ICES WGWIDE REPORT 2010

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

28 August - 3 September 2010

Vigo, Spain

ICES
International Council for the Exploration of the Sea
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Executive Summary

The Working Group (WG) on Widely Distributed Stocks (WGWIDE) met in the Instituto Español de Oceanografia, Vigo, Spain,from the 28 August to 3rd September 2010. 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 and Western Horse Mackerel stocks and Norwegian Spring Spawning Herring. The advice for North Sea and Southern horse mackerel were not updated this year.

In addition, MSY reference points for all stocks for which advice was updated were evaluated by WGWIDE and are reported here.

Preliminary estimates of the Mackerel International Egg Production survey were examined by the WGWIDE. The estimates were used in the stocks assessment and advice for mackerel and western horse mackerel.

Northeast-Atlantic (NEA) Mackerel. This species is distributed in the whole ICES area and currently supports one of the most valuable European fisheries (with 2010 landings estimated at 930 thousand tonnes). 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. Fishing mortality in 2009 is estimated to be at the precautionary level. SSB has increased considerably since 2002 and is estimated at 2.98 million tonnes in 2009. The 2002 year class is the highest on record.

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. A number of assessment methods were conducted for southern horse mackerel in preparation of the benchmark workshop that will take place in 2011.

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. In the absence of strong year classes after 2004, the stock has declined in 2010 and is expected to decline in the near future even when fishing according to the 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. The assessment revealed that the year classes 2005-2009 are among the lowest observed. SSB has declined as a result of low recruitment. The decline is expected to continue if recruitment remains at the recent low level, even with small catches.

1 Introduction

1.1 Terms of Reference

The **Working Group on Widely Distributed Stocks** [WGWIDE] (Chaired by: Beatriz Roel, UK) will meet in Vigo, Spain, 28 August –3 September 2010 to:

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

b) evaluate the 2010 survey preliminary estimates of mackerel SSB and horse mackerel egg abundance. The evaluation will be the basis for a decision on whether to use the estimates in the assessments. This decision should be made on the first day of the working group meeting (August 28th). Members are encouraged to review and discuss the results prior to the meeting.

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.

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date. Results from the mackerel egg survey to be used as basis for the preliminary NEA mackerel SSB index should be circulated by August 23rd (Monday).

WGWIDE will report by 7 September 2010 for the attention of ACOM.

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
Åge Høines	Norway
Svein A. Iversen	Norway
Jan Arge Jacobsen	Faroe Islands
Høgni Debes	Faroe Islands
Teunis Jansen	Denmark
Alexander Krysov	Russian Federation
Charlotte Main	United Kingdom
Manolo Meixide	Spain
Alberto Murta	Portugal
Leif Nøttestad	Norway
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
David Miller	Netherlands
Katja Egberg	Norway
Cristina Morgado	ICES
Tessa van der Hammen	Netherlands

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 is 87%, maintaining the increases of recent years. The proportion of the horse mackerel catch sampled increased from 77% in 2008 to 87% in 2009, but still only a limited number of countries provide data. Norwegian spring spawning herring and blue whiting sampling covers 94% and 88% 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
2009	734,889	87	1,231	139,867	28,722

***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%. 87% of the total catch was covered by national sampling programmes. 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.

Denmark, Iceland, Ireland, Norway, Portugal, Russia and Spain all sampled over 90% of their catch. Samples from the Scottish fishery covered 92% 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 percentages from Germany and Netherlands have decreased.

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	3	0	0	0	0
Denmark	23,491	99	13	1023	1023
Faroe Islands	14,062	42	16	533	326
France	18,340	0	0	0	0
Germany	22,703	22	39	6,571	1,520
Iceland	116,160	99	48	2,094	1,855
Ireland	61,056	99	48	8,105	5,399
Jersey	8	0	0	0	0
Netherlands	23,568	37	25	2,369	625
Norway	121,229	95	168	30,123	5,646
Portugal	1,753	100	119	8,934	683
Russia	41,414	96	75	22,746	696
Spain	114,074	100	540	38,606	4,503
Sweden	7,303	0	0	0	0
UK (England & Wales)	2,974	25	54	6,640	3,248
UK (Northern Ireland)	2,736	0	0	0	0
UK (Scotland)	151,300	92	86	12,123	3,198
Total	722,174	87	1,231	139,867	28,722

*** Percentage based on Working Group catch**

The following table describes the mackerel sampling intensity levels in terms of catch in each ICES division. Areas where insufficient sampling was carried out include IIIa (1682t), VIIc (310t), VIIh (643t), VIIIa (2,456t), VIIId (3,164t) and XIVa (535t). This has been the case for some of these areas for several years.

AREA	OFFICIAL CATCH	WG CATCH	NO SAMPLES	NO AGED	NO MEASURED	NO AGED/ 1000 TONNES*	NO MEASURED/ 1000 TONNES*
IIa	79,234	79,234	84	1,288	21,663	20	270
IIb	16	16	0	0	0	0	0
IIIa	1,682	1,682	0	0	0	0	0
IIIb	2	2	0	0	0	0	0
IIId	4	4	0	0	0	0	0
IVa	222,872	231,397	229	9,749	37,821	40	170
IVb	752	885	3	75	231	100	310
IVc	286	171	1	25	60	90	210
Va	79,154	79,154	32	1,132	1,301	10	20
Vb	4,665	4,665	17	323	2,202	70	470
VIa	137,275	136,723	91	4,468	14,770	30	110
VIIa	29	773	0	0	0	0	0
VIIb	23,378	22,938	19	1,561	2,988	70	130
VIIc	310	239	0	0	0	0	0
VIId	3,377	3,492	11	275	1,111	80	330
VIIe	497	1,744	31	1,649	3,790	3,318	7,626
VIIf	461	461	24	1,624	2,946	3,523	6,390
VIIg	12	12	0	0	0	0	0
VIIh	643	150	0	0	0	0	0
VIIj	40,381	43,774	30	1,367	3,444	30	90
VIIIa	2,456	3,178	0	0	0	0	0
VIIIb	13,242	12,750	172	756	11,719	60	880
VIIIcE	75,974	75,974	257	2,569	20,315	30	270
VIIIcW	15,452	15,452	65	546	3454	40	220
VIIId	3,164	3,164	0	0	0	0	0
IXaN	14,569	14,569	46	632	3,118	40	210
IXaCN	1,753	1,753	119	683	8,934	390	5100
XIVa	535	535	0	0	0	0	0
Total	722,174	734,889	1,231	28,722	139,867	40	190

*** 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
2009	247,637	87	1,258	92,846	13,345

*** Percentage related to Working Group catch**

There was again an increase in overall sampling for horse mackerel from 2008 to 2009. This is the 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 2009, 70% of the horse mackerel measured were from Divisions VIIIa,b and IXa.

Countries that carried out sampling were Germany, Ireland, the Netherlands, Norway, Portugal and Spain and covered 50-100% of their catches. No data from France and Lithuania were provided to the Working Group.

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

COUNTRY	OFFICIAL CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Belgium	5	0			
Denmark	6,098	0			
Faroe Islands	0				
France	0				
Germany	16,420	50	29	4,375	1,114
Ireland	40,754	94	47	7,951	4,218
Lithuania	0				
Netherlands	61,997	80	50	7,617	1,250
Norway	72,619	100	86	5,868	501
Portugal	10,851	100	194	27,144	1,998
Spain	36,722	98	947	49,173	4,485
Sweden	660	0			
UK (Scotland)	1,417	0			
Sum (WG catch)	247,637	87	1353	102,128	13,566

* 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	6,009	0			
Faroe Islands	0				
France	0				
Germany	15,121	54	29	4,375	1,114
Ireland	40,754	94	47	7,283	4,218
Lithuania	0				
Netherlands	43,648	66	23	3,738	575
Norway	59,537	99	78	5,868	442
Spain	21,071	100	680	31,498	3,211
Sweden	258	0			
UK (Scotland)	1,413	0			
Sum (WG catch)	176,918	84	857	52,767	9,560

* 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	5	0			
Denmark	89	0			
France	0	0			
Germany	1,299	0			
Ireland	0				
Netherlands	22,546	95	27	3,879	675
Norway	12,855	99	8	668	59
Sweden	402	0			
UK (Scotland)	4	0			
Sum (WG catch)	44,223	92	35	4,547	734

* 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	10,851	100	194	27,140	1,998
Spain	15,646	95	267	17,675	1,274
Sum (WG catch)	26,497	97	461	44,815	3,272

* 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	1,847	1,847	0				
IIIa	38	38	0				
IVa	59,834	58,810	39	221	2,934	4	50
IVb	14,558	13,925	8	59	668	4	48
IVc	9,027	5,822	1	25	228	4	39
Va	0	0					
Vb	0	0					
VIa	19,833	17,776	19	2,298	2,260	129	127
VIb	0	0					
VIIa	5	5	0				
VIIb	33,074	28,503	36	2,016	5,332	71	187
VIIc	3,651	2,151	6	224	910	104	423
VIId	13,505	24,366	26	650	3,651	27	150
VIIe	3,727	8,726	9	286	1,766	33	202
VIIf	0	0					
VIIg	0	0					
VIIh	3,927	7,108	1	25	164	4	23
VIIj	31,145	18,588	27	1,033	4,721	56	254
VIIk	569	126	0				
VIIIa	2,944	9,733	0				
VIIIb	2,016	1,783	36	579	1,988	325	1,115
VIIIc	20,903	20,903	645	2,657	29,753	127	1,423
VIIId	446	936	0				
IXaCN	5,119	5,119	107	1,998	16,699	390	3,262
IXaCS	3847	3847	31		4,097	0	1,065
IXaN	14,886	14,886	2,67	1,274	17,675	86	1,187
IXaS	760	760	0				
Sum	247,544	247,637	1,353	13,566	102,218	55	413

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
2009	1,686,928	94	663	65536	12265

94% 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 31 and 100%. No sampling was carried by Greenland and Scotland but catches of these countries represent together only 1.7% of the total catch.

COUNTRY	OFFICIAL CATCH	% CATCH COVERED BY SAMPLING PROGRAMME	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	32320	100	13	1576	338
Faroe Islands	85099	80	16	1003	216
Germany	14453	67.	22	8705	1358
Greenland	3730	0	0	0	0
Iceland	265479	100	142	6197	3473
Ireland	10014	100	2	180	158
Norway	1016675	100	312	16919	4233
Russia	210105	85	111	25916	1364
Scotland	25477	0	0	0	0
The Netherlands	23576	31	45	5040	1125
Total	1,686,928	94	663	65536	12265

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/ 1000 TONNES*	NO MEASURED/ 1000 TONNES*
I	873	873	12	360	1150	412	1317
IIa	1471265	1472329	475	7999	37044	5	25
IIb	55123	54504	87	1817	22681	33	416
IVa	44563	44563	21	574	1622	13	36
Va	98688	98688	55	1075	2420	11	25
Vb	240	240	2	96	100	400	417
XIVa	16176	16176	11	344	519	21	32
Total	1,686,928	1,687,373	663	12265	65536	7	39

*** 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
2009	635,639	88	705	79500	18142

* no figures given

88% 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 Demark, France, Germany and Scotland, representing together 2.2% 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	248	0	0	0	0
Faroe Islands	58,354	99	18	1872	983
France	8,831	0	0	0	0
Germany	5,044	0	0	0	0
Iceland	120,202	98	73	4838	2793
Ireland	8,776	96	7	1436	706
Netherlands	35,686	95	66	13684	1700
Norway	225,995	94	175	8592	902
Portugal	2,043	100	37	3570	6105
Russia	149,650	71	157	31594	3052
Spain	20,637	100	172	13914	1901
UK(Scotland)	173	0	0	0	0
Total	635,639	88	705	79500	18142

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	45915	45913	160	17225	1420	375	31
IIb	271	271	7	1235	150	4557	554
IIIa	131	131	0	0	0	0	0
IVa	22234	22234	41	1348	58	61	3
IVb	22	22	0	0	0	0	0
IXa	2043	2043	37	3570	6105	1747	2988
Va	433	433	1	100	50	231	115
Vb	115456	115456	70	12599	1844	109	16
VIa	218514	218514	152	19866	3942	91	18
VIb	74122	74122	21	1973	885	27	12
VIIb	355	355	0	0	0	0	0
VIIc	111010	110534	39	7219	1537	65	14
VIIg	1692	1692	0	0	0	0	0
VIIIa	1868	1867	0	0	0	0	0
VIIIc	20637	20637	172	13914	1901	674	92
VIIj	39	46	0	0	0	0	0
VIIk	6348	6348	0	0	0	0	0
XII	14539	14539	5	451	250	31	17
XIVa	10	10	0	0	0	0	0
Total	635639	635167	705	79500	18142	125	29

* 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

Discarding in pelagic fisheries is more sporadic than in demersal fisheries. This is because the nature of pelagic fishing is to pursue schooling fish, creating hauls with low diversity of species and sizes. Consequently, discard rates typically show extreme fluctuation (100% or zero discards). High discard rates 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 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% by number (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 2010, discard estimates for 2009 from the Netherlands and UK (Scotland) for mackerel, horse mackerel, Norwegian spring spawning herring and blue whiting were provided to the working group. A newly establish Irish discard sampling programme consisted of seven mackerel targeted observer trips during which no discarding was observed. Slippage reports from the Irish MSC mackerel fishery were also provided to the working group. No discarding during three German trips targeting mackerel, Norwegian spring spawning herring and horse mackerel were observed. 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, Scotland, Germany and Ireland provided discard/slippage data on mackerel to the working group. Age and length disaggregated data were available from the Scottish fishery in the fourth quarter in area IVa. The estimated mackerel landings of Scotland and the Netherlands represent approximately 24% of the total landings. Mackerel catches of Germany and Ireland, both of which observed zero discards, represent 3% and 8% of the total catch. For 2009 the total mackerel discards reported were approximately 13kt. The working group considers this to be an underestimate (see section 2.2.2).

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 2009 the Netherlands estimated discards of 633t for their pelagic fleet, accounting for 1% of the national landings. Horse mackerel catches of the Netherlands represent 25% of the total catch of the Western area. No discarding was observed on a sampling trip conducted by Germany.

Norwegian Spring Spawning Herring

The Working Group has no comprehensive data to estimate discards of herring. Although discarding may occur on this stock, it is considered to be very low and a minor problem for 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 and 2009 of about 2% in weight were provided by the Netherlands.

A report from the Norwegian coast guard this year concludes that the herring fishery was conducted in what they consider a satisfactory way. The coast guard followed the fishery during fishing season in the first quarter with several vessels and a plane. Few observations of slipping were made and no observations of net breakage (see section 7.5.2).

Blue Whiting

In general, discards are assumed to be minor in the blue whiting directed fishery. Some discard data to the working group were provided by the Netherlands. Overall discards were estimated to be 368t (1% of the national landings). 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

Under the coordination of Marine Scotland Science, a representative collection of otoliths was prepared. Samples were included from all quarters in the year and all ICES areas relevant to this exchange. This collection was distributed to all 12 countries which supply data for the assessment of North East Atlantic mackerel (13 participating institutes). The exchange started in September 2008 at Aberdeen and ended at DTU Aqua in Denmark in August 2009. Some otolith samples showed deterioration through the course of the exchange. This caused an increase in non-readable otoliths for the countries that received the otolith package towards the end of the exchange.

The estimated ages from each participating institute were returned to the coordinators and analysed by comparing them against the resulting modal age. From this, the percentage agreement, precision coefficient of variation (%CV) and bias were calculated. Participants were divided into readers who provide ages to the assessment (experts) and those that do not (non-experts).

The overall percentage agreement for experts was 67.6%, although it varied between 20% and 100% with higher agreement in the otoliths of smaller fish and lower agreement in the larger fish. High variation in age estimation was observed in some otoliths, the highest range was 4-14. In the expert group % CV ranged from 0% to 387% with an average of 23.8%. The overall agreement for the non-expert group was 49.5%. These demonstrated a tendency to underestimate ages compared to the modal age.

The overall agreement for experts was low enough to merit a more detailed examination of the differences in mackerel age estimation between institutes. Approaches to reading technique and interpretation need to be reviewed. A workshop has been scheduled in November 2010 to address this requirement.

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 aspects 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 also indicates 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 with a workshop held after the exchange. The Institute of Marine Research, Norway, has coordinated the exchange and will also carry out the workshop. Currently the exchange is ongoing and no intermediate results were available to the working group.

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)

In 2010 a Workshop (WKHERMAT)[1] was held to evaluate existing maturity at age data. The Workshop was held because data on maturation were not available and considered in the benchmark assessment in 2008. The work of the Workshop therefore concludes the benchmark process. Three sources of maturity information were considered. The three different data sources were: a) maturity ogive used in assessment, b) survey data on maturity staging collected during surveys 4 and 5 and c) back-calculated maturity ogive using Gulland's method. In addition, data on maturity cycle in Norwegian spring spawning herring were presented and guidelines for sampling of maturity data were discussed in accordance with PGCCDBS. See section 7.5.5 for details.

Blue Whiting

No issues regarding biological data for blue whiting were raised during the WG.

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 stock 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

1 Report of the Workshop on estimation of maturity ogive in Norwegian spring spawning herring (WKHERMAT). 1-3 March 2010 Bergen, Norway. ICES CM 2010/ACOM:51 REF. PGCCDBS

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 (positive or negative) 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.
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 stock 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 in the case of Horse Mackerel. Norwegian spring spawning herring and blue whiting are generally covered, countries not providing data constitute 0.2% and 2.3% 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

In recent years, ICES has implemented a Sharepoint solution for the storage and sharing of working group data and documentation. In addition, a shared folder is usually made available to working group participants for the duration of the meeting. Traditionally, stock data was stored in a folder called 'archives' on this shared disk. Upon completion of the meeting the folder is backed up and maintained by ICES. This is problematic for group members who wish to view historic data. **The WG recommends that an equivalent structure on the Sharepoint point be established for the storage of such data and that ICES communicates this clearly to the stock and assessment coordinators and that access to all historic sharepoint sites in their original form be maintained. Consideration should also be given to making the data and working documents from meetings where no Sharepoint site was available accessible to members of WGWIDE.**

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 2009.

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	NO	NO
Germany	YES	YES	YES
Iceland	YES	YES	YES
Ireland	YES	YES	YES
Netherlands	YES	YES	YES
Northern Ireland	YES	YES	NO
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 Poland not listed (official catches below 100t), ** Incomplete dataset

B. Horse Mackerel

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

Country*	Data Supplied	Data Exchange Sheet	Aged Samples
Denmark	YES	YES	NO
Faroes	YES	YES	NO
Germany	YES	YES	YES
Ireland	YES	YES	YES
Netherlands	YES	YES	YES
Norway	YES	YES	YES
Portugal	YES	YES	YES
Scotland	YES	NO	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	YES
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	NO

D. Blue Whiting

Stock Coordinators: Manolo Meixide

Country	Data Supplied	Data Exchange Sheet	Aged Samples
Denmark	YES	YES	YES
Faroes	YES	YES	YES
France	YES	NO	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	YES	NO	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 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	*Limited data supplied by France*	*Catch data should be supplied by quarter and area*	*French national laboratory should privide 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 and expanded. 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.*

Stock	Data Problem	How to be addressed in DCR	By who
Horse Mackerel (all stocks)	*Most catch data is submitted on spreadsheets. Only some countries provided data 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)*
Horse Mackerel (all stocks)	*No data provided by France 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*

1.3.8 InterCatch

Prior to the working group, ICES requested that all stock data be entered in InterCatch. Due to time constraints and problems with InterCatch functionality it was not possible to enter all WG 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 similar to those reported last year. No comparison was made for Blue Whiting. The 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 further 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 is important that countries continue to provide the data in the current exchange format as this provides catch information 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 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. A provisional estimate of SSB from the triennial Egg survey was used in the assessment

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. This year a provisional estimate of egg abundance became available.

Southern horse mackerel*:* Data exploration in preparation of the benchmark in 2011.

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.

1.5 Reference points relevant for WGWIDE

No revisions of the precautionary reference points were considered at this meeting for blue whiting, Norwegian spring spawning herring, horse mackerel and horse mackerel stocks. MSY reference points were proposed for the stocks for which an assessment was presented. There were considered in the context of maximizing yield and minimizing risk. The results from the analyses can be found in the corresponding stock sections of the Report.

1.6 Special Requests to ICES

None made for this meeting.

1.7 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, 2009).

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). Nevertheless, pelagic planktivorous species such as northeast Atlantic mackerel, Norwegian spring-spawning herring and Atlantic blue whiting may take advantage of warming ocean ecosystems expending possible feeding opportunies, e.g. in Arctic waters.

Circulation pattern

Large-scale circulation patterns set the stage for important processes influencing fish species and ecosystems covered by WGWIDE. The circulation of the North Atlantic Ocean is characterized by two large gyres: the *subpolar gyre* (SPG) and *subtropical gyre* (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 more 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. An increasing trend in temperature and salinity was observed in the upper ocean during the period from 1996-2008 (ICES 2008), and during the period 2008-2010 the Atlantic Water surface temperatures were above the long term mean (NOAA 2010). The increase in SST at several of the stations in the NE Atlantic has been up to 3°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), but also above the long-term average in 2008-2010. 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). A similar trend has been evident in 2008-2010, but not as extreme as in 2006 and 2007.

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). In the Norwegian Sea the average phytoplankton concentrations have shown a reducing trend the last decade, whereas the North Sea has shown an increased trend in phytoplankton concentrations the last few years (Naustvoll *et al* 2010).

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 aboundance 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, and reached a record low in 2009. This decreasing trend has continued in the western areas of the Norwegian Sea 2010, while in the eastern areas it was slightly higher

(WGNAPES, 2010). Generally, the zooplankton concentrations in the Norwegian Sea and surrounding waters were lower in 2010 compared to 2009 both in May and July-August. The overall distribution pattern of zooplankton biomass has changed during the recent years. Previously the highest biomass of zooplankton was usually observed in the cold waters of the East Icelandic Current, where high aggregations of adult herring and mackerel were also observed. However, areas of lowered plankton densities seem to have spread west and northwards in front of the feeding herring, and in 2009 this area of higher plankton densities in the west and northwest disappeared, an observation done both during the May and July/August. This pattern is also evident in the 2010 zooplankton biomass distribution (WGNAPES, 2010).

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 WGWIDE 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 inter-specific 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 appear 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). In 2009 the temperatures were again high and were above the long-term average for the area. At the same time the transport of Atlantic water in and out of the North Sea through out the year was among the lowest for the period 1985-2009. 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 was observed that resulted in the temperatures coming back to normal in 2008 (Mork *et al*. 2009). The surface temperature, however, was warmer than average for most of the Norwegian Sea in 2008 (Mork *et al*. 2009) and increased significantly in 2009 to 0.5-1.0°C above the average. In recent years the surface waters in the northwestern part of the Norwegian Sea have been considerably warmer compared to the last two decades. The temperature in the western Norwegian Sea in 2010 is close to and in some areas less than the 1995-2010 average. In the central and eastern parts, however, the Atlantic water is still warmer than the 1995-2010 average, about 0-1°C dependent on the area and depths (WGNAPES 2010).This has 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 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 has been on a decreasing trend since 1997 and in 2009 it reached a record low. In 2010 it was slightly higher again than in 2009, but in the western part of the ocean the decrease continued (WGNAPES, 2010). Plankton organisms uncommon to the Norwegian Sea are entering at an increasing rate. This is especially worrying regarding the copepod *Calanus helgolandicus*, the temperate sibling-species of the Norwegian Sea copepod *C. finmarchicus*. This invasive species dominates at times along the southwestern coast of Norway (Ellertsen and Melle 2009). Due to a different life-strategy and the lack of suitability as food, any increase in the population of this species at the expense of *C. finmarchicus* might have a detrimental effect on pelagic planktivorous fish 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, 2009 was slightly cooler than the years before. This is probably caused by lower air temperature combined with low transport of Atlantic water into the Barents Sea. The amount of ice in the Barents Sea was low in 2008 and 2009. The seasonal distribution of phytoplankton was more or less similar in 2009 to what has been observed in earlier years. The decrasing trend in zooplankton biomass observed in the last years continued in the Barents Sea in 2009. This may be due to a lesser amount of Atlantic water being transported into the area, but also a record index of 0-group capeling was observed probably contributing to the decrease (Knutsen and Dalpadado 2010). The highest zooplankton biomass were observed in the southwestern part.

The capelin stock is estimated at about 3.8 mill. tonnes in the autumn 2009, a slight decrease from 2008. The year classes 2005-2009 of the herring stock are smaller than previous years, and 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

Norwegian spring spawning herring

Compare to 2009, there were less herring in the western most area presumably causing a slight eastward displacement of the centre of gravity of the acoustic recordings in 2010 as compared to 2009. As in previous years, the smallest and youngest fish were found in the northeastern area and both size and age increased southwestward. According to the 2010 Ecosystem Survey in the Nordic Seas, the herring stock is now dominated by 6 year old herring (2004 year class) in number but 8, 7 year old herring (2002 and 2003 year classes) are also numerous (WGNAPES, 2010). No strong *year class*es were found in the Barents Sea, indicating weak recruitment since 2004.

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. Although the 2010 zooplankton biomass is slightly higher than in 2009, it is still the second lowest since 1997. 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, and the results from 2010 show the same pattern as in 2009. The high herring stock level 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 as 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. Mackerel and herring had the largest overlap in the southern and western Norwegian Sea and Icelandic waters in 2010, however, the horizontal species overlap seemed to be less in 2010 as compared to 2009 (ICES CM 2009/ACOM:12).

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.

The herring feeding migration has shifted the last couple of years to a more southwesterly distribution. There was, however, a slight eastward shift of the center of gravity of the distribution in 2010 compared to 2009.

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.

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Blue whiting

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.

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 since 2005 has been very low, including the 2009 year class.

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.

No new ecological information on horse mackerel has been submitted to the working group. Horse mackerel is widely distributed on the continental shelf in the Northeast Atlantic and Mediterranean Sea. Horse mackerel is a schooling and migratory species that are adapted to swimming at a low but a very constant speed (Enders, 1998). Migration (spawning, feeding, over-wintering) is probably driven by water temperature and availability of prey. Their prey are mainly the different components of the zooplankton. Horse mackerel is a serial spawner probably with indeterminate fecundity. Apparently, the water temperature of 8º C is the lower limit for horse mackerel, which they avoid during over-wintering, and they stop feeding at water temperatures below 9ºC. Migrations are closely associated with the slope current, and horse mackerel migration is known to be modulated by temperature (Reid *et al*., 2001). Continued warming of the slope current is likely to affect the timing and the spatial extent of this migration. For North Sea horse mackerel data exploration again showed inconsistent signals in the catch at age data and a survey index, which may be missing an important component of the stock due to seasonal migration. The WG concluded that more intensive age sampling and a directed survey will need to be available before an analytical assessment can be attempted for this stock.

Horse mackerel are a fairly long-lived species, reaching a maximum age of well over 30 years. Therefore, an occasional strong year class can lead to high abundance of horse mackerel (Abaunza *et al*., 2003). Since the strong 1982 year class of the western stock started to appear in the North Sea in 1987 there has (except for 2000) been good correlation between the modeled influx of Atlantic water to the North Sea in the first quarter and the horse mackerel catches taken in the Norwegian EEZ (NEZ) later the same year (Iversen *et al.* 2002). The correlation has been used locally to predict the catch level in NEZ since 1997. The recruitment seems to be more dependant on environmental factors than on the size of the parental stock (at least when it is not depleted). The recruitment of horse mackerel in the southern areas (Iberian coasts) seems to be related to temperature variables and/or upwelling phenomena (Santos *et al*., 2001; Lavin *et al*., 2007). In this sense cooler waters seems to favour horse mackerel recruitment in southern areas (Lavin *et al*., 2007). More research is needed on how horse mackerel respond to environmental and ecosystem changes and variation within its distributional area.

2 Northeast Atlantic Mackerel

2.1 ICES advice and international management applicable to 2009 and 2010

From 2001 to 2009 the internationally agreed TACs have covered most of the distribution area of the Northeast Atlantic mackerel. However, some parties have unilaterally declared quotas outside the Coastal States/NEAFC agreements, especially in 2009 (see text table A below). In 2010 the Coastal States did not come to an agreement on the management of the mackerel stock with the result that all the parties declared their own quotas for 2010. In addition to the declared quotas some parties decided to transfer quotas not fished in 2009 to 2010, thus the sum of all declared quotas including transfer from 2009 results in expected catch figures in 2010 that exceed the recommended TAC for 2010.

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 (Fig. 2.1.1).

The TAC's agreed by the various management authorities (the Coastal States of mackerel and NEAFC) for 2009 and the advice given by ACOM for 2009 and 2010, as well as the WG catch estimate for 2009 are given in the text table A below. Since there was no agreement on the management of mackerel for 2010, the column in the text table for TAC in 2010 has been excluded. Instead an additional text table B with all quotas declared by the various parties is included.

Text table A.

Agreement / declared quota	Areas and Divisions	TAC in 2009	Declared quotas in 2010	Stock components	ICES advice 2010	Areas used for allocations	Prediction basis	WG catch in 2009
Coastal states (EU, Faroes, Norway)	IIa, IIIa, IV, Vb, VI, VII, VIII, XII, XIV	511,287	NA (see texttable below)	North Sea	Lowest possible level	IIa, IIIa, IV, Va, b, VI, VII, VIIIa,b,d,e, XII, XIV	Northern	627,142
NEAFC	International waters of IIa, IV, Va, b, VI, VII, XII, XIV	57,884	NA	Western	Reduce F in the range 0.20 – 0.22			
Norway-Faroes Northern[4]	IIa, IV, Vb	35,819	NA					
EU-NO [1]	IIIa, IVa,b	1,865	NA					
EU Southern [2]	VIIIc, IXa	35,829	NA	Southern		VIIIc, IXa	Southern[3]	107,747
Total		642,684	866,465		527-572			734,889

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) Norway-Faroes declared Northern quota in 2009.

Below is a text table B with all quotas declared by the various parties for 2010. Included is also the transfer of quotas not fished in 2009 to 2010 for Norway and EU). The total expected outtake from the mackerel stock is expected to be above 930 kT in 2010.

Text table B.

2010 quota components	Expected amounts (t)
EU	367,014
EU transfer from 2009	7,352
UK-Ireland payback	-18,222
Norway	181,000
Norway transfer from 2009	69,000
Russia	45,321
Iceland	130,000
Faroes	85,000
Total	866,465

The details on how the figures in the text table above are obtained is given in section 2.8 (Short term forecast).

Management measures are advised as stated by ACFM (2006) 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 regulations some small quotas are still assigned to IIIa and IVbc. In the same regulation it 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 2009

2.2.1 Catch Estimates

The total estimated working group catch for NEA Mackerel in 2009 was 734,889t, a sizeable increase of 123,826t over the 2008 figure and the largest catch since 2002.

The combined TACs arising from international agreements for 2009 were 642,684t. An autonomous Icelandic TAC of 112,000t was also declared. Given the working group catch, this represents a TAC undershoot in 2009 of approximately 20kt. The primary reason for this undershoot is the earlier than expected migration of mackerel out of the Norwegian waters in quarter 4. The combined fishable TAC as best ascertained by the Working Group (section 2.1) for 2010 amounts to 866,465 t. Of this TAC, the UK and Ireland have agreed not to fish 18,222t.

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)	N
Faroe[1]	Y (catches)	Y (coast guard)	N
France	Y (landings)		N
Germany	Y (landings)		Y
Iceland	Y (landings)		N
Ireland	Y (landings)		Y
Netherlands	Y (landings)	Y	Y
Norway[1]	Y (catches)		N
Portugal		Y (sale slips)	N
Russia[1]	Y (catches)		N
Spain		Y	N
Sweden	Y (landings)		N
UK	Y (landings)	Y	Y

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

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 or slipping are not available for most countries. Anecdotal evidence suggests that discarding and slipping can occur for a number of reasons including highgrading (fish weighing more than 600g attracts a premium price), lack of quota, storage or processing capacity and when mackerel is taken as by-catch.
- Confidential information suggests substantial under reported landings for which numerical information is not available for most countries. Recent

work has indicated considerable uncertainty in true catch figures (WD Simmonds to WGWIDE 2009) and the situation in ongoing.

- Estimates of the magnitude and precision of unaccounted mortality suggests that, on average, total catch related removals were equivalent to 1.7 to 3.6 the catch (Simmonds *et al* 2010).
- 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.

In 2009, reported catches in the Norwegian Sea and area V amounted to 163,604t (see table 2.2.1.2), an increase of 15kt on 2008 and only marginally lower that the highest catch in the time series. As in 2008, exploitation by Icelandic vessels is responsible for the majority of the catches (71%) in this area. For the first time, catches have been reported from subarea XIVa. Russia (10kt) and Faroes (3kt) also reported increased catches. Norwegian catches remain low in comparison with the historical data.

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 2009 amounted to 234,140t, similar to the 2008 total and well below the long term average. Minor misreporting (2kt) of catches taken in this area into VIa was reported to the working group. 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 increased by 55kt to 229,397t with increased catches reported by most nations, notably Scotland and Ireland. A relatively low (and likely underestimated – see section 2.2.2) discard tonnage is included. There is also a minor adjustment due to misreporting from subarea IVa.

Catches in divisions VIIIc and IXa (table 2.2.1.5) have increased dramatically in 2009 to 107,748t, well above the 2008 value (59,859kt) and the 2007 previous historic high (62,834t). Catches in VIIIc and IXa continue to substantially exceed (now by a factor of 3) 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
2009	38	11	31	20

These catches are shown per statistical rectangle in Figs 2.4.1.1 to 2.4.1.4. 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 and may not indicate the true location of the catches or represent the location of the entire stock.

The 2009 data indicated a shift towards a greater proportion of the total catch being taken in the first half of the year. This is due primarily to changes in fleet behavior for some of the major mackerel catching countries. The Norwegian fleet was unable to catch a significant proportion on its quota due to an earlier than expected migration of the stock out of Norwegian waters resulting in a reduced proportion in quarter 4. The Spanish, Icelandic and Scottish fleets all increased both their overall catch and the proportion caught in the first half of the year.

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 fishery has changed significantly over the recent past with over 75% of the total catch in 2009 taken by Scotland (22%), Norway(16%), Iceland(16%), Spain(16%) and Ireland(8%). Russia, the Netherlands, France, Denmark, Germany and the Faroes also have significant catches (>10kt).

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 greatly influenced by the market price and by quotas.

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 (see table 2.2.1.1) since 1978. However, the Working Group considers the estimates for these areas as incomplete. In 2009 discard data for mackerel were provided by four nations: Scotland, the Netherlands, Germany and Ireland. Total discards amounted to approximately 13,000t from these four nations. The Scottish discard programme was less extensive in 2009 compared to previous years and covered only subarea IVa. The German programme was limited to a single observer trip. The Irish discard programme is newly established. No discards were observed by Germany and Ireland. Ireland also provided details of slippage reported under the MSC.

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

The only specific discard age disaggregated data made available to the group is from Scotland from the fishery in subarea IVa in the fourth quarter. The sampling indicates that 4 year olds (the 2005 year class) are the most commonly discarded, comprising 37% of the total number discarded. Over 80% of the discarded fish were accounted for by 2-5 year olds. The percentage length composition of the Scottish discards for this area and period are shown in table 2.3.4.2.

Anecdotal evidence suggests that the majorty of discarding in 2009 was due to the inadvertent catching of mackerel in fisheries directed at other species and the discarding/slipping of catches of small mackerel.

2.2.3 Fleet Composition in 2009

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, initially in the herring fishery and more recently in 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. 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. 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 2009 catches in number-at-age by quarter and area are given in table 2.3.1.1. This catch in numbers relates to a tonnage of 734,889t which is the working group estimate for total catches from the stock in 2009. These figures have been added to the catch-at-age assessment input table (see table 2.7.1).

France was unable to provide a complete dataset of catch information for 2009, due to a database issue. Data provided to the working group included the total annual catch by management area group and monthly landings of French vessels into Dutch ports. The catches were assigned to subarea and quarter according to the proportions recorded in the period 2003-2009 by the French fleet. As such, this data should be considered preliminary. French catches account for less than 3% of the total catch.

Age distributions of commercial catches were provided by Denmark, England, Germany, Faeroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. There remain gaps in the age sampling of catches, notably France (18,340t) and Sweden (7,302t). England sampled the handline fishery in subareas VIIe and VIIf (which accounted for 25% of their reported catches).

The most significant sampling deficiencies identified for 2009 are

- A lack of samples for the freezer trawler fleet (NL,DE,FR) in subarea IVa (Q4), VIa (Q4) and VIIb (Q1) and area VIII
- A lack of Spanish sampling in Q4
- No sampling in area III

Catches for which there were no sampling data were converted into numbers-at-age using data from the most appropriate fleets. Accurate national fleet descriptions are required for the allocation of sample data to unsampled catches. 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.

As last year, the 2005 year class (4 year olds in 2009) is the most populous (29%) cohort seen in the catches, particularly in the heavily exploited subareas (IIa,IVa,VIa). Ages 3-7 all contribute 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 over half of the catch by number comprised of ages 0 and 1.

