	0.338	0.355	0.366	0.377	0.386	0.390	0.403
1959	0.009	0.030	0.071	0.135	0.231	0.259	0.287	0.310	0.327	0.344	0.360	0.372	0.383	0.392	0.397	0.409
1960	0.006	0.011	0.074	0.119	0.188	0.277	0.337	0.318	0.363	0.379	0.360	0.420	0.411	0.439	0.450	0.447
1961	0.006	0.010	0.045	0.087	0.159	0.276	0.322	0.372	0.363	0.393	0.407	0.397	0.422	0.447	0.465	0.452
1962	0.009	0.023	0.055	0.085	0.148	0.288	0.333	0.360	0.352	0.350	0.374	0.384	0.374	0.394	0.399	0.414
1963	0.008	0.026	0.047	0.098	0.171	0.275	0.268	0.323	0.329	0.336	0.341	0.358	0.385	0.353	0.381	0.386
1964	0.009	0.024	0.059	0.139	0.219	0.239	0.298	0.295	0.339	0.350	0.358	0.351	0.367	0.375	0.372	0.433
1965	0.009	0.016	0.048	0.089	0.217	0.234	0.262	0.331	0.360	0.367	0.386	0.395	0.393	0.404	0.401	0.431
1966	0.008	0.017	0.040	0.063	0.246	0.260	0.265	0.301	0.410	0.425	0.456	0.460	0.467	0.446	0.459	0.472
1967	0.009	0.015	0.036	0.066	0.093	0.305	0.305	0.310	0.333	0.359	0.413	0.446	0.401	0.408	0.439	0.430
1968	0.010	0.027	0.049	0.075	0.108	0.158	0.375	0.383	0.364	0.382	0.441	0.410		0.517	0.491	0.485
1969	0.009	0.021	0.047	0.072		0.152	0.296		0.329	0.329	0.341					0.429
1970	0.008	0.058	0.085	0.105	0.171		0.216	0.277	0.298	0.304	0.305	0.309				0.376
1971	0.011	0.053	0.121	0.177	0.216	0.250		0.305	0.333		0.366	0.377	0.388			
1972	0.011	0.029	0.062	0.103	0.154	0.215	0.258		0.322							
1973	0.006	0.053	0.106	0.161	0.213		0.255									
1974	0.006	0.055	0.117			0.249										
1975	0.009	0.079	0.169	0.241			0.381									
1976	0.007	0.062	0.132	0.189	0.250			0.323								
1977	0.011	0.091	0.193	0.316	0.350				0.511							
1978	0.012	0.100	0.210	0.274	0.424	0.454				0.613						
1979	0.010	0.088	0.181	0.293	0.359	0.416	0.436				0.553					
1980	0.012			0.266	0.399	0.449	0.460	0.485				0.608				
1981	0.010	0.082	0.163	0.196	0.291	0.341	0.368	0.380	0.397							
1982	0.010	0.087	0.159	0.256	0.312	0.378	0.415	0.435	0.449	0.448						

Table 7.5.4.1. cont. Norwegian spring spawning herring. Weight at age in the catch (kg).

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	0.011	0.090	0.165	0.217	0.265	0.337	0.378	0.410	0.426	0.435	0.444					
1984	0.009	0.047	0.145	0.218	0.262	0.325	0.346	0.381	0.400	0.413	0.405	0.426				0.415
1985	0.009	0.022	0.022	0.214	0.277	0.295	0.338	0.360	0.381	0.397	0.409	0.417	0.435			0.435
1986	0.007	0.077	0.097	0.055	0.249	0.294	0.312	0.352	0.374	0.398	0.402	0.401	0.410	0.410		0.410
1987	0.010	0.075	0.091	0.124	0.173	0.253	0.232	0.312	0.328	0.349	0.353	0.370	0.385	0.385	0.385	
1988	0.008	0.062	0.075	0.124	0.154	0.194	0.241	0.265	0.304	0.305	0.317	0.308	0.334	0.334	0.334	
1989	0.010	0.060	0.204	0.188	0.264	0.260	0.282	0.306			0.422	0.364				
1990	0.007		0.102	0.230	0.239	0.266	0.305	0.308	0.376	0.407	0.412	0.424				
1991		0.015	0.104	0.208	0.250	0.288	0.312	0.316	0.330	0.344						
1992	0.007		0.103	0.191	0.233	0.304	0.337	0.365	0.361	0.371	0.403			0.404		
1993	0.007		0.106	0.153	0.243	0.282	0.320	0.330	0.365	0.373	0.379					
1994			0.102	0.194	0.239	0.280	0.317	0.328	0.356	0.372	0.390	0.379	0.399	0.403		
1995			0.102	0.153	0.192	0.234	0.283	0.328	0.349	0.356	0.374	0.366	0.393	0.387		
1996			0.136	0.136	0.168	0.206	0.262	0.309	0.337	0.366	0.360	0.361	0.367	0.379		
1997			0.089	0.167	0.184	0.207	0.232	0.277	0.305	0.331	0.328	0.344	0.343	0.397	0.357	
1998			0.111	0.150	0.216	0.221	0.249	0.277	0.316	0.338	0.374	0.372	0.366	0.396	0.377	0.406
1999			0.096	0.173	0.228	0.262	0.274	0.292	0.307	0.335	0.362	0.371	0.399	0.396	0.400	0.404
2000			0.124	0.175	0.222	0.242	0.289	0.303	0.310	0.328	0.349	0.383	0.411	0.410	0.419	0.409
2001			0.105	0.166	0.214	0.252	0.268	0.305	0.308	0.322	0.337	0.363	0.353	0.378	0.400	0.427
2002			0.056	0.128	0.198	0.255	0.281	0.303	0.322	0.323	0.334	0.345	0.369	0.407	0.410	0.435
2003		0.062	0.068	0.169	0.218	0.257	0.288	0.316	0.323	0.348	0.354	0.351	0.363	0.372	0.376	0.429
2004	0.022	0.066	0.143	0.18	0.227	0.26	0.29	0.323	0.355	0.375	0.383	0.399	0.395	0.405	0.429	0.439
2005		0.092	0.106	0.181	0.235	0.266	0.290	0.315	0.344	0.367	0.384	0.372	0.384	0.398	0.402	0.413
2006		0.055	0.102	0.171	0.238	0.268	0.292	0.311	0.330	0.365	0.374	0.376	0.388	0.396	0.398	0.407
2007	0.000	0.074	0.137	0.162	0.228	0.271	0.316	0.332	0.342	0.358	0.361	0.381	0.390	0.400	0.405	0.399
2008	0.000	0.026	0.106	0.145	0.209	0.254	0.296	0.318	0.341	0.353	0.363	0.367	0.395	0.396	0.386	0.413

Table 7.5.4.2. Norwegian spring spawning herring. Weight at age in the stock (kg).

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1950	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1951	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1952	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1953	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1954	0.001	0.008	0.047	0.100	0.204	0.230	0.255	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1955	0.001	0.008	0.047	0.100	0.195	0.213	0.260	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1956	0.001	0.008	0.047	0.100	0.205	0.230	0.249	0.275	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1957	0.001	0.008	0.047	0.100	0.136	0.228	0.255	0.262	0.290	0.305	0.315	0.325	0.330	0.340	0.345	0.364
1958	0.001	0.008	0.047	0.100	0.204	0.242	0.292	0.295	0.293	0.305	0.315	0.330	0.340	0.345	0.352	0.363
1959	0.001	0.008	0.047	0.100	0.204	0.252	0.260	0.290	0.300	0.305	0.315	0.325	0.330	0.340	0.345	0.358
1960	0.001	0.008	0.047	0.100	0.204	0.270	0.291	0.293	0.321	0.318	0.320	0.344	0.349	0.370	0.379	0.378
1961	0.001	0.008	0.047	0.100	0.232	0.250	0.292	0.302	0.304	0.323	0.322	0.321	0.344	0.357	0.363	0.368
1962	0.001	0.008	0.047	0.100	0.219	0.291	0.300	0.316	0.324	0.326	0.335	0.338	0.334	0.347	0.354	0.358
1963	0.001	0.008	0.047	0.100	0.185	0.253	0.294	0.312	0.329	0.327	0.334	0.341	0.349	0.341	0.358	0.375
1964	0.001	0.008	0.047	0.100	0.194	0.213	0.264	0.317	0.363	0.353	0.349	0.354	0.357	0.359	0.365	0.402
1965	0.001	0.008	0.047	0.100	0.186	0.199	0.236	0.260	0.363	0.350	0.370	0.360	0.378	0.387	0.390	0.394
1966	0.001	0.008	0.047	0.100	0.185	0.219	0.222	0.249	0.306	0.354	0.377	0.391	0.379	0.378	0.361	0.383
1967	0.001	0.008	0.047	0.100	0.180	0.228	0.269	0.270	0.294	0.324	0.420	0.430	0.366	0.368	0.433	0.414
1968	0.001	0.008	0.047	0.100	0.115	0.206	0.266	0.275	0.274	0.285	0.350	0.325	0.363	0.408	0.388	0.378
1969	0.001	0.008	0.047	0.100	0.115	0.145	0.270	0.300	0.306	0.308	0.318	0.340	0.368	0.360	0.393	0.397
1970	0.001	0.008	0.047	0.100	0.209	0.272	0.230	0.295	0.317	0.323	0.325	0.329	0.380	0.370	0.380	0.391
1971	0.001	0.015	0.080	0.100	0.190	0.225	0.250	0.275	0.290	0.310	0.325	0.335	0.345	0.355	0.365	0.390
1972	0.001	0.010	0.070	0.150	0.150	0.140	0.210	0.240	0.270	0.300	0.325	0.335	0.345	0.355	0.365	0.390
1973	0.001	0.010	0.085	0.170	0.259	0.342	0.384	0.409	0.404	0.461	0.520	0.534	0.500	0.500	0.500	0.500
1974	0.001	0.010	0.085	0.170	0.259	0.342	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1975	0.001	0.010	0.085	0.181	0.259	0.342	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1976	0.001	0.010	0.085	0.181	0.259	0.342	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1977	0.001	0.010	0.085	0.181	0.259	0.343	0.384	0.409	0.444	0.461	0.520	0.543	0.482	0.482	0.482	0.482
1978	0.001	0.010	0.085	0.180	0.294	0.326	0.371	0.409	0.461	0.476	0.520	0.543	0.500	0.500	0.500	0.500
1979	0.001	0.010	0.085	0.178	0.232	0.359	0.385	0.420	0.444	0.505	0.520	0.551	0.500	0.500	0.500	0.500
1980	0.001	0.010	0.085	0.175	0.283	0.347	0.402	0.421	0.465	0.465	0.520	0.534	0.500	0.500	0.500	0.500
1981	0.001	0.010	0.085	0.170	0.224	0.336	0.378	0.387	0.408	0.397	0.520	0.543	0.512	0.512	0.512	0.512
1982	0.001	0.010	0.085	0.170	0.204	0.303	0.355	0.383	0.395	0.413	0.453	0.468	0.506	0.506	0.506	0.506

Table 7.5.4.2. cont. Norwegian spring spawning herring. Weight at age in the stock (kg).

	age														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1983	0.001	0.010	0.085	0.155	0.249	0.304	0.368	0.404	0.424	0.437	0.436	0.493	0.495	0.495	0.495	0.495
1984	0.001	0.010	0.085	0.140	0.204	0.295	0.338	0.376	0.395	0.407	0.413	0.422	0.437	0.437	0.437	0.437
1985	0.001	0.010	0.085	0.148	0.234	0.265	0.312	0.346	0.370	0.395	0.397	0.428	0.428	0.428	0.428	0.428
1986	0.001	0.010	0.085	0.054	0.206	0.265	0.289	0.339	0.368	0.391	0.382	0.388	0.395	0.395	0.395	0.395
1987	0.001	0.010	0.055	0.090	0.143	0.241	0.279	0.299	0.316	0.342	0.343	0.362	0.376	0.376	0.376	0.376
1988	0.001	0.015	0.050	0.098	0.135	0.197	0.277	0.315	0.339	0.343	0.359	0.365	0.376	0.376	0.376	0.376
1989	0.001	0.015	0.100	0.154	0.175	0.209	0.252	0.305	0.367	0.377	0.359	0.395	0.396	0.396	0.396	0.396
1990	0.001	0.008	0.048	0.219	0.198	0.258	0.288	0.309	0.428	0.370	0.403	0.387	0.440	0.440	0.440	0.44
1991	0.001	0.011	0.037	0.147	0.210	0.244	0.300	0.324	0.336	0.343	0.382	0.366	0.425	0.425	0.425	0.425
1992	0.001	0.007	0.030	0.128	0.224	0.296	0.327	0.355	0.345	0.367	0.341	0.361	0.430	0.470	0.470	0.46
1993	0.001	0.008	0.025	0.081	0.201	0.265	0.323	0.354	0.358	0.381	0.369	0.396	0.393	0.374	0.403	0.4
1994	0.001	0.010	0.025	0.075	0.151	0.254	0.318	0.371	0.347	0.412	0.382	0.407	0.410	0.410	0.410	0.41
1995	0.001	0.018	0.025	0.066	0.138	0.230	0.296	0.346	0.388	0.363	0.409	0.414	0.422	0.410	0.410	0.426
1996	0.001	0.018	0.025	0.076	0.118	0.188	0.261	0.316	0.346	0.374	0.390	0.390	0.384	0.398	0.398	0.398
1997	0.001	0.018	0.025	0.096	0.118	0.174	0.229	0.286	0.323	0.370	0.378	0.386	0.360	0.393	0.391	0.391
1998	0.001	0.018	0.025	0.074	0.147	0.174	0.217	0.242	0.278	0.304	0.310	0.359	0.340	0.344	0.385	0.369
1999	0.001	0.018	0.025	0.102	0.150	0.223	0.240	0.264	0.283	0.315	0.345	0.386	0.386	0.386	0.382	0.395
2000*	0.001	0.018	0.025	0.119	0.178	0.225	0.271	0.285	0.298	0.311	0.339	0.390	0.398	0.406	0.414	0.427
2001	0.001	0.018	0.025	0.075	0.178	0.238	0.247	0.296	0.307	0.314	0.328	0.351	0.376	0.406	0.414	0.425
2002	0.001	0.010	0.023	0.057	0.177	0.241	0.275	0.302	0.311	0.314	0.328	0.341	0.372	0.405	0.415	0.438
2003	0.001	0.010	0.055	0.098	0.159	0.211	0.272	0.305	0.292	0.331	0.337	0.347	0.356	0.381	0.414	0.433
2004	0.001	0.010	0.055	0.106	0.149	0.212	0.241	0.279	0.302	0.337	0.354	0.355	0.360	0.371	0.400	0.429
2005	0.001	0.010	0.046	0.112	0.156	0.234	0.267	0.295	0.330	0.363	0.377	0.414	0.406	0.308	0.420	0.452
2006	0.001	0.010	0.042	0.107	0.179	0.232	0.272	0.297	0.318	0.371	0.365	0.393	0.395	0.399	0.415	0.428
2007	0.001	0.010	0.036	0.086	0.155	0.226	0.265	0.312	0.310	0.364	0.384	0.352	0.386	0.304	0.420	0.412
2008**	0.001	0.010	0.044	0.077	0.146	0.212	0.269	0.289	0.327	0.351	0.358	0.372	0.411	0.353	0.389	0.393
2009***	0.001	0.010	0.044	0.077	0.141	0.215	0.270	0.306	0.336	0.346	0.364	0.369	0.411	0.353	0.389	0.393

***values in 2000 changed to values in the report from 2000.**

**** mean weight at ages 11 and 13 are mean of 5 previous years at the same age. These age groups were not existent in the wintering survey from which the stock weight are derived.**

***** derived from catch data from the wintering area north of 69°N during December 2008 – January 2009 for age groups 4-11**

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Table 7.5.7.4.1. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. No survey in 2003, 1990-2002. See footnotes. Data in black box used. ***Survey 4.***

	survey 4		age		
Year	1	2	3	4	5
1991	24.3	5.2			
1992	32.6	14	5.7		
1993	102.7	25.8	1.5		
1994	6.6	59.2	18	1.7	
1995	0.5	7.7	8	1.1	
1996[1]	0.1	0.25	1.8	0.6	0.03
1997[2]	2.6	0.04	0.4	0.35	0.05
1998	9.5	4.7	0.01	0.01	0
1999	49.5	4.9	0	0	0
2000	105.4	27.9	0	0	0
2001	0.3	7.6	8.8	0	0
2002	0.5	3.9	0	0	0
2003[3]					
2004[3]					
2005	23.3	4.5	2.5	0.4	0.3
2006	3.7	35.0	5.3	0.87	0
2007	2.1	3.7	12.5	1.9	0
2008[4]	0.043	0.38	0.2	0.28	0
2009	0.19	0.47	0.67	0.39	0.41

[1] **Average of Norwegian and Russian estimates**

[2] **Combination of Norwegian and Russian estimates as described in 1998 WG report, since then only Russian estimates**

[3] **No surveys**

[4] **Not a full survey**

Table 7.5.7.4.2. Norwegian spring spawning herring. Estimates from the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions. Biomass in thousands. Biomass in thousands. Data in black box are used in assessment. There have been corrections due to age readings. *Survey 5*.

	survey 5							Age								Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	Biomass
1996	0	0	4114	22461	13244	4916	2045	424	14	7	155	0	3134			50514	8532
1997	0	0	1169	3599	18867	13546	2473	1771	178	77	288	190	60	2697		44915	9435
1998	24	1404	367	1099	4410	16378	10160	2059	804	183	0	0	35	0	492	37415	8004
1999	0	215	2191	322	965	3067	11763	6077	853	258	5	14	0	158	128	26016	6299
2000	0	157	1353	2783	92	384	1302	7194	5344	1689	271	0	114	0	75	20758	6001
2001	0	1540	8312	1430	1463	179	204	3215	5433	1220	94	178	0	0	6	23274	3937
2002	0	677	6343	9619	1418	779	375	847	1941	2500	1423	61	78	28	0	26089	4628
2003	32073	8115	6561	9985	9961	1499	732	146	228	1865	2359	1769		287	0	75580	6653
2004	0	13735	1543	5227	12571	10710	1075	580	76	313	362	1294	1120	10	88	48704	7687
2005	0	1293	19679	1353	1765	6205	5371	651	388	139	262	526	1003	364	115	39114	5109
2006	0	19	306	14560	1396	2011	6521	6978	679	713	173	407	921	618	243	35545	9100
2007	0	411	2889	5877	20292	1260	1992	6780	5582	647	488	372	403	1048	1010	49051	12161
2008	0	1193	587	8332	8270	16345	1381	1920	3958	2500	416	242	159	217	408	45928	9996
2009	0	410	2316	2314	13545	8937	12025	1335	1334	2696	1488	208	175	65	232	47080	10406

Table 7.5.7.5.1. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in August-October. Data in black boxes used in the assessment. ***Survey 6.***

SURVEY 6			
	AGE		
YEAR	1	2	3
2000	14.7	11.5	0
2001	0.5	10.5	1.7
2002	1.3	0	0
2003	99.9	4.3	2.5
2004	14.3	36.5	0.9
2005	46.4	16.1	7.0
2006	1.6	5.5	1.3
2007	3.9	2.6	6.3
2008	0.03	1.62	3.99

Table 7.5.7.5.2. Norwegian spring-spawning herring. Abundance indices for 0-group herring since 1980 in the Barents Sea, August-October. *This index has been recalculated since 2006, these are the new values. Survey 7.*

Survey 7	
Year	Abundance index
1980	4
1981	3
1982	202
1983	40557
1984	6313
1985	7237
1986	7
1987	2
1988	8686
1989	4196
1990	9508
1991	81175
1992	37183
1993	61508
1994	14884
1995	1308
1996	57169
1997	45808
1998	79492
1999	15931
2000	49614
2001	844
2002	23354
2003	28579
2004	133350
2005	26332
2006	66819
2007	22481
2008	15727

Table 7.5.7.6.1. Norwegian Spring-spawning herring. The indices for herring larvae on the Norwegian shelf for the period 1981-2007 (N*10^-12^). Data in black box are used in the assessment. *Survey 8.*

Survey 8		
Year	Index1	Index 2
1981	0.3	
1982	0.7	
1983	2.5	
1984	1.4	
1985	2.3	
1986	1	
1987	1.3	4
1988	9.2	25.5
1989	13.4	28.7
1990	18.3	29.2
1991	8.6	23.5
1992	6.3	27.8
1993	24.7	78
1994	19.5	48.6
1995	18.2	36.3
1996	27.7	81.7
1997	66.6	147.5
1998	42.4	138.6
1999	19.9	73
2000	19.8	89.4
2001	40.7	135.9
2002	27.1	138.6
2003*	3.7	18.8
2004	56.4	215.1
2005	73.91	196.7
2006	98.9	389.0
2007**	90.6	
2008	107.9	393.3
2009	8.4	53.8

Index 1. The total number of herring larvae found during the cruise.

Index 2. Back-calculated number of newly hatched larvae with 10% daily moratlity. The larval age is estimated from the duration of the yolksac stages and the size of the larvae.

*** Poor weather conditions and survey was late in April**

**** only representative for the area 62-66°N**

Table 7.7.2.1. Norwegian spring-spawning herring. The stock summary of the exploratory TISVPA run.

Year	B(0+)	SSB	R(0)	F(5-14) w-d
1986	2122.93	473	16009.86	0.903
1987	3736.65	994	11580.8	0.230
1988	4099.55	3050	27145.53	0.040
1989	4905.62	3806	70425.44	0.025
1990	5560.59	4389	137365.09	0.018
1991	6318.62	4623	370704.94	0.019
1992	7512.27	4505	415721.27	0.022
1993	8685.35	4280	140271.42	0.052
1994	10002.89	4809	46131.5	0.110
1995	11037.15	5877	22088.68	0.184
1996	11234.67	7784	59910.04	0.153
1997	11232.98	9357	34494.04	0.147
1998	9842.38	8656	199373.13	0.123
1999	10788.28	8391	219451.54	0.145
2000	10493.95	7273	80958.85	0.160
2001	8888.45	6036	54112.33	0.135
2002	9097.93	5632	644908.99	0.145
2003	11793.55	6352	209176.89	0.118
2004	15186.26	7116	270840.07	0.095
2005	15302.08	7770	44767.33	0.126
2006	17190.56	12212	692866.42	0.129
2007	20791.55	12434	2406522.02	0.088
2008		12998		0.110
2009		13390		

Table 7.7.3.1. Norwegian spring spawning herring. Stock in numbers (billions).

	AGE															
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1988	25.724	3.882	1.765	3.060	0.693	15.018	0.046	0.013	0.013	0.027	0.012	0.011	0.011	0.006	0.004	0.001
1989	73.988	10.449	1.576	0.712	2.575	0.574	12.415	0.030	0.008	0.006	0.010	0.002	0.007	0.007	0.002	0.002
1990	109.706	30.077	4.247	0.625	0.610	2.213	0.488	10.385	0.023	0.006	0.004	0.005	0.001	0.005	0.005	0.003
1991	320.876	44.602	12.228	1.717	0.521	0.522	1.894	0.410	8.729	0.019	0.004	0.002	0.002	0.000	0.004	0.007
1992	383.922	130.458	18.132	4.970	1.470	0.445	0.448	1.616	0.345	7.310	0.014	0.003	0.002	0.001	0.000	0.009
1993	121.890	156.090	53.040	7.371	4.266	1.234	0.379	0.385	1.380	0.292	6.082	0.010	0.002	0.001	0.000	0.008
1994	42.242	49.553	63.461	21.560	6.318	3.572	0.982	0.318	0.328	1.160	0.234	4.854	0.008	0.002	0.001	0.006
1995	18.644	17.174	20.147	25.796	18.527	5.336	2.737	0.692	0.259	0.275	0.964	0.168	3.580	0.004	0.001	0.005
1996	57.789	7.580	6.983	8.190	22.150	15.625	4.015	1.764	0.381	0.209	0.222	0.765	0.067	2.235	0.000	0.004
1997	50.576	23.495	3.082	2.820	7.018	18.402	11.991	2.583	1.141	0.232	0.174	0.184	0.597	0.041	1.148	0.003
1998	282.408	20.563	9.553	1.239	2.306	5.789	14.173	8.471	1.517	0.680	0.143	0.132	0.128	0.430	0.018	0.646
1999	227.357	114.818	8.360	3.831	1.001	1.760	4.641	10.566	6.119	0.952	0.464	0.084	0.090	0.107	0.266	0.377
2000	54.031	92.436	46.682	3.396	3.170	0.829	1.390	3.596	7.605	4.186	0.549	0.301	0.059	0.040	0.086	0.356
2001	35.695	21.967	37.582	18.970	2.845	2.208	0.681	1.093	2.720	5.340	2.634	0.271	0.193	0.036	0.013	0.269
2002	568.142	14.513	8.931	15.278	16.233	2.300	1.505	0.550	0.852	2.066	3.818	1.796	0.165	0.144	0.027	0.178
2003	185.261	230.989	5.900	3.592	12.966	13.375	1.742	0.992	0.446	0.647	1.533	2.671	1.231	0.093	0.112	0.128
2004	344.513	75.322	93.911	2.396	3.022	10.860	10.834	1.336	0.698	0.362	0.487	1.118	1.773	0.857	0.044	0.191
2005	53.537	140.069	30.622	38.154	2.040	2.515	8.948	8.662	1.047	0.473	0.287	0.371	0.805	1.153	0.542	0.064
2006	63.061	21.766	56.947	12.437	32.424	1.668	2.007	7.105	6.593	0.788	0.293	0.212	0.259	0.564	0.673	0.390
2007	6.443	25.639	8.848	23.124	10.634	27.230	1.360	1.568	5.442	4.958	0.596	0.181	0.154	0.169	0.361	0.706
2008	10.817	2.620	10.421	3.592	19.695	8.813	21.763	1.028	1.124	4.008	3.793	0.469	0.132	0.119	0.123	0.741
2009	1.000	4.398	1.040	4.158	3.058	16.441	6.963	16.602	0.700	0.730	2.905	2.922	0.377	0.080	0.080	0.579

Table 7.7.3.2. Norwegian spring spawning herring. Fishing mortality.

	AGE															
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1988	0.001	0.001	0.008	0.022	0.040	0.040	0.253	0.351	0.678	0.875	1.475	0.320	0.385	0.715	0.654	0.654
1989	0.000	0.000	0.025	0.004	0.002	0.011	0.029	0.131	0.112	0.137	0.458	0.934	0.111	0.054	0.125	0.125
1990	0.000	0.000	0.006	0.033	0.005	0.006	0.024	0.024	0.062	0.304	0.718	0.682	1.856	0.037	0.125	0.125
1991	0.000	0.000	0.000	0.005	0.006	0.003	0.008	0.024	0.027	0.157	0.134	0.054	0.392	-1.000	0.065	0.065
1992	0.000	0.000	0.000	0.003	0.025	0.012	0.003	0.008	0.018	0.034	0.218	0.262	0.200	-1.000	0.022	0.022
1993	0.000	0.000	0.000	0.004	0.027	0.079	0.025	0.010	0.023	0.071	0.076	0.000	0.000	0.000	0.062	0.062
1994	0.000	0.000	0.000	0.002	0.019	0.116	0.200	0.054	0.027	0.035	0.180	0.155	0.469	0.343	0.129	0.129
1995	0.000	0.000	0.000	0.002	0.020	0.135	0.289	0.446	0.067	0.064	0.081	0.771	0.321	-1.000	0.298	0.298
1996	0.000	0.000	0.007	0.005	0.035	0.115	0.291	0.285	0.346	0.030	0.037	0.098	0.333	0.517	0.317	0.317
1997	0.000	0.000	0.011	0.051	0.043	0.111	0.198	0.382	0.369	0.332	0.132	0.211	0.178	0.691	0.428	0.428
1998	0.000	0.000	0.014	0.063	0.120	0.071	0.144	0.175	0.316	0.231	0.385	0.233	0.030	0.332	0.414	0.414
1999	0.000	0.000	0.001	0.040	0.039	0.086	0.105	0.179	0.230	0.401	0.283	0.207	0.656	0.075	0.442	0.442
2000	0.000	0.000	0.001	0.027	0.211	0.047	0.090	0.129	0.204	0.313	0.555	0.296	0.354	0.944	0.346	0.346
2001	0.000	0.000	0.000	0.006	0.063	0.234	0.063	0.099	0.125	0.186	0.233	0.347	0.142	0.113	0.312	0.312
2002	0.000	0.000	0.011	0.014	0.044	0.128	0.266	0.060	0.126	0.149	0.207	0.228	0.424	0.098	0.322	0.322
2003	0.000	0.000	0.001	0.023	0.027	0.061	0.115	0.201	0.057	0.133	0.166	0.260	0.213	0.593	0.081	0.081
2004	0.000	0.000	0.001	0.011	0.034	0.044	0.074	0.094	0.239	0.083	0.123	0.178	0.280	0.308	1.152	1.152
2005	0.000	0.000	0.001	0.013	0.051	0.076	0.081	0.123	0.134	0.330	0.154	0.211	0.207	0.389	0.291	0.291
2006	0.000	0.000	0.001	0.007	0.025	0.055	0.097	0.117	0.135	0.129	0.334	0.168	0.276	0.295	0.259	0.259
2007	0.000	0.000	0.002	0.011	0.038	0.074	0.129	0.183	0.156	0.118	0.089	0.164	0.113	0.170	0.215	0.215
2008	0.000	0.024	0.019	0.011	0.031	0.086	0.121	0.235	0.282	0.172	0.111	0.071	0.349	0.244	0.250	0.250

Negative fishing mortality -1 means that the fishing mortality was not defined, see TASACS manual

Table 7.7.3.4 Norwegian spring spawning herring. Stock summary table. Run id: 20090922 130130.296

	RECRUITMENT AGE 0 IN YEAR	TOTAL BIOMASS	SPAWNING STOCK BIOMASS	LANDINGS	WEIGHTED F
YEAR	BILLIONS	MILLION TONS	MILLION TONS	THOUS. TONS	5-14
1988	25.724	3.571	2.768	135	0.045
1989	73.988	4.223	3.409	104	0.029
1990	109.706	4.755	3.702	86	0.022
1991	320.876	5.401	3.877	85	0.023
1992	383.922	6.471	3.767	104	0.027
1993	121.890	7.594	3.641	232	0.064
1994	42.242	8.696	4.122	479	0.129
1995	18.644	9.545	4.976	906	0.229
1996	57.789	9.659	6.545	1220	0.192
1997	50.576	9.608	7.887	1427	0.180
1998	282.408	8.611	7.290	1223	0.153
1999	227.357	9.890	6.852	1235	0.186
2000	54.031	9.540	5.837	1207	0.213
2001	35.695	7.995	4.794	766	0.180
2002	568.142	8.784	4.928	808	0.184
2003	185.261	11.195	6.298	790	0.114
2004	344.513	14.211	7.149	794	0.094
2005	53.537	14.705	7.715	1003	0.128
2006*	63.061	16.202	11.580	969	0.131
2007**	6.443	15.559	11.836	1267	0.098
2008***	10.817	15.409	12.437	1546	0.125
2009***		14.402	13.335		

*** Recruitment value has been replaced in the forecast by RCT estimate: 90.770**

**** Recruitment value has been replaced in the forecast by RCT estimate: 30.990**

***** Recruitment value has been replaced in the forecast by GM mean 1989-2005**

Table 7.10.1.1. Norwegian spring spawning herring. Input file for RCT3.

NSSH:	VPA and acoustic survey					
5	23	2				
'Yearcl'	'VPAage2'	'Sur70'	'Sur41'	'Sur42'	'sur61'	'sur62'
1986	1.7646	7	-11	-11	-11	-11
1987	1.5763	2	-11	-11	-11	-11
1988	4.2469	8686	-11	-11	-11	-11
1989	12.2281	4196	-11	5.2	-11	-11
1990	18.1318	9508	24.3	14	-11	-11
1991	53.0403	81175	32.6	25.8	-11	-11
1992	63.4613	37183	102.7	59.2	-11	-11
1993	20.1466	61508	6.6	7.7	-11	-11
1994	6.9825	14884	0.5	0.25	-11	-11
1995	3.0818	1308	0.1	0.04	-11	-11
1996	9.5525	57169	2.6	4.7	-11	-11
1997	8.3601	45808	9.5	4.9	-11	-11
1998	46.6817	79492	49.5	27.9	-11	11.5
1999	37.5818	15931	-11	7.6	14.7	10.5
2000	8.9312	49614	0.3	3.9	0.5	-11
2001	5.9004	844	0.5	-11	-11	4.3
2002	93.911	23354	-11	-11	99.9	36.5
2003	30.6223	28579	-11	4.5	14.3	16.1
2004	56.9473	133350	23.3	35	46.4	5.5
2005	8.8483	26332	3.7	3.7	1.6	2.6
2006	10.421	66819	2.1	-11	3.9	1.62
2007	-11	22481	-11	0.47	0.03	-11
2008	-11	15727	0.19	-11	-11	-11

Table 7.10.1.2. Norwegian spring-spawning herring. Output from RCT3

```
 Analysis by RCT3 ver3.1 of data from file :

 nsshrct3.csv

 NSSH:,VPA,and,acoustic,survey,data,

 Data for    5 surveys over   23 years :  1986 - 2008

 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+                                                    included
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   2005

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Sur70      .52  -1.92   1.08   .527     19  10.18    3.34    1.180     .021
 Sur41      .66   1.48    .46   .825     12   1.55    2.50     .528     .107
 Sur42      .83   1.22    .45   .801     14   1.55    2.50     .511     .115
 sur61      .53   2.07    .09   .992      5    .96    2.58     .142     .747
 sur62     1.88  -1.11   1.09   .458      6   1.28    1.30    1.770     .010

                                        VPA Mean =    2.75    1.111     .000


 Yearclass =   2006

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Sur70      .53  -2.08   1.10   .506     20  11.11    3.79    1.205     .023
 Sur41      .66   1.45    .45   .824     13   1.13    2.20     .513     .126
 Sur42
 sur61      .58   1.91    .14   .981      6   1.59    2.83     .197     .831
 sur62     1.57   -.23    .86   .595      7    .96    1.27    1.303     .020

                                        VPA Mean =    2.73    1.086     .000


 Yearclass =   2007

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Sur70      .54  -2.22   1.13   .479     21  10.02    3.16    1.223     .046
 Sur41
 Sur42      .84   1.18    .44   .802     15    .39    1.51     .530     .245
 sur61      .61   1.76    .21   .958      7    .03    1.78     .312     .709
 sur62

                                        VPA Mean =    2.71    1.061     .000
```

Yearclass = 2008

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Sur70	.54	-2.22	1.13	.479	21	9.66	2.97	1.221	.147
Sur41	.66	1.48	.43	.825	14	.17	1.59	.506	.853
Sur42									
sur61									
sur62									
					VPA Mean =		2.71	1.061	.000

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2005	13	2.57	.17	.09	.25	9	2.29
2006	15	2.74	.18	.19	1.11	11	2.44
2007	5	1.78	.26	.23	.77		
2008	6	1.79	.47	.49	1.09		

Table 7.10.1.3 Norwegian Spring-spawning herring. Input to short-term prediction.

2009

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef. spawn.	Prop. of M bef. spawn.	Weight in stock	Exploit. pattern	Weight in catch
0	103000	0.9	0.00	0	0	0.001	0.000	0.000
1	38000	0.9	0.00	0	0	0.010	0.008	0.052
2	5000	0.9	0.00	0	0	0.044	0.007	0.115
3	6000	0.15	0.00	0	0	0.077	0.009	0.159
4	3058	0.15	0.30	0	0	0.141	0.031	0.225
5	16441	0.15	0.90	0	0	0.215	0.071	0.264
6	6963	0.15	1.00	0	0	0.270	0.116	0.301
7	16602	0.15	1.00	0	0	0.306	0.178	0.320
8	700	0.15	1.00	0	0	0.336	0.191	0.338
9	730	0.15	1.00	0	0	0.346	0.140	0.359
10	2905	0.15	1.00	0	0	0.364	0.178	0.366
11	2922	0.15	1.00	0	0	0.369	0.134	0.375
12	377	0.15	1.00	0	0	0.411	0.246	0.391
13	80	0.15	1.00	0	0	0.353	0.236	0.397
14	80	0.15	1.00	0	0	0.389	0.241	0.396
15	579	0.15	1.00	0	0	0.393	0.241	0.406

2010 and 2011

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef. spawn.	Prop. of M bef. spawn.	Weight in stock	Exploit. pattern	Weight in catch
0	103000	0.9	0.00	0	0	0.001	0.000	0.000
1		0.9	0.00	0	0	0.010	0.008	0.052
2		0.9	0.00	0	0	0.041	0.007	0.115
3		0.15	0.00	0	0	0.080	0.009	0.159
4		0.15	0.30	0	0	0.147	0.031	0.225
5		0.15	0.90	0	0	0.218	0.071	0.264
6		0.15	1.00	0	0	0.268	0.116	0.301
7		0.15	1.00	0	0	0.302	0.178	0.320
8		0.15	1.00	0	0	0.324	0.191	0.338
9		0.15	1.00	0	0	0.354	0.140	0.359
10		0.15	1.00	0	0	0.369	0.178	0.366
11		0.15	1.00	0	0	0.364	0.134	0.375
12		0.15	1.00	0	0	0.403	0.246	0.391
13		0.15	1.00	0	0	0.337	0.236	0.397
14		0.15	1.00	0	0	0.399	0.241	0.396
15		0.15	1.00	0	0	0.399	0.241	0.406

Table 7.10.2.1. Norwegian spring spawning herring. Short term prediction.

Basis: Landings (2009) = 1643 (=TAC); $\mathbf{F}_w(2009)^{1)}$ = 0.119; SSB(2009) = 13.3 million t.; SSB(2010)= 12.2 million t.
The fishing mortality applied according to the agreed management plan (F(management plan)) is 0.125.

Rationale	Landings (2010)	Fmult	Basis	F(2010)	SSB(2011)
Zero catch	0	0	F=0	0.000	12.2
Status quo	1483	1	F(2008)	0.125	10.8
Agreed management plan	157	0.1	F(management plan)*0.1	0.013	12.0
	389	0.25	F(management plan)*0.25	0.031	11.8
	770	0.5	F(management plan)*0.50	0.063	11.5
	1132	0.75	F(management plan)*0.75	0.094	11.1
	1353	0.9	F(management plan)*0.90	0.113	10.9
	1483	1	F(management plan)	0.125	10.8
	1628	1.1	F(management plan)*1.1	0.138	10.7
	1822	1.25	F(management plan)*1.25	0.156	10.5
Precautionary limits	1755	1.2	F_{pa}	0.150	10.5

Landings weights in thousand tonnes, stock biomass weights in million tonnes.

1) F_w = Fishing mortality weighted by population numbers (age groups 5–14).

Shaded scenarios are not considered consistent with the precautionary approach.

Table 7.10.2 2 Norwegian spring-spawning herring. Detailed short term prediction

TAC in 2009, F is management plan (0.125) in 2010 and 2011

2009									
Age	stockno 1-jan	stockno at spawntime	Biomass 1-jan	Biomass at spawntime	ssb 1-jan	ssb at spawntime	F	catch in number	catch in weight
0	103000	103000	103	103	0	0	0.000	0.000	0
1	38000	38000	380	380	0	0	0.007	186.987	10
2	5000	5000	220	220	0	0	0.007	21.612	2
3	6000	6000	462	462	0	0	0.009	47.618	8
4	3058	3058	431	431	129	129	0.028	79.350	18
5	16441	16441	3535	3535	3181	3181	0.065	964.283	255
6	6963	6963	1880	1880	1880	1880	0.105	647.966	195
7	16602	16602	5080	5080	5080	5080	0.163	2317.502	742
8	700	700	235	235	235	235	0.174	104.197	35
9	730	730	253	253	253	253	0.127	81.268	29
10	2905	2905	1057	1057	1057	1057	0.163	405.538	148
11	2922	2922	1078	1078	1078	1078	0.122	313.251	117
12	377	377	155	155	155	155	0.225	70.563	28
13	80	80	28	28	28	28	0.216	14.451	6
14	80	80	31	31	31	31	0.220	14.728	6
15	579	579	227	227	227	227	0.220	106.536	43
	203435	203435	15156	15156	13336	13336	0.119	5375.8	1643
	(millions)	(millions)	(thousands)	(thousands)	(thousands)	(thousands)	(WF 5-14)	(millions)	(thousands)

Table 7.10.2.2 (cont'd)

				2010					
Age	stockno 1-jan	stockno at spawntime	Biomass 1-jan	Biomass at spawntime	ssb 1-jan	ssb at spawntime	F	catch in number	catch in weight
0	103000	103000	103	103	0	0	0.000	0	0
1	41877	41877	419	419	0	0	0.007	182	9
2	15334	15334	634	634	0	0	0.006	58	7
3	2020	2020	162	162	0	0	0.008	14	2
4	5120	5120	754	754	226	226	0.025	117	26
5	2558	2558	557	557	501	501	0.057	133	35
6	13258	13258	3553	3553	3553	3553	0.093	1094	330
7	5393	5393	1631	1631	1631	1631	0.143	670	215
8	12145	12145	3939	3939	3939	3939	0.154	1610	544
9	506	506	179	179	179	179	0.112	50	18
10	553	553	204	204	204	204	0.143	69	25
11	2125	2125	774	774	774	774	0.108	202	76
12	2225	2225	896	896	896	896	0.198	372	146
13	259	259	87	87	87	87	0.190	42	17
14	55	55	22	22	22	22	0.194	9	4
15	455	455	182	182	182	182	0.194	75	30
	206884	206884	14095	14095	12194	12194	0.1250	4697	1483
	(millions)	(millions)	(thousands)	(thousands)	(thousands)	(thousands)	(WF 5-14)	(millions)	(thousands)

Table 7.10.2.2 (Cont'd)

2011									
Age	stockno 1-jan	stockno at spawntime	Biomass 1-jan	Biomass at spawntime	ssb 1-jan	ssb at spawntime	F	catch in number	catch in weight
0	103000	103000	103	103	0	0	0.000	0	0
1	41877	41877	419	419	0	0	0.006	178	9
2	16914	16914	699	699	0	0	0.006	63	7
3	6198	6198	496	496	0	0	0.007	43	7
4	1725	1725	254	254	76	76	0.025	39	9
5	4298	4298	936	936	842	842	0.056	219	58
6	2079	2079	557	557	557	557	0.091	169	51
7	10398	10398	3144	3144	3144	3144	0.141	1269	407
8	4022	4022	1305	1305	1305	1305	0.151	524	177
9	8965	8965	3170	3170	3170	3170	0.110	871	312
10	389	389	144	144	144	144	0.141	48	17
11	413	413	150	150	150	150	0.106	39	14
12	1642	1642	661	661	661	661	0.194	270	106
13	1571	1571	529	529	529	529	0.187	249	99
14	184	184	74	74	74	74	0.191	30	12
15	362	362	144	144	144	144	0.191	58	24
	204036	204036	12784	12784	10796	10796	0.125	4068	1308
	(millions)	(millions)	(thousands)	(thousands)	(thousands)	(thousands)	(WF 5-14)	(millions)	(thousands)

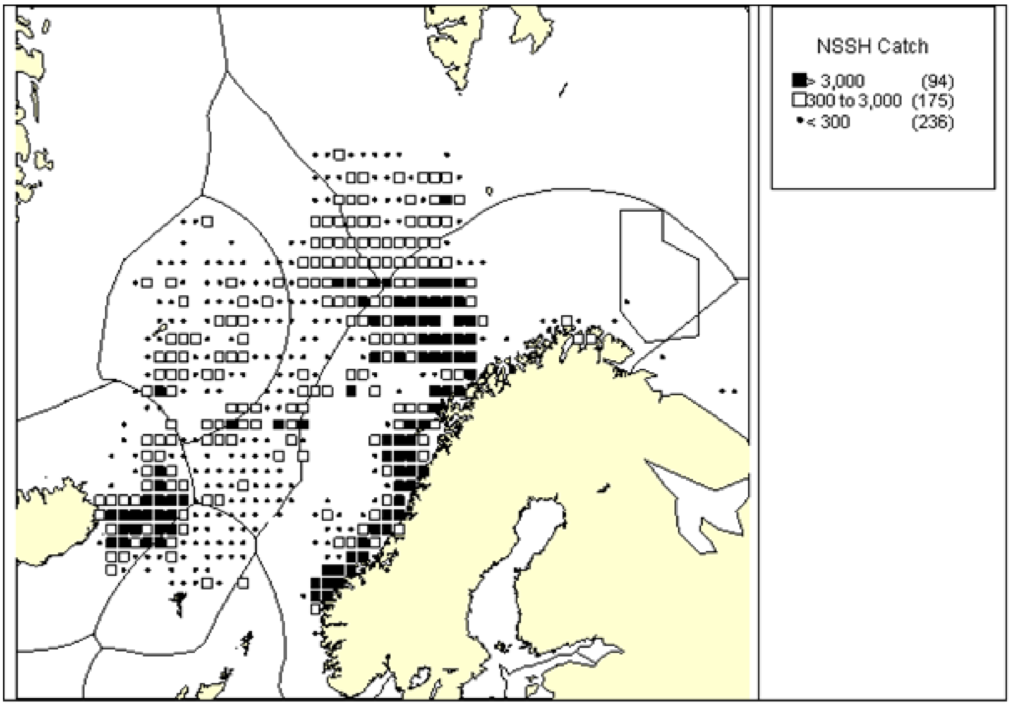


Figure 7.3.1.1. Total reported catches of Norwegian spring-spawning herring in 2008 by ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300–3000 t, and black squares > 3000 t.

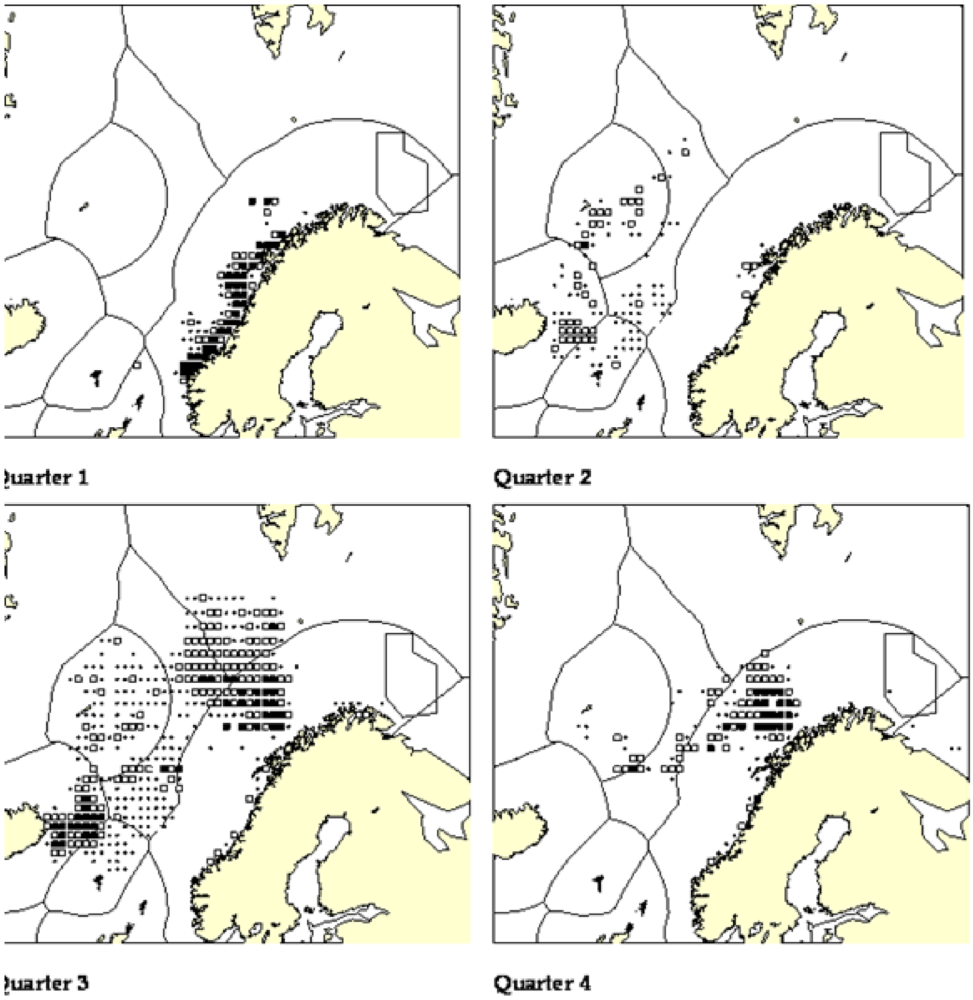


Figure 7.3.1.2. Total reported catches of Norwegian spring-spawning herring in 2008 by quarter and ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300–3000 t, and black squares > 3000 t.

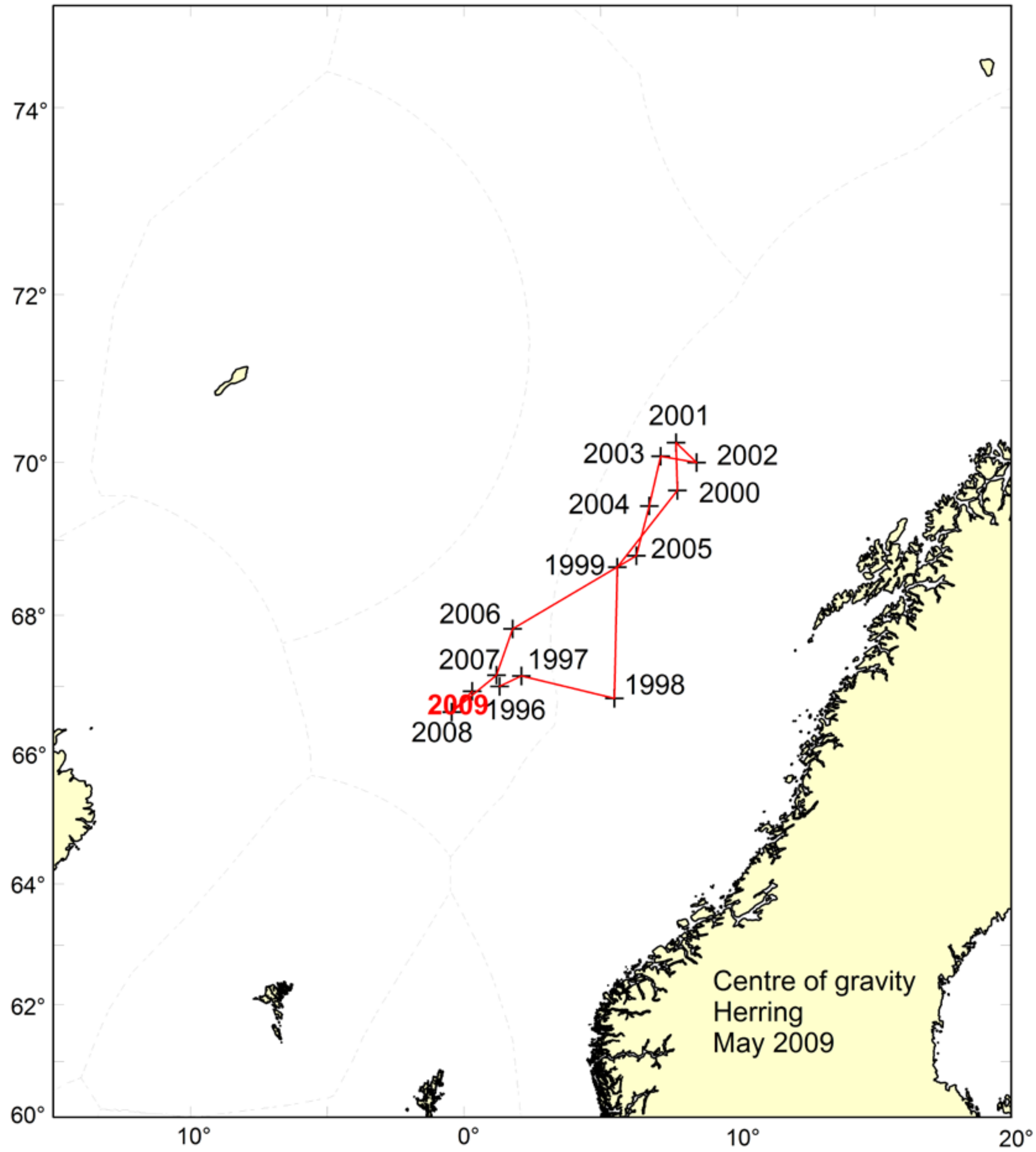


Figure 7.4.2.1 Centre of gravity of herring during the period 1996-2009 derived from acoustic. Acoustic data from area II and III only, i.e. west of 20°E.

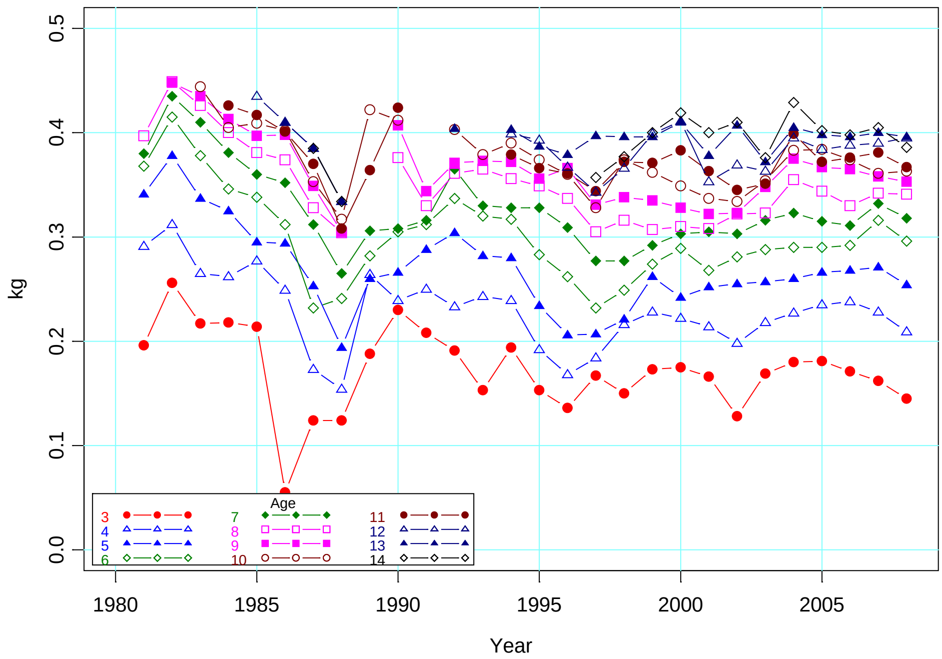


Figure 7.5.4.1. Norwegian spring spawning herring. Mean weight at age by age groups 3-14 in the years 1980-2008 in the catch (weight at age for zero catch numbers were omitted).

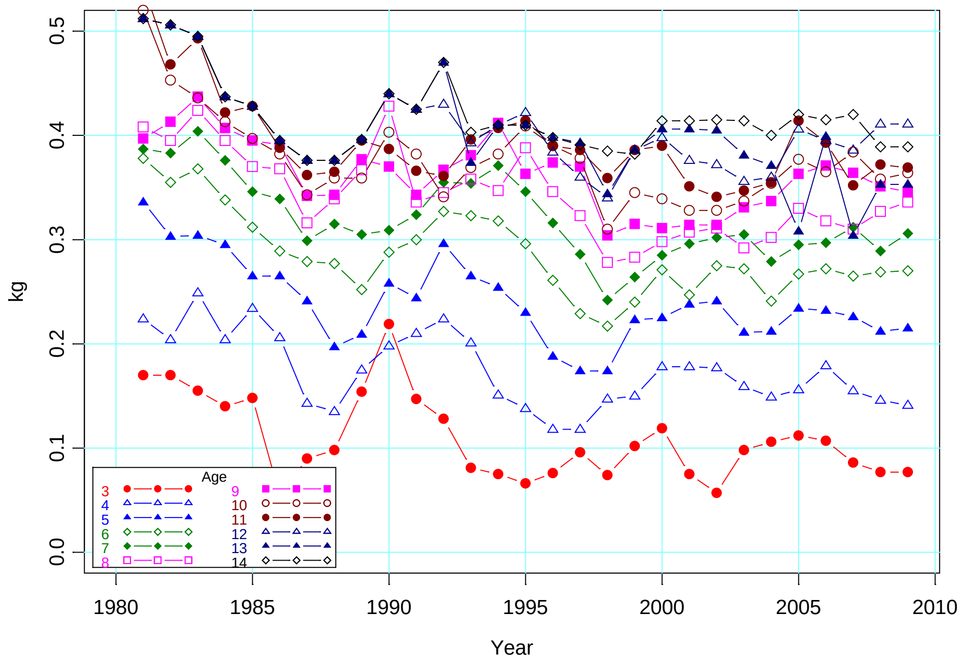
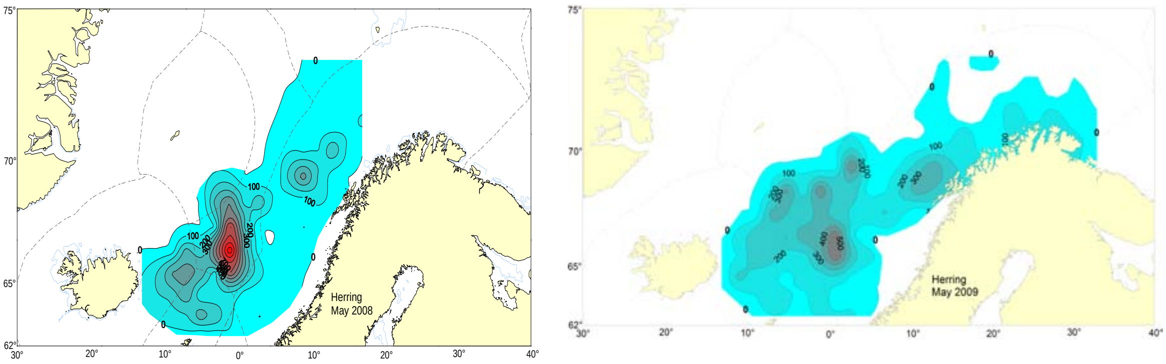
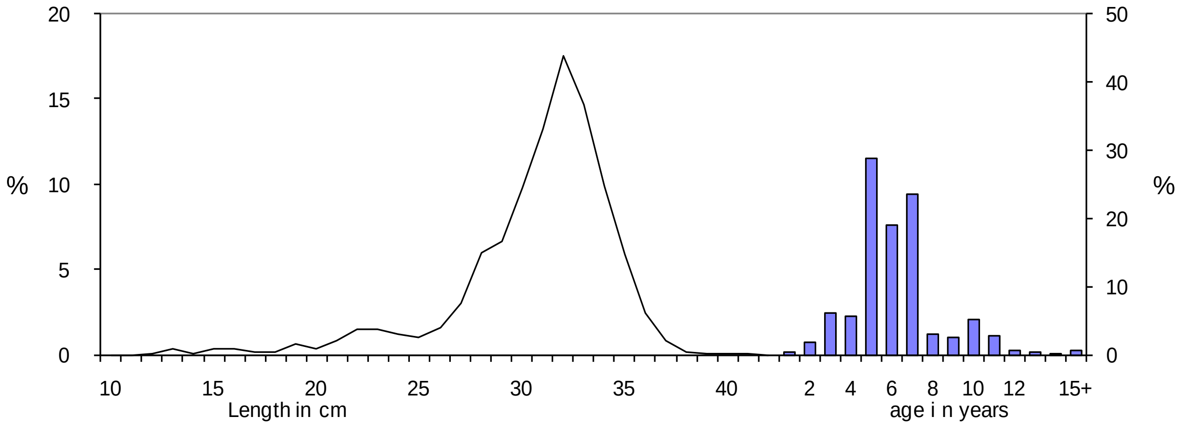


Figure 7.5.4.2. Norwegian spring-spawning herring. Mean weight at age in the stock 1981-2009.



2008 2009

Figure 7.5.7.4.1. Norwegian Spring-Spawning herring. Schematic map of herring acoustic density (sA, m2/nm2) found during the survey in May 2008 and 2009. Note the incomplete coverage of the Barents Sea in 2008.



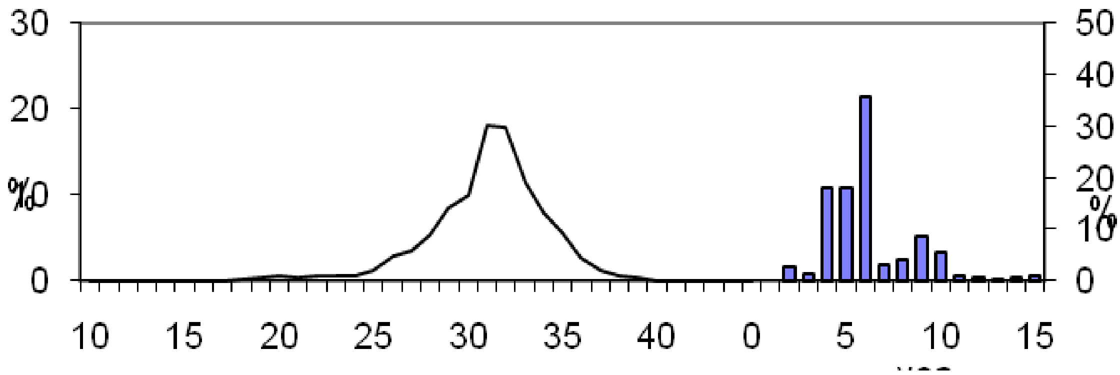


Figure 7.5.7.4.2. Length and age distribution of Norwegian spring spawning herring in the area in the Norwegian Sea, spring 2009 (upper panel), 2008 (lower panel).

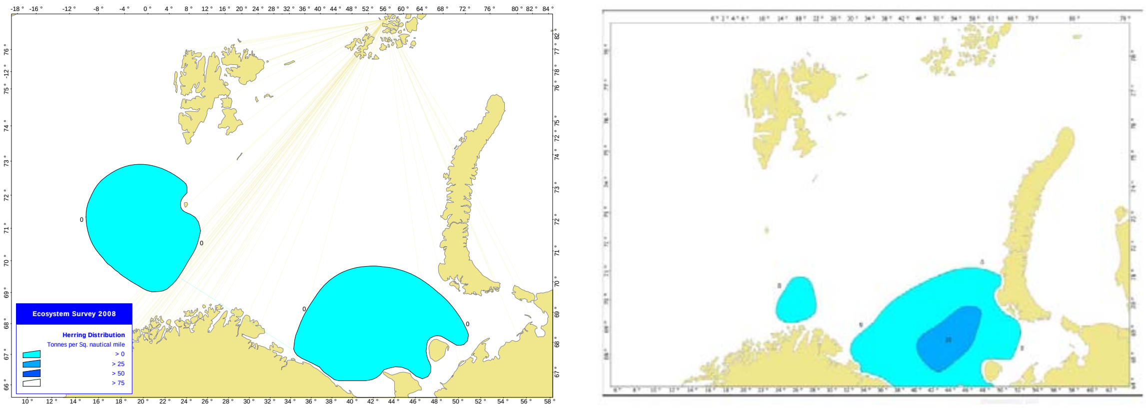


Figure 7.5.7.5.1. Norwegian Spring-Spawning herring. Estimated total density of herring (tonnes/nautical mile²) in August-September 2008 (left panel) and 2007 (right panel) in Barents Sea. ***Survey 6.***

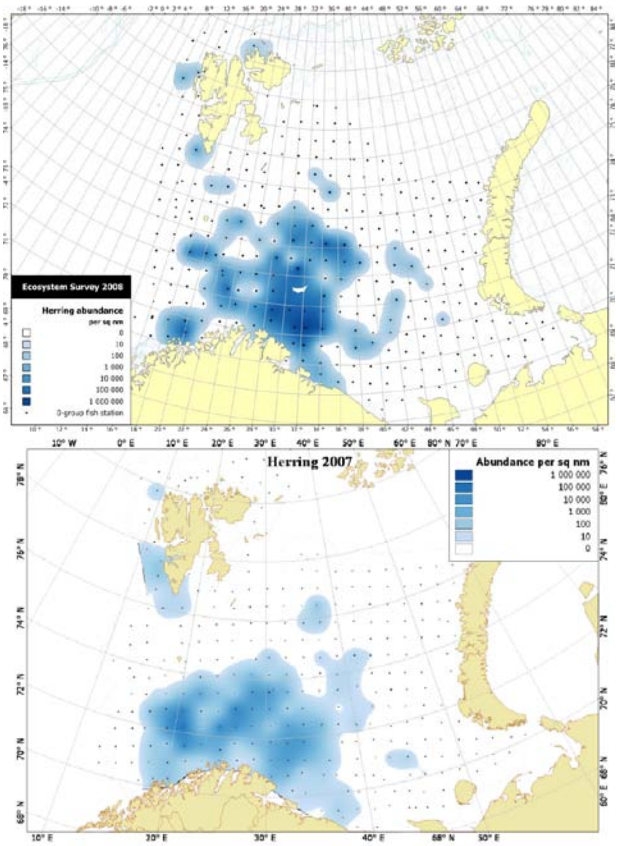


Figure 7.5.7.5.2. Norwegian Spring-Spawning herring. O–group surveys in August/September in the Barents Sea in 2008 (left panel) and 2007 (right panel). ***Survey 7.***

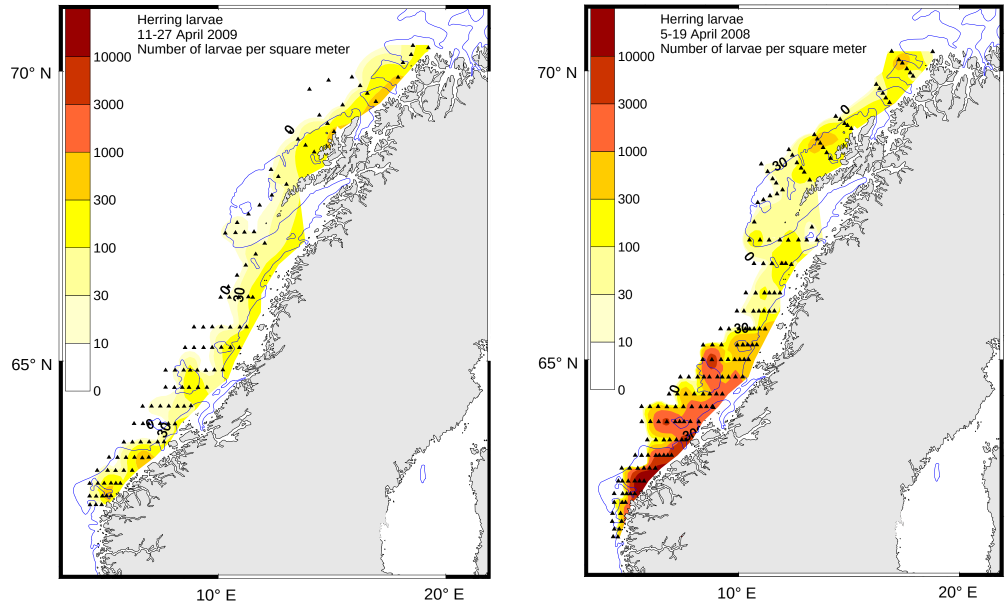


Figure 7.5.7.6.1. Norwegian Spring-Spawning herring.. Distribution of herring larvae on the Norwegian shelf in 2009 (left panel) and 2008 (right panel). The 200 m depth line is also shown. ***Survey 8.***

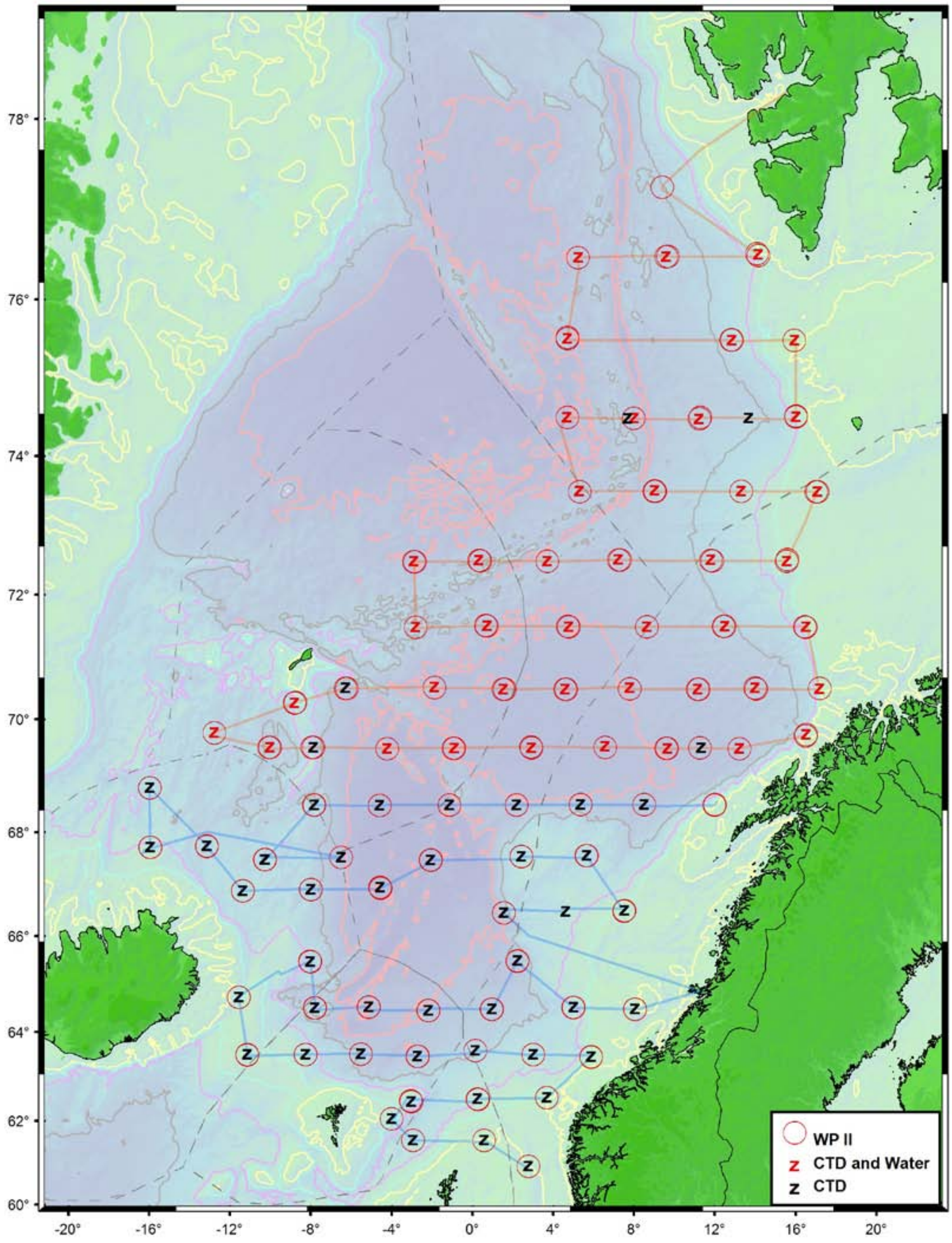


Figure 7.5.7.7.1. Norwegian spring-spawning herring. Survey lines along the cruise tracks with pre-defined CTD stations (0-500 m) and WP2 samples (0-200 m) for M/V"Libas" and M/V"Eros", 15 July – 6 August 2009. This large ocean area included the following Economical Exclusive Zones (EEZ): Norwegian EEZ, United Kingdom EEZ, Faeroe Island EEZ, Iceland EEZ, Jan Mayen fishery protection zone, Spitzbergen protected area and International waters. *Survey 9*.

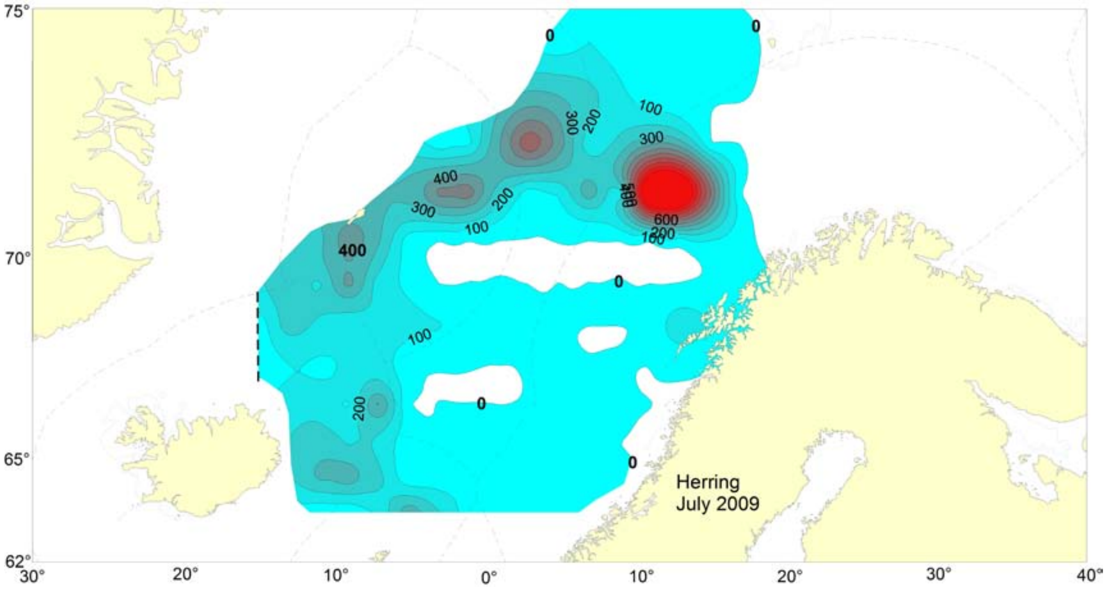


Figure 7.5.7.7.2. Norwegian spring-spawning herring. Sa or Nautical Area Scattering Coefficient (NASC) values of herring along the cruise track. ***Survey 9.***

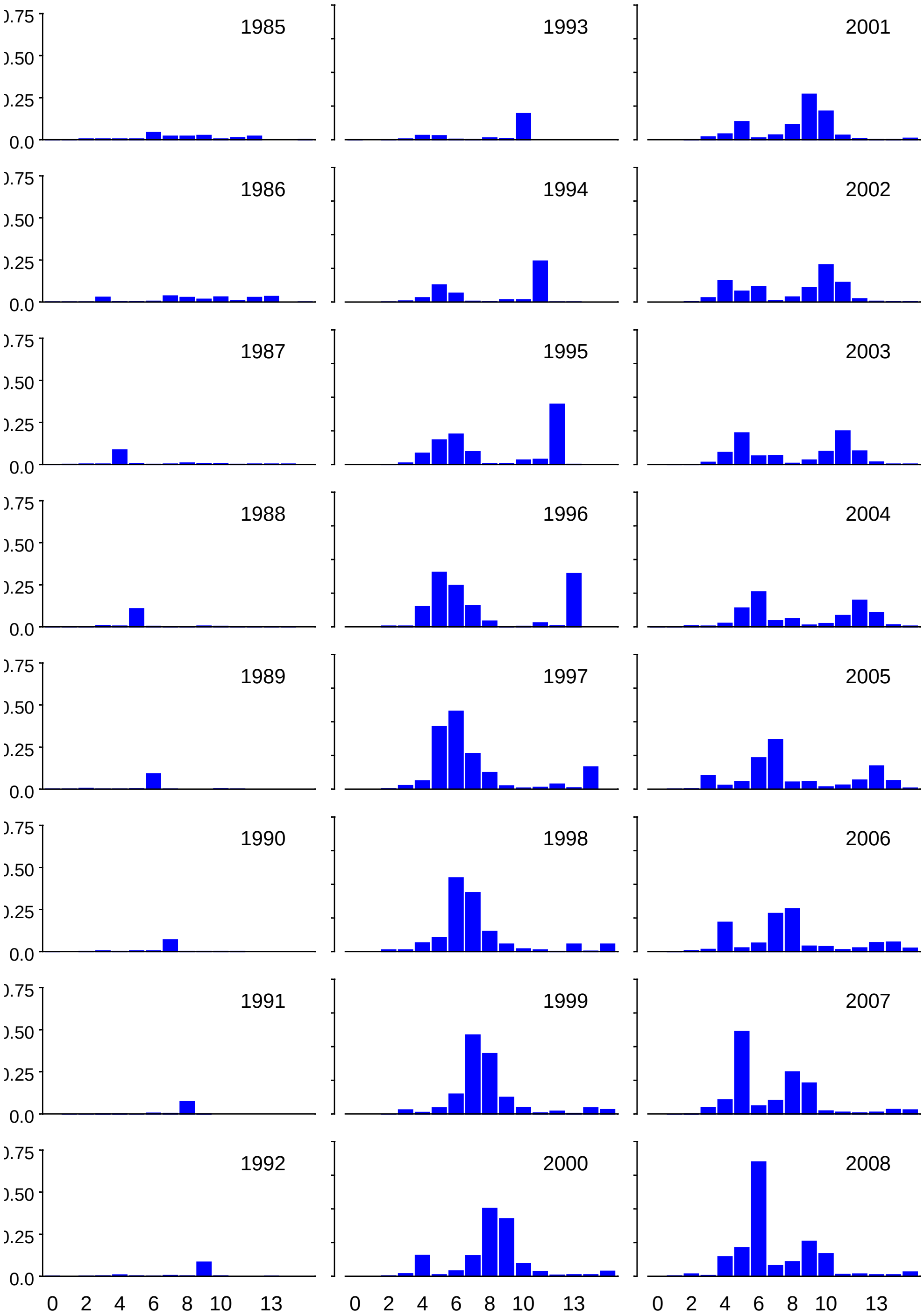


Figure 7.7.1.1. Norwegian spring spawning herring. Catch in weight (million tonnes) by age in the years 1985-2008.

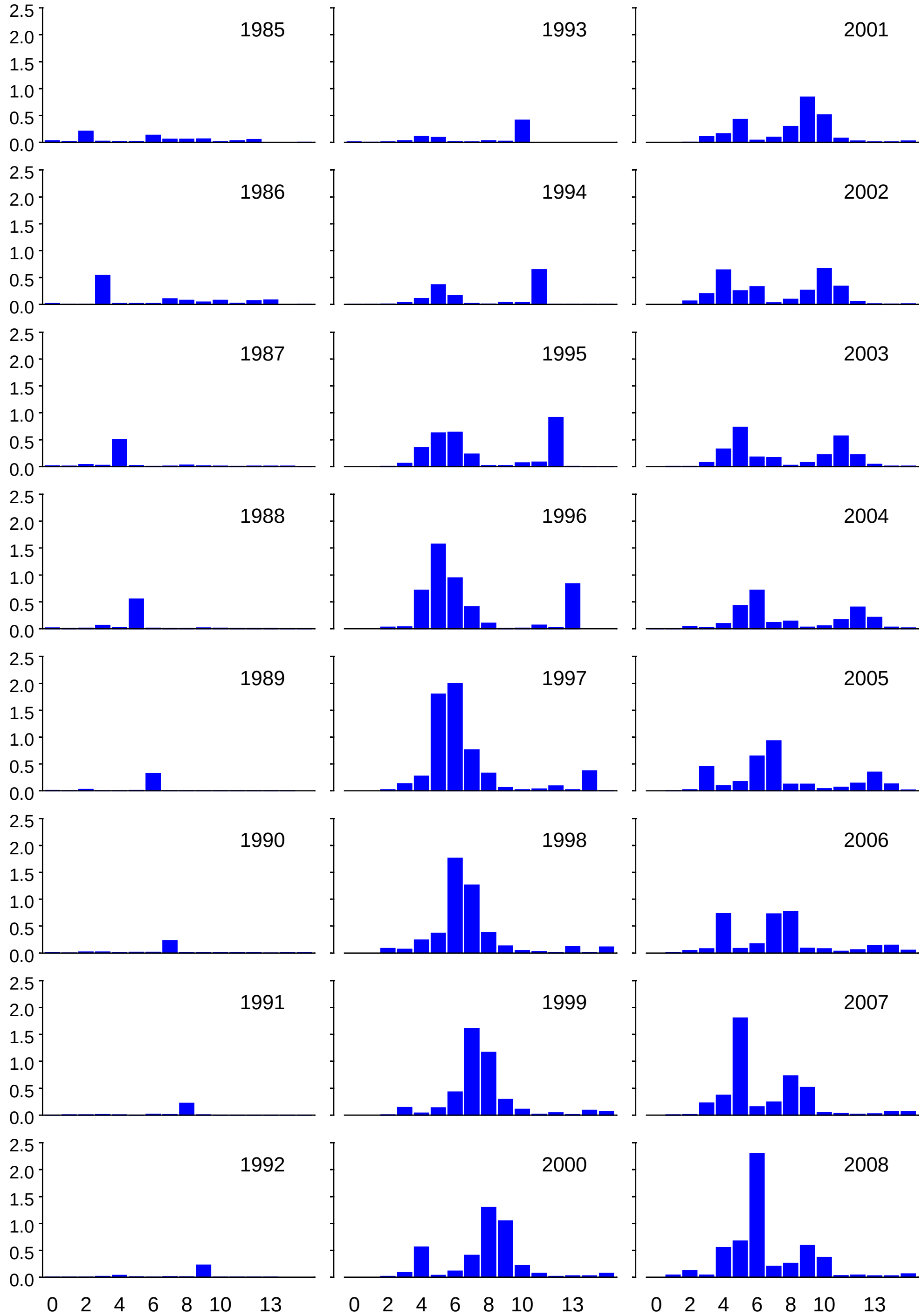


Figure 7.7.1.2. Norwegian spring spawning herring. Catch in numbers (billions) by age in the years 1985-2008.

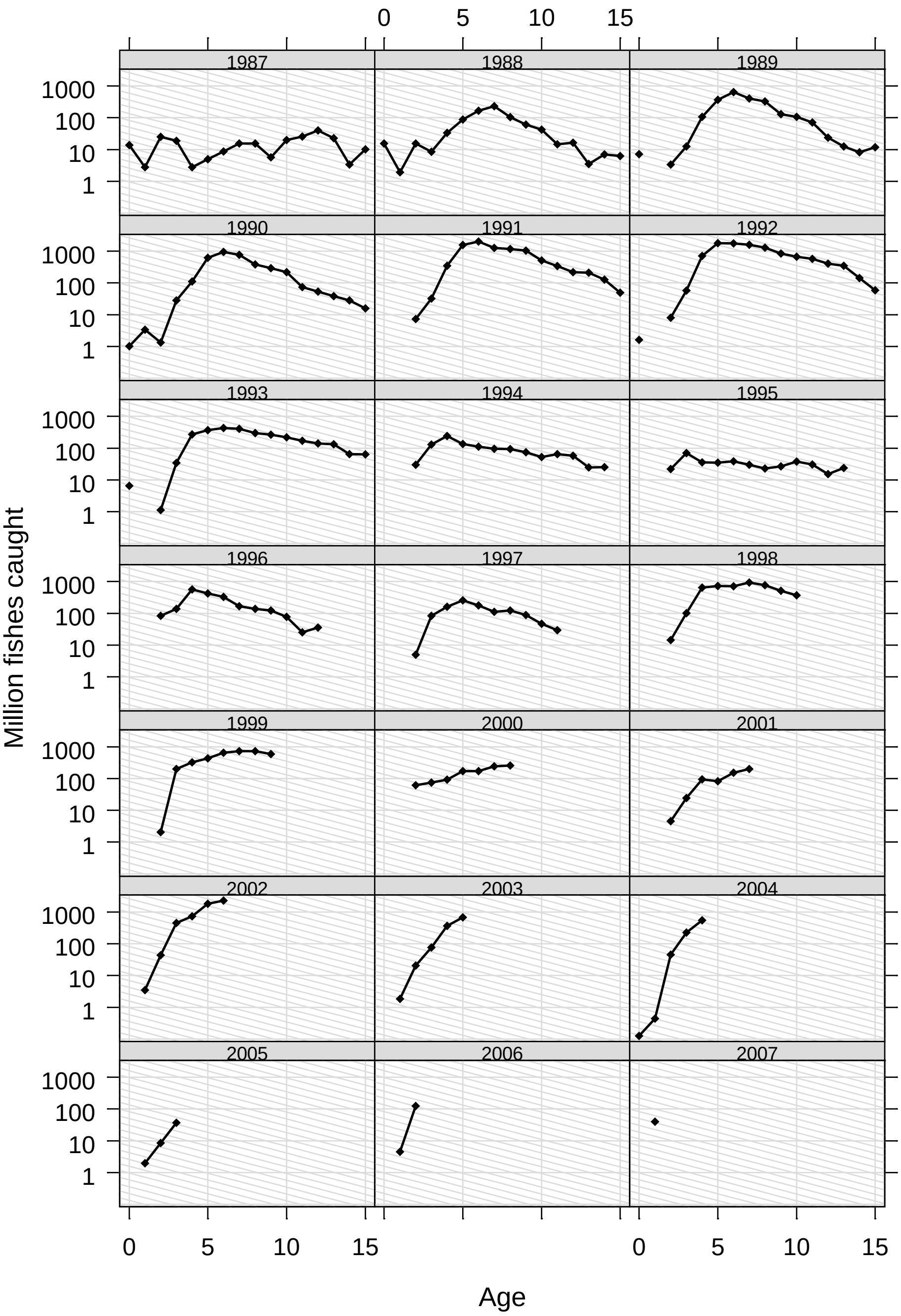


Figure 7.7.1.3. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted on a log scale. Age is on x-axis. The labels above each figure indicate year classes. They grey lines correspond to Z=0.3.

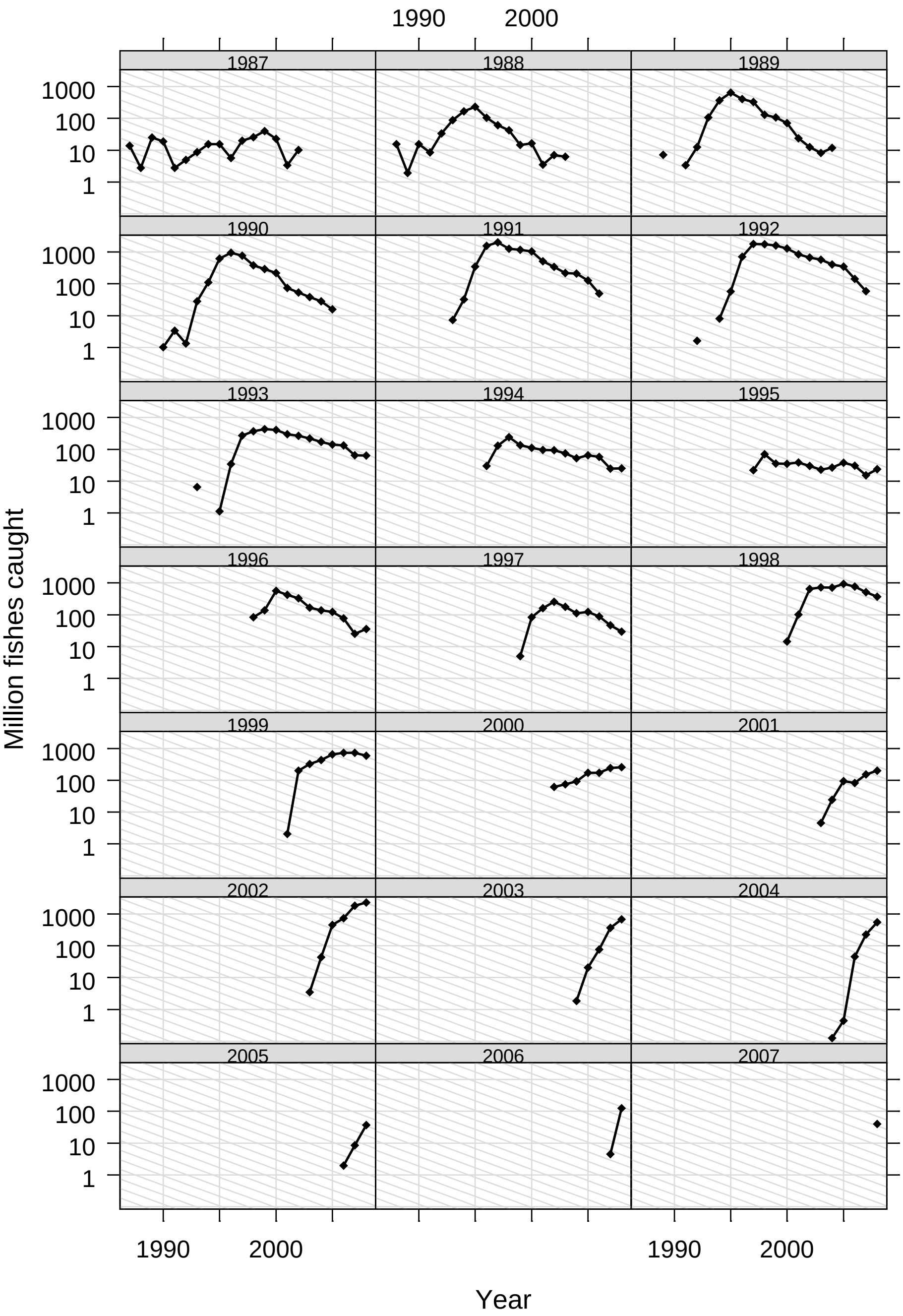


Figure 7.7.1.4. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted on a log scale. Year is on the x-axis. The labels above each figure indicate year classes. They grey lines correspond to Z=0.3.

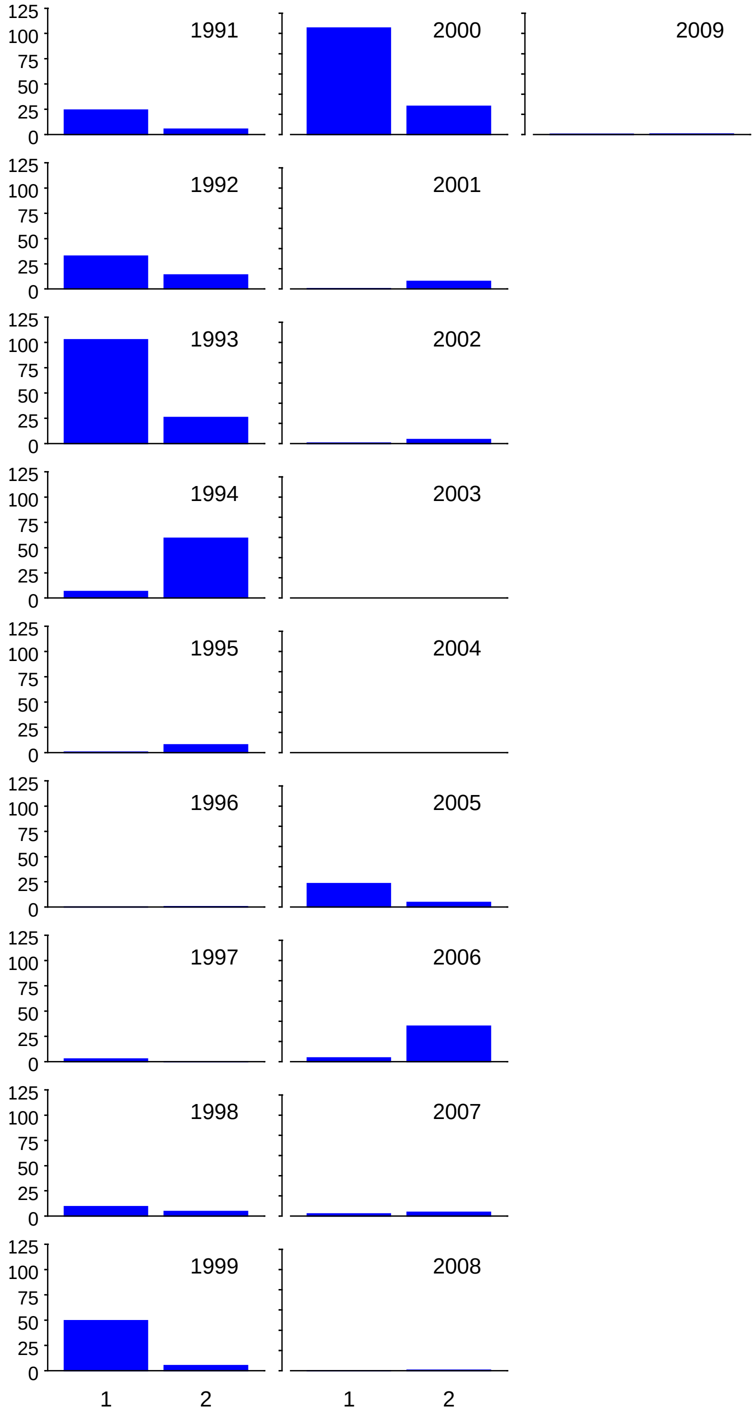


Figure 7.7.1.5. Norwegian spring spawning herring. Age disaggregated abundance indices from the acoustic surveys in the Barents Sea in May/June. Survey 4.

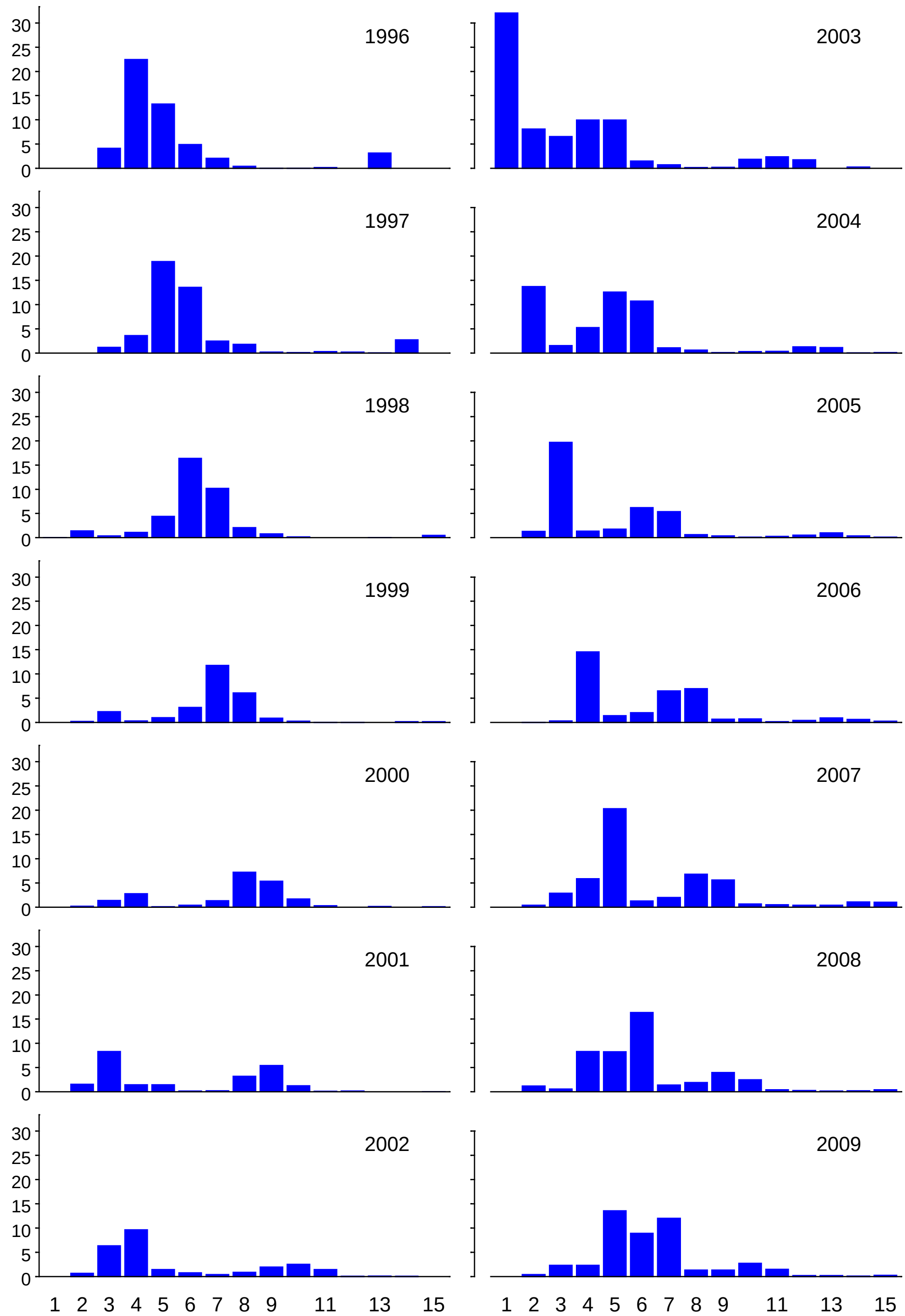


Figure 7.7.1.6. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) in the years 1996-2009.

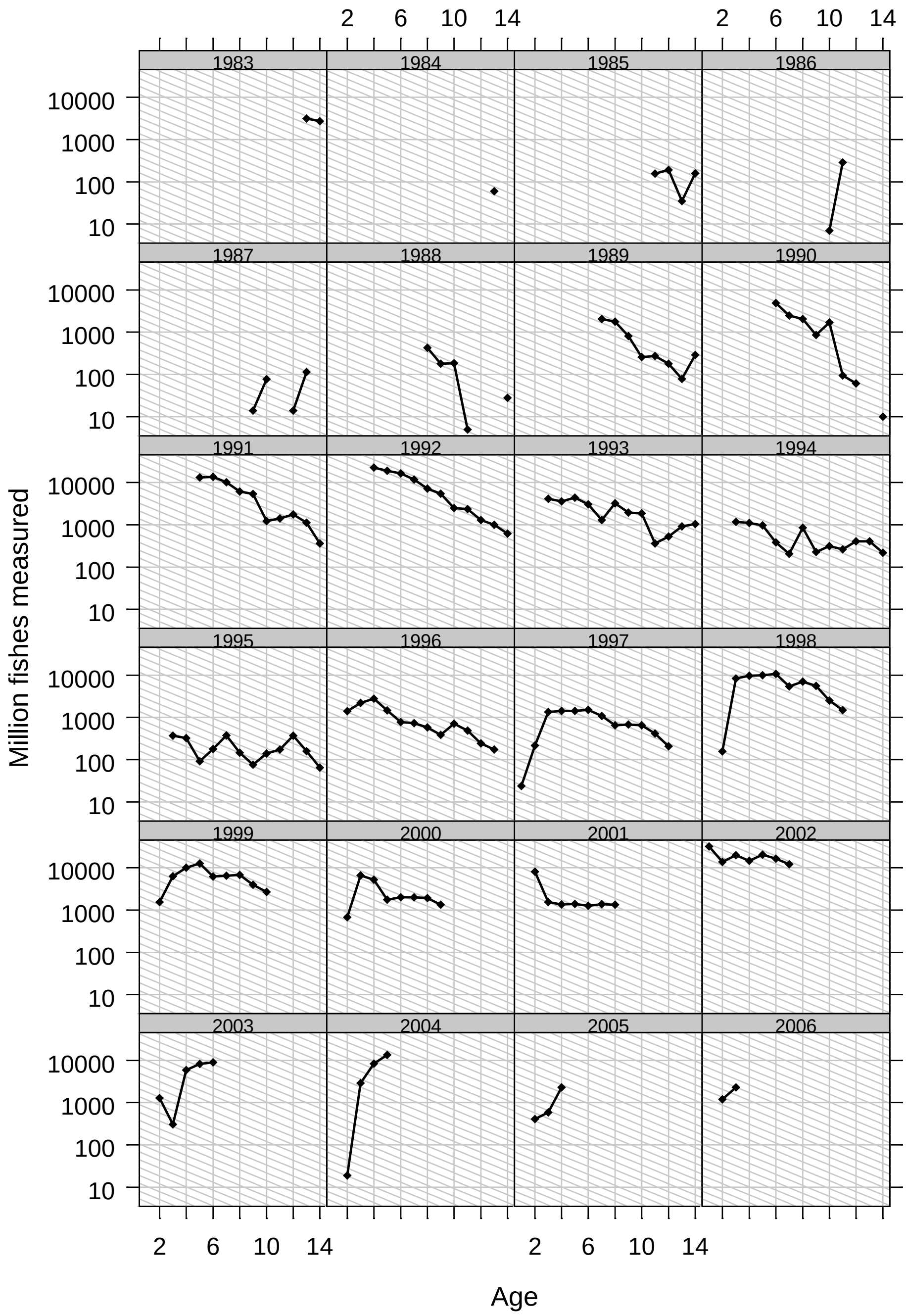


Figure 7.7.1.7. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale. The labels above each figure indicate year classes. The grey lines correspond to Z=0.3.

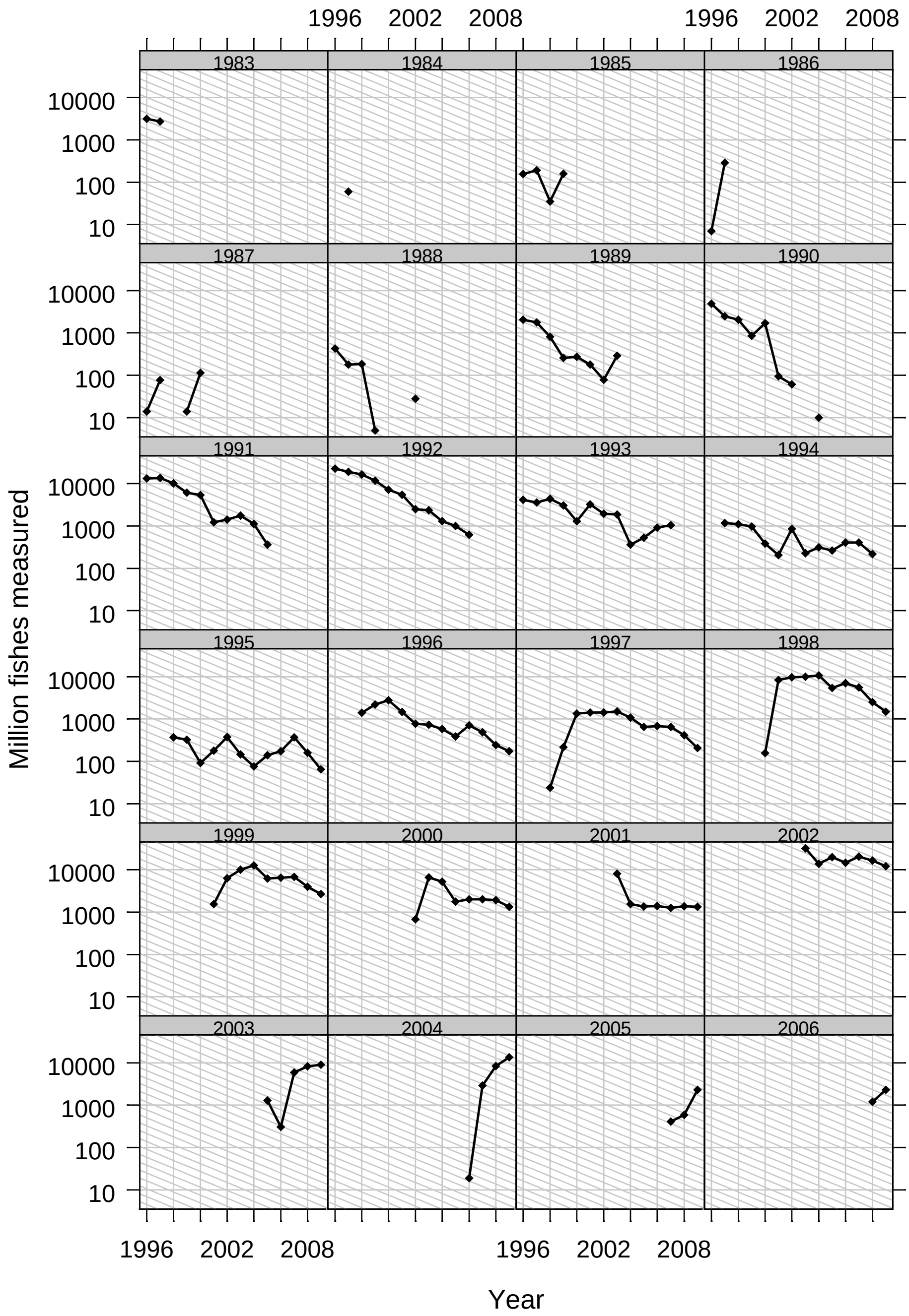


Figure 7.7.1.8. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale. The labels above each figure indicate year classes. The grey lines correspond to Z=0.3.

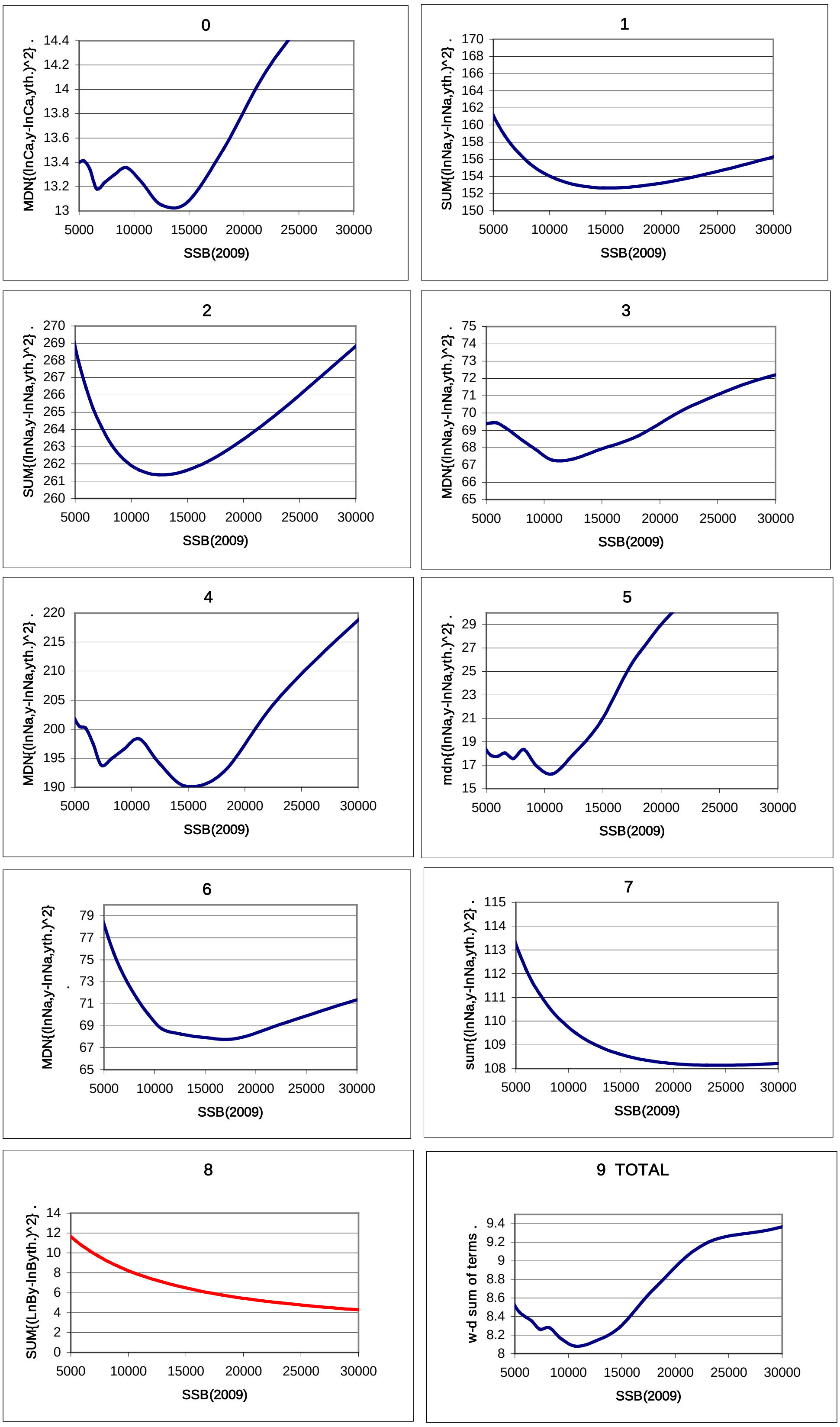


Figure 7.7.2.1. Norwegian spring-spawning herring. Profiles of components of the TISVPA loss function for "the best choice" of exploratory runs: 0 - signal from catch-at-age alone; 1-7 - signals from "surveys" from 1 to 8 respectively (see explanation for numbering of the "surveys" in the text). Survey 8 excluded in the final run.

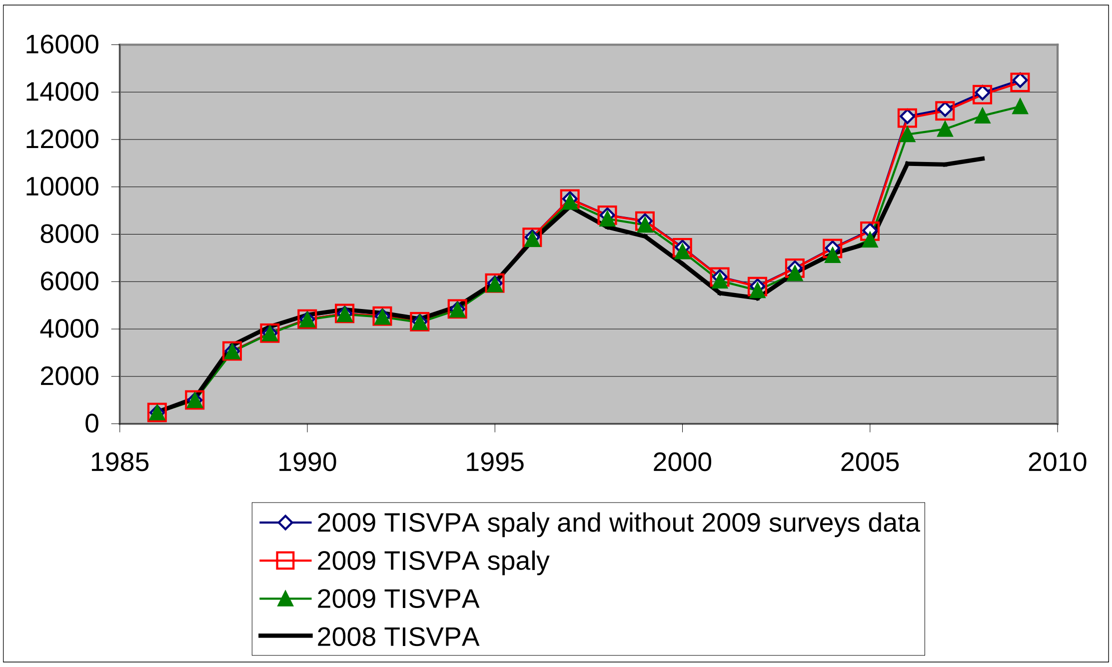
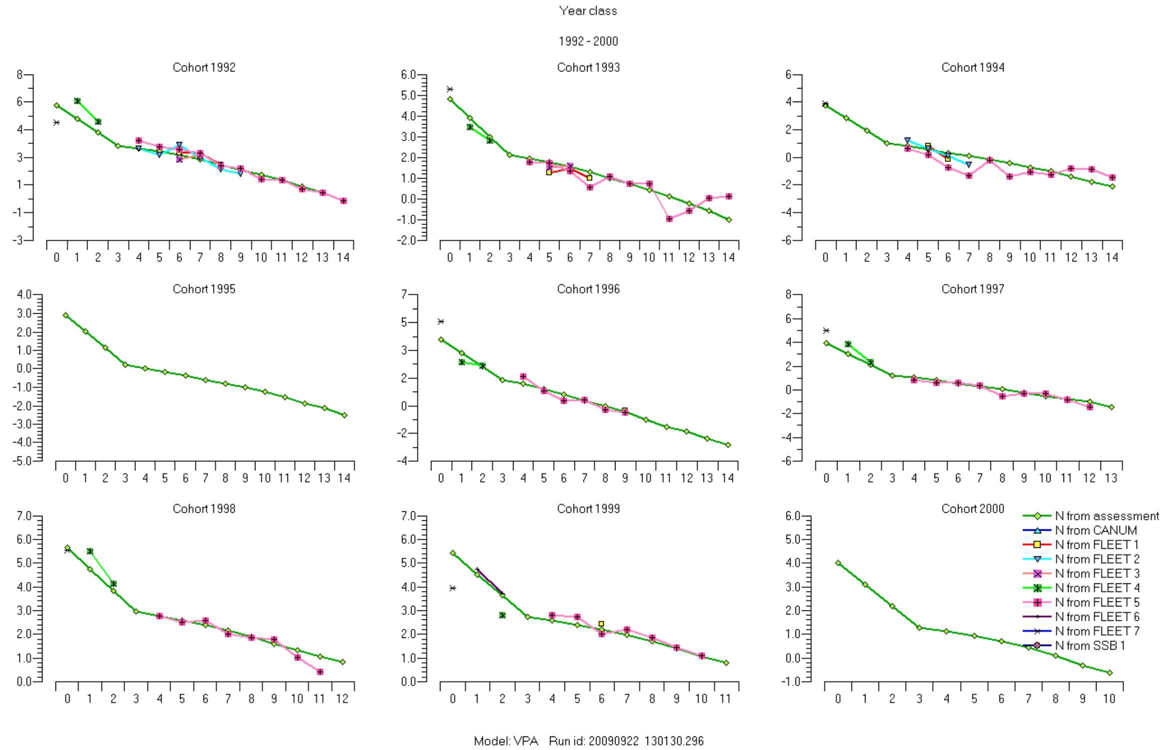


Figure 7.7.2.2. Norwegian spring-spawning herring. Comparison of the exploratory TISVPA results to the previous assessment made by this model.



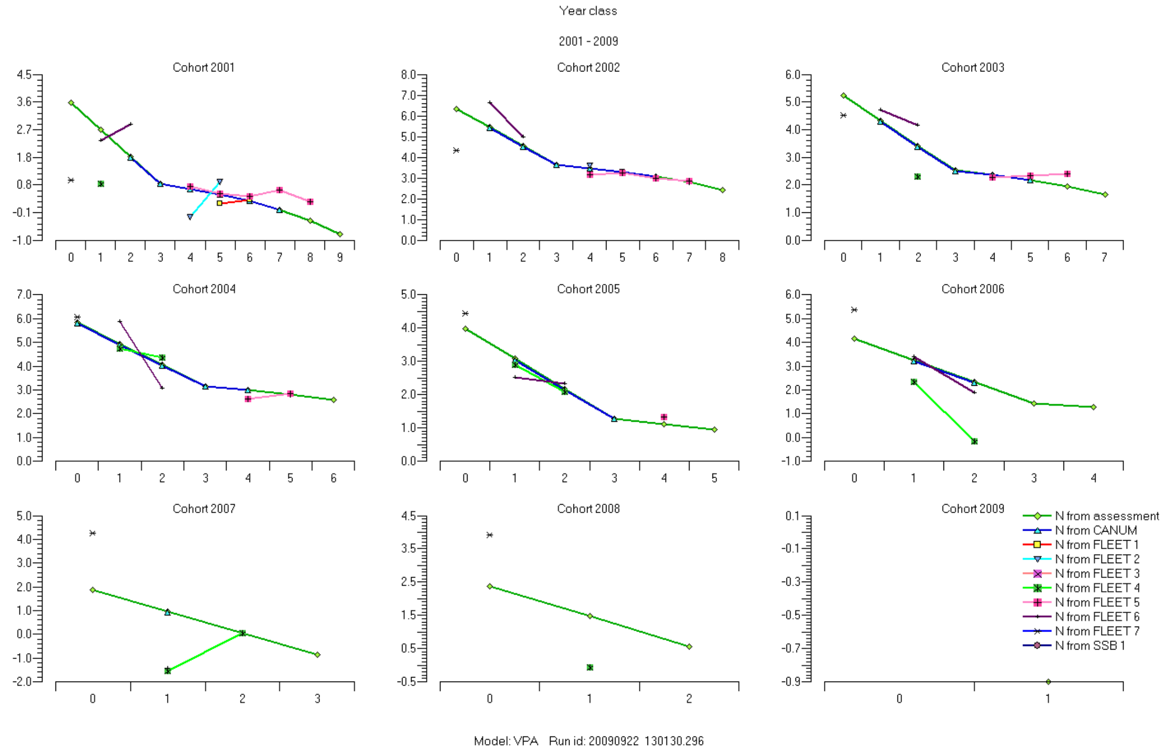


Figure 7.7.3.1 Norwegian spring spawning herring. Year class Ns, excluding values with zero weight.

Fleet 1

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	1	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	1	1	0	0	0	0	0	0	0	0	0
1996	0	0	0	1	1	1	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	1	1	1	1	1	0	0	0	0	0	0
1999	0	0	0	1	1	1	1	1	1	0	0	0	0	0
2000	0	0	0	0	1	1	1	1	1	1	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	1	0	0	1	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fleet 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1992	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1993	0	0	0	1	0	0	0	0	0	1	0	0	0	0
1994	0	0	0	1	1	0	0	0	0	0	1	0	0	0
1995	0	0	0	1	1	1	0	0	0	0	0	0	0	0
1996	0	0	0	1	1	1	1	0	0	0	0	0	0	0
1997	0	0	0	0	1	1	1	1	0	0	0	0	0	0
1998	0	0	0	1	0	1	1	1	1	0	0	0	0	0
1999	0	0	0	0	1	0	1	1	1	1	0	0	0	0
2000	0	0	0	0	0	1	0	1	1	1	1	0	0	0
2001	0	0	0	0	0	0	1	0	1	1	1	1	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fleet 3

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1991	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	1	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1994	0	0	0	1	0	0	0	0	0	1	0	0	0	0
1995	0	0	0	1	1	0	0	0	0	0	1	0	0	0
1996	0	0	0	1	1	1	0	0	0	0	0	1	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	1	1	1	1	1	0	0	0	0	0	1
1999	0	0	0	0	1	1	1	1	1	0	0	0	0	0

Fleet 4

	1	2
1991	1	1
1992	1	1
1993	1	1
1994	1	1
1995	0	1
1996	0	0
1997	1	0
1998	1	1
1999	1	1
2000	0	1
2001	0	1
2002	0	0
2003	0	0
2004	0	0
2005	1	1
2006	1	1
2007	1	1
2008	0	0
2009	1	1

Fleet 5

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1996	0	0	0	1	1	1	1	0	0	0	0	0	1	0	0
1997	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0
1998	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1
1999	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
2000	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0
2001	0	0	0	1	1	0	1	1	1	1	1	1	0	0	0
2002	0	0	0	1	1	1	0	1	1	1	1	1	1	0	0
2003	0	0	0	1	1	1	1	0	1	1	1	1	0	1	0
2004	0	0	0	0	1	1	1	1	0	1	1	1	1	1	0
2005	0	0	0	0	0	1	1	1	1	0	1	1	1	1	1
2006	0	0	0	1	0	0	1	1	1	0	0	1	1	1	1
2007	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1
2008	0	0	0	1	1	1	0	0	1	1	1	0	0	1	1
2009	0	0	0	1	1	1	1	0	0	1	1	1	0	0	1

Fleet 6

	1	2
2000	1	0
2001	0	1
2002	0	0
2003	1	0
2004	1	1
2005	1	1
2006	1	1
2007	1	1
2008	1	1

Fleet 7

	0
1980	0
1981	0
1982	1
1983	1
1984	0
1985	0
1986	0
1987	0
1988	0
1989	1
1990	1
1991	1
1992	1
1993	1
1994	1
1995	0
1996	1
1997	1
1998	1
1999	1
2000	0
2001	0
2002	1
2003	1
2004	1
2005	1
2006	1
2007	1
2008	1

Figure 7.7.3.2. Norwegian spring-spawning herring. Colours description: pink=data is outside age and year range, dark red=zero catches in surveys, white=little information about year classes, mostly noise, green=data used.

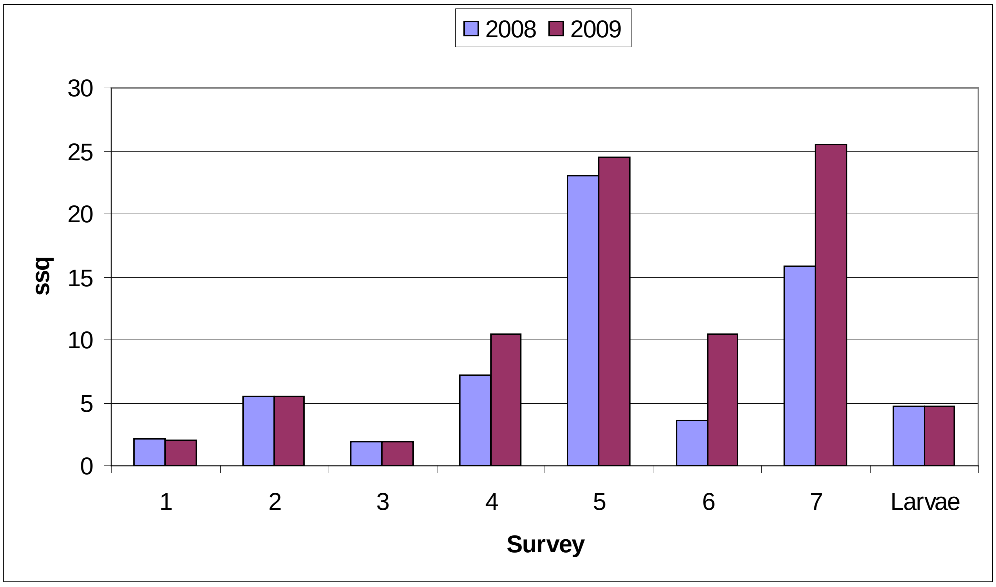


Figure 7.7.3.3. Norwegian spring-spawning herring. Residual sum of squares in the surveys separately from TASACS in 2008 and 2009.

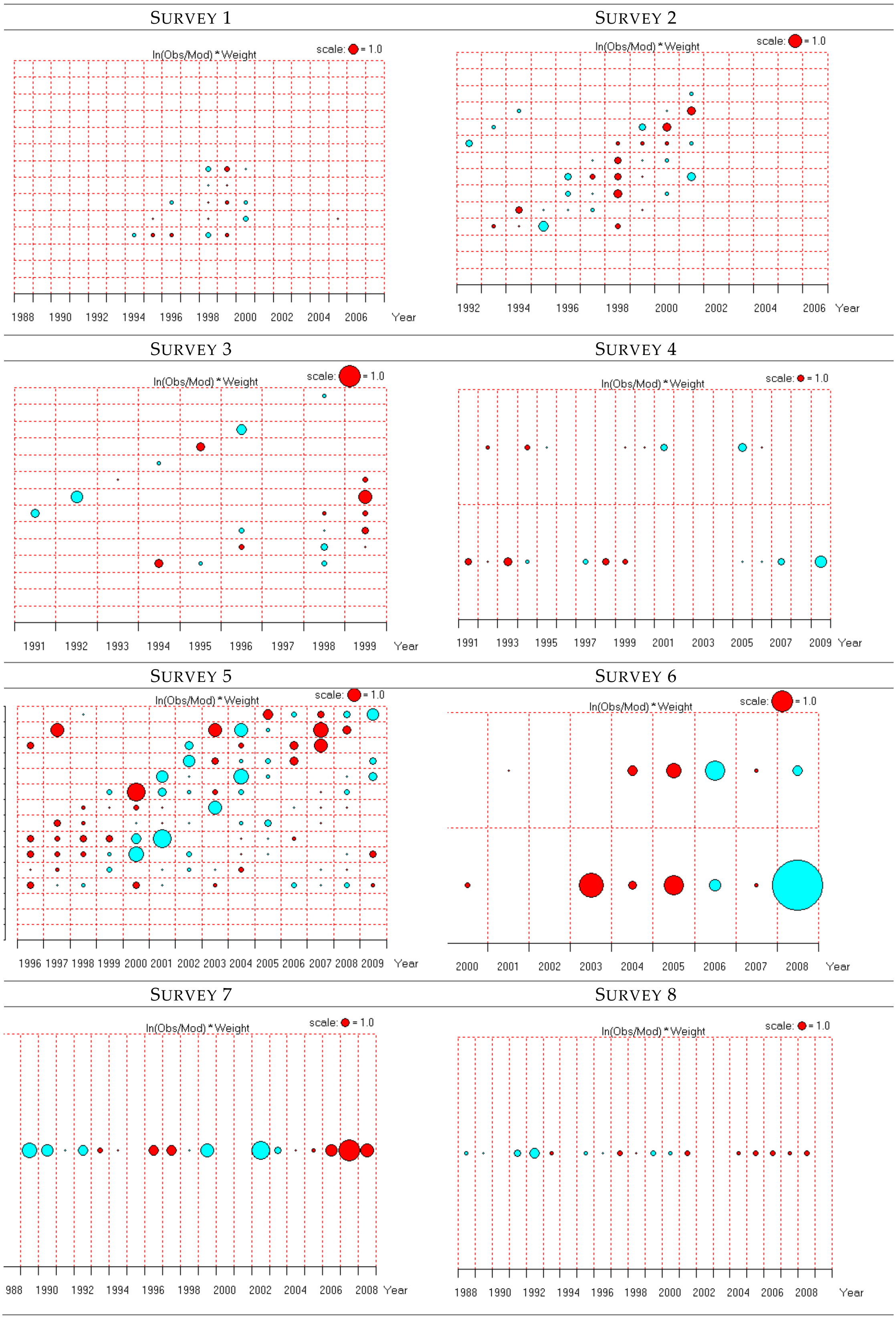


Figure 7.7.3.4 Norwegian spring-spawning herring. VPA weighted residuals for the different surveys.

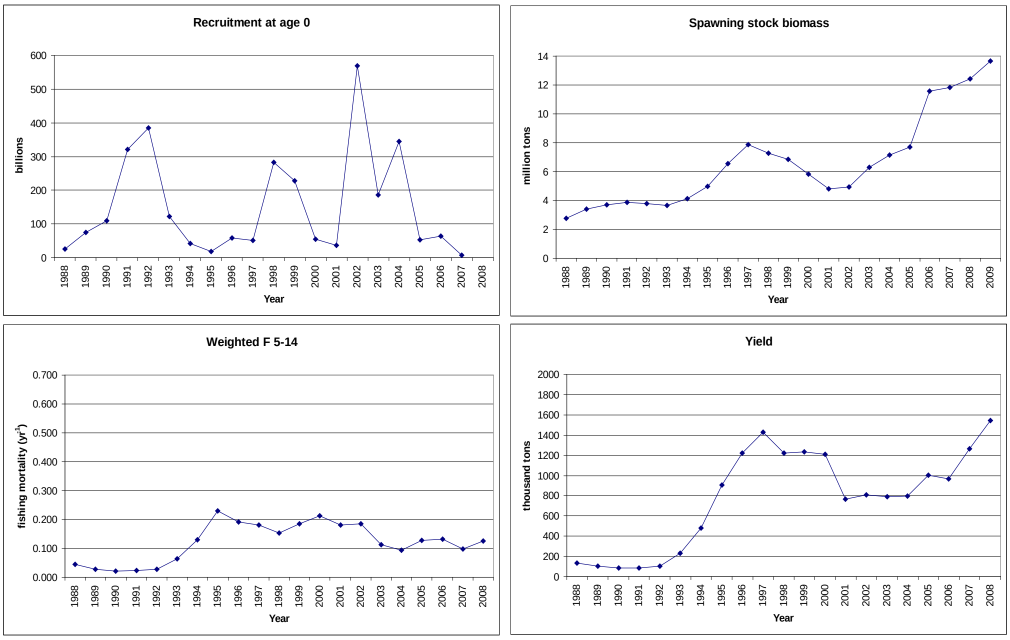


Figure 7.7.3.5. Norwegian spring-spawning herring. Standard plots from final assessment (VPA) in 2009.

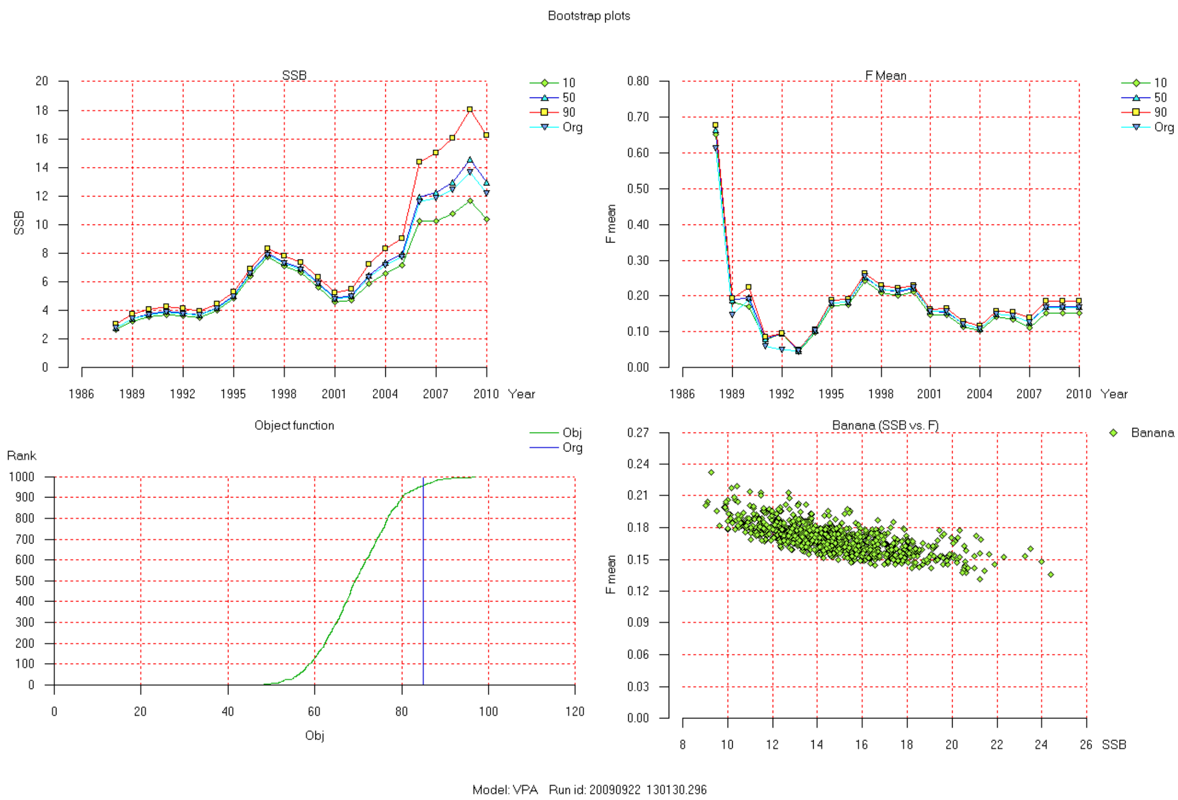


Figure 7.7.4.1. Norwegian spring-spawning herring. Percentiles for spawning stock biomass (top left), mean F 5-10 (top right), SSQ (bottom left) and “Banana”-plot (bottom right) from bootstrap results for final assessment.

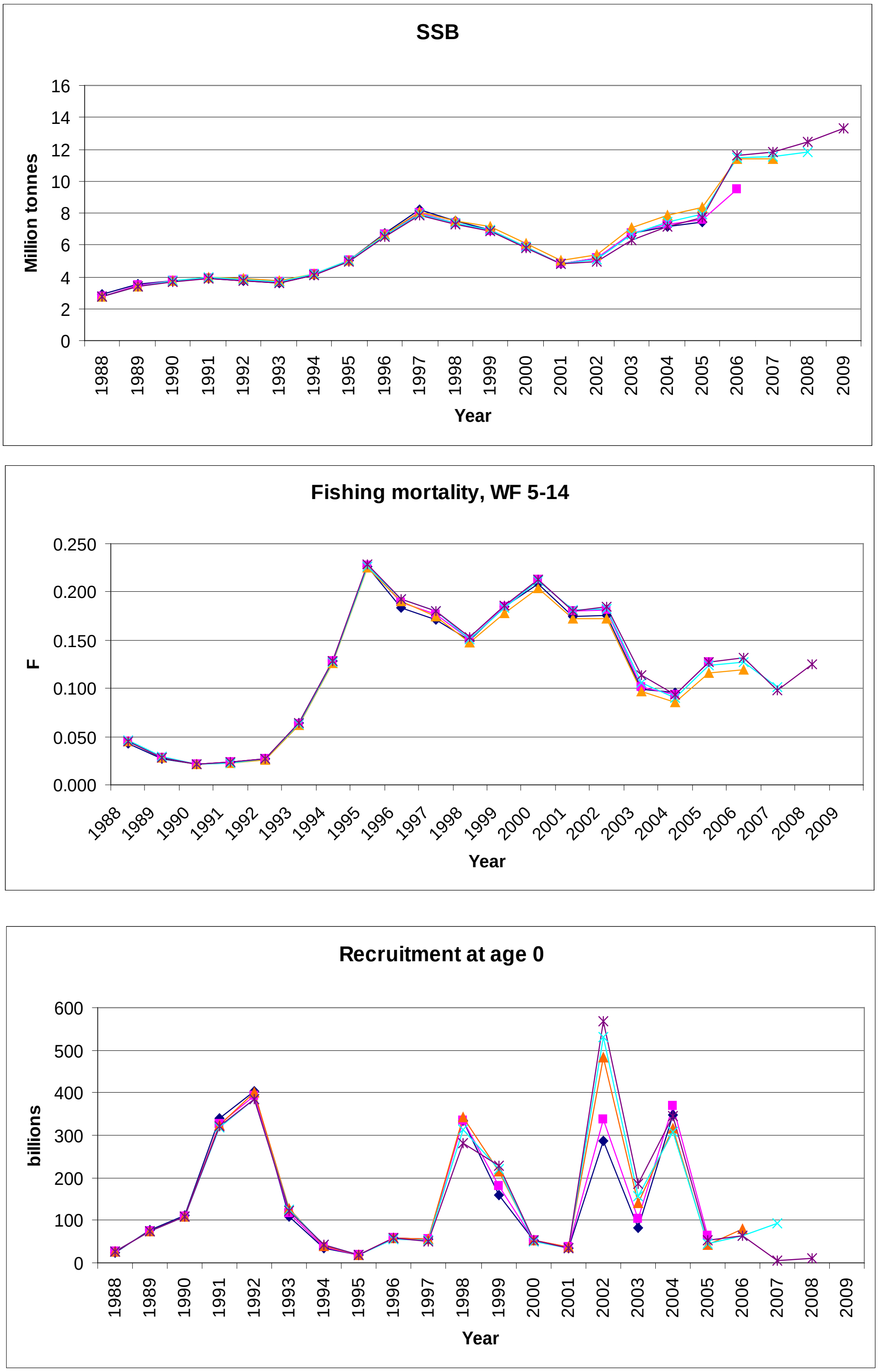


Figure 7.7.5.1 Norwegian spring-spawning herring. Retrospective run for VPA. SSB, F-Mean (F5-10) and recruits

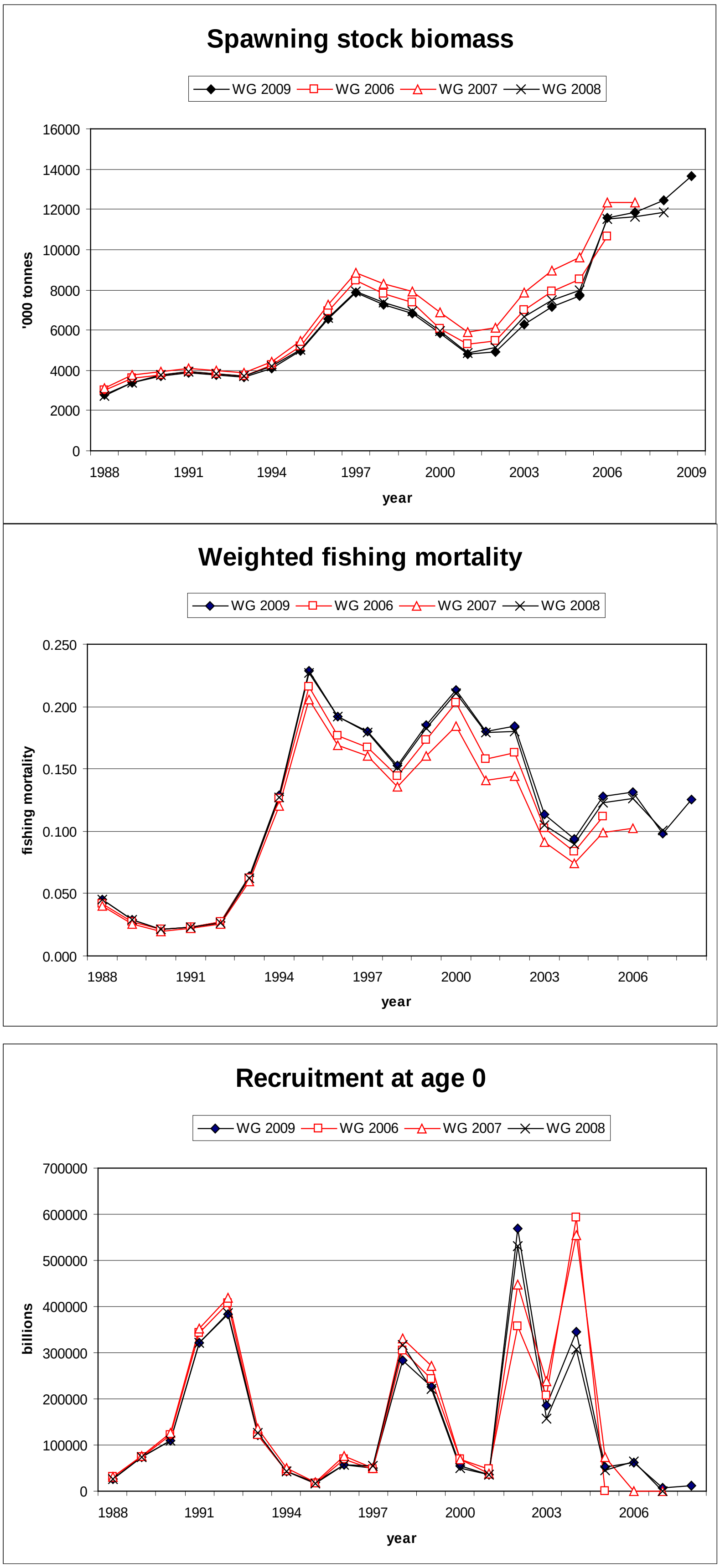


Figure 7.12.1. Norwegian spring spawning herring. Comparisons of spawning stock, weighted fishing mortality F5-14 and recruitment at age 0 with previous assessments.

8 Blue Whiting

Blue whiting (*Micromesistius poutassou*) is a small pelagic gadoid that is widely distributed in the eastern part of the North Atlantic. The highest concentrations are found along the edge of the continental shelf in areas west of the British Isles and on the Rockall Bank plateau where it occurs in large schools at depths ranging between 300 and 600 meters but is also present in almost all other management areas between the Barents Sea and the Strait of Gibraltar and west to the Irminger Sea. Adults reach maturation at 2–7 years old and undertake long annual migrations from the feeding grounds to the spawning grounds. Most of the spawning takes place between March and April, along the shelf edge and banks west of the British Isles. Juveniles are abundant in many areas, with the main nursery area believed to be the Norwegian Sea. See the stock Annex for further details on stock biology.

8.1 ICES advice in 2008

ICES classified the stock as having full reproductive capacity, but being harvested at increased risk. SSB increased to a historical high in 2003, but has decreased since then and was expected to be just above B_{pa} in 2009. The estimated fishing mortality was well above F_{pa}. Recruitment of the 2005 and 2006 year classes were estimated to be in the very low end of the historical time-series. Surveys indicated that the 2007 year class could also be low.

ICES has evaluated the 2006 management plan and found it not to be in accordance with the precautionary approach in a period of low recruitment. In July 2008 a new draft management plan was proposed by the Coastal States. ICES has evaluated the draft management plan and considers it precautionary if fishing mortality in the first year should immediately be reduced to the fishing mortality that is implied by the Harvest Control Rule (see the Stock Annex for details). The management plan has not yet been adopted.

8.2 The fishery in 2008 and 2009

This main fisheries on blue whiting took place in the Faroes region, west of Scotland and around the Porcupine Bank (Figure 8.2.1). The multi-national fleet currently targeting blue whiting consists of several types of vessels but the bulk of the catch is caught with large pelagic trawlers (Table 8.2.1). Thirteen countries reported blue whiting landings in 2008. Specific details from some of these fisheries are provided below. Even though the majority of the blue whiting quotas for most national fleets is landed in the first half of the year, detailed information on the timing and location of catches in the current year are not always available by the time of the WGWIDE meeting in September.

8.2.1 Denmark

The directed fishery in the western and northern areas constituted 97% of the total Danish blue whiting fishery (18 000 tonnes) and this fishery was conducted mainly in March and April. The landings from the North Sea and Skagerrak were 500 tonnes. All landing are for production of fish meal and oil.

8.2.2 Germany

The vessels targeting blue whiting belongs to a pelagic freezer trawler fleet owned by a Dutch company and operating under the German flag. This fleet consist of four large pelagic freezer-trawlers purpose built for pelagic fisheries.

8.2.3 Faroe Islands

The Faroese pelagic fleet was reduced in 2008 and especially in 2009 as a result of poorer fishing opportunities due to a reduction in the Faroese quota of blue whiting the last two years. Also, the amounts taken in the northern area, especially in Icelandic waters has decreased significantly over this time. In 2007 there were 11 larger purse-seiners/trawlers plus three smaller vessels, but in 2009 only six larger vessels are left and only one smaller vessel has been operating. The fishing pattern in recent years follows a similar pattern. Starting in January Faroese vessels follow the pre-spawning blue whiting on their migration southwards in the eastern part of the Faroese zone and the fishery later develops in the spawning area on the Porcupine Bank (VIIc). Later in February and March a large fishery for spawning blue whiting develops to the west of the Hatton-Rockall Plateau in International waters (VIIc and VIb). The Faroese quota in EU is usually finished in April and the fleet then operates outside EU waters until the post-spawning blue whiting starts to enter the southern part of the Faroese area (Division Vb) in late April or early May. The fishery continues here until July, with a gradual shift to the northwest in to the Icelandic zone (Division Va and IIa). In December the fleet again targets the pre-spawning blue whiting in the eastern part of the Faroese zone, on the north-eastern part of the shelf slope. All catches are taken with pelagic trawl.

8.2.4 Iceland

The Icelandic directed fishery started late in January in International waters west of the British Isles and in Faroese EEZ. It continued there through May with a gradual movement towards the Faroese waters. Iceland and Faroese have a bilateral agreement of mutual fishing rights for blue whiting in each others EEZs. In contrast to previous years, almost all of the catch was taken outside of Icelandic EEZ: 104 000 tonnes in the Faroese EEZ, 59 000 tonnes in the International zone and less than 1 000 tonnes in other areas.

8.2.5 Ireland

The Irish fishery for blue whiting began in mid February 2008 with the majority of landings reported from quarter 1 and quarter 2. A total of 16 boats took part in this fishery and reported landings of 22 852 t. This is a decline from 2007 when the Irish landings were 31 131 t. Fishing took place to the west and northwest of Ireland on spawning and post spawning aggregations. The main landings are reported from ICES area VIIc with lesser amounts reported from areas VIa, VIb and VIIb. Fishing was concentrated along the shelf-edge and in deeper waters between 300 m and 600 m. Figure 8.2.5.1 show the proportions at age and length from Irish and Norwegian sampling data from 2005-2009. The proportions of small and young fish have decreased during this time.

8.2.6 Netherlands

The Dutch fleet targeting blue whiting in European waters consisted of 10 freezer trawlers in 2008, up one from 2007. Catches remained stable from 2007 to 2008 (80 730t and 78 447t, respectively). In both years all the directed catches were landed in the first two quarters, with a higher proportion of the catch landed in the first quarter in 2008 compared to 2007. The majority of the catches in 2008 originated from ICES Divisions VIa (mainly second quarter) and VIIc (mainly first quarter).

8.2.7 Norway

After the coastal states agreement in 2007 and quota transfers in other international agreements, the Norwegian TAC for 2008 was set to 429 580 t (of which 323 491 t could be taken in the EU zone and 51 080 t in the Faroese EEZ). The majority of the Norwegian catches were taken in a directed pelagic trawl fishery west of the British Isles and south of the Faeroe Islands during the first half of the year. The remaining catches were mainly taken by the industrial trawl fleet (which uses both pelagic and demersal trawls) in the Norwegian deeps and Tampen area (east of 4ºW). Samples from catches in the directed pelagic trawl fishery west of the British Isles show that the proportion of small and young fish has decreased significantly the last years, with a very low proportion of small/young fish in 2008 and 2009 (Figure 8.2.5.1).

8.2.8 Russia

The Russian blue whiting fishery was carried out by six trawlers in the southern part of Faroese zone in January 2008. The same number of vessels began work in the international waters off the Rockall-Porcupine banks in mid-February, two weeks later than last year. In March, the number of vessels operating increased to a maximum of 20. In mid-April, after the 87000 tons were caught, the fleet moved to the Faroese area. In late May, the fishery moved to the northern part, and the total number of vessels decreased to 13. In mid-July the Russian quota in the waters of NEAFC was implemented and the subsequent fishery was conducted either in the EEZ or on account of the agreed quota there. Blue whiting was caught only as by-catch until mid-November, when 8 trawlers began to targeting blue whiting in the Faroese area. In 2009 the fishery in the Rockall-Porcupine region started again in mid-February, however the maximum number of trawlers did not exceed 14. The fishery moved to Faroese waters after the 1st week of April, one week earlier than in 2008.

8.2.9 Spain

The Spanish blue whiting fishery is carried out mainly by bottom pair trawlers in a directed fishery (approx. one third of the fleet) and by single bottom otter trawlers in a by-catch fishery (approx. two thirds of the fleet). The fleet operates throughout the year. Small quantities are also caught by longliners. These coastal fisheries have trip durations of 1 or 2 days and catches are for human consumption. Thus, coastal landings are driven mainly by market forces, and are rather stable. The fleet operates only in Spanish waters year round and does not follow any blue whiting migration. The Spanish fleet has decreased from 279 vessels in the early 1990s to 135 vessels in 2008. Spanish landings increased slightly in 2008 having a total landing of 14 342 tonnes.

8.2.10 Portugal

Blue whiting is commonly caught as a by-catch by the Portuguese bottom-trawl fleets targeting finfish and crustaceans, which comprises around 100 vessels under 30 meters long. Some vessels of the artisanal fishing fleet also catch blue whiting as by-catch, although this is mostly discarded because it is rarely used for human consumption in Portugal and there is no market demand for industrial transformation. Recently, some vessels started targeting blue whiting for export to Spain, and landings have been fluctuating following the demand from that new market.

8.3 Data available

8.3.1 Catch data

Total catches in 2008 were provided by members of the WG. The data provided as catch by rectangle represented approximately 94% of the total WG catch in 2008. For the fourth consecutive year, total catch has declined, although it remains higher than pre-2000 levels

(Figure 8.3.1.1A). Total catch for 2008 was estimated to be about 1.25 million tonnes, 364 thousand tonnes less than in 2007. The total catch by country for the period 1988 to 2008 is presented in Table 8.3.1.1.

The spatial and temporal variation in catch for the period 2000–2008 are shown in Figures 8.3.1.2 and 8.3.1.3, respectively. Since 2003 there has been a shift the location and timing of the catch. The majority of the catch is now caught further south (shifting from sub-area II towards sub-areas VI and VII) and earlier in the year. Catches by nations and area for 2008 are given in Table 8.3.1.2 and catches by quarter and area are in Table 8.3.1.3. In the first two quarters catches are made over a broad area while later in the year catches are mainly taken further north in sub-area IIa and in the North Sea (Division IVa).

The proportion of landings originating from the Norwegian Sea has been decreasing steadily over the recent period to less than 10% of the total catch (Figure 8.3.1.1B and Table 8.3.1.4). This is accredited to the lack of juvenile fish in recent years (year classes of very poor recruitment).

8.3.1.1 Discards

Discards of blue whiting are thought to be small. Most of the blue whiting is caught in directed fisheries for reduction purposes. There are no new data on discards or by catch in the blue whiting fishery this year. See the Stock Annex for further details.

8.3.1.2 Sampling intensity

Detailed information on the number of samples, number of fish measured, and number of fish aged by country and quarter is given in Table 8.3.1.2.1 and are presented and described by year, country and area in section 1.3.1 (Sampling Data from Commercial Fishery). In total 927 samples were collected from the fisheries in 2008. 113 749 fish were measured and 21 844 were aged. Sampled fish were not evenly distributed throughout the fisheries (Table 8.3.1.2.2). Considering the proportion of samples per catch, the most intensive sampling took place in the southern fishery of Spain and Portugal. Here one sample was taken for every 41 tonnes, followed by the mixed fishery with one sample for every 394 tonnes, and lastly the directed fishery where there was one sample for every 2 966 tonnes caught. In this context it should be noted that implementation of the EU Collection of Fisheries Data, Fisheries Regulation 1639/2001, requires EU Member States to take a minimum of one sample for every 1000 t landed in their country. As can be seen, no sampling data were submitted by Scotland, Sweden, France and Lithuania, all with relatively small landings (none in the case of Sweden). Sampling intensity for age and weight of herring and blue whiting are made in proportion to landings according to CR 1639/2001 and apply to EU member states. For other countries there are no guidelines. Current precision levels of the sampling intensity are unknown and the group recommends reviewing the sampling frequency and intensity on a scientific basis and provide guidelines for sampling intensity.

8.3.1.3 Length and age compositions

Data on the combined length composition of the 2008 commercial catch by quarter of the year from the directed fisheries in the Norwegian Sea and from the stock's main spawning area were provided by the Faroes, Iceland, Ireland, Germany, the Netherlands, Norway and Russia (Table 8.3.1.3.1). Length composition of blue whiting varied from 16 to 48 cm, with 95% of fish ranging from 25–34 cm in length. This range represents a slight shift to longer fish compared to the previous year. The mean length in the fishery was 28.1 cm, which is 8 mm larger than the mean length last year, and 12 mm larger than the mean length the year before. This increase in length appears to be due to a decrease in recruitment in the most recent years lowering the proportion of young fish in the population.

Length compositions of the blue whiting catch and bycatch from "mixed fisheries" in the Norwegian Sea and the North Sea and Skagerrak were presented by Norway (Table 8.3.1.3.2). Like the directed fishery, this fishery also shows an increase in the size of fish landed, but this is less marked,. The catches of blue whiting from the mixed industrial fisheries consisted of fish with lengths of 15–44 cm with 95% of fish ranging from 20-33cm. The mean length was 26.5 cm, up 5mm from last year. The Norwegian mixed fishery shows less variation in the distribution of fish length over the quarters of the year compared to the directed fishery, which shows an increase in the lower bounds in the last two quarters.

The Spanish and Portuguese data used for length distribution of catches showed a length range from 14–41 cm with 95% of fish ranging from 18-27cm (Table 8.3.1.3.3). This distribution is slightly narrower than last year. The mean length was 23.1cm, the same as in the previous year.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the bycatch of blue whiting in "other fisheries" and for landings in the Southern area, were assumed to represent the overall age composition of the total landings for the blue whiting stock. The InterCatch program was used to calculate the total international catch-at-age, and to document how it was done. The catch numbers-at-age used in the stock assessment and the mean age of the stock are given in Table 8.3.1.3.4. The calculation of mean age assigns an age of 10 to all fish in the plus group. Therefore in years of high plus group abundance the mean age could be significantly underestimated. However, the mean age of the stock has been increasing since 2001 despite an increase in plus group abundance over the same period.

Catch proportions at age plotted in Figure 8.3.1.3.1. Strong year classes can be clearly seen in the early 1980s, 1990 and the late 1990s. Poor recruitment over the recent period has lead to an increase in the age of fish caught during this time. Catch curves made on the basis of the international catch-at-age (Figure 8.3.1.3.2) indicate a consistent stock-decline and thereby reasonably good quality catch-at-age data, especially for year classes since 1995.

8.3.2 Information from the fishing industry

No comprehensive information has been received from the fishing industry this year.

8.3.3 Weight at age

Table 8.3.3.1 and Figure 8.3.3.1 show the mean weight-at-age for the total catch during 1983–2008 used in the stock assessment. Compared to the 2007 mean weights, the values from 2008 have increased for ages 1-5 and decreased for ages 7-8. It is however too early to conclude that the decreasing trend in mean weight for the last 10-15 years have stopped. See the Stock Annex for an analysis of the change in mean weights.

The weight-at-age for the stock was assumed to be the same as the weight-at-age for the catch.

8.3.4 Maturity and natural mortality

Blue whiting natural mortality and proportion of maturation-at-age is shown in Table 8.3.4.1. See the Stock Annex for further details.

8.3.5 Fisheries independent data

8.3.5.1 International Blue Whiting spawning stock survey

Background and status

The International Blue Whiting Spawning Stock Survey (IBWSS) is carried out on the spawning grounds west of the British Isles in March-April. The survey started in 2004 and is carried out by Norway, Russia, the Faroe Islands and the EU. This international survey, allowed for broad spatial coverage of the stock as well as a relatively dense net of trawl and hydrographical stations. The survey is coordinated by PGNAPES (ICES CM 2009xx, in press).

The International survey directly incorporates both the Norwegian and Russian spawning stock surveys that started in the early 1990s; details of these surveys can be found in previous working group documents (e.g. ICES CM 2006/ACFM:34). The integrity of the Norwegian time-series has been maintained from 1991–2006, and it was used as the major source of survey information in previous assessments. However, in 2007 the Norwegian contribution to the international survey changed, resulting in coverage of a non-standard area, and therefore a break in the time-series. The index from the Norwegian spawning stock survey time-series could therefore not be used from this year onwards.

Use of this survey in stock assessment

Indices of age 3-8 from the IBWSS survey were used as tuning time series in the assessment this year.

Quality of the survey

Uncertainties in spawning stock estimates have been assessed again in 2009. At present, only one source of uncertainty is considered namely the spatio-temporal variability in acoustic recordings. In 2009 mean acoustic density is similar to that observed in 2004–2006 and 2008 over the entire survey area, and much less as observed in 2007 (Figure 8.3.5.1.1A). This was caused by a few very high density observations in 2007. Relating these data to the stock estimate results show that the observed decline in biomass between 2006–2008 and 2009 is more than could be expected from uncertainty arising from spatial heterogeneity alone. In other words, within the considered domain of uncertainty, the decline is statistically significant.

The International spawning stock survey shows moderately good internal consistency for certain age groups (Figure 8.3.5.1.1B). The international time-series clearly lacks sufficient data points to make a firm conclusion regarding internal consistency. The youngest ages in 2009 show low consistency probably caused by very low incidence of recruits in this survey in the last years, thus making the indices of these age groups less reliable.

Results

The spawning stock biomass appears to be maintained largely by growth of individuals in the spawning stock and only to a small extent from recruitment to the spawning stock.

The distribution of acoustic backscattering densities for blue whiting for the last 4 years is shown in Figure 8.3.5.1.2. The main concentrations were generally recorded in the area between the Hebrides (> 50%) and the banks southwest of the Faroes and the area north of Porcupine Bank. The blue whiting spawning stock estimates based on the international survey are given in Table 8.3.5.1.1.

The estimated total abundance of blue whiting for the 2009 international survey on the spawning grounds was 6.1 million tonnes, representing an abundance of 47x109 individuals. The spawning stock was estimated at 6 million tonnes and 46x109 individuals. In comparison to the results in 2008, there is a significant decrease (about 25%) in the observed stock biomass.

The stock in the survey area is dominated by age 5 and 6, the 2003 and 2004 year classes respectively, contributing close to 60% of the spawning stock biomass. Immature individuals were observed in all sub areas and represents less than 1.4% of the total stock biomass.

Age and length distributions from the five last years are shown in Figure 8.3.5.1.3.

8.3.5.2 International ecosystem survey in the Nordic Seas

Background and status

The international ecosystem survey in the Nordic Seas is aimed at observing the pelagic ecosystem with particular focus on Norwegian spring-spawning herring and blue whiting in the Norwegian Sea. Estimates in 2000–2008 are available both for the total survey area and for a "standardized" survey area (Figure 8.3.5.2.1). The latter is more meaningful as the survey coverage has been rather variable in the non-standard areas.

The survey is carried out in May since 1995 by the Faroes, Iceland, Norway, and Russia, and since 1997 (except 2002 and 2003) the EU. The high effort in this survey with such a broad international participation allowed for broad spatial coverage as well as a relatively dense net of trawl and hydrographic stations.

Since 2005 this survey has extended into the Barents Sea where the main focus of investigations has been young herring. Low numbers of blue whiting found in the Norwegian bottom trawl survey in this area suggest that this gap would not significantly change the estimate for blue whiting. The survey is coordinated by PGNAPES (ICES CM 2009xx, in press).

Use of this survey in stock assessment

Indices of age 1 and 2 (from the standard area) is used as tuning time series in the assessment. Moreover, the age 1 indices are used in the recruitment prediction.

Quality of the survey

Internal consistency within the survey's age composition shows good correlation for the early age groups 1 to 4 year olds (Figure 8.3.5.2.2).

Results for blue whiting

The total biomass of blue whiting reported during the May 2009 survey was 0.9 million tonnes, which is very low. The stock estimate in number for 2009 is 5.7 billion.

An estimate was also made from a subset of the data; namely the "standard survey area" between 8°W-20°E and north of 63°N (Figure 8.3.5.2.1). This area has been used as an indicator of the abundance of blue whiting in the Norwegian Sea because the spatial coverage in this area provides a coherent time series with adequate spatial coverage – this estimate is used as an abundance index in the assessment. The age-disaggregated total stock estimate in the "standard area" is presented in Table 8.3.5.2.1, showing that the part of the stock in this index area is dominated by 4 year old blue whiting.

The observed distribution of blue whiting has decreased as compared to earlier year, in parallel with the decrease in blue whiting abundance (Figure 8.3.5.2.3). It should be noted that the spatial survey design was not intended to cover the whole blue whiting stock during this period.

The blue whiting stock estimates based on the international survey in both the standard and total survey area are given in Table 8.3.5.2.1. Age and length distributions from the last five years are shown in Figure 8.3.5.2.4.

8.3.5.3 Norwegian bottom trawl survey in the Barents Sea

Background and status

Norway has conducted bottom trawl surveys targeting cod and other demersal fish in the Barents Sea since late 1970s. From 1981 onwards there have been systematically designed surveys carried out during the winter months (usually late January-early March) by at least two Norwegian vessels; in some years the survey has been conducted in co-operation with Russia. Blue whiting is a regular bycatch species in these surveys, and has in some years been among the numerically dominant species (Heino et al., 2003). This survey is presently giving the first reliable indication of year class strength of blue whiting.