Distribution of Commercial Catches in 2009

The distribution of the NEA Mackerel catches taken in 2009 is shown by quarter and statistical rectangle in Figures 2.3.1.1 – 4. These data are based on catches reported by Denmark, Faeroes, 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 717,000t including Spanish WG data. The total working group catches were 734,889t. This year, the bulk of the catch not recorded by statistical rectangle was from France.

First Quarter 2009 (277,097t - 38%)

The distribution of catches in quarter 1 is shown in figure 2.3.1.1. The distribution of catch is similar to that reported in recent years with large catches taken along the shelf edge from the Celtic Sea and west of Ireland and Scotland. Significant catches of the southern component were also taken along the North Iberian coast. In general, catches are bigger than those in 2008.

Second Quarter 2009 (78,876t - 11%)

The distribution of catches in the second quarter is shown in figure 2.3.1.2. Catches in this quarter are three times greater than in 2008 and represent 11% of the total catch. This increase is due to increased Icelandic catches in subareas Va and IIa between Iceland and Faroes. As before, significant catches are also taken in subarea IIIc by the Spanish fleet.

Third Quarter 2009 (228,114t - 31%)

The third quarter distribution of catches is shown in figure 2.3.1.3. The Icelandic fishery continues and catches are reported from subarea XIVa for the first time. The traditional summer fishery in IIa also records significant catches. The highest concentration of large catches takes place in the Northern North Sea between the Shetland Isles and the Norwegian coast where the Scottish and Norwegian fleets operate.

Fourth Quarter 2009 (150,801t - 20%)

The fourth quarter distribution of catches is shown in figure 2.3.1.4. Catches in this quarter have reduced although the distribution remains similar with the majority of the catch in IVa and VIa although earlier than normal migration has resulted in a drop in catches in Norwegian waters. Catches are also reported from subarea VIIb to the west of Ireland. The catches north of 62º seen in quarter 3 do not extend into this quarter.

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 Santoña and Santander handline fleets (Sub-division VIIIc East) from 1989 to 2009 and from 1990 to 2009 respectively, for which mackerel is the target species during March to May. The figure also shows the annual effort of La Coruna trawl fleet (Sub-division VIIIc West) from 1983 to 2009 for which the main targets are demersal species. All Spanish fleet effort figures show a decrease in 2003 due to the fishery activity in the first quarter by the catastrophe of the Prestige oil spill. The hand-line fleet effort showed an increasing trend from 1993 to 1998 and since then the effort has been variable. The effort of the Spanish trawler fleets is rather stable during all periods with a smooth decreasing trend especially since 1995. Portuguese mackerel effort from the trawl fleet (Subdivisions IXa Central-North, Central-South and South) during 1988 - 2001 mackerel was a by-catch as in Spain. Since 2002 the effort data has not been available.

Figure 2.3.2.2 and Table 2.3.2.2 show the CPUE corresponding to the Spanish and Portuguese fleets referred to in Table 2.3.2.1. The CPUE in Spanish hand-line fleet shows an increasing trend. Since 2005, the CPUEs of Santoña and Santander handline fleets show an increasing trend. The La Coruña trawl fleet is rather stable during until 2004, peaked in 2006, decreased significantly in 2007 but has increased in 2009. The CPUE of the Portuguese trawl fleet was variable, with a decreasing trend. The CPUE of the Spanish purse-seine fleet shows fluctuations during the period 1983 to 1995. Since 1996 the CPUE of this fleet shows an increasing trend.

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

2.3.3 Survey Data

The preliminary results of the 2010 egg survey for the western and southern components is discussed in section 2.6. 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 2009 are given in Table 2.3.4.1.

Sizes are similar to recent years except for ages 0 and1 fish for which the mean length has increased by 4cm and 2cm respectively. This increase has been reported by several national sampling programmes.

Length distributions of the 2009 catches were provided by England and Wales, Faeroes, 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 2009 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 and 1 which have increased in accord with the increased mean length, noted in section 2.3.4.

The working group used stock weights based on mean weights-at-age from German, Dutch, Irish, Portuguese and Spanish commercial catch data collected in divisions VIIb, VIIj, VIIIb, VIIIc and IXa over the period March to May combined with weights derived from data collected on the 2010 egg survey. For the 2009 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 IVb during 2nd quarter 2009. 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 relative estimated size of the three spawning components, as estimated by the 2010 egg survey for the southern and western components and the 2008 egg survey for the North Sea component . The weight for age 1 fish is 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).

Data source	North Sea	Western Component		Southern Component		NEA Mackerel
Age	Catch	Catch	Survey	Catch	Survey	
0	-	-	-	-	-	0.000
1	0.104	0.160	-	0.112	-	0.070
2	0.221	0.190	0.159	0.178	0.152	0.174
3	0.269	0.229	0.212	0.207	0.220	0.221
4	0.315	0.293	0.249	0.250	-	0.268
5	0.342	0.342	0.302	0.301	0.285	0.316
6	-	0.370	0.344	0.343	0.390	0.346
7	-	0.402	0.406	0.372	0.350	0.380
8	0.366	0.490	0.437	0.426	0.391	0.448
9	-	0.483	0.463	0.464	0.352	0.442
10	-	0.529	0.513	0.499	-	0.498
11	-	0.530	0.571	0.555	-	0.532
12+	-	0.520	0.559	0.568	-	0.526
Component Weighting	3.6%	75.3%		21.2%		

2.3.6 Maturity Ogive

The weighting for the maturity ogive for NEA mackerel is calculated as described above for the stock weights. 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	0	0	0
1	0	0.08	0.02	0.06
2	0.37	0.60	0.54	0.58
3	1	0.90	0.70	0.86
4	1	0.97	1	0.98
5	1	0.97	1	0.98
6	1	0.99	1	0.99
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	1	1
12+	1	1	1	1
Component Weighting	3.6%	75.3%	21.2%	

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 utilized to estimate the year class abundance of mackerel in the period 1986-2008, 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 (Tenningen *et al.* submitted).

The estimated biomass from the tagging data for the years 1986 - 2008 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. Based on egg surveys and the tagging experiments it has been estimated that the actual catches might be 1.7 - 3.6 times the reported catches (Simmonds *et al.*, 2010). The SSB estimates from the tagging experiments do not follow the same patterns as the ICES assessment (Figure 2.3.7.1).

New information regarding new tagging and automatic screening technology for commercial landings of mackerel has a potential to increase the screened proportion of landings substantially compared to the present situation. If more countries installed such screening equipment for automatic detection and registration of individual mackerel tags, using tagging studies and tag-recapture results should provide us with a more robust and reliable time series as additional fishery-independent information for tuning the NEA mackerel stock assessment. At present only Norway is tagging mackerel and tagging was not carried out in 2005 and 2010.

WGWIDE recommends applying this time series as additional fishery independent information for tuning the NEA mackerel stock assessment. Due to the considerable changes in migration pattern of NEA mackerel observed in later years and to improve the time series WGWIDE further recommends that tagging/screening has to be continued on an international basis.

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 for NEA mackerel. 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 and Pelagic trawl surveys

2.5.1 Ecosystem surveys in the Nordic Seas in July–August

2.5.1.1 Coordinated Norwegian, Faroese and Icelandic ecosystem survey in the Norwegian Sea

Three chartered fishing vessels, M/V "Libas" (15 July-20 August) and M/V "Brennholm (15 July-6 August)" from Norway, M/V "Finnur Fríði" (8-23 July) from the Faroes and the Icelandic R/V "Arni Fridriksson" (20 July-12 August), performed a joint ecosystem survey in the Norwegian Sea and adjacent areas (Figure 2.5.1.1.1).

The abundances of Northeast Atlantic mackerel, Norwegian spring-spawning herring and blue whiting were measured acoustically, and the abundance of mackerel was also estimated by a trawl survey swept-area method. Estimated biomass of mackerel was calculated as 4.46 million tons in the Nordic Seas from swept-area survey calculations in the six sub-areas (Figure 2.5.1.1.2). The acoustic estimates provided a biomass of 12.1 million tons (Figure 2.5.1.1.3).

Repeated offshore catches of two year old individuals indicate that the Norwegian Sea is an important nursery and feeding ground for immature mackerel, further that mackerel showed a distinct length-dependent migration pattern with the largest individuals furthest to the west and north (Figure 2.5.1.1.4). The 2005- and 2006 year classes dominated in the catches by more than 50% (Figure 2.5.1.1.5). Medium-sized and large pelagic trawls with a opening of approximately 25 m and 50 m, was applied onboard the four vessels during the ecosystem survey, and catch rates (kg/nm) of mackerel are shown in Figure 2.5.1.1.6.

Mackerel was distributed over larger areas than previously documented in the Norwegian Sea in July-August. The results also suggested a stronger horizontal species segregation between herring and mackerel in 2010 than previous years, with the herring distributed more in the cooler waters influenced by the East-Icelandic Current in the western part of the distribution area in 2010 (Figure 2.5.1.1.7). The spatial overlap between mackerel and Norwegian spring-spawning herring was largest in the central Norwegian Sea, while there was some overlap between mackerel and Icelandic summer-spawning herring on the plateau south of Iceland, however, as mentioned above the horizontal species overlap seemed to be less in 2010 as compared to 2009 (ICES CM 2009/ACOM:12).

Surface waters in the eastern and central part of the Norwegian Sea were colder as compared to measurements in the 2009 survey, but still warmer than the average temperature for the last two decades. Extremely warm sub-surface temperatures (20 m depth) were found in the southern and southwestern part off Iceland (Figure 2.5.1.1.8). The northernmost areas in the Norwegian Sea were in contrast colder than in previous years, although this did not appear to be limiting the extent of the northern migration by herring and especially mackerel compared to the last few years.

The survey is considered to have great potential for providing information at least in parts of the mackerel distribution area. However, due to the dynamic behavior of mackerel in areas outside the current coverage of the survey, it is probably not applicable for the whole distribution area (Anon, 2009). Since the biomass estimates from the methods applied (acoustics and trawl swept area) vary with a factor of 2-3, neither are regarded as reliable. WGWIDE encourage WGNAPES, to standardize the survey with regard to trawl equipment, review the methods and assess potential biases from sources such as: Trawl selectivity (herding, avoidance), algorithms for calculating total biomass from trawl catches, acoustic scrutinization (species identification), and vessel avoidance.

2.5.2 Acoustic estimates of mackerel in the Iberian Peninsula and Bay of Biscay

Spring Acoustic Surveys

The IEO acoustic survey (PELACUS 04) is carried out on board of the R/V *Thalassa* in March-April since 1999 (Figure 2.5.2.1). The aim of the survey is to assess the biomass of the whole pelagic fish community of the North Iberian Peninsula (Divisions VIIIc and IXa), but the focus is mainly on the sardine stock.

The methodology for the estimation of mackerel biomass by acoustic methods are standardised of which the details can be found in the 2005 WGMHSA report (Iglesias *et al.*, WD 2005). In spring, the mackerel abundance is high because they spawn in this area, which facilitates their detection by the scientific echo sounder. The TS/L relationship used is the same as for mackerel in the North Sea and is the relationship recommended by PGAAM. The use of several frequencies, mainly 38 and 120 kHz, helps to identify the echo traces of mackerel.

In all years, mackerel is distributed throughout the whole survey area, and the highest concentrations are found in Division VIIIc-EW (Figure 2.5.2.2), coinciding with the main spawning ground in the Southern Area (ICES 2008a). Mackerel abundance has varied considerably from 2001 to 2010, with higher values in 2002 and 2003 coinciding with a high abundance of juveniles (Table 2.5.2.1). Regarding biomass, a maximum was reached in 2002 with a large reduction in 2005. The biomass estimates of 2008 and 2009 were similar to the estimate of 2005 (Table 2.5.2.2). However, the 2010 biomass estimate was about three times higher than the 2009 estimate (Figure 2.5.2.3). The commercial mackerel fisheries occur mainly in March and April (Villamor *et al.*, 1997). In addition, in 2005-2009, the biomass by length class distribution (Figure 2.5.2.4), show very low biomass values of most length classes. Biomass by age class (Figure 2.5.2.5) reflects a strong year class in 2002 and 2001 (age 1). Age 1 to 7 predominate in the age structure.

In the years studied (2001-2010) the estimated mackerel abundances indicate that in spring the adult fish (> 2 years) are more abundant in the west of the Cantabrian Sea. However, juveniles are more abundant in the sub-division IXa North. When a year class is highly abundant (as that of 2002) the juveniles extend their distribution area. In those cases the juveniles were also distributed throughout the prospected area. (Figure 2.5.2.6).

The IPIMAR acoustic survey (PELAGO) in Portuguese waters mainly targets sardine and the IFREMER annual survey (PELGAS) targets all pelagic fish in the French Biscay area. Since 2008, the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG) (ICES, 2008) produces biomass estimates of most pelagic species in all areas, including Atlantic mackerel (Figure 2.5.2.7). In 2008 the mackerel biomass estimate was 820.000 t for the area of the Iberian Peninsula and Bay of Biscay (Table 2.5.2.1). The coordination of the surveys was considered satisfactory by the members of WGACEGG and the group endorses the continuity of such coordination which allows synoptic coverage of the subareas IX and VIII

Autumn Acoustic Surveys

IEO carries out a new acoustic survey (PELACUS 10) in autumn (September-October) on board of the 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 (Figure 2.5.2.1). This survey focusses particularly on the estimation of abundance/spatial distribution of juveniles and on the process of anchovy recruitment. The mackerel has also been measured acoustically in these surveys, but the abundance of this species is currently being studied and evaluated. This document presents only the distribution and size distribution.

The mackerel was located mainly in the French shelf (Figure 2.5.2.8). In the years studied (2006-2009), the mackerel were mostly <34 cm (age 0 to 4) ranging between 11-42 cm (Figure 2.5.2.9).

2.6 Results from the International Mackerel and Horse Mackerel Egg Survey 2010

The ICES Triennial Mackerel and Horse Mackerel Egg Survey was carried out during January - July 2010. Final results will be presented at the WGMEGS meeting in April 2011. Since 2004 and subsequent to demands for up-to-date data for the assessment WGMEGS aims to provide a preliminary estimate of NEA mackerel biomass and western horse mackerel egg production before the assessment meetings in the same calendar year as the survey.

Following a request of ICES in 2010 it was also agreed, that

- results had to be presented latest on August, 23rd to WGWIDE, 4 days before the actual meeting of WGWIDE,
- and no revisions were allowed after the 27th August.

This required a complete work up of the data from the egg survey itself as well as of the histological data on mackerel fecundity and atresia. The production of estimates for both species required considerable commitment from the members of WGMEGS. The members of WGWIDE were aware and appreciative of this commitment. A report with the preliminary results of the survey was distributed to WGWIDE members on time (Ulleweit *et al*. 2010). However, the preliminary fecundity estimates require re-examination. (Thorsen 2010).

The 2010 survey was split into six sampling periods, alike the last survey in 2007. The assignment of vessels to areas and periods is summarized in table 2.6.1. A significant change to 2007 was the inclusion of the Faroese and Icelandic survey in May and June which expanded the geographic range of the survey in the North during periods 4 and 5. This represents an overall increase of survey days for 2010 compared to 2007, however there was no increased survey effort for the standard areas.

Analysis of the plankton samples as well as of the fecundity samples were carried out according to the sampling protocols established by WGMEGS (ICES 2009a, 2010 and older) and WKMHMES (ICES 2009b).

2.6.1 Data analysis for mackerel annual egg production

Egg counts were converted to stage 1 egg production, using the volume of water filtered and the sampled depth. These values were converted to egg production/day/m^2 using the development equations and water temperature at 20m depth. Arithmetic means were used where more than one sample per rectangle per period was collected. Daily egg production values were interpolated into unsampled rectangles according to the protocols in the above reports. Plots of the distribution of egg production for the western area are presented in Figures 2.6.1.1-2.6.1.6. Interpolated values are highlighted in red. The area coverage is described in detail in Ulleweit *et al*. 2010.

Figure 2.6.1.7 presents the egg production curve for the western area for the 2010 survey, along with those for the surveys in 1998, 2001, 2004 and 2007 for comparison. The nominal start date (used since 1995) of the 10th of February was used although for 2010 – with the extremely large period 2 production value – spawning may have started before this date. However, the survey design could not be adjusted for that. The nominal end of spawning date of the 31st of July is also the same as that used in previous years and the shape of the production curve does not suggest that the end date should be altered. The standard error has not yet been calculated. Due to the increase in survey area and subsequently a greater number of interpolated samples, the standard error is expected to be larger than for 2007. The provisional total annual egg production (TAEP) for the western area in 2010 was calculated at 1.54×10^{15} eggs. This is a 21% increase of the 2007 TAEP which was 1.21×10^{15} eggs The spawning curve differs substantially from the curve observed in previous years; 66% of all the egg production in the western area took place between the 10th of February and the 26th of April which translates to periods 2 and 3. This is in contrast to previous years where peak spawning has occurred in May or June.

Figure 2.6.1.8 presents the 2010 egg production curve for the southern area, along with the 2007 curve. The start for spawning in the southern area was 30th January. This was almost one week earlier than in 2007 because of the occurrence of stage I eggs found off the Portuguese coast during the period 1 survey. As in 2007, the end date of spawning was again set as 17th July which was corroborated by the shape of the spawning curve. The provisional total annual egg production (TAEP) for the southern area in 2010 was calculated at 4.33×10^{14} eggs. This is a 28% increase compared to the 2007 TAEP which was 3.12×10^{14} eggs. As in 2007 peak egg production (99%) took place between the 15th February and 26th April.

A comparison of the total annual egg production for the western and southern area over the last survey years is given below:

Year	Western TAEP	Southern TAEP
2010 (provisional)	$1.54 * 10^{15}$	$4.33 * 10^{14}$
2007	$1.22 * 10^{15}$	$3.12 * 10^{14}$
2004	$1.20 * 10^{15}$	$1.26 * 10^{14}$
2001	$1.21 * 10^{15}$	$2.83 * 10^{14}$
1998	$1.37 * 10^{15}$	$4.34 * 10^{14}$

2.6.2 Mackerel fecundity and atresia estimation

Estimates of fecundity are given as realised fecundity which is the potential fecundity minus the atresia rate. The analysis of potential fecundity and atresia is carried out by six different participating institutes. Preliminary results based on a very limited number of samples showed a realized fecundity of 915 eggs/g female which is the lowest observed fecundity in the time series. However, after the survey report had been distributed, it was discovered that a possible laboratory effect in the analysed material skewed the estimate downwards (for details see Thorsen 2010). This will be investigated further before the WGMEGS meeting in 2011.

2.6.3 Quality and reliability of the 2010 egg survey

Area coverage shows some restrictions due to bad weather but also because of the broadening of the mackerel spawning area to the Northwest in periods 3, 4 and 5 (comp. Ulleweit *et al*. 2010). However, egg production in these areas was low compared to the main spawning areas in period 2 on the Celtic Sea shelf and on Porcupine Bank, which are responsible for the 21% increase in overall production in the Western area compared to 2007.

There is ample empirical evidence that the peak of mackerel spawning normally occurs in April-May in the area of the Sole Banks. Even though an earlier onset of spawning had been observed during previous egg surveys, peak spawning was always observed later than in period 2. Therefore, peak spawning of the magnitude observed in period 2 for mackerel in the western area was unexpected in 2010. It is possible that spawning had started before the nominal start date (10 Feb). However, because evidence is lacking for changing the estimated 'start date' of spawning members of WGMESG decided to keep this date for the calculation of the egg production estimate.

WGWIDE decided that the egg production estimates of 2010 of the western and southern area were used to calculate the biomass. However, the estimated low fecundity was not used due to a possible laboratory effect when analysing the samples. Given this problem a provisional estimate of realized fecundity was produced, by averaging the fecundity estimates of the last three survey years (2001, 2004 and 2007). These years demonstrated similar levels of potential fecundity and atresia rates (see table below).

	Assessment year				
Parameter	1998	2001	2004	2007	Mean 01–07
Number of samples analyzed for fecundity	96	187	205	176	NA
Number of samples analyzed for atresia	112	290	348	416	NA
Potential fecundity	1206	1097	1127	1098	1107
Number of potential fecundity lost per day	3.37	1.07	1.25	1.48	1.27
Number of potential fecundity lost over an individual's spawning season	202	64	75	89	76
Realised fecundity	1004	1033	1052	1009	1031
Percentage of potential fecundity lost	17	6	7	9	7

In 2008 the preliminary estimate of the mackerel egg production was based on an incomplete set of plankton samples which caused a substantial revision of parts of the estimate. This is probably not the case this year because all plankton samples collected were analysed prior this WGWIDE meeting.

2.6.4 Mackerel biomass estimates

Based on the total annual egg production (TAEP) for the western and southern component, a realized fecundity estimate as the mean of the last three survey years (1031 oocytes/g female), a sex ratio of 1:1 and a raising factor of 1.08, the total spawning stock biomass (SSB) was estimated as shown below:

$$SSB = \frac{TAEP}{F'} * s * cf$$

where

F' = realized fecundity,
s = 2 for a given sex ratio of 1:1,
cf = 1.08 (fixed raising factor to convert pre-spawning to spawning fish)

giving

- 3.226 million tonnes for western component
- 0.907 million tonnes for southern component
- 4.133 million tonnes for western and southern components combined.

Parameters used in the calculation and SSB for 2010 in comparison to 2001, 2004 and 2007 are given in the table below:

	Western component	Southern component
Total Annual Eggs Production	$1.54 * 10^{15}$	$0.433 * 10^{15}$
Realised fecundity	1031	1031
Female fraction	0.5	0.5
Pre-spawning biomass to SSB conversion	1.08	1.08
Pre-spawning biomass	2,987,391	839,961
SSB (tonnes) 2010	3,226,382	907,158
SSB (tonnes) 2007	2,590,000	667,909
SSB (tonnes) 2004	2,470,000	280,300
SSB (tonnes) 2001	2,530,000	371,300

2.6.5 Mackerel egg sampling during the international pelagic ecosystem survey in the Nordic seas

Altogether 36 plankton samples taken during the Norwegian and EU participation in the IESNS with RVs G.O. Sars and Dana, some of them taken additionally to the originally planned stations, were analyzed for fish eggs. The covered area was between 62° and 67°N and between 0° E/W and the Norwegian coast. Only 1 mackerel egg was found in those samples. These findings suggest that mackerel spawning off the Norwegian coast form only a minor and negligible part of the total spawning stock. Most of the eggs were those of the pearlside *Maurolicus muelleri*.

2.7 Stock Assessment

NEA Mackerel was classed as an update assessment this year, and the method used was the one defined by the 2007 benchmark assessment (ICES 2007) detailed in the stock annex. 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.

The new data used in this assessment compared to the 2009 assessment are the 2009 catch at age and the 2010 egg survey index. In addition, mean weights at age in the stock and maturity ogives were updated, using the 2010 egg survey to estimate the relative size of the southern and of the western spawning stocks.

The assessment, including the yield per recruit analyses was implemented in R using the appropriate FLR packages (see stock annex). 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 2.7.1 – Table 2.7.5. Table 2.7.6 and Figure 2.7.1 shows the stock summary, including SSB, number of recruits, F and the catches. The estimated stock abundance and fishing mortality at age are shown in Table 2.7.7 and 2.7.8 respectively and the fitted selection pattern in Table 2.7.9. The diagnostics of the fit to the Mackerel egg survey data are presented in Tables 2.7.10 and 2.7.11 and Figure 2.7.2, which do not show any obvious model mis-specification. Diagnostics of the catch for the separable period are shown in Figure 2.7.3. and the estimated catch and residuals for the separable period are given in Table 2.7.12 and 2.7.13. Fitted parameters in the model with estimates of precision and confidence bounds are summarized in Table 2.7.14.

In Figure 2.7.4, yield per recruits and SSB per recruits in relation to Fbar are shown, also indicating the biological reference points.

Figure 2.7.5 shows the agreed management plan including the biomass trigger points and the recent development of the stock (the past 8 years plus the current year) in relation to the precautionary approach reference points.

2.7.1 State of the Stock

The spawning stock at spawning time in 2009 is estimated at approximately 3 million tonnes, which is well above Bpa. The stock reached a historic minimum in 2002 and has increased continuously since then. Fishing mortality in 2009 is estimated to be 0.233, just above Fpa. The 2002 year class is well above average. The year classes from 2005 to 2006 are estimated to be also well above the mean of the time-series, while the 2007 year class is average. There is insufficient information to estimate accurately the size of the 2008 and 2009 year classes (see Table 2.7.14).

2.8 Short term forecast

2.8.1 MSY framework

ICES has previously defined the following precautionary reference points for NEA mackerel:

Reference point	Technical basis
B_{pa} = 2.3 Mt	B_{loss} in Western stock raised by 15%: = 2.3 million t.
B_{lim} = 1.67Mt	B_{loss}
F_{pa} = 0.23	F_{lim} * 0.55 (CV 36%)
F_{lim} = 0.42	F_{loss}
F_{target} = 0.20 to 0.22 $B_{trigger}$ = 2.2 Mt	Reference points defined as part of a precautionary management plan

Analyses were carried out, using a standard package (plotMSY) in an attempt to derive an F_{MSY} estimate for the stock based on the current assessment.

Input data for the plotMSY program were taken from the .sen and .sum files from the current assessment. A thousand MCMC iterations were carried out, a high proportion of which provided converged F_{MSY} estimates for the 3 stock recruit models investigated. However, due to the absence of observations at low stock levels, there is no apparent relationship between recruitment and the SSB in the assessment data and the fit of the three models was very poor (Figure 2.8.1.1). In the case of the Ricker model, the shape of the curve – especially the position of the maximum of the curve - was very variable among the MCMC trials. For the Beverton and Holt model, there was a discrepancy between the deterministic fitting and the median of the MCMC trials, indicating that the fit was very sensitive to the fitting procedure. In the case of the smooth hockey stick model, the position of the inflection point was poorly defined.

Outputs from the analysis, including the ranges of estimates of F_{MSY}, F_{MAX}, F_{CRASH} with corresponding CVs are given in the boxplots in Figure 2.8.1.2 and in Table 2.8.1.1. For the different stock recruitment models tested, there was an important difference between the deterministic value of MSY and the median of the MCMC iterations. For each model, there was large variability in the distribution of the F_{MSY} values corresponding to the MCMC iterations. In the case of the Hockey stick model, the distribution of the F_{MSY} and of the F_{crash} values were completely overlapping.

The yield per recruit curve did not show a marked decrease at high fishing mortality. Consequently, F_{MAX} was poorly defined from the yield per recruit curve (Figure 2.8.1.3).

In conclusion, it was decided that the structure of the stock and recruitment data for this stock do not lead to any clear definition of an optimum yield fishing mortality level (F_{MSY}). Therefore, it was considered that the simulation studies used previously for defining the target mortality rate for the agreed management plan (F = 0.2 to 0.22) and the corresponding spawning stock biomass trigger level (2.2 million tonnes) were appropriate for the definition of a preliminary long term target. The agreed management plan has been designed to maximise yield while maintaining low risk to the stock. Hence, the values 0.20 to 0.22 are retained as the range for F_{MSY} and MSY $B_{trigger}$ is set at 2.2 Mt.

2.8.2 Short term forecast

The short term forecast provides estimates of SSB and catch in 2011 and 2012 given a range of management options.

All procedures used this year follow those used in the benchmark of 2007 and described in the stock annex. Table 2.8.2.1 lists the input data.

Estimation of catch in the intermediate year (2010) is based on declared quotas as shown in the text table below. Modifications of the total of the declared quotas in 2010 come from inter-annual transfer of quotas not fished in 2009 to 2010, discard, estimated overshot in catches, and quota payback. The detailed calculations of intermediate year catch for the short term forecast (STF) are provided in the text tables below.

Calculation of over-catch % in 2009		
NEAFC quota (all areas, including EU Southern quota)	605.001	
EU-Norway quota for Sweden	1.865	
Inter-annual quota transfer to 2010 (EU+NOR)	-76.359	
UK-Ireland payback	-18.222	
Norway-Faroes Northern quota	35.819	
Discards (Previous years estimate)	26.766	
WG estimate of total declared catch + discards (*excluding* Iceland)	574.870	574.870
Reported catch for 2009 (excluding Iceland, including discard)		618.729
Catch over WG estimate		43.859
Overcatch in % of WG estimate of total declared catch (including discard, excluding Iceland)		7,6%

Estimation of 2010 catch 2)		
EU quota, including Southern and Swedish quota	367.014	
Inter-annual quota transfer from 2009 (EU)	7.352	
UK-Ireland payback	-18.222	
Norwegian quota including Northern quota [1)]	181.000	
Inter-annual quota transfer from 2009 (Norway)	69.000	
Russian quota	45.321	
Discards (Previous years estimate)	12.854	
WG estimate of total declared catch (including discards, excluding Iceland and Faroes)	664.319	664.319
Expected overcatch in 2010 based on 2009 overcatch (7,6% see table above)		50.683
Icelandic quota		130.000
Faroese quota		85.000
Total expected catches in 2010 (including discards)		930.002

The Norwegian share of the declared Northern quota (initiated in 2009) was again declared in 2010.

Information provided by WG members

This method for estimating intermediate year catch came close to the actual catches in 2009, except that the inter-annual transfer of 76 kT was not anticipated. The WG assumes that the declared quotas will be taken in 2010 and no inter-annual transfer will take place between 2010 and 2011. Iceland and the Faroes expect no over-catch in relation to their declared quotes. For other declared quotas (EU, Norway and Russia) over-catch in % of the declared quota was assumed to be the same as in 2009.

The 2009 catch estimate was 5% over the actual catch (taking inter-annual transfer into account). In 2010 the estimated overcatch and discard is 5% less than in 2009.

The short term forecast, estimates F at 0.31 and SSB at 2.93 Mt in 2010 (assuming catches for 2010 of 930 kt). Following the management plan by fishing at F = 0.22 (Fmsy) in 2011 will result in a catch of 646 kT. The transition schemes leading to Fmsy in 2015, provided by ICES leads to an F of 0.23 in 2011. This is equivalent to a catch of 672 kT.

A detailed single fleet management option table and plot is presented with catch constraint fishing (catch = 930 kt) in 2010 (Table 2.8.2.2 and Figure 2.8.2). Table 2.8.2.3

provides multi options for 2011 to give key catch and F options. The catch options are: Zero catch, 866 kT (same catch as in 2010 excluding overcatch and discard), 693 kT (866 kT - 20%), 1040 kT (866 kT +20%) and the F options are 0.20, 0.21, 0.22 (Range of F's in the management plan (when SSB is above 2.2 MT) and 0.23 (Fpa/Fmsy).

2.9 Uncertainties in assessment and forecast

2.9.1 Uncertainties in assessment

Analytical retrospective plots (Figure 2.9.1) show fairly consistent stock trajectories.

The R package 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 2009 estimate of SSB and Fbar4-8 (Figure 2.9.2). The 95% confidence interval of SSB and F are estimated as 2.625 and 3.343 Mt and 0.199 and 0.303 respectively, corresponding to a coefficient of variation of 6.2% and 10.8% respectively.

The uncertainty in the population numbers at the 1st of January 2009 is relatively high for the age classes above age 3 (CV around 10% to 15%, Table 2.7.14). For the younger ages the uncertainty is high (CV>20%), to very high for the recruits (CV=242%). 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 latest 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 (ICES 2008, Simmonds *et al*. 2010) result in uncertainty in total biomass. This indicates that the assessment is likely to underestimate the stock by a factor of between 1.7 and 3.6. This work also indicates that estimates of F are more robust than those of SSB. Preliminary results from the 2010 summer survey in the Nordic Seas also suggest that the biomass is underestimated.

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.

2.9.2 Uncertainties in forecast

The forecasts presented in section 2.8 are deterministic, hence no estimates of uncertainty is calculated. Sources of uncertainty are:

- Uncertainty in the ICA survivors estimates at 1st January 2010
- Assumed catches in 2010. Because EU and Norway has agreed to allow reciprocal access on a scale that exceed the 2009-2010 transfer; the WG assume that the individually declared catches will be taken and no inter-annual transfer will take place between 2010 and 2011. 5% of the assumed catches are expected over-catch. This estimate is subject to some uncertainty.
- Assumptions on selectivity in the fishery as well as the biological input parameters such as mean weight at age, recruitment in 2010-11 etc. The assumptions are described in the stock annex.

2.10 Comparison with previous assessment and forecast

The addition of the catch data for 2009 and of the new survey index resulted in a revised perception of the stock. Changes in the TSB, SSB and Fbar4–8 for 2008 between the last two assessments are presented in the table below. Due to the high value of the 2010 egg survey index, the estimates of TSB and SSB in 2008 were revised upward substantially. Fishing mortality in 2008 is, however, not changed.

	TSB (2008)	SSB (2008)	F 4–8 (2008)
2009 Assessment	**3.324 Mt**	**2.491 Mt**	**0.237**
2010 Assessment	**3.742 Mt**	**2.709 Mt**	**0.236**
% difference	**12.58 %**	**8.75 %**	**-0.42 %**

A comparison of the fit of the model to the catch data between the 2009 assessment and the 2010 assessment is shown in Figure 2.10.1. The weighted log residuals of the catch for the separable period from the 2010 assessment are similar to those from last year's assessment. The residuals for the last two years of the separable period (2008 and 2009) are a bit higher than the rest of the time series. The selection patterns are also very similar except for a slight decrease in the selection at age 8 and a slight increase for age 9. The fit of the model to the egg survey index from this year's assessment shows only small differences with last year's assessment.

The uncertainty on the SSB and Fbar4-8 for the last year in the assessment is in the same range of values as last year.

The mackerel catch prediction for 2009 used for the short term forecast in the 2009 assessment was 830.000 tonnes, about 100.000 tonnes (12.9%) higher than the catch reported in 2010 used in the present assessment. Much of this difference is explained by a transfer of 76 000 tonnes of the 2009 EU-NO quota to 2010, due to the difficulty for some countries to fish their quotas in 2009. The estimate of SSB for 2009 from the new 2010 assessment is 3.7 % higher than the value predicted in the short term forecast from the 2009 assessment (table below). The fishing mortality Fbar4–8 for 2009 estimated this year is 26.3% lower than the value predicted in the 2009 short term forecast, due to the catch being lower than predicted and also because of the upward revision of the stock size.

	Catch (2009)	SSB (2009)	F 4–8 (2009)
Forecast from 2009 assessment	830 kt	2.608 Mt	0.298
Observation/Estimate	735 kt		
from 2010 assessment		2.709 Mt	0.236
% difference	- 12.9 %	3.7 %	- 26.3%

Management plans and evaluations

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

ICES (2007) Report of the working group on the assessment of Mackerel, Horse mackerel, Sardine and Anchovy. ICESCM2007/ACFM:31 735 pp

ICES (2008) Report of the Working Group on Widely Distributed Stocks (WGWIDE). ICES CM 2008/ACOM:13 702pp

Simmonds EJ, Portilla E, Skagen D, Beare D, Reid DG (2010) Investigating agreement between different data sources using Bayesian state-space models: an application to estimating NE Atlantic mackerel catch and stock abundance. ICES J Mar Sci 67:1138-1153

2.11 Management Considerations

Although a long term management plan was agreed by the EU, Norway and Faroe Islands in October 2008, the various unilaterally declared TACs in 2009 and 2010 do not reflect what is recommended by the management plan in order to ensure sustainable exploitation of NEA mackerel. This is because fishing mortality is projected to rise above the levels recommended by the management plan.

The spawning stock biomass (SSB) increased from a low of 1.7Mt in 2002 to around an estimated 3.0 Mt in 2009, probably the highest level for about the last 30 years. Figure 2.7.5 indicates the current estimated stock level and recent stock development in relation to the agreed management plan.

Short term projections, assuming a catch of ~930 kt in 2010 (see section 2.8) result in a stable SSB of 2.9Mt in 2010. This stability, despite recent high catches, is mainly due to several good year classes (2005, 2006). The fishing mortality in 2009 was approximately 0.23. Due to increased stock size, F has been relatively stable since 2006.

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 was set in accordance with the Management Plan. However, since 2008 considerable additional catches have been taken outside the agreed TAC and in 2010 an internationally agreed TAC was never reached. The absence of clear international agreements on the exploitation of the stock (between all nations involved in the fishery) is a cause of continued concern and prevents control of the exploitation rate of the stock. According to the short term forecast (Section 2.8) the effect of the total catch in 2010 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 (egg distributions from surveys in 2007 and 2010) indicate that the distribution of the spawning area of mackerel has expanded north and west 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 to new directed fisheries.

An evaluation of unaccounted mortality in the mackerel fishery (Simmonds *et al* 2010) 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.

Slippage in the fishery contributes partly to unaccounted mortality. There is insufficient information about the frequency of slipping for all fleets.

Information on discarding of mackerel is insufficient, with data supplied by only four nations. While some observer programmes have expanded, others have suffered from a lack of observer coverage this year, compared to previous years. This is of concern and managers need to be aware that these data are needed in order to reduce uncertainty in the assessment.

There is uncertainty about the future productivity of the stock. There have been two good recent year classes, but good recruitment cannot be relied upon to support the international fisheries, in a situation where there are no international agreements on management.

2.12 Ecosystem considerations

Catch and survey data from recent years indicate that the stock has expanded North-westwards during spawning and summer feeding migration. The change could be a consequence of observed warming, changes in food availability and increased stock size. At present we cannot verify this due to lack of data and suitable time series.