Most of the blue whiting catches (or samples thereof) have been measured for body length, but very few age readings are available (from 2004 onwards otoliths are systematically collected). The existing age readings suggest that virtually all blue whiting less than 19 cm in length belong to 1–group and that while some 1–group blue whiting are larger, the resulting underestimation is not significant. An abundance index of all blue whiting and putative 1–group blue whiting from 1981 onwards is given in Table 8.3.5.3.1 and follows methods described in Heino *et al*. (2003).

1–group index for 2009 is zero, the lowest observed.

Use of this survey in blue whiting assessment

The survey is not used in the assessments, but it is used for recruitment predictions.

8.3.5.4 Other surveys

The stock Annex provides information and time series from surveys covering just a small fraction of the stock area. Data from these surveys are not used directly in the assessment.

8.4 Stock assessment

In previous years, the NPBWWG and WGWIDE used an array of models for the assessment and made a comprehensive presentation and comparison of the various model output. Based on this evaluation, the SMS assessment has been chosen as the final assessment for the last three years. This year we have done the same exercise, but with a fewer models tested, and made a less comprehensive presentation of the model results. Specification of individual models and their settings are presented in the Stock Annex.

ICES has classified the assessment this year as an update assessment, and no new methods were applied this year, but additional model options were analysed. The survey index values used in the blue whiting assessment are presented in Table 8.4.1.

Note:

The Russian catch data for 2009 as used by WGWIDE, were incorrect. This error was spotted 2 weeks after the assessment was closed.

WGWIDE had used a Russian catch of 164 072t in 2009, where the correct value is 225 163 t (61 091 t from area VIb was excluded). Total international landings were estimated to 1 185 375 t before the correction (table 8.3.1.1 in the WGWIDE rep.); now it is estimated to 1 185 375 + 61 091 = 1 246 465 t. This correction corresponds to a factor of 1 246 465/1 185 375=1.052.

On the correction it was assumed that the "missing" Russian landings have had the same age-composition as the "total International" catch at age numbers. That means that the catch numbers should be raised by the 1.052 factor.

InterCatch was re-run using the updated Russian data. Catches and sampling tables and figures were updated and are available on the report. The final assessment was also updated and is available on the report. However all the exploratory analysis and additional models do not include this correction. However, despite the minor change in catch values, the exploratory analysis remains a valid comparison of model results.

8.4.1 Data exploration in SMS

The data exploration using the Stochastic Multi-Species (SMS) model (Lewy and Vin-ther, 2004) focussed on the effect of down weighting the information from the short time series from The International Blue Whiting Spawning Stock Survey (IBWSSS). This survey was included in the assessment in 2007, even though the time series had only 4 years. The results from the 2007 model runs showed that the model is fitting to the IBSSS with a low CV (0.2) for most ages, and thereby placing a high weight upon it. However, this may be scientifically unwise, due to the very short time series and lack of contrast in the data, and it was decided in 2007 to set a lower bound of the estimated CV at 0.40. Last year, where the survey time series was extended to 5 years a sensitivity analysis showed that the extra year had stabilized the assessment considerably, but it was decided to keep the minimum CV at 0.40 for the survey due to the short time series, even though the estimated CV was 0.20.

With the addition of a further year of data the IBWSSS now spans 6 years, which might be sufficient to loosen the lower bound on the CV and let model and data estimate the uncertainties for the IBWSSS.

Figure 8.4.1.1 shows the output for various configurations of the CV for IBWSSS. If the CV is unconstrained, the model estimates a CV at 0.19 for the survey. The figures also shows output for a configuration using CV=0.4 (as used last year) and a configuration using a minimum CV at 0.30. The results clearly show that a lower CV on IBWSSS result in an increase in SSB and a decrease in *F* in the terminal years. SSB is estimated 19% higher in the run using an unbounded CV compared to the run using a minimum CV at 0.40.

When the configuration allows a better fit (lower CV) at the IBWSSS, the likelihood for survey observations becomes better; however the likelihood for catch observations deteriorates slightly (text table below). Total likelihood for the whole model is best for the unbounded CV configuration.

Text table. SMS model exploration. Un-weighted objective function contributions (negative log likelihood) by submodel.

	Submodel			
Configuration	Catch at age	Survey indices	Stock/recruitment	Sum
Unbounded CV	-194.0	-15.5	9.3	-200.2
Min CV=0.3	-195.4	-9.4	9.6	-195.1
Min CV=0.4	-195.7	-2.7	9.9	-188.5

The difference in the catch likelihoods is small and the catch residual plots from the unbounded CV (Figure 8.4.1.2) and the CV=0.40 configurations appear identical. A plot of the predicted and observed total catch weight for the two configurations (Figure 8.4.1.3) show that the bounded CV configuration (CV=0.4) fits better for yield in 2004 and 2006, however the difference between the two configurations is small.

The residual plot for survey observations for the unbounded CV and the CV=0.4 configurations are almost identical except for the IBWSSS (Figures 8.4.1.4 and 8.4.1.5). As expected, residuals are in general smaller for the unbounded CV but the pattern is the same. The "year effect" with all positive residuals in 2009 are larger for the CV=0.4 configuration.

The results from the retrospective analysis for the unbounded version (Figure 8.4.1.6) show a tendency for underestimation of SSB and overestimation of *F* in the terminal year. The same pattern is seen for SSB in the CV=0.4 configuration (Figure 8.4.1.7), but the retrospective bias seems slightly larger.

The likelihood for the total model is best for the unbounded configuration (text table above) which is also reflected in the estimate of the uncertainties on SSB and mean *F* (Figure 8.4.1.8 and 8.4.1.9). SSB in 2008 is estimated with a CV of around 10% for the unbounded version, while CV on SSB is 15% for the bounded configuration.

A final check for any side effect of an unbounded CV was examined by varying the *a priori* weights applied to all survey information in the SMS model. If the information from the catch and the survey data are the same, the results from the model will be insensitive to the weighting of the various data sources. The default *a prior* weighting value is 1.0 for all sources. Figure 8.4.1.10 shows that for the unbounded configuration there is practically no effect of varying the *a priori* weight for the estimates of SSB and *F*. The same results are obtained for the bounded version. In both configurations the recruitment is estimated lower with a higher *a priori* weights on survey data. This is due to the very low recruitment indices form the International Ecosystem survey.

The uncertainties of SSB derived directly from the survey data from IBWSSS (Figure 8.3.5.1.1) show a CV at around 8-10%. Such low CV of the total SSB indicates that the SMS' estimate of the CV for the abundance indices at age at 0.19 seems likely.

Given the above considerations, in combination with a comparison of output from other models (section 8.4.4), WGWIDE decided that the lower bound on CV for the IBWSSS at 0.40, introduced when the time series included only 4 years, is no longer necessary for the extended time series used in this year's assessment.

Final configuration of SMS: The final SMS configuration (see the Stock annex for details) is the same as last year except for removal of the lower bound on survey CV. The terminal period for constant age-selection in catches was extended from 1999–2007 to 1999–2008.

Examination of the catch residuals from the final SMS run (Figure 8.4.1.2) showed no appreciable patterns. The residuals from the survey observations (Figure 8.4.1.4) showed significant year effects in the IBWSSS and Norwegian spawning stock survey, a well-known phenomenon with acoustic surveys. The residuals from the International Ecosystem Survey in Nordic Seas (IESNS) are very large. This is due to the very low indices for all year classes since the 2005 year class. For age 1 the difference is a factor of more than 300 between the two group of year classes; for age 2 the ratio is a factor of 100. Catch data indicate a steep reduction in the recruitment, however not at that magnitude as indicated by the survey data. Fitting those two times data series with the same trend, but with a very different decrease is not possible with an assumption of constant catchability, leading to the very large residuals for the survey.

Examination of the diagnostic output from the final SMS run (Table 8.4.1.1) does not show any major causes for concern, although there is an unusual effect in the values of the survey catchabilities-at-age. The catchability in the Norwegian Spawning Stock Survey increases with age, and reaches at maximum at age 4. This is an unusual result, and tends to contradict the trend seen in the IBWSSS, where the catchability in-creases with age, even though these two surveys are quite similar in setup. A similar phenomenon was observed Norwegian spawning stock survey in the final SMS run in the 2006–2008 working group. There is no good explanation for the result, but could simply be due to a lower (trawl) catchability of the oldest fish on the Norwegian spawning stock survey.

Comparison of the observed and fitted catches from the SMS run (Figure 8.4.1.3) in combination with the catch residual plot (Figure 8.4.1.2) did not provide strong evidence that the separability assumption has been violated.

Due to the short IBWSSS time series the retrospective (Figures 8.4.1.6 and 8.4.1.7) can only be run for the last three years. The most recent *F* estimates are decreased and the SSB increased by addition of the 2008 data.

The comparison of the final assessment results in 2008 and the final SMS this year is presented in Figure 8.4.1.11) and is discussed in section 8.8.1

The final SMS run (Figure 8.4.1.12, Tables 8.4.1.2–8.4.1.4) shows a decrease in fishing mortality in the terminal year. SSB is very rapidly decreasing associated with a strong decreasing recruitment from 2001 onwards and a limited decrease in landings in the same period. Year classes since 2005 are at historic low level.

The overall level of uncertainties of SSB and mean *F* have decreased considerably since last year's assessment. Last year, CV at SSB and F in the terminal were respectively 15% and 20%; this year, those CVs are estimated to 10% and 12% (Figure 8.4.1.8).

8.4.2 Data exploration in TISVPA

As in the previous assessments (2006 - 2008), the "triple-separable version of the ISVPA model (TISVPA) was used for exploratory runs. The options applied this year are similar to those applied last year. See stock Annex for details on model description.

For surveys the respective components of the model objective function were chosen in order to produce less contradicting signal about the stock from all of them: the median of squared logarithmic residuals for survey 1; the absolute median deviation (AMD) for survey 2, and the sum of squared logarithmic residuals for survey 3 (Figure 8.4.2.1). As it can be seen, surveys indicate somewhat higher stock biomass in 2009 compared to what comes from catch-at-age data.

The selection pattern, estimated by the TISVPA model is shown on Figure 8.4.2.2. Figure 8.4.2.3 shows the model residuals by sources of data.

The ISVPA results and the retrospective analysis are shown in Figure 8.4.2.4. The retrospective analysis shows a clear tendency of underestimating SSB and recruitment.

Compared to the final TISVPA presented last year, the results of the present TISVPA run give somewhat higher estimates of SSB, *F* and recruitment in the most recent years (Figure 8.4.2.5).

8.4.3 Data exploration in XSA

XSA was run with the three surveys with data up to 2008 (and thereby no use of 2009 surveys) using the same options as last year.

The residual plots show, in contrast to the other assessments presented, a good fit for the juvenile estimates from the Ecosystem survey (Figure 8.4.3.1). This is due to the use of stock size dependent catchability for ages up to age 3.

The main results are presented in Figure 8.4.3.2. The retrospective analysis shows a variable estimate of SSB and *F*, however with no consistent trend in the three years presented. There is a good retrospective agreement in the estimates of recruitment in the recent years.

8.4.4 Comparison of results of different assessments

Figure 8.4.4.1 presents output from the three assessment models (SMS, TISVPA and XSA). For all the models there is a steep decrease in recruitment from the large 2000-2002 year classes to very low recruitments of the 2005-2007 year classes. All the models estimate a large SSB reduction since 2006 with SSB at around 3.2-3.6 million tons in the start of 2009. Estimates of mean *F* have decreased since 2004 in all models. TISVPA and SMS both estimate an *F* in 2008 at around 0.27 while XSA estimates *F* to be 0.4.

The explorative runs showed that the very low indices for age 1 and age 2 in 2007- 2009 from the IESNS caused some problems. For fitting all the data sources simultaneously, SMS (Figure 8.4.1.4) ends up with very large residuals and thereby down-weighted its influence on the final population estimates. TISVPA uses fixed weight on the individual survey and used the more robust measure of closeness of fit–the absolute median deviation (AMD), to avoid contradicting signals about the stock from all the data sources. The IESNS residuals from ISVPA (Figure 8.4.2.3) are however large as well. XSA cannot use the 2009 observation from IESNS but the residuals from the time series including 2008 are in general small and without a trend. This is due to the use of the XSA options, "Stock size dependent catchability" for age groups 1-3.

The WGWIDE decided use the SMS assessment results for the forecast. ICES classifies the assessment this year as an "update assessment", and in addition the WG had no strong reasons to change method. SMS has been used for the last four years as the final assessment method and SMS in its final configuration it gave results very close to the TISVPA methods.

8.5 Final assessment

Note: the final assessment presented in this report includes the correct Russian catch data (see note in section 8.4). Figure 8.5.1 shows the comparison of the SMS final assessment with and without revised catch data.

Input data are catch-at-age numbers (Table 8.3.1.3.4), mean weight-at-age in the sea and in the catch (Table 8.3.3.1) and natural mortality and proportion mature in Section 8.3.4. Applied survey data are presented in Table 8.4.1.

The key settings and data for the final blue whiting assessment 2006-2008 can be found in the Stock annex. The only change this year is the removal of the lower bound on CV for the IBWSSS survey. The second separable period has been extended with 2008, so it now includes 1999-2008.

The model was run until 2008. The SSB January 1st in 2009 is estimated from survivors without taking the contribution from recruits into account. 11% of age-group 1 is assumed mature, but with the very low recruitment this omission has practically no implications. The key results are presented in Tables 8.4.1.2–8.4.1.3 and summarized in Table 8.4.1.4 and Figure 8.4.1.12 Residuals of the model fit are shown in Figure 8.4.1.4 and discussed in Section 8.4.1. Uncertainties of mean *F* and SSB are shown in Figure 8.4.1.8.

8.5.1 State of the Stock

Based on the most recent estimates of fishing mortality and SSB, ICES classifies the stock as having full reproductive capacity and being harvested sustainable.

It is confirmed from several time series that the year classes 2005-2008 are in the very low end of the historical recruitments. Information on the 2009 year class is sparse and uncertain. It is not possible to say if the low recruitment is a more permanent shift towards the low recruitment regime, as observed in the period before the mid 1990s. Fishing mortality has declined from 0.54 in 2004 to 0.29 in 2008. Due to the low recruitment SSB has declined since its historical peak in 2003-2004 of more than 7 million tonnes to 3.6 million t in the beginning of 2009.

8.6 Biological reference points

The present precautionary reference points have been introduced in the advice of ACFM in 1998. The values and their technical basis are:

REFERENCE POINT	B_{LIM}	B_{PA}	F_{LIM}	F_{PA}	$F_{0.1}$
Value	1.5 mill t	2.25 mill. t	0.51	0.32	0.18
Basis	B_{loss}	B_{lim}* exp(1.645* σ), with σ= 0.25.	F_{loss}	F_{med}	Yield per recruit (WGWIDE, 2008)

F_{max} is poorly defined. See the Stock Annex on the discussion on the validity of the reference points.

8.7 Short term forecast

8.7.1 Recruitment estimates

In 2008 and 2009 a survey-based estimate of recruitment using the standard ICES software, RCT3 was carried out. This uses the most recent available information from the International ecosystem survey standard area index and the Barents Sea bottom trawl time series. Both recruitment indices show that the 2005-2008 year classes are very weak and are orders of magnitude lower than earlier in the series (Tables 8.4.1 and 8.4.1.4). Figure 8.7.1.1 shows how age 1 estimates from the final SMS assessment relates to age 1 indices from the two surveys. Both indices indicate zero recruitment for the 2009 year class, but because no estimate for this year class is obtained from the SMS, these values have no impact on the correlations. The correlations are similar to the previous assessment, although the log-scale correlation between the SMS estimates and the Barents index has improved from the previous assessment (R^2 increased from 0.58 to 0.67) as has the natural-scale correlation between the SMS and the IES index (R^2 increased from 0.39 to 0.46.

Input to the RCT3 model is given in Table 8.7.1.1, and output in Table 8.7.1.2. There is very little additional information available regarding the strength of incoming year classes and there are no signs of good incoming recruitment. The working group therefore decided to assume that recruitment at age 1 in 2008 and 2009 is equal to the values produced by RCT3 which are 3.869 and 2.023 billion respectively.

Since the stock now appears to have entered a "low" recruitment regime and in order to be consistent with last year the geometric mean of the recruitments from 1981–1996 (8.830 billion at age 1) was assumed for the 2009 and 2010 year classes.

The text table below shows alternative recruitment assumptions. Values used in the short term prediction are underlined.

Year class	Age in 2009	SMS	RCT3	GM 81–96	SMS 81	GM 81–08
2007	2	6.548	**3.869**	8.830	3.285	13.98
2008	1	-	**2.023**	8.830	3.285	13.98
2009–2010	0	-	-	**8.830**	3.285	13.98

8.7.2 Short term forecast

Short term forecasts were conducted with the ICES standard software MFDP (Multi Fleet Deterministic Projection) version 1a.

Input

Table 8.7.2.1 lists the input data for the short term predictions. Mean weight at age in the stock and mean weight in the catch are the same and are calculated as three year averages (2006–2008). Selection (exploitation pattern) is based on *F* in 2008 from the most recent assessment, which assumes a fixed selection since 1999. Natural mortality is assumed to be 0.2 across all ages. The proportion mature for this stock is assumed constant over the years and values are copied from the assessment input. The expected landings in 2009 are 590 000 t which corresponds to the TAC.

Output

The predicted catch and SSB from the short term forecast are presented in Table 8.7.2.2.

Fishing at F_{pa} = 0.32 in 2010, will give landings of 898 thousand tonnes and an SSB of 2.29 million tonnes in 2011. This is above the precautionary limit, B_{pa} = 2.25 million tonnes. F values of 0.34 or higher will cause the SSB to fall below B_{pa} in 2011.

The proposed management plan has a target F of 0.18 ($F_{0.1}$) which applies once SSB is above B_{pa} on the 1st January of the year in which the TAC is to be set. Following this plan and fishing at $F_{0.1}$ implies catches of 543 000 t in 2010.

The forecast was run for additional years to see what the impact of fishing at F=0.18 each year would be. From 2011 – 2013 it can be seen that the SSB and landings will decrease but SSB will remain above B_{pa} each year.

Due to the low recruitment since 2005, the main part of the SSB and Catch in 2009–2012 comes from the last strong year classes 2002–2004. Figure 8.9.2.1 shows the contribution by age to SSB and catch using F_{2009}=0.18.

8.8 Uncertainties in assessment and forecast

The assessments presented this year should be considered as fairly certain with respect to the absolute estimates of stock metrics, and certain in the conclusion on the decline in both SSB and recruitment in the most recent years.

There is only one survey that covers the spawning stock (IBWSS), and this is a rather short time series for assessment purposes. The precision of the survey index remains unchanged from previous years (PGNAPES, ICES CM 2009/RMC:06, in press) but is believed to be low. Two main factors are assumed to be important to the uncertainty of this cruise, timing and coverage. Survey timing is fixed annually to coincide with peak spawning of the stock. However, peak spawning is not determined by time but other factors including water temperature. In some years the bulk of the stock can be located further north than the central spawning area, indicating an earlier migration northwards. This earlier migration of the stock northwards can affect the precision of the estimate depending on if the bulk of the stock is contained within the survey area or not. In 2009 the bulk of the stock was located further north than in 2008 but it was assumed to be within the survey area and so was considered not to have adversely affected the precision of the estimate.

Recruitment is determined from surveys and catches. Both sources show that the abundance of 1 year old blue whiting has decreased to a very low level in the period 2006–2009. Extremely low age-2 abundance observed in survey the following year for the same year class confirms the very low abundance of juveniles in the survey area. It is not possible to estimate the exact level of recruitment, but there is no doubt that recruitment is very low.

Last years estimate of the 2006 year class, used in the forecast was 3.28 billion based on the lowest observed value in the time series. This year the assessment (catch and survey data) estimate the year class at 4.82 billion. Last year the 2007 year class was also estimated to be 3.28 billion to correspond to the lowest observed value in the time series used in the forecast. This year the 2007 year class is estimated by the assessment to be 6.54 billion. This is assumed to be an overestimate and the recruitment value obtained from RCT3 survey indices (3.86 billion) is used in the forecast. The revision of the recruitment estimates illustrates the uncertainties in the recruitment estimate, but does not give a signal of the potential bias.

The three assessment models applied this year give a consistent picture of the state of the stock. That means that the choice of the final assessment model has a very limited influence on the forecast results. Statistical uncertainties of the estimated SSB and fishing mortality from the final assessment (Figure 8.4.1.8) have decreased compared to last year, and are now at the level estimated for most other stocks.

8.8.1 Comparison with previous assessment and forecast

The comparison of the final assessment results in 2008 and the final SMS this year (Figure 8.4.1.11) shows that this year's assessment estimate has a lower F and a higher SSB in the most recent year. This is similar to what is seen by the retrospective analysis. In addition, the removal of the lower bound on CV for survey observations has also increased the estimate of SSB. In 2008 the final SMS assessment estimated SSB (2008) to be 3.39 Mt (without taking the contribution from age 1 into account). The 2009 assessment with the same settings as in 2008 estimates SSB (2008) to 4.18 Mt (including the contributions from the 1 group). The final 2009 assessment estimates SSB (2008) to be 4.70 Mt. The effects of adding a new year of data and changing the model options are not additive. However, in general terms, extending the time series increased the SSB (2008) by 0.79 Mt followed by an increase of 0.52 Mt caused by the change in the model settings.

The revision of the stock size has changed the overall impression of the state of the stock. The forecast that was carried out in 2008 found that fishing at an F of 0.18 in 2009 would correspond to landings of 429 000 t and bring SSB below B_{pa} which is 2.25 million tonnes. The advice was therefore based on a catch level of 384 000 t that would maintain the stock above B_{pa}. Due to the upwards revision of the stock, an F in 2010 of 0.18 is estimated to correspond to landings of 544 000 t and an SSB in 2011 of 2.64 million tonnes which is above B_{pa}.

8.9 Management considerations

In 2008 ICES evaluated the proposed Management plan (section 9.3.2.9 in ICES Ad-vice, 2008) and recommended that to be consistent with the precautionary approach, it is necessary to reduce F according to the Harvest Control Rule (F at 0.18) in one year. In addition, ICES noted that F should be lower than 0.18 for SSB lower than 2.5 million tonnes. The proposed management plan has not been adopted.

The advice from ICES was not followed for setting the TAC for 2009; however the as-assessment this year increased the historical SSB considerably, such that a catch of 590 000 tonnes in 2009 actually corresponds to an F at 0.17. The upward revision of the SSB is mainly due to the extension of the time series with one year's data. In addition, the time series of the survey data from the spawning banks is now so long, that it fully could be taken into account in the assessment. This increased the estimate of SSB further. Last year the information from the time series was down-weighted as it only included 5 years, which is relatively short for such information.

The upward revision of SSB from the assessment this year shows that the absolute estimate of SSB is uncertain, but all model results show a very steep decline in SSB such that SSB in the start of 2009 is only half of what is was in period 2003-2006. All available information show that the recruitment (age 1 fish) has been at a very low level since 2006, so there is no immediate source for rebuilding SSB. The advice this year is based on the proposed management plan, which will give a TAC in 2010 at 544 000 t, given an F at 0.18. Even such low F will lead to a decrease in SSB by 14% in one year, and even further down in the longer run if recruitment remains at the very low level.

8.10 Ecosystem considerations

The main spawning areas of the blue whiting are located along the shelf edge and banks west of the British Isles. The eggs and larvae can drift both towards the south and towards the north, depending on the spawning location and oceanographic conditions. The northward drift spreads the major part of the juvenile blue whiting to all warmer parts of the Norwegian Sea and adjacent areas from Iceland to the Barents Sea. Adult blue whiting carry out active feeding and spawning migrations in the same area as herring. Blue whiting has consequently an important role in the pelagic ecosystems of the area, both by consuming zooplankton and small fish, and by providing a food resource for larger fish and marine mammals. (PGNAPES) ICES 2009 RMC:06)

The blue whiting stock has seen an almost threefold increase in spawning stock biomass since the mid 1990s. However, in recent years spawning stock biomass has declined and there are no signs of good incoming recruitment. The early life stages have a significant influence on the reproductive success of this stock. During the spawning stock survey on blue whiting in 2009, large amounts of mackerel were observed throughout the spawning grounds. The mackerel was distributed from 60-300 meters and fed heavily on pearlsides (*Maurolicus mülleri*) (PGNAPES, ICES CM/RMC:06, 2009). The overlapping distribution of feeding mackerel with the blue whiting spawning grounds suggests a possible ecologic interaction between the two stocks, and predation from mackerel on blue whiting egg and larvae could be a contributing factor to the observed collapse in blue whiting recruitment. This interaction may have increased significantly both with the growth in the mackerel stock and with the changes observed in mackerel distribution in recent years. It is strongly suggested that investigations are carried out on this relationship in order to evaluate possible effects of mackerel on blue whiting recruitment.

8.10.1 Changes in the environment

Increases in temperature and salinity have been recorded over the blue whiting distribution area in recent years. An increase in sea surface temperature (SST) was shown at several of the monitoring stations in the NE Atlantic with temperatures up 3°C since the early 1980s (ICES CM 2008/ACOM:47). Salinity has shown some fluctuations throughout the time series. In the Rockall trough salinity reached a peak in 2003 and has declined slightly since then. The same trend can be seen in the Faroes Shetland Channel. In the Norwegian Sea increases in both temperature and salinity have occurred since the mid 1990s (ICES, 2008 – Cooperative research report No 291).

Changes have occurred in large-scale hydrographic systems in the north Atlantic (the subpolar gyre, SPG). Changes in the strength of the SPG have been shown to coincide with the recent large changes observed in the blue whiting recruitment (Hátún *et al*., 2005). The strength of the SPG might affect the spawning distribution of the blue whiting as well as the main migration pattern into feeding areas in the north. When the gyre is strong, it extends eastwards, branches off and carries cold less saline water to the Rockall Trough and over the Rockall plateau. When the gyre is weak it moves west and allows subtropical water to spread north and west and this results in warmer more saline conditions (Hatún, *et al* 2009a).

Recent work carried out to examine large scale bio-geographical shifts in the northeast Atlantic from the SPG used an ocean circulation model and data from four trophic levels including phytoplankton, zooplankton, blue whiting and pilot whales (Hatún, *et al* 2009b). This study found that changes in the distribution of blue whiting are caused by variable stock size and by shifts in the migration pattern. The subpolar gyre influences this process either by:

1. Directly regulating the currents and or hydrographic conditions that will influence the migration routes
   or

2. Indirectly via trophodynamics.

This work suggests that recent advances in simulating the dynamics of the subpolar gyre may provide a potential for predicting the distribution of the main faunal zones in the north-eastern Atlantic a few years into the future. This in turn would facilitate more rational management of commercially important fish species.

8.11 Regulations and their effects

Existing TAC are based on annual agreement between the EU, Norway, Iceland and the Faroe Island. No minimum landing size is associated with blue whiting.

8.11.1 Management plans and evaluations

In December 2005, the coastal states (EU, Norway, Iceland and Faroe Islands) agreed on a management plan for blue whiting. The full text of this plan is presented in the stock annex. In 2006 this plan was evaluated by ICES and found that it is not precautionary in a period of low recruitment.

A meeting was held in 2008 (Anon, 2008) at which a number of potential management strategies for blue whiting were examined through simulations. Following this meeting a new management plan was proposed by the Coastal States. The full text of this plan is also presented in the stock annex. ICES was requested by the coastal states to evaluate this proposed management plan and this evaluation was carried out by WGWIDE in 2008. ICES considers that this plan is precautionary if fishing mortality in the first year is immediately reduced to the fishing mortality that is implied by the harvest control rule. The full text of the proposal for the management plan is presented in the stock annex. The plan has not been adopted.

8.12 Benchmark workshop

The present assessment has changed the perception of the blue whiting stock significantly compared with last year's assessment. This happens in a period when there is an almost total collapse in recruitment to the stock and the spawning stock is reduced quickly towards B_{pa}. Some of the positive change in perception of the stock comes from changes in model settings, some from the extension of the time series. On this background the working group will propose that the benchmark assessment planned for spring 2011 takes place as soon as possible, preferably prior to the WGWIDE meeting in September 2010. Alternatively, could be an extension of the WGWIDE with 3 days to allow a benchmark of the stock assessment methods used.

Table 8.2.1. Details about the number, length and capacity of vessels prosecuting blue whiting fishery by country.

Country	Vessel length range (m)	Engine power (HP)	Gear	Storage	Discard estimates	Number of vessels
Germany	95-125	4200-11000		Freezer	Yes (some)	3
Ireland	24-71	634-2985	Single midw. trawl	RSW	No	16
Iceland	50-59 m	3000 HP (av.=3000)	Single midw. trawl	RSW	Yes	1
	60-69 m	4012-6690 HP (av.=5306)	Single midw. trawl	RSW, Freezer	Yes	7
	70-79 m	3308-10030 HP (av.=6733)	Single midw. trawl	RSW, Freezer	Yes	8
The Netherlands	55meter	2890 hp	Pair midwater	Freezer	Yes	2
	88-145meter	4400-10455hp	Single Midwater	Freezer	Yes (some)	13
Norway	14-62	236-5400	Industrial trawl			50
	60-94	2640-9000	Directed pelagic trawl			45
Spain	28	477	Pair bottom trawl fishery			38
	27	404	Bottom trawl mixed fishery			86
			Alterning bottom trawl and pair bottom trawl			11
Portugal	27	705	Bottom trawl (fish)			68
	25	563	Bottom trawl (crustaceans)			30
	16	213	Artisanal			377

Table 8.3.1.1. Blue whiting landings (tonnes) by country for the period 1988–2008, as estimated by the Working Group.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL
Denmark	18 941	26 630	27 052	15 538	34 356	41 053	20 456	12 439	52 101	26 270	61 523	64 653	57 686	53 333	51 279	82 935	89 500	41 450	56 979	48 659	18 134	**900 967**
Estonia					6 156	1 033	4 342	7 754	10 982	5 678	6 320						**					**42 265**
Faroes	79 831	75 083	48 686	10 563	13 436	16 506	24 342	26 009	24 671	28 546	71 218	105 006	147 991	259 761	205 421	329 895	322 322	266 799	321 013	317 859	225 003	**2 919 962**
France		2 191				1 195		720	6 442	12 446	7 984	6 662	13 481	13 480	14 688	14 149		8 046	18 009	16 638	11 723	**147 854**
Germany	5 546	5 417	1 699	349	1 332	100	2	6 313	6 876	4 724	17 969	3 170	12 655	19 060	17 050	22 803	15 293	22 823	36 437	34 404	25 259	**259 281**
Iceland		4 977						369	302	10 464	68 681	160 430	260 857	365 101	287 336	501 493	379 643	265 516	309 508	236 538	159 307	**3 010 522**
Ireland	4 646	2 014			781		3	222	1 709	25 785	45 635	35 240	25 200	29 854	17 825	22 580	75 393	73 488	54 910	31 132	22 852	**469 268**
Japan					918	1 742	2 574															**5 234**
Latvia					10 742	10 626	2 582															**23 950**
Lithuania						2 046													4 635	9 812	5 338	**21 831**
Netherlands	800	2 078	7 750	17 369	11 036	18 482	21 076	26 775	17 669	24 469	27 957	35 843	46 128	73 595	37 529	45 832	95 311	147 783	102 711	79 875	78 684	**918 751**
Norway	233 314	301 342	310 938	137 610	181 622	211 489	229 643	339 837	394 950	347 311	560 568	528 797	533 280	573 311	571 479	834 540	957 684	738 490	642 451	539 587	418 289	**9 586 532**
Poland	10																					**10**
Portugal	5 979	3 557	2 864	2 813	4 928	1 236	1 350	2 285	3 561	2 439	1 900	2 625	2 032	1 746	1 659	2 651	3 937	5 190	5 323	3 897	4 220	**66 192**
Spain	24 847	30 108	29 490	29 180	23 794	31 020	28 118	25 379	21 538	27 683	27 490	23 777	22 622	23 218	17 506	13 825	15 612	17 643	15 173	13 557	14 342	**475 922**
Sweden ***	1 229	3 062	1 503	1 000	2 058	2 867	3 675	13 000	4 000	4 568	9 299	12 993	3 319	2 086	18 549	65 532	19 083	2 960	101	464		**171 348**
UK / Scotland	5 183	8 056	6 019	3 876	6 867	2 284	4 470	10 583	14 326	33 398	92 383	98 853	42 478	50 147	26 403	27 382	57 028	104 539	72 106	43 540	38 150	**748 071**
USSR / Russia *	177 521	162 932	125 609	151 226	177 000	139 000	116 781	107 220	86 855	118 656	130 042	178 179	245 198	315 478	290 068	355 319	346 762	332 226	329 100	236 369	225163	**4 346 703**
TOTAL	557 847	627 447	561 610	369 524	475 026	480 679	459 414	578 905	645 982	672 437	1 128 969	1 256 228	1 412 927	1 780 170	1 556 792	2 318 935	2 377 568	2 026 953	1 968 456	1 612 330	1 246 465	**24 114 664**

* From 1992 only Russia

** Reported to the EU but not to the ICES WGNPBW. (Landings of 19,467 tonnes)

*** Imprecise estimates for Sweden: reported catch of 34265 t in 1993 is replaced by the mean of 1992 and 1994, i.e. 2,867 t, and used in the assessment.

Table 8.3.1.2. Blue whiting total landings by country and area for 2008 in tonnes, as estimated by the Working Group.

Area	Denmark	Faroe Islands	France	Germany	Iceland	Lithuania	Ireland	Norway	Portugal	Russia	UK/Scotland	Spain	Netherlands	Grand Total
IIa	67	4 454			2 331			3 419		57 592	4			67 867
IIb		7								165				172
IIIa	185													185
IVa	231	689					1	23 366		5 716	5 731			35 734
IVb	139							3						142
Va					313									313
Vb	5 101	65 715	369	741	57 149	236		2 205		60 082	3 042		25	194 664
VIa	4 741	38 496	4 801	3 348	54 818		8 414	121 421		11 524			31 722	279 285
VIb		47 819			37 781		1 989	34 844		61 091				183 524
VIIa			6											6
VIIb			6 545	858			501				3 129		110	11 143
VIIc	7 670	58 753		16 740	1 816	4 713	11 947	223 226		10 895	26 227		40 275	402 261
VIIf			1											1
VIIIabd			0										3	3
VIIIcIXa			1						4 220			14 342		18 564
VIIj											17		8	25
VIIk				3 572		390		1 665					6 541	12 168
XII		9 071			5 099			8 140		18 098				40 408
Grand Total	**18 134**	**225 003**	**11 723**	**25 259**	**159 307**	**5 338**	**22 852**	**418 289**	**4 220**	**225 163**	**38 150**	**14 342**	**78 684**	**1 246 465**

Note: No reported catches by Sweden in 2008

Table 8.3.1.3. Blue whiting total landings of by quarter and area for 2008 in tonnes, as estimated by the Working Group.

Area	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Grand Total
I					0
IIa	752	41 710	16 863	8 616	67 940
IIb			90	82	171
IIIa	154		37		191
IVa	6 832	6 822	14 502	7 747	35 902
IVb	68		74	3	144
Va	216		97		313
Vb	50 967	137 375	106	6 520	194 968
VIa	28 282	252 540			280 821
VIb	124 239	47 584	2	1	171 826
VIIa	6				6
VIIb	11 051	99			11 151
VIIc	399 886	2 627			402 513
VIIf	1				1
VIIIabd	0	3			3
VIIIc+IXa	3 320	4 895	5 796	4 480	18 490
VIIj	22				22
VIIk	12 167				12 167
XII	41 566				41 566
XIVb					0
Total	679 527	493 654	37 566	27 449	1 238 196

Note: these values are calculated by multiplying estimated numbers at age by estimated mean weights at age, hence some SOP (sum of parts) error may be found in total values.

Table 8.3.1.4. Blue whiting landings (tonnes) from the main fisheries, 1988–2008, as estimated by the Working Group.

Area	Norwegian Sea fishery (SAs 1+2; Divs. Va, XIVa-b)	Fishery in the spawning area (SA XII; Divs. Vb, VIa-b, VIIa-c)	Directed- and mixed fisheries in the North Sea (SA IV; Div. IIIa)	**Total northern areas**	Total southern areas (SAs VIII+IX; Divs. VIId-k)	**Grand total**
1988	55 829	426 037	45 143	**527 009**	30 838	**557 847**
1989	42 615	475 179	75 958	**593 752**	33 695	**627 447**
1990	2 106	463 495	63 192	**528 793**	32 817	**561 610**
1991	78 703	218 946	39 872	**337 521**	32 003	**369 524**
1992	62 312	318 081	65 974	**446 367**	28 722	**475 089**
1993	43 240	347 101	58 082	**448 423**	32 256	**480 679**
1994	22 674	378 704	28 563	**429 941**	29 473	**459 414**
1995	23 733	423 504	104 004	**551 241**	27 664	**578 905**
1996	23 447	478 077	119 359	**620 883**	25 099	**645 982**
1997	62 570	514 654	65 091	**642 315**	30 122	**672 437**
1998	177 494	827 194	94 881	**1 099 569**	29 400	**1 128 969**
1999	179 639	943 578	106 609	**1 229 826**	26 402	**1 256 228**
2000	284 666	989 131	114 477	**1 388 274**	24 654	**1 412 928**
2001	591 583	1 045 100	118 523	**1 755 206**	24 964	**1 780 170**
2002	541 467	846 602	145 652	**1 533 721**	23 071	**1 556 792**
2003	931 508	1 211 621	158 180	**2 301 309**	20 097	**2 321 406**
2004	921 349	1 232 534	138 593	**2 292 476**	85 093	**2 377 569**
2005	405 577	1 465 735	128 033	**1 999 345**	27 608	**2 026 953**
2006	404 362	1 428 208	105 239	**1 937 809**	28 331	**1 966 140**
2007	172 709	1 360 882	61 105	**1 594 695**	17 634	**1 612 330**
2008	68 352	1 111 292	36 061	**1 215 704**	30 761	**1 246 465**

Table 8.3.1.2.1. Sampling intensity for blue whiting from the commercial catches by fishery in 2008.

Quarter	Fisheries	Directed	Mixed*	Southern	Total
1	No. of samples	199	10	111	310
	WG Catch	672 461	863	3 358	675 818
2	No. of samples	163	8	114	277
	WG Catch	492 237	7524	4 891	497 128
3	No. of samples	17	48	129	146
	WG Catch	16 824	14945	5 820	22 644
4	No. of samples	26	2	100	126
	WG Catch	19 593	3456	4 493	24 086
Total No. of samples		405	68	454	927
Total WG Catch		1 201 114	26 788	18 562	1 246 465
tonnes per sample		2 966	394	41	1 345

* **Norwegian mixed fishery only.**

Table 8.3.1.2.2 Blue whiting. Total landings, No. of samples, No. of fish measured and No. of fish aged by country and quarter for 2008.

Country	Quarter	Landings (t)	No. Samples	No. Fish aged	No. Fish measured
Denmark	1	9 083	11	756	756
	2	8 776	3	280	280
	3	125	0	0	0
	4	150	0	0	0
	Total	18 134	14	1 036	1 036
Faroe Islands	1	118 947	20	980	1 799
	2	100 695	13	640	1 217
	3	2 652	6	240	758
	4	2 710	6	180	532
	Total	225 003	45	2 040	4 306
France	1	11 723	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	Total	11 723	0	0	0
Germany	1	21 171	20	801	10 809
	2	4 089	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	Total	25 259	20	801	10 809
Iceland	1	46 118	8	395	714
	2	112 950	47	2 302	3 771
	3	176	0	0	0
	4	63	0	0	0
	Total	159 307	55	2 697	4 485
Ireland	1	16 071	14	1 400	2 920
	2	6 779	2	200	386
	3	0	0	0	0
	4	1	0	0	0
	Total	22 852	16	1 600	3 306
Lithuania	1	5 338	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	Total	5 338	0	0	0
Norway	1	272 132	63	538	3 452
	2	127 756	68	872	3 358
	3	14 945	48	173	776
	4	3 456	18	0	17
	Total	418 289	197	1 583	7 603
Portugal	1	302	51	2 073	6 186
	2	1 154	63	1 059	7 610
	3	1 578	64	2 211	7 155
	4	1 186	42	849	5 585
	Total	4 220	220	6 192	26 536
Russia	1	84 260	9	226	517
	2	110 363	28	1 377	4 948
	3	13 871	11	601	12 024
	4	16 669	4	200	2 354
	Total	225 163	52	2 404	19 843
UK/Scotland	1	38 150	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	Total	38 150	0	0	0
Spain	1	3 056	60	193	5 552
	2	3 737	51	640	4 766
	3	4 242	65	395	5 642
	4	3 307	58	413	5 489
	Total	14 342	234	1 641	21 449
The Netherlands	1	50 331	64	1 600	12 113
	2	28 353	10	250	2 263
	3	0	0	0	0
	4	0	0	0	0
	Total	78 684	74	1 850	14 376
Grand Total		1 246 465	927	21 844	113 749

Table 8.3.1.3.1. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the directed fishery in 2008.

Length (cm)	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16			11		11
17		959			959
18	2	3 835			3 837
19	594	14 389			14 983
20	3 490	28 025			31 515
21	1 730	38 978	32		40 741
22	7 075	18 821	216	161	26 273
23	10 209	15 741	218	97	26 265
24	57 497	47 565	444	976	106 482
25	209 299	182 685	1 169	4 096	397 249
26	520 344	458 788	7 535	11 821	998 487
27	913 724	682 778	18 010	24 749	1 639 261
28	851 431	618 767	29 633	25 098	1 524 929
29	601 211	433 040	23 702	24 472	1 082 425
30	349 496	296 552	14 509	28 487	689 043
31	174 955	162 660	6 256	14 389	358 260
32	100 902	122 820	2 540	12 910	239 173
33	75 670	61 223	1 324	6 616	144 832
34	48 344	45 196	985	4 192	98 716
35	23 073	20 645	763	3 060	47 541
36	12 303	13 560	653	1 130	27 646
37	7 175	11 982	759	323	20 238
38	1 960	7 326	871	166	10 323
39	3 262	2 403	543	49	6 257
40	2 203	730	217	17	3 167
41	37	107	113	4	261
42	5	103	111	3	222
43	2	100	24	1	127
44	3	5	24	2	34
45					
46			11		11
47					
48			11		11
49					
50					
TOTAL numbers	3 975 994	3 289 782	110 685	162 818	7 539 279

Table 8.3.1.3.2. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the mixed fishery in 2008.

Length (cm)	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15	3	70	152	20	245
16	3	70	152	20	245
17	9	211	457	60	737
18	22	493	1 066	143	1 724
19	30	669	1 448	195	2 342
20	63	1 409	3 049	413	4 934
21	51	1 162	2 515	336	4 064
22	62	1 340	2 897	401	4 700
23	150	3 347	7 241	987	11 725
24	193	3 988	8 624	1 265	14 070
25	285	4 788	10 344	1 853	17 270
26	536	7 765	16 760	3 474	28 535
27	662	7 958	17 155	4 267	30 042
28	630	7 288	15 706	4 058	27 682
29	429	4 955	10 677	2 760	18 821
30	237	2 694	5 805	1 520	10 256
31	121	1 504	3 242	780	5 647
32	68	825	1 777	440	3 110
33	44	675	1 458	281	2 458
34	23	287	617	148	1 075
35	15	248	536	96	895
36	14	247	535	86	882
37	8	142	306	50	506
38	8	107	231	50	396
39	5	36	78	26	145
40	3	35	76	14	128
41	4	36	78	24	142
42	2	1	1	10	14
43	1	1	1	8	11
44	2	1	1	12	16
45					
46					
47					
48					
49					
50					
TOTAL numbers	3 683	52 352	112 985	23 797	192 817

Table 8.3.1.3.3. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the southern fishery in 2008.

Length (cm)	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14	5				5
15	120				120
16	377				377
17	2 567	11	2		2 580
18	5 885	607	28	7	6 527
19	7 282	4 345	104	397	12 128
20	6 380	13 544	1 419	923	22 266
21	5 067	16 592	5 790	1 518	28 967
22	4 566	12 049	10 317	4 509	31 442
23	3 749	7 786	11 044	7 692	30 272
24	3 432	5 368	8 781	8 250	25 831
25	3 735	3 496	7 422	8 633	23 286
26	2 141	2 172	4 751	5 716	14 780
27	1 690	1 588	3 279	3 387	9 943
28	1 259	961	1 957	1 654	5 830
29	697	979	2 331	680	4 687
30	388	651	1 418	512	2 969
31	245	359	706	175	1 487
32	82	371	556	100	1 109
33	75	90	659	60	885
34	36	73	155	27	291
35	13	42	39	13	107
36	19	22	27	4	73
37	5	8	24	4	41
38	2	1	9	3	14
39	4	2	3	2	11
40	1	2			3
41	1				1
42					
43					
44					
45					
46					
47					
48					
49					
50					
TOTAL numbers	49 823	71 120	60 821	44 267	226 032

Table 8.3.1.3.4. Blue whiting : Catch in numbers (millions) of the total stock and mean age in the catch

Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Mean age
1981	258	348	681	334	548	559	466	634	578	1460	6.57
1982	148	274	326	548	264	276	266	272	284	673	6.05
1983	2283	567	270	286	299	304	287	286	225	334	3.57
1984	2291	2331	455	260	285	445	262	193	154	255	3.00
1985	1305	2044	1933	303	188	321	257	174	93	259	3.18
1986	650	816	1862	1717	393	187	201	198	174	398	4.00
1987	838	578	728	1897	726	137	105	123	103	195	3.83
1988	425	721	614	683	1303	618	84	53	33	50	4.03
1989	865	718	1340	791	837	708	139	50	25	38	3.61
1990	1611	703	672	753	520	577	299	78	27	95	3.38
1991	267	1024	514	302	363	258	159	49	5	10	3.42
1992	408	654	1642	569	217	154	110	80	32	12	3.29
1993	263	305	621	1571	411	191	107	65	38	17	3.90
1994	307	108	368	389	1222	281	174	90	79	31	4.57
1995	296	354	422	465	616	800	254	160	60	42	4.62
1996	1893	534	632	537	323	497	663	232	98	83	3.61
1997	2131	1519	904	578	296	252	282	407	104	169	3.17
1998	1657	4181	3541	1045	384	323	303	264	212	86	2.97
1999	788	1549	5821	3461	413	207	151	153	69	140	3.36
2000	1815	1193	3466	5015	1550	514	213	151	58	140	3.55
2001	4364	4486	2962	3807	2593	586	170	97	77	66	2.98
2002	1821	3232	3292	2243	1824	1647	344	169	103	143	3.53
2003	3743	4074	8379	4825	2035	1117	400	121	20	27	3.13
2004	2156	4426	6724	6698	3045	1276	650	249	75	37	3.49
2005	1427	1519	5084	5871	4450	1419	518	249	100	55	3.92
2006	413	940	4206	6151	3834	1719	506	181	68	37	4.15
2007	167	307	1795	4211	3867	2353	936	321	130	89	4.77
2008	409	179	545	2917	3263	1919	736	316	113	127	4.93

* Mean age calculation assigns all fish in the plusgroup an age of 10.

Table 8.3.3.1 Blue whiting individual mean weight (kg) at age in the catch

Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10+	Weighted mean
1981	0.052	0.065	0.103	0.125	0.141	0.155	0.170	0.178	0.187	0.213	0.128
1982	0.045	0.072	0.111	0.143	0.156	0.177	0.195	0.200	0.204	0.231	0.134
1983	0.046	0.074	0.118	0.140	0.153	0.176	0.195	0.200	0.204	0.228	0.097
1984	0.035	0.078	0.089	0.132	0.153	0.161	0.175	0.189	0.186	0.206	0.075
1985	0.038	0.074	0.097	0.114	0.157	0.177	0.199	0.208	0.218	0.237	0.083
1986	0.040	0.073	0.108	0.130	0.165	0.199	0.209	0.243	0.246	0.257	0.095
1987	0.048	0.086	0.106	0.124	0.147	0.177	0.208	0.221	0.222	0.254	0.096
1988	0.053	0.076	0.097	0.128	0.142	0.157	0.179	0.199	0.222	0.260	0.097
1989	0.059	0.079	0.103	0.126	0.148	0.158	0.171	0.203	0.224	0.253	0.097
1990	0.045	0.070	0.106	0.123	0.147	0.168	0.175	0.214	0.217	0.256	0.071
1991	0.055	0.091	0.107	0.136	0.174	0.190	0.206	0.230	0.232	0.266	0.096
1992	0.057	0.083	0.119	0.140	0.167	0.193	0.226	0.235	0.284	0.294	0.112
1993	0.066	0.082	0.109	0.137	0.163	0.177	0.200	0.217	0.225	0.281	0.118
1994	0.061	0.087	0.108	0.137	0.164	0.189	0.207	0.217	0.247	0.254	0.123
1995	0.064	0.091	0.118	0.143	0.154	0.167	0.203	0.206	0.236	0.256	0.118
1996	0.041	0.080	0.102	0.116	0.147	0.170	0.214	0.230	0.238	0.279	0.081
1997	0.047	0.072	0.102	0.121	0.140	0.166	0.177	0.183	0.203	0.232	0.067
1998	0.048	0.072	0.094	0.125	0.149	0.178	0.183	0.188	0.221	0.248	0.075
1999	0.063	0.078	0.088	0.109	0.142	0.170	0.199	0.193	0.192	0.245	0.084
2000	0.057	0.075	0.086	0.104	0.133	0.156	0.179	0.187	0.232	0.241	0.079
2001	0.050	0.078	0.094	0.108	0.129	0.163	0.186	0.193	0.231	0.243	0.074
2002	0.054	0.074	0.093	0.115	0.132	0.155	0.173	0.233	0.224	0.262	0.077
2003	0.049	0.075	0.098	0.108	0.131	0.148	0.168	0.193	0.232	0.258	0.079
2004	0.042	0.066	0.089	0.102	0.123	0.146	0.160	0.173	0.209	0.347	0.075
2005	0.039	0.068	0.084	0.099	0.113	0.137	0.156	0.166	0.195	0.217	0.079
2006	0.049	0.072	0.089	0.105	0.122	0.138	0.163	0.190	0.212	0.328	0.096
2007	0.050	0.064	0.091	0.103	0.115	0.130	0.146	0.169	0.182	0.249	0.103
2008	0.055	0.075	0.100	0.106	0.120	0.133	0.146	0.160	0.193	0.209	0.109
arith. mean	0.050	0.076	0.100	0.121	0.144	0.165	0.185	0.201	0.218	0.254	

Table 8.3.4.1. Blue whiting natural mortality and proportion of maturation-at-age

AGE	0	1	2	3	4	5	6	7–10+
Proportion mature	0.00	0.11	0.40	0.82	0.86	0.91	0.94	1.00
Natural mortality	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 8.3.5.1.1 Blue whiting stock composition (millions) from the IBSSS for 2004–2009.

Year\Age	1	2	3	4	5	6	7	8	9	10+	Total
2004	4886	17603	34350	44397	16775	5521	3111	1962	1131	127	129863
2005	3631	4320	18774	25579	26660	8298	2016	728	323	6	90335
2006	3162	5540	32201	38942	16608	7972	2459	791	293	7	107975
2007	1723	2654	16343	32851	24794	13952	7282	2509	951	665	103714
2008	956	1672	4443	17814	20144	11710	6418	3093	791	908	67948
2009	2747	3384	3147	6617	16067	15764	8970	4685	2891	514	46705

Table 8.3.5.2.1. Estimated blue whiting stock numbers and biomass from the International Norwegian Sea ecosystem survey, 2000–2009. The estimates are for the standard area, north of 63°N and between 8°W–20°E.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	Total
2000	48927	3133	3580	1668	201	5						57514
2001	85772	25110	7533	3020	2066							123501
2002	15251	46656	14672	4357	513	445		15		6		81915
2003	35688	21487	35372	4354	639	201	43	3				97787
2004	49254	22086	13292	8290	1495	533	83	39				95072
2005	54660	19904	13828	4714	1886	326	103	43	8	3	11	95486
2006	570	18300	15324	6550	1566	384	246	80	47	2	8	43077
2007	21	552	5846	3639	1674	531	178	49	19			12509
2008	29	75	534	2151	715	287	116	44				3951
2009	0	14	56	617	963	621	296	84	13			2664

Table 8.3.5.3.1 1-group indices of blue whiting from the Norwegian winter survey (late January-early March) in the Barents Sea. (Blue whiting <19 cm in total body length which most likely belong to 1-group.)

	Catch Rate	
Year	All	<19cm
1981	0.13	0
1982	0.17	0.01
1983	4.46	0.46
1984	6.97	2.47
1985	32.51	0.77
1986	17.51	0.89
1987	8.32	0.02
1988	6.38	0.97
1989	1.65	0.18
1990	17.81	16.37
1991	48.87	2.11
1992	30.05	0.06
1993	5.8	0.01
1994	3.02	0
1995	1.65	0.10
1996	9.88	5.81
1997	187.24	175.26
1998	7.14	0.21
1999	5.98	0.71
2000	129.23	120.90
2001	329.04	233.76
2002	102.63	9.69
2003	75.25	15.15
2004	124.01	36.74
2005	206.18	90.23
2006	269.2	3.52
2007	80.38	0.16
2008	16.72	0.01
2009	3.74	0

Table 8.4.1 . Blue Whiting survey indices used in the assessment.

Fleet catch for CPUE data BLUE WHITING-COMBINED, 2009 WG, 3 fleets

##

Norwegian spawning acoustic 1991 2003

effort and catch numbers age 3 - 8

	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	
1	6340	8497	7407	4558	2019	545	#1991
1	26123	4719	1574	1386	810	616	#1992
1	3321	26771	2643	1270	557	426	#1993
1	2950	4476	11354	1742	1687	908	#1994
1	9874	7906	6861	9467	1795	1083	#1995
1	7433	8371	2399	4455	4111	1202	#1996
1	-1	-1	-1	-1	-1	-1	#1997
1	34991	4697	1674	279	407	381	#1998
1	60309	26103	1481	316	72	153	#1999
1	31011	41382	6843	898	427	228	#2000
1	12843	13805	8292	718	175	51	#2001
1	54740	12757	5266	8404	1450	305	#2002
1	70303	28756	5735	2430	1708	260	#2003

##

International Norweigian Sea ecostystem survey 2000-2009

effort and catch numbers age 1-2

	Age 1	Age 2	
1	48927	3133	#2000
1	85772	25110	#2001
1	15251	46656	#2002
1	35688	21487	#2003
1	49254	22086	#2004
1	54660	19904	#2005
1	570	18300	#2006
1	21	552	#2007
1	29	75	#2008
1	0	14	#2009

##

International BW spawning stock survey 2004-2009

Effort and catch numbers age 3-8

	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	
1	34350	44397	16775	5521	3111	1962	#2004
1	18774	25579	26660	8298	2016	728	#2005
1	32201	38942	16608	7972	2459	791	#2006
1	16343	32851	24794	13952	7282	2509	#2007
1	4443	17814	20144	11710	6418	3093	#2008
1	3147	6617	16067	15764	8970	4685	#2009

Table 8.4.1.1. Blue whiting SMS data exploration. SMS diagnostics output from the final run.

```
objective function (negative log likelihood):  -209.135
Number of parameters: 95
Maximum gradient: 4.64541e-005

objective function weight:
                          Catch  CPUE   S/R
                             1     1  0.01

unweighted objective function contributions (total):
               Catch    CPUE     S/R    Stom.  Penalty    Sum
             -194.0   -15.2     9.3     0.0 0.00e+000  -199.9


unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
              -0.69   -0.12    0.33    0.00


contribution by fleet:
----------------------
Norw. Spawning Stock Surv.  total:  -0.554   mean:  -0.008
Intl. Surv. in Nord. Seas.  total:  26.709   mean:   1.406
IBWSSS                      total: -41.397   mean:  -1.150


F, Year effect:
---------------

1981:    1.000
1982:    0.806
1983:    0.944
1984:    1.227
1985:    1.373
1986:    1.816
1987:    1.401
1988:    1.365
1989:    1.790
1990:    1.738
1991:    0.837
1992:    0.749
1993:    0.766
1994:    0.675
1995:    0.889
1996:    1.197
1997:    1.189
1998:    1.645
1999:    1.000
2000:    1.277
2001:    1.133
2002:    1.041
2003:    1.138
2004:    1.297
2005:    1.032
2006:    0.797
2007:    0.778
2008:    0.694

F, age effect:
--------------
                    1      2      3      4      5      6      7      8      9     10
1981-1998:    0.068  0.100  0.173  0.225  0.264  0.333  0.393  0.415  0.415  0.415
1999-2008:    0.053  0.076  0.208  0.396  0.460  0.523  0.489  0.540  0.540  0.540


Exploitation pattern (scaled to mean F=1)
-----------------------------------------
                         1      2      3      4      5      6      7      8      9     10
1981-1998 season 1:  0.245  0.360  0.625  0.810  0.950  1.199  1.416  1.493  1.493  1.493

1999-2008 season 1:  0.129  0.184  0.500  0.955  1.107  1.259  1.179  1.302  1.302  1.302


sqrt(catch variance) ~ CV:
--------------------------

 1       0.393
 2       0.358
 3       0.177
 4       0.177
 5       0.177
 6       0.177
 7       0.467
 8       0.467
 9       0.467
10       0.467
```

Survey catchability:

--------------------	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8
Norw. Spawning Stock Surv.			1.691	2.170	1.238	1.238	1.238	1.238
Intl. Surv. in Nord. Seas.	0.209	0.192						
IBWSSS			0.933	1.663	1.973	1.973	1.973	1.973

sqrt(Survey variance) ~ CV:

---------------------------	age 1	age 2	age 3	age 4	age 5	age 6	age 7	age 8
Norw. Spawning Stock Surv.			0.45	0.45	0.67	0.67	0.72	0.72
Intl. Surv. in Nord. Seas.	1.41	1.41						
IBWSSS			0.19	0.19	0.19	0.19	0.19	0.19

Average F:
----

	sp. 1
1981:	0.278
1982:	0.224
1983:	0.262
1984:	0.341
1985:	0.381
1986:	0.504
1987:	0.389
1988:	0.379
1989:	0.497
1990:	0.483
1991:	0.232
1992:	0.208
1993:	0.213
1994:	0.188
1995:	0.247
1996:	0.332
1997:	0.330
1998:	0.457
1999:	0.415
2000:	0.530
2001:	0.471
2002:	0.432
2003:	0.473
2004:	0.539
2005:	0.429
2006:	0.331
2007:	0.323
2008:	0.288

Recruit-SSB		alfa	beta	recruit s2	recruit s
Blue whiting	Geometric mean:	16.509		0.734	0.857

Table 8.4.1.2 Blue whiting : Fishing mortality at age estimated by the final SMS run

Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Avg. 3-7
1981	0.068	0.100	0.173	0.225	0.264	0.333	0.393	0.415	0.415	0.415	0.278
1982	0.055	0.081	0.140	0.181	0.213	0.269	0.317	0.334	0.334	0.334	0.224
1983	0.064	0.094	0.164	0.212	0.249	0.314	0.371	0.391	0.391	0.391	0.262
1984	0.084	0.123	0.213	0.276	0.324	0.409	0.483	0.509	0.509	0.509	0.341
1985	0.093	0.137	0.238	0.309	0.362	0.457	0.540	0.570	0.570	0.570	0.381
1986	0.124	0.182	0.315	0.409	0.479	0.605	0.714	0.753	0.753	0.753	0.504
1987	0.095	0.140	0.243	0.315	0.370	0.467	0.551	0.581	0.581	0.581	0.389
1988	0.093	0.137	0.237	0.307	0.360	0.455	0.537	0.566	0.566	0.566	0.379
1989	0.122	0.179	0.311	0.403	0.472	0.596	0.704	0.743	0.743	0.743	0.497
1990	0.118	0.174	0.301	0.391	0.458	0.579	0.683	0.721	0.721	0.721	0.483
1991	0.057	0.084	0.145	0.188	0.221	0.279	0.329	0.347	0.347	0.347	0.232
1992	0.051	0.075	0.130	0.169	0.198	0.249	0.295	0.311	0.311	0.311	0.208
1993	0.052	0.077	0.133	0.172	0.202	0.255	0.301	0.318	0.318	0.318	0.213
1994	0.046	0.068	0.117	0.152	0.178	0.225	0.266	0.280	0.280	0.280	0.188
1995	0.061	0.089	0.154	0.200	0.235	0.296	0.350	0.369	0.369	0.369	0.247
1996	0.081	0.120	0.208	0.269	0.316	0.399	0.471	0.496	0.496	0.496	0.332
1997	0.081	0.119	0.206	0.268	0.314	0.396	0.468	0.493	0.493	0.493	0.330
1998	0.112	0.165	0.285	0.370	0.434	0.548	0.647	0.682	0.682	0.682	0.457
1999	0.053	0.076	0.208	0.396	0.460	0.523	0.489	0.540	0.540	0.540	0.415
2000	0.068	0.097	0.265	0.506	0.587	0.667	0.625	0.690	0.690	0.690	0.530
2001	0.061	0.086	0.235	0.449	0.521	0.593	0.555	0.613	0.613	0.613	0.471
2002	0.056	0.079	0.216	0.413	0.479	0.544	0.510	0.563	0.563	0.563	0.432
2003	0.061	0.087	0.236	0.451	0.523	0.595	0.557	0.615	0.615	0.615	0.473
2004	0.069	0.099	0.269	0.514	0.596	0.678	0.635	0.701	0.701	0.701	0.539
2005	0.055	0.079	0.214	0.409	0.475	0.540	0.505	0.558	0.558	0.558	0.429
2006	0.043	0.061	0.166	0.316	0.367	0.417	0.390	0.431	0.431	0.431	0.331
2007	0.042	0.059	0.162	0.308	0.358	0.407	0.381	0.420	0.420	0.420	0.323
2008	0.037	0.053	0.144	0.275	0.319	0.363	0.340	0.375	0.375	0.375	0.288

Table 8.4.1.3 Blue whiting : Stock numbers (millions) and mean age in the stock estimated by the final SMS run

Year/Age	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Mean age
1981	3284	3761	4518	2459	2337	2196	1839	1775	1504	3046	4.87
1982	4088	2512	2786	3110	1608	1470	1289	1016	960	2460	4.56
1983	14672	3168	1897	1983	2123	1064	920	769	595	2004	3.07
1984	18224	11266	2360	1319	1313	1355	636	520	425	1439	2.44
1985	10523	13726	8158	1562	819	778	737	321	256	917	2.56
1986	8552	7847	9795	5263	939	467	403	352	149	543	2.76
1987	8994	6188	5357	5853	2864	476	209	162	136	267	2.78
1988	6693	6694	4404	3440	3496	1620	244	99	74	184	2.94
1989	9362	4993	4781	2845	2071	1996	842	117	46	120	2.79
1990	24610	6786	3418	2869	1557	1057	901	341	46	65	2.02
1991	8667	17902	4669	2070	1589	806	485	372	136	44	2.38
1992	5722	6703	13479	3306	1404	1043	499	286	215	104	2.89
1993	5369	4452	5092	9691	2287	943	665	304	172	192	3.29
1994	5805	4173	3376	3650	6678	1530	598	403	181	216	3.48
1995	8308	4539	3193	2459	2567	4575	1000	376	249	246	3.34
1996	23773	6403	3400	2241	1648	1662	2786	577	213	281	2.39
1997	46286	17941	4651	2262	1401	984	914	1425	288	246	1.84
1998	28885	34950	13041	3098	1417	838	542	469	712	267	2.13
1999	24350	21145	24272	8026	1751	752	397	232	194	405	2.40
2000	40417	18900	16042	16146	4421	905	365	199	111	286	2.32
2001	62386	30909	14039	10075	7970	2012	380	160	82	163	2.07
2002	56652	48078	23212	9084	5264	3875	911	179	71	109	2.16
2003	55104	43874	36360	15310	4923	2670	1841	448	83	84	2.31
2004	49376	42455	32937	23504	7984	2388	1206	863	198	74	2.48
2005	27925	37720	31487	20598	11507	3600	992	523	351	111	2.78
2006	8127	21637	28546	20807	11203	5862	1718	490	245	216	3.36
2007	4862	6377	16671	19806	12420	6358	3164	952	261	246	3.96
2008	6617	3819	4920	11613	11913	7111	3466	1770	512	272	4.30
2009		5221*	2966	3488	7222	7090	4051	2020	996	441	

***changed to 3074 millions in forecast**

Table 8.4.1.4. Blue whiting : Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), landings weight (Yield) and average fishing mortality, estimated from final SMS run. SSB for 2009 does not include age 1.

Year	Recruits (million)	TSB (tonnes)	SSB (tonnes)	Yield (SOP) (tonnes)	Mean F ages 3-7
1981	3284	3416390	2940820	922980	0.278
1982	4088	2848400	2420040	550643	0.224
1983	14672	2834560	1973550	553344	0.262
1984	18224	2904930	1716660	615569	0.341
1985	10523	3137970	1985470	678214	0.381
1986	8552	3250820	2296950	847145	0.504
1987	8994	2939820	1989510	654718	0.389
1988	6693	2609290	1789890	552264	0.379
1989	9362	2628090	1714450	630316	0.497
1990	24610	2961160	1544630	558128	0.483
1991	8667	3545240	1980120	364008	0.232
1992	5722	3656930	2646100	474592	0.208
1993	5369	3433520	2569730	475198	0.213
1994	5805	3277270	2492750	457696	0.188
1995	8308	3234830	2315300	505176	0.247
1996	23773	3476270	2163910	621104	0.332
1997	46286	5112590	2250220	639681	0.330
1998	28885	6287130	3240490	1131950	0.457
1999	24350	6830980	3939060	1261030	0.415
2000	40417	7706430	4260780	1412450	0.530
2001	62386	9454210	4729360	1771810	0.471
2002	56652	11359300	5868600	1556950	0.432
2003	55104	12684400	7352310	2365320	0.473
2004	49376	11944800	7445350	2400790	0.539
2005	27925	10465800	7049340	2018340	0.429
2006	8127	9353290	7129420	1956240	0.331
2007	4862	7193500	5995300	1612270	0.323
2008	6617*	5687300	4748670	1251850	0.288
2009			3588250		
arith. mean	20630	5508401	3521967	1029992	0.363
geo. mean	14012				

*** Replaced by 3869 millions in forecast**

Table 8.7.1.1 Blue whiting 1 group RCT3 Input.

2	29	2	
'YEAR CLASS'	'VPA'	'Barents_idx'	'IES_idx'
1980	3285	-11	-11
1981	4088	0.010144928	-11
1982	14673	0.456467662	-11
1983	18255	2.473336705	-11
1984	10523	0.772955488	-11
1985	8552	0.893334361	-11
1986	8994	0.020615577	-11
1987	6693	0.96928982	-11
1988	9362	0.175609756	-11
1989	24609	16.37007012	-11
1990	8667	2.105831953	-11
1991	5722	0.056229538	-11
1992	5369	0.005464481	-11
1993	5805	-11	-11
1994	8308	0.100640739	-11
1995	23772	5.812809481	-11
1996	46280	175.2618555	-11
1997	28865	0.209994558	-11
1998	24333	0.70887144	-11
1999	40399	120.9015612	48927
2000	62332	233.7569233	85772
2001	56473	9.6862936	15251
2002	54815	15.1463275	35688
2003	49074	36.73747791	49254
2004	27692	90.23164366	54660
2005	8055	3.524569802	570
2006	4822	0.160115526	21
2007	6548	0.013165266	29
2008	-11	0	0

Table 8.7.1.2. Blue whiting. RCT3 output. Year class abundance is number of age 1.

```
 BLUE WHITING DATA 1 GROUP
 Data for    2 surveys over   29 years :  1980 - 2008
 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied
 Final estimates not shrunk towards mean
 Estimates with S.E.'S greater than that of mean
+  included
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.
```

Yearclass =   2007

```
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Barent     .64   8.51    .95   .502     25    .01    8.51    1.154     .226
 IES_id     .36   6.97    .41   .870      8   3.40    8.19     .624     .774

                                        VPA Mean =   10.07     .928     .000
```

Yearclass =   2008

```
         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Barent     .62   8.55    .89   .554     26    .00    8.55    1.077     .252
 IES_id     .33   7.30    .39   .891      9    .00    7.30     .626     .748

                                        VPA Mean =    9.99     .961     .000
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	136852	11.83	.98	.00	.00	62332	11.04
2001	22854	10.04	.75	.00	.00	56474	10.94
2002	31646	10.36	.89	.03	.00	54816	10.91
2003	54936	10.91	.95	.16	.03	49074	10.80
2004	84971	11.35	.93	.30	.10	27693	10.23
2005	19403	9.87	.95	1.61	2.89	8055	8.99
2006	2679	7.89	.79	.80	1.01	4823	8.48
2007	3869	8.26	.55	.14	.06	6548	8.79
2008	2023	7.61	.54	.54	1.01		

Table 8.7.2.1. Blue Whiting input to short term projection.

Age	Weight in the stock (kg)	Weight in the catch (kg)	Proportion Mature	Exploitation Pattern	Stock Numbers 2009
1	0.051	0.051	0.11	0.037	2023300
2	0.070	0.070	0.4	0.053	3074050
3	0.093	0.093	0.82	0.144	2965540
4	0.105	0.105	0.86	0.275	3487800
5	0.119	0.119	0.91	0.319	7221860
6	0.134	0.134	0.94	0.363	7089590
7	0.152	0.152	1	0.340	4050690
8	0.173	0.173	1	0.375	2020360
9	0.196	0.196	1	0.375	995891
10+	0.262	0.262	1	0.375	441380

Table 8.7.2.2. Blue Whiting. Short term projection

2009							
Biomass	SSB	FMult	FBar	Landings			
4042.55	3586	0.6047653	0.167	590			
Rationale	Catch(2010)	Basis	F(2010)	SSB(2010)	SSB(2011)	%SSB change	% TAC change
	0	F=0	0.000	3057	3183	4	-100%
	95	F2008*0.1	0.029	3057	3088	1	-84%
	231	F2008*0.25	0.072	3057	2951	-3	-61%
	443	F2008*0.50	0.144	3057	2739	-10	-25%
	543	Target F: F=0.18	0.180	3057	2639	-14	-8%
	639	F2008*0.75	0.216	3057	2543	-17	8%
	820	Fsq=F2008	0.288	3057	2364	-23	39%
	896	F=Fpa	0.320	3057	2289	-25	52%
	935	Maintain >SSB>Bpa	0.337	3057	2251	-26	58%
Rationale	Catch(2011)	Basis	F(2011)	SSB(2011)	SSB(2012)	%SSB change	
	0	F=0	0.000	3183	3480	9	
	94	F2008*0.1	0.029	3088	3295	7	
	219	F2008*0.25	0.072	2951	3039	3	
	388	F2008*0.50	0.144	2739	2666	-3	
	457	Target F: F=0.18	0.180	2639	2502	-5	
	518	F2008*0.75	0.216	2543	2351	-8	
	614	Fsq=F2008	0.288	2364	2084	-12	
	649	F=Fpa	0.320	2289	1979	-14	
	665	Maintain >SSB>Bpa	0.337	2251	1927	-14	
Rationale	Catch(2012)	Basis	F(2012)	SSB(2012)	SSB(2013)	%SSB change	
	0	F=0	0.000	3480	3745	8	
	96	F2008*0.1	0.029	3295	3475	5	
	215	F2008*0.25	0.072	3039	3117	3	
	356	F2008*0.50	0.144	2666	2626	-2	
	407	Target F: F=0.18	0.180	2502	2423	-3	
	446	F2008*0.75	0.216	2351	2242	-5	
	500	Fsq=F2008	0.288	2084	1940	-7	
	515	F=Fpa	0.320	1979	1828	-8	
	522	Maintain >SSB>Bpa	0.337	1927	1772	-8	

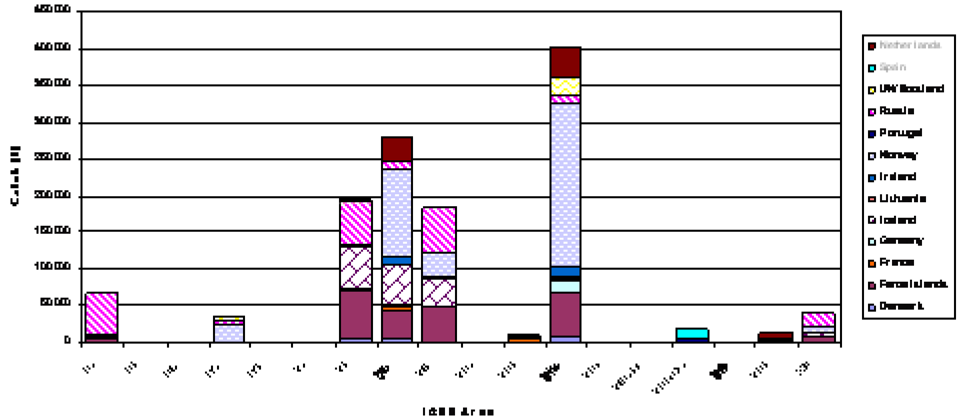


Figure 8.2.1. Blue whiting landings (tonnes) in 2008 presented by ICES area and country.

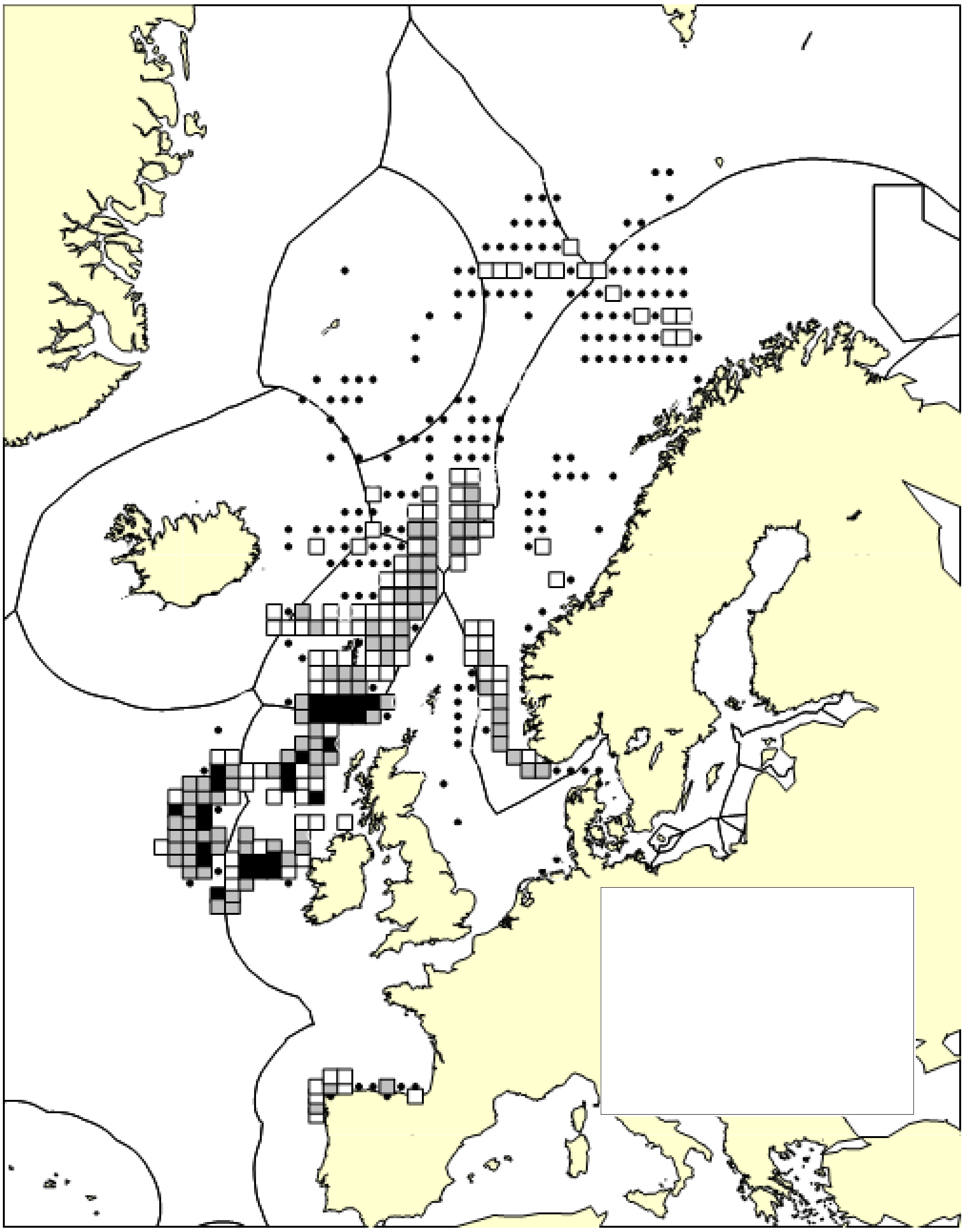


Figure 8.2.2. Total blue whiting catches (t) in 2008 by ICES rectangle. Catches below 10 t are not shown on the map.

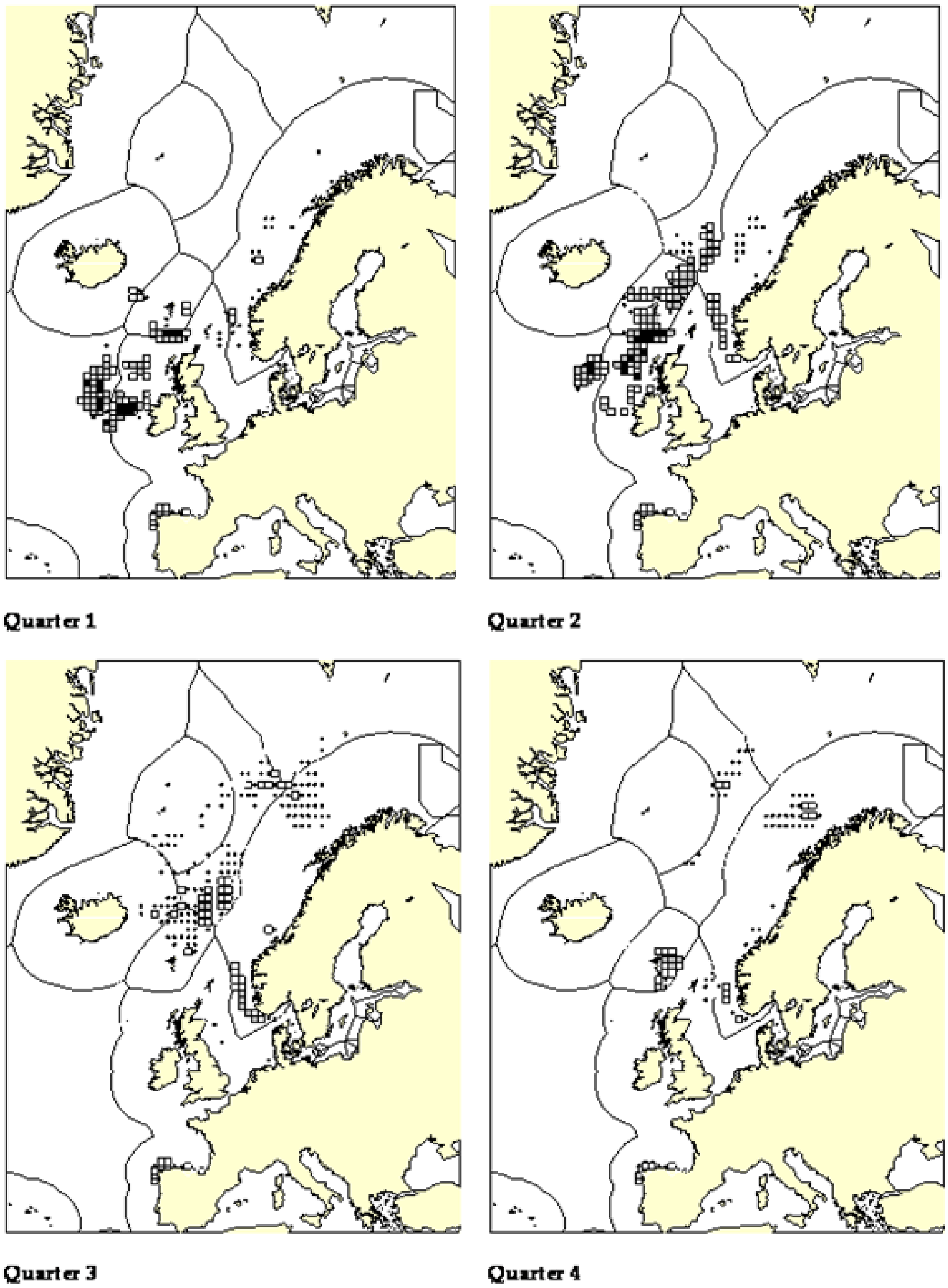


Figure 8.2.3. Total blue whiting catches (t) in 2008 by quarter and ICES rectangle. Grading of the symbols: small dots 10–100 t, white squares 100–1000 t, grey squares 1000–10 000 t, and black squares > 10 000 t. Catches below 10 t are not shown on the map.

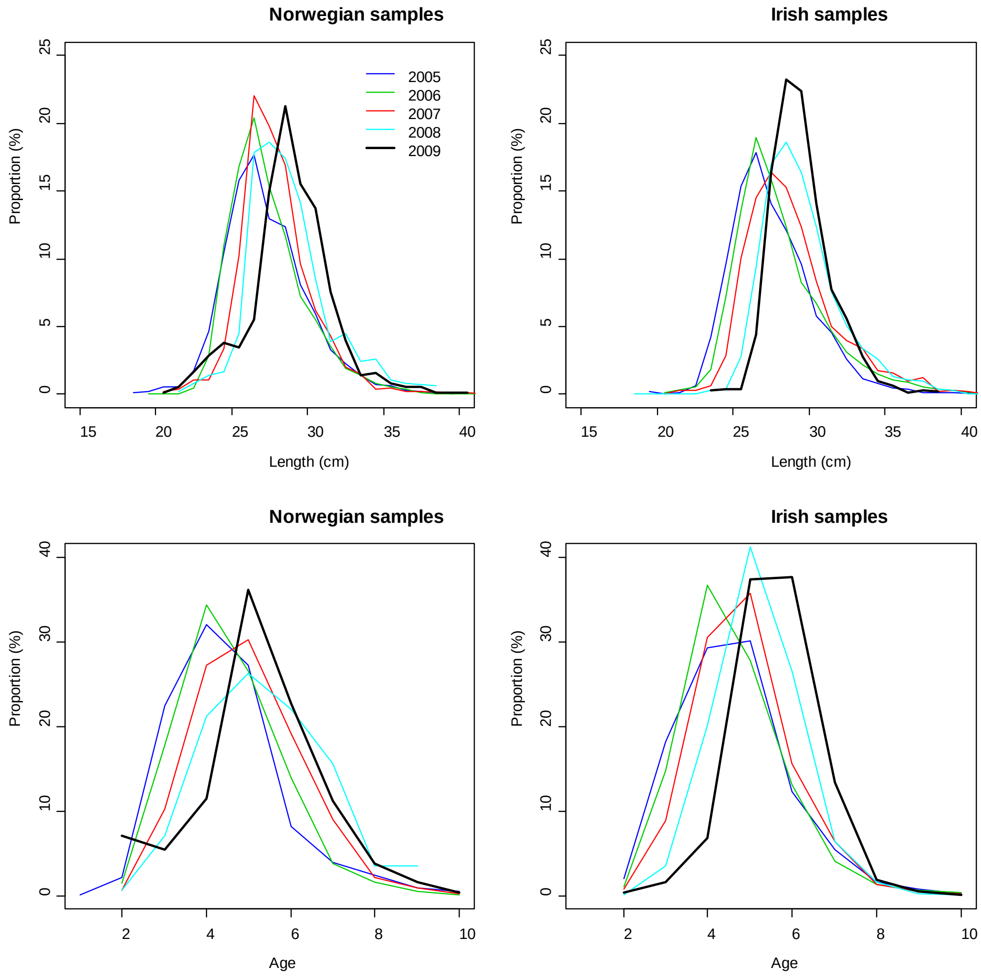
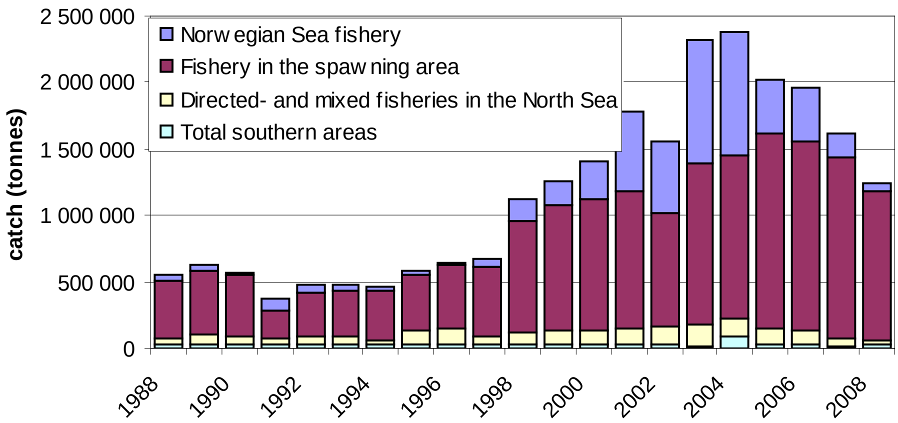


Figure 8.2.5.1 Blue whiting length and age distributions sampled from Norwegian and Irish commercial trawl catches taken on the blue whiting spawning grounds.

A



B

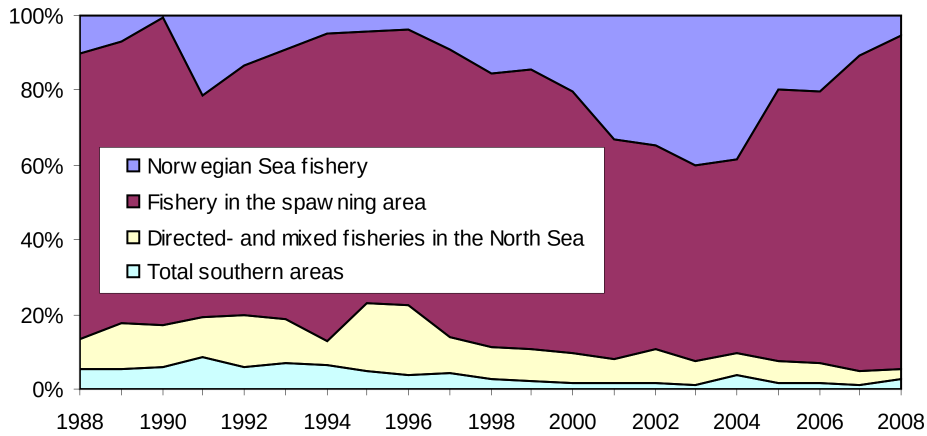


Figure 8.3.1.1. (A) Annual catch (tonnes) of blue whiting by fishery sub-areas from 1998-2008 and (B) the percentage contribution to the overall catch by fishery sub-area over the same period.

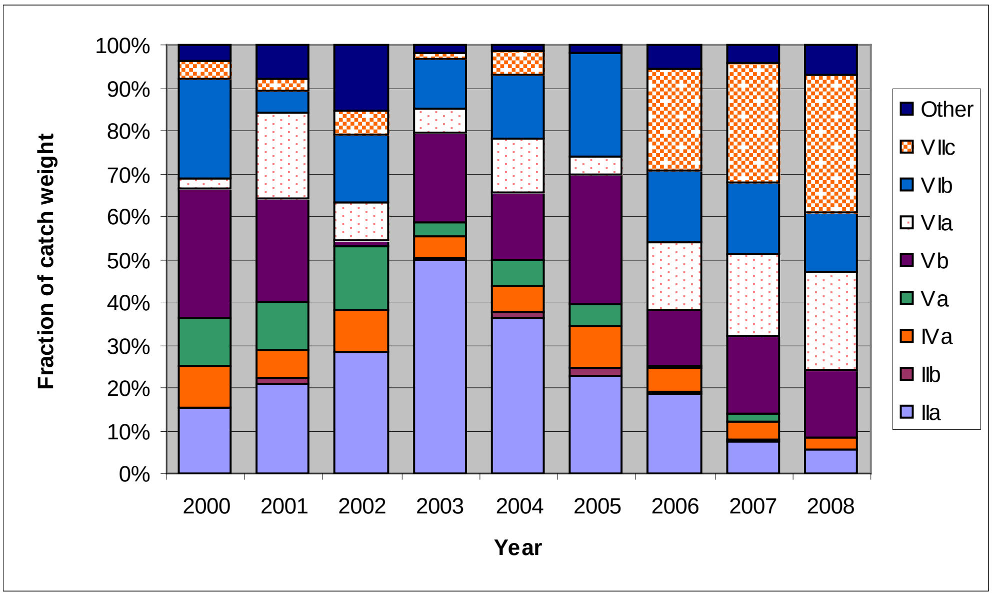


Figure 8.3.1.2. Distribution of total landings of blue whiting by ICES sub-area.

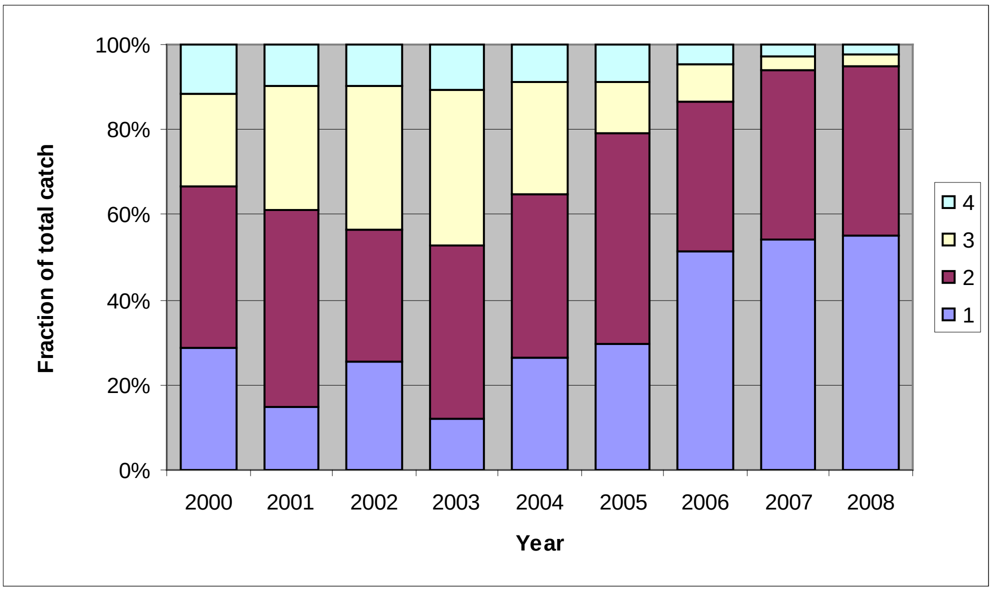


Figure 8.3.1.3. Distribution of total landings of blue whiting by quarter.

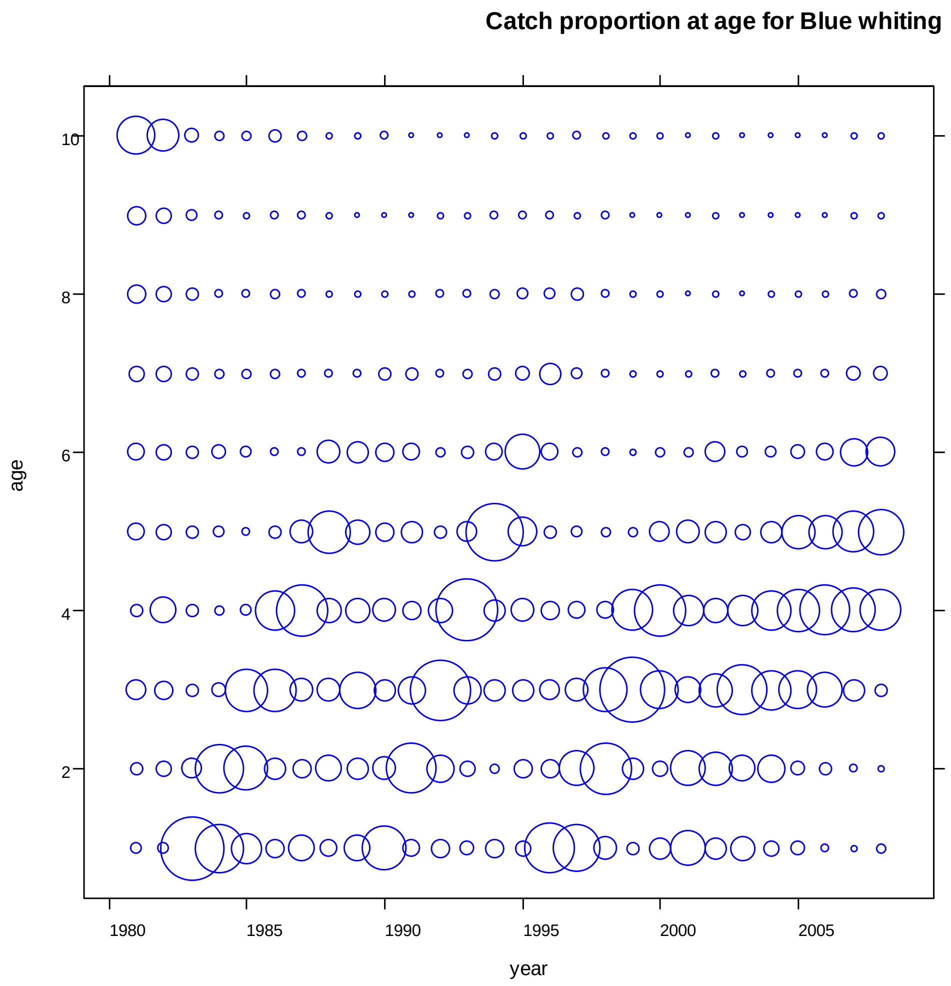


Figure 8.3.1.3.1 Catch proportion at age of blue whiting in the International catch from 1981-2008.

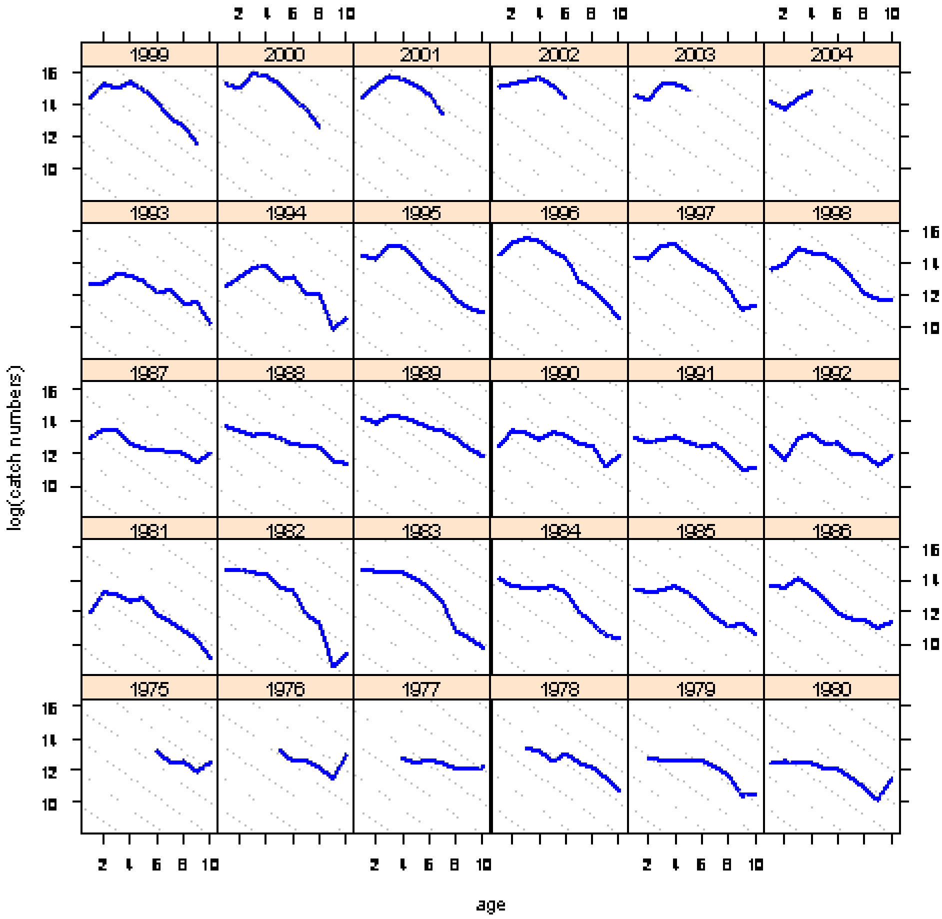


Figure 8.3.1.3.2. Blue whiting. Age disaggregated blue whiting catch (numbers) plotted on log scale. The labels behind each panel indicate year classes. The grey dotted lines correspond to *Z*=0.6.

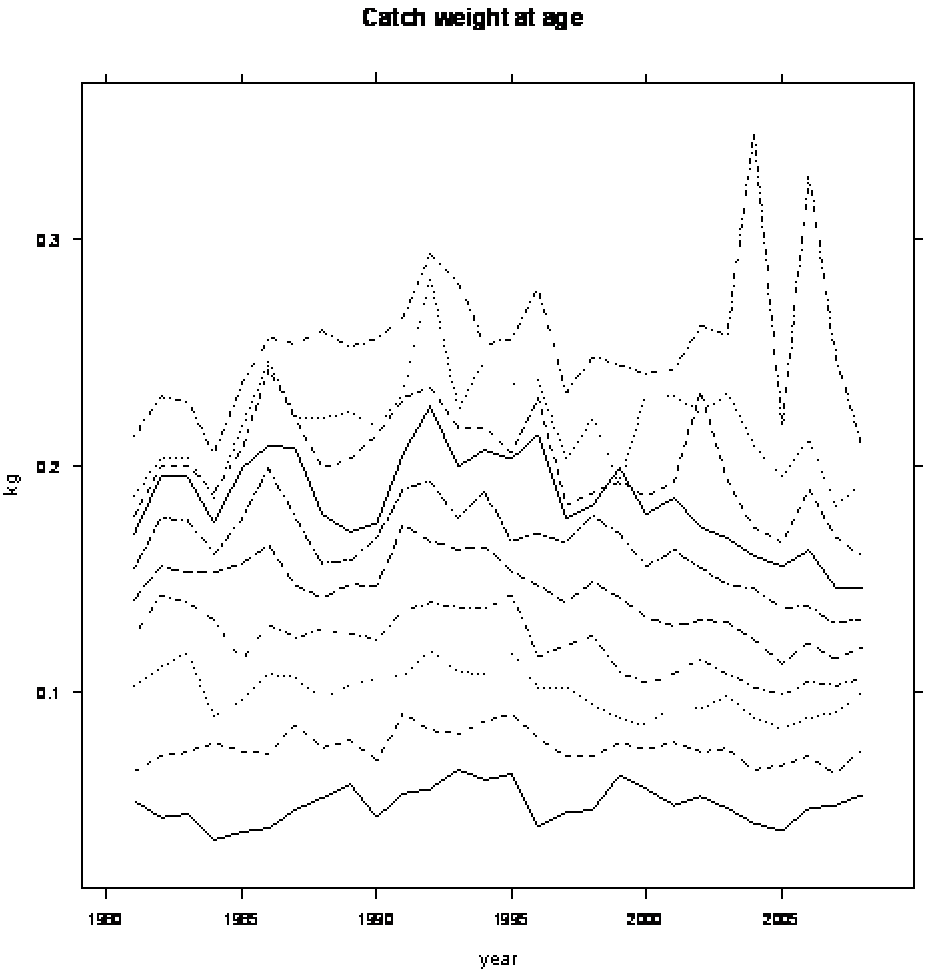


Figure 8.3.3.1. Mean catch weight (kg) at age of blue whiting by year.

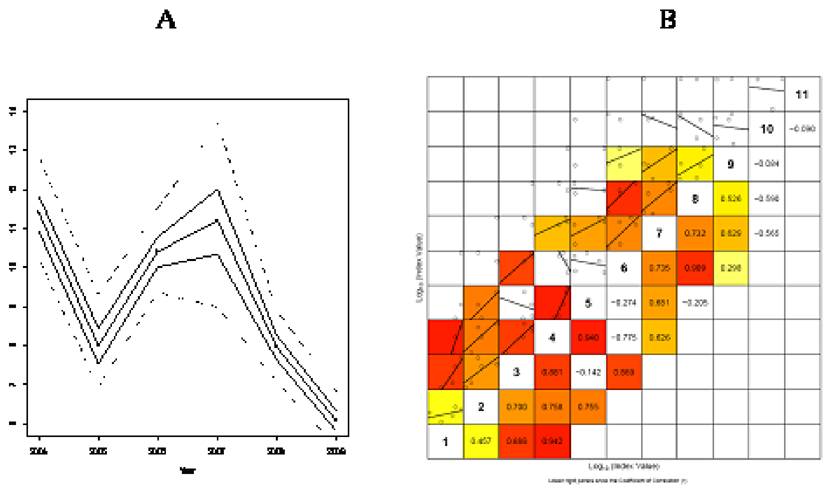
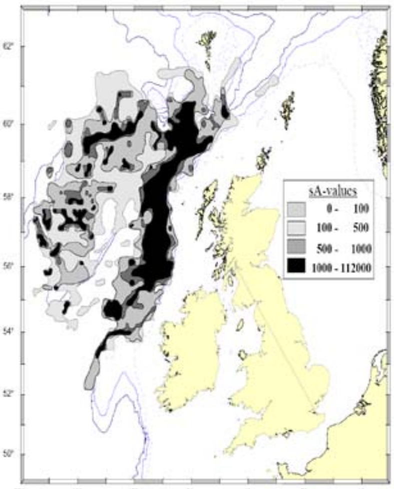
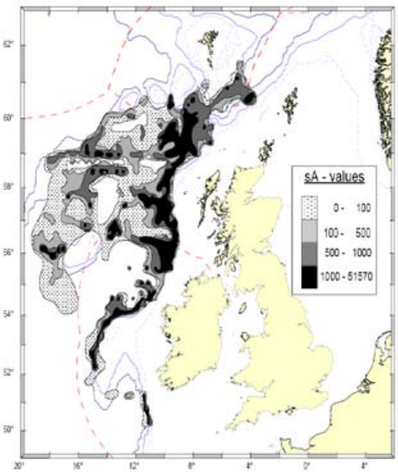
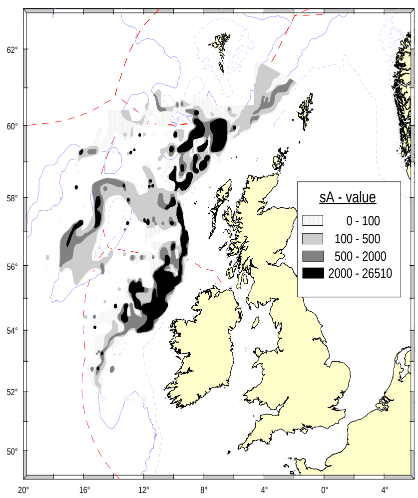


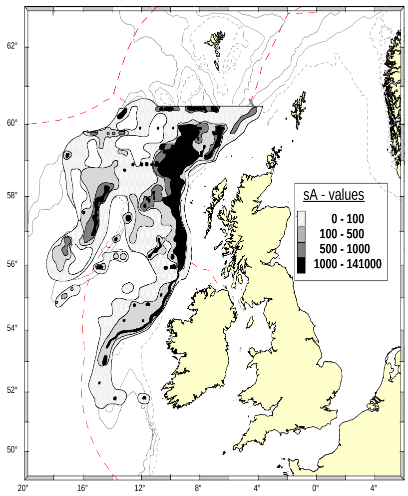
Figure 8.3.5.1.1. (A) Approximate 50% and 95% confidence limits for blue whiting biomass estimates. The confidence limits are based on the assumption that confidence limits for annual estimates of mean acoustic density can be translated to confidence limits of biomass estimates by expressing them as relative deviations from the mean values. These confidence limits only account for spatio-temporal variability in acoustic observations. (B) Internal consistency within the International blue whiting spawning stock survey. The upper left part of the plots shows the relationship between log index-at-age within a cohort. Linear regression line shows the best fit to the log-transformed indices. The lower-right part of the plots shows the correlation coefficient (r) for the two ages plotted in that panel. The background colour of each panel is determined by the r value, where red equates to r=1 and white to r=-1.





2006 **2007**





2008 **2009**

Figure 8.3.5.1.2. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the spawning survey in spring 2006-2009.

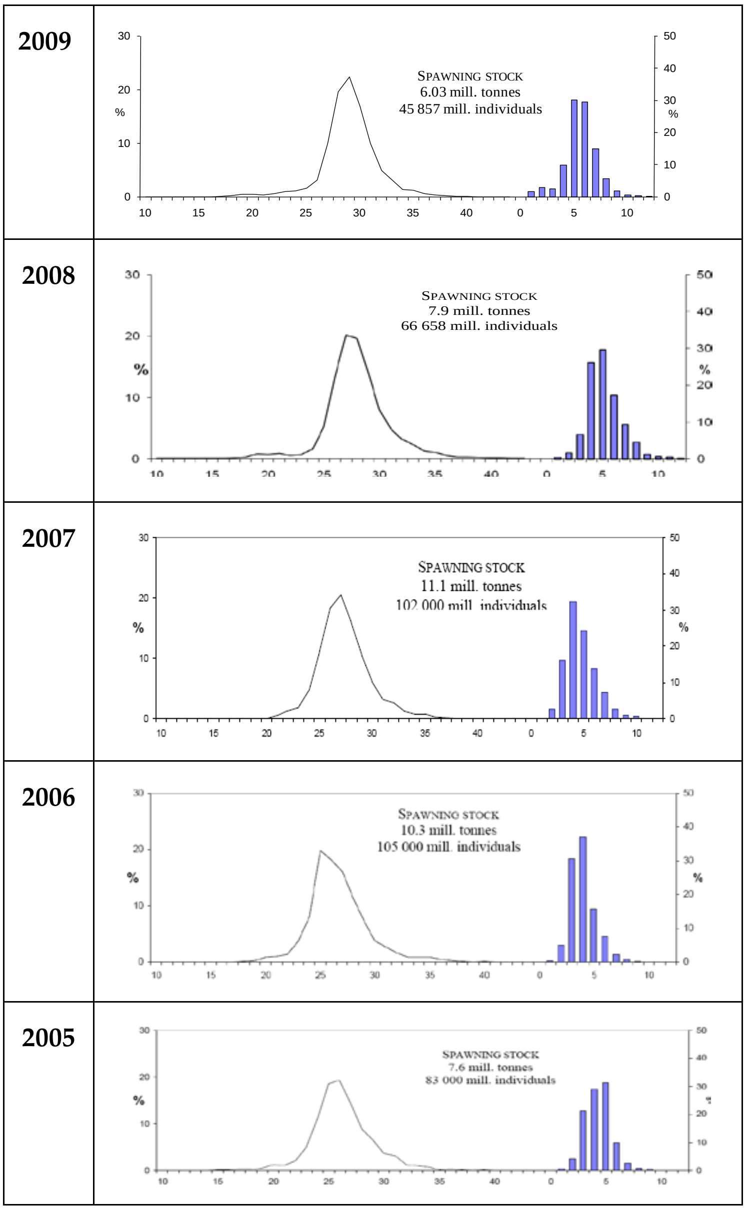


Figure 8.3.5.1.3. Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2005 (lower panel) to 2009 (upper panel).

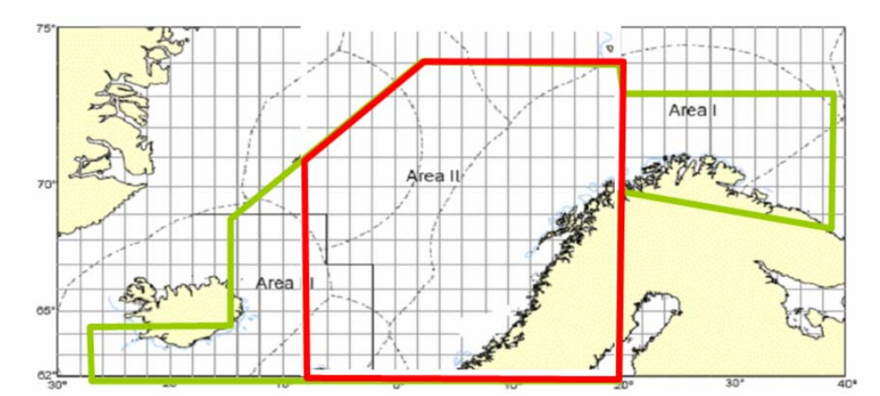


Figure 8.3.5.2.1. Areas defined for acoustic estimation of blue whiting and Norwegian spring spawning herring in the International Ecosystem survey in the Nordic Seas. The dark red box in the middle represents the standard area (8°W–20°E and north of 62°N) of which blue whiting data is used for assessment. The outer green box represents the total survey area.

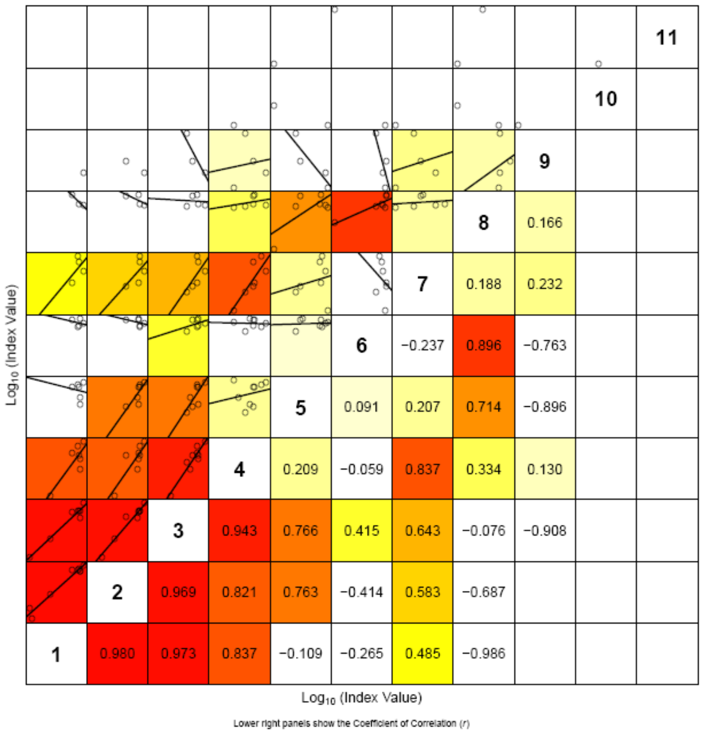


Figure 8.3.5.2.2. Internal consistency within the International Ecosystem survey in the Nordic Seas for blue whiting. The upper left part of the plots shows the relationship between log index-at-age within a cohort. Linear regression line shows the best fit to the log-transformed indices. The lower-right part of the plots shows the regression coefficient (r) for the two ages plotted in that panel. The background colour of each panel is determined by the r value, where red equates to r=1 and white to r=-1.

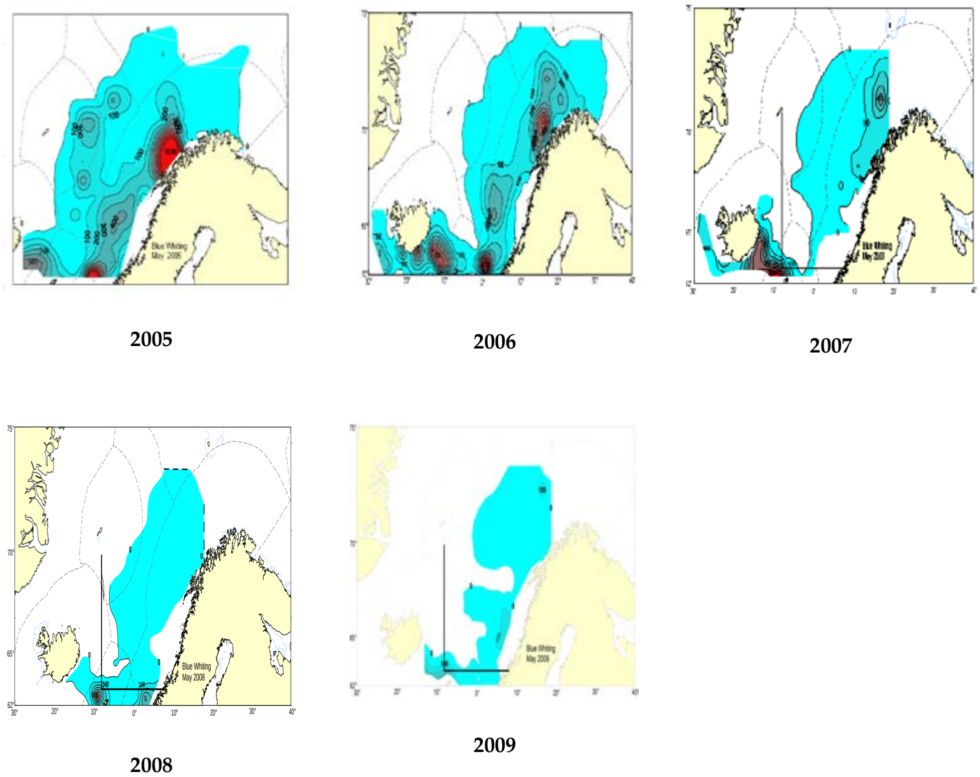


Figure 8.3.5.2.3. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the International Ecosystem survey in the Nordic Seas in spring 2005–2009.

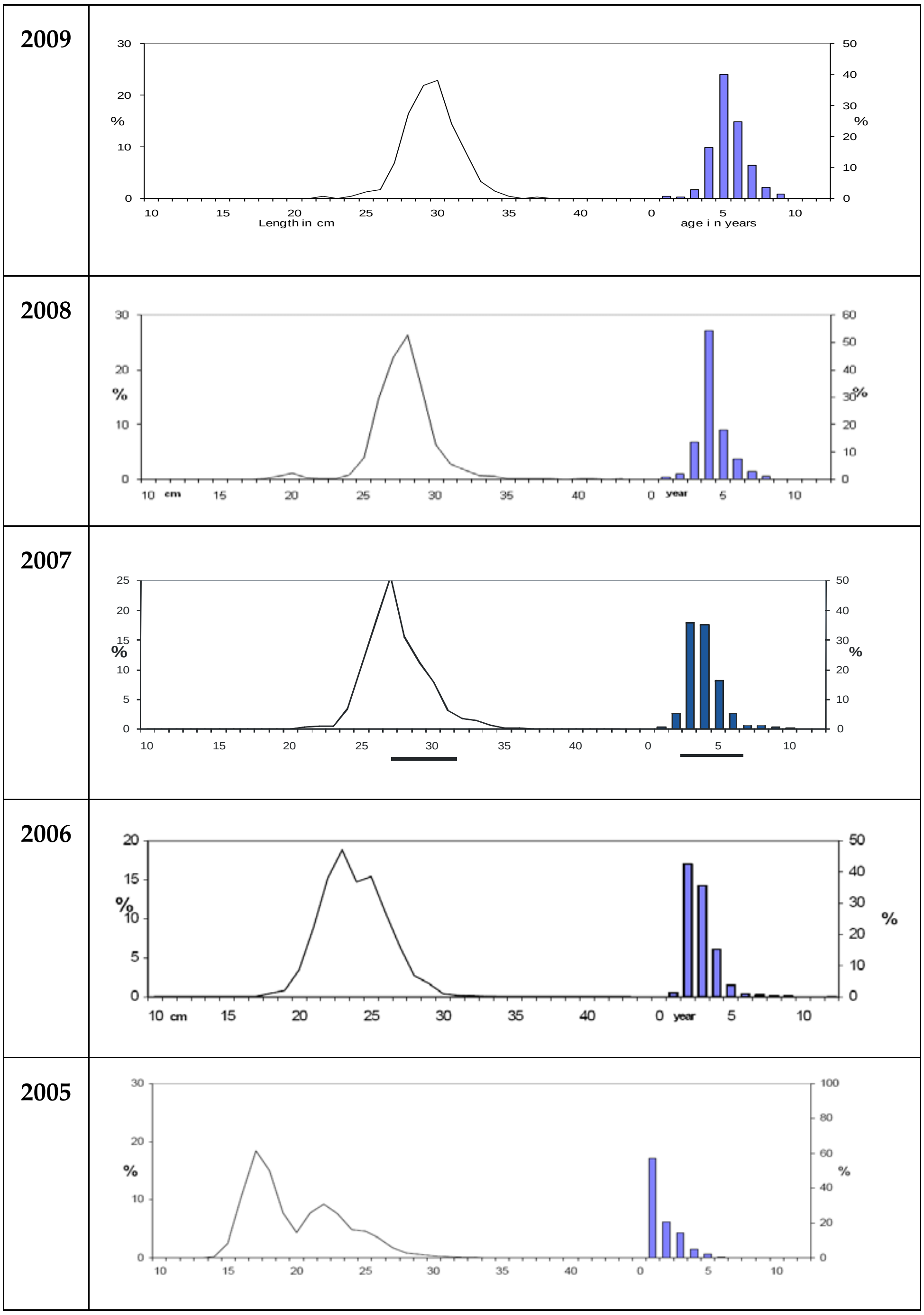


Figure 8.3.5.2.4. Estimated length (line) and age (bar) distributions of blue whiting in the International Ecosystem Survey in the Nordic Seas in May–June for 2005-2009 based on the "standard survey area" between 8°W-20°E and north of 63°N.

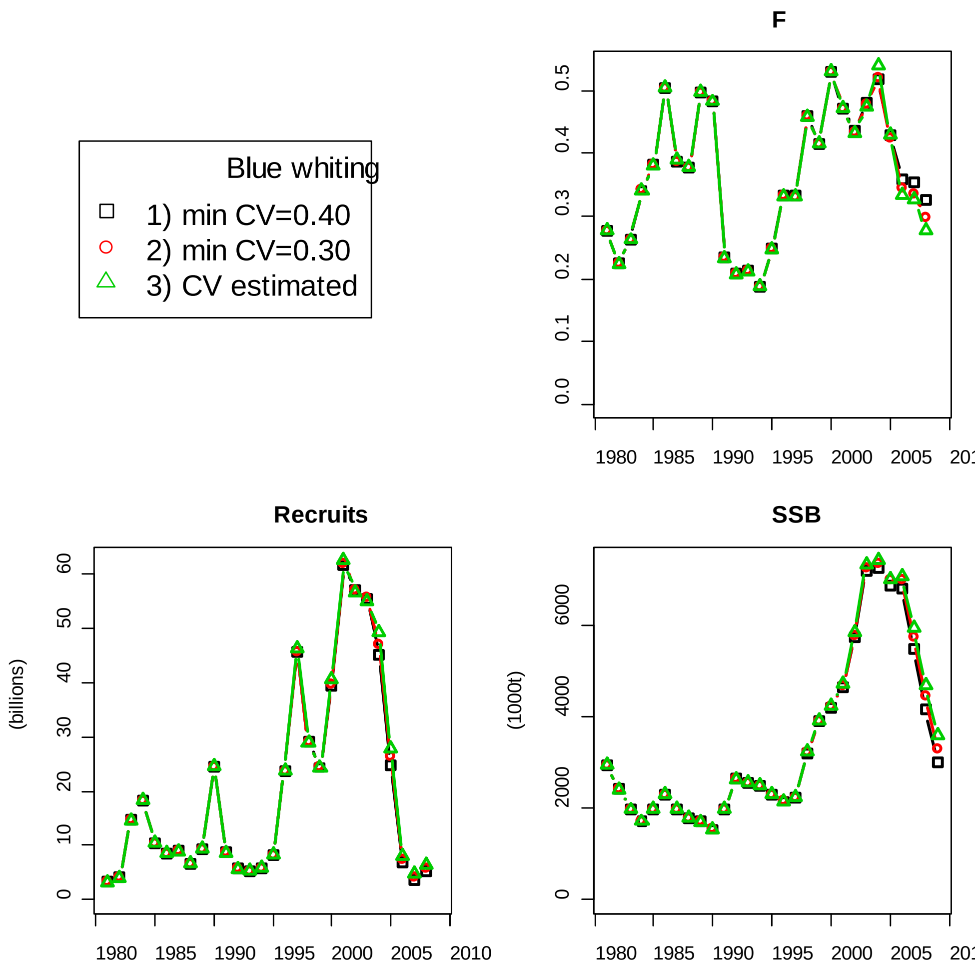


Figure 8.4.1.1. Blue Whiting SMS data exploration: effect of using a lower bounded (1 and 2) or unbounded CV (3) for IBWSSS observations.

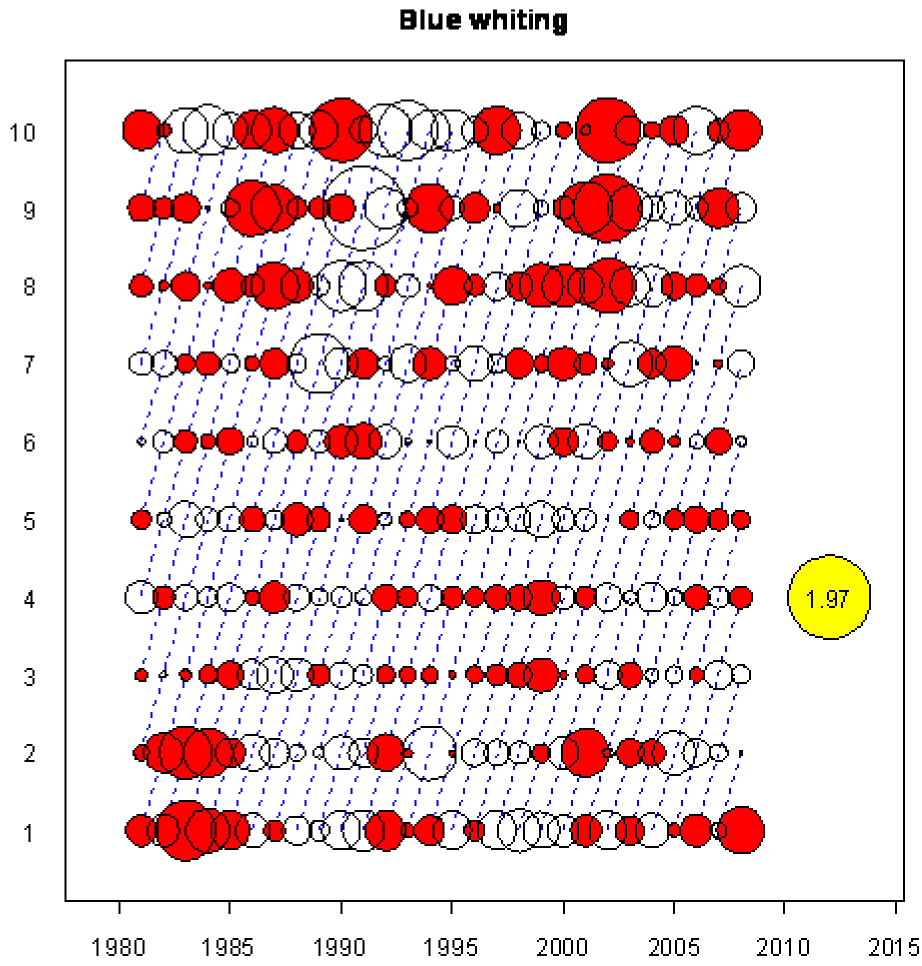
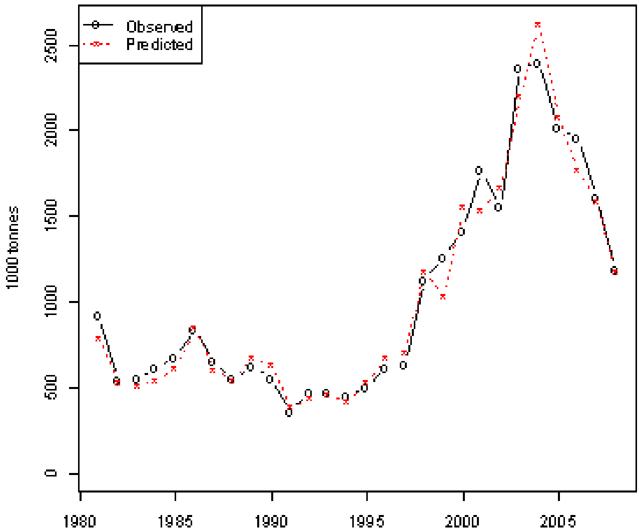


Figure 8.4.1.2. Blue Whiting SMS data exploration, unbounded survey CV configuration: residuals for catch observations. Red (dark) bubbles show that the observed value is larger than the expected value. The bubble at right is the size of the largest residual.

A



B

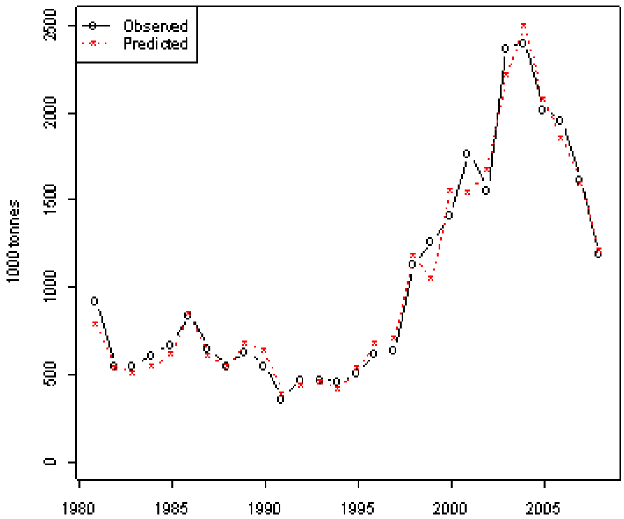


Figure 8.4.1.3. Blue whiting SMS data exploration: comparison of observed and predicted catch weight from the SMS run (no revised cath data, see note in section 8.4). (A) shows the results from an unbounded survey CV; (B) from a lower bounded CV at 0.40. (this analysis is only indicative)

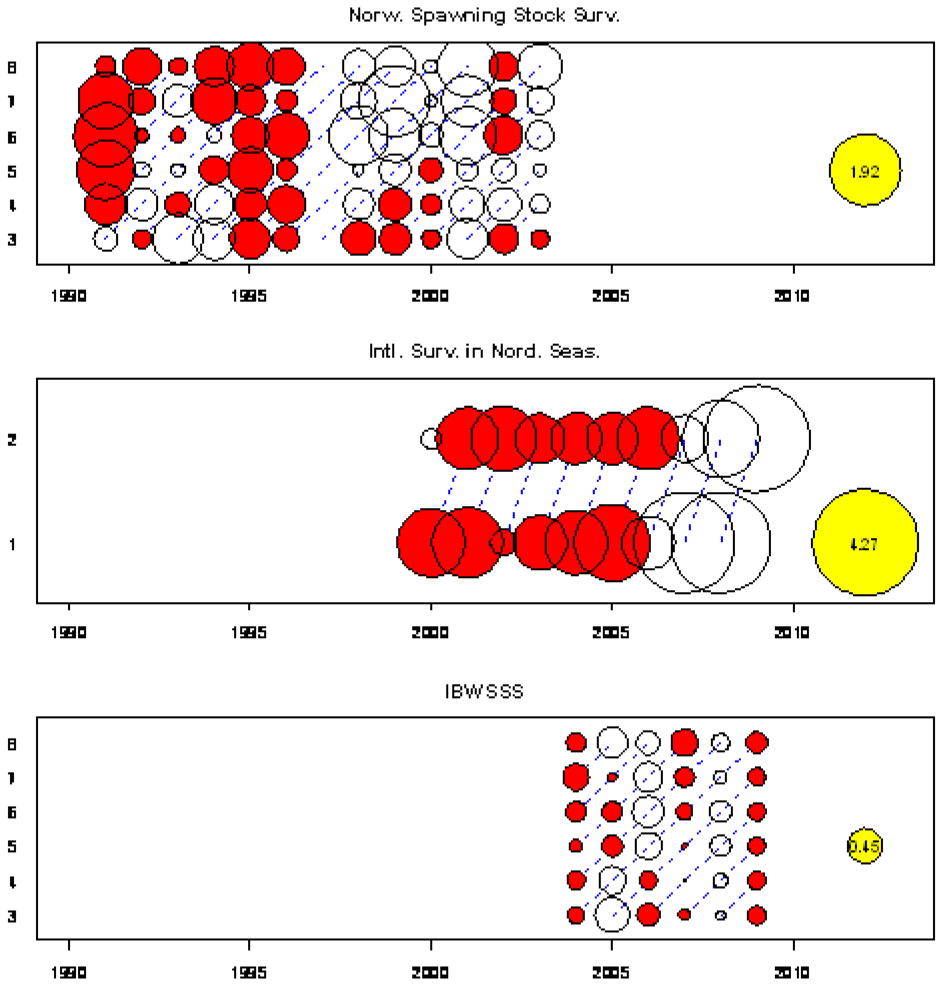


Figure 8.4.1.4. **Blue Whiting SMS data exploration, unbounded survey CV configuration: survey residuals for survey observations for the Norwegian spawning stock survey (top panel), the International ecosystem survey in the Nordic seas (middle panel) and the International Blue Whiting Spawning Stock Survey (IBWSSS; bottom panel). Red (dark) bubbles show that the observed value is larger than the expected value. The bubble at right is the size of the largest residual. The bubble-size scale is constant between the individual surveys.**

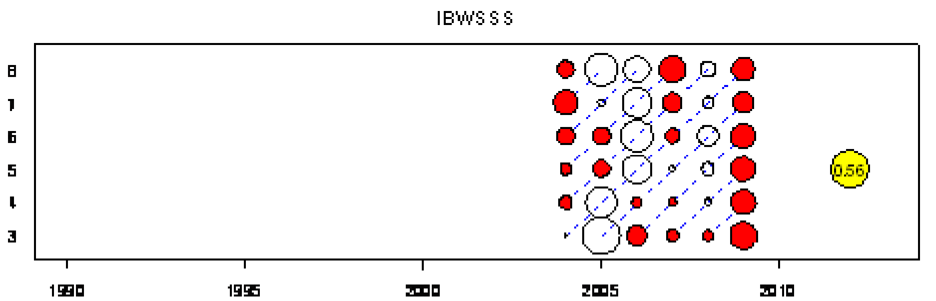


Figure 8.4.1.5. **Blue Whiting SMS data exploration, lower bounded CV (0.4) configuration: survey Residuals for survey observations from IBWSSS.**

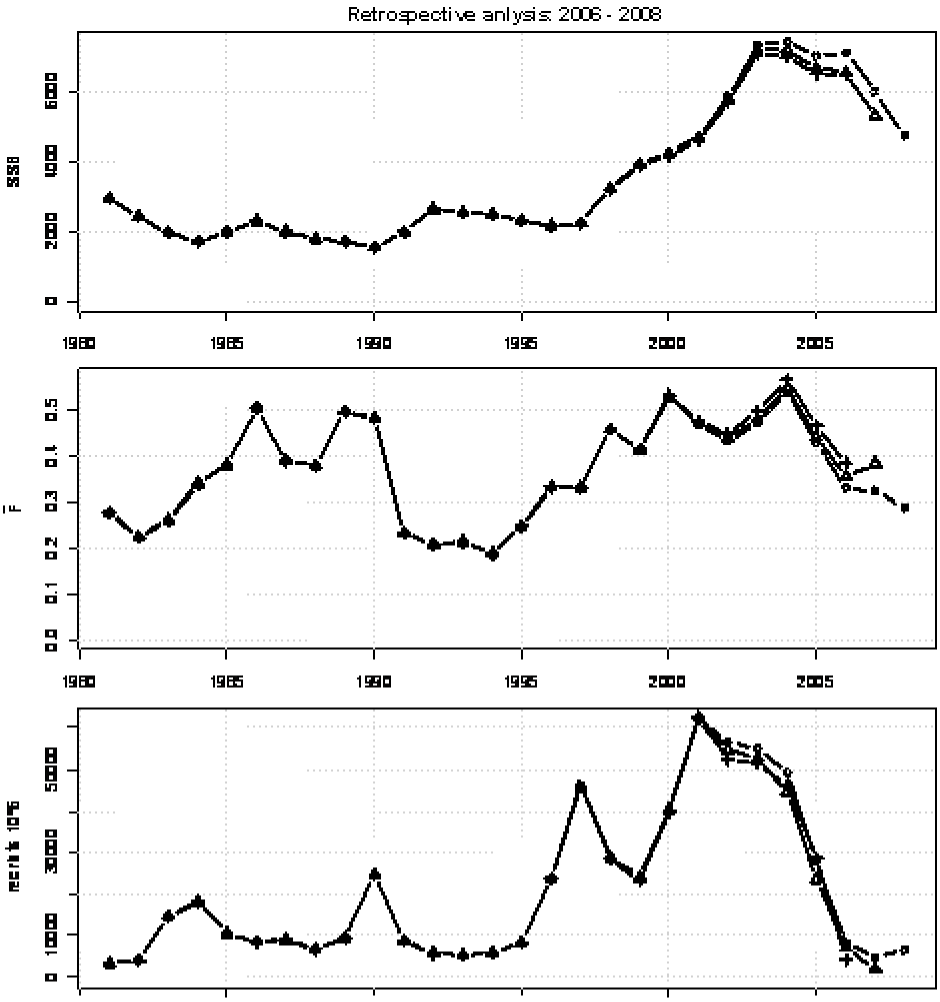


Figure 8.4.1.6. Blue Whiting SMS data exploration, unbound survey CV configuration: Retrospective analysis of SSB, *F* and recruitment (age 1).

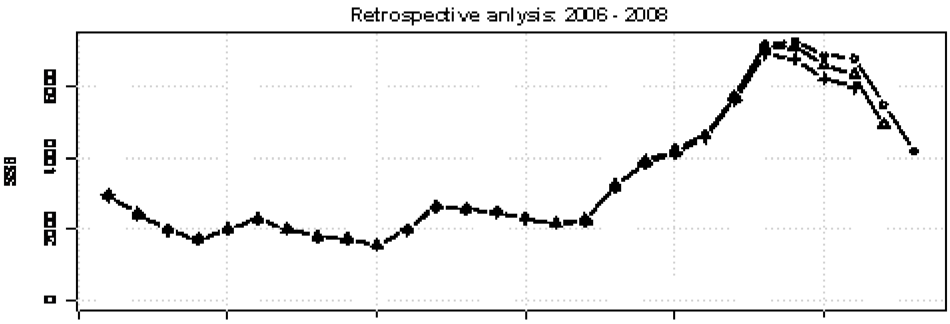


Figure 8.4.1.7. Blue Whiting SMS data exploration, lower bound survey CV=0.4 configuration: Retrospective analysis of SSB.

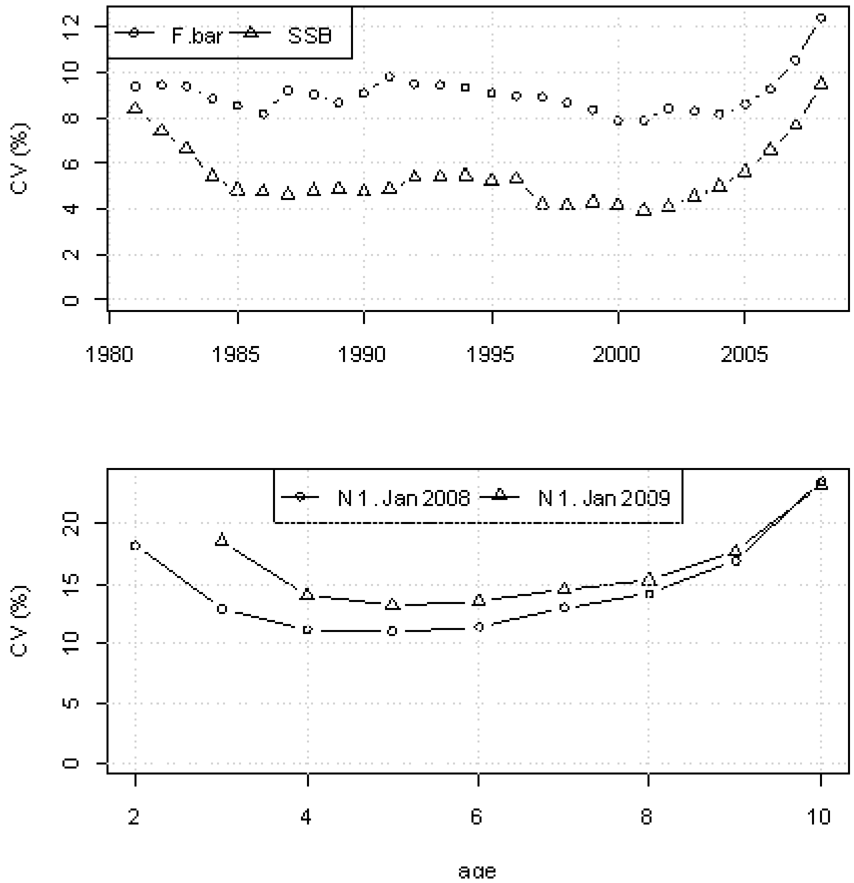


Figure 8.4.1.8. Blue whiting SMS data exploration, Unbounded survey CV configuration: estimates of CV of SSB and *F*-bar (3–7) (top panel) and CV of stock number-at-age in the terminal assessment year and the following. CVs are estimated by SMS from the Hessian matrix.

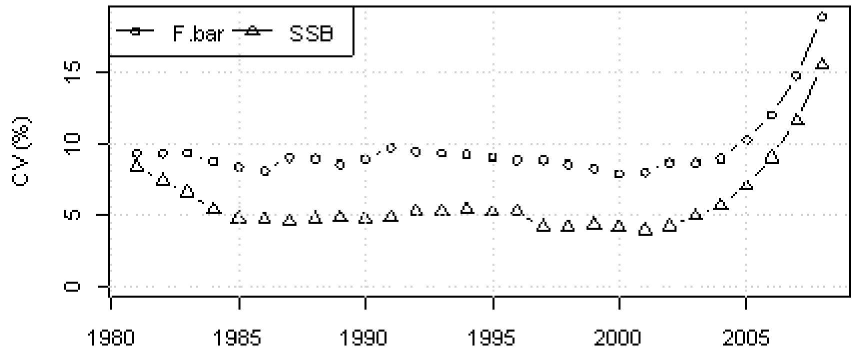


Figure 8.4.1.9. Blue whiting SMS data exploration, lower bounded survey CV=0.4 configuration: estimates of CV of SSB and *F*-bar (3–7).

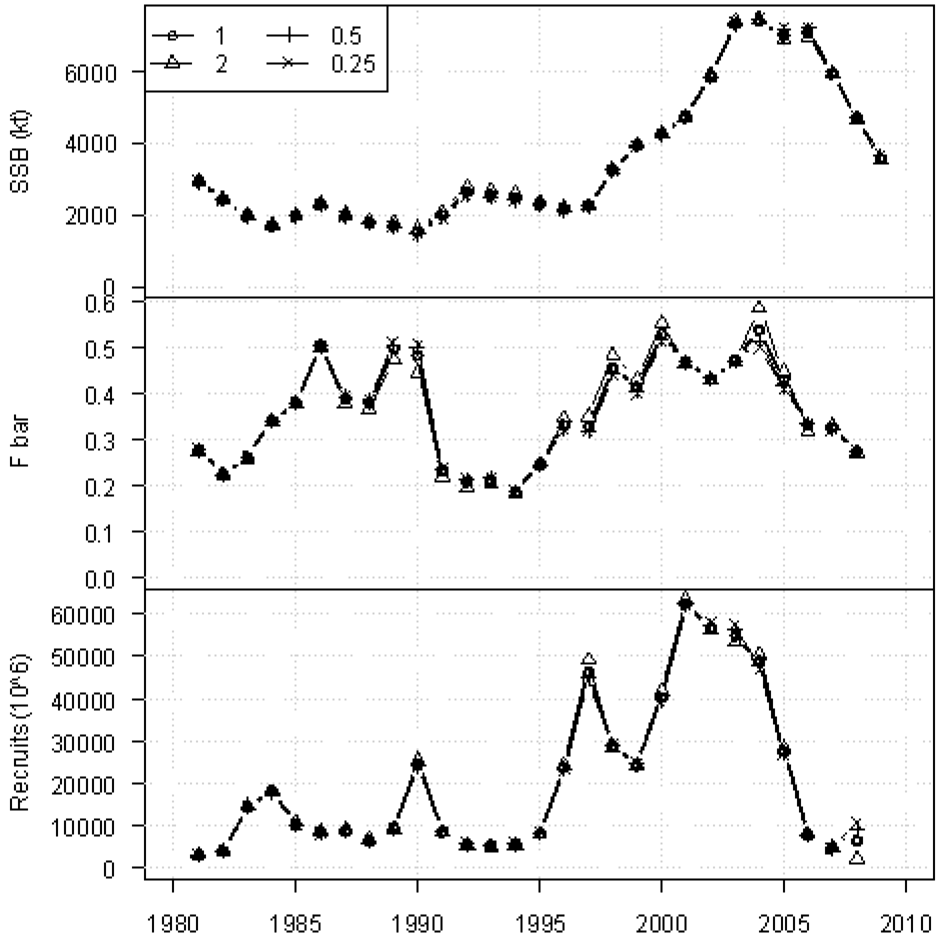


Figure 8.4.1.10. Blue Whiting SMS data exploration, unbounded survey CV configuration: effect on SSB (top panel), mean fishing mortality *F* bar (ages 3–7; middle panel) and estimated recruitment (bottom panel) of changing the a priori weighting on the survey observations. The *a priori* weight on catch observations is kept constant at 1.0, and thus a weighting factor of, for example, 2 represents a relative weight on the survey twice that of the catches.

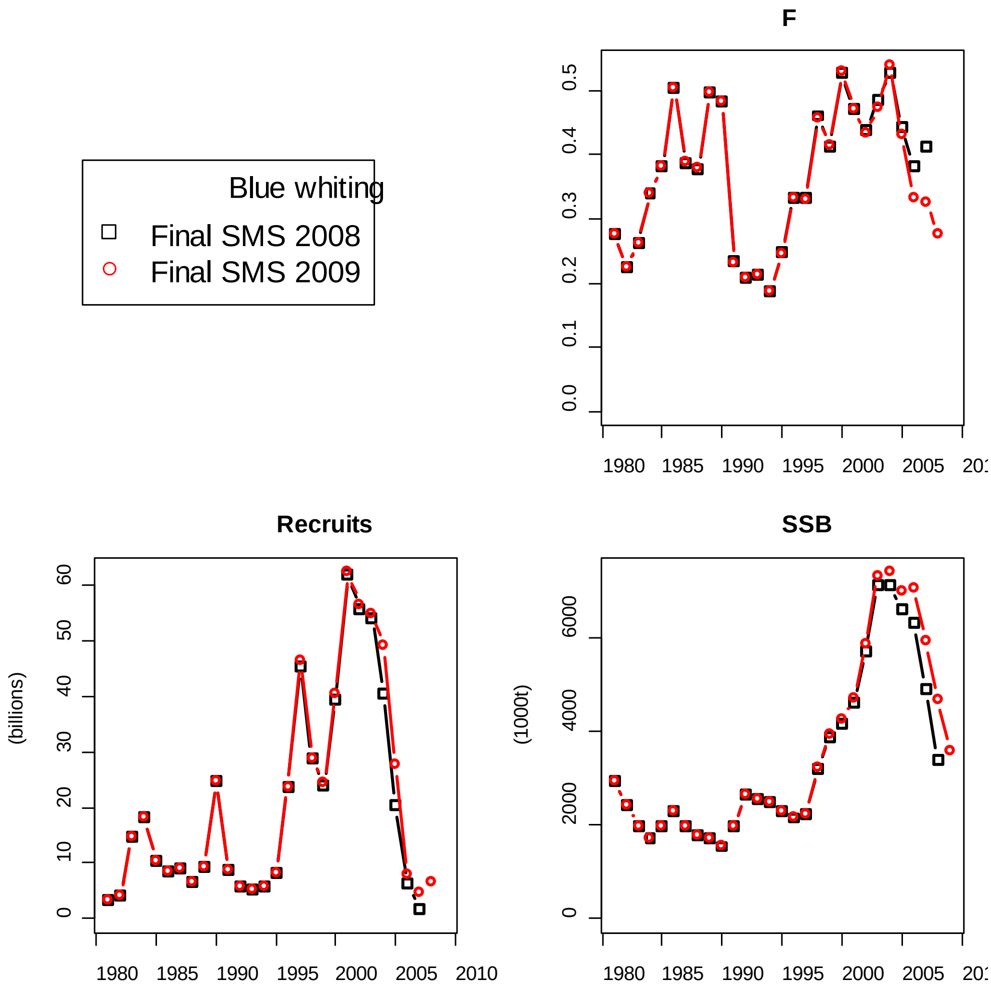


Figure 8.4.1.11. Comparison between the SMS final assessment for blue whiting in 2009 and the 2008 assessment.

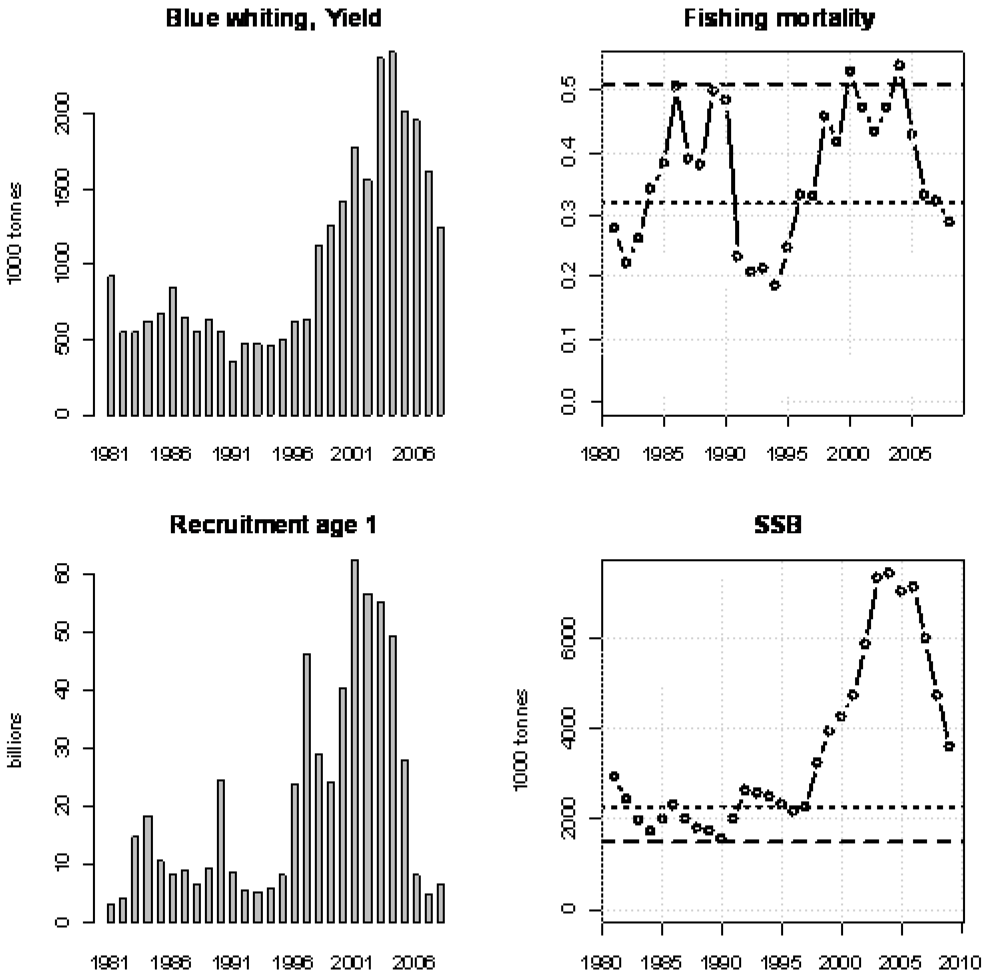


Figure 8.4.1.12. Blue whiting SMS data exploration, unbound survey CV configuration: stock summary. SSB at 1st January 2009 does not include age 1.

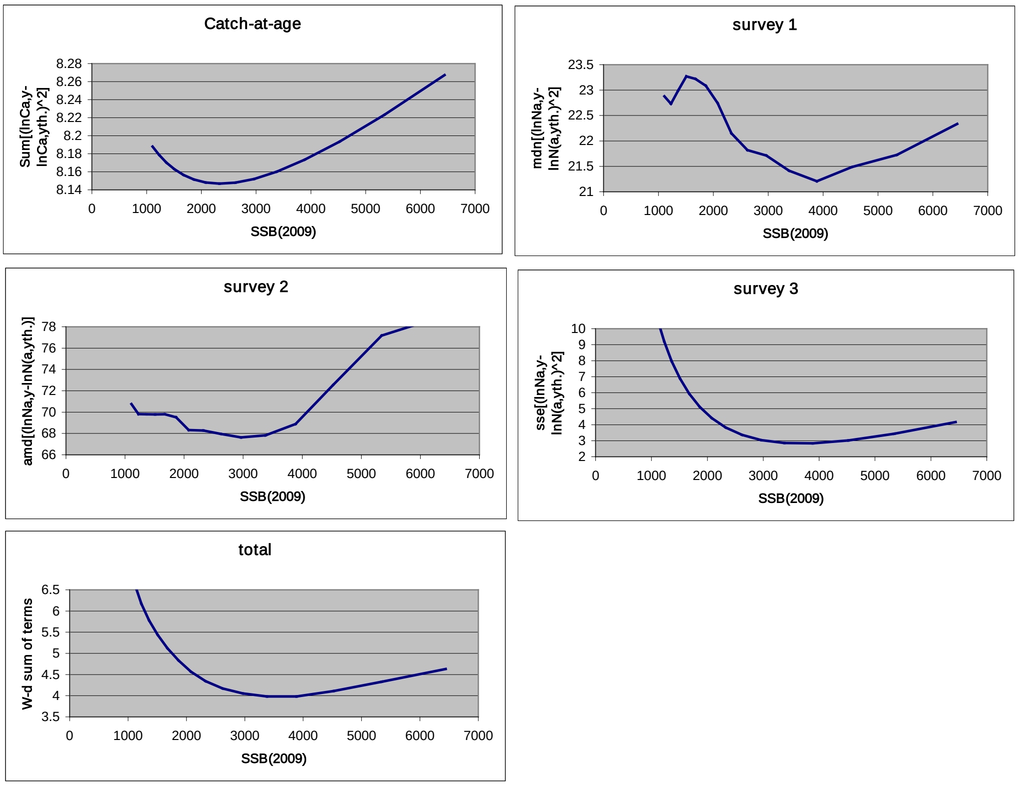


Figure 8.4.2.1. Blue whiting TISVPA data exploration Profiles of components of the TISVPA loss function. Survey 1 = Norwegian Spawning Stock Survey, survey 2 = International Survey in the Nordic Seas and survey 3 = IBWSSS.

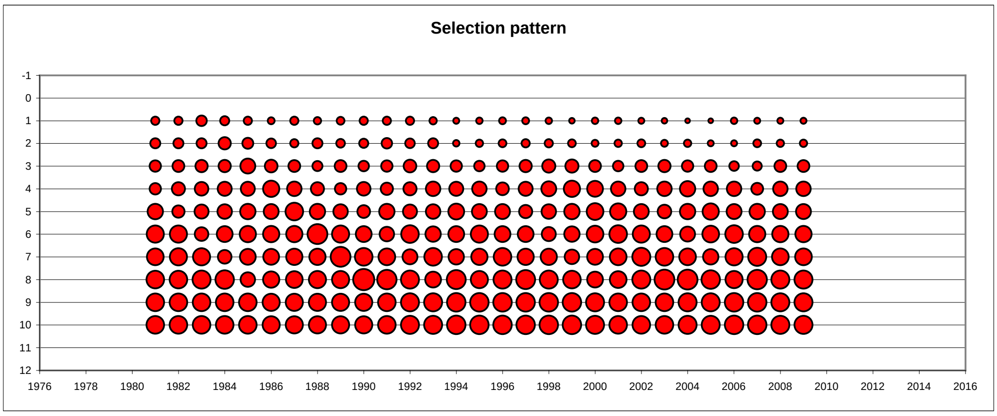


Figure 8.4.2.2. Blue whiting TISVPA data exploration: estimated selection pattern

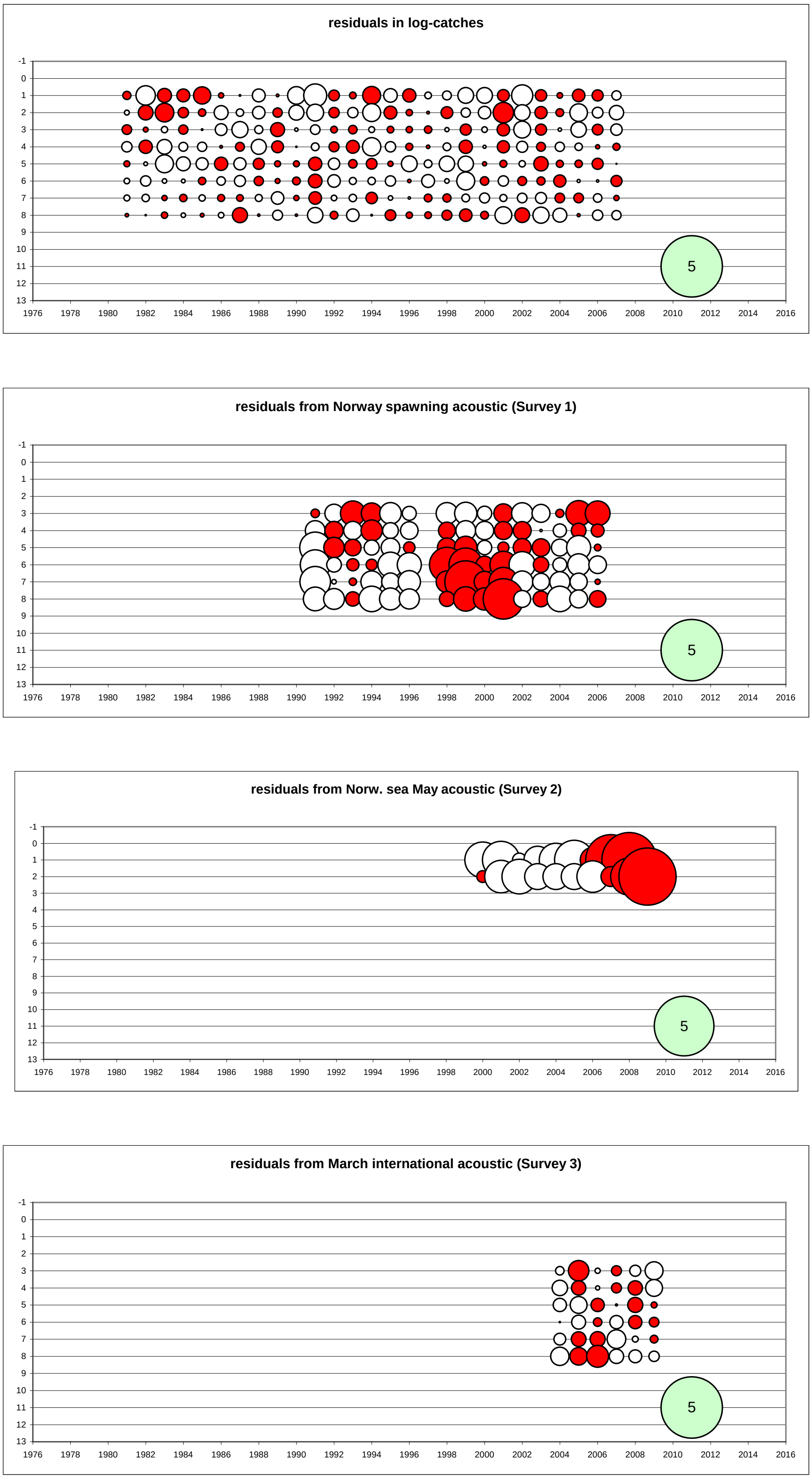


Figure 8.4.2.3. Blue whiting TISVPA data exploration: model residuals for catch at age data and the three blue whiting surveys.

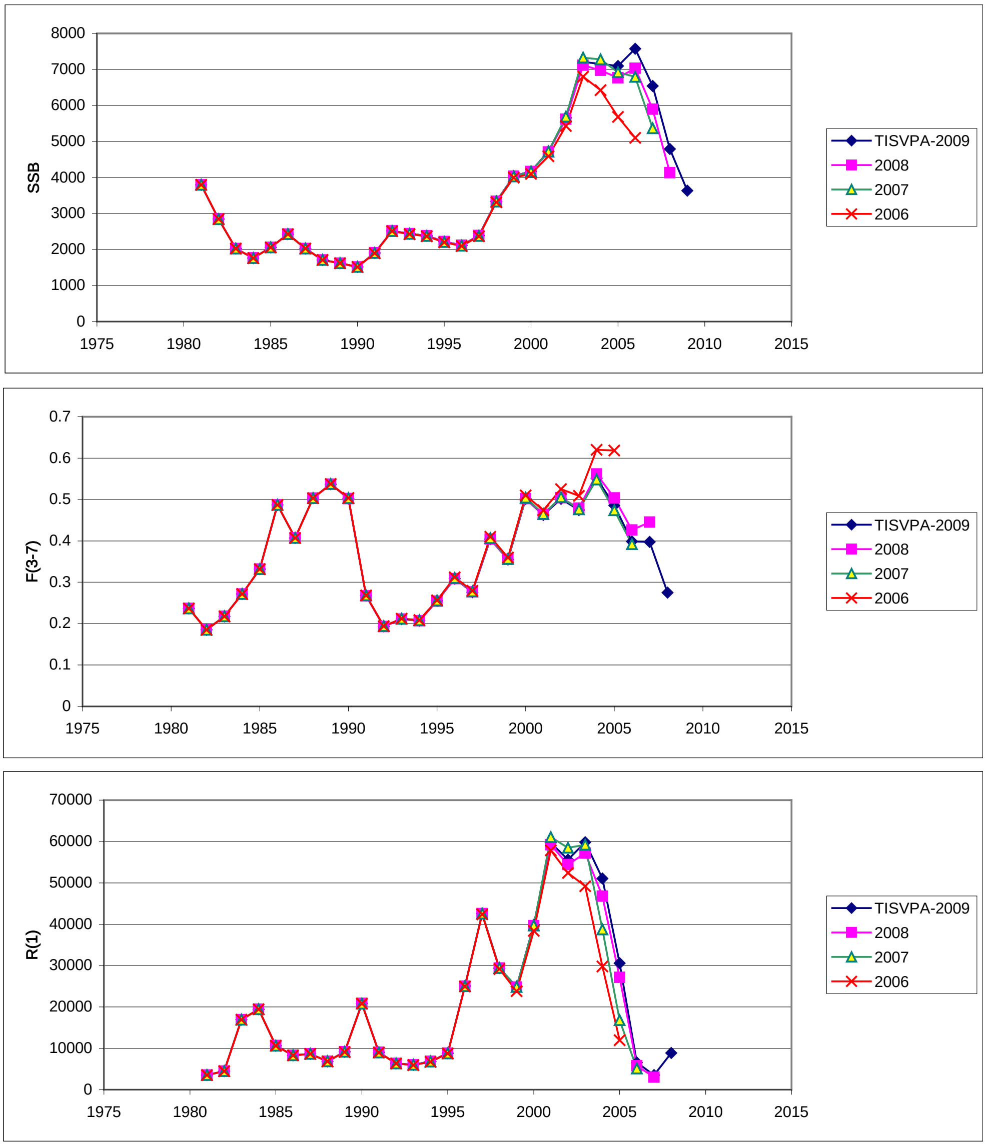


Figure 8.4.2.4 Blue Whiting TISVPA data exploration: retrospective analysis for SSB (upper panel), *F*-bar (ages 3-7) and recruitment (age 1). (N:ote: exploratory analysis with the uncorrected catch), see section 8.4) (This analysis is only indicative)

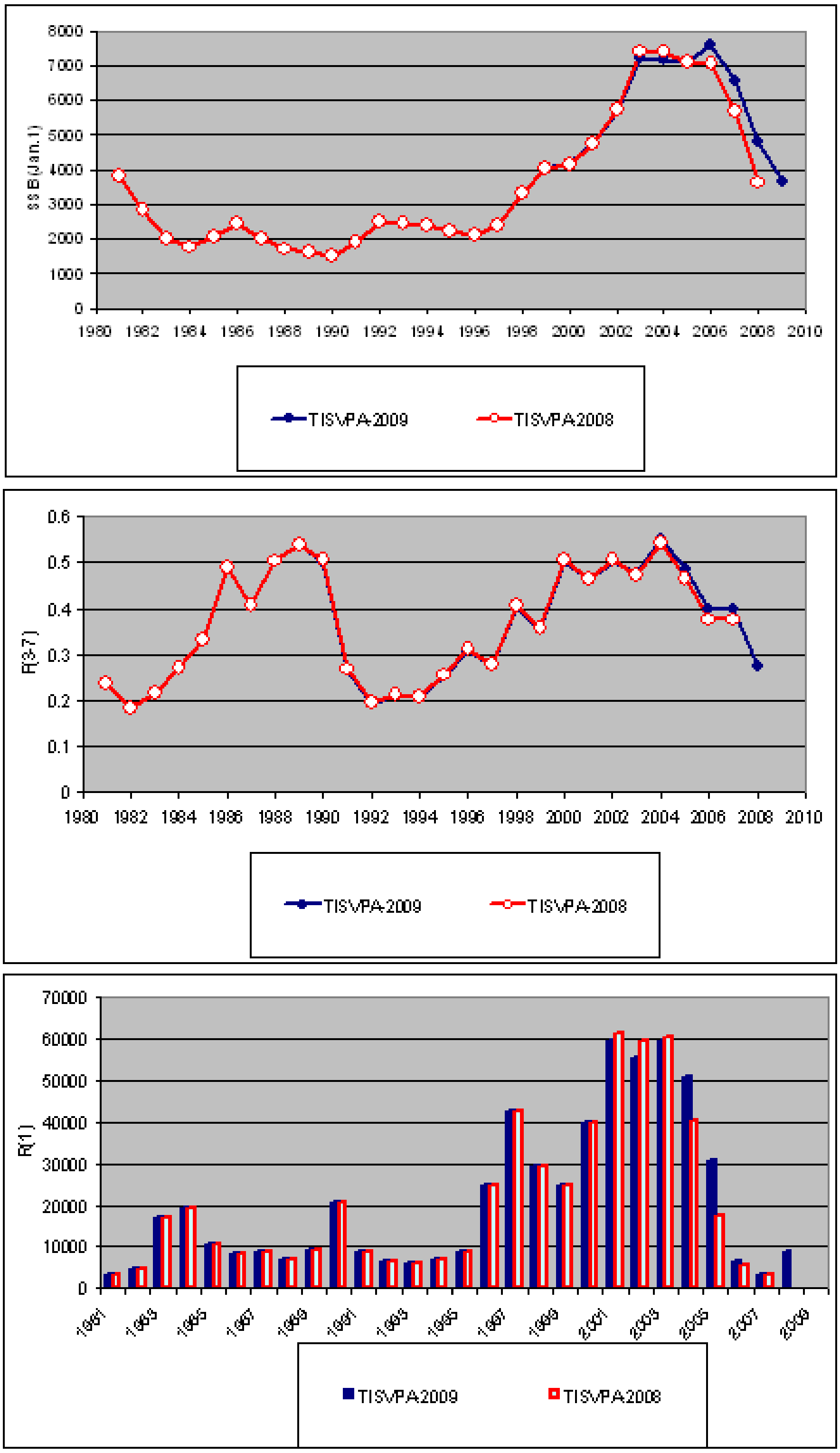


Figure 8.4.2.5. Blue whiting TISVPA data exploration: comparison of TISVPA results from 2008 and 2009. (N:ote: exploratory analysis with the uncorrected catch), see section 8.4) (This analysis is only indicative)

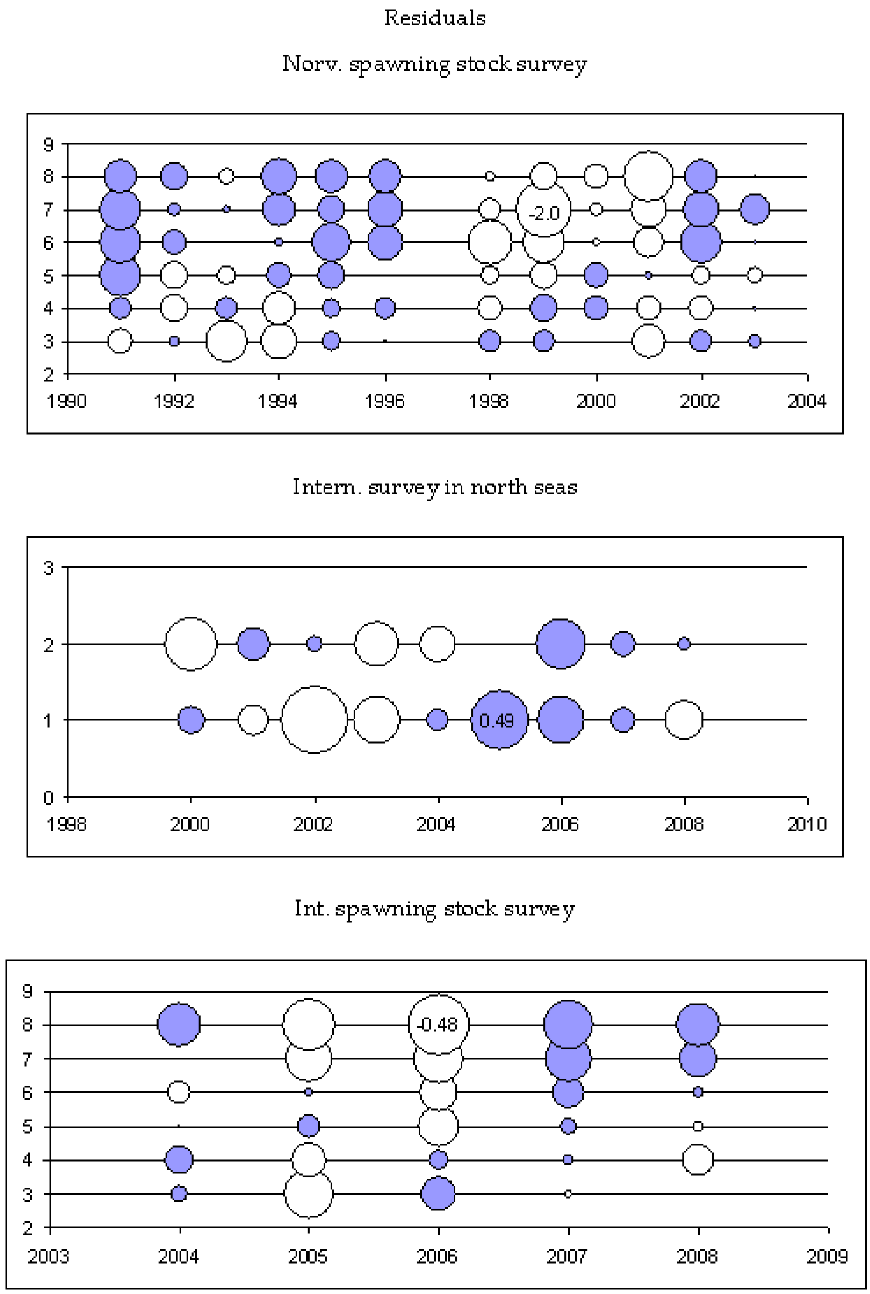


Figure 8.4.3.1. Blue whiting XSA data exploration: survey residuals. (N:ote: exploratory analysis with the uncorrected catch), see section 8.4) (This analysis is only indicative)

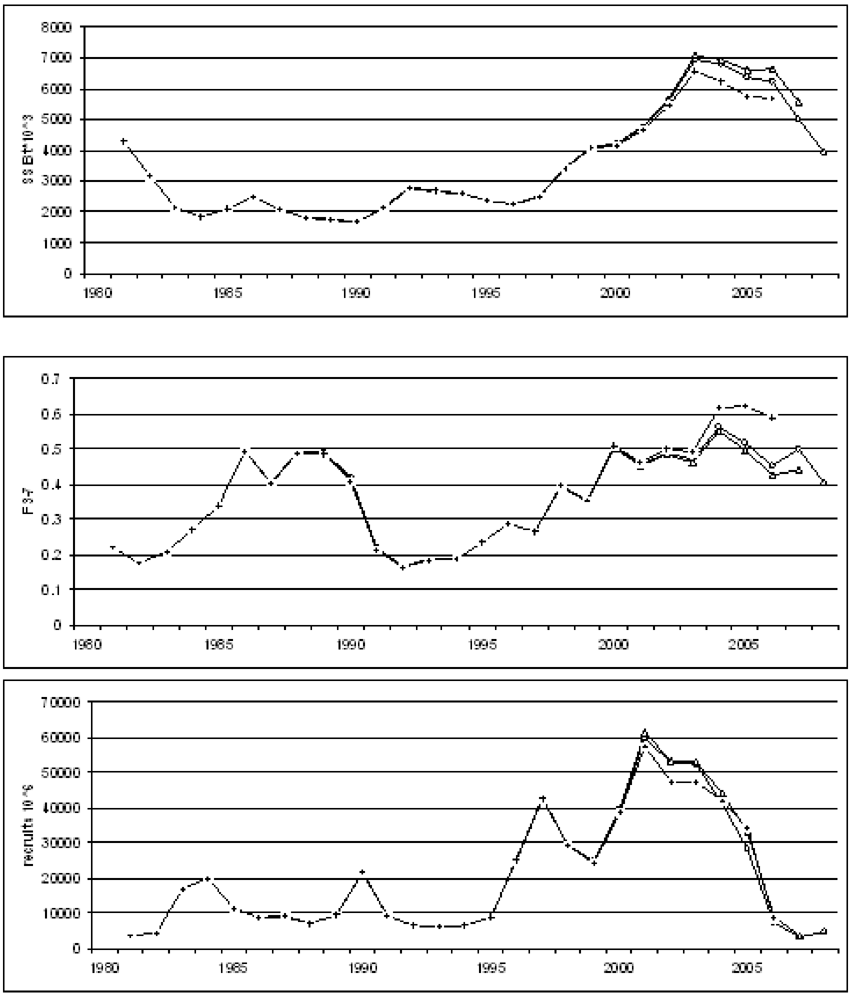


Figure 8.4.3.2. Blue whiting XSA data exploration: retrospective analysis (Note: this exploratory run was performed before the catch correction)

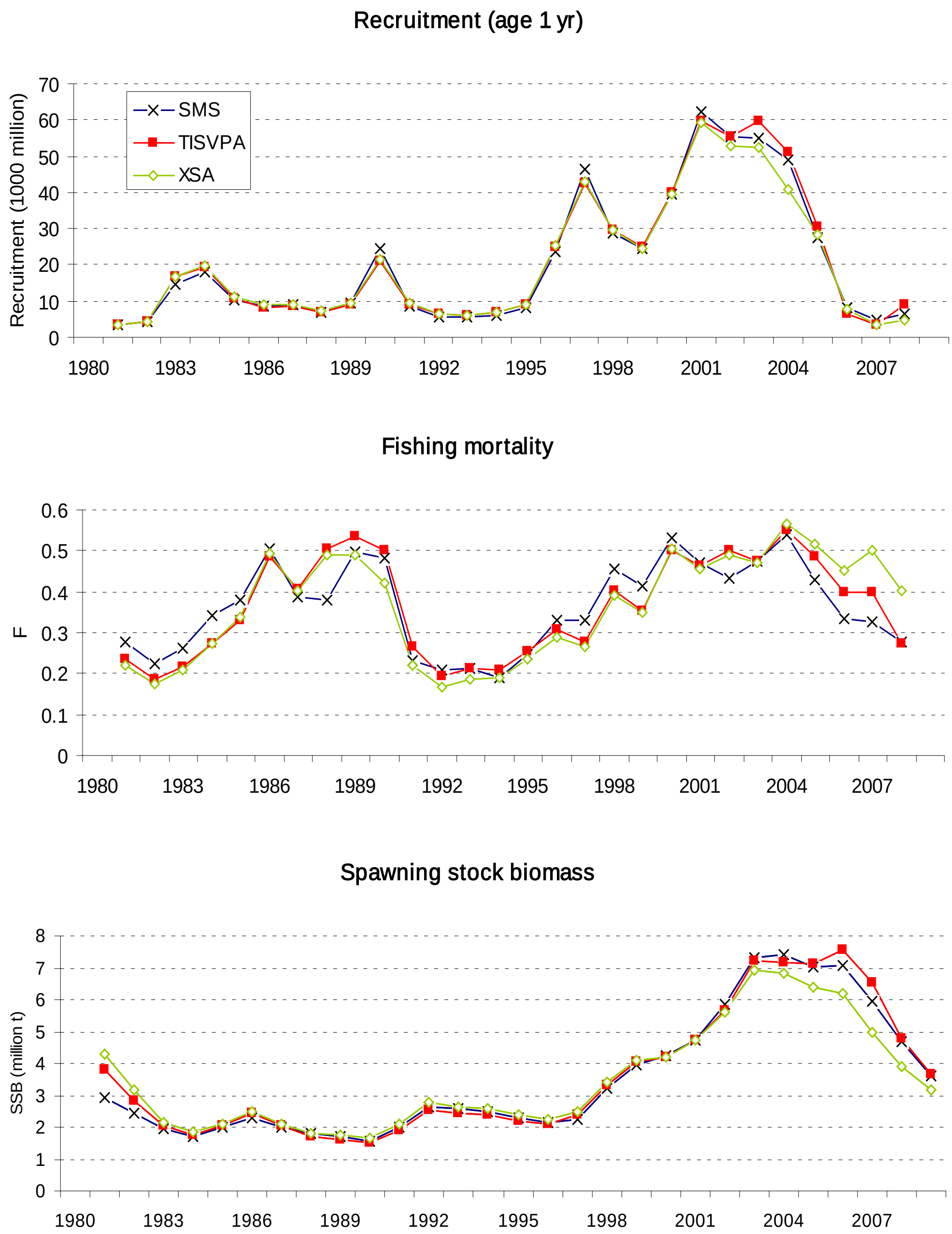


Figure 8.4.4.1. Blue whiting data exploration: comparison between final exploratory SMS, TISVPA and XSA assessments estimates of recruitment (age 1), *F* bar (ages 3-7) and SSB. (Note: exploratory runs with uncorrected catch data see section 8.4). 9This analyses is only indicative)

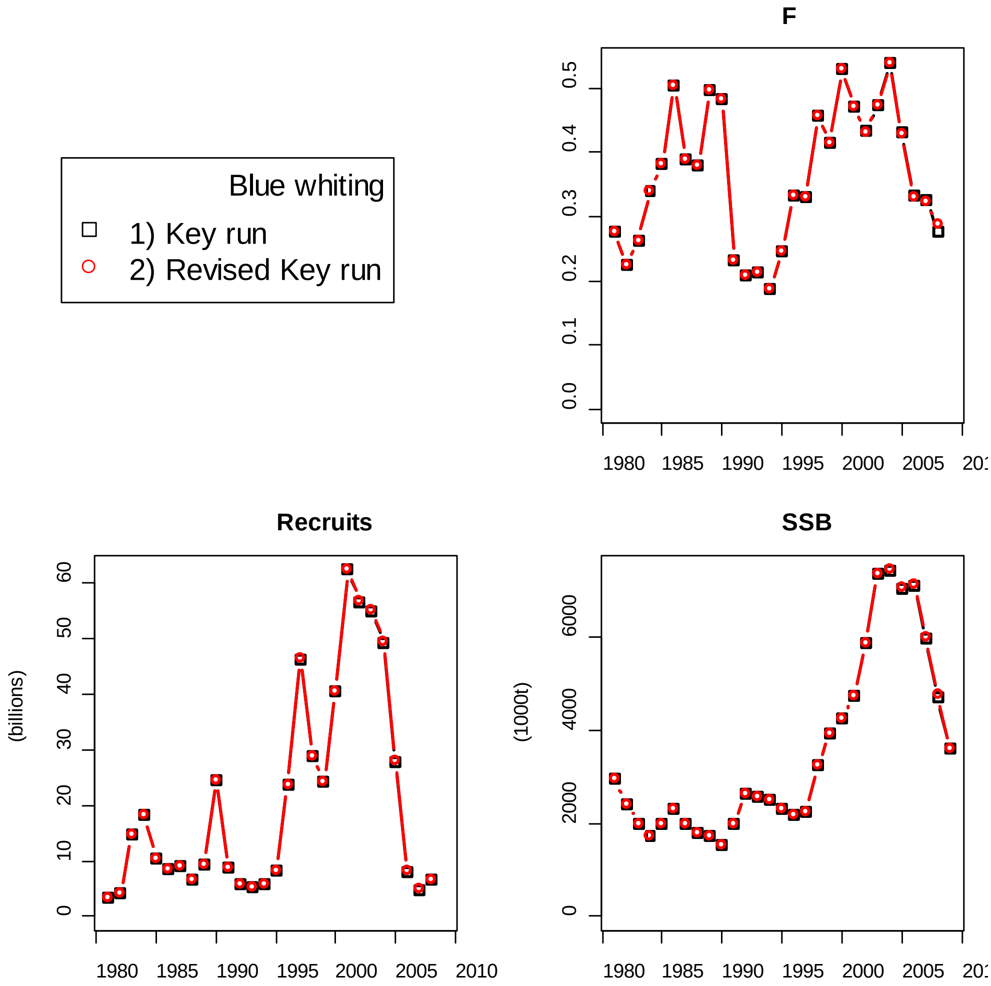


Figure 8.5.1. Blue whiting. Comparison of the SMS final assessment without and with revised catch data.

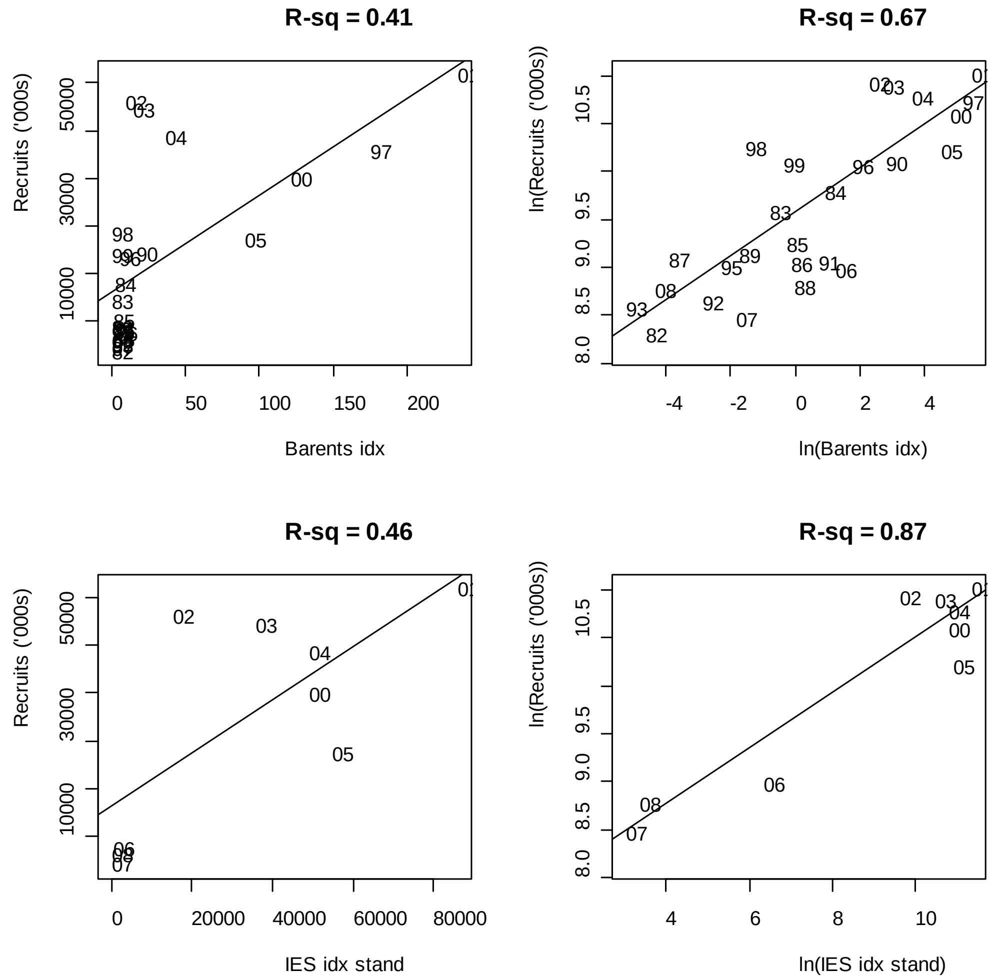


Figure 8.7.1.1. Recruitment (age 1, thousands) from the final SMS assessment and age 1 indices from the Barents Sea bottom trawl survey (upper panels) and the International ecosystem survey in the Nordic Seas (IES) standard area (lower panels), both on natural scale (left panels) and log-scale (right panel). (Note: exploratory runs with uncorrected catch data see section 8.4).

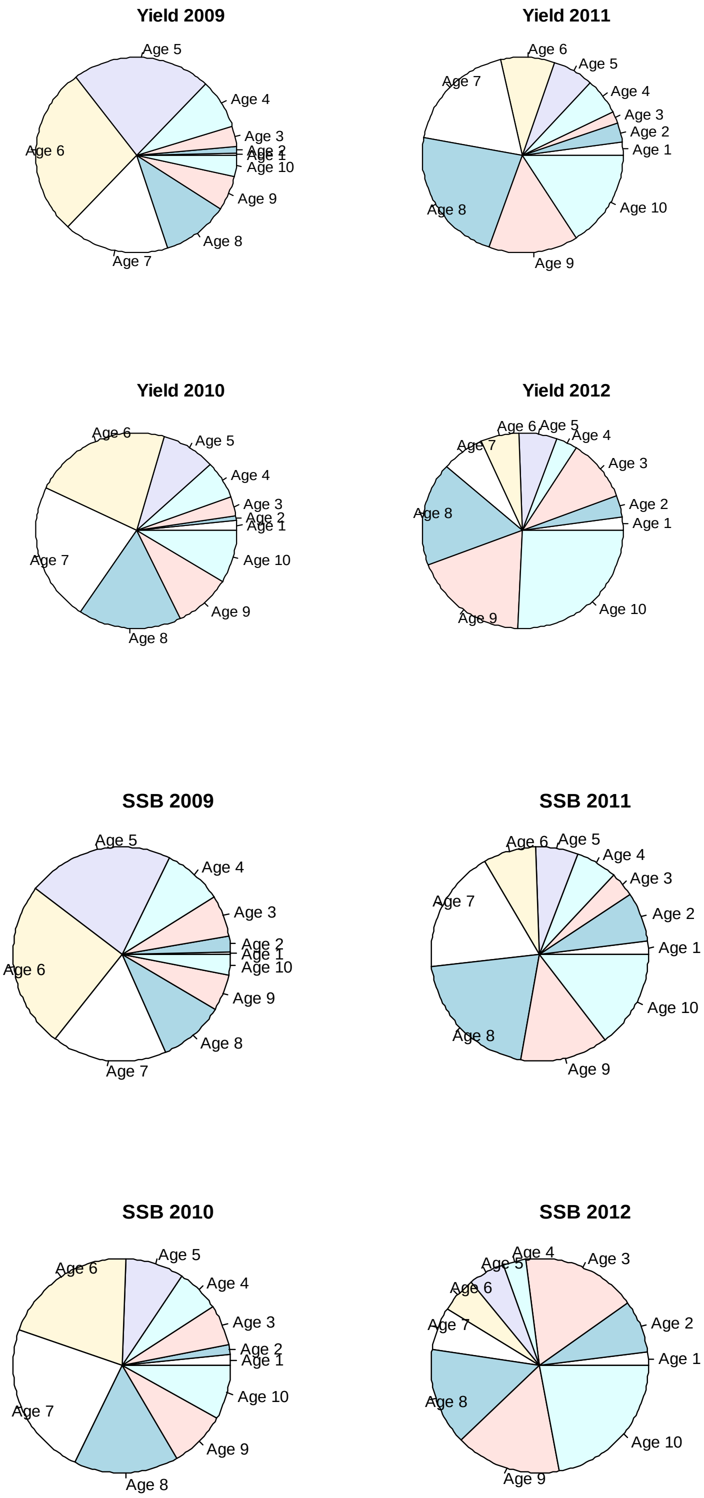


Figure 8.9.2.1. Forecasted age distribution in the blue whiting SSB and catch. (Note: exploratory runs with uncorrected catch data see section 8.4).

9 Recommendations

Recommendation	For follow up by:
1. Increase sampling of weight at age in the 1st quarter for **Norwegian spring spawning herring**	countries fishing on this stock
2. **Workshop on maturity at age** for Norwegian spring spawning herring. Chair, date, data, participants.	ICES
3. that a **WGWIDE surveys coordination group** consisting of experts on acoustics, pelagic trawling, survey design, biology and assessment is established to improve and modify existing surveys targeting mackerel. This group should deal with the harmonization and coordination of national and international surveys that already are targeting mackerel, particularly the ongoing surveys in the mackerel feeding area during the summer, and other surveys that with minor adjustments can provide such information.	SCICOM
4. Since the surveys coordinated by WGMEGS and PGNAPES overlap partly in time, areas and stocks WGWIDE recommends **joint sessions** between these two groups to coordinate these surveys in a more efficient way. In addition the sessions should include participation of experts in survey design.	SCICOM
5. The WG recommends that **egg production estimates** be provided with sampling CVs so that these can be incorporated into the assessment for western horse mackerel.	WGMEGS.
6. To help the stock coordinators, the WGWIDE recommends that a letter is sent by ICES to all countries fishing in ICES waters describing how and in what format the **catch statistics** should be provided. This should include InterCatch format, catch by statistical rectangle by quarter and other information needed by the WGs.	ICES, GENERAL SECRETARY; NATIONAL DELEGATES
7. Provide an opportunity to examine patterns in **NEA mackerel fecundity**	ACOM
8. WG members extract any **historic data on catch at age** (or faling this length) of NEA mackerel from 1972 to 1980 and supply this to: Andy Campbell by 1st January 2010.	WGWIDE participants
9. WGWIDE recommends that in a future benchmark for mackerel the **tagging time-series** is evaluated as an additional fishery independent information for tuning the NEA mackerel stock assessment.	MACKEREL BENCH MARK
10. that the **BLUE WHITING benchmark** assessment planned for spring 2011 takes place as soon as possible, preferably prior to the WGWIDE meeting in September 2010.	ACOM
11. BLUE WHITING benchmark: the group recommends reviewing the sampling frequency and intensity on a scientific basis and provide guidelines for sampling intensity given that the current precision levels of the catch sampling intensity are unknown and	BLUE WHITING BENCHMARK
12. WGWIDE recommends the establishment of an interdisciplinary project to examine the stock structure of blue whiting in the NE Atlantic.	SCICOM

13.	WGWIDE recommends that attention is drawn to MS on their level of participation on the survey given their share in the mackerel total catch in order to attain a better coverage of mackerel spawning area at peak spawning time.	ACOM and NATIONAL DELEGATES.
14.	In addition, it was recommended that **mackerel egg** samples should be taken during the Nordic Seas Ecosystem Survey 2010. Norway intends to sample 20 - 30 stations in the proposed area.	PGNAPES
15.	to re-analyse the **International Egg Survey** data under a survey design where the transects are spread out to allow covering a wider area but without increasing ship time. WGWIDE recommended a workshop for the due consideration of estimating the impact of such changes on bias and precision of both mackerel and horse mackerel estimates.	WGMEGS
16.	that **acoustic data** on mackerel from the North Sea herring cruise and related cruises are stored and made available for scrutinising by acoustic experts.	HAWG, PGIPS & RELEVANT SURVEYS PLANNING GROUP.

After submission of the report, the ICES Secretariat will follow up on the recommendations, which will also include communication of proposed terms of reference to other ICES Expert Group Chairs. The "Action" column is optional, but in some cases, it would be helpful for ICES if you would specify to whom the recommendation is addressed.

Recommendation 1

WGWIDE recommends an increase in sampling for weight at age in the 1st quarter in the commercial fisheries order to derive an increase in precision of the weight at age in the stock.

rationale:

Previously weight at age in the stock was derived from a Norwegian survey in the overwintering areas. The survey has stopped in 2008 and will not be continued. For 2009, commercial data have been used from the fishery in the 1st quarter from the same area where the survey had been carried out. For some age groups there were no or only few observations. It is recommended increase the sampling to obtain estimates for all age groups. It is also recommended to carry out some statistical analyses in order to obtain an indication of how many observations are required to achieve sufficient precision for the weight estimates. In order to cover all age groups in the sampling it may be required to stratify sampling to ensure that also less abundant year classes are well represented in the samples.

Recommendation 2

WGWIDE recommends to hold a Workshop before it next meeting to evaluate maturity at age information from back-calculation analyses and to provide guidance on the way future maturity at age sampling should be carried out.

rationale

The assumption on the maturity at age used in the assessment can have big impact on the estimate of the spawning stock biomass. Different assumptions made on the maturation of the abundant 2002 year class lead to SSB estimates which differed up to 1 million tonnes. There is no documentation for the values used in recent years. Maturity estimates from a back calculation analyses, would allow to update the o-gives used in the assessment for the historical period. An evaluation of the maturity at age information was planned for the benchmark assessment in 2008. However, no data were made available to carry such an analyses. Also in 2009, the data were not available. A discussion on the subject revealed that such an evaluation would require much more time, than can be made available in an assessment working group.

However, data from back calculation studies do not provide information of maturation in recent years and these have to be derived from sampling programmes. Previously, maturity at age was sampled in two surveys: the survey on the overwintering ground (pre-spawning information) and the May survey on the feeding grounds (post-spawning information). The first survey has stopped in 2008. Guidance is required to set up an appropriate protocol for sampling this information.

10 Abstracts of working documents

Sveinn Sveinbjörnsson

Preliminary report on an Icelandic survey as part of the coordined ecosystem survey with R/V Arni Fridriksson and M/V Hoffell in the Norwegian Sea in July-August 2009

Marine Research Institute Reykjavik

Andrew Campbell and Ciarán Kelly

Western Horse Mackerel Management Plan and FPRESS Developments

Fisheries Science Services, Marine Institute, Oranmore, Co Galway, Ireland.

Abstract:

A management plan for the Western Horse Mackerel stock was proposed, refined and agreed by stakeholders in 2006-7 and was implemented in 2008. The primary harvest control is implemented by setting a triennial TAC based on the latest three egg survey results for 2008-2010. An evaluation of the plan by ICES resulted in the plan being considered precautionary in the short term only (3 years). A clause in the plan stipulated a review should take place prior to any further application of the harvest rule. This working document presents a critique of the development of the management plan; recent analysis and simulation work carried as part of the scheduled review and discusses the future implementation of the plan. Advances in the development of FPRESS, the simulation framework used during the initial development and the ongoing review of the management plan are also discussed.

Asta Gudmundsdottir

Norwegian spring spawning herring: Total international catch in numbers in 2008

Marine Research Institute, Reykjavik, Iceland

Abstract:

In this document the total international catches from the Norwegian spring spawning herring in 2008 are presented.

Jan Arge Jacobsen

Wide distribution of mackerel

Faroese Fisheries Laboratory

Abstract:

Large concentrations of mackerel have been observed in the Faroese area the last few years by the Faroese vessels fishing for herring during summer. The amounts have been so high the last three years that the vessels fishing for herring had to "flee" northwards out of the Faroe zone in order to catch herring in clean concentrations. This document gives an overview of the extensive mackerel distribution in the area north of the Faroes in spring and summer 2008 based on data from three Faroese surveys.

Leif Nøttestad

Request from coastal states and NEAFC on Mackerel distribution and migration

IMR, Bergen, Norway

Abstract:

A group of scientists drawn from the NEAFC (EU, Norway, Iceland, Faroe Island, Russia) countries met at the Institute of Marine Research in Bergen, Norway, from 31 March to 2 April 2009, with the following terms of reference as agreed between member states in NEAFC: (i) Map and describe the seasonal distribution and migration of the NEA mackerel; (ii) Evaluate survey possibilities and define a suitable scientific survey programme including an appropriate survey protocol.

The group reviewed a wide range of surveys and methods currently used to investigate the biology, distribution, migration and abundance of Northeast Atlantic mackerel. A series of maps describing the distribution of mackerel at various stages (particular life history, time of the year and historical trends) were reproduced in the report.

The group could neither propose a new survey, nor a survey protocol, which would cover the entire distribution of mackerel in the Northeast Atlantic. Firstly, significant resources are already deployed towards the mackerel egg survey which maps the distribution of adults in the spawning period. Secondly - and more significantly - beyond the spawning period, mackerel behave in a variety of ways. For example, in mid-summer, they either: school close to the surface in the Norwegian Sea; or occur as dispersed individuals throughout the water column in the North Sea; or they may be close to the seabed (e.g. along the western continental shelf). There is currently no single method that will universally cover the whole distribution of mackerel at any time other than the spawning period, and combining the different methods which are tailored to any one of the different behaviours is presently impossible. The group would encourage appropriate consideration of possible solutions to these problems through a collaborative research project.

Notwithstanding the limitations described above, the group recognized that there is scope to coordinate and standardize existing surveys and methods to provide new and valuable information on the distribution and migration of mackerel. A number of surveys were examined which provide information on the ecology, distribution and abundance of mackerel at various stages of their life cycle. These ranged from directed surveys with specific objectives to determine the abundance of mackerel (e.g. egg surveys, Lidar, IBTS juvenile trawl survey); to surveys which target other species, but can easily provide information on the distribution of mackerel (e.g. pelagic acoustic surveys); to surveys for which additional data could be collected with some additional effort (e.g. by collecting and analysing acoustic data on the IBTS survey).

The group made some recommendations pertinent to the surveys identified above, which would allow for data on mackerel to be more comparable. The group considered the egg surveys as the most important survey since it is the basis for measuring the SSB and in addition provides fishery-independent information about distribution of eggs (ie spawning mackerel) during the spawning period. The group also recommended that tagging studies and stock identification methods should be investigated.

Recommendations

WGWIDE recognized the need for additional fishery-independent methods providing information on biology, ecology, distribution, migration and abundance of NEA mackerel.

WGWIDE recommends working on harmonization and coordination of national and international surveys that already are targeting mackerel, particularly the ongoing surveys in the mackerel feeding area during the summer, and other surveys that with minor adjustments can provide such information.

WGWIDE recommend that a coordination group consisting of different experts on acoustics, pelagic trawling, survey design, biology and assessment should be established to improve and modify existing surveys targeting mackerel.

Leif Nøttestad[1] and Jan Arge Jacobsen[2]

Coordinated Norwegian-Faroese ecosystem survey with M/V ″Libas″, M/V ″Eros″, and M/V "Finnur Fríði" in the Norwegian Sea, 15 July- 6 August 2009

[1]IMR, Bergen, Norway

[2]Faroese Fisheries Laboratory

Abstract:

Two chartered fishing vessels, two Norwegian M/V "Libas" and M/V "Eros" and one Faroese M/V "Finnur Fríði" performed an ecosystem survey from 15 July to 6 August 2009 in the Norwegian Sea and adjacent areas. The abundances of Northeast Atlantic mackerel (*Scomber scombrus* L.), Norwegian spring-spawning herring (*Clupea harengus* L.) and blue whiting (*Micromesistius poutassou* L.) were measured acoustically. Estimated biomass of mackerel was calculated to 4.4 million tons in the Norwegian Sea. Mackerel was distributed over larger areas than previously documented in the Norwegian Sea in July. Furthermore, a northwestern distribution was more pronounced in July 2009 compared to previous years. Repeated offshore catches of one and two year's old individuals indicate that the Norwegian Sea is now also an important nursery and feeding ground for immature mackerel. The 2005- and 2006 year classes dominated with 26% and 25% of total catches, respectively. Large mackerel ate adult capelin north of Iceland, which has never been reported before. Estimated biomass of herring was 13.6 million tons. Herring were distributed feeding in the colder and frontal waters in the western, northwestern and northeastern parts of the Norwegian Sea. The 2002- and 2004 year classes were most abundant representing 27% and 22% of total trawl catches, respectively. Estimated biomass of blue whiting was 2.3 million tons in the Norwegian Sea in July. The 2004 year class dominated with 29% of the catches, followed by the 2003 and 2002 year classes with 23% and 20% of total catches. No young year classes less than 4 years of age were found during the survey. Large blue whiting also ate adult capelin north of Iceland, representing new scientific information.

Surface waters in the northwestern part of the Norwegian Sea in the Jan Mayen zone and in Icelandic waters were considerably warmer compared to the last two decades, and coincided with increased presence and concentrations of large herring and mackerel in the area. The northernmost areas were in contrast colder than previous years, limiting the extent of northern migration by herring and mackerel compared to the

last few years. Coastal waters off Norway were also colder than recorded in previous years.

Zooplankton concentrations including *Calanus finmarchicus*, krill and amphipods were generally low, except a few locations with elevated biomasses (20 g/m^2) of *C. finmarchicus* in the northern areas. The average concentration of zooplankton was only 4.8 g/m^2 in the Norwegian Sea in July, suggesting a reduction in biomass compared to previous years.

Very few marine mammals, except sperm whales, were present in the Norwegian Sea in July 2009, based on dedicated whale observations on Libas and opportunistic sightings on Eros and Finnur Fríði. Both herring and mackerel swam predominantly in small and loose aggregations as recorded from sonars and echosounder, making it difficult for marine mammals to prey cost efficiently on schooling fish. Low concentrations of krill and amphipods also suggest why baleen whales such as humpback whale and minke whale were scarcely present in the Norwegian Sea in July.

Antonio Punzón and Begoña Villamor

Changes in the timing of the spawning migration of the Southern component of the Northeast Atlantic mackerel (Scomber scombrus, L. 1758).

Instituto Español de Oceanografía. CO Santander. Promontorio San Martín SN. P.O. Box 240, Santander 39080, Spain

Abstract:

Part of the Northeast Atlantic mackerel population migrates towards the southern spawning area (Cantabrian Sea) at the end of winter. In this seasonal handline fishery targeting mackerel, the most important in the study area that targets this species, the timing of the peak of catches has shifted forward in recent years. This paper presents results pointing to the possibility that this shift may be due to a change in the timing of the pre-spawning migration to the southern area of the Northeast Atlantic mackerel population. Three types of fleet have been identified within this fishery, and in all of them there is a forward shift in time in effort exerted. Moreover, a new model has been defined for the standardization of CPUE. This has allowed us to determine that migration shifted forward by one month between 2000 and 2006. A shift on this scale has important consequences for the management of the resource, the fleets that exploit it and the resource evaluation survey designs that will have to be adapted to this new scenario.

Sveinn Sveinbjörnsson

Preliminary report on an Icelandic survey as part of the coordinated ecosystem survey with R/V Arni Fridriksson and M/V Hoffell in the Norwegian Sea in August 2009

Marine Research Institute, Reykjavik, Iceland

Abstract:

The ecosystem survey was conducted during 4-24 August 2009 on a research and a commercial vessel. It covered the whole continental shelf around Iceland, beside the whole EEZ off the east coast, with an exception of the area northwest of Iceland that

was not covered. The objective was to study the abundance, spatial and temporal distribution and feeding ecology of the Northeast Atlantic mackerel in the area. Acoustic data were sampled continuously during the survey and surface trawl stations were taken at pre-selected positions with a distance of 25-40 nm between tows. The trawls used were a standard Salmon trawl and a small pelagic sampling trawl. Hydrographic stations were also taken at every second trawl station. All fish caught was sorted, and samples taken to determine length, weighed, sex, maturity stage, and age, besides a stomach sampling of mackerel.

Mackerel was caught in the majority of the tows except for the area off western North Iceland. The highest density was apparently off the east and south east coast. In the western more coastal areas, mackerel was mixed with Icelandic summer-spawning herring, while it was more mixed with Norwegian spring-spawning herring in the eastern areas. The mackerel caught in the survey ranged from 29-48 cm (mean=36.6 cm) in length with the highest numbers ranging from 34-39 cm. The weight distribution varied between 288 – 1071 g (mean=491 g). The intention is to repeat this ecosystem survey in the year 2010 and then in coordination with Norwegian and Faroese research vessels, as a part of their ecosystem survey in the Nordic Seas.

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Annex 1 – List of Participants

Working Group on Widely Distributed Stocks (WGWIDE)

2 – 8 September 2009

NAME	ADDRESS	PHONE/FAX	EMAIL
Beatriz Roel (Chair)	Centre for Environment, Fisheries & Aquaculture Science Lowestoft Laboratory Pakefield Road NR33 0HT Lowestoft Suffolk United Kingdom	Phone +44 1 502 52 4358 Fax +44 1502 524 511	beatriz.roel@cefas.co.uk
Thomas Brunel	Wageningen IMARES P.O. Box 68 NL-1970 AB IJmuiden Netherlands	Phone +31 317 487 161 Fax +31	thomas.brunel@wur.nl
Andrew Campbell	Marine Institute Rinville Oranmore Co. Galway Ireland	Phone +353 91 387 200 Fax +353 91 387 201	andrew.campbell@marine.ie
Gersom Costas	Instituto Español de Oceanografía Centro Oceanográfico de Vigo P.O. Box 1552 E-36200 Vigo (Pontevedra) Spain	Phone +34 943004800	gersom.costas@vi.ieo.es
Afra Egan	Marine Institute Rinville Oranmore Co. Galway Ireland	Phone +353 91 387 200 Fax +353 91 387 201	afra.egan@marine.ie
Asta Gudmundsdóttir	Marine Research Institute Skúlagata 4 IS-121 Reykjavík Iceland	Phone +354-5752001 Fax +354-5752000	asta@hafro.is
Jens Christian Holst	Institute of Marine Research P.O. Box 1870 N-5817 Bergen Norway	Phone +47 55 238411 Fax +47 55 238531	jens.christian.holst@imr.no
Åge Høines	Institute of Marine Research P.O. Box 1870 N-5817 Bergen Norway	Phone +47 55 238 674 Fax +47 55 238 687	Aageh@imr.no
Svein A. Iversen	Institute of Marine Research P.O. Box 1870 N-5817 Bergen Norway	Phone +47 55 23 84 07 Fax +47 55 23 85 55	Svein.iversen@imr.no
Jan Arge Jacobsen	Faroe Marine Research Institute P.O. Box 3051 FO-110 Tórshavn Faroe Islands	Phone +298 353900 Fax +298 353901	janarge@frs.fo

Teunis Jansen	The National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot, Jægersborg Alle 1 DK-2920 Charlottenlund Denmark		tej@aqua.dtu.dk
Alexander Krysov	Knipovich Polar Research Institute of Marine Fisheries and Oceanography 6 Knipovitch Street RU-183763 Murmansk Russian Federation	Phone +7 (8152) 47 34 24 Fax +47 789 10 518	a_krysov@pinro.ru
Charlotte Main	Fisheries Research Services FRS Marine Laboratory P.O. Box 101 AB11 9DB Aberdeen Torry United Kingdom	Phone +44 Fax +44	c.main@marlab.ac.uk
Manolo Meixide	Instituto Español de Oceanografía Centro Oceanográfico de Vigo P.O. Box 1552 E-36200 Vigo (Pontevedra) Spain	Phone +34 986 492111 Fax +34 986 492351	manolo.meixide@vi.ieo.es
Alberto Murta	IPIMAR Avenida de Brasilia PT-1449-006 Lisbon Portugal	Phone +351 21 302 7000 Fax +351 21 301 5948	amurta@ipimar.pt
Leif Nøttestad	Institute of Marine Research P.O. Box 1870 N-5817 Bergen Norway	Phone +47 Fax +47	leif.noettestad@imr.no
Jose de Oliveira	Centre for Environment, Fisheries & Aquaculture Science Lowestoft Laboratory Pakefield Road NR33 0HT Lowestoft Suffolk United Kingdom	Phone +44 1502 527 7 27 Fax +44 1502 524 511	jose.deoliveira@cefas.co.uk
Gudmundur J. Oskarsson	Marine Research Institute Skúlagata 4 IS-121 Reykjavík Iceland	Phone +354-5752001 Fax +354-5752000	gjos@hafro.is
Lisa Readdy	Centre for Environment, Fisheries & Aquaculture Science Lowestoft Laboratory Pakefield Road NR33 0HT Lowestoft Suffolk United Kingdom		lisa.readdy@cefas.co.uk

Maxim Rybakov	Knipovich Polar Research Institute of Marine Fisheries and Oceanography 6 Knipovitch Street RU-183763 Murmansk Russian Federation	Phone +7 Fax +7	fisher@pinro.ru
Sonia Sanchez	AZTI-Tecnalia Herrera kaia portualdea z/g E-20110 Pasaia (Gipuzkoa) Spain	Phone 943 004 800 Fax 943 004 801	ssanchez@azti.es
Erling Kåre Stenevik	Institute of Marine Research P.O. Box 1870 N-5817 Bergen Norway	Phone +47 Fax +47	erling.kaare.stenevik@imr.no
Nikolay Timoshenko	AtlantNIRO 5 Dmitry Donskogo Street RU-236000 Kaliningrad Russian Federation	Phone +7 4012 925554 Fax +7 4012 219997	timoshenko@atlant.baltnet.ru
Jens Ulleweit	Johann Heinrich von Thünen-Institute, Institute for Sea Fisheries Palmaille 9 D-22767 Hamburg Germany	Phone +49 40 3890 5217 Fax +49 40 3890 5263	jens.ulleweit@vti.bund.de
Frans van Beek	Centre for Fisheries Research P.O. Box 68 NL-1970 CP IJmuiden Netherlands	Phone +31 317487044 Fax +31 317487326	frans.vanbeek@wur.nl
Dmitry A. Vasilyev	Russian Federal Research Institute of Fisheries & Oceanography 17 Verkhne Krasnoselskaya RU-107140 Moscow Russian Federation	Phone +7 499 264 8974 Fax +7 499 264 91 87	dvasilyev@vniro.ru
Morten Vinther	The National Institute of Aquatic Resources Section for Fisheries Advice Charlottenlund Slot, Jægersborg Alle 1 DK-2920 Charlottenlund Denmark	Phone +45 33 96 33 50 Fax +45 33 96 33 33	mv@aqua.dtu.dk

ANNEX 2 Terms of Reference 2010

WGWIDE

2009/2/ACOM15 The **Working Group on Widely Distributed Stocks** [WGWIDE] (Chaired by: Beatriz Roel, UK) will meet from at ICES Headquarters / Vigo (Spain), 1–7 September 2010 to:

a) address generic ToRs for Fish Stock Assessment Working Groups (see table below).

The assessments will be carried out on the basis of the stock annex in National Laboratories, prior to the meeting. This will be coordinated as indicated in the table below.

WGWIDE will report by 14 September 2010 for the attention of ACOM.

Fish Stock	Stock Name	Stock Coord.	Assess. Coord. 1	Assess. Coord. 2	Perform assessment	Advice
her-noss	Herring in the Northeast Atlantic (Norwegian spring-spawning herring)	Iceland	Norway	Russia	Y	Update
hom-nsea	Horse mackerel (*Trachurus trachurus*) in Division IIIa, Division IVb,c and VIId (North Sea stock)	Norway	Netherlands	Denmark	Y	Same advice as last year
hom-soth	Horse mackerel (*Trachurus trachurus*) in Division IXa (Southern stock)	Spain	Spain	Portugal	Y	Update
hom-west	Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)	Norway	UK (England & Wales)	Netherlands	Y	Update
mac-nea	Mackerel in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)	Ireland	UK (Scotland)	Netherlands	Y	Update
whb-comb	Blue whiting in Subareas I-IX, XII and XIV (Combined stock)	Spain	Denmark	Russia	Y	Update

Annex 3 – Stock Annexes

Annex A – Stock annex Northeast Atlantic mackerel

Quality Handbook		ANNEX: WGWIDE-MAC-NEA

Stock specific documentation of standard assessment procedures used by ICES

Stock	Mackerel in the Northeast Atlantic
Working Group:	Working Group on Widely Distributed Stocks
Date:	8 September 2009
Revised by	T. Jansen, T. Brunel, A. Campbell, C. Main, L. Readdy, L. Nøttestad

A. General

A.1. Stock definition

ICES currently uses the term North East Atlantic Mackerel to define the mackerel present in the area extending from the Iberian peninsula The in the south to the Northern Norwegian Sea in the north, and Iceland in the west to western Baltic Sea in east.

Even though spawning occurs widely on the shelf from Biscay to the Norwegian Sea, there are two loci of increased intensity (Figure A.3.2.1). One elongated area along the shelf break from Spanish and Portuguese waters in March, around Ireland to the west of Scotland where spawning peaks in June (Beare and Reid 2002). The other area is in the central North Sea in May-July. Only the stock in the North Sea is sufficiently distinct to be identified as a separate spawning component. Since the egg distributions in south and west overlaps in the Bay of Biscay, it is impossible to define the northern border of a Southern component and the southern border of a Western component. Since it is currently impossible to allocate catches to the stocks previously considered by ICES, they are at present, for practical reasons, considered as one stock: the North East Atlantic Mackerel Stock.

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 (Uriarte *et al.* 2001). In the North Sea they mix with the North Sea component. However in order to be able to keep track of the development of the spawning biomasses in the different spawning areas, the North East Atlantic mackerel stock is divided into three area components: the Western Spawning Component, the North Sea Spawning Component, and the Southern Spawning Component. By convention the catches from the components are separated according to the area in which they are taken:

1.	Spawning component	2.	Western	3.	Southern	4.	North Sea
5.	Spawning Areas	6.	VI, VII, VIIIa,b,d,e.	7.	VIIIc, IXa.	8.	IV, IIIa.

The Western Component is defined as mackerel spawning in the western area (ICES Divisions and Subareas VI, VII, and VIII a,b,d,e). This component currently comprises most of the North East Atlantic stock. Similarly, the Southern Component is defined as mackerel spawning in the southern area (ICES Divisions VIIIc and IXa). Although the North Sea component has been at an extremely low level since the early 1970s, ICES regards the North Sea Component as still existing. This component spawns in the North Sea and Skagerrak (ICES Subarea IV and Division IIIa).

A.2. Fishery

The patterns of NEA mackerel fishing are very variable throughout its wide distribution and between the seasons as it migrate, spawn, feed and over-winter. The sections below outline the historic changes of the mackerel fisheries and encapsulate the main actors in the recent years:

A.2.1. Mackerel fishing since the 1960s

The largest fisheries have been on the over-wintering and early spawning migration phases. The geographic area of these fisheries has changed over time.

In the 1960's a Norwegian fishery in the Northern North Sea unparalleled in size arose with the development of modern sonar, single vessel purse seining, power blocks and hydraulic fish pumps. After a few years of extreme over-fishing of the North Sea component, the catches dropped to the present day level until, in the late 1970s the stock component collapsed and the fishery ceased. Meanwhile in the Cornwall area, of the UK, in Q4 and Q1 an intensive fishery by USSR and UK had built up, this effectively ended with the introduction of a closed box in the early 1980s. While the first quarter fishery since then has been from west of Orkney to west of Ireland; the 4 quarter fishery moved to the west of Scotland and North of Ireland in the 1980s and by the 1990s this had gradually shifted to the Northern North Sea. A summer fishery in the international zone of IIa has developed since the late 1980s, in most recent years this has extended into the Icelandic zone. Peak fisheries in the Iberian region have shifted slightly in time from early Q2 to late Q1. This fishery is targeting spawning mackerel.

A.2.2. Recent year's major fisheries by area

The largest fishery is in the Northern North Sea (Subareas IV) is by purse seine and pelagic trawl in late Q3, Q4 and early Q1. The catches are predominantly taken by the Norwegian fleet, followed in size by Scottish, English, Danish, Irish and Faroese fleets.

To the west of the British Isles (Subarea VI and divisions VIIb,c) most catches are taken by the Scottish and Irish pelagic trawler fleets, while Subdivisions VIId-j are also fished by the English fleet and Dutch, French and German freezer trawlers.

In the Norwegian Sea (Subarea II) most catches are taken in Q3. The major fisheries are: Russian freezer trawlers (55 – 80 m) that target mackerel, blue whiting and herring at the same time. Most recently Icelandic vessels targeting herring have begun to land much mackerel. The big Norwegian fishery has ceased.

The Spanish fleet operating off the Iberian Peninsula (divisions VIIIa and IXc) consists of demersal trawlers, purse seiners between 10 – 32 m and a large artisanal fleet with vessels between 2 and 34 m. Most of the landings are adult mackerel and the fishery has shifted slightly in time from peaking in early Q2 to late Q1.

The main mackerel catching countries ICES in recent years continue to be Scotland, Norway, Spain, Ireland, the Netherlands, Denmark and Russia. Icelandic catches now also contribute a significant amount to the total. England & Wales, the Faroe Islands, France, Germany, Northern Ireland, Portugal and Sweden all have catches over 1,000t (combined catch 78,000t in 2007).

A.3. Ecosystem and behavioural aspects

A.3.1. Feeding

Post larval mackerel feed on a variety of zooplankton and small fish. They prefer larger prey species over smaller prey (Langoy *et al.* 2006, Pepin *et al.* 1987). Feeding patterns vary seasonally, spatially and with size. Mackerel stop feeding almost completely during winter. Main zooplankton preys in the North Sea are: Copepods (mainly *Calanus finmarchicus*), euphasids (mainly *Meganyctiphanes norvegica*), while primary fish preys are: Sandeel, herring, sprat, and norway pout (ICES 1989, ICES 1997a, Mehl and Westgård 1983, Walsh and Rankine 1979). Mackerel and horse mackerel are responsible for virtually all of the predation on 0- group herring as well as a large part of the consumption of 0-group Norway pout and all ages of sandeel in the North Sea (ICES 2008a). In the Norwegian Sea euphausiids, copepods (mainly *Calanus finmarchicus* and *Oithona*), *Limacina retroversa, Maurolicus muelleri,* amphipods, Appendicularia and capelin are the main diet during the summer feeding migration (Langoy *et al.* 2006, Langoy *et al.* 2010, Prokopchuk 2006).

A.3.2. Spawning

Mackerel spawn at any time of the day or night and the eggs remains in the upper water masses (Nichols and Warnes 1993). Mackerel egg surveys have been conducted since 1968. In the later years these surveys have been carried out every third year, with the North Sea and Western areas in alternating years.

Even though spawning occurs widely on the shelf from Biscay to the Norwegian Sea, there are two loci of increased intensity (figure A.3.2.1). One elongated area along the shelf break from Spanish and Portuguese waters in March, around Ireland to the west of Scotland where spawning peaks in June (Beare and Reid 2002, Iversen 2002). Since the egg distribution of the Southern and Western components overlaps in the Bay of Biscay, it is impossible to define the northern border of the Southern component and the southern border of the Western component. The other area is in the central North Sea in May-July.

Spawning activity in the south and west has shifted location up through the 80s and 90s, declining in the south and rising in the north (Beare and Reid 2002). In the North Sea a westward shift in the main spawning area from the central part of the North Sea in the early 1980s to the western part in recent years (2005 and 2008) (Anon 2009).

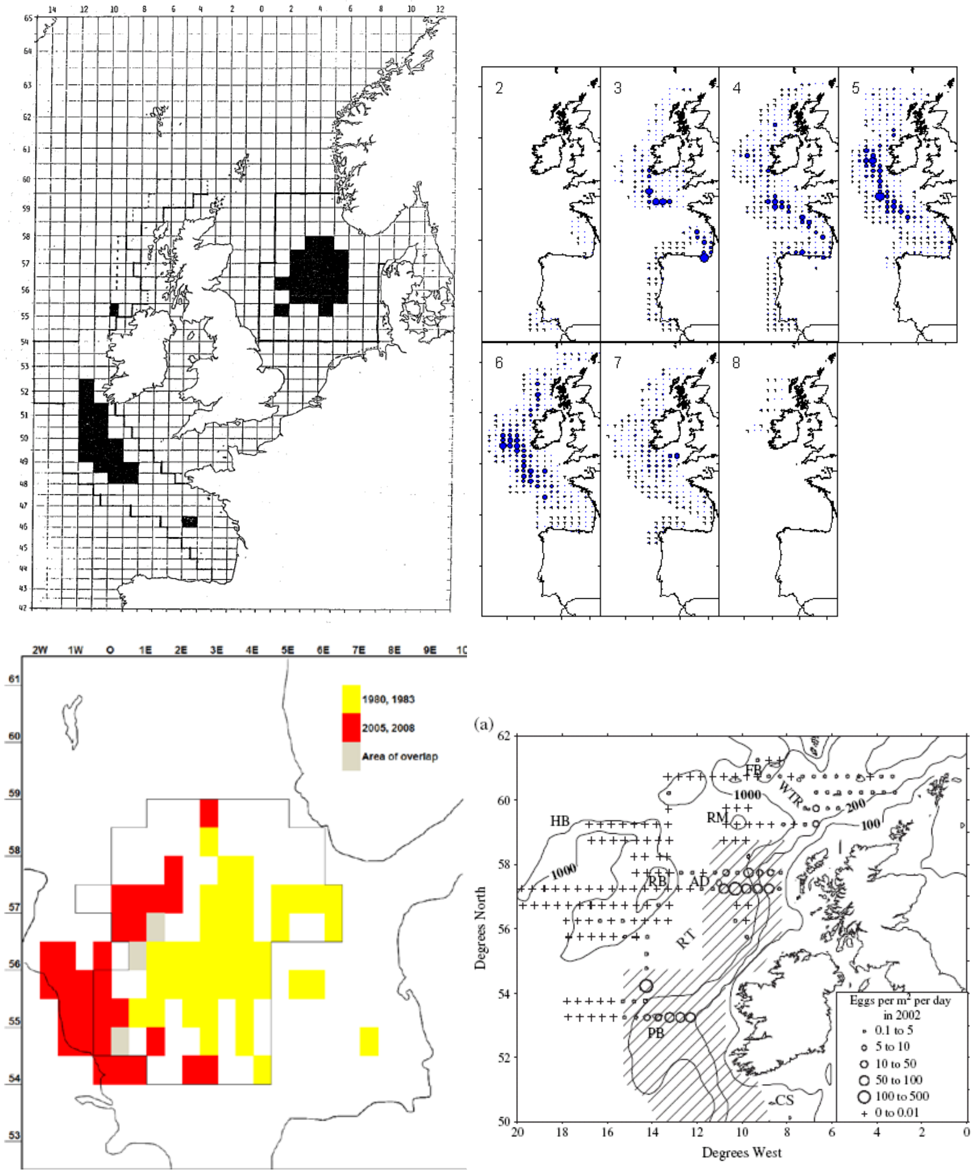

Figure A.3.2.1. NEA mackerel spawning areas. Upper left: Shaded areas indicate > 100 eggs/m2 in at least two of the years in the period 1977-1988 (from (ICES 1990)). Upper right: Average distribution of mackerel eggs by ICES statistical rectangle in 1992-2007, each map represents a survey between February and August (from (Anon 2009)). Lower left: North sea spawning area defined by a daily egg production of at least 50 mackerel eggs per m^2 of sea surface in any of the years 1980, 1983, 2005 and 2008 (from (Anon 2009)). Lower right: Experimental survey in May 2002 (from (Dransfeld *et al.* 2005)).

A.3.3. Migration

Mackerel perform extensive migration between spawning, feeding and overwintering areas. The migration pattern has changed substantially through time.

It is well known that swimming speed is related to fish length (Pepin *et al.* 1988). Tagging has shown that juveniles of the south/western component does not migrate as far as the adults (Uriarte *et al.* 2001) and in the Norwegian Sea it is the larger fish that reach furthest to the North and North-West during the feeding migration in summer (Anon 2009, Holst and Iversen 1992, ICES 2009, Noettestad *et al.* 1999) and in the east end of the feeding migration large mackerel arrive before and leave later than small mackerel (Jansen et al.(in prep.) 2010).

Temperature has been suggested as a cause of the observed changes in the western and southern mackerel pre-spawning migration (Reid *et al.* 2003, Walsh and Martin 1986). The location before the onset of migration in winter, that ultimately ends at the spawning grounds in the spring, is probably constrained by temperature (Reid *et al.* 2001), as are the migration path and speed (Reid *et al.* 1997, Walsh *et al.* 1995). However other factors than temperature preferences are affecting the mackerel behaviour and can in different scenarios have different weights. (D'Amours and Castonguay 1992) showed that mackerel from the northern component of the West Atlantic mackerel migrated into Cabot Straight with approx. 4 ºC in order to get to their spawning grounds. He argued that the fish's thermal preferences could be subordinate to their reproductive requirements, a point supported by the fact that this stock always enter the Cabot Straight around the same date (Anon 1896, Castonguay and Beaulieu 1993). Studies of the post-spawning feeding migration are limited. Patterns of food and temperature related distributions in the Norwegian Sea in the summer are emerging from summer surveys in the Norwegian Sea in 1992 and 2002-2009. But the big picture of when and where is the thermal preference dominating/subordinate in relation to other activities like feeding, spawning and predator avoidance remains to be drawn.

Western and southern stocks

Tagging studies (Belikov *et al.* 1998, Uriarte *et al.* 2001, Uriarte and Lucio 1996) have demonstrated that mackerel travel from both the western and southern spawning ground north up into the Norwegian and North Seas. The migration can be considered as having two elements;

1. A post spawning migration from the spawning areas along the western European shelf edge (Uriarte *et al.* 2001)
2. A pre-spawning migration from feeding grounds in the North and Norwegian Seas (Walsh et al 1995, Reid et al 1997). This pre-spawning migration includes shorter or longer halts that sometimes are referred to as over-wintering.

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 (Figure A.3.3.1.): The migration passed through the west of Scotland area in September 1975. By the late 1990s it passed through this area in January/February. This appears to have been fairly consistent up to 2005 (Reid *et al.* 2003, Reid *et al.* 2006, Walsh and Martin 1986) and the pattern in the last years has been variable but without a common trend: 2006-2007 with later migration (ICES 2007b) and in 2008 commercial fishing and IBTS Q1 data suggests that the stock initiated the south-western migration earlier. There are indications of variation in spawning time too: The Spanish spring fishery in the Bay of Biscay has been occurring earlier each year, and since this fishery is targeting spawning mackerel, this indicates that the spawning in the southern component occur earlier and earlier (Punzon and Villamor 2009). Recently and in the 90s it has been documented that the mackerel distribution in the Nordic Seas in the summer covers a vast area up to 73-75ºN and from Norway in east and beyond Iceland in west. The dynamics and environmental drivers of this is not yet uncovered. Surveys in recent years indicate substantial interannual variation and provides hypothesis on relations to temperature and food (Anon 2002, Anon 2003, Anon 2005, Gill *et al.* 2004, Holst and Iversen 1999, Holst and Iversen 1992, ICES 2006b, ICES 2007a, ICES 2009).

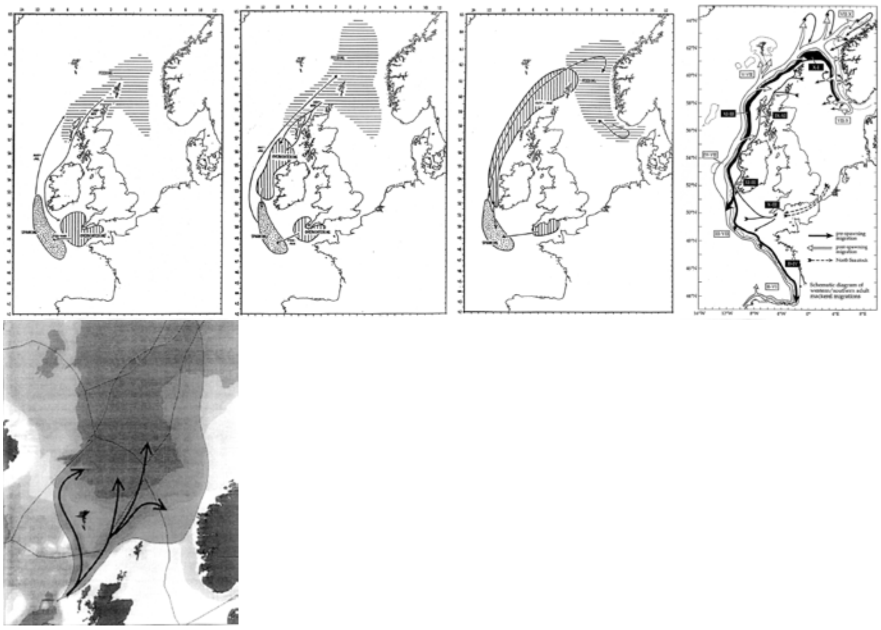

Figure A.3.3.1. Schematic outline of the migration of the western (+ southern in right map) adult mackerel through time. From left: late 1970s (ICES 1990), early 1980s (ICES 1990), latter half of 1980s (ICES 1990), mid 1990 (Anon 1997) and (Belikov *et al.* 1998).

North Sea stock

Due to the inability to separate individuals from this and the other stocks, our perception of the distribution in time and space of the smaller North Sea stock is based on observations from before the stock collapsed in the late 1960s.

After spawning the stock spreads out. The post-spawning feeding migration takes the mackerel north into the Northern North Sea and the Norwegian Sea, East into the transition waters and western Baltic Sea, while parts remain in the North Sea. Later in the autumn the mackerel move to deeper waters in the northern part of the Norwegian Trench, Shetland area, and Viking Bank for wintering. In April/May, they returned to the surface layer for feeding, and migrated towards the spawning area in the central part of the North Sea and Skagerrak (Agger 1970a, Agger 1970b, Hamre 1978, Iversen 2002, Lindquist and Hannerz 1974, Postuma 1972, Revheim 1951, Zijlstra and Postuma 1965)

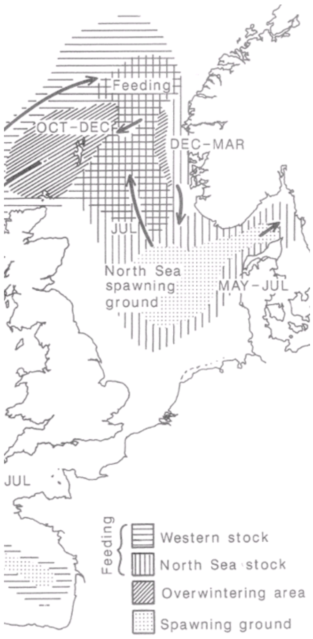

Figure A.3.3.2. Assumed migration and area distribution of the North Sea mackerel. From (ICES 1990).

A.3.4. By-catch

Only fragmented information on by-catch is available.

NEA mackerel and NSS herring currently have a pronounced overlap in spatial distribution in the south-western and northern parts of the Norwegian Sea. Mackerel were caught together with considerable amounts of herring in the same trawl hauls, both in several commercial fisheries and in international surveys, suggesting that by-catch is an issue for the pelagic trawl fisheries in this area (ICES 2008c).

The distribution of chub mackerel (*Scomber colias*) overlaps with the mackerel distribution in the southern area, with some substantial catches in Division IXa.

B. Data

In this section data used directly in the analytical assessment are outlined. This includes:

- Commercial catch data
  - i. Total catch in weight
  - ii. Catch in number at age
  - iii. Mean weight at age
- Biological data
  - i. Weighting of spawning components
  - ii. Mean weight at age
  - iii. Maturity ogive (proportion mature at age)
  - iv. Natural mortality and proportion of F and M
- Survey data
  - i. SSB estimate from egg surveys

ii. Recruit abundance index from demersal trawl survey (no longer being used)

Currently, the western and southern egg survey provides the only fishery-independent data that are actually used for tuning the stock assessment models.

B.1. Commercial catch

Estimates of the magnitude (in tonnes) and precision of the unaccounted fishing mortality in the NEA mackerel fisheries suggest that, on average, total catch related removals are equivalent to between 1.6 and 3.4 times the catch This could be due to:

- Escapees from fishing that die, such as those that pass through the meshes and die
- Discards, slippage and high-grading not included in the ICA assessment
- Unreported catch throughout the time-series

(ICES 2008c, Simmonds 2007).

B.1.2. Total catch weight, catch in numbers and mean weight at age

Data Compilation

Commercial catch and associated sampling data are submitted to the stock coordinator each year by the national laboratories of the major mackerel catching nations. The 'exchange format' Excel worksheet was developed specifically for this purpose. In addition to catches and sampling data, information on misreporting, unallocated and discarded catch can also be submitted using this format. Data for nations with small (and generally unsampled) catches is retrieved by the stock coordinator from the Statlant database to complete the dataset for the year in question.

Once the complete dataset has been screened for errors the stock coordinator will compile the data into the format required for input to the assessment. This involves the allocation of sample data to unsampled catches in order that all catches have an associated age structure. The process for allocating samples is rather ad-hoc with the stock coordinator selecting the appropriate samples (and their associated weighting) on the basis of the fleet definitions (gear), area and quarter.

Assessment Inputs

When the allocation exercise is complete the stock coordinator will format the data for input to the sallocl program (Patterson 1998). This involves the creation of 2 comma separated text files: disfad.csv (which contains the disaggregated dataset) and alloc.csv (which contains details of the sample allocations). The sallocl program produces a file sam.out from which the assessment inputs (catch number at age, catch weight at age and total catch weight) can be extracted. The sam.out, alloc.csv and disfad.csv files are stored in the working group archives folder.

Since 2007, the InterCatch, web-based application has been used in parallel with sallocl. It is necessary to compile the data into an alternative format for upload to InterCatch. Comparisons of the sallocl and InterCatch output show good agreement between the two, with minimal differences.

Stock weights are derived from commercial catch samples in sub-areas VIIb and VIIj in March-May, usually from the Dutch and Irish fleets. Occasionally, insufficient samples are available and it is necessary to consider catches from neighbouring areas and those available from surveys.

B.1.2. Discards

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 Subarea IV, mainly because of the very high prices paid for larger mackerel (>600g) 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. Norway therefore introduced a special regulation to limit the slipping; this regulation was in force from 1988 to 2002. Anecdotal evidence from the fleet suggests that since 1994, discarding/slipping has been reduced in these areas. This is supported by the fact that the price for smaller fish have increased.

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 in the fourth quarter. The level of discards is greatly influenced by the market price and by quotas.

With a few exceptions, since 1978 estimates of discards were provided to the Working Group for the areas VI, VII/VIIIa,b,d,e and III/IV. However, the Working Group considers the estimates for these areas as incomplete, e.g in 2007 discard data for mackerel were only provided by three nations: Scotland, the Netherlands and Germany. Countries providing discard estimates should be encouraged to also provide age based information so that the total stock removal may be more accurately estimated. No discards are available for the areas I/II/Vb and VIIIc/IXa.

B.2. Biological

B.2.1. Weighting of spawning components

The SSB estimates from the last egg surveys in the North Sea and the western/southern area are used.

B.2.2. Weight at age in stock

The mean weight at age in the stock is based on available samples from the area and season of spawning of each of the spawning components. The mean weight at age for the total stock are then calculated as weighted means, where the weighting is the egg survey based estimate of SSB in the three components. For a complete time series on mean weights at age in the three components and their relative weighting for the stock weights see the 2004 WHMHSA report (ICES 2005) and the WGIWIDE reports since then.

B.2.3. Maturity ogive (proportion mature at age)

The maturity ogive is based on the following information:

North Sea component: The present maturity ogive was constructed in 1984 on the basis of analysis of Norwegian biological samples from June-August 1960-81. This revealed that 74% of the 2 year old mackerel, which appeared in the catches, were sexually mature. By comparing fishing mortalities for II-group mackerel with the fishing mortalities for the III-group the year after, when they are fully recruited to the spawning stock, it seems that about 50% of the II-group mackerel are available to the fishery. Assuming that only the spawning component of the stock is available in the fishery, maturity ogive for the North Sea stock was estimated (ICES 1984).

Western component: The present maturity ogive was constructed in 1985 based on Dutch commercial and research vessel samples taken in April, May, June, July and August in Division VIa south of 57"N and Divisions VIIb,e,f,g,hj during the period 1977-1984 (ICES 1985). The ogives was reviewed in 1997, but kept constant as before (ICES 1997b).

Southern component: Based on a histological analysis of mackerel samples collected during the 1998 Egg Survey (ICES 2000, Perez *et al.* 2000).

The proportion of mature mackerel at age for the total stock are calculated as the weighted mean each of the three components. The weighting is the egg survey based estimate of SSB in the three components. The maturity ogive is thus updated only when there has been an egg survey.

B.2.4. Natural mortality and proportion of F and M

The mean time of egg spawning is estimated from the egg survey data by calculating the average egg production per Julian day over the period of spawning. From this the fraction of the year before which spawning occurred was calculated for each of the egg survey years. Very little change between years is observed. A mean value is then obtained over all years.

Natural mortality M has been fixed at 0.15 for decades. The basis for this number is presently unknown. First mackerel working group report where this value was given in was 1983 (ICES 1984).

Catch numbers were taken by quarter and the quarter 2 data partitioned to give an observed catch before and after time of spawning. Partial Fs were then calculated using the output from the last assessment and an estimated catch calculated using the catch equation. A proportion of F before spawning was then obtained by age and year and mean values calculated.

B.3. Surveys

B.3.1. Egg surveys

Two mackerel egg surveys have been performed for decades. Both surveys are presently only adding new information to these valuable time-series every third year. One survey covers the western-southern spawning grounds while the other partly covers the spawning in the North Sea and Skagerrak (figure A.3.2.1.).

Temporally each survey is split into several periods in order to cover the whole spawning season. Most countries use Gulf III or Gulf VII samplers with a mesh size of 250 µm. These samplers are torpedo-shaped with a flow meter, and may be encased or have an open design. Germany uses a Nackthai sampler, which has a similar design. Samples are collected using double oblique hauls at speeds of approximately 5 knots. Trawl samples of fish are collected in order to determine the sex ratio and the fecundity and atresia of female fish. Samples are also collected for DNA analysis and parasite studies.

Mackerel eggs are sorted out from plankton samples. The eggs are staged and aged according the temperature at a five meter depth (Lockwood *et al.* 1981). Total annual egg production is then calculated by integrating all periods. Daily egg production (stage 1 eggs per m^2 per day) is measured and used to calculate a constant spatio-temporal coefficient of variation (CV). Using information on sex ratio and fecundity of the females; the SSB is estimated. The results are reported at the working group for mackerel egg surveys (WGMEGS).

B.3.2. International Bottom Trawl Survey

The CPUE index of mackerel recruits have previously been used in the mackerel assessment, however this was discontinued in the late 90's because of the poor performance of this survey (ICES 2000). Further analysis in 2008 concluded that calibration regression did not provide a more sensible prediction of recruitment than the approach of using the geometric mean of the recruitment series from VPA (ICES 2008c). The distribution of juvenile mackerel is very patchy, and abundance is highly variable between years. Although the survey data indicate presence and absence of young mackerel, they cannot be used to quantify spatial abundance accurately (Anon 2009).

The time series used for this analysis was based surveys carried out by France, Ireland, Portugal, Scotland and Spain (quarter 4 surveys) and by Scotland (quarter 1 surveys):

- 4th Quarter, age 0 mackerel from surveys 1985 – 2007
- 1st Quarter, age 1 mackerel from surveys 1985 – 2008
- 4th Quarter age 1 mackerel from surveys1985 – 2007
- A combined index using data from 4th quarter, age 0 mackerel and 1st quarter, age 1 mackerel from surveys 1985 – 2007.

Background on the IBTS survey

In the 1960s a number of countries around the North Sea started research vessel trawl surveys which were specifically aimed at the distribution and abundance of young herring (*Clupea harengus*) the International Young Herring Survey. Since 1974 the whole of the North Sea, Skagerrak and Kattegat have been surveyed annually in the first quarter of the year. It was soon realised that the survey also yielded valuable information for other fish species, such as cod and haddock, and so the objectives were broadened and the survey was renamed into the International Young Fish Survey (IYFS). A number of additional national surveys developed in a similar manner during the 1970s and 80s, these were mainly carried out in the third quarter.

In 1990 ICES decided to combine these surveys into the International Bottom Trawl Survey (IBTS) and over the years, co-ordinated them under the auspices of the IBTSWG with the aim of improving standardisation and collaboration between surveys. Prior to 1977 there was no standardisation of gear although all ships used bottom trawls with a small mesh cover. In 1977 ICES recommended that all ships should use a GOV trawl as specified by the Institute des Peches Maritimes, Boulogne. A detailed description of the net is to be found in the manual (ICES 2006a). The GOV trawl was gradually phased in, e.g. in 1979 only 3 vessels were equipped with the GOV trawl, but by 1983 all 8 nations were using this gear. It should be noted that although the gear is now standard, variations in the rigging exist between the various countries. This should be borne in mind when comparing results across the areas covered. The fishing method is also standardized and described in the manual (ICES 2006a). Fishing speed is 4 knots measured as trawl speed over the ground. In 1977 ICES also recommended that the duration of a tow should be reduced from an hour to half an hour with the catch data to be expressed in numbers per hour. All nations accepted this recommendation although it was a number of years before 30 minutes became the standard.

Two areas can be distinguished which differ in terms of the degree to which standardisation has been achieved: IBTS North Sea and IBTS Western and Southern areas. The North Sea IBTS are being carried out twice per year (1st and 3rd quarters) and in the period 1991-1996 also in 2nd and 4rd quarter. In 1994, the remit of the IBTSWG was extended to co-ordinate surveys in the western and southern areas (i.e. English Channel, Celtic Sea, Bay of Biscay, eastern Atlantic waters from the Shetlands to the strait of Gibraltar). While some attempts have been made in order to achieve a consensus on the choice of a standard gear, this was not achieved due to the variation in bottom types, and each country uses a different gear (GOV for France, Scotland and Ireland, BAKA for Spain and Norwegian Campelen Trawl for Portugal). Each country conducts surveys in adjacent areas with no overlapping, in various quarters of the year.

B.4. Commercial CPUE

None

B.5. Other relevant data

None

C. Historical Stock Development

A benchmark assessment for NEA Mackerel was carried out in 2007 by the working group on the assessment of Mackerel, Horse mackerel, Sardine and Anchovy (ICES 2007b). Following this benchmark investigation, the tool chosen for the assessment is ICA (Patterson & Melvin 1996). Since 2008, this method has been implemented in FLR (Kell *et al.* 2007) using the FLICA routine[1].

The ICA programme operates by minimising the following general objective function*:*

$$\sum \lambda_C \left(C - \hat{C}\right)^2 + \sum \lambda_I \left(I - \hat{I}\right)^2$$

which is the sum of the squared differences between the estimated and true value for the catches (separable model) and the tuning indices (catchability model).

The final objective function chosen for the stock assessment model in was:

$$\sum_{a=0}^{12+} \sum_{y=Y-12}^{Y} \lambda_{ca} \left(\ln\left(\hat{C}_{a,y}\right) - \ln\left(C_{a,y}\right)\right)^2 + \sum_{y \in \{\text{Y\_Egg}\}} \lambda_{MES} \left(\ln\left(q_{MES} S\hat{S}B_y\right) - \ln\left(MES_y\right)\right)^2$$

where

a and *y* age and year

C catch

[1] In 2008, the assessment was run using both the old ICA software and FLICA and no difference was found between the output of the two methods.

$\hat{C}$ catch estimated by the separable model

$\hat{SSB}$ spawning stock biomass estimated by the model

MES Mackerel Eggs Survey index (biomass index) triennialy

q_{MES} catchability of mackerel egg survey

ω_{ca} and ω_{MES} weighting factors for the catches and the survey

Y Assessment year

Y_Egg Egg survey years (e.g: 1992, 1995, 1998, 2001, 2004, 2007, 2010, etc.)