Timing of spawning and distribution of the overwintering mackerel have previously been linked with temperature in the northern part of the stock (Reid *et al*. 1997; Jansen & Gislason, submitted). The increased temperature observed in the Nordic Seas during summer in recent years (WGNAPES 2010) might have increased the potential habitat for mackerel.

The zooplankton biomass has been declining in the Nordic Seas since 2002, especially in the central areas (WGNAPES 2010, WD Nøttestad *et al*. 2010). This could be forcing the pelagic species to expand their feeding areas.

The seemingly larger degree of horizontal species segregation in 2010 compared to 2009 (WD Nøttestad *et al*. 2010), could be due to competition between mackerel and herring during the feeding season and might have forced the herring to the cooler fringe areas. The herring in this area was observed to be in poorer condition than in previous years (sec. 7.1).

Another explanation to the apparent expansion could also be due to the increased size of the stock with more large individuals able to migrate long distances during their search for food.

In the southern part of the distribution area mackerel overlap with chub mackerel (*Scomber colias*), the landing have increased from the 1990s to the 2000s (Table 2.12.1), if this reflect an increase in abundance, increased interspecific competition with mackerel is possible.

In the main spawning area; peak spawning occurred earlier than observed in previous egg survey years (WGMEGS 2010). The cause of this is unknown. Changes in the timing of the critical larval stages will most likely affect mortality due to changes in match/mismatch with larval food. Different plankton groups have been shown to react differently to changes in temperature (Beaugrand *et al*. 2003).

WGWIDE encourage research in physical forcing of mackerel stock dynamics and resulting changes in trophic interactions and recruitment variability.

2.13 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.

No Coastal State Agreement/NEAFC Agreement could be reached in 2010 so no overall international regulation on catch limitation was in force.

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.

2.14 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 most recent years, although the timing of migration can change markedly from year to year and this affects the fishery in various areas.

Recent changes are notable for two areas and métiers in particular:

One part of the Northeast Atlantic mackerel population migrates towards the southern spawning area (Cantabrian Sea) at the end of winter. In this area, a seasonal handline fishery is the most important fishery that targets mackerel, of which the timing of the peak of catches has shifted forward since 2000 (Punzón and Villamor 2009). This is approximately a one month shift, which 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

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

of the resource, the fleets that exploit it and the resource evaluation survey designs. They will have to be adapted to this new scenario.

Also, 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, 112 in 2008 to around 116 kt in 2009 and are projected to be around 130 kt in 2010. The catch data from 2009, as well as information from the fishery in 2010, indicate that the fishery occurs over a wide area E, NE, SE, S and SW off Iceland and that the catches consist mainly of large and old mackerel. Results from the coordinated survey in the Nordic Seas in July-August 2010 (WD, WGWIDE, Nøttestad *et al*. 2010) also suggest increased distribution of mackerel in this western part of the survey area for 2010 and confirms the length/age composition represented by the catch data. Information about the Icelandic mackerel fishing fleet is given in Table 2.2.3.1 and further description of the fishery in Section 2.3.1.

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			Subareas IV and III[1]			Subareas I,II,V & XIV[2]	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[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			Subareas IV and III[1]			Subareas I,II,V & XIV[2]	Divs. VIIIc, IXa	Total		
	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Discards	Catch	Landings	Landings	Landings	Discards	Catch
2000	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	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	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	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	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[4]	76,358	21,793	98,151	73,377	1,987	75,364	227,251	2,986	230,237	148,669	59,859	584,297	26,766	611,063
2009	135,468	1,255	136,723	88,287	4,387	92,674	226,928	7,212	234,140	163,604	107,747	732,034	12,854	734,889

1 - IIIb, IIId from 2000 onwards

2 - 1976–1985 Div IIa; 1986-1999 Divs IIa,Va; 2000-2008 Subareas I,II,V; 2009 Subareas I,II,V,XIV

3 - Discards reported as part of unallocated catches

4 - Data revised for Northern Ireland

Table 2.2.1.2 NE Atlantic Mackerel catch (t) in the Norwegian Sea (IIa) and Area V 1984–2009 (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
France		16				11		23	6	6	5	5		270
Germany, Fed. Rep.			99		380									
Germany, Dem. Rep.			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 Kingdom			2,131	157	1,413		400	514	802		1,706	194	48	938
USSR (Russia from 1990)	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	2009
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	2,992
France							2	1				
Germany, Fed. Rep.										7		
Germany, Dem. Rep.												
Iceland	357				53	122		363	4,222	36,706	112,286	116,160[1]
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[1]	10,295	13,244	8,914	493	3,474	3,038
Poland												
Sweden				8								
United Kingdom	199	662		54	665	510	1,945				4	
USSR (Russia from 1990)	67,201	51,003	49,100[1]	41,566	45,811	40,026	49,489	40,491	33,580	35,408	32,728	41,414[1]
Misreported (IVa)	-177	-40,011										
Misreported (VIa)		-100										
Misreported (Unknown)					-570		-400					
Unallocated								-2,393		-10	-18	
Discards												
Total	134,219	72,848	92,557	67,097	73,929	53,701	62,486	54,129	46,716	72,882	148,669	163,604

1- Includes catches in subareas I,IIb,XIVa

Table 2.2.1.3 NE Atlantic Mackerel catch (t) in the North Sea, Skagerrak and Kattegat (Sub-area IV and IIIa) 1988-2009 (Data submitted by Working Group members).

Country	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Belgium	20	37		125	102	191	351	106	62	114	125	177	146
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
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
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
Germany, Fed. Rep.	177	6,312	3,500	4,173	4,610	4,940	1,497	712	542	213	423	473	78
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
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
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
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[1]
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	58,282
USSR (Russia from 1990)										3,525	635	345	1,672
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
Misreported (Unknown)													
Unallocated	29,630	6,461	-3,400	16,758	13,566			983	236	1,102	3,147	17,344	34,761
Discards	29,776	2,190	4,300	7,200	2,980	2,720	1,150	730	1,387	2,807	4,753		1,912
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

Table 2.2.1.3 cont.

Country	2001	2002	2003	2004	2005	2006	2007[1]	2008[1]	2009
Belgium	97	22	2	4	1	3	1	2	3
Denmark	21,680	34,375[1]	27,508[1]	25,665	23,212[1]	24,219[1]	25,217[1]	26,716	23,491
Estonia									
Faroe Islands	18,751	12,548	11,754	11,705	9,739	12,008	11,818	7,627	6,648
France	1,981	2,152	1,467	1,538	1,004	285	7,549	490	1,493
Germany, Fed. Rep.	4,514	3,902	4,859	4,514	4,442	2,389	5,383	4,668	5,158
Iceland									
Ireland	10,284	20,715	17,145	18,901	15,605	4,125	13,337	11,628	12,901
Latvia									
Netherlands	2,441	11,044	6,784	6,366	3,915	4,093	5,973	1,980	2,039
Norway	158,401	161,621	150,858	147,069	106,434	113,079	131,191	114,102	118,070
Poland					109				
Romania									
Sweden	5,090	5,232[1]	4,450	4,437	3,204	3,209	3,858[1]	3,664[1]	7,303[1]
United Kingdom	52,988	61,781	51,736	50,474	37,118	28,628	46,264	37,055	47,863
USSR (Russia from 1990)	1				4				
Misreported (IIa)									
Misreported (VIa)	39,024	49,918	46,407	18,480	37,911	8,719		17,280	1,959
Misreported (Unknown)									
Unallocated	24,873	22,985	25,405	18,597	7,043	171	2,421	2,039	-629
Discards	24	8,583	9,390	8,870	2,482	5,383	6,187	2,986	7,212
Total	339,970	394,878	357,765	316,620	252,223	206,311	259,199	230,237	234,140

1-includes small catches in IIIb and IIId

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) 1985–2009 (Data submitted by Working Group members).

Country	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
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	
France	7,400	11,200	11,100	8,900	12,700	17,400	4,095		2,350	9,998	10,178	14,347
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
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
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
Norway	24,300	21,000	21,600	17,300	700		29,156	32,365	44,600	2,552		
Poland									600			
Spain				1,500	1,400	400	4,020	2,764	3,162	4,126	4,509	2,271
United Kingdom	205,900	156,300	200,700	208,400	149,100	162,700	162,588	196,890	215,265	208,656	190,344	127,612
Misreported (IVa)		-148,000	-117,000	-180,000	-92,000	-126,000	-130,000	-127,000	-146,697	-134,765	-106,987	-51,781
Misreported (Unknown)												
Unallocated	75,100	49,299	26,000	4,700	18,900	11,500	-3,802	1,472		4,632	28,245	10,603
Discards	4,500			5,800	4,900	11,300	23,550	22,020	15,660	4,220	6,991	10,028
Total	467,700	232,599	284,100	197,000	199,100	182,400	183,509	236,079	248,785	251,646	270,212	213,272

Table 2.2.1.4 cont.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium								1					1
Denmark			552	82	835		392				6	10	
Estonia													
Faroe Islands	2,448[1]	3,681	4,239	4,863	2,161	2,490	2,260	674		59	1,333	3,539	4,421
France	19,114	15,927	14,311	17,857	18,975	19,726	21,213	18,549	15,182	14,625	12,434	14,944	16,464
Germany, Fed. Rep.	15,161	20,989	19,476	22,901	20,793	22,630	19,202	18,730	14,598	14,219	12,831	10,834	17,545
Guernsey										10			
Ireland	52,849	66,505	48,282	61,277	60,168	51,457	49,715	41,730	30,082	36,539	35,923	33,131	48,155
Jersey									9	8	6	7	8
Lithuania										95	7		
Netherlands	22,749	28,790	25,141	30,123	33,654	21,831	23,640	21,132	18,819	20,064	18,261	17,920	20,900
Norway	223										7	3,948	121
Poland									461		978		
Spain	7,842	3,340	4,120	4,500	4,063	3,483	735	2,081	4,795	4,048	2,772	7,327	8,462
United Kingdom	128,836	165,994	127,094	126,620	139,589	131,599	130,762	122,31	115,68	67,187	87,424	76,306[1]	109,147
Misreported (IVa)	-73,523	-98,255	-59,982	-3,775	-39,024	-43,339	-46,407	-18,049	-37,911	-8,719		-17,280	-1,959
Misreported (Unknown)													
Unallocated	4,577	8,351	21,652	31,564	37,952	27,558	33,767	27,999	8,521	4,783	10,042	-952	490
Discards	16,057	3,277		1,920	1,164	15,191	91	2,102	17,278	12,587	2,428	23,780	5,642
Total	196,110	218,599	204,885	297,932	280,553	252,620	235,370	237,26	187,51	166,87	184,45	173,51	229,397

1 – Catches revised for Northern Ireland

Table 2.2.1.5 NE Atlantic Mackerel catch (t) in Divisions VIIIc and IXa, 1977–2009 (Data submitted by Working Group members).

Country	Div	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
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
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
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
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
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

Country	Div	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
France	VIIIc												
Poland	IXa												
Portugal	IXa	3,112	3,819	2,789	3,576	2,015	2,158	2,893	3,023	2,080	2,897	2,002	2,253
Spain	VIIIc	13,446	16,086	16,940	12,043	16,675	21,246	23,631	28,386	35,015	36,174	37,631	30,061
Spain	IXa	1,763	1,406	1,051	2,427	1,027	1,741	1,025	2,714	3,613	5,093	4,164	3,760
USSR	IXa												
Total	IXa	4,875	5,225	3,840	6,003	3,042	3,899	3,918	5,737	5,693	7,990	6,165	6,013
Total		18,321	21,311	20,780	18,046	19,719	25,045	27,549	34,123	40,708	44,164	43,796	36,074

Country	Div	2001	2002	2003	2004	2005	2006	2007	2008	2009
France	VIIIc			226	177	151	43	55	168	383
Poland	IXa									
Portugal	IXa	3,119	2,934	2,749	2,289	1,509	2,620	2,605	2,381	1,753
Spain	VIIIc	38,205	38,703	17,381	28,428	42,851	43,063	53,401	50,455	91,043
Spain	IXa	1,874	7,938	5,646	3,946	5,107	7,025	6,773	6,855	14,569
USSR	IXa									
Total	IXa	4,993	10,873	8,395	6,234	6,616	9,645	9,378	9,236	16,322
Total		43,198	49,575	26,002	34,840	49,618	52,751	62,834	59,859	107,748

Table 2.2.3.1. NEA Mackerel. Pelagic fleet composition in 2009 of major mackerel catching nations.

Country	Details given	Length (metres)	Engine power (Horse Power)	Gear	Storage	Discard est	No vessels
Denmark	Y	57-63	4077-8188	Trawl	Tank	N	5
		57-77	2475-6689	Purse Seine	Tank	N	6
Faroe Islands	Y	84	6000 kW	Purse Seine/Trawl	Freezer	N	1
		90	6468 kW	Trawl	Freezer	N	1
		56	1213 kW	Purse Seine	RSW	N	1
		60-75	1540-8000 kW	Purse Seine/Trawl	RSW	N	6
France	N			Pelagic Trawl	Dry Hold	N	9
France	N			Pelagic Trawl	Freezer	N	3
Germany	Y	86-140	3600-12000	Single Midwater Trawl	Freezer	Y	4
Iceland	Y	<50	951-1300	Pair Trawl	Fresh	Y	3
		50-59	3060	Pair Trawl	RSW	Y	1
		60-69	2996-7505	Single Midwater Trawl	RSW/Freezer	Y	9
		70-79	3308-11257	Single Midwater Trawl	RSW/Freezer	Y	10
Ireland	Y	13-58	160-2500	Midwater Trawl	Dryhold	N	3
		53-120	1007-6600	Midwater Trawl	RSW	N	4
		24-34	700-736	Pair Midwater Trawl	RSW	N	4
		27-71	670-3460	Pair Midwater Trawl	RSW	N	17
		16-37	171-1119	Pair Midwater Trawl	Dryhold	N	24
Netherlands	Y	55	2890	Pair Midwater Trawl	Freezer	Y	2
		88-145	4400-10455	Single Midwater Trawl	Freezer	Y	1
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
		8-38	25-1100	Purse Seine	Dry hold, ice	N	306
		4–27	5–750	Artisanal: Hook	Dry hold, ice	N	370
		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	25

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2009.

Quarters 1-4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	42.22	0.00	21.21	0.02	0.04	1778.85	0.72	0.00
1	77.34	0.00	39.78	0.05	0.09	3501.18	18.86	41.42
2	5161.73	0.83	157.80	0.39	0.71	21432.50	455.80	73.99
3	47499.37	10.29	1144.99	1.80	3.25	150109.3	1294.10	173.87
4	70931.16	16.43	1459.58	1.67	3.05	193108.0	598.68	108.48
5	43985.04	9.84	688.43	0.75	1.38	94662.21	188.92	25.14
6	17040.44	2.37	210.18	0.22	0.48	42404.43	119.45	43.14
7	11642.91	1.82	284.23	0.30	0.57	43407.52	47.12	34.11
8	5407.78	0.59	110.88	0.13	0.24	17169.58	40.72	44.42
9	878.03	0.13	44.93	0.05	0.09	6331.37	1.60	9.48
10	378.92	0.08	29.81	0.03	0.06	4687.35	2.65	0.00
11	377.99	0.06	8.48	0.01	0.02	2410.73	0.31	0.00
12	160.65	0.02	5.62	0.01	0.01	925.33	0.20	0.00
13	140.32	0.01	3.07	0.00	0.01	333.49	0.11	0.00
14	0.09	0.00	0.05	0.00	0.00	20.21	0.00	0.00
15	2.72	0.00	1.36	0.00	0.00	99.15	0.05	0.00
SOP	79149.62	15.60	1685.78	2.06	3.79	233045.7	897.15	172.12
Catch	79234.37	15.60	1682.38	2.04	3.75	231396.7	885.18	170.62
SOP%	99.89%	99.99%	100.20%	100.96%	101.05%	100.71%	101.35%	100.88%

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	1346.16	5.69	1.68	0.00	0.00	0.00	0.00	0.00
1	571.61	0.00	4136.66	1013.04	1090.16	2.21	5127.27	1825.27
2	11462.37	511.28	28806.82	1040.96	6541.88	70.19	1950.08	1977.34
3	47785.57	3517.75	84768.43	382.17	20388.66	196.30	1858.22	954.08
4	66580.63	4316.73	110171.91	125.30	19634.50	217.69	1909.07	656.98
5	36407.26	2812.67	57304.43	6.32	6796.78	112.97	1192.85	242.28
6	22838.72	1021.51	47897.00	114.50	8897.12	84.77	745.71	349.61
7	11706.30	91.13	45107.85	2.12	6778.83	58.14	537.38	102.24
8	4034.56	271.52	18387.59	223.55	1481.01	18.71	457.66	468.68
9	1740.06	165.81	8399.40	0.73	762.03	3.08	204.41	20.95
10	575.15	1.63	4376.44	0.59	404.88	2.79	0.03	7.04
11	386.29	1.69	1598.33	0.30	169.41	0.84	46.73	8.39
12	0.00	0.04	1201.20	0.22	102.29	1.15	0.01	0.00
13	1.59	0.00	592.32	0.00	15.74	0.03	0.00	0.00
14	1.43	0.00	100.19	0.01	22.30	0.65	0.00	2.15
15	0.00	0.00	3.99	0.01	0.93	0.00	0.00	2.15
SOP	78477.11	4662.28	136747.48	769.37	22900.97	236.12	3507.31	1738.19
Catch	79154.40	4664.52	136722.75	773.24	22937.54	239.03	3492.14	1743.89
SOP%	99.14%	99.95%	100.02%	99.50%	99.84%	98.78%	100.43%	99.67%

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.52	0.00	0.00	0.00	0.00	343.47	82.70
1	338.30	0.87	1.93	287.02	0.00	1750.08	1026.39
2	507.97	4.22	15.07	2687.28	0.00	924.98	1494.02
3	393.76	11.06	165.17	31034.24	0.02	739.02	2824.98
4	376.08	7.10	165.24	49506.25	0.02	1499.23	7448.80
5	178.28	12.49	53.05	18770.17	0.02	1015.47	5187.21
6	117.19	2.04	50.20	16977.27	0.01	2134.19	9550.17
7	56.30	1.74	19.24	12530.07	0.02	1454.64	7055.14
8	59.30	2.41	6.79	3171.57	0.01	556.68	2382.82
9	3.08	0.19	3.28	1929.44	0.00	228.03	1085.95
10	1.69	0.08	1.80	757.15	0.00	114.61	520.15
11	6.57	0.07	0.64	541.20	0.00	42.88	207.84
12	0.00	0.01	0.26	128.05	0.00	13.65	66.79
13	0.00	0.00	0.00	0.00	0.00	11.61	55.46
14	0.00	0.03	0.07	1.09	0.00	0.00	0.00
15	0.00	0.03	0.07	1.09	0.00	0.00	0.00
SOP	461.68	11.73	149.65	43083.59	0.04	3180.44	12772.76
Catch	461.71	11.68	149.54	43773.59	0.04	3177.54	12749.91
SOP%	99.99%	100.42%	100.07%	98.42%	108.59%	100.09%	100.18%

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	291.57	2746.62	0.00	5756.87	4123.65	18.01	16559.99
1	1209.67	6165.40	0.00	5904.77	673.37	0.00	34802.75
2	6433.37	8124.35	259.87	6803.32	1779.39	43.73	108722.21
3	21124.36	15693.42	2332.14	11538.13	2130.17	210.95	448285.60
4	52928.38	16017.28	3851.23	12667.33	486.78	370.45	615164.08
5	36649.79	5529.03	3059.60	5266.35	160.25	264.97	320583.96
6	43377.76	4247.46	671.01	4391.12	93.13	210.95	223592.17
7	42318.01	4423.18	465.45	4993.80	100.19	90.04	193310.36
8	14825.01	1542.82	596.01	1911.92	84.35	38.59	73295.90
9	6206.08	595.74	9.38	837.32	69.23	20.58	29550.42
10	2342.97	245.36	7.74	350.18	46.58	5.15	14860.93
11	1155.48	151.86	3.86	226.26	78.13	5.15	7429.49
12	380.66	55.30	2.88	67.81	0.00	0.00	3112.15
13	309.55	51.18	0.00	55.93	0.00	0.00	1570.42
14	0.00	0.00	0.06	0.00	0.00	0.00	148.34
15	0.00	0.00	0.06	0.00	0.00	0.00	111.60
SOP	76053.43	15419.62	3157.87	14574.41	1752.66	529.56	733318.79
Catch	75973.85	15451.88	3164.00	14568.92	1752.62	535.00	734888.44
SOP%	100.10%	99.79%	99.81%	100.04%	100.00%	98.98%	99.79%

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2009 (cont.).

Quarter 1

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			0.00			0.00	0.00	0.00
1			0.07			0.70	0.00	0.05
2			1.22			21.81	0.03	0.95
3			3.04			60.64	0.07	2.37
4			0.61			72.20	0.01	0.47
5			0.07			37.74	0.00	0.05
6			0.00			27.69	0.00	0.00
7			0.00			19.39	0.00	0.00
8			0.07			6.32	0.00	0.05
9			0.00			1.18	0.00	0.00
10			0.00			1.01	0.00	0.00
11			0.00			0.29	0.00	0.00
12			0.00			0.38	0.00	0.00
13			0.00			0.02	0.00	0.00
14			0.00			0.20	0.00	0.00
15			0.00			0.00	0.00	0.00
SOP			1.33			77.24	0.03	1.04
Catch			1.29			78.10	0.03	1.00
SOP%			103.42%			98.90%	96.55%	103.83%

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0		0.00	0.00	0.00	0.00	0.00	0.00	0.00
1		0.00	225.08	0.00	51.50	2.21	311.69	18.52
2		0.00	5904.39	0.00	2464.62	70.19	152.14	9.79
3		1.40	41760.80	0.01	15419.73	196.30	499.70	35.44
4		7.48	91827.59	0.01	18228.18	217.69	613.49	51.39
5		0.81	51199.50	0.00	6471.61	112.97	373.54	34.41
6		0.14	44976.09	0.00	8735.55	84.77	230.06	22.82
7		0.00	44224.77	0.00	6635.95	58.14	129.87	14.54
8		0.00	17952.53	0.00	1463.63	18.71	122.45	12.61
9		0.00	8185.44	0.00	749.72	3.08	61.84	3.95
10		0.00	4360.07	0.00	396.97	2.79	0.00	0.14
11		0.00	1594.07	0.00	164.55	0.84	16.08	1.73
12		0.00	1195.41	0.00	99.91	1.15	0.00	0.00
13		0.00	592.08	0.00	15.72	0.03	0.00	0.00
14		0.00	96.77	0.00	21.34	0.65	0.00	0.00
15		0.00	3.88	0.00	0.00	0.00	0.00	0.00
SOP		3.35	111448.66	0.01	20116.27	236.12	677.75	55.52
Catch		3.35	110086.52	0.01	20121.37	239.03	667.92	55.11
SOP%		99.95%	101.24%	60.83%	99.97%	98.78%	101.47%	100.74%

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.00	0.00	0.00	0.00		0.00	0.00
1	0.86	0.00	0.06	241.28		156.91	714.63
2	0.97	0.01	1.69	2442.50		232.28	1322.55
3	2.69	0.06	24.64	30670.99		346.09	2428.77
4	3.84	0.05	45.11	49207.67		1129.43	6735.54
5	2.29	0.02	18.53	18475.68		842.06	4809.11
6	1.74	0.02	7.61	16747.58		1734.53	8740.61
7	1.11	0.01	4.19	12367.09		1214.13	6524.91
8	0.96	0.00	3.81	3121.52		407.79	2207.84
9	0.19	0.00	0.09	1869.93		190.21	1002.93
10	0.03	0.00	0.05	709.76		96.17	480.79
11	0.14	0.00	0.01	516.88		37.80	196.48
12	0.00	0.00	0.01	110.96		12.11	63.35
13	0.00	0.00	0.00	0.00		9.85	51.52
14	0.00	0.00	0.00	0.00		0.00	0.00
15	0.00	0.00	0.00	0.00		0.00	0.00
SOP	3.86	0.05	29.91	42492.10		2141.37	11668.70
Catch	3.84	0.05	29.91	43136.23		2137.03	11646.88
SOP%	100.55%	104.21%	100.00%	98.51%		100.20%	100.19%

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00		0.00
1	431.97	1512.15	0.00	614.12	23.43		4305.23
2	5017.82	6006.84	97.26	4623.17	408.96		28779.17
3	16879.14	12891.99	1556.16	8819.81	687.67		132287.50
4	43838.36	13115.50	3209.57	9641.64	189.66		238135.51
5	30843.02	4368.48	1361.63	4324.36	76.64		123352.52
6	36729.63	3072.94	486.30	3895.11	28.49		125521.69
7	35920.45	3000.63	291.77	4554.35	47.74		115009.04
8	12639.59	807.19	291.77	1817.88	8.49		40883.22
9	5275.32	241.73	0.00	803.74	18.49		18407.85
10	1993.98	86.84	0.00	340.55	16.72		8485.87
11	976.06	43.76	0.00	219.49	35.24		3803.41
12	321.61	15.82	0.00	65.61	0.00		1886.31
13	260.03	15.15	0.00	54.08	0.00		998.49
14	0.00	0.00	0.00	0.00	0.00		118.97
15	0.00	0.00	0.00	0.00	0.00		3.88
SOP	63854.97	10594.18	2030.00	10901.39	364.64		276660.03
Catch	63778.67	10614.31	2030.00	10903.08	364.61		277097.34
SOP%	100.12%	99.81%	100.00%	99.98%	100.01%		99.84%

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2009 (cont.).

Quarter 2

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	0.00		1.11	0.00	0.00	13.34	0.59	0.00
1	0.00		2.80	0.01	0.02	24.67	17.36	30.45
2	785.84		22.69	0.22	0.38	88.37	292.85	47.57
3	8251.30		202.42	0.54	0.95	627.55	789.68	123.86
4	11132.71		158.01	0.11	0.19	864.72	205.66	55.76
5	7989.35		68.42	0.01	0.02	411.23	43.99	9.26
6	3667.24		25.86	0.00	0.00	121.02	8.93	21.40
7	2357.51		19.89	0.00	0.00	174.20	8.97	21.36
8	1047.78		7.25	0.01	0.02	68.52	19.20	30.44
9	130.97		2.34	0.00	0.00	28.19	1.25	6.83
10	0.00		2.30	0.00	0.00	18.09	1.07	0.00
11	0.00		0.42	0.00	0.00	4.99	0.22	0.00
12	0.00		0.29	0.00	0.00	3.48	0.16	0.00
13	0.00		0.16	0.00	0.00	1.93	0.09	0.00
14	0.00		0.00	0.00	0.00	0.03	0.00	0.00
15	0.00		0.07	0.00	0.00	0.86	0.04	0.00
SOP	13819.56		208.59	0.24	0.42	979.76	393.92	103.24
Catch	13682.29		206.33	0.23	0.41	979.49	383.28	101.74
SOP%	101.00%		101.09%	103.42%	101.41%	100.03%	102.78%	101.47%

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	571.61	0.00	0.96	0.01	0.05	593.84	55.43	571.61
2	8193.12	497.46	4.33	1.08	13.28	289.91	146.58	8193.12
3	32010.35	2489.71	82.20	2.33	30.78	952.12	241.90	32010.35
4	38869.71	1826.81	290.34	3.30	37.58	1168.98	269.88	38869.71
5	16576.79	1493.40	199.74	3.13	35.51	711.84	117.17	16576.79
6	7049.90	331.99	118.66	2.82	33.26	438.46	87.69	7049.90
7	4953.98	0.28	97.38	1.83	20.94	247.54	45.70	4953.98
8	1143.23	0.06	0.00	0.41	5.55	233.32	48.21	1143.23
9	190.54	0.01	30.95	0.69	7.49	117.86	5.80	190.54
10	190.54	0.00	0.00	0.58	6.06	0.03	2.58	190.54
11	0.00	0.01	0.00	0.28	3.01	30.65	2.35	0.00
12	0.00	0.01	0.00	0.22	2.38	0.01	0.00	0.00
13	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOP	38837.07	2238.55	363.58	6.00	70.37	1291.60	230.44	38837.07
Catch	39109.00	2239.71	363.68	6.57	76.20	1272.86	230.94	39109.00
SOP%	99.30%	99.95%	99.97%	91.28%	92.35%	101.47%	99.78%	99.30%

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.00	0.00	0.00	0.00		0.00	0.00
1	77.63	0.02	1.86	0.19		1.86	4.18
2	209.37	0.17	13.26	80.90		40.15	89.93
3	229.96	1.66	138.95	135.86		163.47	366.15
4	223.89	1.43	118.35	219.77		316.46	708.82
5	95.93	0.42	32.66	236.20		168.25	376.86
6	82.33	0.52	41.42	208.91		361.04	808.66
7	52.34	0.18	13.76	140.16		236.27	529.21
8	45.57	0.03	2.12	32.07		78.00	174.71
9	2.89	0.04	2.84	53.85		36.97	82.82
10	1.66	0.03	1.61	45.21		17.47	39.12
11	6.43	0.01	0.49	22.14		5.07	11.36
12	0.00	0.01	0.26	17.09		1.54	3.44
13	0.00	0.00	0.00	0.00		1.75	3.93
14	0.00	0.00	0.00	0.00		0.00	0.00
15	0.00	0.00	0.00	0.00		0.00	0.00
SOP	221.53	1.43	116.33	434.39		454.61	1018.25
Catch	221.38	1.44	116.34	478.88		454.51	1018.03
SOP%	100.07%	99.45%	99.99%	90.71%		100.02%	100.02%

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00		15.05
1	5.40	153.47	0.00	2689.56	28.49		4259.88
2	1211.59	938.78	13.45	1391.48	302.26		14675.02
3	4161.69	2213.90	20.61	2231.05	531.70		56000.71
4	9076.26	2789.17	35.15	2871.59	175.46		71420.09
5	5801.86	1109.51	39.39	889.01	55.31		36465.28
6	6644.71	1140.09	34.62	464.04	29.14		21722.70
7	6394.82	1404.44	23.47	429.41	38.36		17212.01
8	2184.46	726.78	5.39	91.73	61.78		6006.64
9	930.15	349.23	9.06	32.56	20.48		2043.80
10	348.45	156.06	7.62	9.26	8.78		856.52
11	179.42	108.11	3.74	6.70	17.36		402.77
12	59.05	39.48	2.88	2.21	0.00		132.48
13	49.52	36.03	0.00	1.85	0.00		95.29
14	0.00	0.00	0.00	0.00	0.00		0.06
15	0.00	0.00	0.00	0.00	0.00		0.97
SOP	11972.84	3319.16	71.44	2241.60	308.66		78703.58
Catch	11967.40	3330.97	79.00	2246.88	308.64		78876.20
SOP%	100.05%	99.65%	90.44%	99.77%	100.01%		99.78%

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2009 (cont.).

Quarter 3

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	42.22	0.00	19.89	0.02	0.03	1402.64	0.13	0.00
1	77.34	0.00	36.76	0.04	0.06	2663.17	1.48	0.00
2	4375.36	0.83	132.25	0.17	0.26	10607.36	162.27	22.82
3	39243.67	10.29	930.10	1.26	1.91	79579.88	493.69	39.37
4	59791.83	16.43	1284.91	1.56	2.37	98661.91	383.39	38.68
5	35991.64	9.84	610.54	0.73	1.11	46308.65	140.01	13.18
6	13371.49	2.37	179.35	0.22	0.34	14128.12	107.91	13.47
7	9284.28	1.82	258.88	0.30	0.45	18815.00	37.39	4.48
8	4359.43	0.59	102.27	0.12	0.18	7378.91	21.10	3.01
9	746.97	0.13	41.76	0.05	0.07	2957.91	0.27	0.00
10	378.88	0.08	26.94	0.03	0.05	1985.88	1.51	0.00
11	377.94	0.06	7.44	0.01	0.01	530.46	0.05	0.00
12	160.63	0.02	5.19	0.01	0.01	368.00	0.03	0.00
13	140.30	0.01	2.87	0.00	0.00	202.95	0.02	0.00
14	0.09	0.00	0.04	0.00	0.00	3.12	0.00	0.00
15	2.72	0.00	1.28	0.00	0.00	90.39	0.01	0.00
SOP	65325.77	15.60	1454.77	1.82	2.76	114356.5	491.19	45.39
Catch	65544.49	15.60	1453.91	1.81	2.75	114249.1	489.96	45.39
SOP%	99.67%	99.99%	100.06%	100.64%	100.32%	100.09%	100.25%	100.00%

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	1346.16	5.69	1.68	0.00	0.00	0.00	0.00	1346.16
1	0.00	0.00	33.46	0.91	3.94	2729.32	93.73	0.00
2	3269.24	13.82	158.54	3.35	19.52	970.70	117.97	3269.24
3	15775.22	76.47	330.51	4.75	41.46	287.14	102.17	15775.22
4	27710.92	128.40	195.21	1.63	30.30	126.59	110.96	27710.92
5	19830.47	87.89	82.51	1.99	27.42	77.49	74.83	19830.47
6	15788.82	68.06	21.33	0.27	15.99	77.19	51.71	15788.82
7	6752.32	29.59	23.75	0.28	17.72	129.98	41.54	6752.32
8	2891.33	12.43	8.82	0.39	11.84	101.89	46.20	2891.33
9	1549.52	6.53	3.52	0.04	4.82	24.70	11.20	1549.52
10	384.62	1.63	2.68	0.01	1.86	0.00	4.31	384.62
11	386.29	1.68	0.63	0.01	1.86	0.00	4.31	386.29
12	0.00	0.03	0.44	0.00	0.00	0.00	0.00	0.00
13	1.59	0.00	0.24	0.00	0.00	0.00	0.00	1.59
14	1.43	0.00	0.00	0.01	0.93	0.00	2.15	1.43
15	0.00	0.00	0.11	0.01	0.93	0.00	2.15	0.00
SOP	39640.67	175.63	285.03	3.23	59.63	1062.17	204.14	39640.67
Catch	40045.40	176.00	280.81	3.23	57.48	1065.38	204.15	40045.40
SOP%	98.99%	99.79%	101.50%	100.05%	103.73%	99.70%	100.00%	98.99%

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.00	0.00	0.00	0.00	0.00	343.47	22.38
1	251.81	0.00	0.00	0.00	0.00	1277.39	83.23
2	286.67	1.04	0.12	3.43	0.00	338.63	22.06
3	155.83	5.56	1.44	32.29	0.02	124.81	8.13
4	141.92	4.62	1.62	34.03	0.02	18.45	1.20
5	77.24	11.73	1.69	44.78	0.02	5.16	0.34
6	31.71	1.36	1.06	20.08	0.01	3.73	0.24
7	2.80	1.40	1.18	22.11	0.02	4.24	0.28
8	12.06	2.27	0.79	16.56	0.01	1.13	0.07
9	0.00	0.11	0.32	5.65	0.00	0.84	0.06
10	0.00	0.04	0.12	2.17	0.00	0.98	0.06
11	0.00	0.04	0.12	2.17	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.02	0.06	1.09	0.00	0.00	0.00
15	0.00	0.02	0.06	1.09	0.00	0.00	0.00
SOP	227.68	8.13	3.10	63.89	0.04	352.38	22.96
Catch	227.87	8.09	3.00	62.46	0.04	353.00	23.00
SOP%	99.92%	100.52%	103.29%	102.29%	108.59%	99.82%	99.82%

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	119.77	2245.73	0.00	4926.13	129.35	18.01	10623.31
1	480.72	3679.18	0.00	2436.53	433.07	0.00	14282.16
2	127.52	963.77	0.12	713.40	816.42	43.73	23171.39
3	46.06	480.39	1.44	435.13	712.14	210.95	139132.10
4	6.65	92.07	1.62	142.29	94.69	370.45	189394.73
5	1.74	41.72	1.69	49.93	26.79	264.97	103786.10
6	1.27	28.15	1.06	30.22	35.29	210.95	44191.81
7	1.58	14.81	1.18	9.42	13.49	90.04	35560.30
8	0.40	7.23	0.79	2.12	13.49	38.59	15033.99
9	0.31	3.90	0.32	0.93	29.94	20.58	5410.45
10	0.38	2.01	0.12	0.30	20.72	5.15	2820.54
11	0.00	0.00	0.12	0.00	25.00	5.15	1343.34
12	0.00	0.00	0.00	0.00	0.00	0.00	534.35
13	0.00	0.00	0.00	0.00	0.00	0.00	348.00
14	0.00	0.00	0.06	0.00	0.00	0.00	9.01
15	0.00	0.00	0.06	0.00	0.00	0.00	98.83
SOP	130.88	1231.72	3.10	1287.88	617.67	529.56	227603.32
Catch	131.22	1231.85	3.00	1282.39	617.68	535.00	228114.12
SOP%	99.74%	99.99%	103.32%	100.43%	100.00%	98.98%	99.78%

Table 2.3.1.1 NE Atlantic Mackerel. Catch numbers (000's) at age by area for 2009 (cont.).

Quarter 4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	0.00		0.20		0.00	362.87	0.00	0.00
1	0.00		0.15		0.01	812.63	0.01	10.92
2	0.53		1.64		0.06	10714.96	0.65	2.65
3	4.40		9.43		0.39	69841.28	10.66	8.27
4	6.62		16.05		0.49	93509.24	9.62	13.56
5	4.04		9.41		0.25	47904.59	4.92	2.65
6	1.70		4.97		0.14	28127.60	2.61	8.27
7	1.11		5.46		0.12	24398.93	0.76	8.27
8	0.57		1.29		0.04	9715.84	0.41	10.92
9	0.08		0.83		0.02	3344.09	0.08	2.65
10	0.04		0.57		0.01	2682.37	0.07	0.00
11	0.05		0.62		0.01	1874.99	0.04	0.00
12	0.02		0.14		0.00	553.47	0.01	0.00
13	0.02		0.03		0.00	128.58	0.00	0.00
14	0.00		0.01		0.00	16.86	0.00	0.00
15	0.00		0.00		0.00	7.91	0.00	0.00
SOP	7.64		21.02		0.61	117621.1	12.07	22.48
Catch	7.59		20.84		0.60	116090.0	11.92	22.48
SOP%	100.62%		100.88%		102.27%	101.32%	101.25%	99.99%

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0		0.00	0.00	0.00	0.00	0.00	0.00	0.00
1		0.00	3877.16	1012.12	1034.67	1492.42	1657.59	0.00
2		0.00	22739.56	1036.53	4044.47	537.34	1703.00	0.00
3		950.17	42594.92	375.09	4896.69	119.26	574.56	950.17
4		2354.03	17858.77	120.36	1338.44	0.00	224.75	2354.03
5		1230.58	5822.68	1.20	262.24	29.99	15.87	1230.58
6		621.32	2780.92	111.40	112.33	0.00	187.39	621.32
7		61.26	761.96	0.00	104.22	29.99	0.46	61.26
8		259.03	426.24	222.74	0.00	0.00	361.66	259.03
9		159.27	179.49	0.00	0.00	0.00	0.00	159.27
10		0.00	13.68	0.00	0.00	0.00	0.00	0.00
11		0.00	3.63	0.00	0.00	0.00	0.00	0.00
12		0.00	5.36	0.00	0.00	0.00	0.00	0.00
13		0.00	0.00	0.00	0.00	0.00	0.00	0.00
14		0.00	3.42	0.00	0.00	0.00	0.00	0.00
15		0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOP		2244.63	24662.04	760.22	2654.95	476.20	1248.08	2244.63
Catch		2245.46	24792.75	763.45	2682.50	485.98	1253.70	2245.46
SOP%		99.96%	99.47%	99.58%	98.97%	97.99%	99.55%	99.96%

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.52	0.00	0.00	0.00		0.00	60.33
1	8.00	0.85	0.00	45.56		313.92	224.36
2	10.96	3.00	0.01	160.45		313.92	59.48
3	5.27	3.77	0.14	195.10		104.65	21.92
4	6.43	1.00	0.16	44.78		34.89	3.24
5	2.82	0.33	0.17	13.50		0.00	0.91
6	1.42	0.14	0.10	0.71		34.89	0.66
7	0.05	0.16	0.12	0.71		0.00	0.74
8	0.72	0.11	0.08	1.42		69.76	0.20
9	0.00	0.04	0.03	0.00		0.00	0.15
10	0.00	0.02	0.01	0.00		0.00	0.17
11	0.00	0.02	0.01	0.00		0.00	0.00
12	0.00	0.00	0.00	0.00		0.00	0.00
13	0.00	0.00	0.00	0.00		0.00	0.00
14	0.00	0.01	0.01	0.00		0.00	0.00
15	0.00	0.01	0.01	0.00		0.00	0.00
SOP	8.62	2.11	0.30	95.82		231.99	61.89
Catch	8.62	2.10	0.29	96.02		233.00	62.00
SOP%	100.00%	100.58%	104.68%	99.79%		99.57%	99.82%

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	171.80	500.88	0.00	830.74	3994.29		5921.63
1	291.58	820.60	0.00	164.57	188.38		11955.49
2	76.44	214.96	149.03	75.28	251.74		42096.64
3	37.48	107.14	753.93	52.13	198.66		120865.29
4	7.11	20.54	604.90	11.81	26.97		116213.76
5	3.17	9.31	1656.89	3.05	1.51		56980.06
6	2.15	6.28	149.03	1.75	0.21		32155.98
7	1.16	3.30	149.03	0.62	0.60		25529.01
8	0.55	1.61	298.06	0.20	0.60		11372.05
9	0.30	0.87	0.00	0.10	0.32		3688.32
10	0.16	0.45	0.00	0.07	0.36		2697.99
11	0.00	0.00	0.00	0.07	0.54		1879.98
12	0.00	0.00	0.00	0.00	0.00		559.01
13	0.00	0.00	0.00	0.00	0.00		128.64
14	0.00	0.00	0.00	0.00	0.00		20.30
15	0.00	0.00	0.00	0.00	0.00		7.92
SOP	96.56	274.72	1053.43	144.90	461.78		152163.23
Catch	96.57	274.75	1052.00	136.58	461.68		150800.89
SOP%	99.99%	99.99%	100.14%	106.09%	100.02%		100.90%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2009. Zeros represent values <1%.

Quarters 1-4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	0%		1%	0%	0%	0%	0%	
1	0%		1%	1%	1%	1%	1%	7%
2	3%	2%	4%	7%	7%	4%	16%	13%
3	23%	24%	27%	33%	33%	26%	47%	31%
4	35%	39%	35%	31%	31%	33%	22%	20%
5	22%	23%	16%	14%	14%	16%	7%	5%
6	8%	6%	5%	4%	5%	7%	4%	8%
7	6%	4%	7%	5%	6%	7%	2%	6%
8	3%	1%	3%	2%	2%	3%	1%	8%
9	0%	0%	1%	1%	1%	1%	0%	2%
10	0%	0%	1%	1%	1%	1%	0%	0%
11	0%	0%	0%	0%	0%	0%	0%	
12	0%	0%	0%	0%	0%	0%	0%	
13	0%	0%	0%	0%	0%	0%	0%	
14	0%		0%		0%	0%	0%	
15	0%		0%	0%	0%	0%	0%	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	1%	0%	0%					
1	0%		1%	35%	1%	0%	37%	28%
2	6%	4%	7%	36%	9%	9%	14%	30%
3	23%	28%	21%	13%	28%	26%	13%	14%
4	32%	34%	27%	4%	27%	28%	14%	10%
5	18%	22%	14%	0%	9%	15%	9%	4%
6	11%	8%	12%	4%	12%	11%	5%	5%
7	6%	1%	11%	0%	9%	8%	4%	2%
8	2%	2%	4%	8%	2%	2%	3%	7%
9	1%	1%	2%	0%	1%	0%	1%	0%
10	0%	0%	1%	0%	1%	0%	0%	0%
11	0%	0%	0%	0%	0%	0%	0%	0%
12		0%	0%	0%	0%	0%	0%	
13	0%		0%		0%	0%		
14	0%		0%	0%	0%	0%		0%
15			0%	0%	0%			0%

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0%					3%	0%
1	17%	2%	0%	0%		16%	3%
2	25%	10%	3%	2%	1%	9%	4%
3	19%	26%	34%	22%	17%	7%	7%
4	18%	17%	34%	36%	19%	14%	19%
5	9%	30%	11%	14%	20%	9%	13%
6	6%	5%	10%	12%	12%	20%	24%
7	3%	4%	4%	9%	14%	13%	18%
8	3%	6%	1%	2%	9%	5%	6%
9	0%	0%	1%	1%	4%	2%	3%
10	0%	0%	0%	1%	1%	1%	1%
11	0%	0%	0%	0%	1%	0%	1%
12		0%	0%	0%		0%	0%
13						0%	0%
14		0%	0%	0%	1%		
15		0%	0%	0%	1%		

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	0%	4%		9%	42%	1%	1%
1	1%	9%		10%	7%		2%
2	3%	12%	2%	11%	18%	3%	5%
3	9%	24%	21%	19%	22%	16%	21%
4	23%	24%	34%	21%	5%	29%	29%
5	16%	8%	27%	9%	2%	21%	15%
6	19%	6%	6%	7%	1%	16%	11%
7	18%	7%	4%	8%	1%	7%	9%
8	6%	2%	5%	3%	1%	3%	4%
9	3%	1%	0%	1%	1%	2%	1%
10	1%	0%	0%	1%	0%	0%	1%
11	1%	0%	0%	0%	1%	0%	0%
12	0%	0%	0%	0%			0%
13	0%	0%		0%			0%
14			0%				0%
15			0%				0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2009. Zeros represent values <1% (cont.).

Quarter 1

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0								
1			1%		2%	0%	1%	1%
2			24%		22%	9%	24%	24%
3			60%		59%	24%	60%	60%
4			12%		12%	29%	12%	12%
5			1%		2%	15%	1%	1%
6						11%		
7						8%		
8			1%		2%	3%	1%	1%
9						0%		
10						0%		
11						0%		
12						0%		
13						0%		
14						0%		
15						0%		

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1			0%	1%	0%	0%	12%	9%
2			2%	3%	4%	9%	6%	5%
3		14%	13%	31%	25%	26%	20%	17%
4		76%	29%	32%	30%	28%	24%	25%
5		8%	16%	10%	11%	15%	15%	17%
6		1%	14%	13%	14%	11%	9%	11%
7			14%	7%	11%	8%	5%	7%
8			6%	1%	2%	2%	5%	6%
9			3%	1%	1%	0%	2%	2%
10			1%	1%	1%	0%		0%
11			1%	1%	0%	0%	1%	1%
12			0%		0%	0%		
13			0%		0%	0%		
14			0%		0%	0%		
15			0%					

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0							
1	6%	0%	0%	0%		2%	2%
2	7%	4%	2%	2%		4%	4%
3	18%	37%	23%	22%		5%	7%
4	26%	33%	43%	36%		18%	19%
5	15%	9%	18%	14%		13%	14%
6	12%	11%	7%	12%		27%	25%
7	8%	4%	4%	9%		19%	18%
8	6%	1%	4%	2%		6%	6%
9	1%	1%	0%	1%		3%	3%
10	0%	0%	0%	1%		2%	1%
11	1%	0%	0%	0%		1%	1%
12		0%	0%	0%		0%	0%
13						0%	0%
14							
15							

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0							
1	0%	3%		2%	2%		1%
2	3%	13%	1%	12%	27%		3%
3	9%	29%	21%	22%	45%		16%
4	23%	29%	44%	24%	12%		28%
5	16%	10%	19%	11%	5%		15%
6	19%	7%	7%	10%	2%		15%
7	19%	7%	4%	11%	3%		14%
8	7%	2%	4%	5%	1%		5%
9	3%	1%		2%	1%		2%
10	1%	0%		1%	1%		1%
11	1%	0%		1%	2%		0%
12	0%	0%		0%			0%
13	0%	0%		0%			0%
14							0%
15							0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2009. Zeros represent values <1% (cont.).

Quarter 2

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			0%			1%	0%	
1			1%	1%	1%	1%	1%	9%
2	2%		4%	24%	24%	4%	21%	14%
3	23%		39%	60%	60%	26%	57%	36%
4	31%		31%	12%	12%	35%	15%	16%
5	23%		13%	1%	1%	17%	3%	3%
6	10%		5%			5%	1%	6%
7	7%		4%			7%	1%	6%
8	3%		1%	1%	1%	3%	1%	9%
9	0%		0%			1%	0%	2%
10			0%			1%	0%	0%
11			0%			0%	0%	
12			0%			0%	0%	
13			0%			0%	0%	
14			0%			0%	0%	
15			0%			0%	0%	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1	1%		0%	0%	0%	12%	5%	1%
2	7%	7%	1%	6%	7%	6%	14%	7%
3	29%	37%	10%	14%	16%	20%	24%	29%
4	35%	28%	35%	20%	19%	24%	26%	35%
5	15%	22%	24%	19%	18%	15%	11%	15%
6	6%	5%	14%	17%	17%	9%	9%	6%
7	5%	0%	12%	11%	11%	5%	4%	5%
8	1%	0%		2%	3%	5%	5%	1%
9	0%	0%	4%	4%	4%	2%	1%	0%
10	0%			3%	3%	0%	0%	0%
11		0%		2%	2%	1%	0%	
12		0%		1%	1%	0%		
13					0%			
14					0%			
15								

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0							
1	8%	0%	1%	0%		0%	0%
2	20%	4%	4%	7%		3%	3%
3	22%	37%	38%	11%		11%	11%
4	22%	32%	32%	18%		22%	22%
5	9%	9%	9%	20%		12%	12%
6	8%	11%	11%	18%		25%	25%
7	5%	4%	4%	12%		17%	17%
8	4%	1%	1%	3%		5%	5%
9	0%	1%	1%	5%		3%	3%
10	0%	1%	0%	4%		1%	1%
11	1%	0%	0%	2%		0%	0%
12		0%	0%	1%		0%	0%
13						0%	0%
14							
15							

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0							0%
1	0%	1%		24%	2%		2%
2	3%	8%	7%	13%	24%		6%
3	11%	20%	11%	20%	42%		24%
4	24%	25%	18%	26%	14%		31%
5	16%	10%	20%	8%	4%		16%
6	18%	10%	18%	4%	2%		9%
7	17%	13%	12%	4%	3%		7%
8	6%	7%	3%	1%	5%		3%
9	3%	3%	5%	0%	2%		1%
10	1%	1%	4%	0%	1%		0%
11	0%	1%	2%	0%	1%		0%
12	0%	0%	1%	0%			0%
13	0%	0%		0%			0%
14							0%
15							0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2009. Zeros represent values <1% (cont.).

Quarter 3

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	0%		1%	0%	0%	0%	0%	
1	0%		1%	1%	1%	1%	0%	
2	3%	2%	4%	4%	4%	4%	12%	17%
3	23%	24%	26%	28%	28%	28%	37%	29%
4	36%	39%	35%	35%	35%	35%	28%	29%
5	21%	23%	17%	16%	16%	16%	10%	10%
6	8%	6%	5%	5%	5%	5%	8%	10%
7	6%	4%	7%	7%	7%	7%	3%	3%
8	3%	1%	3%	3%	3%	3%	2%	2%
9	0%	0%	1%	1%	1%	1%	0%	
10	0%	0%	1%	1%	1%	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%	0%	
14	0%		0%		0%	0%	0%	
15	0%		0%	0%	0%	0%	0%	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	1%	1%	0%					1%
1			4%	7%	2%	60%	14%	
2	3%	3%	18%	25%	11%	21%	18%	3%
3	16%	18%	38%	35%	23%	6%	15%	16%
4	29%	30%	23%	12%	17%	3%	17%	29%
5	21%	20%	10%	15%	15%	2%	11%	21%
6	17%	16%	2%	2%	9%	2%	8%	17%
7	7%	7%	3%	2%	10%	3%	6%	7%
8	3%	3%	1%	3%	7%	2%	7%	3%
9	2%	2%	0%	0%	3%	1%	2%	2%
10	0%	0%	0%	0%	1%		1%	0%
11	0%	0%	0%	0%	1%		1%	0%
12		0%	0%					
13	0%		0%					0%
14	0%		0%	0%	1%		0%	0%
15			0%	0%	1%		0%	

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0						16%	16%
1	26%					60%	60%
2	30%	4%	1%	2%	1%	16%	16%
3	16%	20%	17%	17%	17%	6%	6%
4	15%	16%	19%	18%	19%	1%	1%
5	8%	42%	20%	24%	20%	0%	0%
6	3%	5%	12%	11%	12%	0%	0%
7	0%	5%	14%	12%	14%	0%	0%
8	1%	8%	9%	9%	9%	0%	0%
9		0%	4%	3%	4%	0%	0%
10		0%	1%	1%	1%	0%	0%
11		0%	1%	1%	1%		
12							
13							
14		0%	1%	1%	1%		
15		0%	1%	1%	1%		

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	15%	30%		56%	6%	1%	2%
1	61%	49%		28%	18%		2%
2	16%	13%	1%	8%	35%	3%	4%
3	6%	6%	17%	5%	30%	16%	24%
4	1%	1%	19%	2%	4%	29%	32%
5	0%	1%	20%	1%	1%	21%	18%
6	0%	0%	12%	0%	2%	16%	8%
7	0%	0%	14%	0%	1%	7%	6%
8	0%	0%	9%	0%	1%	3%	3%
9	0%	0%	4%	0%	1%	2%	1%
10	0%	0%	1%	0%	1%	0%	0%
11			1%		1%	0%	0%
12							0%
13							0%
14			1%				0%
15			1%				0%

Table 2.3.1.2 NE Atlantic Mackerel. Percentage catch numbers at age by area for 2009. Zeros represent values <1% (cont.).

Quarter 4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			0%		0%	0%		
1			0%		0%	0%	0%	16%
2	3%		3%		4%	4%	2%	4%
3	23%		19%		25%	24%	36%	12%
4	35%		32%		32%	32%	32%	20%
5	21%		19%		16%	16%	16%	4%
6	9%		10%		9%	10%	9%	12%
7	6%		11%		8%	8%	3%	12%
8	3%		3%		3%	3%	1%	16%
9	0%		2%		1%	1%	0%	4%
10	0%		1%		1%	1%	0%	
11	0%		1%		1%	1%	0%	
12	0%		0%		0%	0%	0%	
13	0%		0%		0%	0%	0%	
14			0%		0%	0%		
15			0%			0%		

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1			4%	35%	9%	68%	35%	
2			23%	36%	34%	24%	36%	
3		17%	44%	13%	42%	5%	12%	17%
4		42%	18%	4%	11%		5%	42%
5		22%	6%	0%	2%	1%	0%	22%
6		11%	3%	4%	1%		4%	11%
7		1%	1%		1%	1%	0%	1%
8		5%	0%	8%			8%	5%
9		3%	0%					3%
10			0%					
11			0%					
12			0%					
13								
14			0%					
15								

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	1%						16%
1	22%	9%		10%		36%	60%
2	30%	32%	1%	35%		36%	16%
3	15%	40%	17%	42%		12%	6%
4	18%	11%	19%	10%		4%	1%
5	8%	4%	20%	3%			0%
6	4%	2%	12%	0%		4%	0%
7	0%	2%	14%	0%			0%
8	2%	1%	9%	0%		8%	0%
9		0%	4%	0%			0%
10		0%	1%	0%			0%
11		0%	1%	0%			
12							
13							
14		0%	1%	0%			
15		0%	1%	0%			

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	29%	30%		73%	86%		1%
1	49%	49%		14%	4%		3%
2	13%	13%	4%	7%	5%		10%
3	6%	6%	20%	5%	4%		28%
4	1%	1%	16%	1%	1%		27%
5	1%	1%	44%	0%	0%		13%
6	0%	0%	4%	0%	0%		7%
7	0%	0%	4%	0%	0%		6%
8	0%	0%	8%	0%	0%		3%
9	0%	0%		0%	0%		1%
10	0%	0%		0%	0%		1%
11				0%	0%		0%
12							0%
13							0%
14							0%
15							0%

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

	SPAIN				PORTUGAL
	TRAWL		HOOK (HAND-LINE)		TRAWL
	AVILES (Subdiv.VIIIc East)	LA CORUÑA (Subdiv.VIIIc West)	SANTANDER (Subdiv.VIIIc East)	SANTOÑA (Subdiv.VIIIc East)	(Subdiv.IXa CN,CS &S)
	(Days * 100 HP)	(Days * 100 HP)	(Fishing trips)	(Fishing trips)	(Fishing hours)
YEAR	Annual	Annual	March-April	March-April	Annual
1983	12568	51017	-	-	-
1984	10815	48655	-	-	-
1985	9856	45358	-	-	-
1986	10845	39829	-	-	-
1987	8309	34658	-	-	-
1988	9047	41498	-	-	55178
1989	8063	44401	-	605	52514
1990	8492	44411	322	509	49968
1991	7677	40435	209	724	44061
1992	12693	38896	70	698	74666
1993	7635	44479	151	1216	47822
1994	9620	39602	130	1926	38719
1995	6146	41476	217	1696	42090
1996	4525	35709	560	2007	43633
1997	4699	35191	736	2095	42043
1998	5929	35191	754	3022	86020
1999	6829	30131	739	2602	55311
2000	4453	30073	719	1709	67112
2001	2385	29923	700	2479	74684
2002	2748	21823	1282	2672	-
2003	2526	12328	265	759	-
2004	-	19198	626	2151	-
2005	-	20663	553	1504	-
2006	-	12866	845	1933	-
2007	-	21202	1031	1895	-
2008	-	20212	1143	1350	-
2009	-	21112	839	1780	-

\- Not available

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

	SPAIN				PORTUGAL
	TRAWL		HOOCK (HAND-LINE)		TRAWL
	AVILES (Subdiv.VIIIc East)	LA CORUÑA (Subdiv.VIIIc West)	SANTANDER (Subdiv.VIIIc East)	SANTOÑA (Subdiv.VIIIc East)	(Subdiv.IXa CN,CS &S)
	(Kg/ 100 HP)	(Kg / 100 HP)	(Kg/Fishing trips)	(Kg/Fishing trips)	(Kg/Fishing hours)
YEAR	Annual	Annual	March-April	March-April	Annual
1983	14.2	22.8	-	-	-
1984	24.1	26.7	-	-	-
1985	17.6	25.4	-	-	-
1986	41.1	22.8	-	-	-
1987	13.0	24.4	-	-	-
1988	15.9	32.5	-	-	36.4
1989	19.0	28.7	-	1427.5	26.8
1990	82.7	39.5	739.6	1924.4	39.2
1991	68.2	36.3	632.9	1394.4	39.9
1992	35.1	13.3	905.6	856.4	21.2
1993	12.8	12.8	613.3	1790.9	16.9
1994	57.2	44.0	2388.5	1590.6	20.9
1995	94.9	36.1	3136.1	1987.9	24.5
1996	124.5	32.9	1165.7	1508.9	23.8
1997	133.2	38.6	2137.9	1867.8	18.5
1998	142.1	80.1	2361.5	2128.0	15.4
1999	136.4	43.9	2438.0	2084.7	23.9
2000	311.6	65.2	1795.5	1879.7	25.7
2001	222.9	61.1	2323.2	2401.0	26.4
2002	342.5	58.3	2062.3	1871.2	-
2003	357.0	51.9	1868.2	1413.5	-
2004	-	18.7	2046.2	1312.6	-
2005	-	143.0	3617.7	2424.8	-
2006	-	442.4	2907.9	2741.8	-
2007	-	21.9	2675.6	2888.9	-
2008	-	12.4	1921.5	2831.7	-
2009	-	67.3	4659.0	3546.0	-
-	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	1350	0	4	64	709	1591	3087	3516	1374	326	196	95	51	29	24	3	1
2009	1780	0	1	284	1250	4547	3096	3597	3511	1226	527	200	97	33	25	0	0

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	1143	0	12	11	122	634	1603	1947	918	249	150	79	42	24	18	0	0
2009	839	0	0	69	208	1037	1593	2609	2678	1042	437	172	80	25	20	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

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
2009	21112	10	231	750	1535	1554	542	421	433	153	60	26	14	5	5	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 2009.

Quarters 1-4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	25.60		25.56	25.60	25.39	24.74	25.60	
1	27.80		27.81	26.88	26.86	27.86	24.18	29.40
2	30.75	28.96	30.62	29.79	29.89	30.94	29.40	29.57
3	32.70	32.15	32.56	31.95	32.05	32.76	30.15	29.58
4	33.66	33.15	34.05	34.01	34.11	34.31	33.95	33.46
5	35.02	34.44	35.46	35.52	35.61	35.70	35.58	33.29
6	36.58	35.94	36.94	36.98	37.23	37.33	35.94	34.87
7	37.44	37.98	37.88	38.15	38.19	37.83	38.12	35.48
8	38.19	38.69	38.95	38.50	38.69	38.96	35.04	38.68
9	40.58	39.87	39.60	39.60	39.73	39.77	39.62	39.50
10	40.35	40.26	41.49	41.72	41.74	40.81	43.00	44.08
11	41.12	39.81	40.90	40.90	40.83	40.82	40.86	
12	41.92	42.17	40.27	40.20	40.70	41.63	40.34	
13	39.58	45.55	42.80	42.80	42.50	42.27	42.75	
14	46.00		46.06	46.00	46.20	45.73	46.00	
15	45.00		45.01	45.00	45.05	45.21	45.00	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	16.57	16.57	25.60					
1	28.67		26.13	28.60	27.05	20.93	28.21	28.43
2	30.89	29.07	29.13	30.80	29.45	27.18	30.37	30.49
3	32.75	31.00	31.18	31.75	31.55	30.35	30.91	31.19
4	34.46	33.31	33.12	32.42	33.54	33.04	32.51	32.34
5	36.24	35.23	34.89	34.36	35.89	35.17	33.30	33.14
6	37.22	37.71	36.66	37.46	37.06	36.94	35.52	35.70
7	37.84	38.82	37.42	36.14	37.15	37.68	37.84	35.73
8	39.14	38.78	38.20	37.50	39.53	38.86	37.93	36.97
9	38.56	40.76	39.96	38.39	40.03	40.16	40.60	38.63
10	42.66	42.00	40.36	39.81	40.28	40.99	39.81	36.19
11	41.98	41.98	40.55	39.89	43.28	43.15	43.50	40.56
12		41.00	41.22	38.97	41.58	41.00	38.95	
13	39.00		41.09		41.50	41.50		
14	41.00		41.76	43.50	43.50	38.81		43.50
15			43.54	39.50	39.50			39.50

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	22.25					26.76	26.76
1	26.54	27.29	25.88	26.11		28.05	25.76
2	28.63	30.37	30.70	28.54	31.50	28.97	27.93
3	30.11	31.24	32.41	31.43	30.80	30.58	30.58
4	31.58	32.42	33.56	32.97	32.97	33.79	33.72
5	32.37	32.52	35.57	34.78	34.42	35.98	35.83
6	32.98	34.97	37.57	36.69	34.84	36.21	36.30
7	34.37	37.50	38.91	37.79	37.14	37.43	37.41
8	33.16	36.26	37.87	37.34	37.39	38.71	38.84
9	36.14	38.09	40.73	40.10	37.37	39.52	39.52
10	31.50	39.61	40.73	39.90	39.16	38.93	39.08
11	38.38	40.32	42.72	40.19	40.02	41.67	41.63
12		41.11	42.65	40.97		42.08	42.11
13						42.41	42.41
14		43.50	43.50	43.50	43.50		
15		39.50	39.50	39.50	39.50		

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	26.65	26.56		25.37	22.09	16.57	24.01
1	25.63	27.56		26.72	27.81		27.34
2	29.58	29.19	28.78	28.78	29.98	31.53	29.82
3	30.75	29.90	30.64	29.80	31.65	33.85	31.95
4	33.41	31.71	32.43	32.18	33.33	35.80	33.66
5	35.47	33.15	33.16	33.80	35.63	37.14	35.32
6	36.81	35.43	35.07	35.64	36.57	37.60	36.81
7	37.41	36.32	38.88	36.63	37.64	38.51	37.51
8	38.82	38.51	36.27	38.90	38.39	39.13	38.54
9	39.64	39.71	38.35	40.00	39.75	38.50	39.78
10	39.94	40.54	39.80	40.63	40.63	42.00	40.45
11	41.43	41.81	39.86	41.58	43.57	42.00	41.06
12	42.03	42.98	38.95	42.03			41.55
13	42.31	43.05		41.93			41.60
14			43.50				42.59
15			39.50				44.92

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2009 (cont.).

Quarter 1

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0								
1			23.50		23.50	20.85	23.50	23.50
2			29.11		29.11	27.09	29.11	29.11
3			30.66		30.66	30.29	30.66	30.66
4			32.39		32.39	33.04	32.39	32.39
5			32.50		32.50	35.14	32.50	32.50
6						36.92		
7						37.72		
8			32.50		32.50	38.82	32.50	32.50
9						40.09		
10						40.97		
11						42.48		
12						40.86		
13						42.69		
14						38.60		
15						43.50		

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1			20.62	25.88	23.00	20.93	24.00	24.00
2			27.56	30.27	29.04	27.18	26.82	27.17
3		31.60	30.94	32.10	31.58	30.35	30.41	30.58
4		33.74	33.15	33.72	33.60	33.04	32.43	32.45
5		34.00	34.93	36.02	35.98	35.17	33.39	33.40
6		38.00	36.69	37.67	37.09	36.94	35.60	35.09
7			37.41	38.41	37.16	37.68	37.79	36.31
8			38.19	39.99	39.54	38.86	37.55	36.04
9			39.89	40.94	40.06	40.16	40.75	40.38
10			40.35	40.59	40.29	40.99		31.50
11			40.54	42.90	43.38	43.15	43.50	41.40
12			41.22	42.78	41.64	41.00		
13			41.09		41.50	41.50		
14			41.87		43.49	38.81		
15			43.50					

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0							
1	24.25	25.88	25.88	25.88		25.20	24.67
2	27.85	31.17	26.27	28.43		27.23	27.80
3	30.48	32.64	30.92	31.43		30.58	30.61
4	32.09	33.85	32.63	32.97		33.94	33.76
5	33.23	36.16	34.34	34.78		36.04	35.84
6	34.51	37.91	35.95	36.70		36.27	36.34
7	35.52	38.96	39.73	37.81		37.47	37.42
8	34.84	39.49	36.57	37.33		38.88	38.84
9	39.71	41.28	41.28	40.16		39.53	39.52
10	31.50	40.94	40.94	39.91		38.90	39.09
11	39.96	43.94	43.94	40.20		41.70	41.64
12		43.50	43.50	41.28		42.11	42.12
13						42.38	42.39
14							
15							

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0							
1	21.05	26.05		26.66	26.36		24.88
2	29.58	29.17	24.50	28.80	28.85		28.66
3	30.79	29.84	30.50	29.67	30.84		30.93
4	33.46	31.69	32.50	32.27	33.21		33.09
5	35.51	32.98	34.21	34.08	35.44		35.03
6	36.83	35.03	35.50	35.92	36.40		36.66
7	37.43	35.64	39.83	36.87	37.50		37.39
8	38.82	37.49	36.50	39.02	37.88		38.38
9	39.63	38.49		40.07	39.49		39.82
10	39.93	39.92		40.62	40.36		40.13
11	41.42	41.49		41.57	43.79		41.03
12	42.04	43.38		42.02			41.47
13	42.30	43.54		41.91			41.57
14							42.14
15							43.50

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2009 (cont.).

Quarter 2

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			25.60			25.60	25.60	
1			27.93	23.50	23.50	27.80	23.84	29.28
2	31.67		31.60	29.11	29.11	30.45	29.15	29.46
3	33.19		32.56	30.66	30.66	32.59	30.91	31.00
4	33.92		34.81	32.39	32.39	33.95	33.08	33.24
5	35.38		36.33	32.50	32.50	35.36	34.83	31.85
6	36.93		37.99			36.79	37.81	34.84
7	35.78		38.55			37.83	38.24	35.18
8	38.75		39.27	32.50	32.50	38.90	33.58	38.75
9	42.00		39.60			39.61	39.60	39.50
10			42.37			41.44	42.09	44.08
11			40.90			40.90	40.90	
12			40.20			40.20	40.20	
13			42.80			42.80	42.80	
14			46.00			46.00	46.00	
15			45.00			45.00	45.00	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1	28.67		23.50	25.88	24.50	24.00	24.91	28.67
2	30.63	29.00	29.83	29.73	29.70	26.82	27.86	30.63
3	32.20	30.47	31.46	31.98	31.87	30.41	30.01	32.20
4	33.51	32.55	34.10	33.45	33.61	32.43	31.40	33.51
5	35.16	34.44	36.14	35.64	35.79	33.39	32.65	35.16
6	36.38	38.50	37.50	36.03	36.24	35.60	32.99	36.38
7	36.92	37.28	37.99	35.96	36.23	37.79	34.37	36.92
8	39.17	39.00		38.88	39.27	37.55	33.34	39.17
9	39.00	40.00	41.75	38.44	38.55	40.75	39.88	39.00
10	44.00			39.83	39.88	39.81	31.50	44.00
11		41.64		39.89	39.99	43.50	40.92	
12		41.00		38.97	39.12	38.95		
13					41.50			
14					45.50			
15								

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0							
1	25.07	25.88	25.88	25.88		28.45	28.45
2	27.60	31.15	31.25	29.65		29.35	29.35
3	29.70	32.68	32.69	31.71		30.47	30.47
4	31.15	33.92	33.93	33.36		33.37	33.37
5	32.66	36.28	36.33	35.61		35.69	35.69
6	33.53	37.84	37.95	35.90		35.81	35.81
7	34.50	38.53	38.83	35.87		37.25	37.25
8	33.12	40.17	40.39	38.85		38.91	38.91
9	35.91	40.65	41.12	38.41		39.47	39.47
10	31.50	40.60	40.85	39.82		38.87	38.87
11	38.35	42.24	43.42	39.88		41.47	41.47
12		41.07	42.63	38.98		41.85	41.85
13						42.60	42.60
14							
15							

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0							25.60
1	22.26	26.45		25.51	25.78		25.78
2	29.75	29.56	29.62	28.29	28.68		30.03
3	30.61	30.21	31.62	30.08	31.23		31.90
4	33.19	31.82	33.33	31.89	32.89		33.35
5	35.29	33.84	35.60	32.53	35.54		35.07
6	36.70	36.51	35.86	33.49	36.42		36.48
7	37.31	37.76	35.83	34.21	37.50		36.93
8	38.81	39.64	38.83	36.61	38.43		38.78
9	39.67	40.54	38.38	38.37	39.33		39.92
10	39.97	40.85	39.81	40.93	40.26		40.96
11	41.47	41.93	39.85	41.74	42.38		41.62
12	41.99	42.81	38.95	42.26			41.67
13	42.31	42.85		42.34			42.54
14							45.78
15							45.00

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2009 (cont.).

Quarter 3

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	25.60		25.60	25.60	25.60	25.60	25.60	
1	27.80		27.81	27.85	27.85	27.82	28.18	
2	30.59	28.96	30.45	30.63	30.63	30.53	29.85	29.62
3	32.60	32.15	32.57	32.51	32.51	32.66	28.87	24.44
4	33.61	33.15	33.95	34.12	34.12	34.07	34.39	33.73
5	34.94	34.44	35.36	35.57	35.57	35.49	35.76	34.66
6	36.49	35.94	36.77	36.98	36.98	36.91	35.73	34.94
7	37.86	37.98	37.83	38.15	38.15	37.88	38.09	37.50
8	38.06	38.69	38.92	39.12	39.12	38.89	36.30	36.00
9	40.33	39.87	39.60	39.60	39.60	39.60	39.60	
10	40.35	40.26	41.44	41.72	41.72	41.53	43.78	
11	41.12	39.81	40.90	40.90	40.90	40.90	40.90	
12	41.92	42.17	40.20	40.20	40.20	40.21	40.20	
13	39.58	45.55	42.80	42.80	42.80	42.80	42.80	
14	46.00		46.00	46.00	46.00	46.00	46.00	
15	45.00		45.00	45.00	45.00	45.00	45.00	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	16.57	16.57	25.60					16.57
1			24.49	27.33	23.50	29.16	28.46	
2	31.53	31.53	30.26	30.01	30.67	31.41	30.37	31.53
3	33.85	33.68	32.12	31.07	30.82	32.70	31.10	33.85
4	35.80	35.63	33.66	31.71	32.66	33.70	33.69	35.80
5	37.13	36.99	35.62	32.54	34.65	32.30	33.99	37.13
6	37.60	37.55	37.12	34.09	34.84	34.83	34.90	37.60
7	38.51	38.47	38.07	37.33	37.14	37.84	37.08	38.51
8	39.13	39.13	38.96	36.31	37.39	39.25	37.14	39.13
9	38.50	38.55	39.60	37.37	37.37	39.50	37.37	38.50
10	42.00	42.00	41.84	39.16	39.16		39.16	42.00
11	41.98	41.99	40.90	40.02	40.02		40.02	41.98
12		41.00	40.20					
13	39.00		42.80					39.00
14	41.00		46.00	43.50	43.50		43.50	41.00
15			45.00	39.50	39.50		39.50	

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0						26.76	26.76
1	26.97					28.26	28.26
2	29.37	31.50	31.50	31.50	31.50	28.40	28.40
3	30.70	30.89	30.80	30.82	30.80	29.70	29.70
4	32.17	32.11	32.97	32.81	32.97	34.08	34.08
5	31.98	32.34	34.42	33.52	34.42	35.19	35.19
6	31.49	33.85	34.84	34.80	34.84	36.71	36.71
7	31.43	37.40	37.14	37.15	37.14	36.64	36.64
8	33.14	36.16	37.39	37.16	37.39	40.07	40.07
9		37.37	37.37	37.37	37.37	41.53	41.53
10		39.16	39.16	39.16	39.16	42.99	42.99
11		40.02	40.02	40.02	40.02		
12							
13							
14		43.50	43.50	43.50	43.50		
15		39.50	39.50	39.50	39.50		

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	26.78	26.56		25.60	20.88	16.57	24.63
1	28.27	28.10		28.01	28.23		28.23
2	28.35	28.99	31.50	29.45	30.82	31.53	30.57
3	29.67	30.09	30.80	30.78	32.55	33.85	32.74
4	34.24	31.77	32.97	32.22	34.14	35.80	34.18
5	35.35	32.94	34.42	32.35	36.38	37.14	35.61
6	36.83	35.02	34.84	32.82	36.83	37.60	37.01
7	36.60	37.23	37.14	34.13	38.50	38.51	37.99
8	40.17	38.66	37.39	36.07	38.50	39.13	38.68
9	41.63	40.16	37.37	37.64	40.20	38.50	39.37
10	43.03	42.32	39.16	41.67	41.00	42.00	41.43
11			40.02		44.09	42.00	41.33
12							40.72
13							41.48
14			43.50				44.01
15			39.50				44.76

Table 2.3.4.1 NE Atlantic Mackerel. Mean length (cm) at age by area for 2009 (cont.).