Implementation of the method is using R2.8.1, the following FLR packages : FLCore3.0, FLAssess1.99-102, FLICA1.4-10, FLSTF1.99-1, FLEDA2.0, FLBRP2.0, FLash2.0 and the scripts developed to work with ICA : NEAMac Assessment.r, HAWG Common assessment module.r, HAWG Retro func.r, WriteIcaSum.r.

Input data types and characteristics:

Type	Name	Year range Y = Assessment year	Age range	Variable from year to year
Caton	Catch in tonnes	1972 - Y-1		Yes
Canum	Catch at age in numbers	1972 - Y-1	0-12+	Yes
Weca	Weight at age in the commercial catch	1972 - Y-1	0-12+	Yes
West	Weight at age of the spawning stock at spawning time.	1972 - Y-1	0-12+	Yes
Mprop	Proportion of natural mortality before spawning	1972 - Y-1	0-12+	No, fixed at 0.35[1]
Fprop	Proportion of fishing mortality before spawning	1972 - Y-1	0-12+	No, fixed at 0.42[2]
Matprop	Proportion mature at age	1972 - Y-1	0-12+	Yes
Natmor	Natural mortality	1972 - Y-1	0-12+	No, fixed at 0.15

1: estimated from the Julian day by which 50% of the egg spawning had occurred in each of the egg survey years and the fraction of the year this represents.

2: Catch numbers were taken by quarter and the quarter 2 data partitioned to give an observed catch before and after time of spawning. Partial Fs were then calculated using the output from the 2006 ICA mackerel assessment and an estimated catch calculated using the catch equation. A proportion of F before spawning was then obtained by age and year and mean values calculated

NOTA : Due to the lack of data, the age for the plus group in the first years in the catch at age matrix is increasing until the year 1980 when it is definitely set at age 12. For this reason Fbar4–8 cannot be correctly estimated when the plus group was smaller than 8 (before 1977), and SSB cannot be correctly estimated when the plus group was smaller than 12 (before 1980). Recruitment and total catch estimates are not affected by this problem.

Tuning data:

Type	Name	Year range	Age range
Survey	ICES Triennial Mackerel and Horse Mackerel Egg Survey	1992, 1995, 1998, 2001, 2004, 2007, 2010, etc.	Not applicable (gives SSB)

Model Options chosen according to the 2007 benchmark:

	Settings	Description
FLICA.control settings		
sr	FALSE	No stock-recruitment relationship used in the model
lambda.age	0.0033, 0.033, 0.33, 0.33, 0.33, 0.33, 0.33, 0.33, 0.33, 0.33, 0.33, 0.33, 0.33	Weighting matrices for catch-at-age; for aged surveys; for SSB surveys
lambda.yr	1 1 1 1 1 1 1 1 1 1 1 1	Relative weights by year
lambda.sr	0.1	weight for the SRR term in the objective function
index.model	linear	Catchability model for each survey
index.cor	FALSE	Are the age-structured indices correlated across ages
sep.nyr	12	Number of years for separable model
sep.age	5	Reference age for fitting the separable model
sep.sel	1.5	Selection on last true reference age
FLIndex settings		
index.var	0.1 for all years	Variance of the index (inverse of the weight given to each survey year)

D. Short-Term Projection

Deterministic short-term predictions are calculated using the MDFP v.1a. Projections are done three years ahead: assessment year (Y) to Y +2. For the intermediate year (= Y) a constraint is used on the catch (see below for more details). A range of management options for Y +1 are then tested.

The input data are detailed below:

Initial stock size:

Age 2 to 12+	the survivors at the 1st of January Y estimated by ICA are used as the starting populations in the prediction. The recruitment of age 0 (year class Y) and the abundance at age 1 (year class Y-1) are routinely revised due to the uncertainty of these estimates:
Age 0	The geometric mean of the recruitments for the period from the first year of data until two years before the assessment year (i.e. 1972 – Y-2) is used for the recruitment at age 0 for Y-1 – Y in the predictions.
Age 1	the abundance of the survivors at age 1 (in Y) is the geometric mean recruitment at age 0 brought forward 1 year by the total mortality at age 0 in the year before the assessment year.

Exploitation pattern:

The exploitation pattern used in the predictions was the separable ICA F's, scaled to the F in the final year. As the model is fitted with 12 year separable period this is effectively the mean exploitation from Y-12 to Y-1 inclusive.

Maturity at age, weight at age in the catch and weight at age in the stock:

The 3 year average (years Y-3 – Y-1) was used.

Proportion of natural and fishing mortality occurring before spawning:

Use the constant values used for the whole period

Assumptions for the intermediate year:

The catch in the intermediate year (=Y) is taken as a TAC constraint. The catch is calculated from the agreed TAC for Y modified by quota reduction due to EU COMMISSION REGULATION (EC) No 147/2007 plus an assumed amount of discards.

In addition, two other sources of catch have been identified, an over catch of Coastal States agreement taken mostly in the southern area and additional catches taken by Iceland outside the Coastal States agreement. The percentage of the over catch compared to the total catch in the previous year (Y-1) was used to calculate the over catch expected corresponding to the Y TAC.

Management Option Tables for the TAC year

The different management options for the catch in Y+1 are tested, according to the management plan implemented for NEA Mackerel since 2009:

- $Catch_{2010}$ = zero
- $Catch_{2010} = TAC_Y - 20\%$
- $Catch_{2010} = TAC_Y$
- $Catch_{2010} = TAC_Y + 20\%$
- $Fbar_{2010} = 0.20$
- $Fbar_{2010} = 0.21$
- $Fbar_{2010} = 0.22$

Additionally projections were also done using a range of F multipliers (from 0 to 2 by increments of 0.1) for F_{Y+1} compared to F_Y. Model used:

E. Medium-Term Projections

No medium-term projections

F. Long-Term Projections

No long term projections

G. Biological Reference Points

Limit points

Investigation using precautionary software (PaSoft, Cefas 1999) showed that there was no indications of reduced recruitment at biomasses above the lowest observed biomass of B_{loss} =1.67Mt. A segmented regression fits a point of inflection to the same biomass point. On this basis B_{lim} is given the value of B_{loss}.

Yield per recruit evaluations using B_{loss} and assuming historic mean recruitment give an estimate of F_{loss} = 0.42. The value of F_{loss} is compatible with the proposed B_{lim} and on this basis F_{lim} is given the value of F_{loss}.

Precautionary reference points

Evaluations of precision of the assessment carried out during the management plan evaluations (ICES 2007b) show that the precision of F estimated in the assessment has a CV of 36%. The ICES procedure for evaluating precautionary reference points from limit points uses a formula based on the CV (ICES 2001) This formula gives a factor of 0.55 and an estimate of F_{pa} =0.23.

A similar evaluation of precision of the SSB (29%) would result in B_{pa} = 2.69Mt, which exceeds the observed biomass during most of the period of the assessment of SSB (more reliable values since 1979). Due to the limited range of stock biomass and the precision of the assessment in the final year, it is therefore not possible to define both B_{lim} and B_{pa} that lie within the observed range of biomass. Setting a B_{pa} outside the range of reliable observations is not thought to be appropriate. Given this situation it was deiced that B_{pa} should not be revised, until more information becomes available. Note that given B_{lim} the existing B_{pa} = 2.3 Mt does not reflect the assessment uncertainty. Under these circumstances it is not recommended to use B_{pa} as a management target but rather to follow one of the precautionary options under the proposed management plan.

	Type	Value	Technical basis
Precautionary approach	B_{lim}	1.67 million t	B_{loss}
	B_{pa}	2.3 million t	Trigger reference point used in the management agreed between Norway, Faroe, Islands, and the EU in 1999.
	F_{lim}	0.42	F_{loss}
	F_{pa}	0.23	F_{lim}*0.55 (CV 36%)
Targets	F_y	Between 0.20 and 0.22	2008 Management plan
	B_y	> 2.2 million t	

B_{pa} unchanged since 1998; target reference points changed in 2008; F_{pa}, F_{lim}, and B_{lim} revised in 2008

H. Other Issues

H.1. Management plans and evaluations

During 2007 and 2008 ICES provided a report on NEA mackerel long-term management (ICES 2008b) The content of the study was developed through a request from the European Commission and a series of meetings with representatives of Pelagic Regional Advisory Council (PRAC). The report was used by ICES to give advice in June 2008, which was presented to the PRAC in July 2008. Following this a request was made by the PRAC to provide information on tradeoffs between different management criteria, particularly concentrating on average catch, inter-annual change in catch and proportion of older fish. More runs were carried out with the software HCM with the same model conditioning and setting used to give ICES advice. These were used to give more detail in the region of greatest interest. The information on the methods used was given in (ICES 2008b).

An agreed management plan for NE Atlantic mackerel was finalised in October 2008. The management plan is as follows:

The agreed record of negotiations between Norway, Faroe Islands, and EU in 2008 states that the long-term management plan shall consist of the following elements:

1. *For the purpose of this long-term management plan, "SSB" means the estimate according to ICES of the spawning stock biomass at spawning time in the year in which the TAC applies, taking account of the expected catch.*
2. *When the SSB is above 2,200,000 tonnes, the TAC shall be fixed according to the expected landings, as advised by ICES, on fishing the stock consistent with a fishing mortality rate in the range of 0.20 to 0.22 for appropriate age groups as defined by ICES.*
3. *When the SSB is lower than 2,200,000 tonnes, the TAC shall be fixed according to the expected landings as advised by ICES, on fishing the stock at a fishing mortality rate determined by the following:*

   $$\text{Fishing mortality } F = 0.22^{*} SSB/ 2{,}200{,}000$$

4. *Notwithstanding paragraph 2, the TAC shall not be changed by more than 20% from one year to the next, including from 2009 to 2010.*
5. *In the event that the ICES estimate of SSB is less than 1,670,000 tonnes, the Parties shall decide on a TAC which is less than that arising from the application of paragraphs 2 to 4.*
6. *The Parties may decide on a TAC that is lower than that determined by paragraphs 2 to 4.*
7. *The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES*

From (NEAFC 2008)

ICES consider the agreement to be consistent with the precautionary approach. However, the management plan does not specify measures that would apply under poor stock conditions that preclude further evaluation.

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Stock Annex B – Western Horse Mackerel

Quality Handbook ANNEX: B – Western Horse Mackerel

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Western Horse Mackerel (Divisions IIa, IIIa-west, IVa, Vb, VIa, VIIa-c, VIIe-k, VIIIa-e)
Working Group:	Working Group on Widely Distributed Stocks
Date:	8 September 2009
Revised by	T. Jansen, T. Brunel, A. Campbell, C. Main, L. Readdy, L. Nøttestad

A. General

A.1. Stock definition

Stock Identity

For many years, ICES considered horse mackerel (*Trachurus trachurus*) in the northeast Atlantic to be separated into three stocks. Prior to the conclusion of the project HOMSIR in 2003 (description to follow), this separation was motivated mainly on the basis of temporal and spatial distributions of the fishery and observed egg and larval distributions (ICES 2008/ACOM:13), but early on was also supported by information from acoustic and trawl surveys, and from parasite infestation rates in horse mackerel (ICES 1989/Assess:19, 1990/Assess:24, 1991/Assess:22). The southern stock was defined as that found in the Atlantic waters of the Iberian Peninsula, the North Sea stock in the eastern English Channel and North Sea area, and the western stock on the northeast continental shelf of Europe, stretching from the Bay of Biscay in the south to Norway in the north.

The occurrence of the large 1982 year class in the eastern part of the North Sea during the latter half of 1987, which resulted in the commencement of a sizeable Norwegian fishery for horse mackerel in the third and fourth quarters from the late 1980s, led to questions about the distribution of the North Sea stock (ICES 1989/Assess:19). A combination of commercial catch and bottom trawl survey data indicated that western horse mackerel had a similar migration pattern to mackerel, so that outside the spawning season bigger fish migrate north to reach the northern North Sea in the latter half of the year (Iversen *et al*. 2002). Differences were also noted in the development of the fishery and in the parasite infestation rates of horse mackerel in Divisions IIa and IVa compared to Divisions IVb-c and the English Channel, suggesting that fisheries in these two areas were exploiting fish from two different spawning areas (ICES 1990/Assess:24, 1991/Assess:22). Therefore, since 1989 ICES has allocated catches taken in Division IIa and in Division IVa (in later years only during the third and fourth quarters of the year for IVa, and including the western part of Division IIIa) to the western stock (ICES 1989/Assess:19).

A Study Group on stock identity held in 1992 (ICES 1992/H:4) found that, although there were clear centres of egg production, there were no major discontinuities in the distribution of eggs between the western and southern areas, bringing into question the separation between these stocks (ICES 1992/Assess:17). It was hoped a tagging program launched in Spain and Portugal in 1994 (ICES 1995/Assess:2), and two studies conducted in 1997 using allozyme differentiation and morphometric characteristics (ICES 1998/Assess:6) would shed further light on stock identity, but none of the tags were ever recovered (ICES 1996/Assess:7, 1997/Assess:3, 1998/Assess:6, 1999/ACFM:6, 2000/ACFM:5, 2001/ACFM:06), and neither study provided a basis for changing the stock separation previously defined (ICES 1998/Assess:6).

Further refinements of the definitions of stock units were made based on the results from HOMSIR (EU-funded project: QLK5-CT1999-01438), which integrated a variety of approaches to investigate horse mackerel stock identification (ICES 2005/ACFM:08, Abaunza *et al*. 2008). The project investigated the stock structure of horse mackerel from a holistic point of view within the western, southern, North Sea and Mediterranean areas. It included various genetic approaches (multilocus allozyme electrophoresis, mitochondrial DNA analysis, microsatellite DNA analysis and single stranded conformation polymorphysm SSCP analysis), the use of parasites as biological tags, body morphometrics, otolith shape analysis and the comparative study of life history traits (growth, reproduction and distribution). The project concluded in June 2003, and some of the main results from this project, which are of relevance to the western stock, were as follows (ICES 2005/ACFM:08):

- Horse mackerel from the west Iberian Atlantic coast can be distinguished from the rest of the Atlantic areas.
- In the Atlantic Ocean, the northern boundary of the so called "southern stock" ought to be revised, and accordingly, the southern boundary of the so called "western stock". The body morphometrics and the otolith shape analysis joined the northwest of the Iberian Peninsula (North Galicia) to the areas located more to the North in the Atlantic Ocean, Bay of Biscay and Celtic Sea. On the other hand, the genetic results from SSCP associated the northwest of Iberian Peninsula to the Portuguese sampling sites. These differences between the techniques suggested that North Galicia may correspond to a transition area between two possible stock units. Therefore, it was proposed to move the actual boundary of the "Southern" and "Western" stocks from Cape Breton Canyon (southeast of Bay of Biscay) to the northwest of Iberian Peninsula (Galician coasts) and specifically to Cape Finisterre at 43º N latitude, which could be considered also as a boundary for certain hydrographic features, like the influence of North-Atlantic Central Water (Fraga *et al*., 1982).
- Parasites and body morphometrics indicated that horse mackerel in the North Sea could constitute a stock well differentiated from the rest of adjacent Atlantic areas.
- Horse mackerel along western European coasts, from the northwest of Spain to Norway, seem to be a unique stock. This definition is very similar to that previously used for the "western stock", except that, based on results from HOMSIR, the north coast of the Iberian Peninsula should also be included. Neither the SSCP results nor the parasite composition study showed any contradiction with this definition. Anisakid parasite species composition is homogenous throughout this area. Otolith shape analysis

and body morphometrics include the sampling sites from this area in the same cluster, showing a great similarity in morphometric characteristics.

- However, the population structure in the western European coasts could be more complicated and more research is needed to clarify the migration patterns within the Northeast Atlantic Ocean. This is especially relevant to the boundary areas between the North Sea Stock and the Western stock (Northern North Sea and English Channel).

Therefore, in many ways, results from the HOMSIR project largely supported ICES perceptions of stock units. Based on findings from the project, ICES now includes Division VIIIc as part of the distribution area of the western horse mackerel stock. The boundaries for the different stocks are given in Figure B.1.

Allocation of catches to stock

Based on spatial and temporal distribution of the horse mackerel fishery the catches were allocated to the western stock as follows:

Western stock: Quarters 3&4 only: Divisions IIIa (west), IVa
All Quarters: Divisions IIa, Vb, VIa, VIIa-c,e-k and VIIIa-e.

The reason why catches from only the western part of Division IIIa are allocated to the western stock is that these catches are taken in the third and fourth quarter, and are often taken in the neighbouring area of catches from the western stock in Division IVa. ICES is not sure if catches in Divisions IVa and IIIa during the first two quarters are of western or North Sea origin. Usually this is a minor problem because the catches in these areas during this period are small. However, in 2006 and 2007, relatively larger catches, 2 600 and 2 100 tons, were taken in Division IVa during the first half of the year and these catches were allocated to the North Sea stock.

A.2. Fishery

Ireland, Denmark, Scotland, England and Wales, France, Germany and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain and Portugal have both directed and mixed trawl and purse seine fisheries. In earlier years most of the catches were used for meal and oil while in later years most of the catches have been used for human consumption.

The French, Dutch and German fleets operated mainly west of the Channel, in the Channel area, and in the southern North Sea. The Spanish and Portuguese fleets operated mainly in their respective waters. Ireland fished mainly west of Ireland and Norway in the north eastern part of the North Sea.

A.3. Ecosystem aspects

Western horse mackerel have a long spawning season with a peak in late spring/early summer (Abaunza *et al*., 2003). They spawn in the Bay of Biscay and southwest of the British Isles (indicated as the "juvenile area" in Figure B.1). Age and length distributions from around the British Isles suggest that, as for northeast Atlantic mackerel (*Scomber scombrus*), the largest fish tend to travel farthest and may reach areas around the Shetland Islands, the Norwegian coast, and the northern North Sea by September (Eaton, 1983).

Three species of genus Trachurus: *T. trachurus*, *T. mediterraneus* and *T. picturatus* are found together and are commercially exploited in NE Atlantic waters.

Following the Working Group recommendation (ICES 2002/ACFM: 06), special care has been 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*.

T. mediterraneus is almost exclusively landed in ports of the Cantabrian Sea in the north of Spain. The fishery for *T. picturatus* takes place in the southern part of Division IXa and in Subarea X. The annual landings of *T. mediterraneus* show substantial variability, ranging from about 500t to 7,000 tones. Since 2004 there has been a decrease in landings reaching the lowest level in 2007.

B. Data

B.1. Commercial catch

Catch in numbers

Since 1998 there has been an increase in age readings compared with previous years, which has improved the quality of the catch at age matrix for western horse mackerel. Catches from some countries were converted to numbers at age using adequate samples from other countries. The procedure has been carried out using the specific software for calculating international catch at age (Patterson WD presented in ICES 1999/ACFM:6). Usually catch at age data are provided by the Netherlands, Norway, Ireland and Spain. In some years also Germany and Scotland have provided such data. Therefore adequate sampling has never been conducted in all fishing areas during the fishing season.

Discards

Over the years, only one, and in later years two, countries have provided data on discards, so that the estimated amount of discards are not representative for the total fishery. During recent years only the Netherlands and Germany have provided discard data. No data on discards were provided during 1998-2001. Based on the limited data available it is impossible to estimate the amount of discard in the horse mackerel fisheries.

B.2. Biological

Mean weight at age in the stock

The mean weight at age for two year olds was given a constant weight, while the weight for the older ages is based on all mature fish sampled from Dutch freezer trawlers in the first and second quarter in Divisions VIIj,k. In 2007, due to no catches in VIIk, weights were only available from Division VIIj. The mean weight by age groups in the stock and in the catches were lower than usual in 2001, but returned to normal since 2002.

Maturity ogive

Due to difficulties in estimating a maturity ogive (ICES 2000/ACFM:5, 2000/G:01) the working group has been unable to update the maturity ogive annually. Therefore the same maturity at age has been used since 1998.

Natural mortality

The natural mortalities applied in previous assessments of western horse mackerel are summarised and discussed in ICES (1998/Assess:6). The natural mortality is uncertain but probably low. ICES currently applies M=0.15.year^{-1}.

B.3. Surveys

Egg survey estimates of biomass

The Mackerel and Horse Mackerel Egg Survey takes place triennially with the participation of Portugal, Spain, Scotland, Ireland, The Netherlands, Norway and Germany. It is not possible to convert the horse mackerel egg production to SSB since horse mackerel is considered an indeterminate spawner.

In general the quality and reliability of the egg surveys are good. There was an increase in survey effort in 2007 compared to 2004, in spite of the lack of participation by England. This absence was mainly compensated for by an additional survey carried out by Scotland and specific modifications in coverage carried out by several other countries.

Since 2003 the ICES working group WGMEGS has held an egg identification and staging workshop prior to the survey. This permits a harmonisation of egg identification and realised fecundity in mackerel as well as spawning rates in horse mackerel across the participating institutes. These activities led to an improvement in the quality of the estimate.

Even when the survey coverage is good, WGMEGS concludes that while the starting of the spawning event is fully covered for mackerel and horse mackerel, the surveys end too early to adequately cover the end of spawning in the northern areas for both mackerel and horse mackerel, and in the southern area (south of 47°N) for horse mackerel.

Bottom trawl surveys

Bottom trawl surveys are carried out in a systematic and standardized way through the Northeast Atlantic. They cover a significant part of the western horse mackerel distribution area and are carried out mainly during the autumn. These surveys are coordinated in the International Bottom Trawl Surveys Working Group (IBTSWG, ICES 2009/RMC:04) with the main objective of obtaining an index of recruitment for the most important commercial fish species. Horse mackerel is a pelagic species, but its behaviour is closer to that of a demersal species than the rest of typical pelagic species. The IBTS could therefore provide information on horse mackerel distribution, catch rates and length distributions. Taking in consideration the problems with the abundance index used in the western horse mackerel assessment, it is useful to consider the surveys under IBTSWG in order to analyse whether they could provide an index of recruitment or abundance for western horse mackerel.

Data from the bottom trawl survey carried out in autumn in the Cantabrian Sea and Galician coasts (North of Spain, Division VIIIc) were analysed in relation to horse mackerel. This survey is not used in the assessment because it covers only a small part of the western horse mackerel stock, but it provides valuable information on horse mackerel dynamics. Length distributions show a gap in length range 18-23cm that could be related to the particular exploitation pattern of this species. Juveniles are more abundant in the eastern part of the Cantabrian Sea, although the depth strata <120m, in which the young horse mackerel are also distributed, are very poorly sampled in the Galician coasts. The recruitment in 1994 appeared to be strong in the data series (ICES 2008/ACOM:13). The evolution of the cohorts through the data matrix compiled from this survey indicated poor information on mortality. This could be due to migration to and from other areas, especially the French continental shelf (Murta *et al*., 2008; Velasco *et al*. 2008). The information provided by this survey will be combined with the results of other bottom trawl surveys carried out in adjacent areas. Traditionally age 0 has been adopted as the recruitment age for horse mackerel in this survey; nevertheless the use of age 1 as a proxy for recruitment may be more appropriate. The years before 1997 have been revised to account for the change in the strata of the sampling design adopted in 1997 (Velasco *et al*. 2008).

The French bottom trawl survey (EVHOE) covers the Bay of Biscay (French continental shelf) and part of the Celtic Sea. It is carried out in autumn and it is directed at demersal resources. Information on horse mackerel distribution and length distributions are available. The survey is carried out during the recruitment season, and juveniles form the majority in the catches.

It might be useful for the WG to collect all information available about horse mackerel from other bottom trawl surveys carried out in the distribution area of the western horse mackerel stock (e.g. IBTS).

Acoustic surveys

Horse mackerel data from the French acoustic PELGAS surveys are available as independent information on the western horse mackerel stock (ICES 2006/LRC:18). This multidisciplinary survey covers Divisions VIIIa and VIIIb during spring, collecting information on spatial distribution and length distribution. Revised survey estimates were presented in 2008 (Massé et al. WD presented in ICES 2008/ACOM:13).

Horse mackerel data from the Spanish acoustic PELACUS surveys are available as independent information on the western horse mackerel stock. This multidisciplinary survey covers Divisions VIIIc and IXa (north) during spring. In some years the survey is extended to the south of Divisions IXa (north) and VIIIb. Information on distribution and abundance estimates are available since 1997, but the biomass estimates of the historical series were calculated considering Divisions IXa (north) (actually belonging to the southern stock) and VIIIc (western stock) until 2006 .The information will be split up by stock in the future.

B.4. Commercial CPUE

Information on effort and catch per unit effort is only available from the southern limit of the stock distribution area. Since Division VIIIc became part of the western stock in 2004 (ICES 2005/ACFM:08), the bottom trawl fleet operating in the western part of Division VIIIc (north of the Galician coast) is exploiting the western stock. This area represents a very small part of the western horse mackerel stock and therefore the fleet has not been used in the assessment.

The activity of this bottom trawl fleet is considered as mixed fisheries in which different métiers can be distinguished. Due to the assumption that CPUE is proportional to abundance, it is important that any other factors that may influence CPUE are removed from the index. The process of reducing the influence of these factors on CPUE is commonly referred to as standardizing the CPUE. Therefore, it is possible to present in the future a new revised and standardized version of this CPUE series following the métiers classification, with the objective of obtaining a more reliable CPUE at age series.

C. Historical Stock Development

Model used: SAD (linked separable-ADAPT VPA assessment model).

Software used: AD Model Builder, version 2008 (ICES 2008/ACOM:13). The source code is freely available in ICES folders.

Description of SAD

The SAD model has been used by the working group since the 2000 meeting. The WGMHSA Review Group of ACFM in 2005 stated that the SAD model, purposely designed to assess this stock, was the most appropriate tool. A detailed description of the SAD assessment model and rationale for its use is provided in ICES (2003/ACFM:07) and De Oliveira *et al*. (submitted). Figure B.2 presents an illustration of the model structure and the "free" parameters estimated by maximum likelihood (i.e. those estimated directly), and the following table summarises its main features.

A summary of the main features of the SAD model used for the assessment of western horse mackerel:

Model	SAD
Version	2008 Working Group (WGWIDE) (ICES 2008/ACOM:13)
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 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, ignoring the 1982 year-class where applicable), multiplied by a scaling parameter 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 in the model.
Data used	Egg production estimates, used as relative indices of abundance and catch-at-age data (numbers). Weights-at-age in the stock and maturity-at-age vary temporally, but are assumed to be known without error. Natural mortality and the proportions of fishing and natural mortality before spawning are fixed and year-invariant. Fecundity data are potential fecundity vs. fish weight data for the years 1987, 1992, 1995, 1998, 2000 and 2001, and a realised fecundity 'prior' distribution for 1989, with a mean and CV derived from a normal distribution in log-space, which covers (with a 95% probability) the range of realised fecundity values reported by Abaunza *et al*. (2003).
Selection	The separable period assumes constant selection-at-age, and requires estimation of fishing mortality age- and year-effects (the former reflecting selectivity-at-age) for ages 1-10 and the final x years for which catch data are available (x being the length of the separable period). Selectivity at age 8 is assumed to be equal to 1. The length of the separable period should be balanced against the precision of model estimates and whether there is any indication, from the log-catch residuals, that the separable assumption no longer holds.
Fishing mortality assumptions	The fishing mortality at age 10 (the final true age) is equal to the average of the fishing mortalities at ages 7-9 (ignoring the 1982 year-class where applicable) multiplied by a scaling parameter estimated within the model. The fishing mortality at age 10 in 1992 (applicable to the 1982 year-class) is estimated separately. The plus-group fishing mortality is assumed equal to that of age 10.
Estimated parameters	The parameters treated as "free" in the model (i.e. those estimated directly) are: (1) Fishing mortality year effects for the final four years for which catch data are available; (2) Fishing mortality age effects (selectivities) for ages 1-10 (except for selectivity at age 8 which is set to 1); (3) scaling parameter for fishing mortality at age 10 relative to the average for ages 7-9 (ignoring the 1982 year-class where

	applicable); (4) fishing mortality on the 1982 year-class at age 10 in 1992; (5) realised fecundity parameter, relating realised fecundity to potential fecundity, and therefore also relating estimated SSB to the egg production estimates; (6) potential fecundity parameters (intercept and slope), relating potential fecundity to fish weight.
Plus-group	A dynamic pool is assumed (plus group this year is the sum of last year's plus group and last year's oldest true age, both depleted by fishing and natural mortality). The plus group modelled in this manner allows the catch in the plus group to be estimated, and making the assumption that log-catches are normally distributed allows an additional component in the likelihood, fitting these estimated catches to the observed plus-group catch.
Objective function	The estimation is based on maximum likelihood. There are five components to the likelihood, corresponding to egg estimates, catches for the separable period, catches for the plus-group, potential fecundity vs. fish weight, and realised fecundity. The variance of each component is estimated, apart from that associated with realised fecundity for which a CV is input.
Variance estimates / uncertainty	Estimates of precision may be calculated by several methods, the simplest (based on the delta method) being used for results shown.
Program language	AD Model Builder (Otter Research Ltd)
References	Description in Working Group reports, De Oliveira *et al.* (submitted).

In 2005 the WG identified aspects of the assessment that warranted further exploration, which included whether there was additional information, particularly in relation to fecundity, that would allow scaling the model (ICES 2006/ACFM:08). Fecundity data (both actual data and estimates from the literature) was subsequently identified for inclusion in the model. Further investigation revealed evidence that potential (i.e. standing stock) fecundity per gram increases with fish weight (ICES 2002/G:06), and total realised fecundity would be expected to follow the same pattern. In line with this argument, the stock average fecundity would have increased as the 1982 year-class matured (as individuals gained weight) and then decreased when the strong year class was fished out. Ignoring these effects could lead to biased population estimates.

The SAD model explicitly incorporates and directly fits potential and realised fecundity data as functions of fish weight, with separate parameters for the two types of fecundity data, thus placing the estimation of fecundity parameters in a self-consistent framework. The model uses a realised fecundity 'prior' distribution (mean=1847 eggs per gram spawning female, CV=0.287), which is derived from a normal distribution, in log-space, which covers (with a 95% probability) the range of realised fecundity values reported by Abaunza *et al*. 2003 (1040-3280 eggs per gram spawning female). This allows the incorporation of a realistic level of uncertainty about realised fecundity.

The likelihood function used in SAD is as follows (ICES 2008/ACOM:13):

$$
\begin{aligned}
-\ln L = {} & \tfrac{1}{2} \sum_{y \in Y_{egg}} \left\{ \frac{\left(\ln N_{egg,y} - \ln(\hat{N}_{egg,y})\right)^2}{\hat{\sigma}^2_{egg}} + \ln\left[2\pi\hat{\sigma}^2_{egg}\right] \right\} \\
& + \tfrac{1}{2} \sum_{y=2003}^{2007} \sum_{i=1}^{10} \left\{ \frac{\left(\ln C_{y,i} - \ln \hat{C}_{y,i}\right)^2}{\hat{\sigma}^2_{sep}} + \ln\left[2\pi\hat{\sigma}^2_{sep}\right] \right\} \\
& + \tfrac{1}{2} \sum_{y=1983}^{2007} \left\{ \frac{\left(\ln C_{y,11+} - \ln \hat{C}_{y,11+}\right)^2}{\hat{\sigma}^2_{11+}} + \ln\left[2\pi\hat{\sigma}^2_{11+}\right] \right\} \\
& + \tfrac{1}{2} \sum_{y \in Y_{pfec}} \sum_{j=1}^{J_y} \left\{ \frac{\left(\ln f^p_{y,j} - \ln \hat{f}^p_{y,j}\right)^2}{\hat{\sigma}^2_{pfec}} + \ln\left[2\pi\hat{\sigma}^2_{pfec}\right] \right\} \\
& + \tfrac{1}{2} \left\{ \frac{\left(\ln \bar{f}^r_{1989} - \ln \hat{\bar{f}}^r_{1989}\right)^2}{\sigma^2_{rfec}} + \ln\left[2\pi\sigma^2_{rfec}\right] \right\}
\end{aligned}
$$

where i represents age, $N_{egg,y}$ the egg production estimates, $C_{y,i}$ catch-at-age, $f^p_{y,j}$ potential fecundity for sample j in year y, and $\bar{f}^r_{1989}$ population-mean realised fecundity for 1989. Model estimates are shown with "^" and data without.

The model estimates egg production as follows:

$$\hat{N}_{egg,y} = \sum_i q_{fec}(a_{fec} + b_{fec} w_{y,i}) B^{sp}_{y,i} s^f$$

where i represents age, q_{fec} the realised fecundity parameter, a_{fec} and b_{fec} the potential fecundity parameters, $w_{y,i}$ mean weights-at-age in the population, $B^{sp}_{y,i}$ SSB-at-age, and s^f the female sex ratio.

Potential fecundity is estimated as follows:

$$\hat{f}^p_{y,j} = a_{fec} + b_{fec} w_{y,j}$$

where $w_{y,j}$ are the sample weights for sample j of year y associated with the potential fecundity data $f^p_{y,j}$, and a_{fec} and b_{fec} are as before.

Population-mean realised fecundity is estimated as follows:

$$\hat{\bar{f}}^r_y = \frac{q_{fec}}{\sum_i N_{y,i} m_{y,i}} \sum_i N_{y,i} m_{y,i} (a_{fec} + b_{fec} w_{y,i})$$

where i represents age, $N_{y,i}$ population numbers-at-age, $w_{y,i}$ mean weights-at-age in the population, $m_{y,i}$ maturity-at-age, and q_{fec}, a_{fec} and b_{fec} as before.

The "free" parameters estimated directly in the model are:

1) Fishing mortality year effects (F_y) for the separable period;
2) Fishing mortality age effects (S_a, the selectivities) for ages 1-10 (excluding age 8, which is set at 1);

3) scaling parameter (F_{scal}) for fishing mortality at age 10 relative to the average for ages 7-9 (ignoring the 1982 year-class where applicable);

4) fishing mortality on the 1982 year-class at age 10 in 1992 ($F_{92,10}$);

5) realised fecundity parameter (q_{fec}), relating realised fecundity to potential fecundity, and therefore also relating SSB to egg production; and

6) potential fecundity parameters (a_{fec} and b_{fec}), relating potential fecundity to fish weight

Natural mortality (constant at age and by year at 0.15), maturity-at-age, stock weights-at-age and the proportions of F and M before spawning (0.45), are assumed to be known precisely.

Model Options chosen

For 2008, the separable window was 5 years long (2003-2007) (ICES 2008/ACOM:13). Decisions about whether to shift the window along (keeping it 5 years long) or whether to extend the window (keeping the starting date at 2003) depend on whether improved precision of model estimates are obtained, and whether the log-catch residuals show the separable assumption to continue to hold or not. Egg data that become available for the year following the final year of catch data are used in the assessment.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	-	-	Not used
Canum	Catch at age in numbers	1982-present	0-11+	Yes
Weca	Weight at age in the commercial catch	-	-	Not used
West	Weight at age of the spawning stock at spawning time.	1982-present	0-11+	Yes
Mprop	Proportion of natural mortality before spawning			No
Fprop	Proportion of fishing mortality before spawning			No
Matprop	Proportion mature at age	1982-present	0-11+	Yes (but constant since 1998)
Natmor	Natural mortality	-	-	No

Tuning data (data appearing in likelihood function):

Type	Name	Year range	Age range
Western Horse Mackerel egg survey	Total egg production estimates	1983, 1989, 1992,… (every third year)	-
Separable period catch-at-age	Separable catch-at-age	2003-present (but depends on length of separable window)	1-10
Plus-group catch	Plus-group catch	1982-present	11+
Potential fecundity	Potential fecundity vs. fish weight data	1987, 1992, 1995, 1998, 2000 and 2001	-
Realised fecundity	Total realised fecundity, based on Abaunza et al. (2003)	1989	-

D. Short-Term Projection

A short-term forecast is not conducted for western horse mackerel because a management plan is in place.

E. Medium-Term Projections

A medium-term forecast is not conducted for western horse mackerel because a management plan is in place.

F. Long-Term Projections

Long-term projections are not carried out for western horse mackerel.

G. Biological Reference Points

The stock is characterised by infrequent, extremely large recruitments.

Biomass reference points

It could be assumed 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 WG therefore considers the biomass that produced the extraordinary 1982 yc as a good proxy for B_{lim}. This follows the rationale of SGPRP 2003 (ICES 2003/ACFM:15), proposing to use the stock size in 1982 for B_{lim}. Evaluation of precision of the assessment shows that the CV in SSB is 16%. The ICES procedure for evaluating precautionary reference points from limit points uses a formula based on the CV (ICES 2001/ACFM:11). This formula gives a factor of 30% and an estimate of B_{pa} = 1.8Mt.

Fishing mortality reference points

The age range used in the calculation of mean F was changed in 2003 from $F_{4\text{-}10}$ to $F_{1\text{-}10}$ to include the ages exploited in both the adult and juvenile fisheries. The management plan currently in place is not based on F (see section 5). There are indications that the assumed natural mortality (0.15) might be too high. However, there is insufficient data to estimate M.

H. Other Issues

None.

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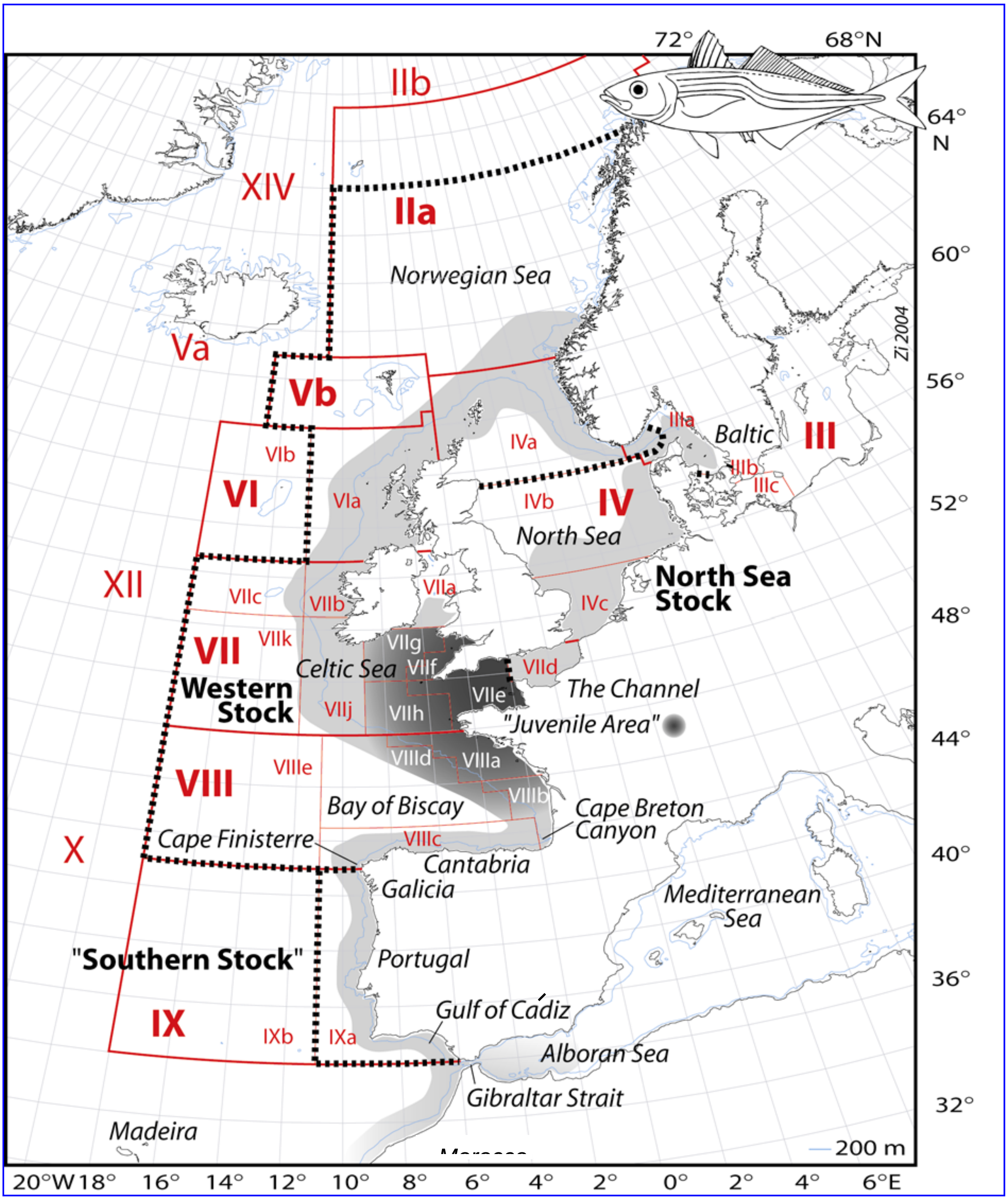

Figure B.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by ICES (2005). Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar projection, 200m depth contour drawn.

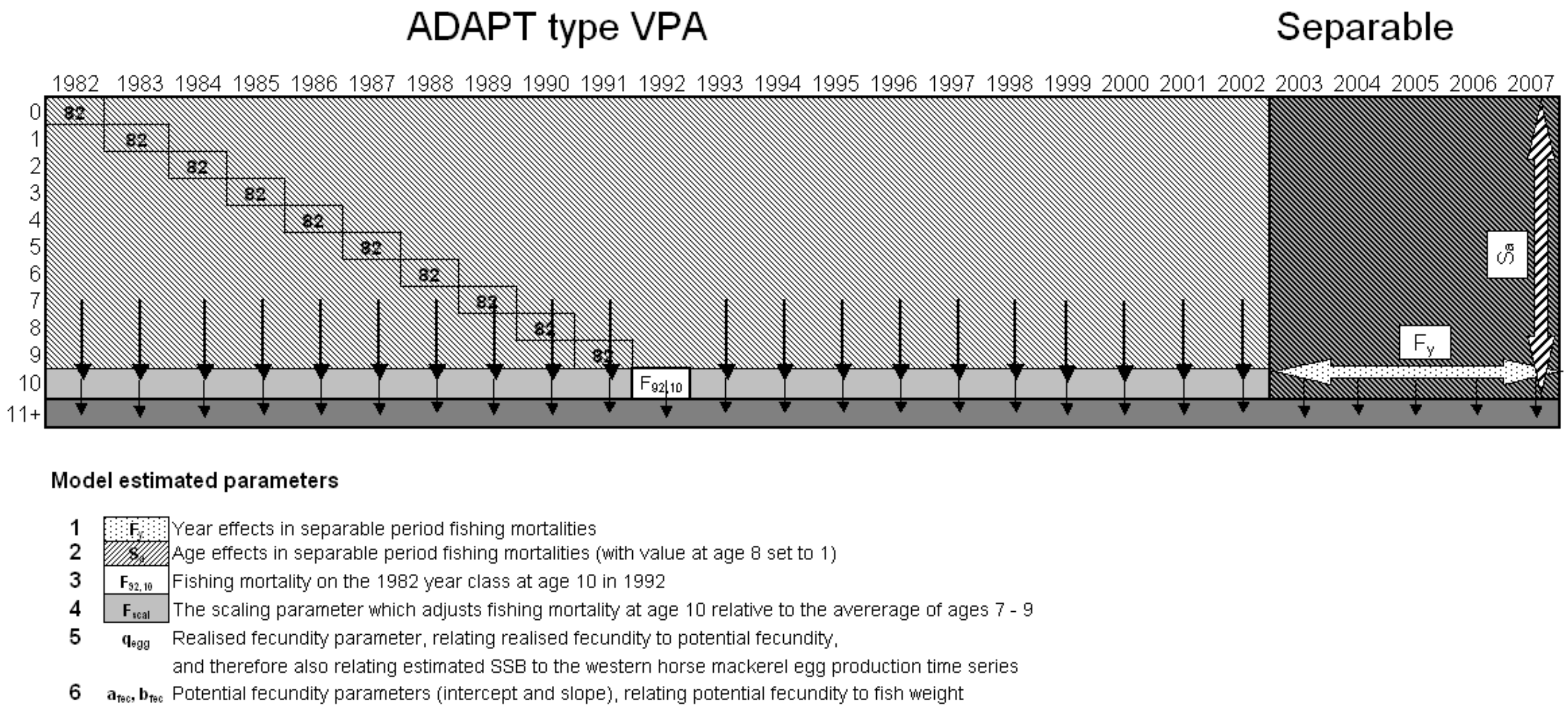

Figure B.2. Western Horse Mackerel. An illustration of the SAD model structure used for the assessment of the Western horse mackerel stock and the "free" parameters estimated by maximum likelihood.

Stock Annex C – Southern Horse Mackerel

Quality Handbook ANNEX: C - Southern Horse Mackerel

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Horse Mackerel in Div. IXa (Southern horse mackerel)
Working Group:	WGWIDE
Date:	07 September 2009
Revised by	Alberto Murta

A. General

A.1. Stock definition

Stock Units

For many years the Working Group has considered the horse mackerel in the north east Atlantic as separated into three stocks: the North Sea, the Southern and the Western stocks (ICES 1990/Assess: 24, ICES 1991/Assess: 22). According the technical minutes from the group reviewing last year's Working Group report, they discussed and questioned the stock unit definitions. Until the results from the EU project (HOMSIR, QLK5-Ct1999-01438), was available the separation into stocks was based on the observed egg distributions and the temporal and spatial distribution of the fishery. The extremely strong 1982 year class turned for the first time up in the eastern part of the North Sea in 1987 during the third and mainly the fourth quarter. This year class was the basis for the start of the Norwegian horse mackerel fishery in the eastern part of North Sea during the third and mainly the fourth quarter. Since Western horse mackerel are assumed to have broadly similar migration patterns as NEA mackerel the Norwegian catches have been considered to be fish of western origin migrating to this area to feed. In addition there is a fishery further south in the North Sea which is considered to be fish of North Sea origin. These views were supported by results from the mentioned EU project which was reviewed in ICES(2004/ACFM:8) which also concluded to include Division VIIIc as part of the distribution area of the western horse mackerel stock (see also Abaunza et al. 2008 for a comprehensive discussion of the results from the HOMSIR project).

Allocation of Catches to Stocks

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

Western stock: Divisions IIa, IIIa (western part), Vb, IVa (third and fourth quarter), VIa, VIIa–c,e–k and VIIIa-e. Allthough 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 often are taken in neighbouring area of catches of western fish in Division IVa. 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 small. However, in 2006 relatively larger catches were taken in this area during the first half of the year (3,600 tons) and these catches were allocated to the North Sea stock. In 2007 2,100 tons were caught during the two first quarters in Divisions IVa and IIIa and were allocated to the North Sea stock.

North Sea stock: Divisions IIIa (eastern part), IVa (first and second quarter), IVb,c and VIId. The catches 3-4 quarters of Divisions IVa and IIIa and 1-4 quartes from Divisions IVb,c and VIId from were allocated to the North Sea stock. In 2007 some small catches were reported from Divisions IIIb (4 tons) and IIIc (21.5 tons) which were allocated to the North Sea stock.

Southern stock: Division IXa. All catches from these areas are allocated to the southern stock.

A.2. Fishery

The catches of horse mackerel in Division IXa (Subdivision IXa North, Subdivision IXa Central-North, Subdivision IXa Central-South and Subdivision IXa South) are allocated to the Southern horse mackerel stock. In the years before 2004 the catches from Subdivisions VIIIc West and VIIIc East, were also considered to belong to the southern horse mackerel stock.

The Spanish catches in Subdivision IXa South (Gulf of Cádiz) are available since 2002. They will not be included in the assessment data until de time series is completed, to avoid a possible bias in the assessment results. On the other hand, the total catches from the Gulf of Cádiz are scarce and represent less than the 5% of the total catch. Therefore, their exclusion should not affect the reliability of the assessment.

The “Prestige” oil spill had also an effect in the fishery activities in the Spanish area in 2003. The Spanish catches increased markedly from 1991 until 1998, whereas the Portuguese ones are more stable showing a smooth decreasing trend since the peak obtained in 1992 (with a secondary peak in 1998).

Catches in Subdivisions IXa Central-North showed a decreasing trend whereas in Subdivision IXa North they increased markedly until 1998 and since then the catches were always higher than 7,000 t. The catches from bottom trawlers are the majority in both countries. The rest of the catches are taken by purse seiners, especially in the Spanish area and by the artisanal fleet which is much more important in the Portuguese area.

Description of the Portuguese fishing fleets operating in Division IXa (data provided by the Portuguese Fisheries Directorate) and catch horse mackerel (only trawlers and purse seiners):

Gear	Length	Storage	Number of boats
Trawl	10-20	Freezer	2
Trawl	20-30	Freezer	7
Trawl	30-40	Freezer	5
Trawl	0-10	Other	259
Trawl	10-20	Other	68
Trawl	20-30	Other	60
Trawl	30-40	Other	29
Purse seine	0-10	Other	79
Purse seine	10-20	Other	103
Purse seine	20-30	Other	79

Note that horse mackerel is also caught in all polyvalent and most small scale fisheries.

Description of the Spanish fishing fleets operating in Division IXa including the Gulf of Cádiz (Southern stock) and Division VIIIc (Western stock) (Hernández, 2008):

Gear	Bottom trawl	Purse seine	Lgline Bottom	Lgline surface	Gillnet (big mesh size)	Gillnet	Other artisanal
Number	282	410	100	67	35	57	5379
Construction year (mean)	1996	1992	1990	1995	1990	1993	1982
Length	9-35 (22.9)	8-38 (21)	6-28 (15.1)	18-38 (27.6)	4-28.6 (14)	12-27 (17.2)	3-27 (7)
Power	66-800 (322.3)	24-1100 (302.5)	12-476 (150.3)	175-780 (418.9)	10-500 (141.8)	50-408 (164.9)	2-450 (32.6)
Tonnage	6-228 (81.2)	4-221 (56.6)	2-118 (26)	37-206 (116)	1-110 (23.7)	10-99 (27.6)	0.3-83 (3.5)

It is indicated the range and the arithmetic mean (in parenthesis). Data from official census (Hernández 2008). Note that horse mackerel in the Spanish area is mainly fished by bottom trawlers and purse seiners.

The Spanish bottom trawl fleet operating in ICES Divisions VIIIc (Western stock) and Subdivision IXa north (Southern stock), historically relatively homogeneous, has evolved in the last decade (approximately since 1995) to incorporate several new fishing strategies. A classification analysis for this fleet between the years 2002 and 2004 was made based on the species composition of the individual trips (Castro and Punzón 2005). The analysis resulted in the identification of five catch profiles in the bottom otter trawl fleet: 1) targeting horse mackerel (>70% in landings), 2) targeting mackerel (>73% in landings); 3) targeting blue whiting (>40% in landings); 4) targeting demersal species; and 5) a mixed "metier". In the bottom pair trawl fleet the classification analysis showed two métiers: 1) targeting blue whiting; and 2) targeting hake. These results should help in obtaining standardized and more coherent CPUE series from fishing fleets.

In the Portuguese area (Division IXa) Silva and Murta (2007) classified trawl fleet in two main types: those directed to fish and cephalopods species and those fishing crustaceans. Looking at the the fishing trips of those that catch fish and cephalopods, they identified three main clusters:

- Directed to horse mackerel,
- Directed to cephalopods
- The third cluster is a mixed cluster, not well defined.

In 2005, the landings of blue whiting increased, probably due to increased market demand and consequent reduction of discards, resulting in a fourth specific cluster. The Crustacean trawl clusters do not follow the same pattern every year, depending on the abundance of the two main target crustacean species, which are Norway lobster and deepwater rose shrimp. There can be one target species by cluster or mixed clusters with different percentages of these two species.

A.3. Ecosystem aspects

B. Data

B.1. Commercial catch

Mean length at age and mean weight at age

Both mean length at age and mean weight at age values are calculated by applying the mean weighted by the catch over the mean weights or mean lengths at age obtained by Subdivision.

Taking in consideration that the spawning season is very long, spawning is almost from September to June, and that the whole length range of the species has commercial interest in the Iberian Peninsula, with probably very scarce discards, there is no special reason to consider that the mean-weight in the catch is significantly different from the mean weight in the stock.

Catch in numbers at age

The sampling scheme is believed to achieve a good coverage of the fishery (above 95% of the total catch). The number of fish aged seems also to be sufficient through the historical series. 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. In the case of Subdivision IXa north the catch in number estimates before 2003 have changed. In previous years the age length key applied to the length distributions from Subdivision IXa north had included otoliths from Division VIIIc, which has been defined recently as part of the Western stock. Since 2003 the catch in numbers at age from Subdivision IXa north were estimated using age length keys which included only otoliths from Division IXa.

B.2. Biological

Maturity at age

For multiple spawners, such as horse mackerel, macroscopical analysis of the gonads cannot provide a correct and precise means to follow the development of both ovaries and testes. Histological analysis has to be included because it provides precise information on oocyte developmental stages and it can distinguish between immature gonads and regressing ones or those partly spawned (Abaunza *et al.*, 2008). The HOMSIR project provided microscopical maturity ogives from the different IXa subdivisions. The maturity ogive from Subdivision IXa South is adopted here as the maturity at age for all years until 2006 of the southern stock, since it was based on a better sampling than in the others subdivisions. The percentage of mature female individuals per age group was adjusted to a logistic model.

In 2007 a new estimate of maturity proportion by age was available for Division IXa for the application of the Daily Egg Production Method (DEPM). This maturity ogive was then adopted since 2007 and will be revised with new data collected in the DEPM to be carried out in 2010.

Natural mortality

Natural mortality is considered to be 0.15. This level of natural mortality was adopted for all horse mackerel stocks since 1992 (ICES 1992/Assess: 17).

B.3. Surveys

There are currently 2 bottom-trawl survey series that can be used for tuning the assessment: the Portuguese and Spanish October surveys. These surveys cover Subdivisions VIIIc East, VIIIc West, IXa North (Spain) and Subdivisions IXa Central-North, Central-South and South (Portugal) from 20–500 m depth. The Spanish survey was disaggregated by Subdivision in order to use the data from the subdivision IXa North which is part of the southern horse mackerel stock. The same sampling methodology was used in both surveys but there are differences in the gear design. The Portuguese and the Spanish October survey indices are estimated for the whole range of distribution of horse mackerel in the area, which has been consistently sampled over the years. The two bottom-trawl surveys series, available to use as tuning data in the assessment, are joined given that both vessels and gears have a similar catchability for horse mackerel, as shown by the results of EU project SESITS. The weight given to each data set was proportional to the respective area covered, roughly 85% to the Portuguese data and 15% to the Spanish one. The variances of the survey indices in each age and year were approximated by the following expression:

var(I) = A^2 . var(Q) + Q^2 . var(A),

where A is the abundance index in each year and length class, and Q is the proportion of each age in each length class in the age-length keys applied to the survey data. The variance of A was calculated across all hauls in each year, and var(Q) = p . (1–p), where p is the proportion of fish of a given length class that are in that age class in the age-length key. Given that there is a high natural variability in the survey indices from year to year, each year-class was smoothed with a moving average, in which:

$N_i = 0.75N_i + 0.125N_{i-1} + 0.125N_{i+1}$, where N_i is the number/hour at age i in the year-class.

Recent work suggests that horse mackerel has indeterminate fecundity (Gordo et al., 2008), which makes the Annual Egg Production Method (AEPM) unsuitable to estimate SSB for this species. For species with indeterminate fecundity, the Daily Egg Production Method (DEPM) must be used instead. The existence of different series of data from egg surveys covering the whole area of the southern horse mackerel stock, makes it possible to obtain egg production estimates using DEPM.

For this stock, a total of three SSB estimates, for the years 2002, 2005 and 2007 were made available. The SSB estimate and variance for 2007 was obtained from a DEPM egg survey directed at horse mackerel. Details of the sampling procedure, data obtained and methods followed are available from the 2008 report of the Working Group on Mackerel and Horse Mackerel Egg Surveys (ICES, 2008 - ICES CM 2008/LRC:09). However, some details were corrected after the WGMEGS report, namely the total egg distribution area (which was corrected from 1.7e11 sq.meter to 7.1e11 sq.meter) and the fitting of the mortality curve to the egg abundance data, which was done using a GLM with a log link and assuming a Poisson distribution for the variance, instead of the non-linear regression described in the WGMEGS report. This resulted in a change of egg production from 13 eggs/sq.meter to 17 eggs/sq.meter.

The 2002 and 2005 estimates were obtained with egg abundance data collected during the surveys directed at sardine in 2002 and 2005 and from horse mackerel adult samples collected at the same time of those surveys. The methodology followed to estimate SSB was the same as the one for 2007, although the area covered in the egg sampling, which corresponded to the sampling grid for sardine, was smaller than in 2007.

There are different criteria that can be used to estimate the spawning fraction, such as the presence of migratory nucleus, hydrated oocytes or post-ovulatory follicles (POF). Estimates of SSB were obtained for the three years with all these criteria, and the obtained trends in SSB were parallel but with different levels. The POF criteria, assuming POF last for 2 days as in other species at similar temperatures (Ganias et al., 2003; Hunter and Macewicz, 1985) was the one providing the lowest CV, being therefore adopted to use in the assessment. However, given the uncertainty in the absolute value of SSB, partly due to the choice of the criteria for the spawning fraction, the SSB index for the assessment must be treated as relative and a corresponding catchability parameter has to be estimated.

Still another source of uncertainty is the egg distribution area, which was roughly defined and kept fixed for the three years. In all these egg surveys, there are several transects with the presence of eggs in the most offshore station, which indicates that the area with egg presence must, in some cases, be extended further away from the coast. However, a good approximation of that area is impossible to obtain with the available data.

B.4. Commercial CPUE

No commercial CPUE data is used in the stock assessment.

B.5. Other relevant data

C. Historical Stock Development

Model used:

The ASAP model (Legault and Restrepo, 1998), here used in the version ASAP 2.0.19, is a flexible, forward computing algorithm, which minimises an objective function based on likelihoods using a quasi-Newton minimisation method, with partial derivatives calculated by automatic differentiation (Griewank and Corliss, 1991). The automatic differentiation and minimisation routines are those supplied by the software package AD Model Builder (Otter Research). ASAP is currently used in many stock assessments in North American waters (e.g. red grouper, yellowtail flounder, Pacific sardine, Greenland halibut, Florida lobster and several cod stocks), being therefore a standard, well tested, and widely used methodology.

ASAP differs from the virtual population analysis methods in that:

- calculations proceed from the initial conditions to the present and into the future,
- the catch at age is not assumed to be known exactly,
- fishing mortality is separable but selection at age is allowed to change gradually over time,
- separate components of the fishery are treated independently,
- a stock recruitment relationship is required, and
- some parameters, which are assumed constant in XSA, such as the catchability coefficients associated with tuning indices, may be allowed to change over time.

The model begins in the first year of available data with an estimate of the population abundance at age. Recruitments are entered for each year as deviations from a Beverton and Holt model. These deviations can be constrained but for the present stock they were left unconstrained. The spawning stock for that year is calculated, and the expected recruitment for next year generated from the spawner-recruit relationship. Each cohort estimated in the initial population abundance at age is then reduced by the total mortality rate, and projected into the next year and next age. This process of estimating recruitment and projecting the population forward continues until the final year of data is reached.

The fishing mortality rates for each sector in the fishery are assumed to be separable into an age component (called selectivity) and a year component (called the F multiplier). The selectivity patterns are allowed to change over time. Expected catches are computed according to the usual catch equation using the determined fishing mortality rate, the assumed natural mortality rate, and the estimated population abundance described above. The statistical fitting procedure used with the model will try to match the indices and the catch at age. The emphasis of each of these sources of information depends on the values of the relative weights assigned to each component by the user.

The minimization processes proceeds in phases, in which groups of parameters are estimated simultaneously, while the remaining parameters are maintained at their initially assigned values. Once the objective function is minimized for a particular phase, more parameters are treated as unknown and added to those being estimated. This process of estimation in phases continues until all parameters to be estimated contribute to the objective function and the best set of all parameters that minimize the objective function value is determined.

Software used: ASAP version 2.0.19 (http://nft.nefsc.noaa.gov/)

Model Options chosen:

The objective function in ASAP is the weighted sum of a number of negative log-likelihoods, such as:

$$obj\ fxn = \lambda * (-\ln(L))$$

There are two types of error distributions in the calculation of the objective function: lognormal and multinomial. The lognormal error distribution is assumed for:

1. Total catch in weight
2. Indices
3. Stock recruitment relationship
4. Selectivity parameters (relative to initial guesses)
5. The two stock recruitment parameters (relative to their initial guesses)
6. Fmult in year 1 by fleet (relative to initial guesses)
7. Fmult deviations
8. Catchability in year 1 by fleet (relative to initial guesses)
9. Catchability deviations
10. Numbers at age in year 1 (relative to a population in equilibrium)

and has the expression:

$$-\ln(L) = 0.5\ln(2\pi) + \sum \ln(obs_i) + \ln(\sigma) + 0.5\sum \frac{(\ln(obs_i) - \ln(pred_i))^2}{\sigma^2}$$

The lognormal model fits all contain a lambda weight that allows emphasis of that particular part of the objective function along with an input coefficient of variation (CV) that is used to measure how strong a particular deviation is.

The multinomial distribution is just assumed for the proportions of catch at age, with the expression:

$$-\ln(L) = -\ln(ESS!) + \sum_{i=1}^{k} \ln(n_i!) - ESS \sum_{i=1}^{k} p_i \ln(predp_i)$$

where *ESS* is the expected sample size (McAllister and Ianelli, 1997−appendix 2), $n_i = p_i \,.\, ESS$, p_i is observed proportion of fish in age class *i*, and $predp_i$ is the fitted proportion of fish in age class *i*.

The assessment input data set was made of six matrices of catch in numbers at age, for the fleets of bottom-trawlers, purse seiners and artisanal fishing boats from Portugal and Spain (ICES subdivision IXa North); one abundance index for each age (mean number/hour by year) from the combined bottom-trawl survey, three SSB indices from the DEPM surveys, the CVs for landings and abundance indices data, and the ESS for the catch at age data. The CV for the landings was fixed at 0.15 (given that black landings and discards seem to be insignificant in this stock) and the ESS at 50. The biological data set was made of one matrix with the natural mortality rates (fixed and 0.15/year for all ages and years), the weight at age matrices in the catch and in the stock (assumed equal) and a maturiy at age by year matrix. All data sets covered the years 1992–2007 and the age range 0–11plus years.

The separability in the fishing mortality was assumed during the whole time series. A F multiplier was estimated for the first year, and was allowed to change in time by estimating deviations to this parameter for each year. The fishing mortality at each age, year and fleet resulted from the product of the F multipliers by the selectivity parameter at each age and fleet. Three selectivity vectors were estimated, corresponding to blocks of fleets sharing a similar selectivity at age. This is a useful feature of the model, that helps to avoid overparameterisation. By looking at the plots of catch at age by fleet, it was decided to have a common selectivity for the purse-seine fleets, together with the Portuguese bottom-trawl fleet, another one for the artisanal fleets and a third one just for the Spanish bottom-trawl fleet. One catchability parameter was also estimated for each abundance index, and kept fixed along time.

The model fitting, given a set of weights (lambdas), is done by the minimisation of the objective function. However, different combinations of weights can influence the fitting of the model, by attributing a lower or higher importance to different data sources that contribute to the objective function. Therefore, an interactive procedure must take place, by trying to find a set of weights that allow to achieve a coherent fit of all objective function components. In this procedure we had as first priority to achieve a good fit to the lading data by year and fleet, given that is the data source considered most accurate, and also because the overall level of the estimated SSB was dependent on how good was the fitting to the total landings. A second priority was the fitting to the survey data, which is typically a much noisier data source.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1992-2008	0-11+	Si
Canum	Catch at age in numbers	1992-2008	0-11+	Si
Weca	Weight at age in the commercial catch	1992-2008	0-11+	Si
West	Weight at age of the spawning stock at spawning time.	1992-2008	0-11+	Si
Mprop	Proportion of natural mortality before spawning	1992-2008	0-11+	Si
Fprop	Proportion of fishing mortality before spawning	1992-2008	0-11+	No
Matprop	Proportion mature at age	1992-2008	0-11+	No
Natmor	Natural mortality	1992-2008	0-11+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Combined Spanish-Portuguese bottom-trawl survey	1992-2008	0-11+
Tuning fleet 2	DEPM survey	2002, 2005 and 2007	0-11+

D. Short-Term Projection

Model used: Apropos designed function, named *mff*, to perform deterministic forecast, only with catch constraints (allowing the introduction of variability in the assumed recruitment values). Having the initial numbers at age at the beginning of the year, the total F at age in the assessment year y-1 and the assumptions we want to make on the weight at age, the selectivity at age by fleet, the maturity ogive, the natural mortality rate and the recruitment. We can project forward the population given a level of catches for the intermediate year y and for the protection year y+1. It is also possible to add some variability to the recruitments, just including a standard deviation value.

To project the population forward, we take in to account the population dynamics equations (Quinn and Deriso, 1999).

The projection method is not exactly the same for the different years.

- Year of the assessment: call to function *fwdF*, which allows projecting the population number known the fishing mortality by fleet. Through the equations:

$$N_0 = rec \cdot e^{\varepsilon}, \qquad \varepsilon \sim N(0,\sigma)$$
$$N_1 = N_0 \cdot e^{-(M_0+F_0)\cdot p}$$
$$N_a = N_{a-1} \cdot e^{-(M_{a-1}+F_{a-1})}, \quad a \text{ in } 2,\ldots,\text{A -1}$$
$$N_A = N_{A-1} \cdot e^{-(M_{A-1}+F_{A-1})} + N_A \cdot e^{-(M_A+F_A)}$$

Where: rec corresponds to the assumed recruitment level, N_a are the numbers at age a, M_a is the natural mortality at age a, F_a is the fishing mortality at age a, σ is the standard deviation of the recruitment and p is the proportion of the year from the recruitment time to the end of the year.

- Intermediate year: call to function *fwdCatch*, which allows projecting the population numbers given a catch constraint by fleet, using Pope's approximation forward. The equations used are the following:

$$\lambda = \frac{catch}{\sum_a S_a \cdot N_a \cdot W_a}, \quad proportiontothe\max imumthatcouldbecaptured$$
$$C_a = \sum_a S_a \cdot N_a \cdot \lambda$$
$$N_0 = rec \cdot e^{\varepsilon}, \qquad \varepsilon \sim N(0,\sigma)$$
$$N_1 = (N_0 - C_0 \cdot e^{M_0 \cdot p/2}) \cdot e^{-M_0 \cdot p}$$
$$N_a = (N_{a-1} - C_{a-1} \cdot e^{M_{a-1}/2}) \cdot e^{-M_{a-1}}, \quad a \text{ in } 2,\ldots,\text{A -1}$$
$$N_A = (N_{A-1} - C_{A-1} \cdot e^{M_{A-1}/2}) \cdot e^{-M_{A-1}} + (N_A - C_A \cdot e^{M_A/2}) \cdot e^{-M_A}$$

Where: λ is the proportion to the maximum catch that could be captured, rec corresponds to the assumed recruitment, N_a are the numbers at age a, M_a is the natural mortality at age a, F_a is the fishing mortality at age, S_a is the selectivity at age, a and p is the proportion of the year from the recruitment time to the end of the year.

The source code is detailed in the text table below:

```
################################################################################
##  MULTI-FLEET DETERMINISTIC FORECASTS ONLY WITH CATCH CONSTRAINTS          ##
##--------------------------------------------------------------------------##
##  CREATED BY: ALBERTO MURTA (IPIMAR) AND SONIA SÁNCHEZ (AZTI)              ##
##                  WGWIDE, 2-9 SEPTEMBER 2009 (COPENHAGEN)                   ##
################################################################################

MFF <- FUNCTION( NLAST, FLAST, WAGE, SFLEET, OGIVE, CATCH1, CATCH2, LY=2008,
                 M=0.15, RECT=0.25, RECSD=0.0){

    ## LY     : LAST YEAR IN THE ASSESSMENT
    ## NLAST  : NUMBERS AT AGE THE 1ST JANUARY IN YEAR LY
    ## FLAST  : TOTAL F AT AGE IN YEAR LY
    ## WAGE   : WEIGHT AT AGE
    ## SFLEET : MATRIX WITH SELECTIVITY AT AGE (COLUMNS) BY FLEET (LINES)
    ## OGIVE  : MATURITY OGIVE
    ## CATCH1 : CATCHES FOR EACH FLEET IN THE INTERMEDIATE YEAR ( LY+1 )
    ## CATCH2 : CATCHES FOR EACH FLEET IN THE TAC YEAR          ( LY+2 )
    ## M      : NATURAL MORTALITY RATE
    ## RECT    : PERCENTAGE OF THE YEAR FROM THE RECRUITMENT TIME TO THE END OF
THE YEAR
    ## RECSD  : STANDARD DEVIATION OF THE RECRUITMENT SERIES

    # PROJECTION OF THE NUMBERS AT AGE FOR THE ASSESSMENT YEAR
    SURVIV  <-  FWDF  (  NAGE=NLAST,  WAGE=WAGE,  SFLEET=SFLEET,  FAGE=FLAST,
```

```
RECT=RECT, RECSD=RECSD)

    # PROJECTION OF THE NUMBERS AT AGE FOR THE INTERMEDIATE YEAR
    N1AHEAD <- FWDCATCH( NAGE=SURVIV, WAGE=WAGE, SFLEET=SFLEET, CATCH=CATCH1,
RECT=RECT, RECSD=RECSD)

    # PROJECTION OF THE NUMBERS AT AGE FOR THE TAC YEAR
    N2AHEAD <- FWDCATCH( NAGE=N1AHEAD, WAGE=WAGE, SFLEET=SFLEET, CATCH=CATCH2,
RECT=RECT, RECSD=RECSD)

    # ESTIMATION OF THE SSB FOR THE INTERMEDIATE YEAR, THE TAC'S ONE AND THE
NEXT
    SSB       <-       C(SUM(SURVIV*WAGE*OGIVE),       SUM(N1AHEAD*WAGE*OGIVE),
SUM(N2AHEAD*WAGE*OGIVE))

    # OUTPUT: SSB AND TOTAL LANDINGS
    RES <- C( SUM(CATCH1), SUM(CATCH2), SURVIV[1], N1AHEAD[1], N2AHEAD[1], SSB)
    RES.NAM <- C( PASTE("LAND",LY+1,SEP="_"),PASTE("LAND",LY+2,SEP="_"),
                  PASTE("REC",LY,SEP="_"),
PASTE("REC",LY+1,SEP="_"),PASTE("REC",LY+2,SEP="_"),
                  PASTE("SSB",LY+1,SEP="_"),
PASTE("SSB",LY+2,SEP="_"),PASTE("SSB",LY+3,SEP="_") )
    NAMES(RES) <- RES.NAM
    RETURN(RES)



# POPULATION PROJECTION KNOWN F AT AGE BY FLEET
FWDF <- FUNCTION( NAGE, WAGE, SFLEET, FAGE, RECT, RECSD) {

    NAGES <- LENGTH(NAGE)    ## NUMBER OF AGES
    SURVIV <- NUMERIC(NAGES) ## BY AGE

    # ESTIMATION OF THE SURVIVORS AT AGE
    SURVIV[1] <- NAGE[1] * EXP(RNORM(1,0,RECSD))
    SURVIV[2] <- NAGE[1] * EXP((-M - FAGE[I-1])*RECT)
    FOR(I IN 3:(NAGES-1)){ ## IT IS ASSUMED LAST AGE IS A PLUS GROUP
        SURVIV[I] <- NAGE[I-1] * EXP(-M - FAGE[I-1])
    }
    SURVIV[NAGES]  <-  NAGE[NAGES-1]  *  EXP(-M  -  FAGE[NAGES-1])  +  NAGE[NAGES]  *
EXP(-M - FAGE[NAGES])

    # RETURN THE SURVIVORS
    RETURN(SURVIV)


# POPULATION PROJECTION KNOWN TOTAL CATCHES BY FLEET
FWDCATCH <- FUNCTION( NAGE, WAGE, SFLEET, CATCH, RECT, RECSD) {

    NAGES <- LENGTH(NAGE)    ## NUMBER OF AGES
    SURVIV <- NUMERIC(NAGES) ## BY AGE

    # ESTIMATION OF THE CATCHES AT AGE
    LMAX <- APPLY(SWEEP(SFLEET, 2, NAGE * WAGE, "*"), 1, SUM)   ## BY FLEET
    FACTORS <- CATCH/LMAX                                       ## BY FLEET
    CAGE <- SWEEP(SWEEP(SFLEET, 2, NAGE, "*"), 1, FACTORS, "*") ## BY FLEET AND
AGE
    CAGE <- APPLY(CAGE, 2, SUM)                                 ## BY AGE

    # ESTIMATION OF THE SURVIVORS AT AGE (USING POPE'S APROXIMATION FORWARD)
    SURVIV <- NUMERIC(NAGES) ## BY AGE
    SURVIV[1] <- NAGE[1] * EXP(RNORM(1,0,RECSD))
    SURVIV[2] <- (NAGE[1] - CAGE[1] * EXP((M*RECT)/2)) * EXP(-M*RECT)
    FOR(I IN 3:(NAGES-1)){ ## IT IS ASSUMED LAST AGE IS A PLUS GROUP
        SURVIV[I] <- (NAGE[I-1] - CAGE[I-1] * EXP(M/2)) * EXP(-M)
    }
    SURVIV[NAGES]  <-  (NAGE[NAGES-1]  -  CAGE[NAGES-1]  *  EXP(M/2))  *  EXP(-M)  +
(NAGE[NAGES] - CAGE[NAGES] * EXP(M/2)) * EXP(-M)