Quarter 4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			21.40		21.40	21.40		
1			28.30		28.11	28.00	28.30	29.75
2	30.55		31.96		31.51	31.37	29.95	31.50
3	32.86		32.96		33.16	32.88	32.96	32.50
4	33.94		34.57		34.72	34.57	35.12	33.70
5	35.27		35.76		36.06	35.92	37.18	31.50
6	36.42		37.56		37.85	37.54	38.36	34.83
7	37.87		37.60		38.37	37.79	38.37	35.17
8	38.20		39.84		40.08	39.01	38.94	39.25
9	40.40		39.81		40.33	39.92	39.95	39.50
10	40.14		40.02		41.85	40.28	40.39	
11	40.83		40.94		40.72	40.79	40.57	
12	42.09		43.03		42.58	42.59	42.23	
13	42.05		43.03		40.76	41.44	40.13	
14			46.40		46.40	45.77		
15			47.60		47.60	47.60		

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1			26.47	28.60	27.27	29.02	28.60	
2			29.53	30.80	29.70	31.39	30.74	
3		32.19	31.40	31.75	31.48	32.75	31.74	32.19
4		33.78	32.95	32.40	32.75		32.77	33.78
5		36.06	34.48	34.00	33.80	32.50	32.20	36.06
6		37.31	36.15	37.50	35.72		37.26	37.31
7		39.00	37.85		36.70	38.50	30.50	39.00
8		38.76	38.94	37.50			37.47	38.76
9		40.85	42.76					40.85
10			40.90					
11			43.11					
12			40.88					
13								
14			38.50					
15								

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	22.25						26.76
1	27.59	27.33		27.33		28.61	28.26
2	28.96	29.94	31.50	29.94		30.83	28.40
3	30.72	31.10	30.80	31.12		31.83	29.70
4	33.61	31.59	32.97	31.26		32.50	34.08
5	32.38	34.29	34.42	32.97			35.19
6	32.29	34.84	34.84	33.51		37.50	36.71
7	30.50	37.14	37.14	37.50			36.64
8	33.66	37.39	37.39	36.00		37.50	40.07
9		37.37	37.37	37.37			41.53
10		39.16	39.16	39.16			42.99
11		40.02	40.02	40.02			
12							
13							
14		43.50	43.50	43.50			
15		39.50	39.50	39.50			

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	26.56	26.56		23.99	22.13		22.90
1	28.11	28.10		27.69	27.32		27.72
2	28.96	28.99	31.50	30.01	30.65		30.14
3	30.08	30.09	30.90	31.53	32.38		32.27
4	31.86	31.77	32.00	33.11	34.13		34.26
5	32.99	32.94	32.23	33.85	35.58		35.65
6	35.07	35.02	33.50	34.73	36.93		37.39
7	37.20	37.23	37.50	36.17	38.50		37.79
8	38.70	38.66	36.00	37.20	38.50		38.83
9	40.21	40.16		39.00	40.56		40.10
10	42.38	42.32		41.34	40.97		40.28
11				43.27	43.27		40.80
12							42.57
13							41.44
14							44.54
15							47.59

Table 2.3.4.2 NE Atlantic Mackerel. Percentage length composition in catches by country and gear, 2009. Zeros represent values <1%.

Len (cm)	NL – PTF	PT – ALL	RU – PT	IE – PTF	NO – PS IVa	UKS – all IVa	UKS – all VIa	UKS – all VIIb	UKS – all VIIj	UKS – IVa Discards	FO – PT	DE – PTF VIa	DE – PTF VIIb	DE – PTF VIIj	ES – PS	ES – Trawl	ES – Artisanal	UKE – Lines VIIe	UKE – Lines VIIf	IC – All
15																				0
16																				0
17																				0
18		0																		0
19	0	0			0		0					0				0				
20	0	3			0		0					0			0	0		0		
21		15			0		0					0			0	0		0	0	
22	0	11			0						0	0			0	0		0	0	
23	0	4		0	0		0					0			0	0		0	0	
24	0	2	0	0	0		0		0			0	1		0	0	0	0	1	
25	0	0	0	0	0		0		0			1	2		3	0	0	1	5	
26	1	3	0	0	0	0	0	0	0	0		4	2		3	2	0	4	8	
27	0	3	0	1	0	0	0		0	0		5	3	0	2	5	0	8	9	0
28	9	4	0	2	0	0	1	0	1	0		5	15	3	4	9	1	11	11	0
29	11	8	0	5	0	0	3	3	3	0	0	8	17	4	4	13	3	14	15	1
30	13	11	2	8	2	2	6	5	5	3	0	10	16	8	4	15	3	15	15	4
31	12	10	7	10	5	5	8	11	7	8	7	10	12	6	5	11	4	15	11	6
32	16	7	18	12	11	12	11	15	11	17	9	10	12	8	7	9	5	11	9	9
33	11	6	20	13	17	17	13	13	15	21	13	10	8	10	9	8	10	7	6	14
34	12	2	20	12	18	17	10	10	10	18	17	8	4	12	11	7	12	4	4	15
35	3	2	14	9	15	13	10	10	10	11	14	7	3	14	9	4	10	2	3	11
36	2	1	6	7	10	10	11	11	10	7	9	7	1	11	9	3	11	1	1	10
37	3	2	4	6	7	8	10	9	11	4	12	6	1	10	9	4	13	0	0	9
38	0	2	3	6	5	7	7	6	7	4	8	4	0	5	9	3	12	0	0	9
39	3	0	2	4	4	5	4	3	5	2	5	3	0	4	5	3	8	0	0	6
40	2	0	1	2	2	2	3	2	2	1	2	1		3	3	2	5	0	0	3
41	0	0	0	1	1	1	1	0	1	0	2	0		1	2	2	2	0	0	2
42	0	0	0	0	0	0	0	0	0	0		0		1	0	0	1	0	0	1
43	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0		0	0
44		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			
47		0			0												0	0		
48		0	0		0												0			
49		0															0			
50		0																		
51		0																		
52		0																		
58		0																		

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2009.

Quarters 1-4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	0.136		0.135	0.136	0.133	0.126	0.136	
1	0.170		0.170	0.156	0.156	0.174	0.115	0.197
2	0.272	0.210	0.239	0.229	0.232	0.253	0.227	0.228
3	0.335	0.319	0.330	0.310	0.310	0.327	0.296	0.279
4	0.362	0.347	0.383	0.381	0.379	0.379	0.373	0.337
5	0.416	0.397	0.442	0.445	0.442	0.435	0.444	0.337
6	0.467	0.452	0.509	0.511	0.508	0.496	0.446	0.297
7	0.506	0.524	0.558	0.572	0.563	0.528	0.562	0.397
8	0.521	0.561	0.608	0.603	0.603	0.580	0.448	0.498
9	0.619	0.585	0.637	0.637	0.633	0.616	0.634	0.542
10	0.647	0.643	0.749	0.763	0.755	0.681	0.843	0.913
11	0.622	0.538	0.741	0.752	0.697	0.644	0.736	
12	0.683	0.741	0.614	0.611	0.634	0.677	0.618	
13	0.568	0.859	0.830	0.831	0.801	0.762	0.827	
14	0.850		0.853	0.850	0.861	0.844	0.850	
15	0.822		0.822	0.822	0.824	0.829	0.822	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	0.037	0.037	0.136					
1	0.233		0.125	0.189	0.138	0.054	0.176	0.186
2	0.279	0.245	0.184	0.242	0.188	0.142	0.225	0.235
3	0.316	0.282	0.239	0.290	0.238	0.211	0.223	0.265
4	0.366	0.353	0.295	0.268	0.298	0.291	0.265	0.266
5	0.424	0.425	0.353	0.333	0.376	0.364	0.300	0.290
6	0.465	0.501	0.416	0.485	0.420	0.440	0.360	0.404
7	0.500	0.547	0.445	0.398	0.428	0.472	0.471	0.371
8	0.548	0.559	0.479	0.545	0.531	0.528	0.460	0.505
9	0.499	0.663	0.553	0.475	0.546	0.590	0.601	0.506
10	0.673	0.656	0.571	0.527	0.560	0.654	0.527	0.400
11	0.641	0.635	0.580	0.531	0.720	0.783	0.723	0.560
12		0.526	0.612	0.496	0.636	0.654	0.495	
13	0.573		0.606		0.614	0.614		
14	0.663		0.649	0.677	0.760	0.541		0.677
15			0.727	0.522	0.522			0.522

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.093					0.140	0.140
1	0.163	0.136	0.130	0.131		0.165	0.123
2	0.198	0.214	0.214	0.176	0.275	0.188	0.155
3	0.222	0.240	0.253	0.229	0.259	0.215	0.205
4	0.258	0.281	0.288	0.274	0.315	0.280	0.278
5	0.276	0.272	0.358	0.333	0.349	0.340	0.336
6	0.287	0.378	0.431	0.401	0.374	0.349	0.351
7	0.311	0.431	0.490	0.449	0.430	0.386	0.386
8	0.287	0.389	0.461	0.439	0.440	0.448	0.433
9	0.369	0.474	0.577	0.540	0.447	0.457	0.458
10	0.234	0.524	0.570	0.530	0.506	0.437	0.442
11	0.427	0.556	0.681	0.553	0.540	0.538	0.537
12		0.599	0.674	0.582		0.554	0.556
13						0.569	0.569
14		0.677	0.677	0.677	0.677		
15		0.522	0.522	0.522	0.522		

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	0.138	0.137		0.120	0.076	0.037	0.106
1	0.128	0.154		0.141	0.169		0.156
2	0.186	0.184	0.209	0.176	0.211	0.294	0.214
3	0.211	0.197	0.215	0.196	0.246	0.334	0.281
4	0.272	0.236	0.262	0.247	0.282	0.391	0.329
5	0.329	0.273	0.286	0.288	0.348	0.442	0.386
6	0.368	0.334	0.360	0.340	0.394	0.474	0.423
7	0.388	0.360	0.494	0.370	0.415	0.510	0.452
8	0.434	0.428	0.396	0.441	0.445	0.548	0.495
9	0.463	0.469	0.473	0.478	0.531	0.490	0.538
10	0.473	0.496	0.527	0.499	0.573	0.656	0.586
11	0.529	0.544	0.529	0.533	0.724	0.642	0.598
12	0.552	0.591	0.495	0.551			0.624
13	0.564	0.595		0.548			0.624
14			0.677				0.693
15			0.522				0.814

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2009 (cont.).

Quarter 1

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0								
1			0.104		0.104	0.054	0.104	0.104
2			0.221		0.221	0.140	0.221	0.221
3			0.269		0.269	0.211	0.269	0.269
4			0.315		0.315	0.292	0.315	0.315
5			0.342		0.342	0.363	0.342	0.342
6						0.440		
7						0.474		
8			0.366		0.366	0.526	0.366	0.366
9						0.584		
10						0.649		
11						0.746		
12						0.646		
13						0.690		
14						0.530		
15						0.724		

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1			0.058	0.130	0.075	0.054	0.098	0.098
2			0.153	0.205	0.176	0.142	0.139	0.145
3		0.284	0.232	0.248	0.237	0.211	0.209	0.212
4		0.347	0.293	0.295	0.299	0.291	0.261	0.257
5		0.353	0.352	0.373	0.378	0.364	0.302	0.291
6		0.494	0.415	0.433	0.421	0.440	0.373	0.343
7			0.444	0.467	0.428	0.472	0.456	0.384
8			0.477	0.533	0.531	0.528	0.446	0.378
9			0.547	0.582	0.547	0.590	0.609	0.589
10			0.571	0.563	0.561	0.654		0.226
11			0.580	0.692	0.725	0.783	0.723	0.589
12			0.612	0.677	0.639	0.654		
13			0.606		0.614	0.614		
14			0.654		0.764	0.541		
15			0.724					

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0							
1	0.102	0.130	0.130	0.130		0.110	0.104
2	0.160	0.221	0.136	0.173		0.141	0.152
3	0.211	0.259	0.212	0.228		0.203	0.206
4	0.249	0.296	0.262	0.274		0.283	0.279
5	0.283	0.376	0.316	0.332		0.341	0.337
6	0.321	0.441	0.377	0.402		0.349	0.352
7	0.351	0.488	0.533	0.450		0.387	0.386
8	0.334	0.519	0.417	0.439		0.434	0.433
9	0.554	0.599	0.599	0.543		0.457	0.458
10	0.231	0.579	0.579	0.530		0.436	0.443
11	0.509	0.745	0.745	0.554		0.539	0.537
12		0.715	0.715	0.596		0.556	0.556
13						0.568	0.568
14							
15							

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0							
1	0.062	0.130		0.139	0.123		0.112
2	0.186	0.183	0.105	0.176	0.167		0.172
3	0.212	0.196	0.201	0.193	0.208		0.222
4	0.273	0.235	0.258	0.250	0.266		0.280
5	0.330	0.268	0.312	0.296	0.330		0.338
6	0.369	0.322	0.362	0.347	0.360		0.390
7	0.388	0.339	0.539	0.376	0.398		0.418
8	0.434	0.395	0.414	0.445	0.411		0.456
9	0.463	0.429		0.480	0.473		0.512
10	0.473	0.475		0.498	0.509		0.531
11	0.528	0.533		0.533	0.696		0.565
12	0.553	0.608		0.551			0.598
13	0.564	0.616		0.547			0.590
14							0.672
15							0.724

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2009 (cont.).

Quarter 2

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			0.136			0.136	0.136	
1			0.172	0.104	0.104	0.170	0.109	0.196
2	0.312		0.283	0.221	0.221	0.231	0.222	0.226
3	0.341		0.344	0.269	0.269	0.327	0.276	0.273
4	0.353		0.409	0.315	0.315	0.380	0.342	0.322
5	0.421		0.478	0.342	0.342	0.439	0.425	0.274
6	0.473		0.547			0.505	0.543	0.250
7	0.469		0.592			0.557	0.577	0.377
8	0.519		0.645	0.366	0.366	0.604	0.407	0.498
9	0.688		0.637			0.638	0.637	0.542
10			0.805			0.746	0.787	0.913
11			0.752			0.752	0.752	
12			0.611			0.611	0.611	
13			0.831			0.831	0.831	
14			0.850			0.850	0.850	
15			0.822			0.822	0.822	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1	0.233		0.098	0.130	0.090	0.098	0.114	0.233
2	0.272	0.243	0.232	0.225	0.218	0.139	0.161	0.272
3	0.307	0.274	0.295	0.268	0.259	0.209	0.201	0.307
4	0.349	0.352	0.384	0.310	0.313	0.261	0.232	0.349
5	0.403	0.413	0.459	0.378	0.382	0.302	0.266	0.403
6	0.444	0.526	0.513	0.393	0.399	0.373	0.277	0.444
7	0.486	0.364	0.535	0.394	0.402	0.456	0.317	0.486
8	0.549	0.418		0.489	0.508	0.446	0.290	0.549
9	0.563	0.425	0.718	0.477	0.482	0.609	0.563	0.563
10	0.709			0.528	0.531	0.527	0.231	0.709
11		0.493		0.531	0.537	0.723	0.575	
12		0.526		0.496	0.504	0.495		
13					0.614			
14					0.859			
15								

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0							
1	0.120	0.130	0.130	0.130		0.160	0.160
2	0.159	0.223	0.223	0.225		0.177	0.177
3	0.198	0.260	0.260	0.271		0.200	0.200
4	0.229	0.298	0.298	0.312		0.268	0.268
5	0.264	0.382	0.382	0.378		0.332	0.332
6	0.289	0.439	0.442	0.389		0.336	0.336
7	0.312	0.473	0.482	0.391		0.380	0.380
8	0.277	0.541	0.550	0.488		0.434	0.434
9	0.357	0.572	0.592	0.475		0.455	0.455
10	0.234	0.564	0.575	0.527		0.434	0.434
11	0.425	0.655	0.717	0.530		0.530	0.530
12		0.597	0.673	0.496		0.545	0.545
13						0.578	0.578
14							
15							

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0							0.136
1	0.076	0.135		0.121	0.114		0.134
2	0.187	0.191	0.225	0.169	0.164		0.241
3	0.206	0.203	0.272	0.201	0.217		0.290
4	0.266	0.239	0.313	0.240	0.257		0.327
5	0.324	0.291	0.378	0.255	0.332		0.385
6	0.365	0.366	0.388	0.280	0.361		0.410
7	0.385	0.405	0.390	0.300	0.398		0.429
8	0.434	0.465	0.487	0.373	0.432		0.475
9	0.465	0.497	0.474	0.429	0.467		0.508
10	0.475	0.507	0.527	0.510	0.504		0.540
11	0.530	0.548	0.529	0.540	0.602		0.555
12	0.550	0.584	0.495	0.560			0.553
13	0.564	0.586		0.564			0.579
14							0.854
15							0.822

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2009 (cont.).

Quarter 3

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0	0.136		0.136	0.136	0.136	0.136	0.136	
1	0.170		0.170	0.171	0.171	0.170	0.176	
2	0.265	0.210	0.231	0.239	0.239	0.236	0.236	0.229
3	0.333	0.319	0.327	0.328	0.328	0.331	0.326	0.298
4	0.364	0.347	0.380	0.386	0.386	0.384	0.389	0.363
5	0.415	0.397	0.438	0.447	0.447	0.444	0.449	0.401
6	0.465	0.452	0.504	0.511	0.511	0.508	0.436	0.400
7	0.515	0.524	0.557	0.572	0.572	0.559	0.558	0.526
8	0.521	0.561	0.605	0.628	0.628	0.604	0.482	0.463
9	0.607	0.585	0.637	0.637	0.637	0.637	0.637	
10	0.647	0.643	0.746	0.763	0.763	0.752	0.893	
11	0.622	0.538	0.752	0.752	0.752	0.750	0.752	
12	0.683	0.741	0.611	0.611	0.611	0.611	0.611	
13	0.568	0.859	0.831	0.831	0.831	0.831	0.831	
14	0.850		0.850	0.850	0.850	0.850	0.850	
15	0.822		0.822	0.822	0.822	0.822	0.822	

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0	0.037	0.037	0.136					0.037
1			0.114	0.136	0.098	0.193	0.188	
2	0.294	0.294	0.243	0.196	0.254	0.251	0.233	0.294
3	0.334	0.326	0.302	0.227	0.260	0.274	0.264	0.334
4	0.391	0.383	0.362	0.256	0.307	0.325	0.326	0.391
5	0.442	0.435	0.448	0.273	0.372	0.278	0.334	0.442
6	0.475	0.470	0.510	0.359	0.374	0.249	0.378	0.475
7	0.510	0.504	0.568	0.426	0.430	0.500	0.428	0.510
8	0.548	0.544	0.610	0.391	0.440	0.509	0.466	0.548
9	0.491	0.488	0.637	0.447	0.447	0.542	0.447	0.491
10	0.656	0.656	0.771	0.506	0.506		0.506	0.656
11	0.641	0.636	0.752	0.540	0.540		0.540	0.641
12		0.526	0.611					
13	0.573		0.831					0.573
14	0.663		0.850	0.677	0.677		0.677	0.663
15			0.822	0.522	0.522		0.522	

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0						0.140	0.140
1	0.176					0.166	0.166
2	0.226	0.275	0.275	0.275	0.275	0.168	0.168
3	0.258	0.243	0.259	0.255	0.259	0.194	0.194
4	0.300	0.283	0.315	0.309	0.315	0.293	0.293
5	0.289	0.266	0.349	0.313	0.349	0.324	0.324
6	0.281	0.354	0.374	0.373	0.374	0.372	0.372
7	0.274	0.425	0.430	0.429	0.430	0.371	0.371
8	0.322	0.384	0.440	0.429	0.440	0.479	0.479
9		0.447	0.447	0.447	0.447	0.532	0.532
10		0.506	0.506	0.506	0.506	0.594	0.594
11		0.540	0.540	0.540	0.540		
12							
13							
14		0.677	0.677	0.677	0.677		
15		0.522	0.522	0.522	0.522		

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	0.141	0.137		0.123	0.063	0.037	0.117
1	0.166	0.163		0.162	0.178		0.171
2	0.167	0.180	0.275	0.189	0.242	0.294	0.245
3	0.194	0.201	0.259	0.216	0.292	0.334	0.331
4	0.297	0.239	0.315	0.247	0.344	0.391	0.378
5	0.328	0.270	0.349	0.250	0.429	0.442	0.433
6	0.375	0.326	0.374	0.262	0.448	0.474	0.481
7	0.370	0.389	0.430	0.298	0.522	0.510	0.537
8	0.483	0.432	0.440	0.354	0.522	0.548	0.567
9	0.536	0.484	0.447	0.403	0.609	0.490	0.589
10	0.596	0.565	0.506	0.537	0.652	0.656	0.723
11			0.540		0.845	0.642	0.682
12							0.633
13							0.724
14			0.677				0.737
15			0.522				0.809

Table 2.3.5.1 NE Atlantic Mackerel. Mean weight (kg) at age by area for 2009 (cont.).

Quarter 4

Ages	IIa	IIb	IIIa	IIIb	IIId	IVa	IVb	IVc
0			0.086		0.086	0.086		
1			0.183		0.179	0.186	0.191	0.203
2	0.266		0.292		0.269	0.269	0.232	0.254
3	0.342		0.320		0.320	0.322	0.337	0.286
4	0.376		0.380		0.374	0.373	0.395	0.325
5	0.425		0.426		0.427	0.426	0.482	0.245
6	0.463		0.492		0.499	0.489	0.529	0.249
7	0.513		0.501		0.530	0.504	0.540	0.377
8	0.528		0.617		0.619	0.561	0.571	0.509
9	0.602		0.625		0.615	0.597	0.571	0.542
10	0.626		0.645		0.719	0.629	0.621	
11	0.598		0.613		0.614	0.614	0.615	
12	0.708		0.724		0.722	0.721	0.720	
13	0.686		0.712		0.624	0.652	0.611	
14			0.872		0.872	0.847		
15			0.915		0.915	0.915		

Ages	Va	Vb	VIa	VIIa	VIIb	VIIc	VIId	VIIe
0								
1			0.129	0.190	0.141	0.191	0.190	
2			0.191	0.242	0.195	0.250	0.242	
3		0.299	0.245	0.291	0.240	0.271	0.294	0.299
4		0.352	0.300	0.267	0.279		0.279	0.352
5		0.439	0.356	0.314	0.319	0.286	0.265	0.439
6		0.491	0.422	0.488	0.379		0.478	0.491
7		0.569	0.496		0.427	0.531	0.224	0.569
8		0.560	0.568	0.545			0.543	0.560
9		0.670	0.785					0.670
10			0.657					
11			0.799					
12			0.657					
13								
14			0.526					
15								

Ages	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb
0	0.093						0.140
1	0.179	0.136		0.136		0.190	0.166
2	0.207	0.192	0.275	0.192		0.244	0.168
3	0.248	0.225	0.259	0.223		0.299	0.194
4	0.327	0.245	0.315	0.229		0.270	0.293
5	0.289	0.338	0.349	0.284			0.324
6	0.289	0.374	0.374	0.347		0.488	0.372
7	0.240	0.430	0.430	0.423			0.371
8	0.323	0.440	0.440	0.377		0.545	0.479
9		0.447	0.447	0.447			0.532
10		0.506	0.506	0.506			0.594
11		0.540	0.540	0.540			
12							
13							
14		0.677	0.677	0.677			
15		0.522	0.522	0.522			

Ages	VIIIcE	VIIIcW	VIIId	IXaN	IXaCN	XIVa	Total
0	0.137	0.137		0.101	0.076		0.088
1	0.163	0.163		0.161	0.161		0.162
2	0.179	0.180	0.275	0.212	0.238		0.216
3	0.201	0.201	0.242	0.249	0.287		0.290
4	0.241	0.239	0.279	0.292	0.344		0.359
5	0.271	0.270	0.262	0.318	0.396		0.414
6	0.327	0.326	0.347	0.350	0.452		0.482
7	0.388	0.389	0.423	0.402	0.522		0.503
8	0.433	0.432	0.377	0.432	0.522		0.555
9	0.486	0.484		0.508	0.629		0.609
10	0.567	0.565		0.589	0.650		0.629
11				0.789	0.789		0.614
12							0.721
13							0.652
14							0.793
15							0.914

Table 2.5.3.1. Biomass, abundance, mean length and mean weight at age of mackerel from the Spanish spring acoustics surveys (PELACUS 04) from 2001 to 2009.

	2001				2002				2003			
	Number	L	W	Biomass	Number	L	W	Biomass	Number	L	W	Biomass
AGE	(millions)	(cm)	(g)	t ('000)	(millions)	(cm)	(g)	t ('000)	(millions)	(cm)	(g)	t ('000)
1	29.0	25.9	126.2	3.7	621.4	23.3	80.5	50.0	5678.6	23.1	81.6	463.2
2	47.6	31.0	213.7	10.2	94.8	32.0	221.9	21.0	324.5	28.9	165.1	53.6
3	184.3	33.7	277.3	51.1	378.1	34.3	277.1	104.8	109.0	33.5	261.3	28.5
4	386.6	36.1	340.3	131.6	706.8	35.8	317.9	224.7	229.0	35.0	299.7	68.6
5	382.1	37.5	383.0	146.4	1065.9	36.8	348.0	370.9	265.2	37.1	359.1	95.2
6	393.6	38.0	397.7	156.5	604.6	38.2	390.9	236.3	230.1	38.0	385.7	88.8
7	202.7	39.5	446.7	90.5	674.5	39.1	419.2	282.8	94.3	39.8	443.4	41.8
8	143.5	40.0	464.5	66.7	191.4	39.9	447.2	85.6	88.5	40.1	454.6	40.2
9	83.7	40.5	481.7	40.3	158.4	40.3	461.4	73.1	19.6	41.5	505.1	9.9
10	17.0	40.2	469.3	8.0	100.2	41.0	490.2	49.1	10.0	41.9	519.9	5.2
11	26.3	42.1	541.4	14.2	54.0	41.4	504.0	27.2	14.0	42.6	549.6	7.7
12	12.3	41.9	533.8	6.5	12.4	43.5	586.7	7.3	3.8	41.5	503.1	1.9
13	1.9	41.5	517.1	1.0	0.0	0.0	0.0	0.0	3.7	43.1	566.9	2.1
14	6.1	43.5	596.5	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15+	9.4	42.8	568.1	5.3	2.9	45.5	676.9	2.0	2.0	43.3	578.1	1.2
TOTAL	1926.2	37.3	381.9	735.6	4665.3	35.5	329.0	1534.8	7072.1	25.5	128.4	907.8

	2004				2005				2006			
	Number	L	W	Biomass	Number	L	W	Biomass	Number	L	W	Biomass
AGE	(millions)	(cm)	(g)	t ('000)	(millions)	(cm)	(g)	t ('000)	(millions)	(cm)	(g)	t ('000)
1	195.2	25.0	114.6	22.4	43.4	24.8	112.1	4.6	83.7	20.8	58.5	4.9
2	952.4	28.3	164.5	156.6	106.5	29.2	181.8	19.0	9.3	29.7	177.2	1.7
3	599.3	32.8	258.1	154.7	229.1	32.3	245.4	56.1	57.3	31.9	223.1	12.8
4	227.5	37.5	377.8	86.0	259.6	36.5	349.4	92.4	230.7	33.5	262.7	60.6
5	425.6	38.1	395.5	168.3	82.6	38.3	403.4	34.2	104.7	36.7	345.0	36.1
6	336.7	39.1	428.4	144.2	163.8	38.8	417.6	70.4	34.2	38.5	398.1	13.6
7	181.5	40.1	461.7	83.8	114.9	39.5	438.4	52.0	22.2	39.2	420.5	9.3
8	106.1	40.8	483.2	51.3	63.8	39.8	451.7	29.8	7.6	40.9	483.3	3.6
9	76.5	41.0	492.5	37.7	33.6	41.0	493.9	17.2	2.0	41.9	513.6	1.0
10	31.1	42.3	538.0	16.7	15.3	42.3	535.4	8.5	3.4	41.3	495.1	1.7
11	18.9	42.2	533.9	10.1	13.7	41.8	518.8	7.4	1.4	42.7	545.7	0.8
12	13.5	43.3	573.8	7.7	6.6	42.0	526.6	3.6	0.5	42.8	551.1	0.3
13	3.2	43.9	599.8	1.9	11.3	42.5	544.1	6.4	0.1	43.8	590.7	0.1
14	0.0	0.0	0.0	0.0	5.1	43.8	592.6	3.2	0.0	0.0	0.0	0.0
15+	5.9	46.4	710.5	4.2	7.3	43.7	594.9	4.6	0.0	44.5	621.0	0.0
TOTAL	3173.2	33.8	298.0	945.6	1156.6	35.9	346.7	409.5	557.3	32.7	263.0	146.6

	2007				2008				2009			
	Number	L	W	Biomass	Number	L	W	Biomass	Number	L	W	Biomass
AGE	(millions)	(cm)	(g)	t ('000)	(millions)	(cm)	(g)	t ('000)	(millions)	(cm)	(g)	t ('000)
1	182.2	21.5	64.1	11.7	407.1	24.4	100.4	40.9	7.5	24.3	98.5	0.7
2	34.6	25.6	110.5	3.8	100.5	27.1	135.2	13.6	65.1	29.3	176.1	11.5
3	22.1	33.4	254.5	5.6	327.4	29.8	180.7	59.1	148.4	30.0	189.4	28.1
4	129.6	34.9	291.7	37.8	125.8	33.5	261.9	32.9	201.7	32.5	248.1	50.0
5	189.4	36.1	324.0	61.4	233.6	36.2	328.2	76.5	86.8	35.0	314.3	27.3
6	117.5	38.1	379.7	44.6	277.5	36.3	328.5	91.0	148.8	36.9	370.0	55.0
7	31.9	39.8	435.9	13.9	131.0	37.9	374.1	48.9	180.8	37.7	394.7	71.3
8	20.5	39.7	431.5	8.8	25.2	39.5	423.4	10.6	93.0	39.5	454.8	42.2
9	4.8	41.2	484.0	2.3	20.1	39.5	422.7	8.5	32.6	40.2	484.7	15.7
10	6.1	40.7	464.7	2.8	20.5	40.2	443.6	9.0	14.9	40.7	500.8	7.5
11	1.5	41.4	490.3	0.8	9.2	41.1	474.8	4.4	4.6	41.6	537.0	2.4
12	4.7	44.5	608.6	2.8	7.3	41.8	500.0	3.6	3.5	42.2	561.9	2.0
13	0.7	43.5	567.6	0.4	2.4	43.4	561.4	1.3	4.1	42.4	569.2	2.3
14	2.6	44.0	591.5	1.5	1.1	44.6	607.1	0.7	0.0	0.0	0.0	0.0
15+	0.7	46.5	697.9	0.5	0.4	46.5	690.3	0.3	0.0	0.0	0.0	0.0
TOTAL	748.9	32.5	265.4	198.8	1689.2	31.7	238.0	401.4	991.8	34.8	319.0	316.2

Table 2.5.3.2. Mackerel Abundance and Biomass by ICES sub-divisions from Spanish spring acoustic surveys (PELACUS04) from 2001 to 2010.

	ICES IXa-N		ICES VIIIc-W		VIIIc-EW		VIIIc-EE		TOTAL	
	Abund. (million)	Biomass (kt)	Abund. (million)	Biomass (kt)	Abund. (million)	Biomass (kt)	Abund. (million)	Biomass (kt)	Abund. (million)	Biomass (kt)
2001	0.02	7.4	0.31	120.1	1.23	489.1	0.36	119.1	1.93	735.7
2002	0.00	0.0	0.82	333.7	3.80	1191.1	0.04	10.0	4.67	1534.8
2003	4.58	376.6	1.07	184.4	0.88	202.5	0.54	144.3	7.14	907.8
2004	0.61	118.6	1.03	304.3	1.50	515.7	0.03	7.0	3.17	945.6
2005	0.16	45.6	0.23	13.0	0.60	228.6	0.16	32.3	1.06	409.5
2006	0.01	0.7	0.39	100.5	0.15	41.5	0.02	4.0	0.56	146.6
2007	0.16	11.2	0.22	77.4	0.36	108.4	0.01	1.8	0.75	198.8
2008	0.16	21.4	0.38	109.0	0.84	235.0	0.05	4.2	1.42	369.7
2009	0.06	11.8	0.04	10.1	0.57	220.2	0.33	74.1	0.99	316.2
2010	0.38	34.2	0.88	293.7	2.09	628.6	0.00	1.0	3.35	957.5

Table 2.6.1. Participating countries, vessels, areas assigned, dates and sampling periods of the 2010 surveys.

Country	Vessel	Areas	Dates	Period
Portugal	Noruega	Cadiz, Portugal & Galicia	25 Jan – 28 Feb	1
Spain (IEO)	Cornide de Saavedra	Cantabrian Sea & Biscay	14 Mar – 05 Apr	2
		Biscay & Cantabrian Sea	15 Apr – 12 May	3
Germany	Walther Herwig III	West Ireland & W Scotland	24 Mar – 12 Apr	2
		Celtic Sea & Biscay	13 – 30 Apr	3
Netherlands	Tridens	Celtic Sea & Biscay	3 – 20 May	4
		Celtic Sea & Biscay	1 – 19 June	5
Spain (AZTI)	Investigador	Biscay	23 Mar – 9 April	2
		Biscay & Cantabrian Sea	3 May – 26 May	4
Norway	Johan Hjort	West Ireland & West of Scotland	11 May – 5 June	4
		West of Scotland		5
Ireland	Celtic Explorer Celtic Voyager	Celtic Sea	5 – 29 March	2
		Celtic Sea, West Ireland & West of Scotland	8 – 28 July	6
Scotland	Scotia	West Ireland & West of Scotland	20 April – 11 May (22 Days)	3
	Corystes	NW Ireland & West of Scotland	19 May – 1 June	4
	Unity	West of Ireland & West of Scotland	14 June – 5 July	5
Faroe Islands	Magnus Heinason	Faroes & Shetland	19 May – 2 June	4
Iceland	Arni Fridriksson	Faroes & Shetland	9 – 22 June	5

Table 2.7.1. Catch Number at age

Units: Thousands

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

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

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

age	2002	2003	2004	2005	2006	2007	2008	2009
0	70409	14409	5168	5014	58294	15374	25738	16560
1	222214	182121	24617	44235	69303	79398	42029	34803
2	69728	265153	425834	131909	165134	189765	156841	108722
3	366981	88950	499455	661629	156631	227859	386710	448286
4	349853	290227	142792	289505	468403	204001	279310	615164
5	262485	230568	244885	118453	194147	448612	257358	320584
6	236927	180479	137998	119907	96817	200620	253961	223592
7	151241	132355	83997	63297	73749	75312	123294	193310
8	118814	93165	61426	38025	33234	58619	56833	73296
9	79919	74779	37614	23744	18785	28301	32082	29550
10	43776	45793	32816	18703	13951	16451	19186	14861
11	21606	25691	15385	7863	8313	11796	6779	7429
12	40260	30887	18151	10558	10071	13548	9580	4943

Table 2.7.2. Weights at age in the catch

Units : Kg

	year											
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	0.052	0.050	0.051	0.050	0.059	0.056	0.036	0.016	0.057	0.060	0.053	0.050
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
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
3	0.341	0.285	0.261	0.259	0.263	0.275	0.250	0.243	0.285	0.287	0.285	0.276
4	0.423	0.368	0.334	0.323	0.320	0.333	0.325	0.318	0.345	0.344	0.345	0.310
5		0.448	0.392	0.348	0.346	0.352	0.345	0.348	0.378	0.377	0.378	0.386
6			0.481	0.430	0.406	0.407	0.403	0.401	0.454	0.454	0.454	0.425
7				0.488	0.443	0.446	0.421	0.416	0.498	0.499	0.496	0.435
8					0.518	0.546	0.518	0.506	0.520	0.513	0.513	0.498
9						0.537	0.536	0.513	0.542	0.543	0.541	0.545
10							0.529	0.537	0.574	0.573	0.574	0.606
11								0.522	0.590	0.576	0.574	0.608
12									0.580	0.584	0.582	0.614

	year											
age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.031	0.055	0.039	0.076	0.055	0.049	0.085	0.068	0.051	0.061	0.046	0.072
1	0.102	0.144	0.146	0.179	0.133	0.136	0.156	0.156	0.167	0.134	0.136	0.143
2	0.184	0.262	0.245	0.223	0.259	0.237	0.233	0.253	0.239	0.240	0.255	0.234
3	0.295	0.357	0.335	0.318	0.323	0.320	0.336	0.327	0.333	0.317	0.339	0.333
4	0.326	0.418	0.423	0.399	0.388	0.377	0.379	0.394	0.397	0.376	0.390	0.390
5	0.344	0.417	0.471	0.474	0.456	0.433	0.423	0.423	0.460	0.436	0.448	0.452
6	0.431	0.436	0.444	0.512	0.524	0.456	0.467	0.469	0.495	0.483	0.512	0.501
7	0.542	0.521	0.457	0.493	0.555	0.543	0.528	0.506	0.532	0.527	0.543	0.539
8	0.480	0.555	0.543	0.498	0.555	0.592	0.552	0.554	0.555	0.548	0.590	0.577
9	0.569	0.564	0.591	0.580	0.562	0.578	0.606	0.609	0.597	0.583	0.583	0.594
10	0.628	0.629	0.552	0.634	0.613	0.581	0.606	0.630	0.651	0.595	0.627	0.606
11	0.636	0.679	0.694	0.635	0.624	0.648	0.591	0.649	0.663	0.647	0.678	0.631
12	0.663	0.710	0.688	0.718	0.697	0.739	0.713	0.708	0.669	0.679	0.713	0.672

	year											
age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.058	0.076	0.065	0.062	0.063	0.069	0.052	0.081	0.086	0.067	0.042	0.093
1	0.143	0.143	0.157	0.176	0.135	0.172	0.160	0.171	0.160	0.149	0.099	0.121
2	0.226	0.230	0.227	0.235	0.227	0.224	0.256	0.271	0.267	0.270	0.196	0.218
3	0.313	0.295	0.310	0.306	0.306	0.305	0.307	0.338	0.326	0.307	0.307	0.295
4	0.377	0.359	0.354	0.361	0.363	0.376	0.367	0.387	0.402	0.366	0.357	0.369
5	0.425	0.415	0.408	0.404	0.427	0.424	0.425	0.439	0.422	0.434	0.428	0.408
6	0.484	0.453	0.452	0.452	0.463	0.474	0.460	0.477	0.488	0.440	0.480	0.453
7	0.518	0.481	0.462	0.500	0.501	0.496	0.512	0.523	0.523	0.495	0.494	0.505
8	0.551	0.524	0.518	0.536	0.534	0.540	0.537	0.572	0.557	0.539	0.543	0.529
9	0.576	0.553	0.550	0.569	0.567	0.577	0.580	0.612	0.575	0.556	0.584	0.569
10	0.596	0.577	0.573	0.586	0.586	0.603	0.601	0.631	0.598	0.582	0.625	0.575
11	0.603	0.591	0.591	0.607	0.594	0.611	0.629	0.648	0.633	0.635	0.635	0.587
12	0.670	0.636	0.631	0.687	0.644	0.666	0.665	0.715	0.686	0.657	0.690	0.668

	year	
age	2008	2009
0	0.051	0.106
1	0.128	0.156
2	0.227	0.215
3	0.295	0.283
4	0.371	0.331
5	0.418	0.388
6	0.444	0.424
7	0.497	0.451
8	0.550	0.496
9	0.570	0.538
10	0.620	0.586
11	0.595	0.598
12	0.662	0.630

Table 2.7.3. Weights at age in the stock

Units : Kg

	year											
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
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
1	0.132	0.132	0.130	0.129	0.128	0.127	0.111	0.110	0.109	0.087	0.086	0.086
2	0.178	0.177	0.173	0.171	0.170	0.167	0.175	0.174	0.173	0.186	0.135	0.172
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
4	0.411	0.301	0.296	0.294	0.293	0.289	0.300	0.299	0.297	0.313	0.280	0.280
5		0.438	0.322	0.318	0.318	0.313	0.346	0.345	0.343	0.323	0.385	0.339
6			0.469	0.365	0.365	0.361	0.382	0.380	0.379	0.378	0.353	0.377
7				0.497	0.419	0.416	0.410	0.408	0.407	0.419	0.408	0.404
8					0.512	0.446	0.432	0.430	0.429	0.434	0.437	0.439
9						0.530	0.451	0.449	0.448	0.449	0.446	0.503
10							0.514	0.504	0.503	0.443	0.479	0.473
11								0.516	0.508	0.523	0.526	0.555
12									0.518	0.531	0.534	0.563

	year											
age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.081	0.085	0.077	0.078	0.072	0.076	0.074	0.075	0.078	0.078	0.079	0.081
2	0.194	0.165	0.179	0.148	0.156	0.177	0.138	0.155	0.212	0.197	0.178	0.164
3	0.253	0.293	0.267	0.240	0.237	0.244	0.222	0.230	0.259	0.268	0.237	0.267
4	0.295	0.306	0.304	0.286	0.301	0.306	0.287	0.307	0.310	0.315	0.301	0.326
5	0.324	0.341	0.356	0.374	0.329	0.352	0.339	0.357	0.362	0.360	0.361	0.398
6	0.393	0.384	0.351	0.386	0.423	0.380	0.373	0.409	0.402	0.416	0.413	0.448
7	0.436	0.430	0.416	0.411	0.445	0.429	0.414	0.432	0.424	0.454	0.466	0.491
8	0.441	0.459	0.473	0.429	0.432	0.474	0.409	0.502	0.462	0.465	0.470	0.508
9	0.479	0.468	0.443	0.482	0.455	0.457	0.437	0.541	0.487	0.484	0.483	0.546
10	0.520	0.559	0.468	0.499	0.522	0.466	0.514	0.566	0.522	0.511	0.550	0.514
11	0.510	0.579	0.497	0.470	0.589	0.510	0.523	0.566	0.552	0.585	0.608	0.619
12	0.550	0.607	0.575	0.549	0.632	0.595	0.529	0.594	0.583	0.577	0.584	0.639

	year											
age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.076	0.076	0.077	0.081	0.074	0.078	0.078	0.074	0.059	0.074	0.076	0.064
2	0.133	0.186	0.149	0.194	0.185	0.164	0.181	0.181	0.138	0.168	0.178	0.169
3	0.251	0.228	0.223	0.242	0.235	0.241	0.239	0.273	0.246	0.238	0.228	0.224
4	0.317	0.296	0.285	0.301	0.289	0.342	0.311	0.316	0.313	0.336	0.297	0.278
5	0.366	0.361	0.342	0.353	0.350	0.390	0.364	0.371	0.355	0.381	0.345	0.309
6	0.444	0.402	0.400	0.396	0.390	0.446	0.411	0.446	0.412	0.401	0.391	0.363
7	0.462	0.445	0.426	0.423	0.426	0.459	0.436	0.446	0.463	0.481	0.436	0.439
8	0.501	0.478	0.466	0.440	0.447	0.499	0.462	0.475	0.462	0.501	0.458	0.448
9	0.565	0.519	0.502	0.485	0.485	0.529	0.500	0.584	0.508	0.550	0.517	0.498
10	0.573	0.537	0.549	0.498	0.492	0.576	0.522	0.527	0.520	0.550	0.523	0.517
11	0.611	0.532	0.524	0.465	0.532	0.603	0.533	0.599	0.538	0.576	0.578	0.542
12	0.632	0.585	0.580	0.565	0.544	0.586	0.565	0.610	0.590	0.590	0.614	0.565

	year	
age	2008	2009
0	0.000	0.000
1	0.071	0.070
2	0.157	0.174
3	0.198	0.221
4	0.269	0.268
5	0.308	0.316
6	0.339	0.346
7	0.396	0.380
8	0.431	0.448
9	0.457	0.442
10	0.463	0.498
11	0.506	0.532
12	0.530	0.526

Table 2.7.4. Proportion mature at age

Units : proportion

	year												
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
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
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
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
3	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89	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
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
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
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	year												
age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
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
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
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
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	0.88
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	0.97
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	0.97
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
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	year											
age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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
1	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06
2	0.58	0.58	0.58	0.59	0.59	0.59	0.59	0.58	0.57	0.58	0.58	0.58
3	0.86	0.86	0.86	0.88	0.88	0.88	0.88	0.89	0.89	0.86	0.87	0.86
4	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98
5	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.98	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	0.99	0.99	0.99
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2.7.5. 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	2008	2009	2010
SSB	3750	NA	NA	2900	NA	NA	2750	NA	NA	3260	NA	NA	4133

Table 2.7.6. Stock summary

Year	Recruitment	TSB	SSB	Fbar	Landings
	Age 0			Age 4-8	
	(Thousands)	(Tonnes)	(Tonnes)		(Tonnes)
1972	2085645	5199651	3857946	0.019	361262
1973	4709253	5092285	3914001	0.185	570719
1974	3930988	4967992	3734122	0.210	607473
1975	4866816	4779779	3460216	0.223	784329
1976	4894496	4495038	3129591	0.259	828434
1977	944038	4191431	2957332	0.200	620016
1978	3206806	3844752	2912654	0.197	736519
1979	5272224	3416418	2458755	0.261	842739
1980	5514151	3108732	2053704	0.253	734950
1981	7185936	3226151	2076110	0.235	754045
1982	2004846	3167472	2007181	0.229	716987
1983	1550114	3293793	2309138	0.218	672283
1984	7354594	3077408	2336643	0.227	641928
1985	3283142	3254049	2275007	0.223	614371
1986	3389599	3269024	2306482	0.236	602201
1987	5105993	3141445	2307153	0.222	654992
1988	3559961	3217653	2314265	0.244	680491
1989	4390675	3302379	2395977	0.184	585920
1990	3165130	3095034	2266356	0.185	626107
1991	3685614	3384281	2522688	0.229	675665
1992	4705800	3499069	2544660	0.257	760690
1993	5565462	3433293	2384252	0.322	824568
1994	4749535	3310100	2206047	0.361	819087
1995	4226987	3515308	2397397	0.349	756277
1996	4157612	3342525	2424668	0.242	563472
1997	3088117	3492673	2541173	0.234	573029
1998	2966216	3332124	2457824	0.297	666316
1999	3321609	3362217	2469329	0.306	640309
2000	2053829	3074018	2205950	0.356	738606

2001	4852982	2962676	2138374	0.402	737463
2002	7854289	2638442	1749298	0.449	772905
2003	3474797	2893282	1748701	0.440	669600
2004	4436814	2751195	1848672	0.397	650221
2005	6794043	3182784	2290881	0.285	543486
2006	6914980	3457794	2409602	0.234	472652
2007	3818138	3708540	2540759	0.263	579379
2008	4506953	3742153	2709395	0.236	612856
2009	3904766	3989039	2978321	0.233	734889

Table 2.7.7. Estimated stock numbers at age

Units : thousands

	year								
age	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	2085645	4709253	3930988	4866816	4894496	944038	3206806	5272224	5514151
1	5084959	1785208	4037538	3356300	4155385	4154803	806909	2728037	4431722
2	2067250	4344246	1493674	3375004	2830501	3314685	3413759	662543	2014361
3	4099274	1731440	3670051	1241693	2819296	2205459	2548712	2419774	512025
4	7658534	3348155	1389309	3014899	990480	2080378	1688570	1778306	1519981
5	0	5989107	2497803	1058319	2349511	689084	1572103	1195180	1174398
6	0	0	4401404	1757444	758620	1731526	530384	1092295	797021
7	0	0	0	3165640	1280097	529239	1317632	383556	710990
8	0	0	0	0	1810238	751445	358485	974778	244570
9	0	0	0	0	0	1116024	434826	240238	682202
10	0	0	0	0	0	0	741640	256200	138619
11	0	0	0	0	0	0	0	414008	126289
12	0	0	0	0	0	0	0	0	235743

	year								
age	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	7185936	2004846	1550114	7354594	3283142	3389599	5105993	3559961	4390675
1	4715395	6132461	1715225	1327399	6064021	2750035	2871136	4387907	3010669
2	3433671	3802757	5080061	1431915	1112945	4970212	2313117	2434025	3635281
3	1370558	2490752	2872503	3753634	1152757	938560	3884858	1845842	1967515
4	380984	965325	1707144	2071248	2599912	938145	772266	2730413	1412510
5	1005053	297539	660269	1124537	1424503	1826021	736603	612214	1852543
6	776004	694178	231522	451355	735583	992922	1235191	551649	459471
7	553833	507788	469065	180596	297893	480510	662418	837127	394059
8	477617	369210	333158	320410	135005	198780	297112	431058	534892
9	159905	295200	234979	220208	218652	98107	131763	176509	257990
10	466316	99611	172240	157281	145261	144259	71923	81293	100365
11	82479	266554	60310	102806	100759	90311	93882	43763	50850
12	520372	453601	403310	236254	364893	319056	230252	190932	130980

	year								
age	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	3165130	3685614	4705800	5565462	4749535	4226987	4157612	3088117	2966216
1	3718484	2701782	3162963	4010055	4772300	4064452	3624522	3543313	2624593
2	2531761	3070339	2271277	2644944	3332765	3971071	3422759	3008618	2916002
3	2839397	1984831	2445875	1810182	2081803	2663435	3102345	2789571	2416846
4	1501243	2063979	1517316	1775724	1311393	1507905	1977684	2361699	2180281
5	1060690	1099595	1429430	1059514	1160526	881624	1043639	1443973	1682386
6	1259522	767977	772044	947488	686311	720698	586187	734008	1014682
7	350404	849356	541600	520288	579725	420038	437717	415491	506927
8	285419	262226	548287	360926	309486	323952	230334	266158	279648
9	357594	199718	178497	344086	220440	168586	174320	146713	167683
10	159066	228877	131791	106387	184296	115987	81429	94925	89867
11	56670	106381	131666	79648	55831	105487	60735	46294	57034
12	95338	189513	219267	186926	157453	110470	101423	82878	76369

	year								
age	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	3321609	2053829	4852982	7854289	3474797	4436814	6794043	6914980	3818138
1	2538784	2842486	1755924	4145516	6703300	2966085	3790357	5816377	5925586
2	2215192	2141505	2389811	1471879	3464079	5604683	2487059	3201719	4929588
3	2369530	1796941	1720472	1903171	1161450	2738165	4467504	2025813	2633719
4	1830894	1788165	1327308	1246293	1350842	827518	1987556	3402395	1576893
5	1533586	1280031	1208505	869817	790843	862349	544047	1409810	2498158
6	1117770	1010999	807957	733246	506397	463980	525393	365375	989677
7	631141	688499	589685	448456	386434	269473	258874	331243	243517
8	311469	383874	395722	321926	232006	201935	147908	161304	218646
9	167277	184281	213661	208352	159937	116519	106942	89823	104249
10	99198	97847	101218	110825	101796	79018	60801	64259	57548
11	51998	56715	52334	50952	52363	48668	40030	35766	40457
12	105455	98441	106705	97005	75532	48018	36417	41013	49976

age	year 2008	2009	2010
0	4506953	3904766[1]	3904766[1]
1	3270061	3861954	3346168[2]
2	5012604	2771132	3273470
3	4032470	4121762	2280184
4	2024831	3136202	3210455
5	1135339	1484701	2305065
6	1710156	795624	1043618
7	639126	1137325	531145
8	155564	420926	752007
9	136403	100296	272541
10	64402	87172	64379
11	34861	40439	54993
12	38732	20242	38546

[1] Geometric mean of recruitment over the period 1972-2008

[2] Calculated from abundance, fishing and natural mortality at age 0 in 2009

Table 2.7.8. 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	0.04	0.03	0.10	0.11	0.19	0.11	0.24	0.17	0.13	0.15
3	0.05	0.07	0.05	0.08	0.15	0.12	0.21	0.32	0.15	0.20	0.23	0.18
4	0.10	0.14	0.12	0.10	0.21	0.13	0.20	0.27	0.26	0.10	0.23	0.27
5	0.00	0.16	0.20	0.18	0.16	0.11	0.21	0.26	0.26	0.22	0.10	0.23
6	0.00	0.20	0.18	0.17	0.21	0.12	0.17	0.28	0.21	0.27	0.24	0.10
7	0.00	0.21	0.26	0.41	0.38	0.24	0.15	0.30	0.25	0.26	0.27	0.23
8	0.00	0.22	0.28	0.26	0.33	0.40	0.25	0.21	0.28	0.33	0.30	0.26
9	0.00	0.23	0.29	0.27	0.23	0.26	0.38	0.40	0.23	0.32	0.39	0.25
10	0.00	0.24	0.31	0.28	0.24	0.17	0.43	0.56	0.37	0.41	0.35	0.37
11	0.00	0.24	0.30	0.27	0.23	0.17	0.32	0.75	0.65	0.53	0.46	0.43
12	0.00	0.24	0.30	0.27	0.23	0.17	0.32	0.75	0.65	0.53	0.46	0.43

	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	0.24	0.17	0.20	0.26	0.28	0.33	0.26
6	0.27	0.28	0.26	0.24	0.19	0.12	0.24	0.20	0.25	0.34	0.34	0.35
7	0.14	0.26	0.33	0.28	0.30	0.17	0.14	0.29	0.26	0.37	0.43	0.45
8	0.23	0.17	0.26	0.37	0.36	0.25	0.21	0.24	0.32	0.34	0.46	0.47
9	0.27	0.27	0.16	0.33	0.42	0.33	0.30	0.27	0.37	0.47	0.49	0.58
10	0.30	0.33	0.28	0.35	0.32	0.42	0.25	0.40	0.35	0.50	0.41	0.50
11	0.38	0.34	0.32	0.35	0.39	0.35	0.38	0.36	0.41	0.50	0.50	0.49
12	0.38	0.34	0.32	0.35	0.39	0.35	0.38	0.36	0.41	0.50	0.50	0.49

	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	0.00	0.01
1	0.04	0.05	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.02
2	0.06	0.07	0.06	0.06	0.07	0.08	0.09	0.09	0.08	0.06	0.05	0.05
3	0.12	0.10	0.13	0.13	0.15	0.17	0.19	0.19	0.17	0.12	0.10	0.11
4	0.17	0.19	0.20	0.21	0.24	0.27	0.31	0.30	0.27	0.19	0.16	0.18
5	0.20	0.20	0.26	0.27	0.31	0.35	0.39	0.38	0.35	0.25	0.20	0.23
6	0.19	0.22	0.33	0.34	0.39	0.44	0.49	0.48	0.43	0.31	0.26	0.29
7	0.35	0.25	0.34	0.35	0.40	0.46	0.51	0.50	0.45	0.32	0.27	0.30
8	0.30	0.31	0.36	0.38	0.44	0.49	0.55	0.54	0.49	0.35	0.29	0.32
9	0.46	0.34	0.38	0.39	0.45	0.51	0.57	0.56	0.50	0.36	0.30	0.33
10	0.42	0.36	0.40	0.41	0.48	0.54	0.60	0.59	0.53	0.38	0.31	0.35
11	0.39	0.39	0.39	0.40	0.47	0.52	0.59	0.58	0.52	0.37	0.31	0.34
12	0.39	0.39	0.39	0.40	0.47	0.52	0.59	0.58	0.52	0.37	0.31	0.34

	year	
age	2008	2009
0	0.00	0.00
1	0.02	0.02
2	0.05	0.05
3	0.10	0.10
4	0.16	0.16
5	0.21	0.20
6	0.26	0.25
7	0.27	0.26
8	0.29	0.29
9	0.30	0.29
10	0.32	0.31
11	0.31	0.30
12	0.31	0.30

Table 2.7.9. Fitted selection pattern

age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
1	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
2	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
3	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
4	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
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	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
7	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
8	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
9	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
10	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
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 2.7.10. Predicted index values

year												
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
all	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
year												
age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
all	NA	NA	NA	NA	NA	NA	NA	NA	3456253	NA	NA	3256498
year												
age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
all	NA	NA	3338650	NA	NA	2904528	NA	NA	2511004	NA	NA	3451155
year												
age	2008	2009	2010									
all	NA	NA	4077354									

Table 2.7.11. Index residuals

year												
age	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
all	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
year												
age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
all	NA	NA	NA	NA	NA	NA	NA	NA	-0.025	NA	NA	-0.137
year												
age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
all	NA	NA	0.116	NA	NA	-0.002	NA	NA	0.091	NA	NA	-0.057
year												
age	2008	2009	2010									
all	NA	NA	0.014									

Table 2.7.12. 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	36012	15388	17748	12757	33971
1	83583	128144	147315	81529	119852	144390	47285	47102	61234	42586
2	156292	210319	221489	340898	168882	186481	151474	118434	132536	166050
3	356209	266677	306979	340215	333365	238426	269403	271581	237090	253579
4	266591	398240	267420	275031	279182	378881	370993	320003	357742	295116
5	306143	244285	301346	186855	177667	246781	357482	334457	318180	332583
6	156070	255472	184925	197856	96303	135059	262372	296391	304088	267900
7	113899	149932	189847	142342	119831	84378	135264	172671	213477	201402
8	138458	97746	106108	113413	55812	66504	79571	90837	126638	143557
9	51208	121400	80054	69191	59801	39450	48916	50008	62269	79337
10	36612	38794	57622	42441	25803	26735	27487	31085	34603	39281
11	40956	29067	20407	37960	18353	13950	17126	15998	19705	19965
12	68205	68217	57551	39753	30648	24974	22932	32446	34202	40706

	year							
age	2002	2003	2004	2005	2006	2007	2008	2009
0	61448	26652	30691	33783	28261	17524	18575	21005
1	112246	177976	71094	65473	82674	94526	46872	54543
2	113848	262878	384985	123962	131728	227215	207942	113295
3	310640	186172	399181	478488	180122	261495	361430	364234
4	305246	325234	182085	325419	465182	239947	279006	426236
5	262650	234919	234955	111352	242026	476103	196399	253400
6	265595	180590	152380	131017	76808	230301	362182	166304
7	167186	141858	91167	66631	71938	58512	139832	245606
8	127255	90335	72577	40616	37449	56098	36381	97178
9	84241	63705	42868	30113	21402	27437	32737	23764
10	46766	42328	30388	17958	16086	15898	16238	21701
11	21147	21412	18397	11605	8783	10967	8623	9875
12	40260	30887	18151	10558	10071	13548	9580	4943

Table 2.7.13. Catch residuals

	year											
age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	1.379	1.328	1.047	-0.266	0.136	-0.615	-1.781	-1.908	0.724	-0.131	0.326	-0.238
1	0.742	0.446	0.514	-0.055	0.683	0.023	-1.061	-0.392	-0.176	-0.174	-0.109	-0.449
2	0.417	0.116	0.075	-0.044	-0.49	0.009	0.101	0.062	0.226	-0.18	-0.282	-0.041
3	-0.018	-0.194	0.15	-0.08	0.167	-0.739	0.224	0.324	-0.14	-0.138	0.068	0.208
4	-0.138	-0.201	0.089	0.007	0.136	-0.114	-0.243	-0.117	0.007	-0.162	0.001	0.367
5	0.012	-0.174	-0.074	-0.071	-0.001	-0.019	0.041	0.062	-0.22	-0.059	0.27	0.235
6	-0.234	-0.194	-0.23	-0.145	-0.114	-0.001	-0.099	-0.089	0.232	-0.138	-0.355	0.296
7	-0.133	-0.082	-0.195	-0.031	-0.1	-0.069	-0.082	-0.051	0.025	0.252	-0.126	-0.239
8	-0.09	-0.046	-0.175	-0.177	-0.069	0.031	-0.167	-0.066	-0.119	0.044	0.446	-0.282
9	-0.032	0.012	-0.173	-0.094	-0.053	0.16	-0.131	-0.238	-0.13	0.031	-0.02	0.218
10	-0.12	-0.024	-0.101	0.079	-0.066	0.079	0.077	0.041	-0.142	0.034	0.167	-0.379
11	-0.034	0.064	-0.041	0.029	0.021	0.182	-0.179	-0.389	-0.055	0.073	-0.241	-0.285
12	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.7.14. Fitted parameters

Parameter	Value	CV	Lower 95%Confidence	Upper 95%Confidence
F, 1998	0.26	10%	0.21	0.32
F, 1999	0.27	10%	0.22	0.32
F, 2000	0.31	9%	0.26	0.37
F, 2001	0.35	9%	0.29	0.42
F, 2002	0.39	9%	0.32	0.47
F, 2003	0.38	10%	0.32	0.46
F, 2004	0.35	10%	0.28	0.42
F, 2005	0.25	10%	0.20	0.30
F, 2006	0.20	11%	0.17	0.25
F, 2007	0.23	11%	0.19	0.28
F, 2008	0.21	11%	0.16	0.26
F, 2009	0.20	11%	0.16	0.25
Selectivity at age 0	0.02	71%	0.01	0.09
Selectivity at age 1	0.08	23%	0.05	0.12
Selectivity at age 2	0.22	10%	0.18	0.27
Selectivity at age 3	0.49	10%	0.41	0.60
Selectivity at age 4	0.78	10%	0.65	0.94
Selectivity at age 6	1.25	9%	1.05	1.50
Selectivity at age 7	1.30	9%	1.10	1.55
Selectivity at age 8	1.41	8%	1.19	1.66
Selectivity at age 9	1.45	8%	1.24	1.70
Selectivity at age 10	1.53	8%	1.31	1.80
Terminal year pop, age 0	5172823	242%	44976	594935429
Terminal year pop, age 1	3861953	58%	1249094	11940401
Terminal year pop, age 2	2771131	22%	1784783	4302575
Terminal year pop, age 3	4121761	16%	3036440	5595011
Terminal year pop, age 4	3136201	13%	2450724	4013409
Terminal year pop, age 5	1484700	12%	1179661	1868618
Terminal year pop, age 6	795623	11%	635505	996085
Terminal year pop, age 7	1137325	10%	935998	1381955
Terminal year pop, age 8	420925	11%	342340	517548
Terminal year pop, age 9	100295	12%	79871	125940
Terminal year pop, age 10	87171	12%	68745	110536
Terminal year pop, age 11	40439	13%	31243	52341
Last TRUE age pop, 1998	57033	25%	35073	92742
Last TRUE age pop, 1999	51997	19%	36046	75004
Last TRUE age pop, 2000	56714	16%	41432	77633
Last TRUE age pop, 2001	52333	15%	39338	69621
Last TRUE age pop, 2002	50951	14%	38851	66819
Last TRUE age pop, 2003	52362	14%	40123	68334
Last TRUE age pop, 2004	48667	14%	37127	63794
Last TRUE age pop, 2005	40029	14%	30595	52373
Last TRUE age pop, 2006	35765	13%	27614	46323
Last TRUE age pop, 2007	40456	13%	31617	51766
Last TRUE age pop, 2008	34860	13%	27108	44829
Index 1, biomass, Q	1.36	2%	1.29	1.42

Table 2.8.1.1. Results from PlotMSY indicating deterministic fits and the range of values estimated from 1000 iterations of the programme. Results are presented from the Ricker and Smooth hockey stick models. Results from the Beverton and Holt model were not meaningful and are therefore not given here.

Ricker

967/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	1.36	0.42	1716070	672166	0.47	2.00	5.84	5.18E-07
Mean	1.12	0.32	1672219	637711	0.51	1.86	5.74	4.83E-07
5%ile	0.32	0.11	1130449	324463	0.35	1.00	3.06	2.60E-07
25%ile	0.70	0.21	1389105	498556	0.43	1.52	4.25	3.94E-07
50%ile	0.99	0.29	1584730	633848	0.50	1.86	5.35	4.82E-07
75%ile	1.44	0.40	1822325	774796	0.57	2.22	6.79	5.75E-07
95%ile	2.26	0.65	2527490	973593	0.69	2.74	9.79	7.11E-07
CV	0.56	0.52	0.37	0.32	0.21	0.29	0.37	0.29

Smooth hockeystick

970/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.38	0.38	1750060	632570	0.66	0.69	1.12	1748700
Mean	0.21	0.20	1831251	543742	0.60	0.79	1.01	1990267.608
5%ile	0.01	0.01	1751822	62522	0.49	0.70	0.83	1766322
25%ile	0.13	0.12	1820990	405209	0.56	0.73	0.94	1829470
50%ile	0.20	0.19	1930890	553527	0.60	0.77	1.01	1935790
75%ile	0.28	0.28	2098718	692890	0.64	0.84	1.09	2106520
95%ile	0.42	0.40	2390678	892317	0.71	0.96	1.19	2404196.5
CV	0.59	0.58	0.43	0.42	0.11	0.10	0.11	0.10

Per recruit

	F35	F40	F01	Fmax	Bmsypr	MSYpr	Fpa	Flim
Deterministic	0.23	0.18	0.173	0.774	0.45	0.16	0.23	0.42
Mean	0.41	0.33	0.152	0.829	0.50	0.14		
5%ile	0.01	0.01	0.002	0.367	0.42	0.02		
25%ile	0.20	0.16	0.120	0.525	0.46	0.10		
50%ile	0.39	0.31	0.165	0.697	0.49	0.14		
75%ile	0.57	0.46	0.199	0.989	0.53	0.17		
95%ile	0.88	0.71	0.238	1.850	0.60	0.22		
CV	0.67	0.68	0.448	0.562	0.12	0.41		

Table 2.8.2.1 North East Atlantic Mackerel. Short term prediction: INPUT DATA

2010	Stock abundance	Natural mortality	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploitation pattern	Weights in the catch
0	3904766	0.15	0.00	0.421	0.35	0.00	0.00	0.08
1	3346168	0.15	0.06	0.421	0.35	0.07	0.02	0.14
2	3273470	0.15	0.58	0.421	0.35	0.17	0.05	0.22
3	2280184	0.15	0.86	0.421	0.35	0.21	0.10	0.29
4	3210455	0.15	0.98	0.421	0.35	0.27	0.17	0.36
5	2305065	0.15	0.98	0.421	0.35	0.31	0.21	0.40
6	1043618	0.15	0.99	0.421	0.35	0.35	0.27	0.44
7	531145	0.15	1.00	0.421	0.35	0.41	0.28	0.48
8	752007	0.15	1.00	0.421	0.35	0.44	0.30	0.53
9	272541	0.15	1.00	0.421	0.35	0.47	0.31	0.56
10	64379	0.15	1.00	0.421	0.35	0.49	0.33	0.59
11	54993	0.15	1.00	0.421	0.35	0.53	0.32	0.59
12	38546	0.15	1.00	0.421	0.35	0.54	0.32	0.65

2011	Stock abundance	Natural mortality	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploitation pattern	Weights in the catch
0	3904766	0.15	0.00	0.421	0.35	0.00	0.00	0.08
1	-	0.15	0.06	0.421	0.35	0.07	0.02	0.14
2	-	0.15	0.58	0.421	0.35	0.17	0.05	0.22
3	-	0.15	0.86	0.421	0.35	0.21	0.10	0.29
4	-	0.15	0.98	0.421	0.35	0.27	0.17	0.36
5	-	0.15	0.98	0.421	0.35	0.31	0.21	0.40
6	-	0.15	0.99	0.421	0.35	0.35	0.27	0.44
7	-	0.15	1.00	0.421	0.35	0.41	0.28	0.48
8	-	0.15	1.00	0.421	0.35	0.44	0.30	0.53
9	-	0.15	1.00	0.421	0.35	0.47	0.31	0.56
10	-	0.15	1.00	0.421	0.35	0.49	0.33	0.59
11	-	0.15	1.00	0.421	0.35	0.53	0.32	0.59
12	-	0.15	1.00	0.421	0.35	0.54	0.32	0.65

2012	Stock abundance	Natural mortality	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploitation pattern	Weights in the catch
0	3904766	0.15	0.00	0.421	0.35	0.00	0.00	0.08
1	-	0.15	0.06	0.421	0.35	0.07	0.02	0.14
2	-	0.15	0.58	0.421	0.35	0.17	0.05	0.22
3	-	0.15	0.86	0.421	0.35	0.21	0.10	0.29
4	-	0.15	0.98	0.421	0.35	0.27	0.17	0.36
5	-	0.15	0.98	0.421	0.35	0.31	0.21	0.40
6	-	0.15	0.99	0.421	0.35	0.35	0.27	0.44
7	-	0.15	1.00	0.421	0.35	0.41	0.28	0.48
8	-	0.15	1.00	0.421	0.35	0.44	0.30	0.53
9	-	0.15	1.00	0.421	0.35	0.47	0.31	0.56
10	-	0.15	1.00	0.421	0.35	0.49	0.33	0.59
11	-	0.15	1.00	0.421	0.35	0.53	0.32	0.59
12	-	0.15	1.00	0.421	0.35	0.54	0.32	0.65

Input units are thousands and kg - output in tonnes

Table 2.8.2.2 North East Atlantic Mackerel Short term prediction single option table. Catch constraint of 930 Kt in 2010 and F status quo for 2011 and 2012

Year : 2010		F Mult =1.346		Fbar=0.314					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.006	21359	1780	3904766	0	0	0	0	0
1	0.021	63543	8578	3346168	228655	211924	14481	199344	13622
2	0.061	179054	39392	3273470	545578	1898612	316435	1756081	292680
3	0.135	267156	77742	2280184	488719	1968559	421928	1764952	378288
4	0.213	573130	204607	3210455	872174	3146246	854730	2729435	741496
5	0.273	513144	207652	2305065	716875	2258964	702538	1910699	594227
6	0.343	282275	124295	1043618	364570	1033181	360925	848688	296475
7	0.355	148206	71781	531145	215114	531145	215114	433929	175741
8	0.384	223619	117400	752007	332638	752007	332638	607097	268539
9	0.395	83067	46434	272541	126913	272541	126913	218944	101955
10	0.419	20563	12208	64379	31718	64379	31718	51212	25230
11	0.410	17248	10234	54993	28963	54993	28963	43917	23130
12	0.410	12089	7898	38546	20828	38546	20828	30783	16633
Total		2404453	930002	21077337	3972745	12231097	3427211	10595081	2928016

Year : 2011		F Mult =1		Fbar=0.233					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.004	15871	1323	3904766	0	0	0	0	0
1	0.015	47232	6376	3341068	228306	211601	14459	199486	13632
2	0.045	115451	25399	2821192	470199	1636292	272715	1523437	253906
3	0.100	234540	68251	2651667	568341	2289272	490667	2082666	446385
4	0.158	233342	83303	1715369	466008	1681061	456688	1492397	405434
5	0.203	381526	154391	2233454	694604	2188785	680712	1906945	593060
6	0.254	315892	139098	1509984	527488	1494884	522213	1274396	445189
7	0.264	137835	66758	637731	258281	637731	258281	541474	219297
8	0.285	74032	38867	320398	141723	320398	141723	269645	119273
9	0.294	104573	58456	440979	205349	440979	205349	369772	172191
10	0.311	39358	23365	157964	77824	157964	77824	131492	64782
11	0.304	8909	5286	36451	19198	36451	19198	30431	16027
12	0.304	13065	8536	53456	28884	53456	28884	44627	24114
Total		1721625	679409	19824479	3686205	11148874	3168713	9866768	2773290

Year : 2012		F Mult =1		Fbar=0.233					
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0.004	15871	1323	3904766	0	0	0	0	0
1	0.015	47304	6386	3346154	228654	211923	14481	199790	13652
2	0.045	115890	25496	2831914	471986	1642510	273752	1529227	254871
3	0.100	205317	59747	2321275	497527	2004034	429531	1823170	390766
4	0.158	280928	100291	2065192	561044	2023889	549823	1796749	488117
5	0.203	215336	87140	1260579	392040	1235368	384199	1076295	334728
6	0.254	328368	144591	1569618	548320	1553922	542837	1324725	462771
7	0.264	217818	105496	1007790	408155	1007790	408155	855678	346550
8	0.285	97407	51139	421564	186472	421564	186472	354784	156933
9	0.294	49181	27492	207395	96577	207395	96577	173906	80982
10	0.311	70507	41857	282983	139416	282983	139416	235560	116052
11	0.304	24348	14446	99623	52468	99623	52468	83169	43802
12	0.304	13954	9117	57095	30850	57095	30850	47665	25755
Total		1682229	674521	19375948	3613509	10748096	3108561	9500718	2714979

Table 2.8.2.3 North East Atlantic Mackerel. . Short term prediction; single area management option table. OPTION: Catch constraint 930 Kt in 2010.

2010				
Biomass	SSB	Fmult	Fbar	Landings
3972745	2928017	1.346	0.314	930002

2011					2012		
TSB	SSB	Fmult	Fbar	Landings	TSB	SSB	Implied changed in the landings
3686205	3006648	0.00	0.00	0	4178115	3474966	-100%
-	2973921	0.10	0.03	99969	4094893	3358304	-89%
-	2941608	0.20	0.06	197151	4014037	3246471	-79%
-	2909705	0.30	0.09	291631	3935472	3139249	-69%
-	2878204	0.40	0.13	383494	3859127	3036430	-59%
-	2847101	0.50	0.16	472821	3784932	2937816	-49%
-	2816391	0.60	0.19	559692	3712819	2843218	-40%
-	2786068	0.70	0.22	644182	3642722	2752456	-31%
-	2756127	0.80	0.25	726365	3574578	2665359	-22%
-	2726562	0.90	0.28	806312	3508326	2581764	-13%
-	2697368	1.00	0.31	884093	3443908	2501515	-5%
-	2668541	1.10	0.34	959773	3381266	2424463	3%
-	2640075	1.20	0.38	1033417	3320344	2350467	11%
-	2611966	1.30	0.41	1105088	3261090	2279393	19%
-	2584209	1.40	0.44	1174846	3203451	2211111	26%
-	2556798	1.50	0.47	1242749	3147378	2145499	34%
-	2529729	1.60	0.50	1308853	3092822	2082441	41%
-	2502998	1.70	0.53	1373214	3039737	2021824	48%
-	2476600	1.80	0.56	1435884	2988078	1963544	54%
-	2450531	1.90	0.60	1496914	2937799	1907497	61%
-	2424785	2.00	0.63	1556354	2888861	1853588	67%

Table 2.12.1. Catches in tonnes of *Scomber colias* in Divisions VIIIb, VIIIc and IXa in the period 1982 – 2009.