    # RETURN THE SURVIVORS
    RETURN(SURVIV)
```

Software used: R (www.r-project.org)

Initial stock size: the one estimated by the assessment model

Maturity: the same as in the previous year of the assessment

F and M before spawning: both of them are 0

Weight at age in the stock: the same as in the previous year of the assessment

Weight at age in the catch: assumed equal to the weight at age in the stock

Exploitation pattern: the one estimated in the assessment model

Intermediate year assumptions: the catches by fleet are assumed to be exactly the same as the ones in the previous year

Stock recruitment model used: no stock recruitment model is used, the recruitment is assumed to be stochastic in all the years (the assessment year, the intermediate and the projection year), around the geometric mean of the historical values with the same variability as the one observed in the series.

Procedures used for splitting projected catches:

E. Medium–Term Projections

No medium-term projection has been performed for this stock

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:

6. Weight at age in the catch:
7. Exploitation pattern:
8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections

No long-term projection has been performed for this stock.

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

Reference points have not been defined for this stock

H. Other Issues

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Stock Annex D – Norwegian Spring Spawning Herring

Quality Handbook	ANNEX:D – Norwegian Spring Spawning Herring

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Norwegian Spring Spawning herring
Working Group:	WGWIDE
Date:	5 September 2009 of last revision
Revised by	WGWIDE (first draft)

A. General

A.1.1 Stock definition

The Norwegian spring spawning herring (*Clupea harengus*) is the largest herring stock in the world. It is widely distributed and highly migratory throughout large parts of the NE Atlantic during its lifespan. Formally, the description of the Norwegian spring spawning herring stock is not linked to specific areas and the ICES advice applies to all areas where it occurs. By far the majority of the stock occurs in Divisions IIa,b Va,b and XIVa. Juveniles of the stock have their nurseries in Division Ia. In some years, small amounts of Norwegian spring spawning herring can be found in adjacent areas mixing with other herring stocks.

It is a herring type with high number of vertebrae, large size at age, large maximum size, different scale characteristics from other herring stocks and large variation in year class strength. The herring spawns along the Norwegian west coast in February-April. Large variations in the north-south distribution of the spawning areas have been observed through the centuries. The larvae drift north and northeast and distribute as 0–group in fjords along the Norwegian coast and in the Barents Sea. The Barents Sea is by far the most important juvenile area for the large year classes, which form the basis for the large production-potential of the stock. Some year classes are in addition distributed into the Norwegian Sea basin as 0–group. Examples of this are the 1950 and 2002 year classes. Most of the young herring leave the Barents Sea as 3 years old and feed in the north-eastern Norwegian Sea for 1–2 years before recruiting to the spawning stock. Large year classes typically mature at a higher mean age due to density dependent distribution and growth. However, exceptions occur and the 2002 year class is a large year class, which has shown quick growth and a relatively early maturation. Juveniles growing up in the Norwegian Sea grow faster than those in the Barents Sea and mature one year earlier. With maturation the young herring start joining the adult feeding migration in the Norwegian Sea. The feeding migration starts just after spawning with the maximum feeding intensity and condition increase occurring from late May until early July. The feeding migration is in general length dependent, meaning that the largest and oldest fish perform longer and typically more western migrations than the younger ones. After the dispersed feeding migration the herring concentrate in one or more wintering areas in September-October. These areas are unstable and since 1950 the stock has used at least 6 different wintering areas in different periods. During the 1950s and 1960s they were situated east of Iceland and since around 1970 in Norwegian fjords. In 2001–2002 a new wintering area was established off the Norwegian coast between 69º30'N and 72ºN and in 2007\2009 no herring was observed in the fiords in winter. After wintering, the spawning migration starts around mid January.

Norwegian spring spawning herring is one the few stocks for which data have been collected over a very long period. Figure A1.1.1 shows the dynamics of the stock in the past century indicated by assessments which go back to 1907.

A.1.2. Migration

A characteristic feature of this herring stock is a very flexible and varying migration pattern. The migration is characterised as relatively stable periods and periods characterised by large changes occurring at varying time intervals. The changes may or may not be correlated between the major distribution areas: Spawning, feeding and wintering. At present we see a period of large changes in both the wintering and feeding area. Until about 2002 the bulk of the adult herring wintered in fjords in northern Norway. The 1998 and 1999 year classes were expected to enter the fjords around 2002, but were instead observed wintering off the coast in the ocean off Vesterålen/Troms, between 69º30'N–72ºN. This continued in the years to come and in 2005 also the 2002 year class was observed wintering in the same area. During these years, the amount of older herring wintering in the fjords has decreased rapidly and during the winter 2007 and 2008 no herring was observed in the fjords. The survey covering the oceanic wintering area in November have shown a strong decrease in the biomass in the wintering stock in the area, indicating that may be a third and so for unknown wintering area could be under establishment somewhere else. Such a development is supported by the western feeding distribution in recent years, and the fact that the return migration of the smaller herring feeding in the west could be too long compared with comparable return migration distances observed in earlier periods. It is also supported by the fact that the international survey in May did not show any such negative trend in the stock.

In May the herring is migrating westward into the Norwegian Sea to start feeding and main concentrations are found in the central part of this area. In July the herring are spread out over a wide area feeding around the fringes of the Norwegian Sea, particularly in the northern and western region, while almost no herring are observed in the central region.

During the autumn in the period 2004–2008 Norwegian spring spawning herring has been caught as bycatch in smaller concentrations in catches of Icelandic summer spawning herring off the Icelandic east coast. This feature is probably linked to the western movement of the south-western summer feeding area. It is not known whether Norwegian spring spawning herring are wintering in this area.

A.2. Fishery

The fishery is regulated and carried out by the Coastal States. The Coastal States involved are the European Community, Faroe Islands, Iceland, Norway and the Russian Federation. The fishery is carried out all year round by purse seines and pelagic trawlers. The catches are used as well for reduction purposes and human consumption. The traditional fishing pattern follows the clockwise migration pattern of the herring. Changes in the migration pattern have occurred in the past and consequently also leading to changes in the fishery, following the fish. The migration pattern, together with environmental factors, was mapped in 2008 during the ICES PGNAPES (Planning Group on Northeast Atlantic Pelagic Ecosystem Surveys) investigations (ICES 2008/RMC:05).

Due to limitations by some countries to enter the EEZs of other countries the fisheries do not necessarily depict the distribution of herring in the Norwegian Sea and the preferred fishing pattern of the fleets given free access to any zone.

Most of the catches consist of herring only and discarding is absent or very low. In recent years increasing amounts of bycatch of mackerel are reported on the traditional fishing grounds, pointing to a change in de distribution of mackerel.

A.3. Ecosystem aspects

Norwegian spring spawning herring is a straddling stock. Juveniles and adults of this stock form an important part of the ecosystems in the Barents Sea, the Norwegian Sea, and the Norwegian coast. Herring has an important role as food resource to higher trophic levels (e.g. large fish, seabirds, and marine mammals), but also as a consumer of zooplankton in the Norwegian Sea and capelin larvae in the Barents Sea. The present high stock size will therefore have positive effects on its predators, but the effects on other pelagic fish stocks feeding in the Norwegian Sea such as blue whiting and mackerel may be negative due to competition for food.

Recent changes in the herring migration have led to an increased proportion of the population feeding in Faroese and Icelandic waters. The growth of these herring is faster than those feeding further east and north.

Not much information is available on the impact of the herring fishery on the ecosystem. The fishery is entirely pelagic. There is little quantitative information on the bycatches in the fisheries for herring but these are thought to be small. Therefore unintended effects of the fishery on the ecosystem are probably small or absent. Since herring is a major source of food for some populations of other species, overfishing of the herring stock could affect these populations. This is presently not the case since the herring stock is very abundant and is exploited at a low rate.

B. Data

B.1. Commercial catch

B.1.1. Nominal catch

The catches used in the assessment are the catches provided by the Working Group members.

B.1.2. Catch at age

From each country participating in the herring fishery exists a data delivery sheet containing at minimum information about total catch in tons by quarter of the year and ICES area. If the fleet has taken samples then catch in numbers by age, mean weight at age and mean length at age for each quarter of the year and ICES area are provided. Catch in tonnes by ICES rectangles and quarters are also reported. These sheets are combined into one file, the so called 'disfad' file. None sampled catches have then to be allocated to sampled ones. To do so positions of the catches by fleet are plotted, to see where the fleet was operating. Mean weights and mean lengths behind the sampled catches are also plotted. On the basis on these inspections allocations are done. Then the program SALLOC (ICES 1998/ACFM:18) is used to calculate the total international catch in numbers. Output from SALLOC is total catches in numbers by age as well as by quarters and areas.

B.1.3. Weight at age of the catch

Annual weight at age of the catch originate from national sampling programmes of the commercial catches. They are provided by most fishing nations each year on a quarterly basis. The weight at age of the catch used in the assessment is the average of the different nations weighted over the associated catch numbers. Mean weights by age in the catch by age is also output from SALLOC.

B.1.4. Length at age of the catch

Mean length by age in the catch is calculated the same way as mean weight at age of the catch. It is not used in the assessment Mean length by age in the catch is also output from SALLOC.

B.2. Biological parameters

B.2.2. Weight at age of the stock

Up to 2008 weight of age of the stock was taken from the Norwegian survey in the wintering area (reference). The survey has stopped in 2008. From 2009 onwards weight at age of the stock is taken from commercial catches taken in the same area and period as the Norwegian survey. In 2009 initiatives will be taken to increase the sampling in this period and area to increase the precision of the estimates.

B.2.3. Natural mortality

The back ground of the natural mortality used in the assessment has been reviewed in the 2008 benchmark assessment of this stock. By scanning through the Working Group reports from 1990 to 2007 it was noticed that different values had been used for natural mortality at age through the years. In some years an additional mortality at age had been applied because of a disease. But taken directly from the 1997 WGNPBW-report (ICES 1997): "Values of natural mortality assumed by the Working Group previously (ICES 1996/ASSESS:14) for ages 3 and older were 0.16 for the years 1950 to 1970 and 0.13 for the years 1971 and subsequently. In the previous assessment of this stock it was assumed (on the basis of observations of many diseased and dying fish in catches) that the fish of the 1987 cohorts and older had suffered a higher natural mortality in the years 1991 to 1994. An additional disease-induced natural mortality of 0.1 was assumed. However, interim studies (Patterson, WD 1997; Tjelmeland WD 1997) directed at estimating disease-induced mortality have failed to provide compelling evidence for values above zero. Attempts to estimate natural mortality from tagging information (Hamre, WD 1997; Patterson, WD 1997a; Tjelmeland, WD 1997) were highly consistent with values in the range 0.13 to 0.16, but the Working Group did not consider that this parameter could be estimated with sufficient precision to justify a discrimination between levels of 0.13 and 0.16. Consequently it was decided to predicate the assessment model estimates on an arbitrarily-chosen M=0.15 for ages 3 and older, and no attempt was made to include additional disease-induced mortality in the maximum likelihood assessment model."

This value M=0.15 has been used for ages 3 and older since the assessment in 1997 (for all years) until the assessment made in 2005 (ICES 2005). Then a value of 0.5 was used for the plus group (16+) and was used until 2007. This increase of M was done in order to get the SSB at low values in the collapsed phase in the 1970s. It caused only a slight decrease of the SSB in the newest years (ICES 2005).

From 2008 onwards age 15 is used in the assessment as a plus group and a value of M=0.15 is used.

In the Working Group report from 1992 (ICES 1992) a comparison of acoustic estimates for year classes 1983-1985 and 1988, and the same year classes as 3 year old (VPA) gave an average annual M=0.88, so M=0.9 was used for ages 0-2.

For ages 0-2 then the following is stated in the report from 1997 (ICES 1997): "Values of natural mortality for juvenile fish (ages 0-2) used by the Working Group in 1996 were 0.9 for all years in historic VPA, but for forecasting purposes values of 1.56 for age 1 and 0.54 for age 2 were used for the 199-1995 year classes. These values were based on an unpublished Ph.D. Thesis by de Barros (1995); this work was not available for evaluation by the Working Group, and hence it was decided to retain the assumption of M=0.9 for ages 0 to 2 in all years. This value is consistent with the mean of de Barros' estimates." This value of M=0.9 is still used in the present assessments for ages 0-2.

B.2.4. Maturity at age

Except for the year class 2002, the proportion mature at age used in assessment has generally been the same during the last ten years (Table B.2.4.1).

The growth rate of the 2002 year class has been higher than usually seen in large year classes of this stock. One reason for this is that a large part of the juveniles stayed in the Norwegian Sea as juveniles, favouring quicker growth than in the Barents Sea, which is the area where juveniles normally are distributed.

The proportion mature of this year class was calculated from samples collected during the surveys in the wintering area in November (before spawning) and in the Norwegian Sea in May (after spawning). The proportion of fishes in maturation stage 3 or larger (fish to spawn) in November 2005 was used as a first proxy to the proportion maturing. The proportion maturing according to these data was 0.85. The proportion in stages >5 (spent) in May was used as a proxy for the proportion having spawned. The proportion having spawned according to these data was 0.92. Based on these observations and calculations 0.9 was adopted as proportion mature of the 2002 year class at age 4. Based on this 1.0 instead of 0.9 was adopted as proportion mature of the 2002 year class at age 5. All other year classes in the later years were set at the standard 0.3 at age 4, 0.9 at age 5 and 1.0 at age 6 both in the assessment and predictions.

The Working Group has accepted the present values for the use in the assessment but considers that there is a need to validate the presently assumed values in particular for the most recent years. The proportion mature at age used in assessment is based on various surveys carried out many years ago and is not always well documented. The Working Group acknowledged the potential problem of obtaining random samples of proportion mature at age from survey for this stock due to the different catchability of mature and immature fish of the same age groups caused by spatial segregation. An alternative method for estimating proportion mature at age was proposed to the Working Group. This method involves back-calculation of proportion mature at age from fully matured year classes and is based on work done by Engelhard *et al.* (2003) and Engelhard and Heino (2004). The Working Group found this approach interesting, but decided to explore it further before any decision should be taken regarding using it in assessment. The Working Group recommends that effort should be put into updating estimates on proportion mature at age from recent years with this method and compare it with data on direct measurements on proportion mature at age from the May survey during the period since 1997 when this survey was assumed to cover the entire stock. This work will be done by IMR but has not completed yet. Based on this, an evaluation will be done and may lead to revisions of the maturity 0-gives in the past.

The surveys in the wintering area in November (reference) have stopped in 2008. From 2008 onwards only information is available from the May survey (reference). In 2009, WGWIDE has recommended to adjust (increase) the sampling for maturity in this survey in the May survey to ensure sufficient coverage (spatial and by age) of the data.

B.3. Surveys

A number of surveys on this stock have been carried out in the Norwegian Sea and Barents Sea to estimate the size of the stock, its age composition or the recruitment to the stock. Some of the surveys have stopped but data are still used in the assessment The surveys and its potential use are described in the sections below.

B.3.1. Survey 1. Norwegian acoustic survey on spawning grounds in February/March

Background and status

The survey has been carried out since 1988 but not in every year. The survey will not be carried out after 2008.

Use of this survey in stock assessment

The age groups 5–15+ have been used in the assessment for the years 1994 to 2005. After this year the survey has not been used in the assessment. The reason for this being that the survey was carried out very earlier and before the herring had reached the spawning grounds, with the possibilities of herring emerging the spawning grounds also through other routes than those covered in the survey.

Results

Results can be found in Table B.3.1.1 and Figure B.3.1.1.

B.3.2. Survey 2. Norwegian acoustic survey in November/December

Background and status

The survey has been carried out by Norway since 1992 in the Norwegian fjords where the adult herring winter. Since 2003 also the oceanic areas north of Lofoten/Vesterålen has been included in the survey to take account of changes in the wintering area. The fjordic coverage was ceased during the winter 2007/2008 because the herring had totally left the fjords.

Results

In 2007 the RV Johan Hjort carried out an acoustic survey in the oceanic wintering area in northern Norway (Figure B.3.2.1). The results of this survey are shown in Table B.3.2.1. This survey covers the known wintering area of the mature part of the stock. The survey gave a very low biomass estimate due to unknown reasons. One possible explanation is that a new wintering area is building up somewhere else. This has so far not been confirmed and remains an open question.

Use of this survey in stock assessment

Given the large changes in the wintering pattern of herring and the possibility of a third and undescribed wintering area, it was decided not to use this survey for the period following the new wintering pattern of the herring in the assessment. The survey will not be continued by Norway and will not be carried from 2008 onwards.

B.3.3. Survey 3. Norwegian acoustic survey in January

Background and status

This survey was carried out by Norway in the fjords in the period 1991–1999.

Results

The results of the survey in the wintering area in January can be found in Table B.3.3.1.

Use of this survey in stock assessment

Although the survey series has ended, the data are still used in the assessment. The age groups 5–15+ from 1991 to 1999 are currently used.

B.3.4. Survey 4 and 5. International ecosystem survey in the Nordic Seas and Barents Sea

Background and status

The international ecosystem survey in the Nordic Seas and the Barents Sea is aimed at observing the pelagic ecosystem, focusing herring, blue whiting, zooplankton and hydrography. The survey, carried out since 1995, is coordinated by the ICES PGNAPES (ICES CM 2009/RMC:06) and is a cooperative effort by Faroes, Iceland, Norway, Russia, and the EU (Denmark, Germany, Ireland, The Netherlands, Sweden and UK). This trawl-acoustic survey supplies the most important time series for the assessment of NSSH and also a time series for young blue whiting in the juvenile areas.

Results

The age-disaggregated time-series of abundance for the Barents Sea and Norwegian Sea are presented in Table B.3.4.1. and Table B.3.4.2.

Both surveys together covering the entire stock during its migration on the feeding grounds. An example of the coverage of the survey (2009) is given in Figure B.3.4.1.

Use of this survey in stock assessment

From the area west of 20°E the full time series of age groups 4 and older in survey 5 are used for the assessment. Survey 4 in the area east of 20°E covering the Barents Sea has been used in the final assessment from 2005 onwards. The survey supplies the recruitment for age groups 1 and 2 in the assessment. No data exist for 2003 and 2004 in this survey. The data for 2008 are not used. The data for survey 4 are also used for estimating recruitment in RCT3.

B.3.5. Survey 6 and 7. Joined Russian-Norwegian ecosystem autumn survey in the Barents Sea

Background and status

The survey consists of a trawl survey catching 0–group herring amongst other species and an acoustic survey estimating one and two year old herring. In 2001, the Working Group decided to include data on immature herring obtained during the Russian-Norwegian survey in August-October in estimating the younger year classes in the Barents Sea.

Results

The results from these surveys on 0–group herring are given in Table B.3.5.1. The results for the 1 to 3 age groups are given in Table B.3.5.2. The youngest age groups (0+ to 3+) of the Norwegian spring spawning herring stock are found in the Barents Sea at irregular intervals. It is difficult to access the stock size during autumn, due to various reasons. The age groups 1 to 3 are found mixed with 0–group herring and are difficult to catch in the sampling trawl used in this survey. The stock size estimates of herring are therefore considered less reliable than those for capelin and polar cod. An example of the distribution of young herring is shown in Figure B.3.5.1. An example of the distribution of 0–group herring is presented in Figure B.3.5.2.

Use of this survey in stock assessment

The indices of age groups 1 and 2 of survey 6 are used in the assessment with the exception of 2002.. The index of survey 7 is used for the estimation of recruitment by RCT3.

B.3.6 Survey 8 Norwegian herring larvae survey on the Norwegian shelf

Background and status

A Norwegian herring larvae survey has been carried out on the Norwegian shelf since 1981 during March-April. The objectives of the survey are to map the distribution of herring larvae and other fish larvae on the spawning grounds on the Norwegian shelf and to collect data on hydrography, nutrients, chlorophyll and zooplankton. The larval indices are used as indicator of the size of the spawning stock. Two indices are available from this survey.

Results

Two larvae indices are available from this survey and presented in Table B.3.6.1. Index 1 represents the total number of herring larvae found during the survey. Index 2 represents the back-calculated number of newly hatched larvae assuming 10% daily mortality. Examples of the distribution of the herring larvae are given in Figure B.3.6.1.

Use of this survey in stock assessment

The "Index 1" is used in the assessment as representative for the size of the spawning stock except for the years 2003 and 2009 (Table B.3.6.1).

B.4. Commercial CPUE

No commercial CPUE data are used in the assessment.

B.5. Other relevant data

With the exception of 1999, 2001 and 2005, tagging has been carried out annually between 1975 and 2007. In 2007 Norway has decided to discontinue the tagging program in 2008 and in future years.

The use of the tagging data in the assessment was discontinued since 2006 due to a low number of recaptures. This comes as a result of too low tag density in the stock given the high stock size and amount of fish screened for tags.

C. Historical Stock Development

Model used: VPA

Software used: TASACS

Model Options chosen:

Analyses are restricted to the years 1988-present

Age range for the analyses is 0-15+

Natural mortality is assumed at 0.9 for ages 0, 1 and 2 and 0.15 for older ages.

Assumed fraction of fishing mortality and natural mortality for each of the age-structured surveys

FLEET 1	FLEET 2	FLEET 3	FLEET 4	FLEET 5	FLEET 6	FLEET 7
0.17	0.91	0.17	0.41	0.41	0.70	0.70

Catchability for the age structured surveys independent of age for ages >4

Exploration of the survey data is carried out in order to investigate whether the survey contributes information to the assessment or whether there is no or little in-formation in the survey data. In the case where the survey contributes mostly noise to the assessment it is not included in further exploration and in the final assessment. In addition, when conflicting information appears between different surveys, it is attempted, as far as possible, to use expert knowledge about the performance and known problems of the different surveys, to resolve conflicts by excluding the data that were considered the least reliable.

Rather than excluding information from the survey on a subjective basis, criteria are set for exclusion. These are set based on the general observations and the analysis of comparisons of the consistency within and between the surveys. The following criteria are used for exclusion of data:

1) Data outside the range of years and age windows selected by previous WG have also been excluded in the present assessment. Such as incomplete survey coverage of the stock of survey not completed due to other reasons.

2) Survey data of poor year classes with mostly noise are excluded. This is for instance the case for year class 1995 in all surveys.

3) Reject ages where the analysis of consistency between and within surveys indicate severe problems. For instance for survey 1, the conclusion from the correlation analyses is not to use information at ages older than age 11.

4) If there is a conflict between data from different surveys, discard the data where known problems with the survey indicates that these are the least

reliable. This applied in particular to conflicts between survey 2 and survey 5, where survey 2 indicated a rapid decline in the stock and survey 5 a more gentle decline. Since representative sampling of old fish in survey 2 is a known problem, caused by vertical segregation in the wintering areas in the Lofoten fjord, the survey 2 data are ignored and the survey 5 data used. at ages above 10 years.

5) If there are internal inconsistencies in the old ages in a survey (mismatch between abundance at young and old age), the old ages are ignored.

6) No zero values are used.

All observations still included were given equal weight, except for the catches at the youngest ages, where the following weightings, relative to the standard weighting of 1.0 are used:

Age 0	0.001
Age 1	0.001
Age 2	0.01
Age 3	0.1

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1988-last data year	0-15+	Yes
Canum	Catch at age in numbers	1988-last data year	0-15+	Yes
Weca	Weight at age in the commercial catch	1988-last data year	0-15+	Yes
West	Weight at age of the spawning stock at spawning time.	1988-last data year	0-15+	Yes
Mprop	Proportion of natural mortality before spawning	1988-last data year	0-15+	Yes
Fprop	Proportion of fishing mortality before spawning	1988-last data year	0-15+	Yes
Matprop	Proportion mature at age	1988-last data year	0-15+	Fixed in later years
Natmor	Natural mortality	1988-last data year	0-15+	Yes

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian acoustic survey on spawning grounds	1995-2005	5-15+
Tuning fleet 2	Norwegian acoustic survey in Nov/Dec	1992-2001	4-14+
Tuning fleet 3	Norwegian acoustic survey in January	1991-1999	5-15+
Tuning fleet 4	International survey in the Nordic Seas and Barents Sea	1991-last data year	1-2
Tuning fleet 5	International survey in the Nordic Seas and Barents Sea	1991-last data year	4-15+
Tuning fleet 6	Russian-Norwegian ecosystem autumn survey in the Barents Sea	2000-last data year	1-2
Tuning fleet 7	Russian-Norwegian ecosystem autumn survey in the Barents Sea	2000-last data year	0
Tuning fleet 8	Norwegian herring larvae survey	1981-last data year	

D. Short-Term Projection

Model used: Deterministic short-term projection, with management option table presenting average F-values for age 5-14 weighted over population numbers at the start of the year.

Software used: Excel spread sheet. No approved and formal tested software exists. A spreadsheet was developed because available software programmes cannot provide management option tables with annual F-factors which take account for weighted F.

Initial stock size: Input to the short-term projection are the stock number at age 4-15+ (survivors) at the 1st of January taken from the final assessment. For instance, if the last data year is 2008, the assessment provides the surviving stock numbers at the 1st of January 2009. Stock numbers at age 0-3 are estimated separately from independent data sources (for instance using RCT3).

Maturity: As a default a standard fixed maturity o-give is applied. In the case biological information is available indicating a change in proportions maturation at age, the values may be adjusted

age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1

F and M before spawning: The SSB is calculated at the 1st of january. Consequently the proportion of F and M before spawning is 0.

Weight at age in the stock: for the intermediate year are the observed weights obtained from the winter survey (reference). For the other years the average of the last 3 years are used. Since 2008 the winter survey has stopped and weight at age data from commercial sampling in the same period and are used

Weight at age in the catch: is the average of the observed catch weights over the last three years.

Exploitation pattern: is the average over the last 3 years

Natural mortality: fixed values, the same as used in the assessment

Intermediate year assumptions: catch constraint

Stock recruitment model used: not applicable

Procedures used for splitting projected catches: not applicable

E. Medium-Term Projections not defined

Model used:

Software used:

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock recruitment model used:

Uncertainty models used:

1. Initial stock size:
2. Natural mortality:
3. Maturity:
4. F and M before spawning:
5. Weight at age in the stock:
6. Weight at age in the catch:
7. Exploitation pattern:

8. Intermediate year assumptions:
9. Stock recruitment model used:

F. Long-Term Projections not defined

Model used:

Software used:

Maturity:

F and M before spawning:

Weight at age in the stock:

Weight at age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological Reference Points

G.1. Precautionary and limit reference points:

The reference points for herring were considered by the Workshop on Limit and Target Reference Points (WKREF) held in Gdynia in 2007. Although it was the intention to review and update the biological basis of limit reference point taking into account the possible effects of species interactions and regime shifts, this has not been done because of lack of data. Instead, the breakpoint of a segmented regression applied to the stock recruitment plot was investigated. This breakpoint gives an indication at which SSB recruitment starts to decline and is a candidate for Blim. The breakpoint in the stock recruit data varied between 2 to 4 million tonnes and seemed to be very sensitive to small changes in the estimates of the poor year classes (points near the origin of the S/R plot) in assessments carried out in different years. WKREF could not explain the sensitivity and considered this behaviour of the model highly undesirable. WKREF decided to ask the Methods Working Group to investigate this observation further. Given this, the use of segmented regression technique to establish a limit biomass reference point for Norwegian spring spawning herring was not considered appropriate until the observed methodological issue has been resolved.

The presently used values originate from an analysis carried out in 1998.

	ICES CONSIDERS THAT:	ICES PROPOSED THAT:
Precautionary Approach reference points	$\mathbf{B}_{lim}$ is 2.5 million t	$\mathbf{B}_{pa}$ be set at 5.0 million t
	$\mathbf{F}_{lim}$ is not considered relevant for this stock	$\mathbf{F}_{pa}$ be set at F = 0.15

Technical basis:	
$\mathbf{B}_{lim}$: MBAL	$\mathbf{B}_{pa}=\mathbf{B}_{lim}$*exp(0.4*1.645) (ICES Study Group 1998)
$\mathbf{F}_{lim}$: not relevant for this stock	$\mathbf{F}_{pa}$: based on medium term simulations (ICES Study Group 1998)

The new assessment did not give different perceptions of the dynamics and levels of SSB and Fishing Mortality compared to the assessment which was the basis for establishing the reference points. Therefore there was no need to reconsider the reference points because of the new assessment method.

G.2. Target reference points

The Coastal States have agreed a target reference point defined at F=0.125. (Note that the average fishing mortality is calculated as a weighted mean over the age groups 5–14 (weighted over abundance).

H. Other Issues not defined

I. References

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Table B.2.4.1. Norwegian spring spawning herring. Maturity at age information used in the assessment

	AGE																
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	0	0	0	0	0.1	0.3	0.6	0.9	1	1	1	1	1	1	1	1	1
1951	0	0	0	0	0.1	0.3	0.6	0.9	1	1	1	1	1	1	1	1	1
1952	0	0	0	0	0.1	0.3	0.6	0.9	1	1	1	1	1	1	1	1	1
1953	0	0	0	0	0.1	0.3	0.6	0.9	1	1	1	1	1	1	1	1	1
1954	0	0	0	0	0.1	0.3	0.6	0.9	1	1	1	1	1	1	1	1	1
1955	0	0	0	0.08	0.22	0.37	0.85	1	1	1	1	1	1	1	1	1	1
1956	0	0	0	0.08	0.22	0.37	0.85	1	1	1	1	1	1	1	1	1	1
1957	0	0	0	0	0	0.5	0.6	1	1	1	1	1	1	1	1	1	1
1958	0	0	0	0.08	0.22	0.37	0.85	1	1	1	1	1	1	1	1	1	1
1959	0	0	0	0.08	0.22	0.37	0.85	1	1	1	1	1	1	1	1	1	1
1960	0	0	0	0.08	0.22	0.37	0.85	1	1	1	1	1	1	1	1	1	1
1961	0	0	0	0.04	0.35	0.68	0.94	1	1	1	1	1	1	1	1	1	1
1962	0	0	0	0	0.11	0.67	1	1	1	1	1	1	1	1	1	1	1
1963	0	0	0	0.04	0.03	0.32	0.9	1	1	1	1	1	1	1	1	1	1
1964	0	0	0	0.02	0.06	0.28	0.32	1	1	1	1	1	1	1	1	1	1
1965	0	0	0	0	0.34	0.35	0.76	1	1	1	1	1	1	1	1	1	1
1966	0	0	0	0.01	0.15	1	0.96	1	1	1	1	1	1	1	1	1	1
1967	0	0	0	0	0.01	0.23	1	1	1	1	1	1	1	1	1	1	1
1968	0	0	0	0	0	0.01	0.76	1	1	1	1	1	1	1	1	1	1
1969	0	0	0	0.62	0.89	0.95	1	1	1	1	1	1	1	1	1	1	1
1970	0	0	0	0.06	0.13	0.31	0.17	1	1	1	1	1	1	1	1	1	1
1971	0	0	0	0.1	0.25	0.6	0.9	1	1	1	1	1	1	1	1	1	1
1972	0	0	0	0	0.1	0.25	0.6	0.9	1	1	1	1	1	1	1	1	1
1973	0	0	0	0.5	0.9	1	1	1	1	1	1	1	1	1	1	1	1
1974	0	0	0	0.5	0.9	1	1	1	1	1	1	1	1	1	1	1	1
1975	0	0	0	0.5	1	1	1	1	1	1	1	1	1	1	1	1	1
1976	0	0	0	0.5	0.9	1	1	1	1	1	1	1	1	1	1	1	1
1977	0	0	0	0.73	0.89	1	1	1	1	1	1	1	1	1	1	1	1
1978	0	0	0	0.13	0.9	1	1	1	1	1	1	1	1	1	1	1	1
1979	0	0	0	0.1	0.62	0.95	1	1	1	1	1	1	1	1	1	1	1
1980	0	0	0	0.25	0.5	0.97	1	1	1	1	1	1	1	1	1	1	1
1981	0	0	0	0.3	0.5	0.9	1	1	1	1	1	1	1	1	1	1	1
1982	0	0	0	0.1	0.48	0.7	1	1	1	1	1	1	1	1	1	1	1
1983	0	0	0	0.1	0.5	0.69	0.71	1	1	1	1	1	1	1	1	1	1
1984	0	0	0	0.1	0.5	0.9	0.95	1	1	1	1	1	1	1	1	1	1
1985	0	0	0	0.1	0.5	0.9	1	1	1	1	1	1	1	1	1	1	1
1986	0	0	0	0.1	0.2	0.9	1	1	1	1	1	1	1	1	1	1	1

Table B.2.4.1, cont. Norwegian spring spawning herring. Maturity at age information used in the assessment.

	AGE																
YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1987	0	0	0	0.1	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
1988	0	0	0	0.1	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
1989	0	0	0	0.1	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
1990	0	0	0	0.4	0.8	0.9	0.9	0.9	1	1	1	1	1	1	1	1	1
1991	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1	1	1
1992	0	0	0	0.1	0.2	0.8	1	1	1	1	1	1	1	1	1	1	1
1993	0	0	0	0.01	0.3	0.8	1	1	1	1	1	1	1	1	1	1	1
1994	0	0	0	0.01	0.3	0.8	1	1	1	1	1	1	1	1	1	1	1
1995	0	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1	1
1996	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
1997	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
1998	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
1999	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2000	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2001	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2002	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2003	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2004	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2005	0	0	0	0.1	0.3	0.9	1	1	1	1	1	1	1	1	1	1	1
2006	0	0	0	0	0.9	0.9	1	1	1	1	1	1	1	1	1	1	1
2007	0	0	0	0	0.3	1	1	1	1	1	1	1	1	1	1	1	1

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Table B.3.1.1. Norwegian Spring-spawning herring. Estimates from the acoustic surveys on the spawning stock in February-March. Numbers in millions. Biomass in thousands. Data in black box are used in assessment. There have been corrections due to age readings. *Survey 1.*

	SURVEY 1					age									Total
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	Biomass
1988		255	146	6805	202										7408	
1989	101	5	373	103	5402	182									6166	
1990	183	187	0	345	112	4489	146								5462	
1991	44	59	54	12	354	122	4148	102							4895	
1992*																
1993*																
1994	16	128	676	1375	476	63	13	140	35	1820					4742	
1995		1792	7621	3807	2151	322	20	1	124	63	2573				18474	3514
1996	407	231	7638	11243	2586	957	471	0	0	165	0	2024			25722	4824
1997*																
1998			381	1905	10640	6708	1280	434	130	39	0	64	0	915	22496	5360
1999	106	1366	337	1286	2979	11791	7534	1912	568	132	0	0	392	437	28840	7213
2000	1516	690	1996	164	592	1997	7714	4240	553	71	3	0	6	24	19566	4913
2001**																
2002**																
2003**																
2004**																
2005	103	281	811	3310	7545	10453	887	563	159	122	610	1100	686		26649	6501
2006	13	75	10167	684	1103	4540	4407	133	47	11	113	120	323	135	21871	4858
2007	109	534	2097	14575	952	592	3270	3092	263	276	20	285	189	628	26882	6004
2008	10	145	3517	3749	15066	972	612	2410	2374	426	136	121	90	171	29798	7244

*** No estimate due to poor weather conditions.**

**** No surveys.**

Table B.3.2.1 Norwegian Spring-spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in November-December. Numbers in millions. Data in black box are used in assessment. There have been corrections due to age readings. *Survey 2.*

	SURVEY 2						age									Total
year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	total	biomass
1992		36	1247	1317	173	16	208	139	3742	69					6947	
1993	72	1518	2389	3287	1267	13	13	158	26	4435					13178	
1994		16	3708	4124	2593	1096	34	25	196	29	3239				15209	
1995	380	183	5133	5274	1839	1040	308	19	13	111	39	907			15246	
1996		1465	3008	13180	5637	994	552	92	0	7	41	15	393		25384	
1997	9	73	661	1480	6110	4458	1843	743	66	0	0	64	0	904	16411	
1998	65	1207	441	1833	3869	12052	8242	2068	629	111	14	0	40	573	31144	
1999	74	159	2425	296	837	2066	6601	4168	755	212	0	15	0	146	17754	
2000	56	322	1522	5260	165	497	1869	4785	3635	668	205	0	0	11	18995	
2001	362	522	3916	1528	2615	82	338	864	3160	2216	384	127	0	1	16115	
2002*	7	50	276	1659	624	1029	32	188	516	1831	911	184	0	0	7307	
2003**	586	406	2167	10670	13237	1047	678	41	134	301	1214	502	10	37	31030	
2004**	257	6814	1123	1596	5334	6731	363	280	37	42	187	761	392	83	24000	
2005	61	352	7173	465	685	2030	3101	177	190	57	46	184	476	327	15325	
2006	940	7785	3712	21320	1153	340	2879	4851	4	23	713	4	150	58	43778	
2007	1233	343	4161	2407	6213	226	288	695	694	0	43	0	126	188	16617	3660

*** Much of the youngest yearclasses (-98,-99) wintered outside the fjords this winter and are not included in the estimate**

**** In 2003-2004 a combined estimate from the Tysfjord, Ofotfjord and oceanic areas off Vesterålen/Troms.**

Table B.3.3.1 Norwegian spring spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in January. Numbers in millions. Data in the black box are used in the assessment. There have been corrections due to age readings. *Survey 3*.

	SURVEY 3							age						
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
1991	90	220	70	20	180	150	5500	440							6670
1992		410	820	260	60	510	120	4690	30						6900
1993		61	1905	2048	256	27	269	182	5691	128					10567
1994	73	642	3431	4847	1503	102	29	161	131	3679					14598
1995		47	3781	4013	2445	1215	42	24	267	29	4326				16189
1996		315	10442	13557	4312	1271	290	22	25	200	58	1146			31638
1997*															-
1998	214	267	1938	4162	9647	6974	1518	743	16	4	0	33	7	462	25985
1999**	0	1358	199	1455	4452	12971	7226	1876	499	16	16	0	156	220	30444

*** No estimate due to poor weather conditions.**

**** No surveys since 1999.**

Table B.3.4.1. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. No survey in 2003, 1990-2002. See footnotes. Data in black box used in the assessment except the yellow highlighted cell. ***Survey 4.***

	SURVEY 4		AGE		
YEAR	1	2	3	4	5
1991	24.3	5.2			
1992	32.6	14	5.7		
1993	102.7	25.8	1.5		
1994	6.6	59.2	18	1.7	
1995	0.5	7.7	8	1.1	
1996[1]	0.1	0.25	1.8	0.6	0.03
1997[2]	2.6	0.04	0.4	0.35	0.05
1998	9.5	4.7	0.01	0.01	0
1999	49.5	4.9	0	0	0
2000	105.4	27.9	0	0	0
2001	0.3	7.6	8.8	0	0
2002	0.5	3.9	0	0	0
2003[3]					
2004[3]					
2005	23.3	4.5	2.5	0.4	0.3
2006	3.7	35.0	5.3	0.87	0
2007	2.1	3.7	12.5	1.9	0
2008[4]	0.043	0.38	0.2	0.28	0
2009	0.191	0.845	2.180	2.643	1.213

[1] **Average of Norwegian and Russian estimates**

[2] **Combination of Norwegian and Russian estimates as described in 1998 WG report, since then only Russian estimates**

[3] **No surveys**

[4] **Not a full survey**

Table B.3.4.2. Norwegian spring spawning herring. Estimates from the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions. Biomass in thousands. Data in black box are used in assessment. There have been corrections due to age readings. ***Survey 5.***

	SURVEY 5						AGE									TOTAL
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	TOTAL	BIOMASS
1996	0	0	4114	22461	13244	4916	2045	424	14	7	155	0	3134			50514	8532
1997	0	0	1169	3599	18867	13546	2473	1771	178	77	288	190	60	2697		44915	9435
1998	24	1404	367	1099	4410	16378	10160	2059	804	183	0	0	35	0	492	37415	8004
1999	0	215	2191	322	965	3067	11763	6077	853	258	5	14	0	158	128	26016	6299
2000	0	157	1353	2783	92	384	1302	7194	5344	1689	271	0	114	0	75	20758	6001
2001	0	1540	8312	1430	1463	179	204	3215	5433	1220	94	178	0	0	6	23274	3937
2002	0	677	6343	9619	1418	779	375	847	1941	2500	1423	61	78	28	0	26089	4628
2003	32073	8115	6561	9985	9961	1499	732	146	228	1865	2359	1769		287	0	75580	6653
2004	0	13735	1543	5227	12571	10710	1075	580	76	313	362	1294	1120	10	88	48704	7687
2005	0	1293	19679	1353	1765	6205	5371	651	388	139	262	526	1003	364	115	39114	5109
2006	0	19	306	14560	1396	2011	6521	6978	679	713	173	407	921	618	243	35545	9100
2007	0	411	2889	5877	20292	1260	1992	6780	5582	647	488	372	403	1048	1010	49051	12161
2008	0	1193	587	8332	8270	16345	1381	1920	3958	2500	416	242	159	217	408	45928	9996
2009	202	906	2980	2754	14292	9487	11629	1472	1253	2587	1357	267	183	60	258	49687	10700

Table B.3.5.1. Norwegian spring-spawning herring. Abundance indices for 0-group herring 1980-2008 in the Barents Sea, August-October. *This index has been recalculated since 2006, these are the new values. Survey 7.*

SURVEY 7	
YEAR	ABUNDANCE INDEX
1980	4
1981	3
1982	202
1983	40557
1984	6313
1985	7237
1986	7
1987	2
1988	8686
1989	4196
1990	9508
1991	81175
1992	37183
1993	61508
1994	14884
1995	1308
1996	57169
1997	45808
1998	79492
1999	15931
2000	49614
2001	844
2002	23354
2003	28579
2004	133350
2005	26332
2006	66819
2007	22481
2008	15727

Table B.3.5.2. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in August-October. Data in black boxes used in the assessment. *Survey 6.*

SURVEY 6			
	AGE		
YEAR	1	2	3
2000	14.7	11.5	0
2001	0.5	10.5	1.7
2002	1.3	0	0
2003	99.9	4.3	2.5
2004	14.3	36.5	0.9
2005	46.4	16.1	7.0
2006	1.6	5.5	1.3
2007	3.9	2.6	6.3
2008	0.03	1.6	4.0

Table B.3.6.1.. Norwegian Spring-spawning herring. The indices for herring larvae on the Norwegian shelf for the period 1981-2009 ($N*10^{-12}$). Data in black box are used in the assessment. ***Survey 8.***

SURVEY 8		
YEAR	INDEX1	INDEX 2
1981	0.3	
1982	0.7	
1983	2.5	
1984	1.4	
1985	2.3	
1986	1	
1987	1.3	4
1988	9.2	25.5
1989	13.4	28.7
1990	18.3	29.2
1991	8.6	23.5
1992	6.3	27.8
1993	24.7	78
1994	19.5	48.6
1995	18.2	36.3
1996	27.7	81.7
1997	66.6	147.5
1998	42.4	138.6
1999	19.9	73
2000	19.8	89.4
2001	40.7	135.9
2002	27.1	138.6
2003*	3.7	18.8
2004	56.4	215.1
2005	73.91	196.7
2006	98.9	389.0
2007**	90.6	
2008	107.9	393.3
2009***	8.4	53.8

Index 1. The total number of herring larvae found during the cruise.

Index 2. Back-calculated number of newly hatched larvae with 10% daily moratlity. The larval age is estimated from the duration of the yolksac stages and the size of the larvae.

*** Poor weather conditions and survey was late in April**

**** only representative for the area 62-66°N**

*****Likely that spawning was particularly early in 2009**

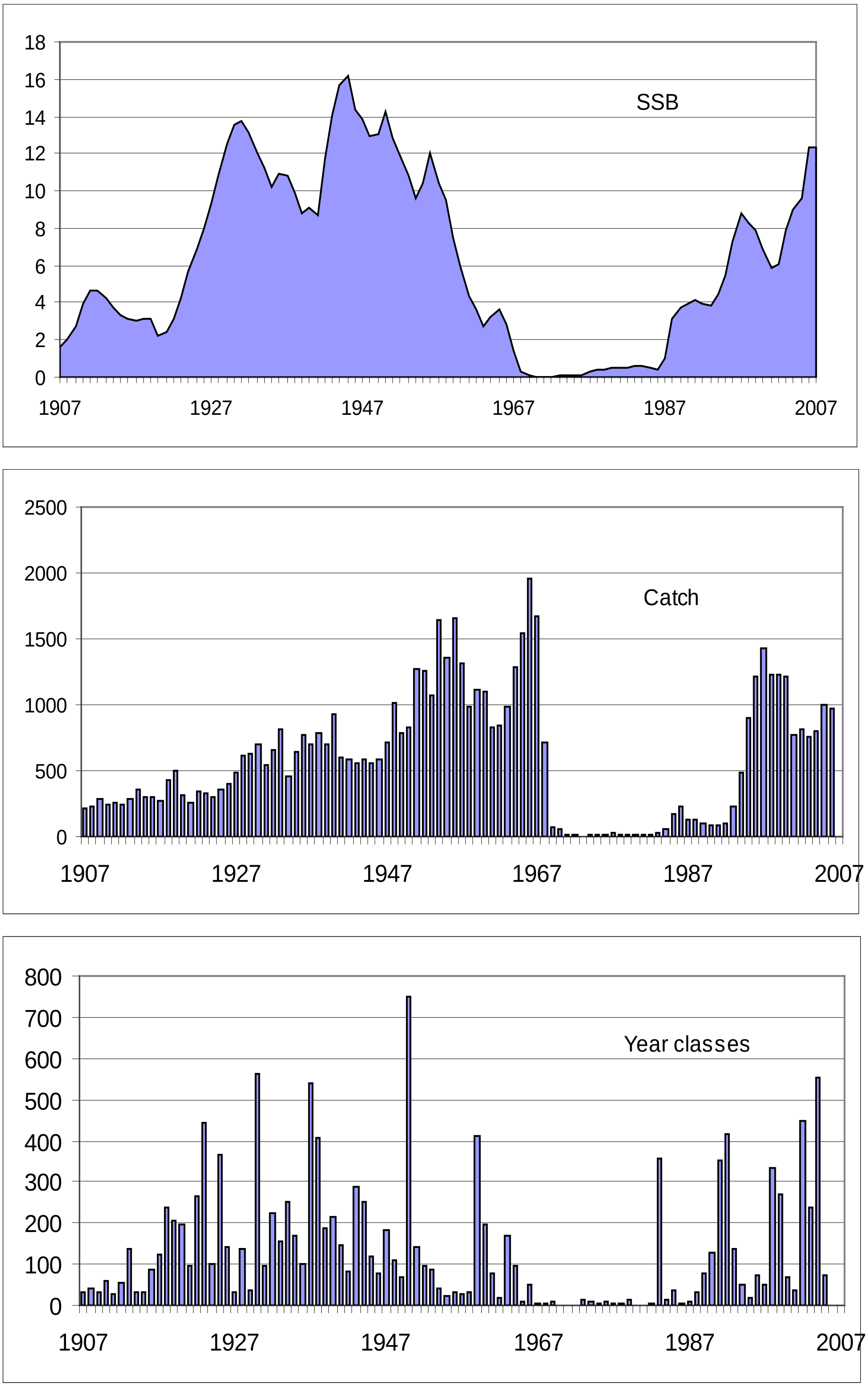

Figure A.1.1.1. Norwegian spring spawning herring. Long term trends in spawning stock, catches and recruits (1907-1988 from Toresen and Østvedt; 1989-2007 from WGNPBW 2007).

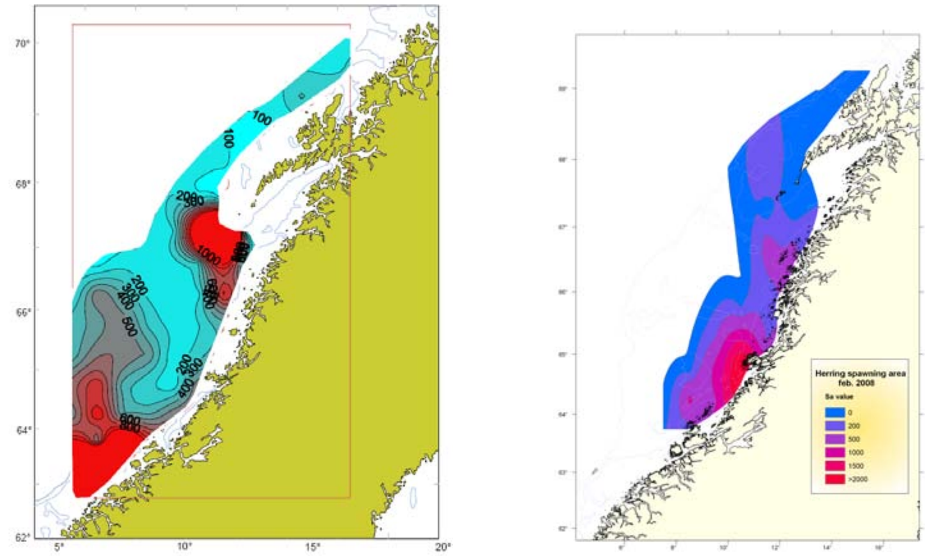

Figure B.3.1.1. NSSH Acoustic survey on spawning grounds in February March, 2007 (left) and 2008 (right).

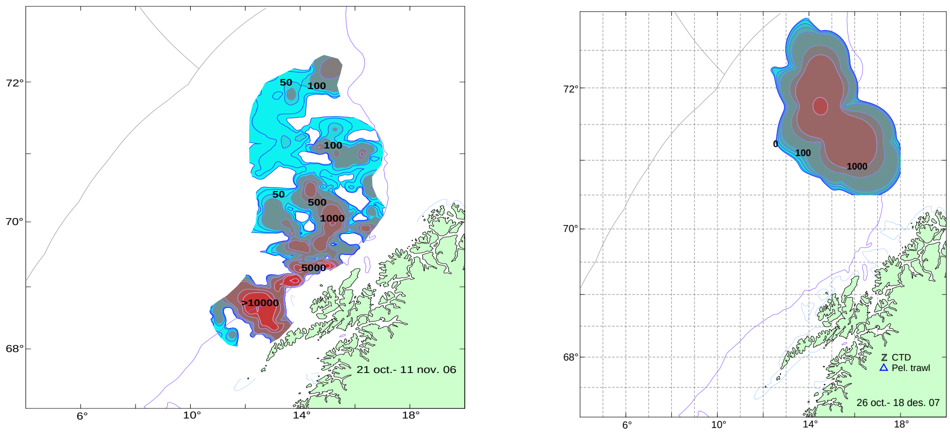

Figure B.3.2.1. NSSH Acoustic survey in November/December 2006 (left panel here) and 2007 (right panel).

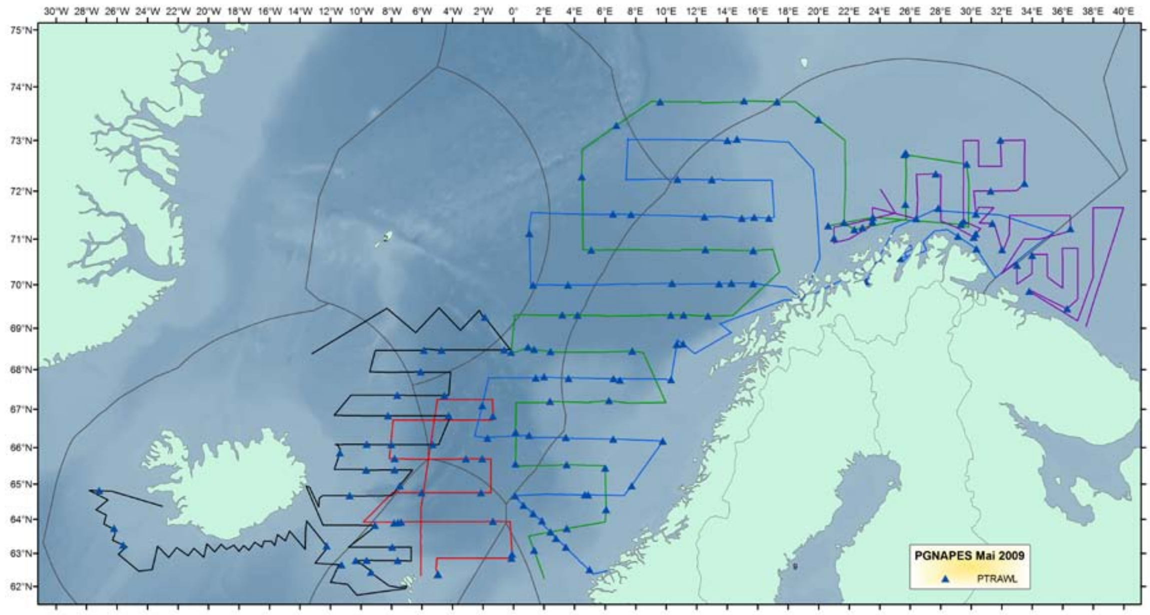

Figure B.3.4.1. Cruise tracks during the International North East Atlantic Ecosystem Survey in April-May 2009 and location of trawl stations.

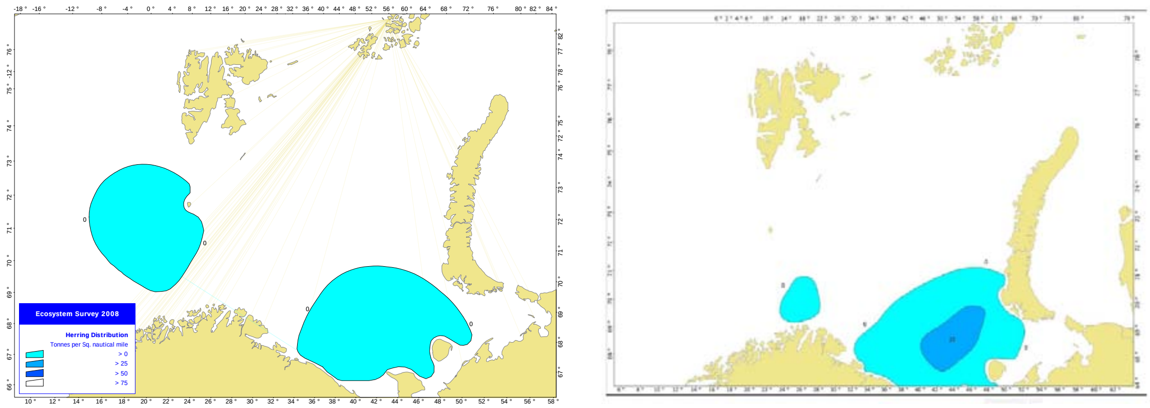

Figure B.3.5.1. Estimated total density of herring (tonnes/nautical mile²) in August-September 2008 (left panel) and 2007 (right panel).

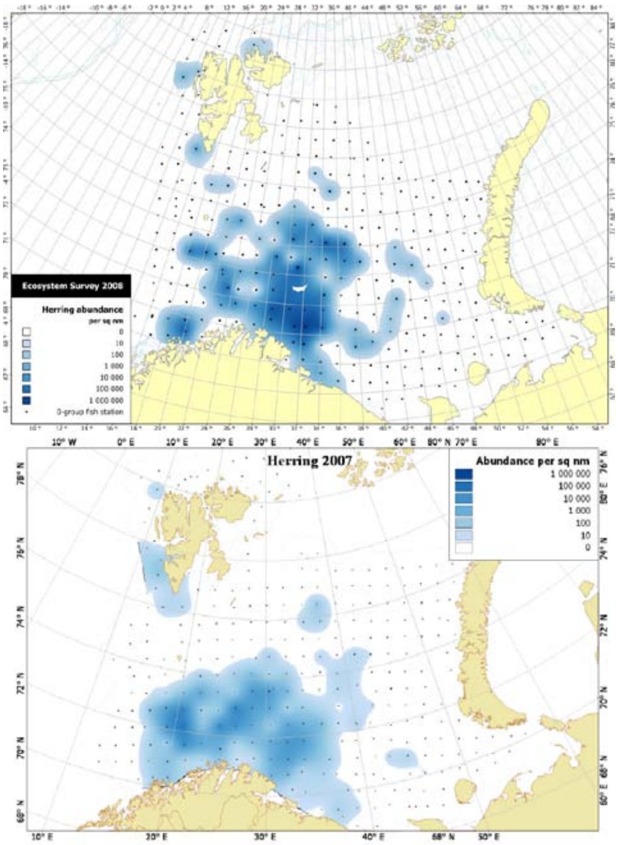

Figure B.3.5.2. NSSH O–group surveys in August/September in the Barents Sea in 2008 (left panel) and 2007 (right panel).

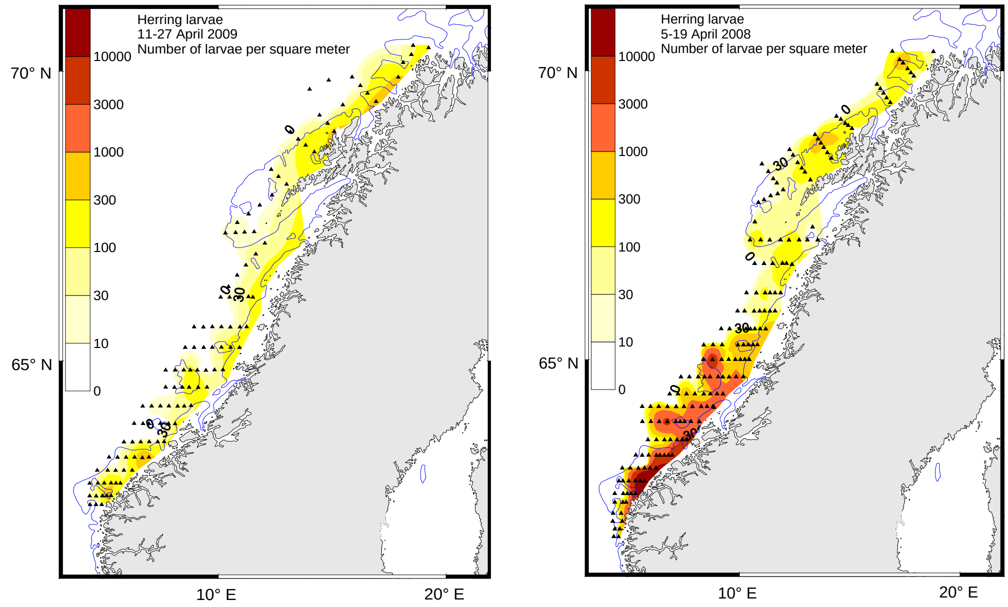

Figure B.3.6.1. NSSH. Distribution of herring larvae on the Norwegian shelf in 2009 (left panel) and 2008 (right panel). The 200 m depth line is also shown.

Stock Annex E – Stock Annex Blue Whiting combined stock (Subareas I–IX, XII and XIV

Quality Handbook	**Blue whiting combined stock (Subareas I–IX, XII and XIV)**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Blue Whiting
Working Group:	Working Group for Widely distributed stocks
Date:	September 2009
Revised By:	Afra Egan *et al*.

A. General

A.1. Stock definition

Blue whiting (*Micromesistius poutassou*) is a pelagic gadoid that is widely distributed in the eastern part of the North Atlantic. The highest concentrations are found along the edge of the continental shelf in areas west of the British Isles and on the Rockall Bank plateau where it occurs in large schools at depths ranging between 300 and 600 meters but is also present in almost all other management areas between the Barents Sea and the Strait of Gibraltar and west to the Irminger Sea. Adults reach maturation at 2-7 years old and undertake long annual migrations from the feeding grounds to the spawning grounds (Bailey, 1982). Most of the spawning takes place between March and April, along the shelf edge and banks west of the British Isles. Juveniles are abundant in many areas, with the main nursery area believed to be the Norwegian Sea. Morphological, physiological, and genetic research has suggested that there may be several components of the stock which mix in the spawning area west of the British Isles. Due to the large population size, its considerable migratory capabilities and wide spatial distribution, much remains to be understood regarding the stock composition and dynamics. The migration routes of blue whiting in the north Atlantic are shown in Figure E1.

Blue Whiting Stock Identity

Prior to 1993, for the purposes of assessment, it was assumed that blue whiting had two components, a northern and a southern component. The Northern stock was known to feed in the Norwegian Sea and spawn to the west of the British Isles. The Southern stock was found along the continental shelf off the coast of Spain and Portugal with the main spawning areas towards the Porcupine Bank. The Porcupine Bank is considered a transitional area between the two main stocks (ICES, 1990). In 1993 it was argued that there was no strong evidence to maintain this division between the two stocks. Results from an otolith age reading workshop at that time showed no significant difference in mean annual ring diameter between northern and southern stocks. It was agreed by ACFM in 1993 that the two stocks should be combined for assessment purposes (ICES, 1995). Since then this stock has been assessed as one unit.

Several approaches have been employed to investigate the stock structure of blue whiting. The details of studies relating to genetics, larval otolith growth patterns and the movements of eggs and larvae have been published in recent years.

Blue Whiting have a wide geographic distribution and large population size, which is generally advantageous for the accumulation and preservation of genetic variability (Mork and Giaever, 1995). The first genetic work was carried out in the early 1990s. A study was carried out by Mork and Giaever, 1995 included samples from most of the eastern Atlantic but the amount of samples from the southern part of this area was generally low. Further work revealed significant geographic heterogeneity with reproductive units found at the fringes of the distribution range. A genetically distinct population was found in the Barents Sea and potential populations identified in the Mediterranean and Romsdalsfjord area of Norway. Samples taken from the area west of the British Isles and from the Norwegian Sea were genetically similar, which suggests a single blue whiting stock throughout the area (Giaever and Stein, 1998). Genetically distinct populations were also found in the Barents Sea and Mediterranean by Ryan *et al* 2005 by using one minisatellite and five microsatellite loci. Temporal variation was also seen between samples collected on the main spawning area. In this case there was insufficient data to identify explicitly the geographic range of these possible stocks. The most recent study conducted by Was *et al*, 2008 used a landscape genetics approach which combines spatial and genetic information to detect barriers to gene flow. This microsatellite analysis found that samples collected and analysed from along the south flowing current from the Porcupine Bank i.e. the Celtic Sea and Bay of Biscay were genetically different from those in the northward flowing current. Temporal variation was seen in samples collected in the Rockall Bank area and the reasons for this are inconclusive.

Oceanographic modelling has been used to examine movements of blue whiting eggs and larvae. Larval drift is an important factor in recruitment. A hypothesis put forward by Skogen *et al*, 1999, was that the southern stock will spawn in an area where the eggs and larvae are likely to drift southwards and the northern stock where the eggs and larvae will drift northwards. Based on modelled drift patterns they found that a possible separation line was located at 54.5ºN but this was subject to significant interannual variability over the twenty years studied. Work conducted by Bartsch and Coombs (1997) used a three dimensional baroclinic model suggests that particles released on the Porcupine Bank drifted southwards with a separation at about 53-54ºN. This work gave some additional information about stock separation but suggested that the division might be more southerly. Additional testing of the use of this type of model was recommended.

An investigation of larval growth histories was carried out in 2007 (Brophy and King, 2007). Groups that are spatially or temporally distinct after hatching show measurable differences in the larval portion of the otolith. This study has shown that larvae from the Bay of Biscay grow faster than those from more northerly spawning areas. It also confirmed that fish spawning to the west of Ireland and Scotland, do not form a randomly mixing unit and that subunits within this aggregation have experienced difference during the larval phase. The dispersal of larvae influences the subsequent dispersal of spawning adults. The fish that are found in the feeding assemblages throughout the distribution do not contribute equally to the spawning assemblages in the north and south of the spawning grounds.

There is growing evidence from these studies that there may be several components in the North east Atlantic blue whiting stock. It is difficult to determine how many possible sub-populations may exist. In many of the studies conducted to date sample sizes are small and further more rigorous sampling is recommended. Further investigation is needed if any changes are to be implemented regarding existing management units.

In 2009 the stock identification methods working group (SIMWG) stated that that the perception of blue whiting in the NE Atlantic as a single unit stock is not consistent with recently observed differences in genetics and growth and should be revised; based on current available data. They recommended that a precautionary approach should initially treat blue whiting populations in areas VIIk and VIIj and further south as a separate unit from all other NE populations. SIMWG is in support of an initial, precautionary delineation of "two main stocks" but also vigorously suggests that a large, interdisciplinary project on this species is needed in order to comprehensively understand blue whiting stock structure in the NE Atlantic so that SIMWG may provide more robust advice (ICES, 2009a).

A.2. Fishery

Since 1988, 18 national fleets have been involved in the blue whiting fisheries. The highest landings have been reported by Norway, followed the USSR/Russia, Iceland and the Faroes. Over the last decade, 13 or 14 national fleets land parts of the blue whiting quota each year. The highest concentrations of catches are generally found along the edge of the continental shelf in the area west of the British Isles, on the Rockall and Hatton Banks and around the Faroe islands in quarter 1. In the following quarters catches are generally taken further north in the Norwegian Sea and also in the North Sea with lesser quantities of blue whiting caught in the southern area off Spain and Portugal.

Most of the catches are taken in the directed pelagic trawl fishery in the spawning and post spawning areas (Divisions Vb, VIa, b, and VIIb, c). Catches are also taken in the directed and mixed fishery in Subarea IV and Division IIIa, and in the pelagic trawl fishery in the Subareas I and II and in Divisions Va and XIVb. These fisheries in the northern areas have taken between 360,000–2,300,000 t per year in the last decade, while catches in the southern areas (Subarea VIII, IX, Divisions VIId, e and g–k) have been in the range of 20,000–85,000 t. The proportion of landings originating from the Norwegian Sea fluctuates greatly, having increased from 5% in the mid-1990 to around 30% in 2003–2004, after which the proportion decreased again to below 10%. These fluctuations are thought to be linked to fluctuations in recruitment. In Division IXa blue whiting is mainly taken as bycatch in mixed trawl fisheries (ICES, 2008a). The proportions of landings originating in each area are mapped and presented in the annual working group reports.

The procedure of the working group is to split length frequency data into three areas, although it is recognised that the northern area comprises both spawning size fish and juveniles. The three areas are as follows:

1. The southern area around Spain and Portugal
2. The northern area which includes the spawning grounds and the Norwegian Sea
3. The North Sea and the Skagerrak.

A.3. Ecosystem aspects

The blue whiting stock has seen an almost threefold increase in spawning stock biomass since the mid 1990's. In recent years the stock has declined in terms of spawning stock biomass and there are no signs of good incoming recruitment. The early life stages have a significant influence on the reproductive success of this stock. The main spawning areas of the blue whiting are located along the shelf edge and banks west of the British Isles. The eggs and larvae can drift both towards the south and towards the north, depending on the spawning location and oceanographic conditions. The northward drift spreads the major part of the juvenile blue whiting to all warmer parts of the Norwegian Sea and adjacent areas from Iceland to the Barents Sea. Adult blue whiting carry out active feeding and spawning migrations in the same area as herring. Blue whiting has consequently an important role in the pelagic ecosystems of the area, both by consuming zooplankton and small fish, and by providing a food resource for larger fish and marine mammals. (ICES, 2009b).

During the spawning stock survey on blue whiting in 2009, large amounts of mackerel were observed throughout the spawning grounds. The mackerel was distributed from 60-300 meters and fed heavily on pearlsides (*Maurolicus mülleri*) (PGNAPES, ICES C.M./ xx, 2009). The overlapping distribution of feeding mackerel with the blue whiting spawning grounds suggests a possible ecologic interaction between the two stocks, and predation from mackerel on blue whiting egg and larvae could be a contributing factor to the collapse in blue whiting recruitment observed. This interaction may have increased significantly both with the growth in the mackerel stock and with the changes observed in mackerel distribution in recent years. It is strongly suggested that investigations are carried out on this relationship in order to evaluate possible effects of mackerel on blue whiting recruitment.

Environmental conditions in the main spawning areas have undergone significant changes during this time. Changes in temperature, salinity and circulation have been recorded in long term trend data. Blue whiting are sensitive to temperature and salinity and will only spawn in waters with suitable ranges. Hatún *et al* 2009a suggests a temperature range of 9°-10°C and salinity ranges of between 35.35 and 35.45 psu.

The ICES report on ocean climate (ICES, 2008b) provides a summary of long term trends in environmental conditions until the end of 2007. Increases in temperature and salinity have been recorded over the blue whiting distribution area. An increase in sea surface temperature (SST) was shown at several of the monitoring stations in the NE Atlantic with temperatures up 3°C since the early 1980s (ICES, 2008c). Salinity has shown some fluctuations throughout the time series. In the Rockall trough salinity reached a peak in 2003 and has declined slightly since then. The same trend can be seen in the Faroes Shetland Channel. In the Norwegian Sea increases in both temperature and salinity have occurred since the mid 1990s (ICES, 2008b).

The circulation of the North Atlantic is characterized by two large gyres: the subpolar and subtropical gyre. Some of the water in the subtropical gyre is re-circulated to the west of the Mid Atlantic Ridge (MAR) and some water continues east and crosses the MAR in the Azores Current and the remainder forms the North Atlantic Current (NAC) (ICES 2008f). The subpolar gyre controls the flow trajectory of the NAC in the Northeastern Atlantic. When the gyre is strong, it extends eastwards, branches off and carries cold less saline water to the Rockall Trough and over the Rockall plateau (Figure E2a). When the gyre is weak it moves west and allows subtropical water to spread north and west and this results in warmer more saline conditions (Figure E2b) (Hatún, *et al* 2009).

Work carried out by Hatún, *et al* 2007 used a gyre index value which is obtained from the simulated sea surface height over the entire North Atlantic Ocean and it reflects the shape and strength of the subpolar gyre. Since blue whiting are known to spawn in water masses with a relatively narrow temperature and salinity range the variability in the strength of the gyre index influences their spawning distribution. A strong gyre index is associated with cold and fresh conditions in the North East Atlantic and this seems to coincide with spawning to the east, along the continental slope and the Porcupine Bank area. The post spawning migration takes place in the Faroe Shetland channel and is possibly associated with a smaller total fish stock. When the gyre index is weak spawning takes place on the western slope of the Faroe plateau and over the Rockall plateau. The post spawning migration is also on the west through the Faroe Bank channel and is possibly leads top a larger stock size. The estimated threefold increase in blue whiting biomass coincided with major changes in the marine climate and this shift between east and west during the mid 1990s indicates a possible connection.

Hatún, *et al* 2009a explored the hypothesis that the spawning distribution is predominantly controlled by the marine climate conditions west of Ireland, along the continental slope and west of Rockall when the sub polar gyre is weak and towards the Porcupine bank when the sub polar gyre is strong. This study used hydrographic, acoustic biomass and larval data as well as catch statistics and data from the regional gyre index. This study showed that the spawning distribution of blue whiting is determined by oceanographic conditions to the west of Great Britain and Ireland which in turn are regulated by the North Atlantic subpolar gyre.

Further work was carried out to examine large scale bio-geographical shifts in the northeast Atlantic from the SPG which used an ocean circulation model and data from four trophic levels including phytoplankton, zooplankton, blue whiting and pilot whales (Hatún, *et al* 2009b). This study found that changes in the distribution of blue whiting are caused by variable stock size and by shifts in the migration pattern. The subpolar gyre influences this process either by

1. Directly regulating the currents and or hydrographic conditions that will influence the migration routes

   or

2. Indirectly via trophodynamics.

This work suggests that recent advances in simulating the dynamics of the subpolar gyre may provide a potential for predicting the distribution of the main faunal zones in the north-eastern Atlantic a few years into the future. This in turn would facilitate more rational management of commercially important fish species.

B. Data

B.1. Commercial catch

SALLOCL

Commercial catch data is obtained from national laboratories of nations exploiting blue whiting. Data exchange spreadsheets are submitted to the stock coordinator. Prior to 2009 the data in the exchange spreadsheets were allocated samples to catch using the SALLOCL-application (Patterson, 1998). This programme gave the needed standard outputs on sampling status and biological parameters. It also clearly documented any decisions made by the species co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set.

InterCatch

Starting in 2009 the data were submitted using the 'Data Submission Workbook' spreadsheet and converted into the InterCatch format by the program "InterCatch-Filemaker", developed by Andrew Campbell from Marine Institute, Galway, Ireland. The total International Catch-at-Age was obtained through the InterCatch web program in 2009, available on the ICES server to work online from the Internet. The allocations for those countries making Catches without samples, were generally made using all available data for the same ICES Division and the same quarter. In cases where this was not possible, data from the nearest Divisions and the same quarter were used.

B.2. Biological Data

Sampling Protocol

In recent years all of the main countries participating in this fishery have provided sampling data to the working group. The European Commission Regulation 1639/2001 sets out the minimum and extended programmes for the collection of data in the fisheries sector and includes guidelines for blue whiting. This regulation requires EU Member States to take a minimum of one sample to be taken for every 1000 t landed in their country. Detailed information on the number of samples collected, number of fish aged and measured by year and by country is presented in the working group report (ICES, 2008a). This regulation applies to EU member states and there are currently no guidelines in place for other countries. Current precision levels of the sampling intensity are unknown and the group recommends reviewing the sampling frequency and intensity on a scientific basis and providing guidelines for sampling intensity.

Age Reading

The most recent age reading workshop took place in Hirtschals Denmark in June 2005. Guidelines for ageing blue whiting are outlined in this report and all of the workshop participants agreed to follow these guidelines. The workshop found that overall there was a high level of agreement between age readers. The two main reasons for disagreement between age readers were firstly the position of the first ring when the Bowers ring is clear and secondly true rings not counted by less experienced readers. Younger fish achieved better precision than older fish. This illustrates the problems associated with ageing older fish and is a common problem among many fish species (Worsøe Clausen, *et al* 2005)

Age composition in the catch

The catch numbers at age were mean standardised by year and are presented in Figure E3. Strong year classes can be seen in the past as they moved through the fishery. In recent years the numbers of fish at younger year classes are not as abundant and there are no signs of incoming strong recruitment.

Weight at age in the catch and Weight at age in the stock

Mean weight at age in the catch data are calculated on an annual basis from data supplied by Denmark, the Faroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. Figure E4 shows the mean weight at age for the total catch from 1981–2007 which is used in the stock assessment..

Maturity

Maturity at age used in the assessment was obtained by combining maturity ogives from the southern and northern areas, weighted by catch in numbers at age (ICES, 1995). These values have been used since 1994. Although the values of maturity at age may be too low, sufficient information for estimating new ogives is not available.

Natural Mortality

The current M of 0.2 was derived from investigations undertaken in the 1980s that examined the age distribution of the stock before the industrial fishery started. The possible need for revising the current estimate of instantaneous natural mortality rate *M* for blue whiting was discussed in detail by the 2002 WG (ICES, 2002). The value of M estimated from different methods was in the range of 0.38 to 0.60. Although it was acknowledged that the current estimate M =0.2 yr might be too low, there is not a strong basis for revision. Methodological work by WGMG (ICES, 2003a) emphasizes that natural mortality rate cannot be estimated reliably with information normally available for stock assessment models. The working group therefore considers that there is no new information that would justify a revision of the current estimate of M.

F and M before spawning This is not used by SMS

Discards

Discards of blue whiting are thought to be small. Most of the blue whiting is caught in directed fisheries for reduction to fish meal and fish oil. However, some discarding occurs in the fisheries for human consumption and as bycatch in fisheries directed to other species. Estimates of discarding are not included in the assessment. Reports on discarding from fisheries which catch blue whiting were available from the Netherlands for the years 2002–2007. A study carried out to examine discarding in the Dutch fleet found that blue whiting made a minor contribution to the total pelagic discards when compared with the main species mackerel, horse mackerel and herring (Figure E5). The length frequencies of landed and discarded fish caught were compared and from this data it is clear that herring and blue whiting are not selected and discarded for length reasons (Figure E6). It is more likely that in sorting and processing of mackerel small fish are commonly discarded (Borges, *et al* 2008).

Information on discards was available for Spanish fleets in 2006. Blue whiting is a bycatch in several bottom trawl mixed fisheries. The estimates of discards in these mixed fisheries in 2006 ranged between 23% and 99% (in weight) as most of the catch is discarded and only last day catch may be retained for marketing fresh. The catch rates of blue whiting in these fisheries are however low. In the directed fishery for blue whiting for human consumption with pair trawls, discards were estimated to be 13% (in weight) in 2006.

In general, discards are assumed to be minor in the blue whiting directed fishery. Discard data are provided by the Netherlands to the working group. Blue whiting is also by catch in several Spanish bottom trawl mixed fisheries. However, the catch rates of blue whiting in these fisheries are low (ICES, 2008a).

B.3. Surveys

A number of surveys are carried out which provide data on blue whiting abundance in different areas of their distribution. Three surveys are used to tune the assessment. The remaining surveys are not used in the assessment but data are updated on an annual basis.

Surveys Used in the assessment

1. International Blue Whiting spawning stock survey

The International Blue Whiting Spawning Stock Survey (IBWSS) is carried out annually on the spawning grounds west of the British Isles in March-April. The survey started in 2004 and is carried out by Norway, Russia, the Faroe Islands and the EU. The primary purpose of the survey was to obtain estimates of blue whiting stock abundance in the main spawning grounds using acoustic methods as well as to collect hydrographic information. Results of all the surveys are presented in national reports and also combined in one international survey report. The International survey is coordinated by PGNAPES. International co-operation allows for wider and more synoptic coverage of the stock and better use of resources. This survey was first used the tune the assessment in 2007.

2. International ecosystem survey in the Nordic Seas

An international ecosystem survey is carried out annually in the Nordic Seas from late April to early June aimed at observing the pelagic ecosystem in this area. This survey focuses on Norwegian spring spawning herring, blue whiting, zooplankton and hydrography.

The survey area was split into three subareas which are as follows:

- Area I - Barents Sea
- Area II - northern and central Norwegian Sea
- Area III - Southwestern area, i.e. Faroese and Icelandic zones and Southwestern part of the Norwegian Sea