Sub-Divisions		**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
VIIIb	Spain	0	0	0	0	0	0	0	0	0	487	7	4	427	247
VIIIc	Spain	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558
IXa North	Spain	0	0	0	0	0	0	0	0	0	0	895	3357	8573	5068
IXa-CN, CS & S	Portugal	2458	1364	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884

Sub-Divisions		**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
VIIIb	Spain	778	362	1218	632	344	426	99	157	40	222	262	744	42	122
VIIIc	Spain	2679	5026	1765	418	1905	1496	1509	2525	2741	3150	4260	7153	5203	3930
IXa North	Spain	5437	2340	1381	983	1001	553	1566	981	888	812	2984	8239	8544	11860
IXa-CN, CS & S	Portugal	4759	5408	6690	13877	10520	4228	5301	8030	14714	14905	13031	20222	23286	14428

Table 2.15: Overview of major existing regulations on mackerel catches

Technical measure	National/International level	Specification	Note
Catch limitation	Coastal States/NEAFC	2010: not agreed	
Management plan	European (EU, Norway)	If SSB >= 2.200.000t, F = 0.2 to 0.22 if SSB is between 1.670.000t and 2.200.000t, F = 0.22 * SSB/2.200.000 TAC should not be changed more than 20% if SSB < 1.670.000t, parties shall decide on a TAC which is less than that arising from the calculation above	
Minimum size (North Sea)	European (EU, Norway, Faroes)	30cm in the North Sea	
Minimum size (all areas except North Sea)	European (EU, Faroes)	20cm in all areas except North Sea	10% undersized allowed
Minimum size	National (Nor)	30cm in all areas	
Catch limitation	European (EU, Norway, Faroes)	Within the limits of the quota for the western component (VI,VII, VIIIabde, Vb(EC), IIa(nonEC), XII, XIV), a certain quantity may be taken from IVa but only during the periods 1 January to 15 February and 1 October to 31 December.	
Area closure	National (UK)	South-West Mackerel Box off Cornwall	except where the weight of the mackerel does not exceed 15 % by liveweight of the total quantities of mackerel and other marine organisms onboard which have been caught in this area
Quota adaptation	European (EU)	Reducing of UK and Irish mackerel quota with a scheduled payback until 2012 following the exceeding of fishing opportunities 2001 to 2004	
Discard prohibition	National (Nor)	All discarding is prohibited in Norwegian waters	

*** incl. unilateral Norway/Faroes**

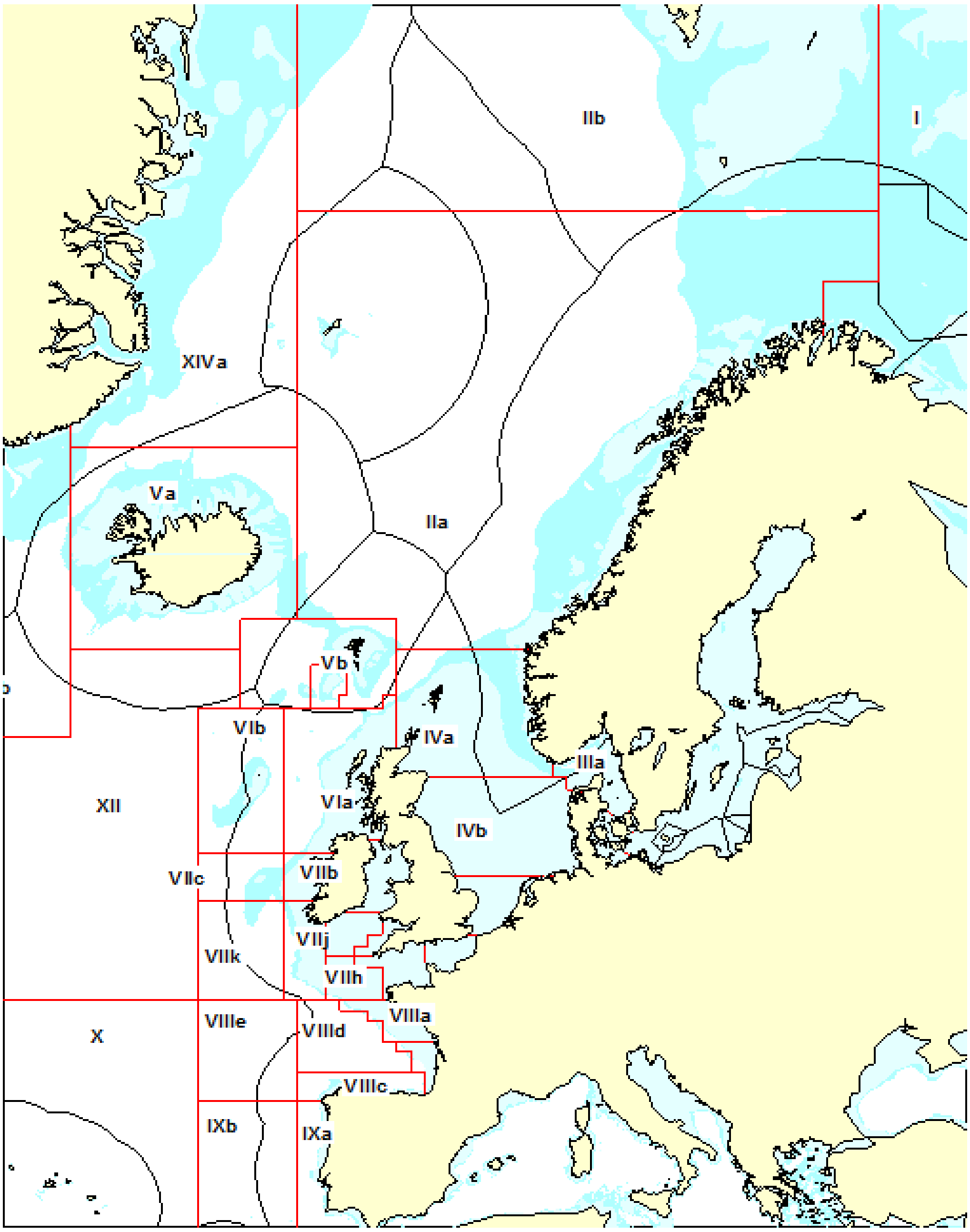


Figure 2.1.1. Map of approximate national zones and ICES Divisions and Subareas. Note that EU region is considered as one zone in this map. The 200 and 500 m depth contour is shown on the map.

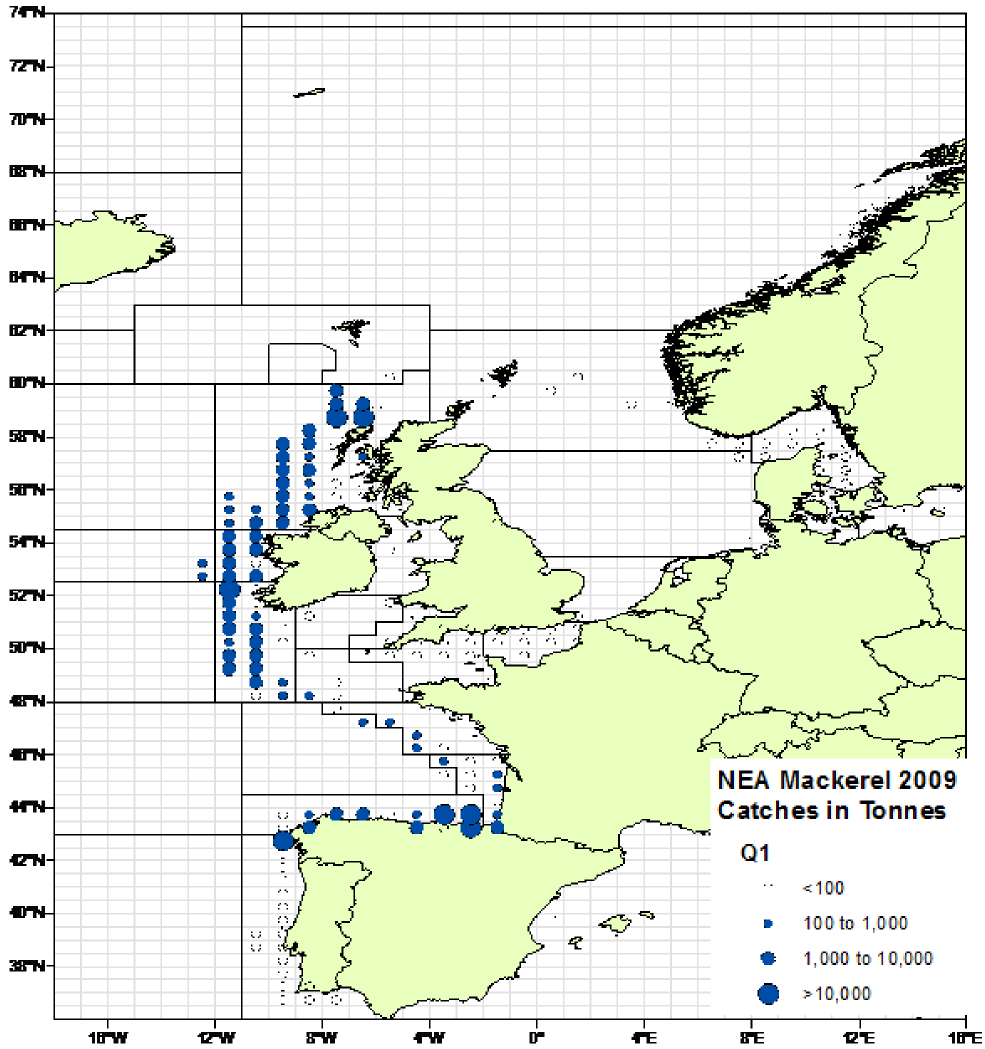


Figure 2.3.1.1 NE Atlantic Mackerel, commercial catches in 2009, quarter1.

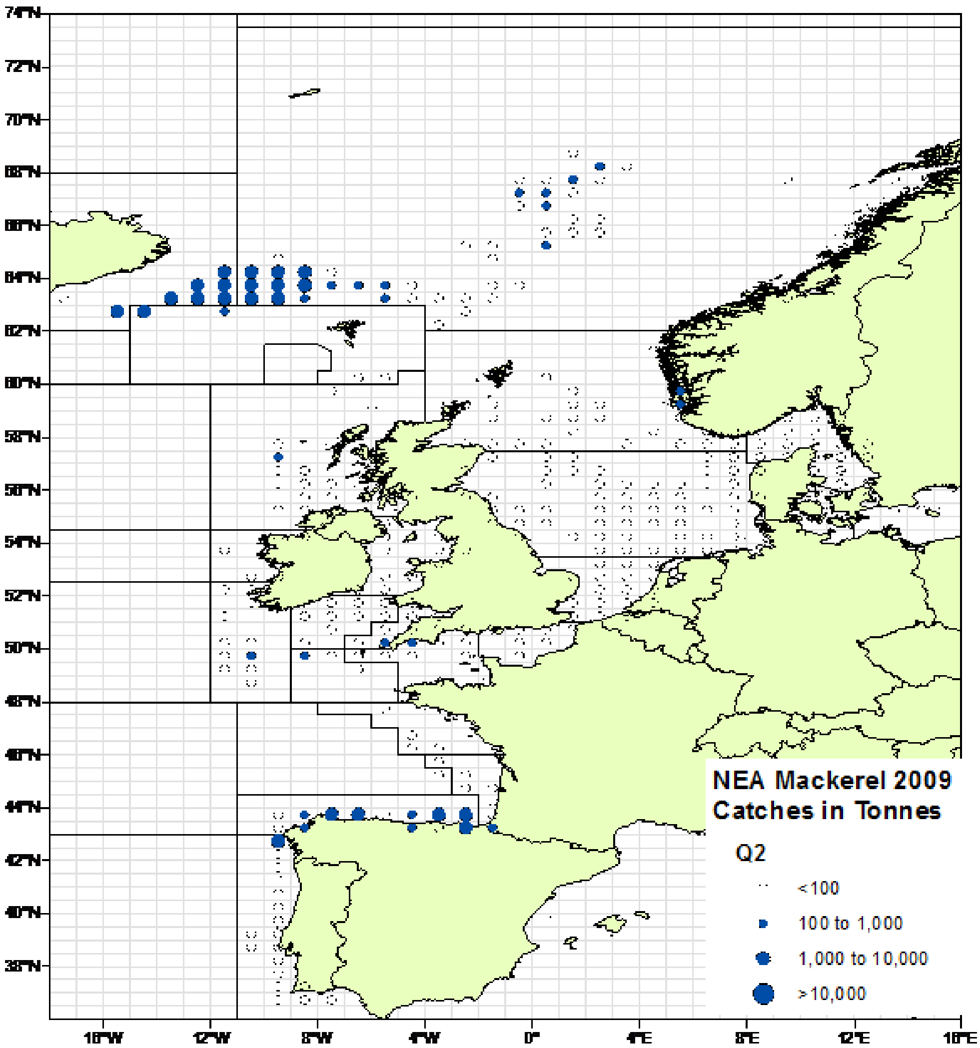


Figure 2.3.1.2 NE Atlantic Mackerel, commercial catches in 2009, quarter2.

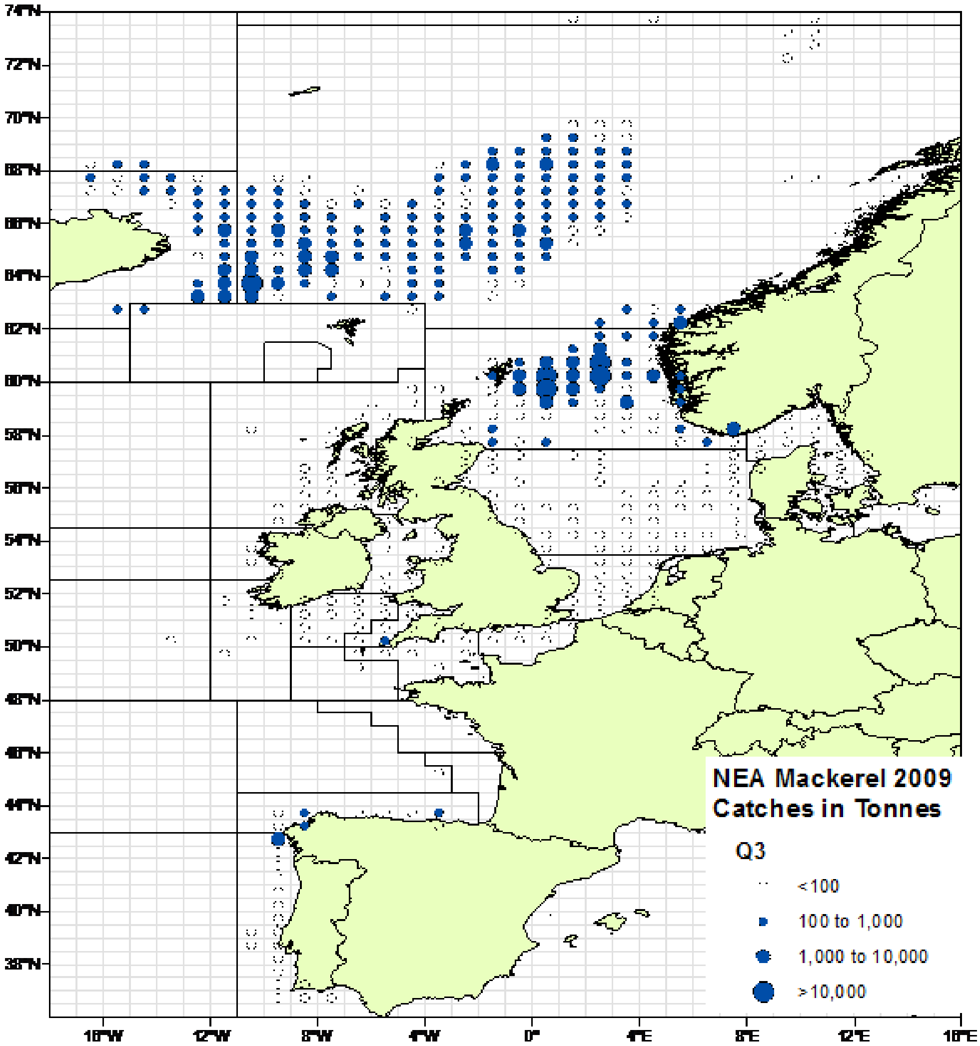


Figure 2.3.1.3 NE Atlantic Mackerel, commercial catches in 2009, quarter3.

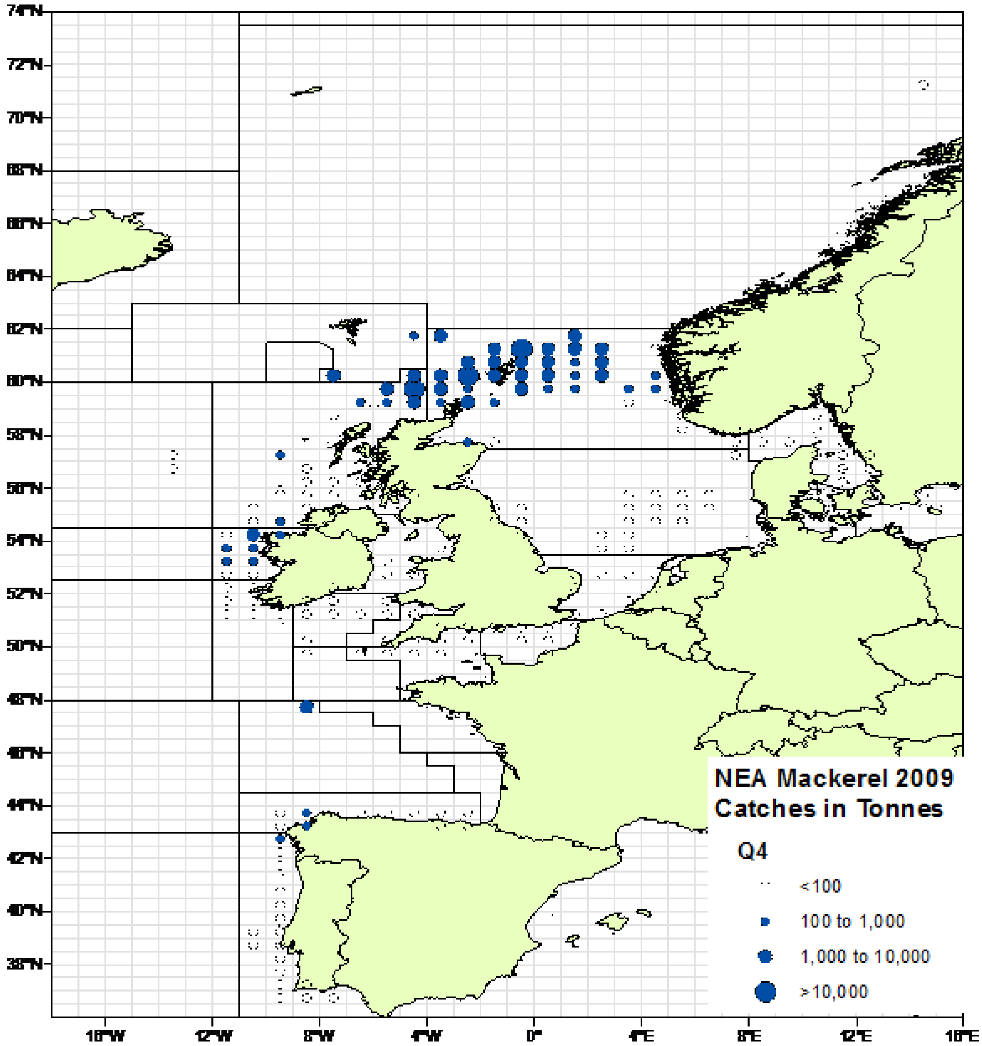
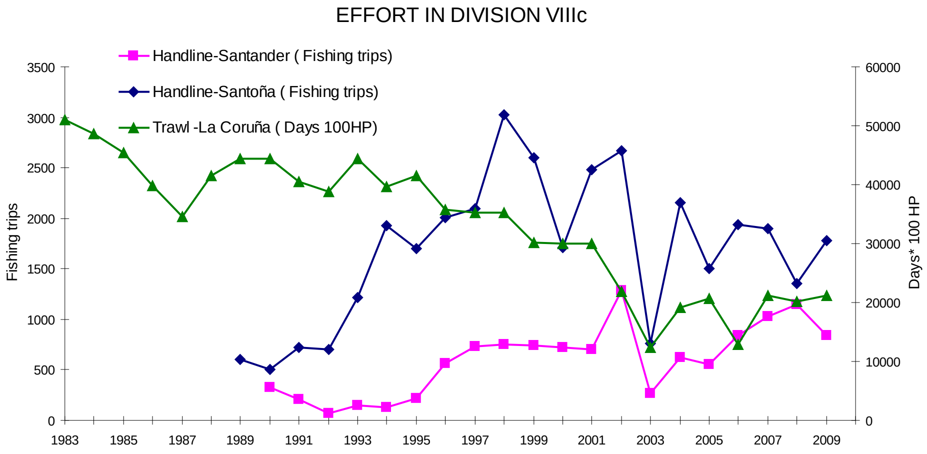


Figure 2.3.1.4 NE Atlantic Mackerel, commercial catches in 2009, quarter4.



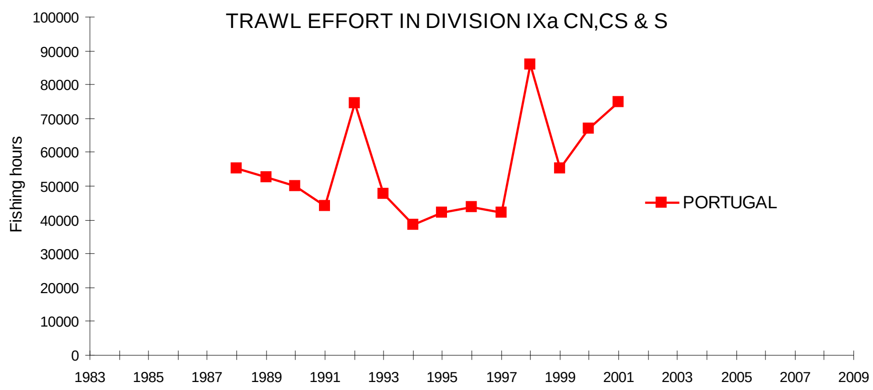
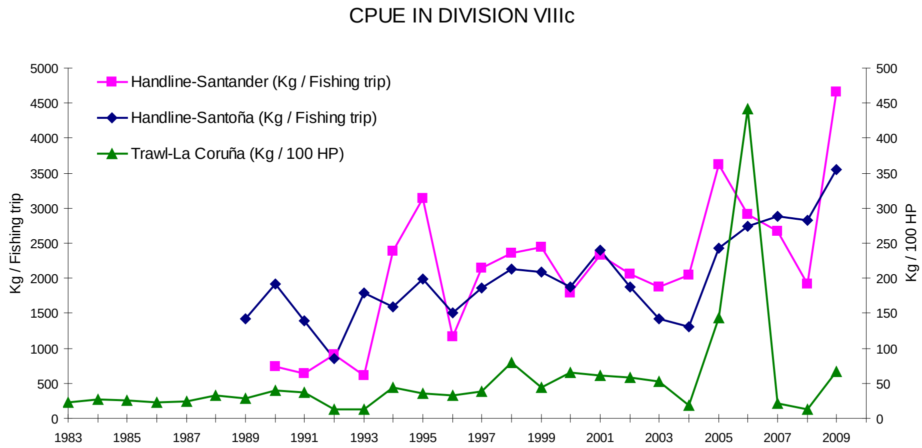


Figure 2.3.2.1. NEA mackerel (Southern component). Effort data by fleets and area .



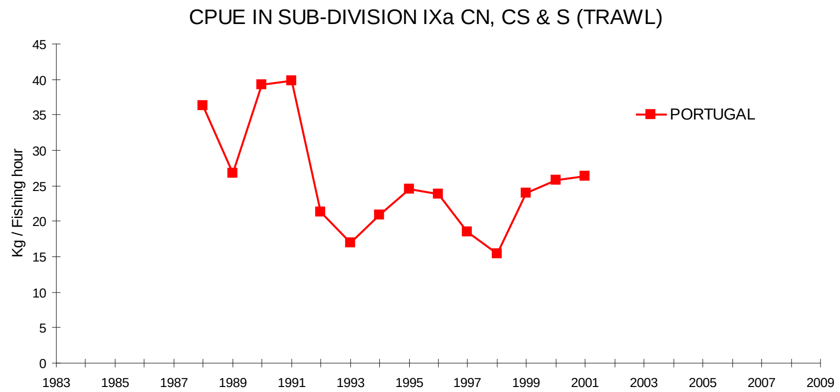


Figure 2.3.2.2. NEA mackerel (Southern component). CPUE data by fleet and area.

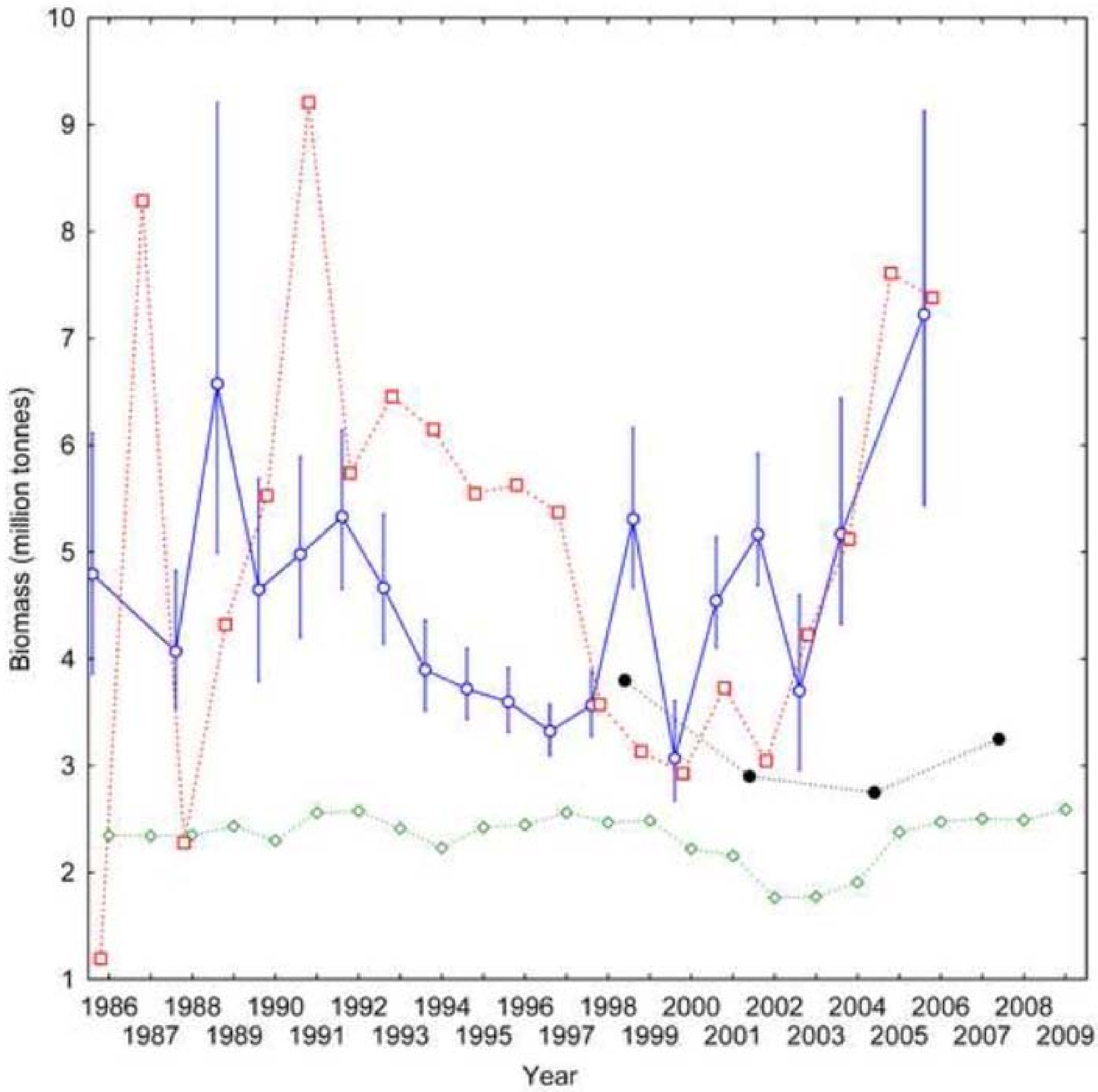


Figure 2.3.7.1. Stock biomass estimates of 3-12 years old mackerel, 1986-2006, based on the MERKAN (solid line and circles) and the HAMRE (broken line and squares) models. The estimates are compared with the official spawning stock biomass estimates (dotted line and diamonds, ICES, 2009a) and the triennial egg survey SSB estimates (dotted line and filled circles, ICES, 2008). The MERKAN estimates are presented as bootstrap medians with 25th and 75th percentiles.

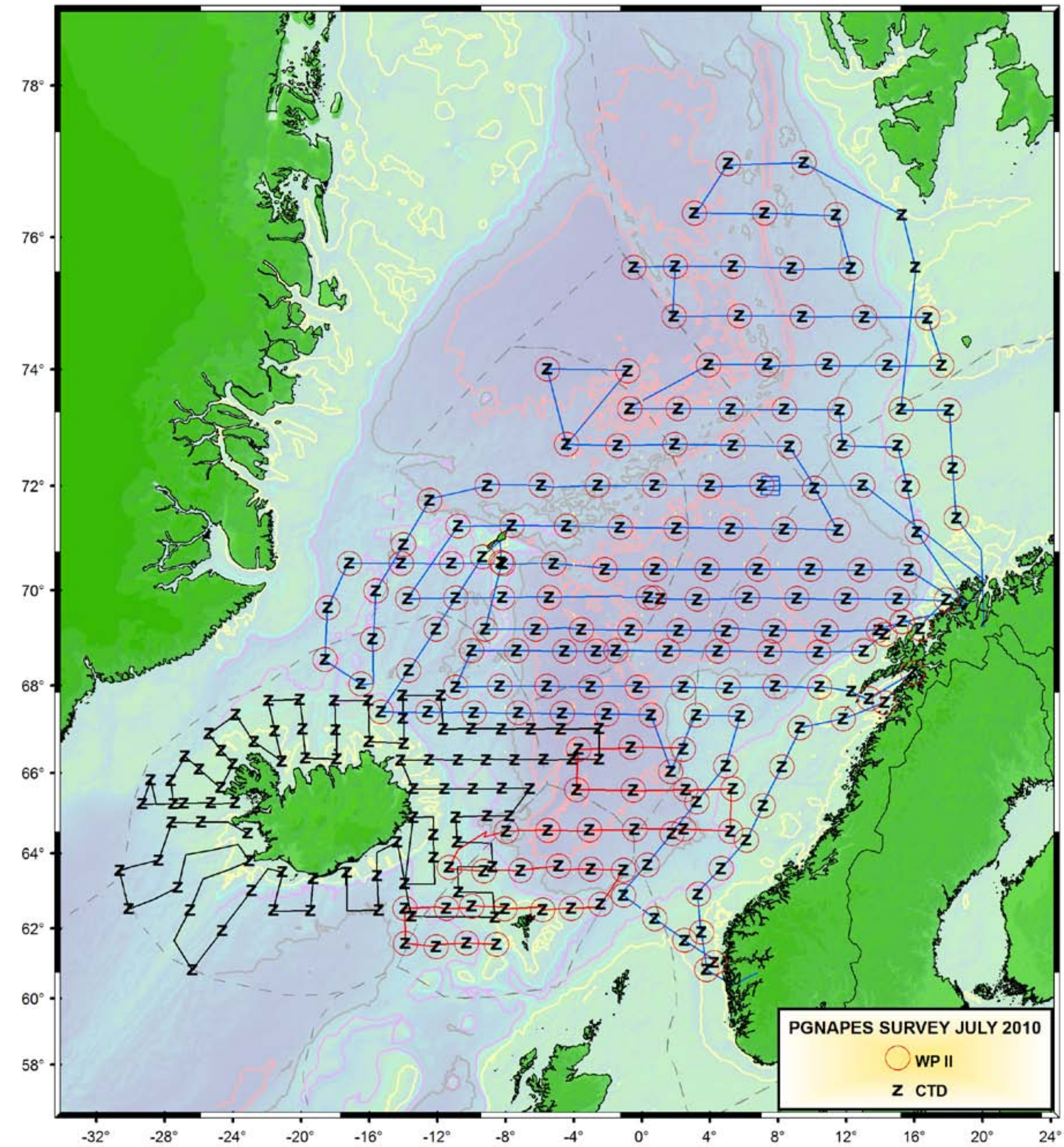
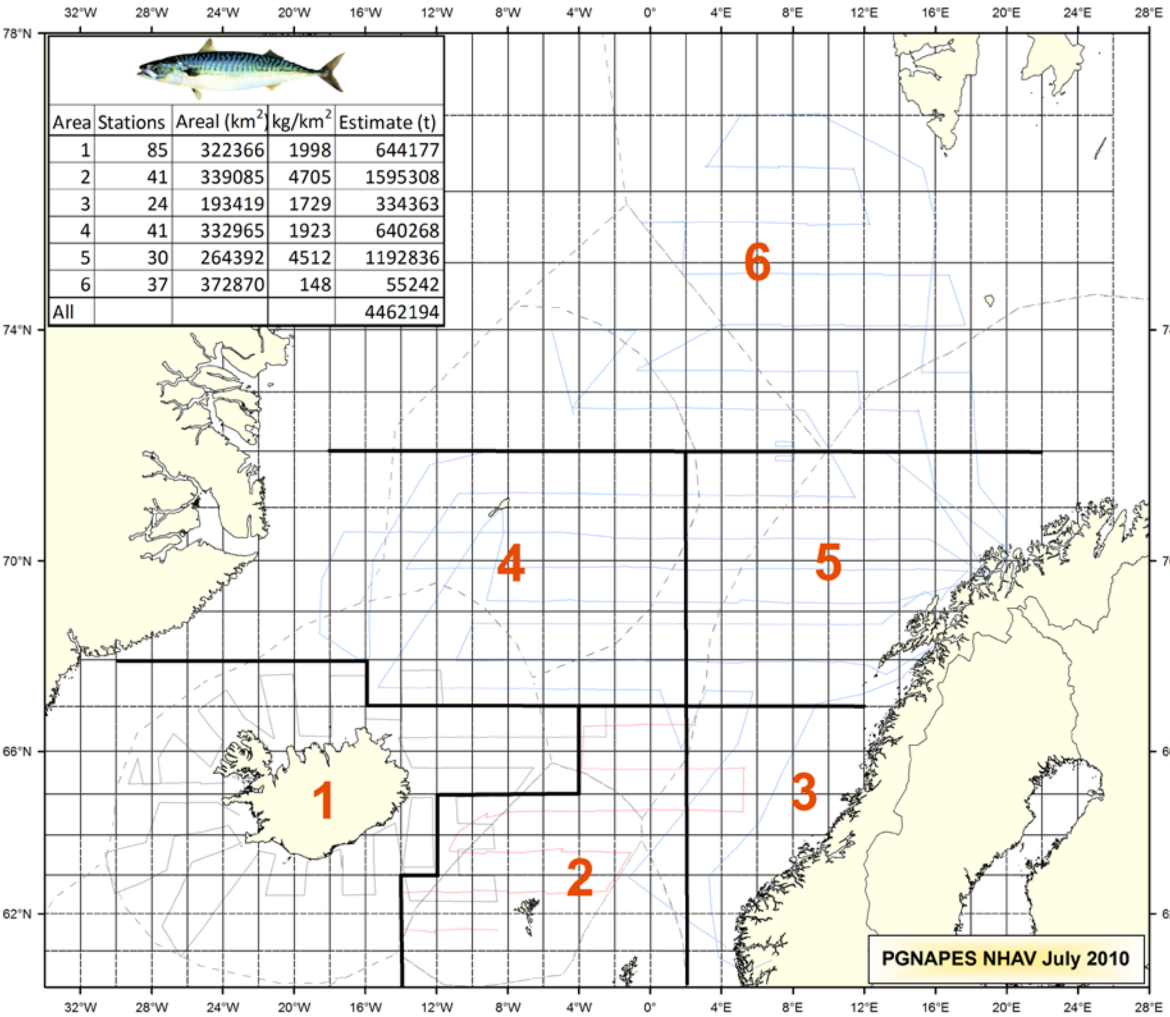


Figure 2.5.1.1.1 Survey lines along the cruise tracks with pre-defined CTD stations (0-500 m) and WP2 samples (0-200 m) for M/V"Libas", M/V"Brennholm", M/V "Finnur Fridi" and R/V "Arni Fridriksson" 9 July – 20 August 2010. This large ocean area included the following Economical Exclusive Zones (EEZ): Norwegian EEZ, United Kingdom EEZ, Faeroe Island EEZ, Iceland EEZ, Jan Mayen fishery protection zone, Spitzbergen protected area and International waters.