The survey is coordinated by PGNAPES.

3. Norwegian survey on the spawning grounds

The Norwegian survey on the spawning grounds for blue whiting, west of the British Isles, provides the longest time series covering a significant part of the blue whiting stock, and is an important time series for tuning the assessment. This survey was carried out from 1991-2006. The time series from 1991 – 2003, ages 3-8 is currently used to tune the assessment. This survey was replaced by the International spawning stock survey.

Surveys not used in the assessment but provide information

4. Norwegian bottom trawl survey in the Barents Sea

Norway has conducted bottom trawl surveys targeting cod and other demersal fish in the Barents Sea since late 1970s. From 1981 onwards there have been systematically designed surveys carried out during the winter months (usually late January-early March) by at least two Norwegian vessels; in some years the survey has been conducted in co-operation with Russia. Blue whiting is a regular bycatch species in these surveys, and has in some years been among the numerically dominant species (Heino *et al*, 2003). This survey is presently giving the first reliable indication of year class strength of blue whiting. The survey is not used in the assessment because of it coverage at the edge of the distribution area, but it is used for recruitment predictions. The indices of 1 group blue whiting are presented in Table E1.

5. Spanish bottom trawl survey

Bottom trawl surveys have been conducted off the Galician (NW Spain) coast since 1980, following a stratified random sampling design and covering depths down to 500 m. The survey is directed to a mixture of species. Since 1983, the area covered in the Spanish survey was extended to completely cover Spanish waters in Division VIIIc. A new stratification has been established since 1997. The survey is not used in the assessments as it is only representative for a small part of the stock area. The mean catch and standard error of these bottom trawl surveys are presented in Table E2 and Figures E7. The stratified mean catch is presented in Figure E8.

6. Portuguese bottom trawl survey

Bottom trawl surveys have been conducted off the Portuguese coast since 1979, following a stratified random sampling design and covering depths down to 500 m. The area covered in the Portuguese survey was extended in 1989 to the 750 m contour. The survey is not used in the assessments as it is only representative for a small part of the stock area. The mean catch and standard error of these surveys is presented in Table E3.

7. Other Surveys

Several other surveys have in the past provided data to the Working Group. In recent years however these data have not been updated. Historical results from the following surveys are presented in WGNPBW working group reports.

- • Norwegian Sea summer survey carried out in 1981 – 2001, 2005 – 2007. The stock estimates in numbers at age are given in the 2007 report.
- • Faroes plateau spring bottom trawl survey carried out in March 1996–2008. The survey is aimed at cod, haddock and saithe, but varying amounts of blue whiting are caught as bycatch each year.
- • Faroes plateau autumn bottom trawl survey carried out in August- September 1994–2008. The survey is aimed at cod, haddock and saithe, but varying amounts of blue whiting are caught as bycatch each year.

B.4. CPUE

Spanish pair trawl CPUE

The Spanish pair trawls CPUE series was used for several years as a tuning fleet in the blue whiting assessment. Following a recommendation of the methods working group (ICES, 2003) the use of this CPUE data was discontinued because this fleet represents only a small part of the landings caught in a small part of the distribution area. This data series runs from 1983-2003 and has not been updated since then. The age stratified CPUE data are shown in Table 4 and Figure 9 and show a slight decreasing trend in CPUE.

Norwegian CPUE

CPUE data in the spawning area was collected from the Norwegian commercial fleet 1982–2003. The time series has not been updated in recent years. The data are not considered to be representative for the development of the stock and are not used in the assessment.

B.5. Other relevant data

C. Historical Stock Development

Analytical assessment

A benchmark assessment for this stock has not been conducted to date but is scheduled for 2011.

Models used for exploratory assessments

1. TISVPA

Since 2006 a "triple-separable" version of the ISVPA model (TISVPA) was used for exploratory blue whiting assessment runs. This version of the model allows it to take into account possible cohort-dependent peculiarities in selection pattern originating from different interactions of different cohorts with fishing fleet, or by possible errors in aging of some cohort or by some other unknown reasons. The so called mixed version of the model was used (giving equal weights to assumptions that catch-at-age data are true and that selection pattern is stable). Other settings of the model were the following: unbiased separable representation of fishing mortalities and single selection pattern for the whole period (ICES, 2006a)

The model settings were chosen to minimize non-contradicting signals from all available data (catch-at-age and 3 surveys: Norwegian spawning stock survey (survey 1); IESNS (survey 2), and the IBSSS (survey 3)) in order to retain the meaningful input into the model from all of them.

In 2009 the following settings were used:

- The "catch-controlled" version (catch-at-age is assumed as true and all residuals in catch-at-age are attributed to violations of selection pattern stability) with the assumption of unbiased separable representation of fishing mortalities (more correctly – of exploitation rates);
- The window for estimation of cohort-factors – from age 1 to age 8; the measure of closeness of fit for catch-at-age – sum of squared residuals in logarithmic catch-at-age;
- Catchability-at-age were estimated for all surveys.

The year of the change in selection pattern was chosen as 1994 (first year of the second selection pattern in the model) as corresponding to the best fit the catch-at-age data. The results are presented in annual working group reports.

2. XSA

XSA or extended survivors analysis is also used for exploratory assessment runs. XSA focuses on the relationship between catch per unit effort and population abundance, allowing the use of a more complicated model for the relationship between CPUE and year class strength at the youngest ages (Darby and Flatman, 1994).

XSA was used in 2009 with the following configuration:

- q plateau set at age 7;
- Catchability depends on stock size for ages less than 3;

- SE at survey estimates set as 0.3;
- Regression type P;
- Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages.

Model used for the Final Assessment: SMS

Since 2005, SMS has been the final assessment model chosen by the working group.

SMS (Stochastic Multi Species model) (Lewy and Vinther, 2004) is an age structured assessment model to handle biological interactions, however, it can be reduced to operate with one species only. In "single species mode" an objective functions for catch at age numbers and survey indices at age time series are minimized assuming a log-normal error distribution for both data sources. The expected catch is calculated from the catch equation and F at age, which is assumed to be separable into an age selection and a year effect. SMS uses maximum likelihood to weight the various data sources (ICES, 2006a).

Model Options chosen:

Details of why specific SMS Settings were used – from Morten

Table of final assessment settings from 2006-2008

Settings/options for the final assessment	2006	2007	2008	2009
Software	SMS	SMS	SMS	SMS
Age range for the analysis		1–10+	1–10+	1–10+
Catch data				
Constant selection pattern for the catch	2 periods: 1981–1992, 1993–2005	2 periods: 1981–1992, 1993–2006	2 periods: 1981–1998, 1999–2007	2 periods: 1981–1998, 1999–2008
First age with age independent catchability	8	8	8	8
Age groups with the same variance	1, 2, 3–6, 7–10	1, 2, 3–6, 7–10	1, 2, 3–6, 7–10	1, 2, 3–6, 7–10
Age-structured tuning time-series				
Norwegian spawning ground survey, ages 3–8,	1993–2006	1993–2003	1993–2003	1993–2003
First age with age independent catchability	5	5	5	5
Age groups with the same variance	3–4, 5–6, 7–8	3–4, 5–6, 7–8	3–4, 5–6, 7–8	3–4, 5–6, 7–8
International ecosystem survey in the Nordic Seas, ages 1–2	2000–2006	2000–2007	2000–2008	2000–2009
First age with age independent catchability	2	2	2	2
ages 1–2	2000–2007	2000–2007	2000–2008	2000–2009
Age groups with the same variance	1, 2	1, 2	1, 2	1, 2
Upper bound on CV	no	no	1, 4	1, 4
International blue whiting spawning stock ground survey , *ages 3–8*	Not used	2004–2007	2004–2008	2004–2009
First age with age independent catchability		5	5	5
Age groups with the same variance		3–8,	3–8,	3–8
Lower bound on CV		0.40	0.40	No bounds

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1981 - 2008	1-10	Yes
Canum	Catch at age in numbers	1981 - 2008	1-10	Yes
Weca	Weight at age in the commercial catch	1981 - 2008	1-10	Yes
West	Weight at age of the spawning stock at spawning time.	1981 - 2008	1-10	Yes
Mprop	Proportion of natural mortality before spawning	1981 - 2008	1-10	No
Fprop	Proportion of fishing mortality before spawning	1981 - 2008	1-10	No
Matprop	Proportion mature at age	1981 - 2008	1-10	No
Natmor	Natural mortality	1981 - 2008	1-10	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Norwegian Acoustic Survey	1991-2003	3-8
Tuning fleet 2	International Ecosystem Survey	2000 - 2009	1-2
Tuning fleet 3	International Spawning Stock Survey	2004 - 2009	3 - 8

D. Short-Term Projection

Software used: MFDP (Multi Fleet Deterministic Projections)

Initial stock size: Stock numbers from the assessment

Recruitment: In 2006 and 2007 recruitment at age 1 in the assessment year was predicted based on three different survey time series (1) the Norwegian bottom trawl survey in the Barents Sea, (2) the International Ecosystem survey in the Nordic Seas total area and (3) the International Ecosystem survey in the Nordic Seas standard area. These time series were chosen based on the exploration of recruitment signals in different data sources in 2006 (ICES 2006a). The recruitment indices available indicated that both the 2006 and 2007 year classes are very weak.

In 2008 and 2009 a survey-based estimate of recruitment using the standard ICES software, RCT3 was carried out. This uses the most recent available information from the International ecosystem survey standard area index and the Barents Sea bottom trawl time series. Both recruitment indices show the same signal as previous years that the 2005-2008 year classes are very weak and are orders of magnitude lower than earlier in the series.

Maturity: The proportion mature for this stock is assumed constant over the years. The maturity ogive used in the short term forecast is the same as the ogive used in the assessment.

F and M before spawning: Spawning is assumed to take place the 1. January.

Weight at age in the stock and weight at age in the catch: Weight at age in the catch and weight at age in the stock are the same and for the short term forecast are calculated as three year averages.

Exploitation pattern: This is based on F in the year where the final year of data calculated from the most recent assessment. The assessment assumes a fixed selection from 1999 to the final year of data.

Natural Mortality: Natural mortality is assumed to be 0.2 across all ages.

E. Medium-Term Projection

Medium term projections were carried out as part of the management plan evaluation simulations at a meeting in May 2008 (Anon, 2008). These simulations were updated at WGWIDE in September 2008. HCS (Skagen, 2008) with some minor modifications were made to cover the needs of the blue whiting simulations. As a control, some simulations were repeated with the SMS software which is also used to assess the stock of blue whiting and was used for evaluation of the management plan presently in use (ICES, 2008a).

F. Long-Term Projections

Long term projections have not been carried out.

G. Biological Reference Points

Reference Point	B_{lim}	B_{pa}	F_{lim}	F_{pa}
Value	1.5 mill t	2.25 mill t	0.51 yr^{-1}	0.32 yr^{-1}
Basis	B_{loss}	Blim*exp(1.645* σ) With σ = 0.25	F_{loss}	F_{med}

Although problems have been identified with these reference points they have remained unchanged since then. A major problem is that fishing at F_{pa} implies a high probability of bringing the stock below B_{pa}, in other words the present combination of F_{pa} and B_{pa} is inconsistent. The Workshop on Limit and Target Reference Points (WKREF) considered the biological reference points for Blue Whiting at a meeting in Gdynia, Poland in January last year (ICES, 2007b). The original reference points for this stock were set in 1998, before the era of high productivity became apparent. The group examined the consequences of these new observations on the reference points by first splitting the time-series into two productivity regimes (low productivity from 1981–1994, and high productivity from 1995–2005). Standard methods (i.e. using the guidelines from the Study Group on Precautionary Reference points, SGPRP (ICES, 2003b) were then used to re-estimate the reference points, which were found to be comparable to the current values. A new probabilistic approach for estimating B_{lim} was also employed, but again, the result was found to be comparable with the current values. The group concluded that there was no basis for revising the current reference points. WKREF also noted that there may be no need for different B_{lim} values in different productivity regimes.

A stochastic equilibrium analysis made during the Working Group established by the Blue Whiting Coastal States on Blue Whiting management strategies (Anon, 2008) indicates a high risk of stock collapse with an F from approximately 0.3 and upwards given the "low recruitment" regime as observed in 1981–1996. F_{max} is poorly defined and a very limited increase in yield is obtained for F in the range 0.18 to 0.30. $F_{0.1}$ was estimated at 0.18. Sensitivity analysis of a change in exploitation pattern showed that these conclusions are robust with respect to the choice of exploitation pattern. A yield per recruit analysis was conducted using MFYPR which also calculated $F_{0.1}$ as 0.18.

H. Other Issues

Changes in Blue Whiting Mean Weights over time

Possible causal relations for the visible reductions in mean weight at age were investigated by WGWIDE in 2008. Several aspects relating to the biology of fish stocks such as recruitment, growth or natural mortality, are influenced by ecosystem conditions. Some of these conditions were suggested as possible reasons for the change in mean weight at age. These include the following:

- Density dependant competition– too many fish competing for the same food resource.
- Changes in plankton abundance would impact on the amount of food available for blue whiting.
- External environmental factors, such as temperature and salinity. Spawning is effected by both of these environmental variables.

An in depth analysis of the causes of these changes in mean weights, which would be needed for any kind of forecast is outside the scope of this working group (ICES, 2008a)

Possible effects of protecting juvenile Blue Whiting

The modern blue whiting fishery developed during the second half of the 1970s when the landings increased from around 100 000 tonnes to above 1 million tonnes. The majority of the catches have since been taken on the spawning grounds west of the British Isles. A small but fairly constant fraction of the catches are taken in the southern areas and in the North Sea (Norwegian trench) and a variable fraction in the Norwegian Sea (Figure E10). The proportion of landings taken in the Norwegian Sea increased after the strong year classes from 1995 onwards led to increased densities of (young) blue whiting in this area, but is now decreasing and was in 2007 around the pre-2000 level.

Landings from the Norwegian Sea and the North Sea are generally comprised of a higher proportion of juvenile fish compared to landings from the spawning area, though this proportion varies between years. A measure to reduce the exploitation of juveniles could therefore, in theory, be to close the fishery in these areas (or a temporal closure of the fishery outside the spawning season). However, it is impossible to estimate the resulting reduction in juvenile fishing mortality of such measures since juveniles are also exploited in the spawning ground fishery.

The effects on the yield per recruit curve of applying three different exploitation patterns on ages 1–2 were explored using the standard ICES software MFYPR; (1) zero exploitation, (2) "high" exploitation and (3) the constant F selection pattern used in SMS from 1999 onwards. The "high" exploitation pattern which gave the highest relative fishing mortality on ages 1–2 during the last 15 years was derived from the XSA assessment. The SMS exploitation pattern was used on ages older than 2 years. Figure E11 shows the three F selection patterns used and the resulting yield per recruit curves. The difference between the curves is marginal with similar values for $F_{0.1}$ derived. The conclusion is that the effect on yield of protecting juveniles is likely to be very small. A separate clause for the protection of juveniles in the management plan is not needed (ICES, 2008a).

H.1 Management and ICES advice

In 2003, ICES stated that both estimates of SSB and fishing mortality were high but uncertain. Nevertheless, the spawning stock biomass in 2003 was likely to be above B_{pa}. Therefore, based on the most recent estimates of fishing mortality and SSB, ICES classified the stock as likely to be harvested outside safe biological limits ($F>F_{lim}$). The incoming year classes seemed to be strong. ICES recommended that catches should be less than 925 000 tonnes in 2004 in order to achieve a 50% probability that the fishing mortality in 2004 is less than F_{pa} (=0.32). This would also assure a high probability that the spawning stock biomass in 2005 to be above B_{pa} (ICES, 2005).

In 2004 ICES concluded from the most recent estimates of fishing mortality and SSB, that the stock had full reproductive capacity, but was harvested unsustainably. Although the estimates of SSB and fishing mortality were not considered precise, it was certain that SSB was above B_{pa} and the estimated fishing mortality well above F_{lim}. Recruitments in the last decade appeared to be at a much higher level than earlier. The unimplemented management plan implied catches of less than 1.075 million t in 2005 which was expected to keep fishing mortality less than 0.32 with 50% probability. This would also have assured a high probability that the spawning stock biomass in 2006 would be above B_{pa}. ICES recommended that measures be taken to protect juveniles (ICES, 2005).

In 2005 ICES stated that fishing within the limits of the management plan (F=0.32) implied catches of less than 1.5 million t in 2006. This would result in a high probability that the spawning stock biomass in 2007 would be above B_{pa}. The present fishing level was well above levels defined by the management plan and should be reduced. The primarily approach to reduce catch of juveniles is to reduce overall fishing mortality. Catches of juveniles in the last 4 years were much greater than in earlier periods. If an overall reduction of fishing mortality cannot be achieved then specific measures should be taken to protect juveniles (ICES, 2006a).

In 2006 ICES stated that the maximum catch in 2007 corresponding to a new agreed management plan is 1.9 million tonnes, which is expected to leave the spawning stock biomass at 2.86 million t, i.e. above B_{pa} in 2008, but would lead to an F above F_{lim} in 2007. Fishing mortality is estimated at 0.48 and was above the fishing mortalities expected to lead to high long-term yields and low risk of depletion of production potential. Fishing at F_{pa} implies catches of less than 980 thousand t in 2007. This was expected to result in a spawning stock biomass in 2008 well above B_{pa}. The newly agreed management plan was evaluated by ICES and was not considered in accordance with the precautionary approach. ICES concluded that the exploitation boundaries for this stock should be based on the precautionary limits (ICES, 2007a).

In 2007 ICES classified the stock as having full reproductive capacity, but being harvested at increased risk. SSB increased to a historical high in 2003, but has decreased since then. The estimated fishing mortality was well above F_{pa}. Recruitment in the last decade appears to be at a much higher level than prior to 1996. The 2005 and 2006 year classes were estimated at the pre 1996 level. ICES has evaluated the present management plan in 2006 and found it not to be in accordance with the precautionary approach. ICES concluded that the exploitation boundaries for this stock should be based on the precautionary limits. The advice for 2008 is a maximum TAC at 835 000 t based on an F at F_{pa} (ICES, 2008a).

The 2008 advice for Blue whiting states that based on the most recent estimates of fishing mortality and SSB, ICES classifies the stock as having full reproductive capacity, but being harvested at increased risk. SSB increased to a historical high in 2003, but has decreased since then and is expected to be just above B_{pa} in 2009. The estimated fishing mortality is well above F_{pa}. Recruitment of the 2005 and 2006 year classes are estimated to be in the very low end of the historical time-series. Surveys indicate that the 2007 year class could also be low.

A management plan was agreed for this stock between the four coastal states (Norway, Faroe Islands, Iceland, and EU) in December 2005. The text for the agreed plan is given below. This management agreement aims to maintain the SSB of the blue whiting stock at levels above 1.5 million tonnes (B_{lim}) and the fishing mortality rates at levels of no more than 0.32 (F_{pa}). To achieve this, TAC are reduced by at least 100 000 t a year until the fishing mortality is reduced to 0.32 (F_{pa}). The plan states that if the spawning stock falls below 2.25 million t unspecified actions to obtain a safe and rapid recovery to this level should be taken. ICES has evaluated this management plan in 2006 and found it not to be in accordance with the precautionary approach in a period of low recruitment.

Text for the agreed management plan for Blue Whiting

1) The Parties agree to implement a multi-annual management arrangement for the fisheries on the blue whiting stock which is consistent with the precautionary approach, aiming at constraining harvest within safe biological limits, protecting juveniles, and designed to provide for sustainable fisheries and a greater potential yield, in accordance with advice from ICES.

2) The management targets are to maintain the Spawning Stock Biomass (SSB) of the blue whiting stock at levels above 1.5 million tonnes (Blim) and the fishing mortality rates at levels of no more than 0.32 (Fpa) for appropriate age groups as defined by ICES.

3) For 2006, the Parties agree to limit their fisheries of blue whiting to a total allowable catch of no more than 2 million tonnes.

4) The Parties recognise that a total outtake by the Parties of 2 million tonnes in 2006 will result in a fishing mortality rate above the target level as defined in Paragraph 2. Until the fishing mortality has reached a level of no more than 0.32, the Parties agree to reduce their total allowable catch of blue whiting by at least 100 000 tonnes annually.

5) When the target fishing mortality rate has been reached, the Parties shall limit their allowable catches to levels consistent with a fishing mortality rate of no more than 0.32 for appropriate age groups as defined by ICES.

6) Should the SSB fall below a reference point of 2.25 million tonnes (Bpa), either the fishing mortality rate referred to in Paragraph 5 or the tonnage referred to in Paragraph 4 shall be adapted in the light of scientific estimates of the conditions *then prevailing. Such adaptation shall ensure a safe and rapid recovery of the SSB to a level in excess of 2.25 million tonnes.*

7) *This multi-annual management arrangement shall be reviewed by the Parties on the basis of ICES advice*

The stock is currently in a period of low recruitment. In July 2008 a new draft management plan was proposed by the Coastal States. ICES has evaluated the draft management plan and considers it precautionary if fishing mortality in the first year is immediately reduced to the fishing mortality that is implied by the HCR. The text of this plan is also presented below.

Text for the Proposed management plan for Blue Whiting

1) *The Parties agree to implement a long term management plan for the fisheries on the Blue Whiting stock, which is consistent with the precautionary approach, aiming at ensuring harvest within safe biological limits and designed to provide for fisheries consistent with maximum sustainable yield, in accordance with advice from ICES.*

2) *For the purpose of this long term management plan, in the following text, TAC means the sum of the coastal State TAC and the NEAFC allowable catches.*

3) *As a priority, the long term plan shall ensure with high probability that the size of the stock is maintained above 1.5 million tonnes (Blim).*

4) *The Parties shall aim to exploit the stock with a fishing mortality of 0.18 on relevant age groups as defined by ICES.*

5) *While fishing mortality exceeds that specified in paragraph 4, the Parties agree to establish the TAC consistent with annual [x%] reductions in fishing mortality until the fishing mortality established in paragraph 4 has been reached.*

For the purposes of this calculation, the fishing percentage mortality reduction should be calculated

with respect to the year before the year in which the TAC is to be established. For this year, it shall be assumed that the relevant TAC constrains catches.

6) *When the fishing mortality in paragraph 4 has been reached, the Parties agree to establish the TAC in each year in accordance with the following rules:*

• *In the case that the spawning biomass is forecast to reach or exceed 2.5 million tonnes (SSB trigger level) on 1 January of the year for which the TAC is to be set, the TAC shall be fixed at the level consistent with the specified fishing mortality.*

• *In the case that the spawning biomass is forecast to be less than 2.5 million tonnes on 1 January of the year for which the TAC is to be set (B), the TAC shall be fixed that is consistent with a fishing mortality given by:*

$$F = 0.05 + [(B - 1.5)(0.18 - 0.05) / (2.5 - 1.5)]$$

• *In the case that spawning biomass is forecast to be less than 1.5 million tonnes on 1 January of the year for which the TAC is to be set, the TAC will be fixed that is consistent with a fishing mortality given by F = 0.05.*

7) *When the fishing mortality rate on the stock is consistent with that established in paragraph 4 and the spawning stock size on 1 January of the year for which the TAC is to be set is forecast to exceed 2.5 million tonnes, the Parties agree to discuss the appropriateness of adopting constraints on TAC changes within the plan.*

8) The Parties, on the basis of ICES advice, shall review this long term management plan at intervals not exceeding five years and when the condition specified in paragraph 4 is reached

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Table E1: 1-group indices of blue whiting from the Norwegian winter survey (late January-early March) in the Barents Sea. (Blue whiting <19cm in total body length which most likely belong to 1-group.)

	Catch Rate	
Year	All	<19cm
1981	0.13	0
1982	0.17	0.01
1983	4.46	0.46
1984	6.97	2.47
1985	32.51	0.77
1986	17.51	0.89
1987	8.32	0.02
1988	6.38	0.97
1989	1.65	0.18
1990	17.81	16.37
1991	48.87	2.11
1992	30.05	0.06
1993	5.8	0.01
1994	3.02	0
1995	1.65	0.10
1996	9.88	5.81
1997	187.24	175.26
1998	7.14	0.21
1999	5.98	0.71
2000	129.23	120.90
2001	329.04	233.76
2002	102.63	9.69
2003	75.25	15.15
2004	124.01	36.74
2005	206.18	90.23
2006	269.2	3.52
2007	80.38	0.16
2008	16.72	0.01
2009	3.74	0

Table E2: Stratified mean catch (Kg/haul and Number/haul) and standard error of Blue Whiting in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September-October.

Kg/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
Year	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	9.50	5.87	119.75	45.99	68.18	13.79	92.83	28.24
1986	9.74	7.13	45.41	12.37	29.54	8.70	36.93	7.95
1987	-	-	-	-	-	-	-	-
1988	2.90	2.59	154.12	38.69	183.07	141.94	143.30	45.84
1989	14.17	12.03	76.92	17.08	18.79	6.23	59.00	11.68
1990	6.25	3.29	52.54	9.00	18.80	4.99	43.60	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.10	17.16
1992	6.37	2.59	44.12	6.64	29.50	6.16	34.60	4.23
1993	1.06	0.63	14.07	3.73	51.08	22.02	22.59	6.44
1994	8.04	5.28	37.18	8.45	25.42	5.27	29.70	5.19
1995	19.97	13.87	36.43	4.82	15.97	4.10	28.52	3.66
1996	7.27	3.95	49.23	7.19	92.54	17.76	54.52	6.36
Kg/haul	70-120 m		121-200 m		201-500 m		TOTAL 70-500 m	
Year	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1997	17.87	7.35	44.68	10.52	57.14	16.60	42.62	7.29
1998	14.13	4.17	42.78	8.13	78.88	22.01	47.14	7.58
1999	93.01	14.60	112.39	19.92	169.21	50.26	124.66	17.85
2000	62.39	12.00	91.99	14.75	58.72	24.94	76.19	10.61
2001	8.35	3.31	50.18	10.09	52.41	16.71	42.02	7.02
2002	31.40	5.02	69.00	13.41	36.75	12.07	51.80	7.64
2003	42.52	12.22	71.40	11.01	46.43	11.42	58.13	6.92
2004	2.80	2.11	14.05	7.79	59.51	21.41	24.76	7.31
2005	50.63	16.15	95.17	19.28	40.06	8.88	69.94	10.57
2006	14.28	7.01	70.79	12.60	115.08	39.88	71.64	13.18
2007	4.76	3.75	39.10	23.21	21.69	4.41	26.86	11.74

Table E3 Stratified mean catch (Kg/haul) and standard error of bottom trawl surveys in Portuguese waters (Division IXa).

		20-100 m		100-200 m		200-500 m		500-750 m		TOTAL	
Year	Month	**y**	sy	**y**	sy	**y**	sy	**y**	sy	**y**	sy
1990	July	**2**	2	**153**	103	**242**	42	**50**	5	**96**	35
	October	**11**	5	**90**	28	**762**	234	**42**	10	**153**	35
1991	July	**1**	1	**140**	40	**268**	38	**64**	18	**98**	15
	October	**8**	5	**83**	18	**259**	53	**121**	27	**91**	11
1992	February	**7**	7	**43**	35	**249**	21	**73**	3	**68**	12
	July	**1**	1	**29**	18	**216**	43	**27**	5	**47**	9
	October	**1**	1	**22**	7	**208**	44	**80**	3	**54**	7
1993	February	**0**	0	**19**	14	**105**	31	**36**	0	**42**	10
	July	**0**	0	**3**	3	**151**	28	**55**	5	**34**	4
	November	**0**	0	**90**	0	**189**	43	**6**	1	**86**	9
1994	October	**0**	0	**374**	30	**283**	32	**49**	7	**174**	11
1995	July	**0**	0	**18**	14	**130**	20	**52**	3	**35**	5
	October	**18**	15	**103**	21	**328**	91	**31**	12	**94**	16
1996	October	**25**	24	**12**	2	**36**	6	**25**	7	**22**	8
1997	June	**0**	0	**3**	3	**116**	42	**45**	12	**27**	7
	October	**2**	1	**54**	20	**77**	13	**7**	2	**32**	8
1998	July	**0**	0	**8**	5	**105**	17	**38**	3	**25**	3
	October	**1**	1	**384**	87	**427**	101	**20**	2	**212**	36
1999	July	**1**	0	**60**	21	**66**	19	**25**	2	**37**	9
	October	**0**	0	**69**	16	**80**	20	**18**	8	**41**	7
2000	July	**23**	13	**109**	34	**116**	10	**63**	6	**75**	13
	October	**11**	4	**155**	53	**196**	22	**54**	4	**99**	19
2001	July	**18**	7	**238**	37	**305**	116	**57**	14	**152**	23
	October	**106**	6	**474**	224	**294**	66		0	**295**	97
2002	October	**19**	12	**176**	81	**180**	24		0	**116**	34
2003	October	**24**	10	**114**	14	**119**	30	**34**	6	**76**	8
2004	October	**0**	0	**44**	10	**380**	27			**84**	15
2005	October	**0**	0	**25**	7	**407**	239			**81**	42
2006	October	**1**	1	**154**	59	**196**	32			**95**	26
2007	October	**1**	1	**136**	66	**141**	25			**91**	32

Table E4: Age stratified CPUE from the Spanish surveys

Numbers				age				
	1	2	3	4	5	6	7	total
1982								
1983		7196	16392	9311	7476	6326	1718	48419
1984		13710	27286	14845	4836	1755	1750	64182
1985		14573	23823	14126	6256	1232	217	60227
1986		3721	14131	14745	7113	1278	505	41493
1987		25328	13153	6664	2938	1029	166	49278
1988		7778	21473	18436	6391	1300	781	56159
1989		15272	18486	17160	8374	3760	1003	64055
1990		21444	19407	5194	1803	1357	451	49656
1991		15924	15370	4989	2329	1045	440	40097
1992		10007	24235	9671	4316	1194	462	49885
1993		4036	13991	22493	7979	1354	658	50511
1994		543	6066	15917	7474	2990	1055	34045
1995		9090	14409	6833	4551	1990	623	37496
1996		3905	14557	14449	3931	3639	1834	42315
1997		8742	15875	11134	3698	1046	450	40945
1998		5884	13236	9803	10844	5229	1153	46149
1999		2048	10268	20242	9833	6287	3047	51725
2000		6207	15518	13987	5375	1264	1414	43765
2001		16223	16488	6830	1620	1148	162	42471
2002		10520	13725	10265	3385	336	69	38300
2003		9069	10461	6517	3983	1932	737	32699

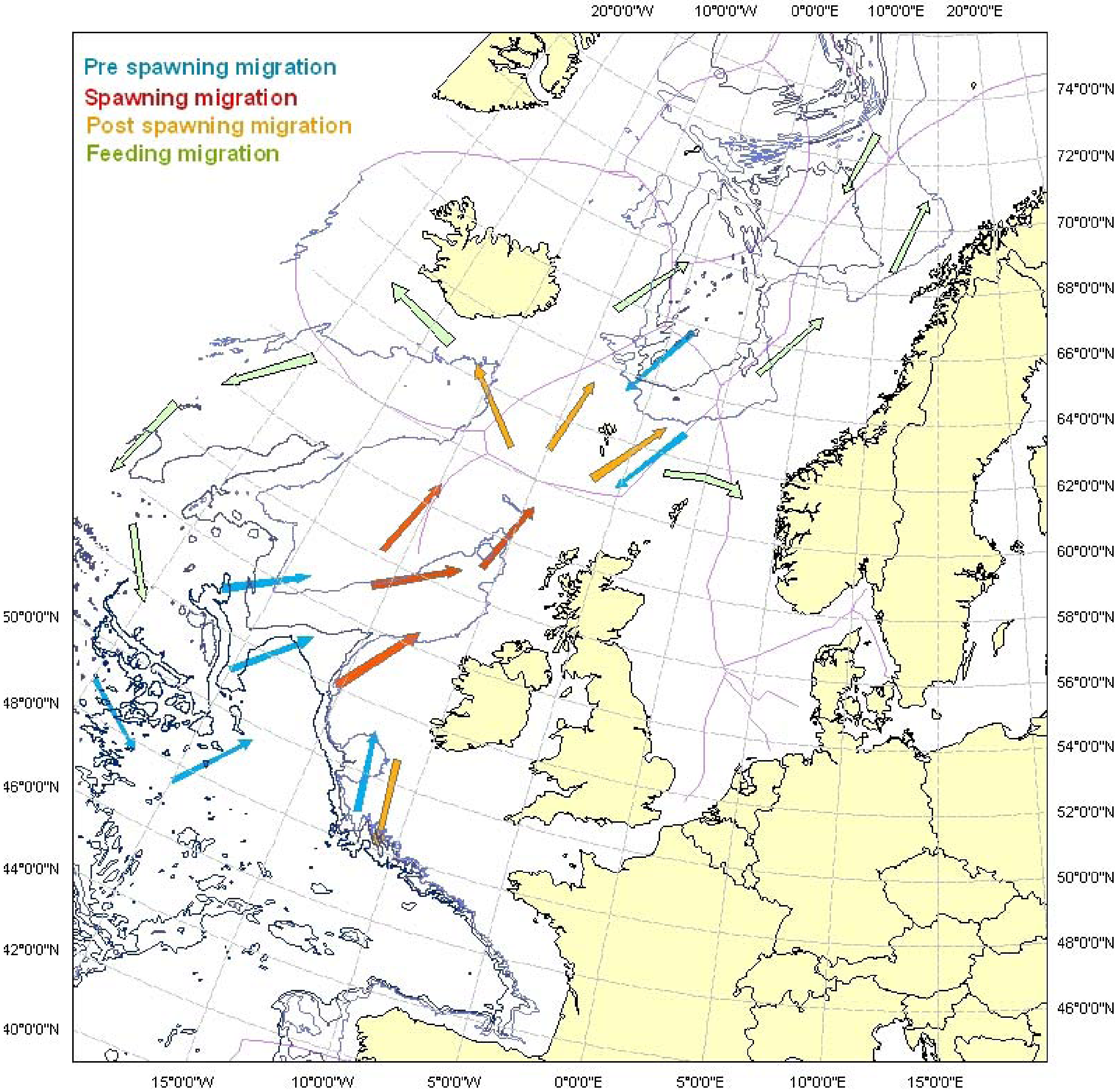


Figure E1. Migration routes for the blue whiting in the Northern Atlantic. Tangen and Sveinbjörnsson (Source: Worsoe Clausen, *et al* 2005)

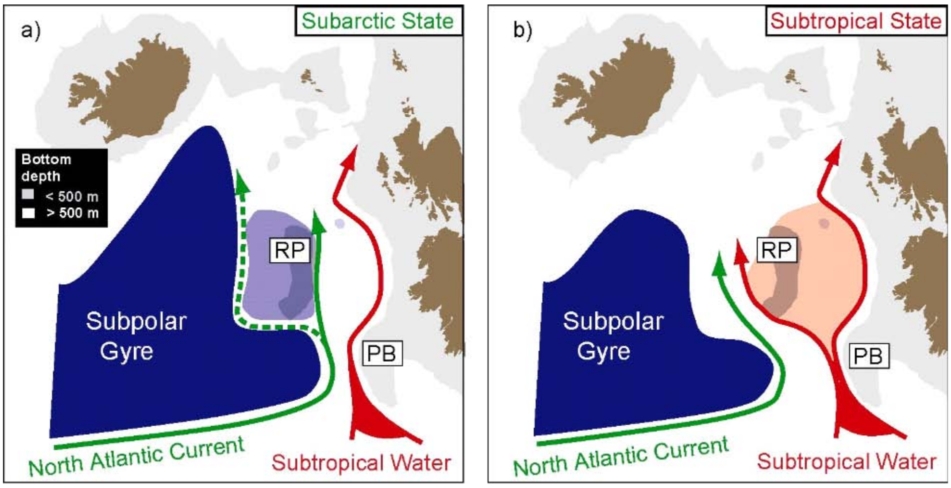


Figure E2 **Outline of the source flows to the blue whiting spawning grounds in the Rockall Region. (a) A strong subpolar gyre (SPG) results in strong influence of cold subarctic water near the Rockall Plateau. (b) A weak gyre results in warm subtropical dominance near the plateau (based on Hátún *et al.*, 2005). Abbreviations - RP: Rockall Plateau and PB: Porcupine Bank. (Source: Hatun *et al* 2009a)**

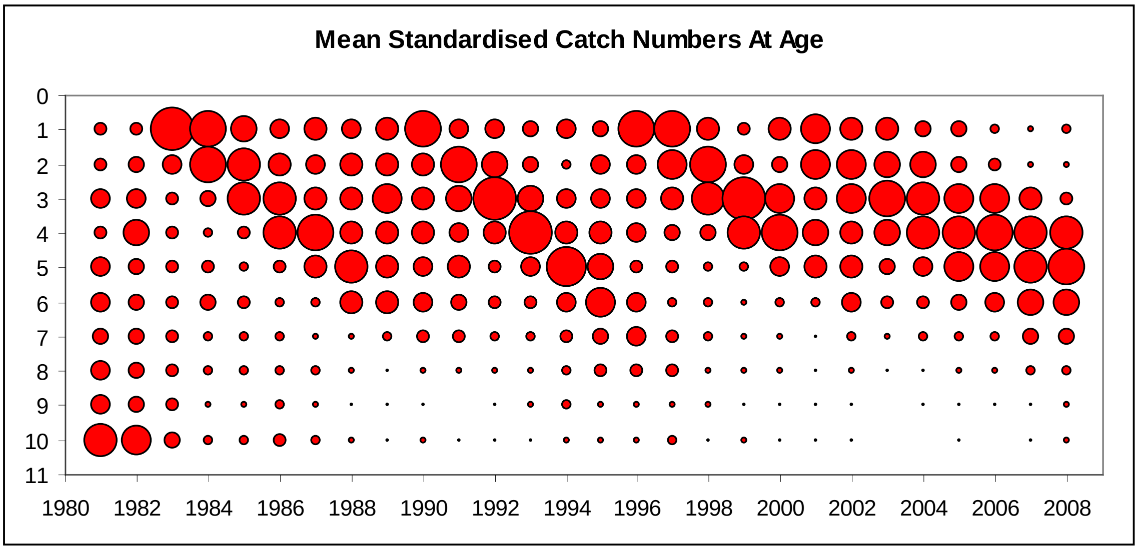


Figure E3: Catch numbers at age mean standardised by year

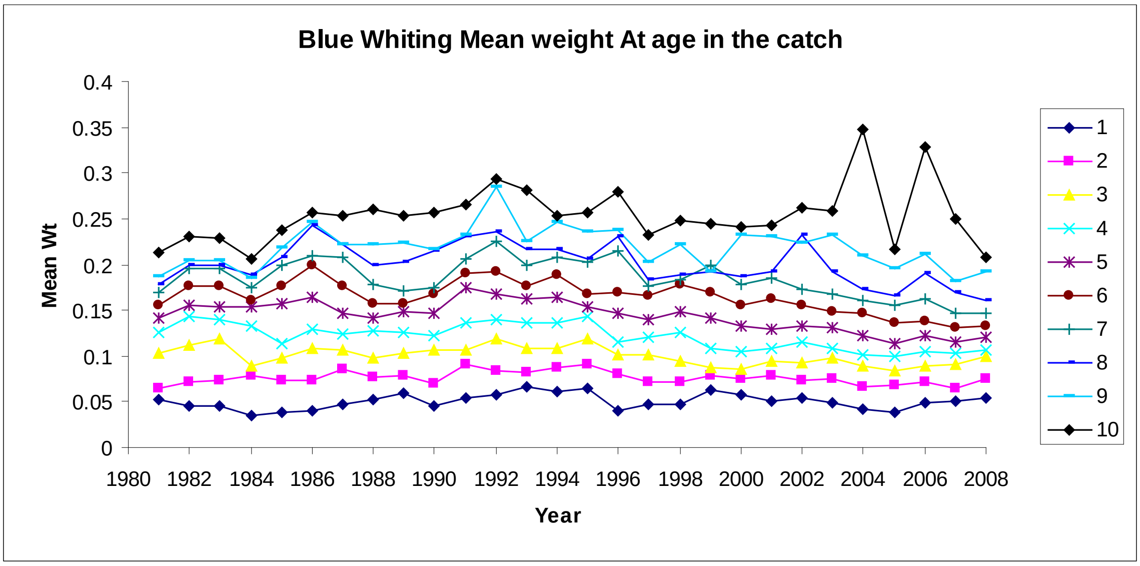


Figure E4: Mean weight in the catch

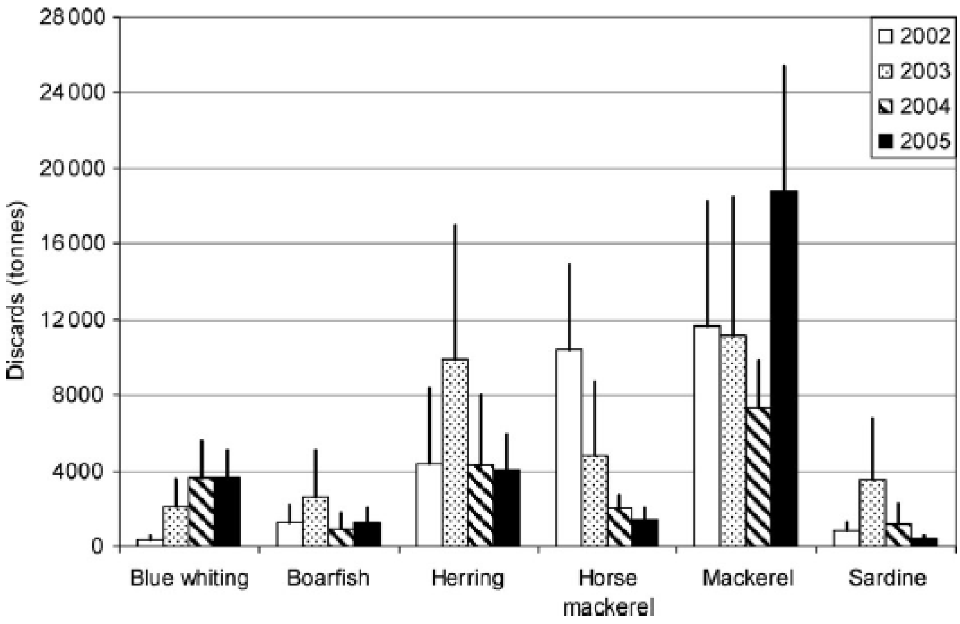


Figure E5: Biomass discarded by the Dutch freezer trawler fleet annually (raised using total number of trips) for the six most discarded species. The vertical lines represent the standard error on the estimates. (From Borges *et al* 2008)

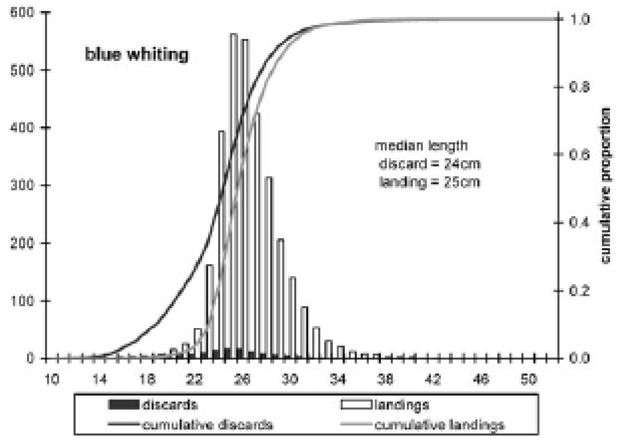


Figure E6: Length frequencies of discarded (filled histograms) and landed blue whiting (white histograms) by the Dutch fleet between 2002 and 2005. (From Borges, *et al* 2008)

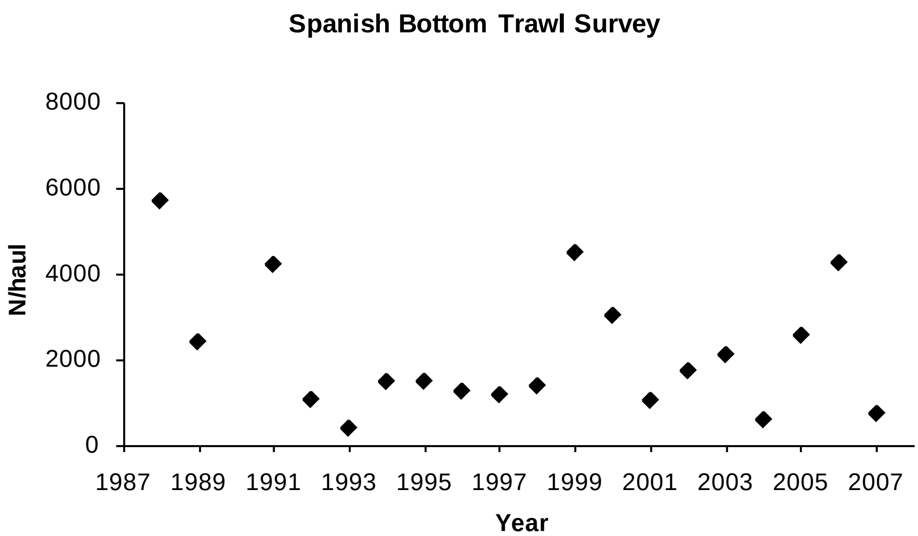
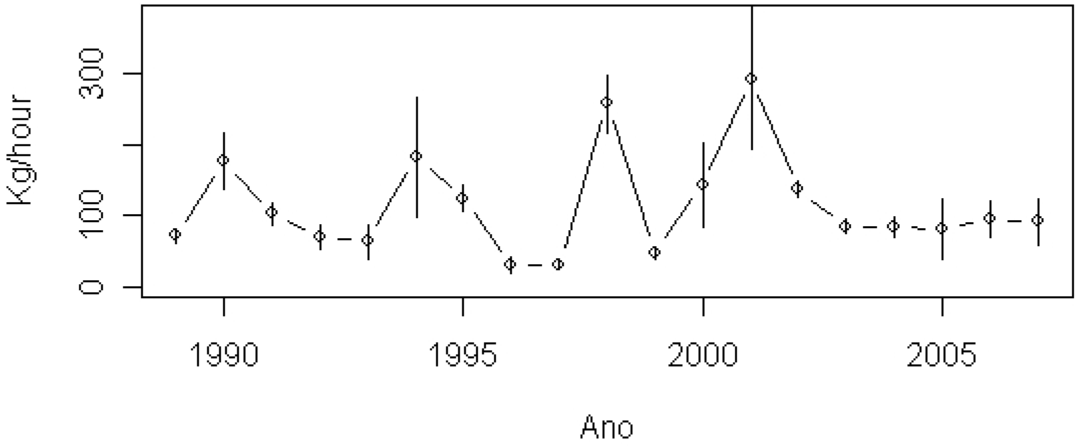


Figure E7. Mean catch rates (Kg/haul and Number/haul) of blue whiting in Spanish bottom trawl survey.



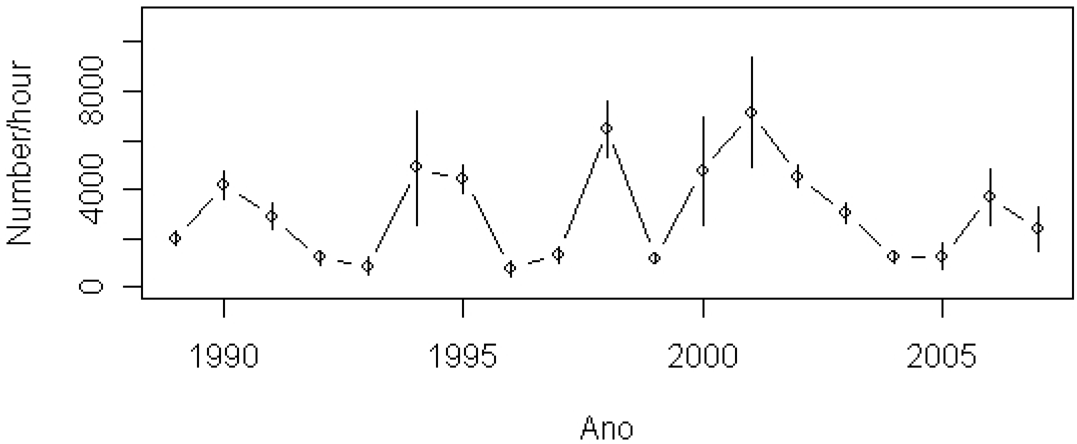


Figure E8: Stratified mean catch (Kg/haul and Number/haul) and standard error of blue whiting in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September –October

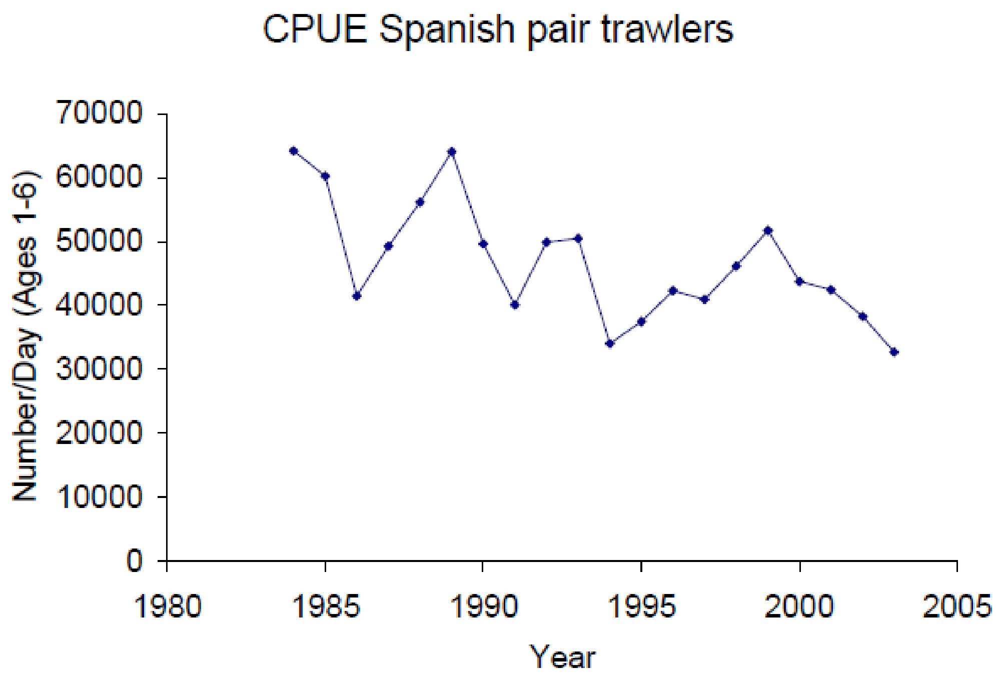


Figure E9: Blue Whiting CPUE from Spanish Pair Trawlers in ICES Div VIIIc and IXa (North)

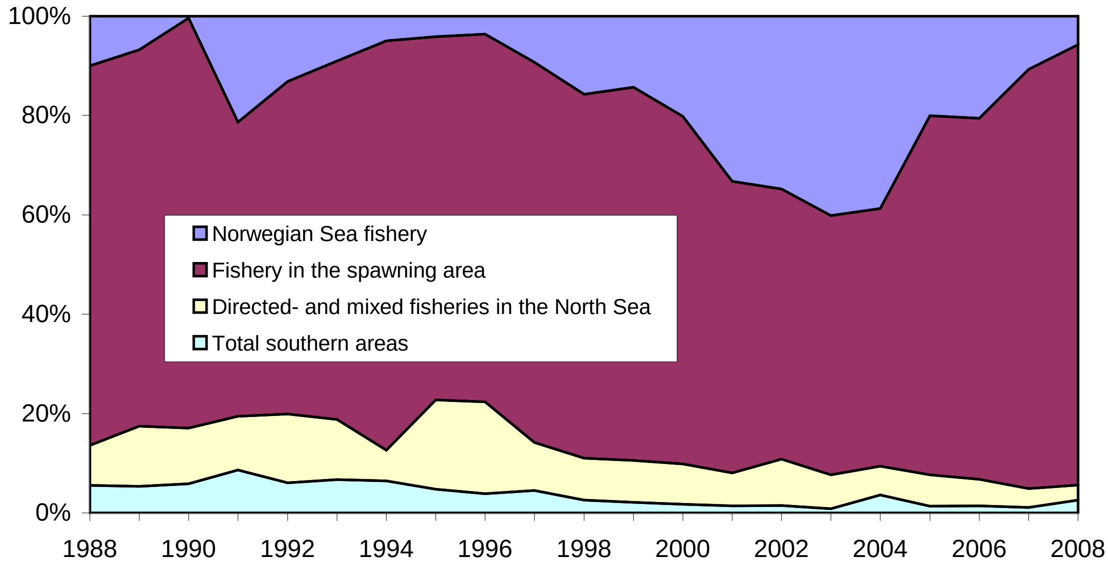


Figure E10: Development of Blue Whiting fisheries in different areas

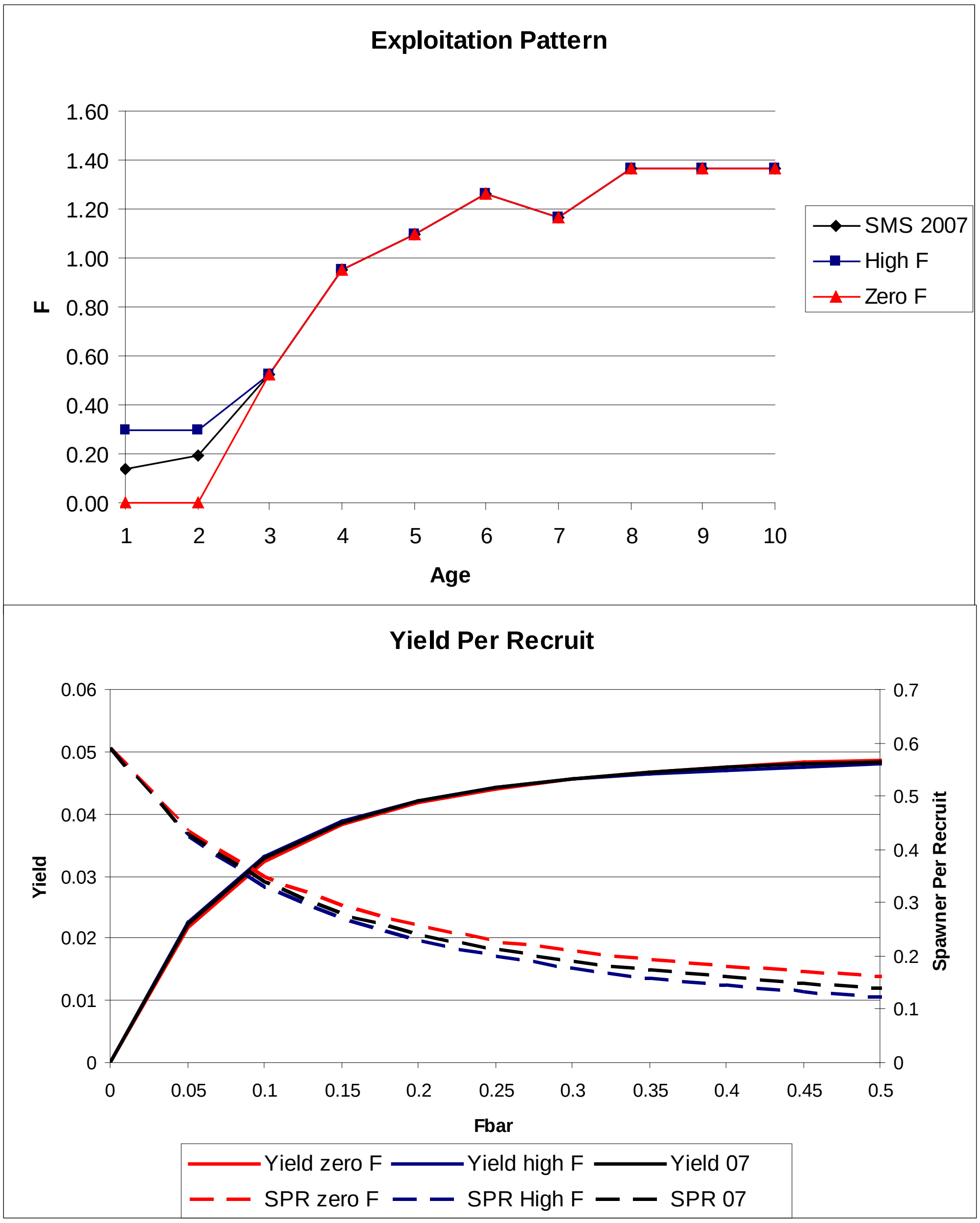


Figure E11: Blue Whiting exploitation pattern (upper) and yield per recruit curves (lower)

Annex 4 - Technical Minutes

Review of ICES Working Group for Widely Distributed Stocks (WGWIDE) Report 2009 - *15.9. – 28.9.2009 - By correspondence*

Reviewers: Antonio Avila de Melo,

Michel Bertignac,

Maurice Clarke,

Ari Leskelä (chair)

Chair WG: Beatriz Roel

Secretariat: Cristina Morgado

Audience to write for: advice drafting group, ACOM, benchmark groups and next years EG.

General

The RG acknowledges the intense effort expended by the working group to produce the report. The report was delivered to RG in time. Working Group provided the information needed and offered help during the review as asked. Especially the re-runs of some assessments during the review process increased the workload of WG chair and members.

The Review Group considered the following stocks:

Fish Stock	Stock Name	Advice
her-noss	Herring in the Northeast Atlantic (Norwegian spring-spawning herring)	Advice
hom-nsea	Horse mackerel (*Trachurus trachurus*) in Division IIIa, Division IVb,c and VIId (North Sea stock)	Same advice as last year
hom-soth	Horse mackerel (*Trachurus trachurus*) in Division IXa (Southern stock)	Advice
hom-west	Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)	Advice
mac-nea	Mackerel in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)	Advice
whb-comb	Blue whiting in Subareas I-IX, XII and XIV (Combined stock)	Advice

The review group worked by correspondence. In the beginning of RG work, the stocks were allocated to RG members so that each member worked mostly with the stock(s) allocated to him. Other commitments and workload of the RG members made it impossible to find common timeslot for internet meetings, either. As a result, the RG feels that there wasn’t enough time for discussion, sharing of thoughts and for building a common opinion on assessments during the review process.

Norwegian spring spawning herring (**Report section 7**)

1) **Assessment type:** Update assessment
2) **Assessment**: analytical assessment
3) **Forecast**: short term forecast presented
4) **Assessment model**: VPA (TASACS toolbox), 8 surveys
5) **Consistency**: Assessment is consistent with last year assessment, which was a benchmark assessment.
6) **Stock status**: SSB well above B_{pa}, F well below F_{pa}.
7) **Man. Plan.**: Agreed in 1996. ICES considers that the management plan is consistent with precautionary approach

General comments

In the assessment originally received from the WG, retrospective run was not able to fully reproduce the 2008 final assessment. The reason for this was not resolved during the WG. However, during the review the WG noticed that some terms were weighted differently this year than last year. This was corrected, new assessment was produced and reviewed. This review refers to the corrected assessment made 22.9.2009.

In 2008 an extensive benchmark analysis was made for northern spring spawning herring. Several stock assessment methods were examined and VPA within TASACS framework was chosen as the assessment method due to somewhat better fit of the survey data to the catch data. The assessment appeared to be more sensitive to the choice of data used than to the choice of model.

For this year assessment, catch data was available from all those countries, which took part to the fishery in 2008. Sampled catches accounted for 95 % of the total catches. Information on by-catches was available from the Faroes and Iceland, where there was high by-catches of mackerel in summer fisheries. Discarding in fisheries catching northern spring spawning herring is considered to be very low, as confirmed by recent estimates from some countries. Wouldn't it be possible to get both by-catch and discard information from EU countries as a part of sampling within EU Data Collection framework?

In 2008 catches, an unexpectedly high catches in numbers of ages 1 and 2 were observed. The exploratory TISVPA analysis picked up the signals of strong year classes 2007 and 2008. RG notes, that this is contradictory with survey results, which suggest weak recruitment since 2004.

Assessment uses 8 surveys. 3 of the surveys have ceased, but their data is still used in the assessment. The winter surveys in the Norwegian fjords where the adult herring was wintering are stopped, as the herring do not winter in the fjords any longer. It is assumed, that there is a new wintering area developing somewhere, but this has not been confirmed.

Detailed comments

Comparison with last years benchmark assessment and stock annex

This years assessment was run according to the benchmark in 2008 using the VPA population model in the TASACS toolbox with the same model procedures and settings as in the benchmark assessment and stock annex.

This years assessment results are in accordance with last years results. Retrospective analysis shows weak retrospective pattern, except for underestimation of SSB and overestimation of F in 2006 caused by strong year class 2002.

Catch in numbers and weight-at-age in the catches were produced using the computer program SALLOC as described in the stock annex.

Natural mortality values used in the assessment were according to stock annex and benchmark assessment (M=0.15 for ages 3 and older and M=0.9 for ages 0-2). In the stock annex and report of the 2008 benchmark assessment the M values used for this stock are discussed. Although relatively low, the chosen M values are supported by earlier tagging studies. The next benchmark analysis might study the choice of M further, as suggested by 2008 RG.

Maturity values were according to stock annex. Except for the year class 2002 with exceptionally high growth, the proportion mature at age used in assessment has been the same since 1996.

There is work going on to update estimates on proportion mature at age using back-calculation methods, as recommended by WG and last years benchmark group. Results from that work were not yet available for the WG. In addition, alternative values of proportion mature at age from the May survey in 2009 were presented to the WG. After discussion, WG rejected those values, since the sample size of the young age-classes (age 3) was considered too small. Working group decided to use the same proportion mature at age values in 2009 as in the most recent years. The WG recommended to further explore the different approaches to maturity ogives. One of WG recommendations is to organize a workshop before next WG to evaluate back-calculation method and provide guidance on the maturity at age sampling.. RG agrees, that such a workshop should be arranged, when the results of the ongoing work on back-calculation analyses are in hands.

In the short term prediction, the numbers of ages 2 and 3 in 2009 were estimated using RCT3 program, whereas the geometric mean was used for ages 0 and 1, and for the age 0 in 2010 and 2011. This was the same procedure as in benchmark assessment.

Ecosystem information

The ecosystem information provided in the WG report is useful and gives information on the ecosystem changes which might help to understand the observed changes in the migrations and wintering patterns of northern sea-spawning herring. The changing ecosystem and ecosystem oscillations which probably affect the migrations of the herring stock, also provide a challenge for the assessment. E.g. the possible new wintering area led to omitting winter surveys from the assessment, thus narrowing the data used in the assessment. Studies in the ecosystem effects to the hatching time and mortality of herring eggs and larvae would be useful to explain the larval density anomalies like the one observed in 2009.

Use of Survey 8 data

The assessment uses data from 8 surveys. Survey data were used according to the stock annex. However, 2009 data produced by survey 8 "Norwegian herring larvae survey on the Norwegian shelf" was omitted. A larval index produced by the survey is used in the assessment as a representative for the size of the spawning stock. In 2009, the number of larvae found in this survey was very low. The survey in 2009 started somewhat later than in the previous year, and the mean length of the captured larvae was 13.6 mm, the highest since 2003.

WG considered that the low numbers of larvae could have been due to an excessive mortality of eggs on the spawning grounds either due to adverse physical conditions or exceptionally high predation mortality. Alternatively, the early stage larvae could have been subject to very high mortality rates. Alternatively, the relatively large mean size of the larvae caught in the survey could suggest that spawning was particularly early in 2009 and the survey was not able to catch the larger larvae.

To check what is the effect of omitting the 2009 index value from survey 8, WG made a re-run where the survey 8 2009 was added. In this run, the SSB 2009 was 9.6 % lower than and WF 5-14 was 10,4 % higher than in the run without survey 8 value for 2009. The residual plot for this index 2009 value produced exceptionally large residuals.

RG notes that during the survey 8 time series the index produced by this survey has reflected the increase in SSB quite accurately (except in 2003, when weather conditions during the survey were poor and survey was late in April). Since other information on spawning stock suggests, that spawning stock at present is in a high level, RG agrees with the WG that the 2009 index value is an outlier and should be omitted.

According to this year's assessment, the last strong year class was born in 2004. In the absence of strong year classes, the stock is expected to gradually decline in the coming years. However, the recruitment estimates of the most recent years are uncertain and there are some contradictory signals in the catch data which suggest, that year classes 2007 and 2006 may be strong. Historically this stock has shown large variations and dependency on the occurrence of irregular strong year classes. It might be worth a try in the future to allocate more research effort into improving recruitment estimates.

WG recommendations

WG recommends 1) increase in sampling for weight at age in the 1st quarter in the commercial fisheries in order to increase precision of the weight at age estimates 2) workshop on maturity at age issues in Norwegian spring spawning herring. Both recommendations are well justified and RG agrees that these recommendations should be followed.

Conclusions

The Review Group agrees with the WG on this stock.

General comment on generic Horse Mackerel section (Section 3)

The RG found Figure 3.1.1. not very clear (why not use more or less continuous levels of grey or color to represent various levels of catches by rectangles instead of "dots and squares").

The RG found a bit strange the numbering of tables and figures. For instance, in the text figure 3.3.1 comes before figure 3.1.1. Is it the usual way of numbering ? Maybe a numbering based only on the stock section number would be easier to read.

North Sea horse mackerel (Trachurus trachurus)

Assessment type	Update landings only
Assessment:	No assessment
Forecast:	None
Assessment model:	None
Consistency:	same as last year
Stock status:	not known
Man. Plan.:	No management plan

General comments

There is still a mismatch between TAC set by EU and stock limits but apparently this issue should be addressed in the near future. The RG support such revision.

The RG does not understand what the WG means by a sampling intensity of 89% for catch at age data, need to be clarified (p185 of the report)

Technical comments

Improvements for next year:

Things that need update before ADG:

N/A

Conclusions

RG agrees with WG on this stock

Southern horse mackerel (*Trachurus trachurus*) (Division IXa)

Assessment type	update assessment
Assessment:	presented and agreed
Forecast:	short-term forecast (2009-2010) was carried out with stochastic recruitment around the 1992-2007 geometric mean, constant selectivity by fleet and catch by fleet following different catch assumptions: 1) status quo catch (2008), 2) 1999-2008 average catch, 3) expected catch from the historical catch trend and 4) expected catch from the status quo overall catch (2008) split according to the catch proportion trend of each fleet.
Assessment model:	The ASAP model was used in the version ASAP 2.0.19
Consistency:	Catch at age disaggregated by fleet and stock at age and SSB indices from Div. IXa bottom trawl surveys were updated with 2008 data. A double logistic function was used to get the selectivity pattern of each fleet block instead of going to through independent computation of each selectivity at age.
Stock status:	Reference points have not been defined for this stock. Apparent steady increase of average fishing mortality since 2005, though not reflected on SSB that has been stable over most recent years. Above average recruitment last observed in 2004.
Man. Plan.:	No management plan evaluated by ICES. SSB seems insensitive to any of the four short term catch assumptions and will remain at the actual level in 2009-2010. However, fishing mortality is increasingly driven by a sharp increase of the Spanish trawl fishing mortality. Catches from this fleet are mainly composed of larger (and older) fish. The medium term impact of such mortality increase on the adult component of the stock needs to be evaluated.

General comments

1) Catch statistics for the period 1991-2008 are available for Subdivision IXa. However, the Spanish catches from southeast limit of this stock distribution (Gulf of Cádiz), are still not included in the assessment. If these catches are mainly composed by the youngest age groups (0-2 years old) their importance in numbers should be well above 5%.

2) Apart a peak in 1998, total catches from 1991 till 2008 don’t present an overall trend. Spain increased its importance in the total catch since the early 1990’s and by 2007-2008 the Spanish bottom trawl and purse seine fleets dominate the total catch. This change lead to a change in the overall exploitation pattern of the stock with higher fishing mortalities at the older ages (and plus group) and to a recent increase in the average 1-11+ fishing mortality (if un-weighted by numbers or biomass at age).

3) Portuguese and Spanish bottom trawl surveys are available, with gears having a similar catchability for horse mackerel despite their different de-

sign. These surveys provide combined tuning indices for the whole distribution of the stock, with the weight given to each data set proportional to the respective area covered. This is an important support of a sound assessment.

4) A maturity ogive from Subdivision IXa South was adopted for 1992-2006. In 2007 a new estimate of maturity proportion by age was available for Division IXa, and applied on the last couple of years of the assessment. In order to avoid sudden up or down changes in the proportion of maturity at age between consecutive years (such as the case of age 1 between 2006 and 2007) three year moving averages could be considered on the computation of this annual parameter.

5) SSB estimates were available from egg surveys directed to sardine (2002 and 2005) and horse mackerel (2007). The SSB estimates of the Daily Egg Production Method were treated as relative SSB (with an associated catchability), and used for an extra tuning of the expected SSB on those years. Anyway it is hard to find the impact of such exercise on the outcome of this assessment as regards SSB magnitude and recent trends.

6) The perception of the stock recent dynamics (2005-2007, 2008) changed from last year to present assessment: SSB is stable (instead of growing), fishing mortality is increasing fast (instead of a discrete increase). This change is coupled with a general downward revision of SSB and recruitment and an upward revision of fishing mortality. In summary the picture given by the present assessment is more conservative (realistic?) than the previous one.

The four catch assumptions used on the short term forecast were not the result of four different fishing strategies but were, in practical terms, four slides of the same scenario: keep the 2008 level of catches, at present and next year. If you are adopting a status quo catch (and regardless the recruitment hypothesis) you should expect on the short term a status quo SSB.

Technical comments

The objective function in ASAP is the weighted sum of a number of negative log-likelihoods, all of them containing an input weight (lambda) that allows different emphasis on each particular component of the objective function. These weights are dependent of the user perception on the quality of each set of input data and correspondent priority should be given to the fitness of the most accurate data sets. So ultimately the assessment results are also dependent of that previous judgement from the user.

Reduction of the number of parameters required to run an assessment is in principle a good choice. However, the model seems to be highly sensitive to the method used to estimate the selection pattern of each fleet block, since apparently this has lead to a change in the perception of the stock from the 2008 to the 2009 assessment.

On top of an important parameter reduction, turning to the double logistic function option has reduced the size of the catch proportion at age residuals of all fleets. But kept their residual patterns, namely the one of the Spanish trawl fleet: for this fleet the model generally overestimates catches up to 8 years old and underestimates catches of older ages. Negative residuals also continue to dominate the catch proportions at age through the (strong) 1996 cohort in the Portuguese artisanal, Spanish artisanal and Spanish trawl.

The 2009-2006 retrospective assessment shows an over retrospective bias on both average fishing mortality and SSB. These anomalous retrospective results can be explained if different selectivity patterns occur (for one or more fleet blocks) every next year, when one more set of catch proportions at age is added to each logistic fit (which violates the model assumption of constant selectivity within the time interval of every block considered in the assessment).

Improvements for next year:

Investigate the robustness of the model: possible changes of selectivity at age for the available options of computing selectivity at age by fleet and their reflection on the assessment (for the same time interval) and retrospective patterns of average F and SSB.

Evaluate the impact of the present fishing mortality on SSB *versus* $F_{0.1}$ (level of fishing mortality is generally well above $F_{0.1}$ throughout the assessment interval) over a larger time scale: medium term projections with a low productivity regime (random recruitment around a geomean excluding the strong 1996 and 2004 year classes), under $F_{status\ quo}$ and $F_{0.1}$, both split by the several fleet blocks according with the present effort distribution.

Things that need update before ADG:

Conclusions: RG agrees agree with WG on this stock

Western horse mackerel (*Trachurus trachurus*) (Divisions IIa, IVa, Vb, VIa, VIIa-c,e-k, VIIIa-e)

Assessment type: update assessment

Assessment: analytical

Forecast: not presented

Assessment model: SAD is a linked separable VPA and ADAPT-VPA which explicitly incorporates and fits potential and realised fecundity data, with separate parameters for the two types of fecundity data. Uses also egg production estimates (sampled every three years) and catch at age data.

Consistency: Update of the 2008 assessment. Consistent model formulation and data input.

Stock status: SSB increased from 2001 to 2005, more or less stable after that, so far well above B_{lim} (the 1982 SSB); fishing mortality is estimated to be relatively low compared to historical figures ; 1982 year class exceptionally high, followed by moderate year classes on the first half of the 1990's, an above average year class on 2001 and weak ones since then.

Man. Plan: Management plan evaluated by ICES, providing a constant TAC set for 3 years. The TAC was last set in 2007, based on an egg production estimate derived from triennial egg survey results, and will remain unchanged for 2008-2010. But so far the TAC has only been given for a partial distribution of this stock whereas it should apply to all areas where western horse mackerel is caught.

General comments

The assessment is an update of the 2008 assessment, with one more year and almost identical settings except the length of the separable window which has been expended by one year (from 5 to 6 years). The reasons for this change in settings given in the report are consistent and potential consequences are investigated. The assessment has been carried out according to the stock annex descriptions. The assessment is well documented and results are clearly presented.

Ecological factors or environmental conditions possibly impacting the distribution of the population are not taken into account into the assessment and management which is acknowledged in the report.

Very little information is available on discards which makes for the moment impossible to estimate the amount of discards in the horse mackerel fishery.

The TAC set by EU is not in accordance with the distribution of the stock.

The existing egg surveys do not cover the end of the horse mackerel spawning season, despite their good geographical coverage. Furthermore egg production conversion to SSB is said to be poor.

Analysis of the catch-at age data analysis suggests that selection has shifted towards younger fish over the past decade.

Technical comments

Effort devoted to the combination of survey indices based on acoustic and bottom trawl survey should be encouraged for a potential incorporation into the assessment in order to provide more information on stock abundance. This possibility of considering those surveys in the future to provide indices of abundance is mentioned in the report.

As stated by the WG, the model relies heavily on a single prior distribution of the realized fecundity parameter and its stability over time. Any additional information on realised fecundity would be welcome to improve the reliability of the assessment.

As noted several time in the report by the working group, a recent change in selectivity-at-age for younger ages violates the assumption of constant selectivity in the separable period and should be contributing to the retrospective bias of the assessment. Maybe a way to incorporate variable selectivity (random walk) into the model should be investigated, which would help relaxing this assumption.

What does the WG means by "the catch sampled for age readings in 2008 covered 70% of the total catch" page 193.

In the summary sheet, wrong figure numbering for figure 9.4.3.2 which should be 9.4.3.3.

Conclusions

The assessment has been performed correctly according to prescribed procedures in the stock annex. All results and implications are well presented and explained. The main areas for potential improvement in the assessment have been mentioned (incorporation of further survey indices, extra information on realised fecundity, assumption on selectivity in the separable model) and should be investigated.

Review of NEA Mackerel

Assessment Type: Update

Assessment: Analytical

Forecast: Short term forecast presented in the assessment.

Assessment method: An integrated catch analysis (ICA) was used and calibrated with a triennial egg survey providing an SSB estimate.

Consistency: ICA settings have not changed since previous assessments, data were updated but with no significant changes, and the perception of the stock remains relatively unchanged. Retrospective analysis indicates revisions in survey years mainly. There is considerable noise, but it is balanced to some extent.

Stock Status: SSB has been above Btrigger (2.2 mt) and Bpa (2.3 mt) since 2005. Before that it experienced a dip to lower levels between 1999 and 2001. For most of the recent time series and F has been above F_{pa} and exceeded F_{lim} in 2002 and 2003.

In summary

The assessment of NEA mackerel as presented in section 2 is generally sound and the report is of a high quality. The assessment follows the annex in most aspects, and the exceptions are highlighted in the text below. There is some work to be done in the annex especially in describing how discards are treated. Notes are provided on possible improvements in data that can be considered in advance of the next benchmark. Overall this is a high quality work and the comments below are focused on the small number of shortcomings that exist.

The high quality of the section is impaired by two inconsistencies:

- Intermixing of scientific and legal/political considerations (see Sections 2.1 and 2.2 below).
- Incorporation of the ecosystem approach (see below)

In addition, there are some corrections that appear necessary in the summary sheet, and these are dealt with separately.

Section 2.1 and 2.2

This section contains important information on the mackerel quota allocations and management. However they suffer because scientific and legal meanings are being mixed up. The text table is also misleading because it highlights the only countries that have taken the trouble to provide estimates of discards. Those countries that do not have estimates of discards should have a "N" entered in the discard column. References to what is considered to "officially" happen is of no relevance in a scientific report.

Text on precision of EU quota compliance is hard to follow.

2.2.2 Discard estimation

It is mentioned in the summary sheet that discarding is considered a feature of this fishery, that is for human consumption, and targets larger fish. WGWIDE is to be commended for including discard estimates. In particular UK Scotland is to commended for providing age structured data. This is an example for other stocks of pelagic fish. Further improvements in discard estimation are still possible. Following the procedure used to assign landings samples to unsampled métiers, could the Scottish discard age structure be applied to other RSW trawler métiers, such as Ireland and Denmark? Similarly, the German and Dutch discard tonnages could presumably be applied to French and English freezer trawlers.

It is a matter of regret that discard estimates are not provided by the RSW seiner métiers, though initial studies were conducted (Napier *et al*. 1999). There is no published study available to suggest that discarding is not a feature of purse seine fisheries. It should be explained why estimates are not available. Any estimate is better than none. Just because discarding is illegal in some of these fleets is no reason not to have estimates. Elsewhere in the chapter, landings above quota are presented by some countries, so the same should apply to discarding.

The discard percentage in Table 2.2.1.1 (*c* 1.5- 3%) seems low. Several recent year classes contribute so much to the SSB, but have not yet reached the optimal market size (600 g). It is to be expected that discarding has been very widespread in this fishery.

Section 2.4

RGWIDE supports the group's decision not to present the recruitment indices in the report. However, given that these indices are being updated, they should be presented in the annex.

Section 2.5 and 2.6

For the same reason as for Section 2.4, the acoustic surveys should not be presented in the report, but rather in the annex. This is because they are not used directly in the assessment, either. Why does WGWIDE recommend the further development of the acoustic surveys and not of the recruitment indices? Also (see comments on section 2.14) is there a need to expand the egg survey to these northern and western areas? One of the major weaknesses in the assessment is the extremely high CV on young ages. It would be helpful if the group could inform the reader if the problems encountered with the recruit indices can be resolved. Regarding the acoustic surveys, one can envisage major problems in making them useful as tuning indices, viz:

- Not synoptic, they only cover the Norwegian and North Seas (herring surveys) and Iberia
- To west of British Isles mackerel are found at considerable depths off the shelf, but also well inshore in bays and lochs.
- Acoustic signature of mackerel is problematic.

Section 2.5 is too detailed for a report on mackerel. The methodological difficulties with mackerel should be referred to ICES WGFAST. FAST should be asked to advise on how a synoptic acoustic survey for mackerel could be developed and comment on the utility of such a survey for assessment purposes. WGWIDE should rather provide managers and ICES community with a priority list of surveys that are required to improve the assessment of the stock, based on what are considered the current weaknesses.

The information presented in section 2.6 is of some use in the report because it presents a time series of data. However if these are not used in assessment or advice, then they should appear in the annex, and be referred to briefly in the report. It provides some abundance data for part of the combined stock in part of the area. The information in 2.5 is not presented for stock assessment purposes and certainly does not belong in the report. It is only concerned with the distribution of part of the stock in part of the stock area.

Section 2.8

Settings and data are consistent with R-script and input files on sharepoint.

Section 2.9

The exact method for calculating intermediate year catch is not explained here or in the annex. Is the discard estimate a minimum, based on the final assessment year reported data? This needs to be explained. Of the countries providing discard estimates, two are freezer trawler fleets and one an RSW trawler fleet. Could their estimates be applied to the remaining nations using those gears? No purse seine fleet presents discard estimates though there is no scientific basis to assume that it does not occur. Estimates from these fleets should be provided, and if not they should be estimated.

There are some inconsistencies between the summary sheet and this section, see below and summary sheet comments.

Text table

The text table is misleading, and the column headings are unclear. What year do the columns refer to?

The third column WG estimate of total declared adds up to 615 409 by my calculation, not 613,545, giving a total estimated catch of 832,064. Perhaps I have misinterpreted the data?

Section 2.10

The uncertainty in the forecast and assessment due to discarding warrants further attention. It is likely that discard age structure is different (younger/smaller fish slipped or high-graded) and the effect of this on the assessment needs to be considered.

Section 2.13

The fourth paragraph, sentence 1 is not substantiated. There is *some* evidence that the spawning area has expanded, not that it has shifted.

Fifth paragraph: Is the analysis of unaccounted mortality conducted in 2007 robust to differing levels of unaccounted removals at different times. Could varying degrees of discarding, unreported catching and high grading in different epochs change the F trajectories over time?

Section 2.14 Ecosystem considerations

WGWIDE has made a good attempt to incorporate the ecosystem considerations into its work. However the section should be restructured for the future. There is much too much information in this section, and it is imbalanced with more information on the northern area. It is difficult to know if the absence of information, from, for example, the southern area is because there is no information or there is no change in existing circumstances. Most information on the distribution and migration of the stock is well described in the annex. This section should only provide updated information relating to the most recent season. The stock is clearly showing an expansion westwards and northwards. The salient points are:

- March/April 2009: Mackerel distributed in high densities across blue whiting survey area, off shelf break and feeding on mesopelagic layers.
- May 2009: Mackerel found off Norwegian shelf
- July 2009: Mackerel found off the shelf and far to west in Norwegian Sea. Confirms this sea as an important juvenile area.

The last paragraph is rather weak. The most important question is whether the expansion of mature mackerel outside the egg survey area contributes to significant unrecorded egg production. Previous studies (Dransfeld *et al*. (2002) suggested that the westward expansion did not. The contribution of spawning in northern and western areas may be a priority to investigate, and would be helpful to the stock assessment as well. But isn't a recruitment index a priority too, given that it would assist the forecast as well as the assessment?

References

Dransfeld, L., Dwane, O., Molloy, J., Gallagher, S., and Reid, D. G. 2005. Estimation of mackerel (Scomber scombrus L., 1758) and horse mackerel (Trachurus trachurus L., 1758) daily egg production outside the standard ICES survey area. ICES Journal of Marine Science: 1705-1710.

Napier, I. R., Robb, A. P., Holst, J.C. (1999). Investigation of the extent and nature of discarding from herring and mackerel fisheries in ICES sub-areas IVa and VIa. Studies in support of the Common Fisheries Policy, North Atlantic Fisheries College**:** 22 pp.

Review of NEA blue whiting

Assessment Type: (unclear) Technically an update, but no benchmark has ever been conducted.

Assessment: Analytical

Forecast: Short forecast presented with the assessment.

Assessment method: SMS was used and calibrated with three acoustic surveys, with differing time spans .

Consistency: The assessment is consistent with previous final assessment in most aspects. One model parameter setting was changed compared to last year (lower bound of cv) and the assessment results in a perceived increase in SSB in recent years.

Stock Status: SSB has been above Btrigger (2.5 mt) and Bpa (2.25 mt). F (0.276) is below Fpa (0.32) but above $F_{0.1}$ (0.18). There is a quite marked historical retrospective pattern in this assessment with a clear tendency to underestimate F and overestimate SSB.

Reference points have been reviewed and it was decided to keep them as they are. However there is an inconsistency because Fpa is often associated with SSB < Bpa.

General

The assessment is technically sound, and conducted according to the annex. However the annex was only written in 2009, at the same time as the assessment was being conducted. Much work has been devoted to developing a standard assessment for this stock and it seems that SMS has been settled upon. The assessment has had to evolve over a number of years and may not have reached a stable set of settings yet. Only one change was made in 2009, removing a lower bound on the CV for the survey. This has led to an upward revision of SSB. The change is justified and well documented in the report. The main recommendation is to have a benchmark of this stock as soon as possible.

I attach some minor comments on small inconsistencies in the text. Overall the RG feels that the assessment is a valid basis for advice, though it will be hard to explain the changing perception of the stock to managers.

Ecosystem

This section of the report is about the right length, though it tends to focus on the mackerel interaction issue. Other useful information is in the annex, on the work by Hatun *et al*. A summary of this information would have been a useful paragraph in the report also.

Section 8.3

The fishery description is difficult to follow. It is difficult to understand what is meant by "mixed fisheries".

Section 8.4 Assessment

The assessment run that was chosen as final is different to that used last year. However there is good reason to do this. The short time series of international surveys warranted a minimum CV being allowed. In 2009, a longer time series is available. It seems justified to remove the constraint.

There are very strong year effects in the international survey and the Norwegian Spawning Stock Survey.

The settings used are almost the same as last year. Though the one change made did have a significant impact on SSB estimate, it seems justified. The stock annex was only written this year, and was not the product of a benchmark. Indeed, a benchmark has never been conducted for this stock. Therefore the annex is a summary of recent model formulations and not a manual for the assessment.

In Table 8.4.1.4 it is stated that the SSB for 2009 does not include age 1. Why is this? Does the SSB estimate for 2008 not include age 1? This needs to be stated.

Section 8.8

The comparison with previous assessment and forecast section is hard to follow. A text table showing the 2006 and 2007 estimates of F and SSB from the last two assessments should be included here. The revisions are of the order of one million tones on SSB. It is going to be very hard to explain this to managers.

Short term forecast:

Catch for F_{pa} option should read 899 not 898.

Does the 358 000 t used as a basis for the forecast include age 1?

Revision of the Blue whiting assessment

During the review process, a new assessment run was produced by the WG. The reason for this was that the Russian catch figure for 2008 in the original assessment was a wrong one. WGWIDE used a catch of 164072 t, and the corrected value was 225163 t. The new text, tables and figures were included in the WG report.

The increase in the Russian catch estimate, which represented ca 5 % of the whole 2008 catch, had relatively small effect on the assessment. Survey residuals, catch residuals, retrospective plot and SMS diagnostics were almost in the new and the former assessment run. In the short term forecast, the TAC according to management plan changed from 544 thousand t to 543 thousand t, and SSB in 2011 changed from 2640 thousand t to 2639 thousand t.

Conclusion

The review group agrees with the WG on this assessment