Area	Stations	Areal (km^2)	kg/km^2	Estimate (t)
1	85	322366	1998	644177
2	41	339085	4705	1595308
3	24	193419	1729	334363
4	41	332965	1923	640268
5	30	264392	4512	1192836
6	37	372870	148	55242
All				4462194

Figure 2.5.1.1.2 Swept area estimates for Northeast Atlantic mackerel based on pelagic trawl haul catches at the surface onboard Libas, Brennholm, Finnr Fridi and Arni Fridriksson from 9 July to 20 August 2010.

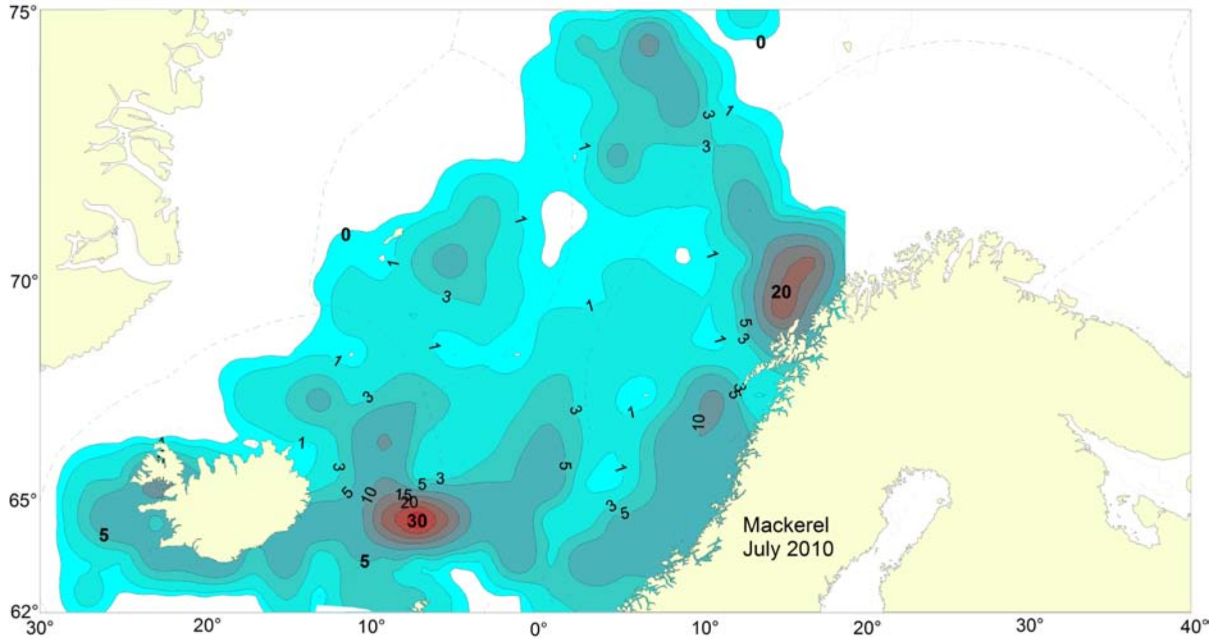


Figure 2.5.2.1.3 Sa or Nautical Area Scattering Coefficient (NASC) values of mackerel along the cruise track.

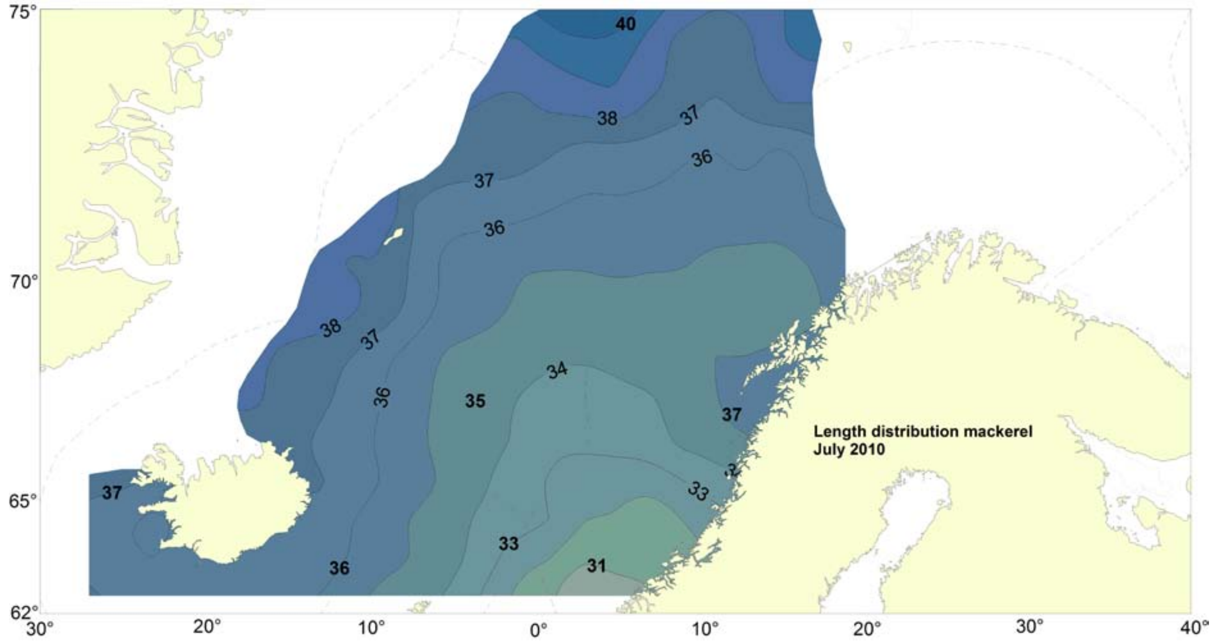


Figure 2.5.1.1.4 Length distribution of mackerel within the sampled area from 9 July to 20 August 2010.

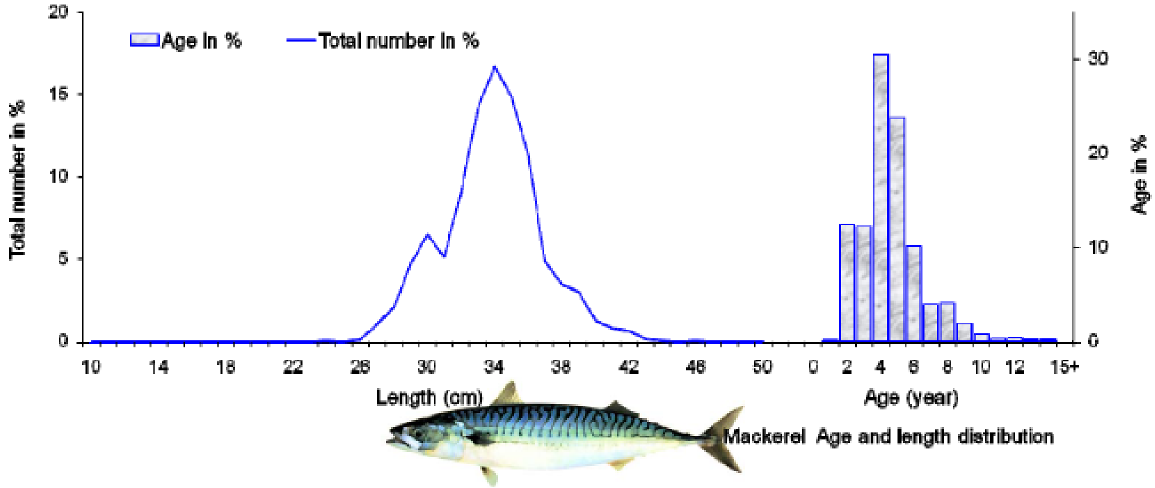


Figure 2.5.1.1.5 Age and length distribution in percent (%) of Atlantic mackerel in the Norwegian Sea and surrounding waters from pelagic trawl samples.

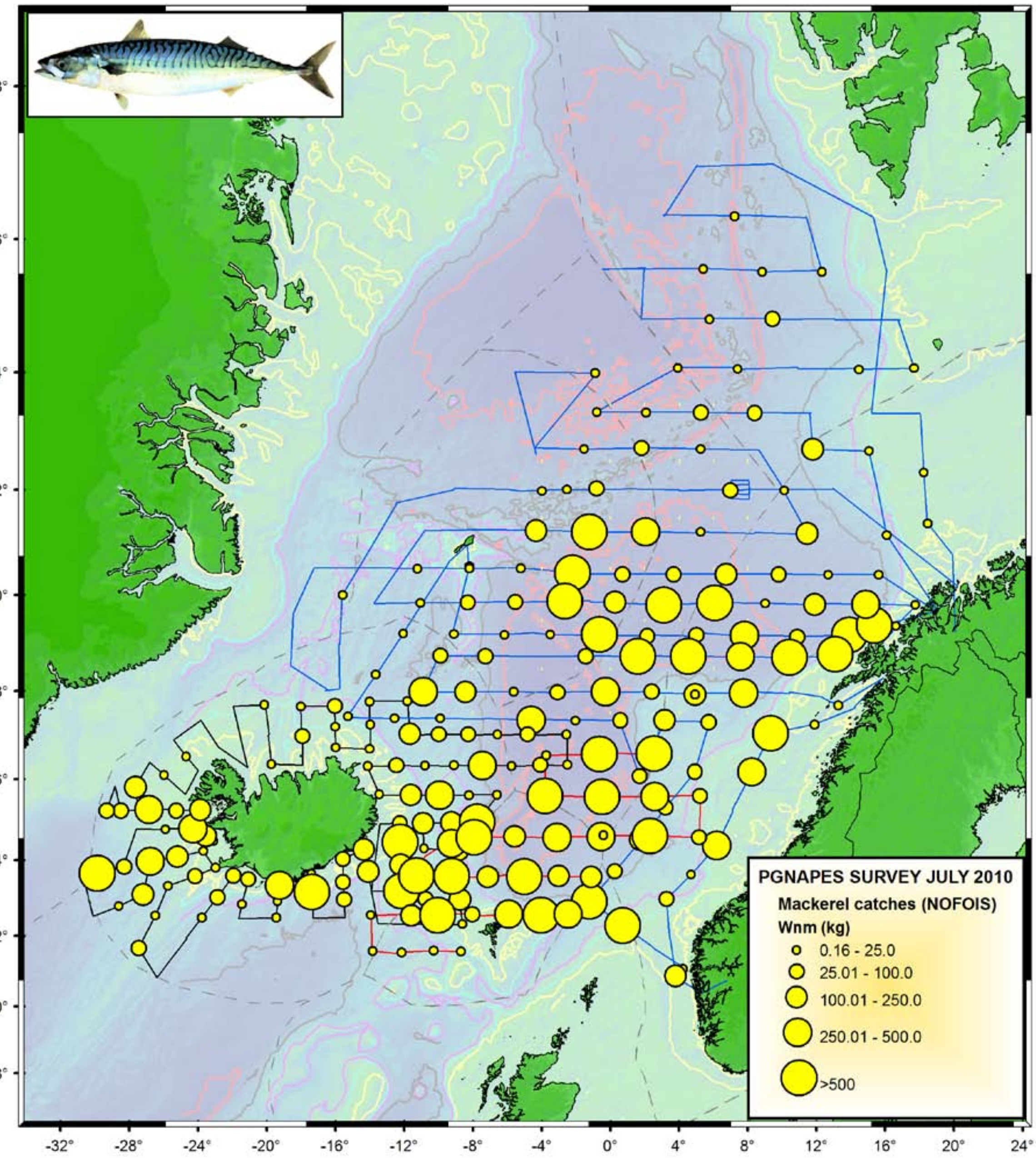


Figure 2.5.1.1.6 Mackerel catches (kg/nmi) from Libas, Brennholm, Finnur Fridi and Arni Fridriksson combined in the Norwegian Sea and surrounding waters, 9 July- 20 August 2010.

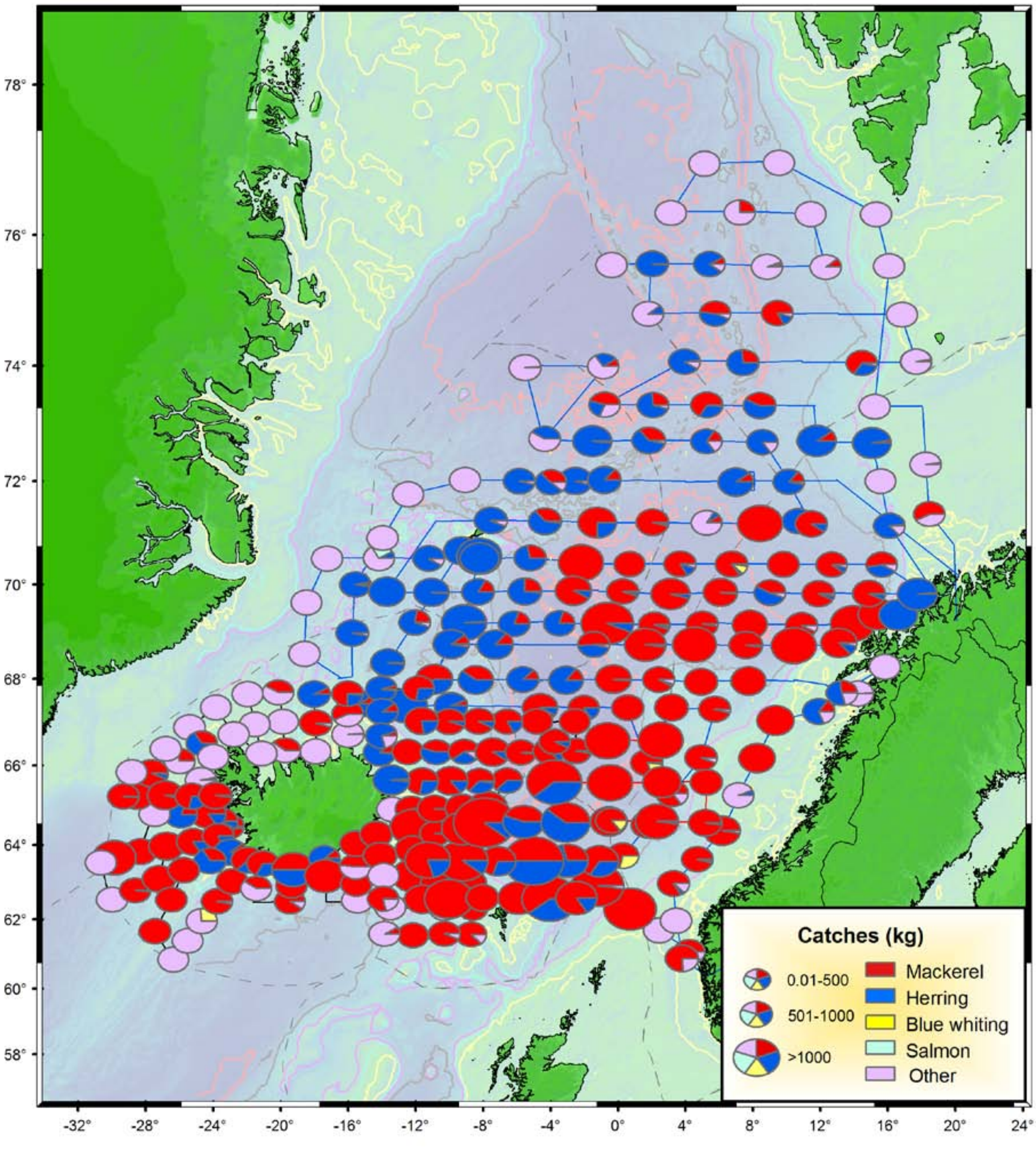


Figure 2.5.1.1.7 Distribution and spatial overlap between mackerel (red), herring (blue), blue whiting (yellow) salmon (turquoise) and other species (violet) from Libas, Brennholm, Finnur Fridi and Arni Fridriksson in the Norwegian Sea and surrounding water from 9 July and 20 August 2010.

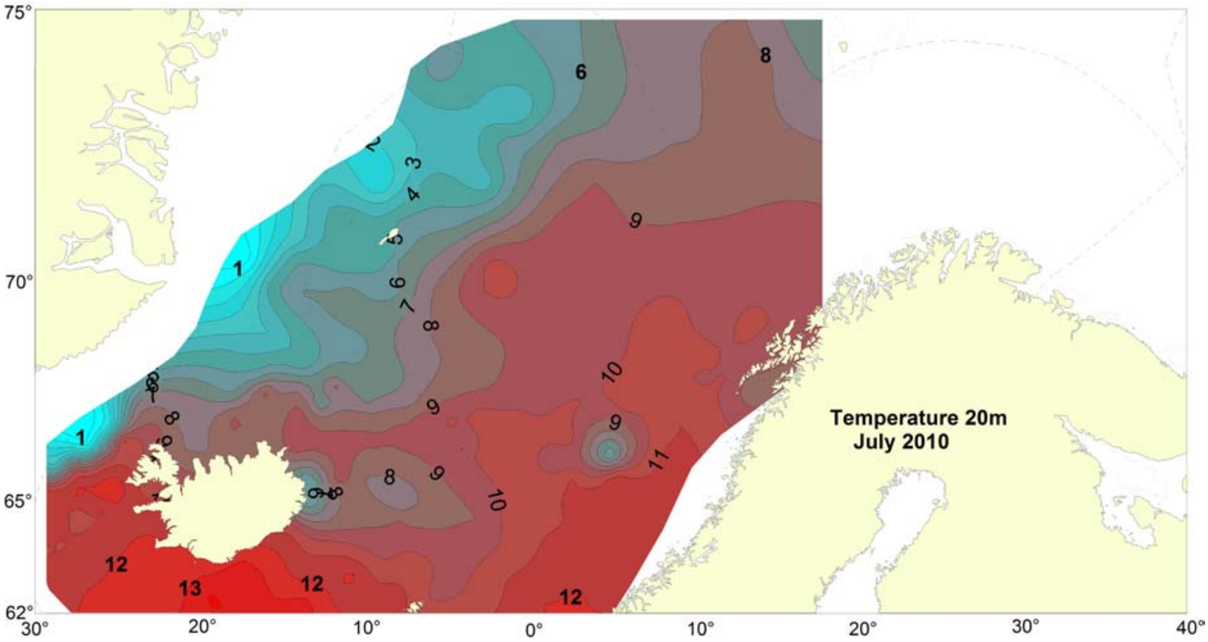


Figure 2.5.1.1.8 Temperature at 20 m depth in the Norwegian Sea and surrounding waters, 9 July - 20 August 2010.

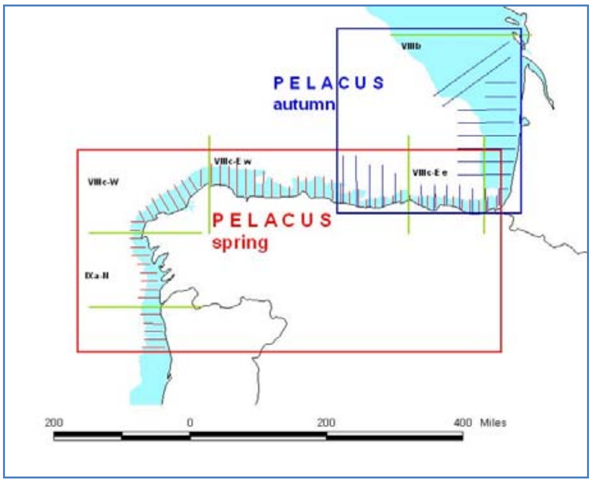


Figure 2.5.3.1. Sampling design of the acoustic surveys carred out by the IEO (PELACUS04 and PELACUS10). It identifies the tracks and the ICES divisions.

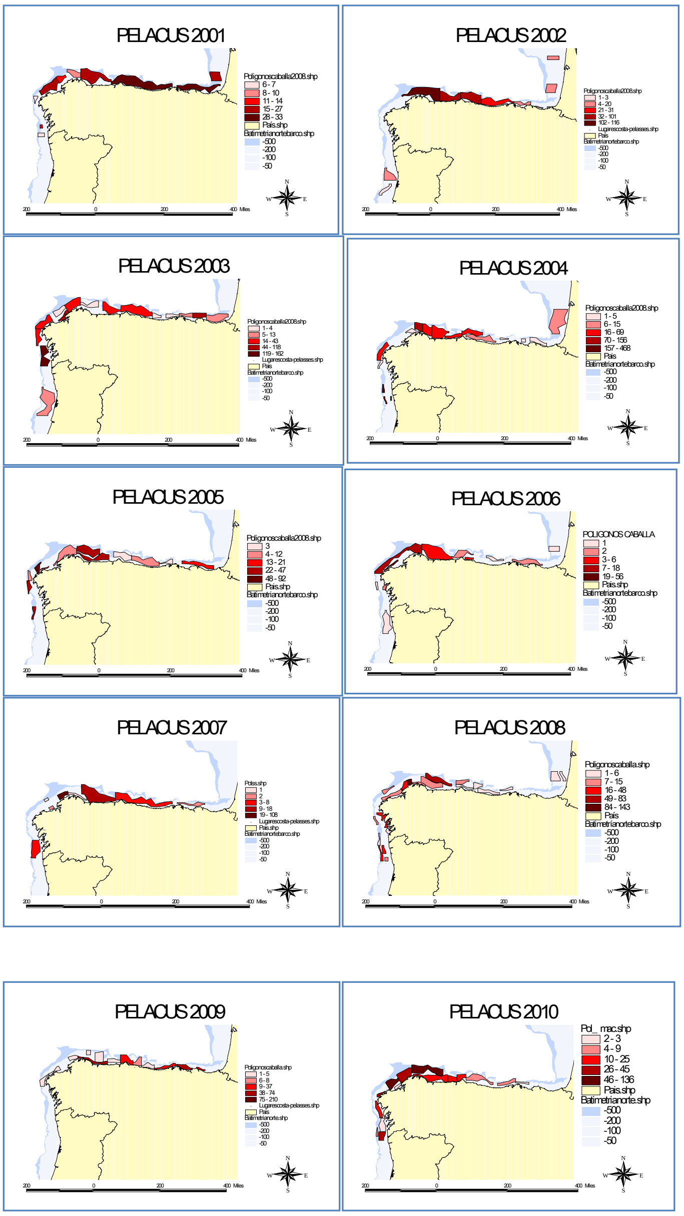
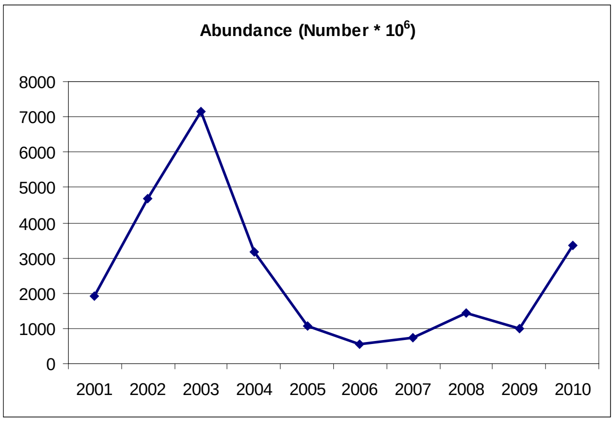


Figure 2.5.3.2. Mackerel distribution from Spanish spring acoustic surveys (PELACUS 04) from 2001 to 2009. Polygon colour indicates the average of values of integrated energy in m^2/mn^2(sA, NASC) within each polygon.



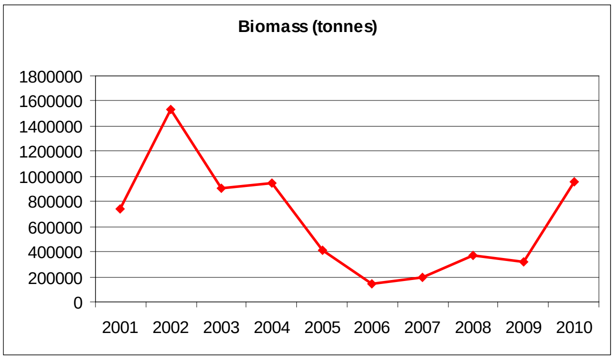


Figure 2.5.3.3. Spanish spring acoustic surveys (PELACUS04) from 2001 to 2010. Mackerel abundance (individuals x10 ^{6}) and Biomass (t) .

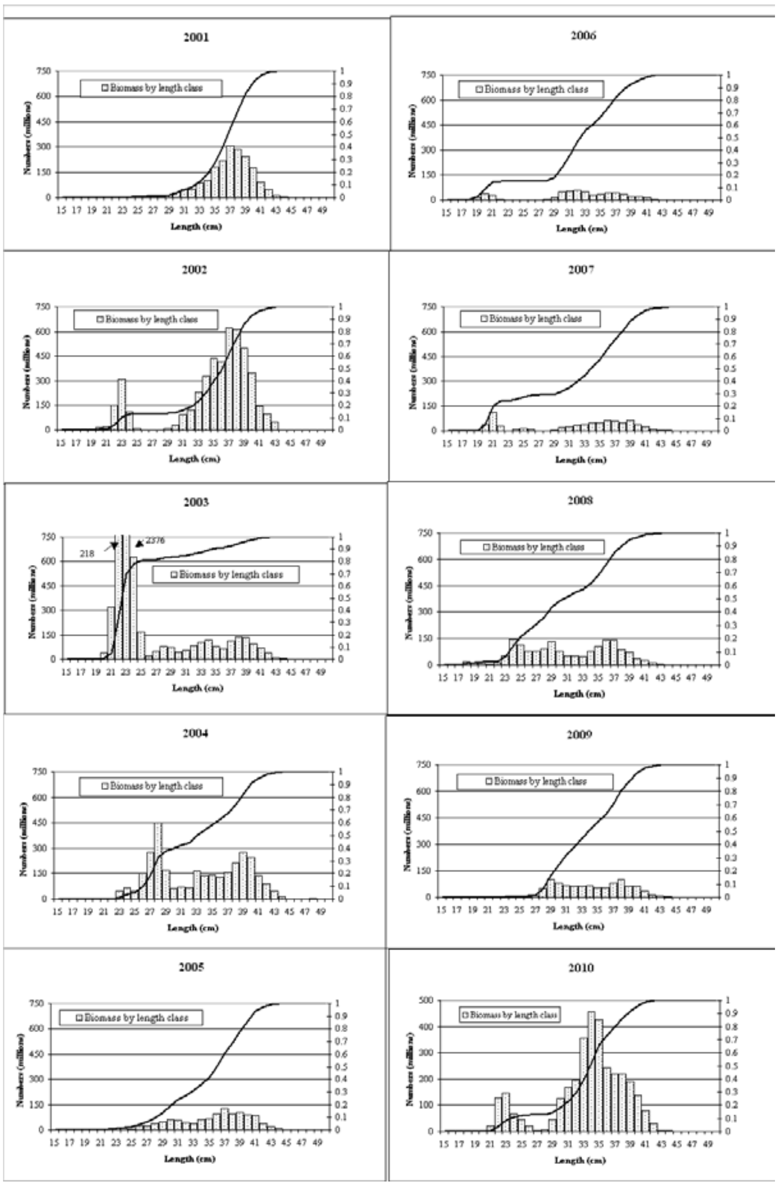


Figure 2.5.3.4. Mackerel length distribution for the spring Spanish acoustic survey (PELACUS04) from 2001 to 2010. The line denotes the cumulative frequency.

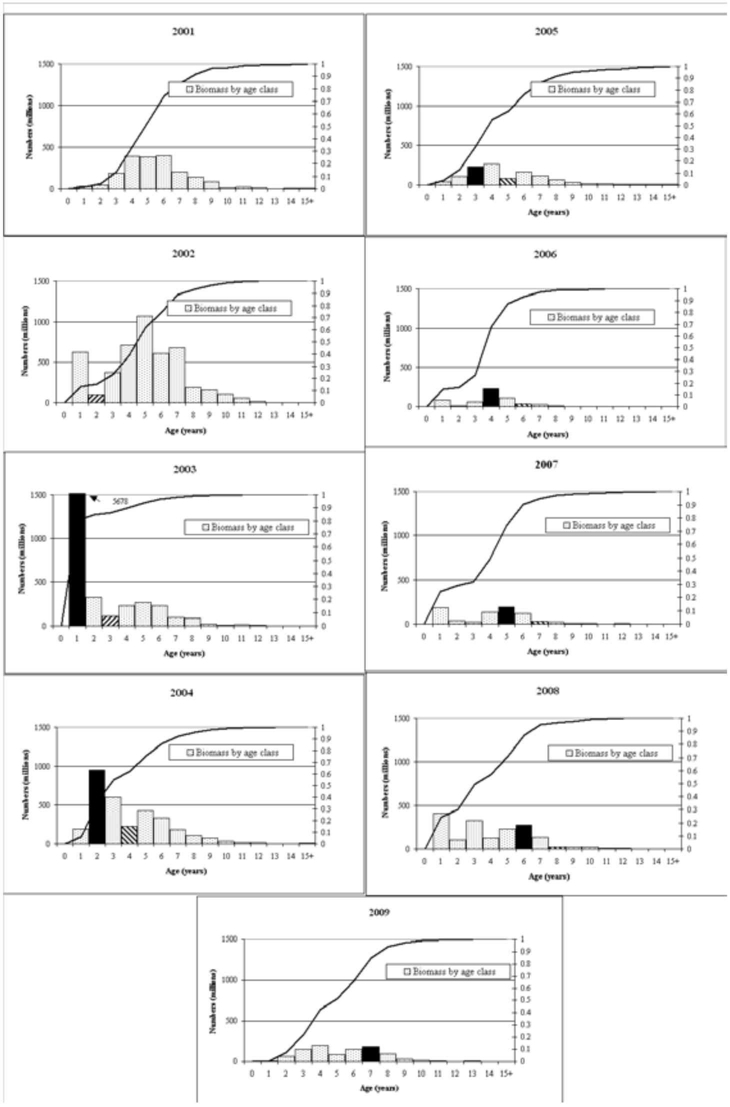


Figure 2.5.3.5. Mackerel age distribution for the spring Spanish acoustic survey (PELACUS04) from 2001 to 2009. The line denotes the cumulative frequency.

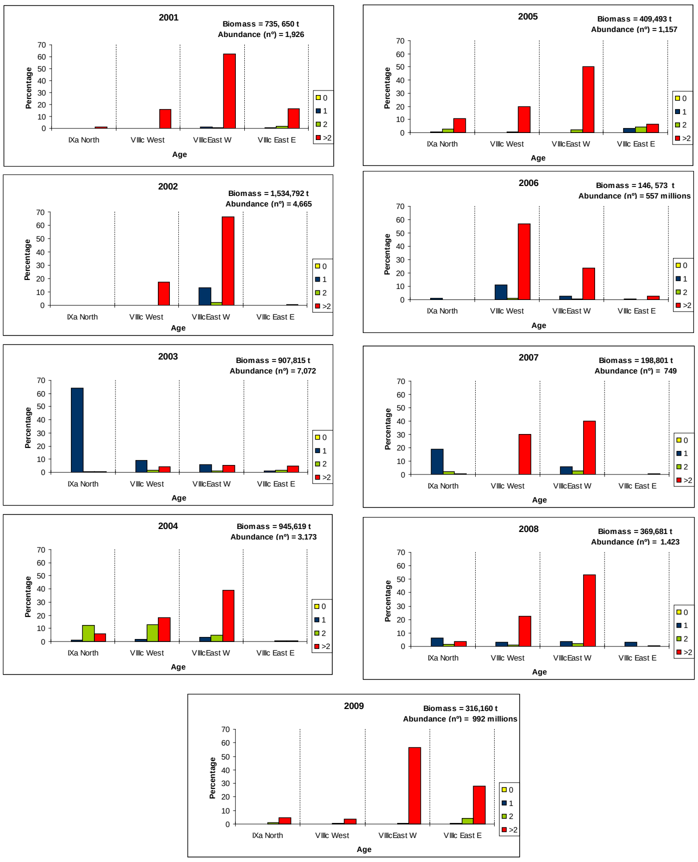


Figure 2.5.3.6. Mackerel abundance (percentage) by age group and ICES Subdivision from the Spanish acoustic surveys (PELACUS04). For each year the abundance (number) and biomass (t) are shown for the whole Spanish area.

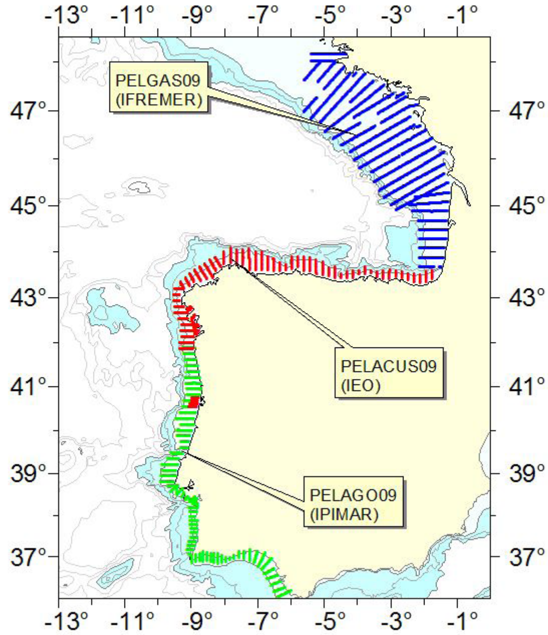


Figure 2.5.3.7. Tracks surveyed by PELAGO (Portuguese acoustic survey), PELACUS (Spanish acoustic survey) and PELGAS (French acoustic survey) during spring 2009.

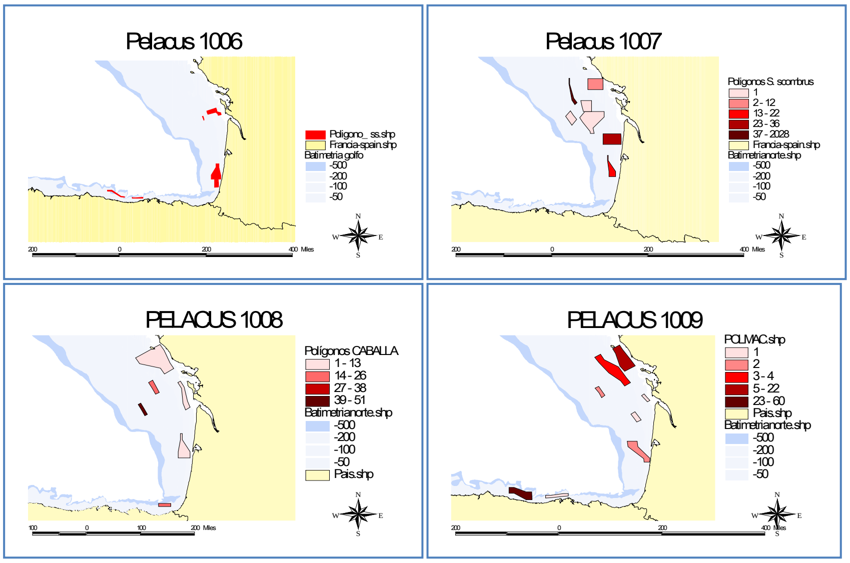


Figure 2.5.3.8. Mackerel distribution from Spanish acoustic survey in autumn (PELACUS 10) from 2006 to 2009. Polygon colour indicates the average of values of integrated energy in m2/mn2 (sA, NASC) within each polygon.

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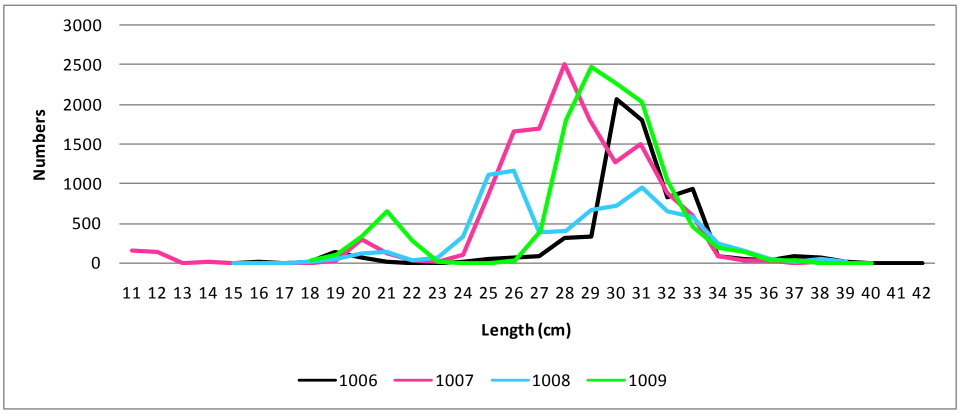

Figure 2.5.3.9. Mackerel length frequency distribution from the fishing trawls in the Spanish autumn acoustic survey (PELACUS 10). Period 2006-2009.

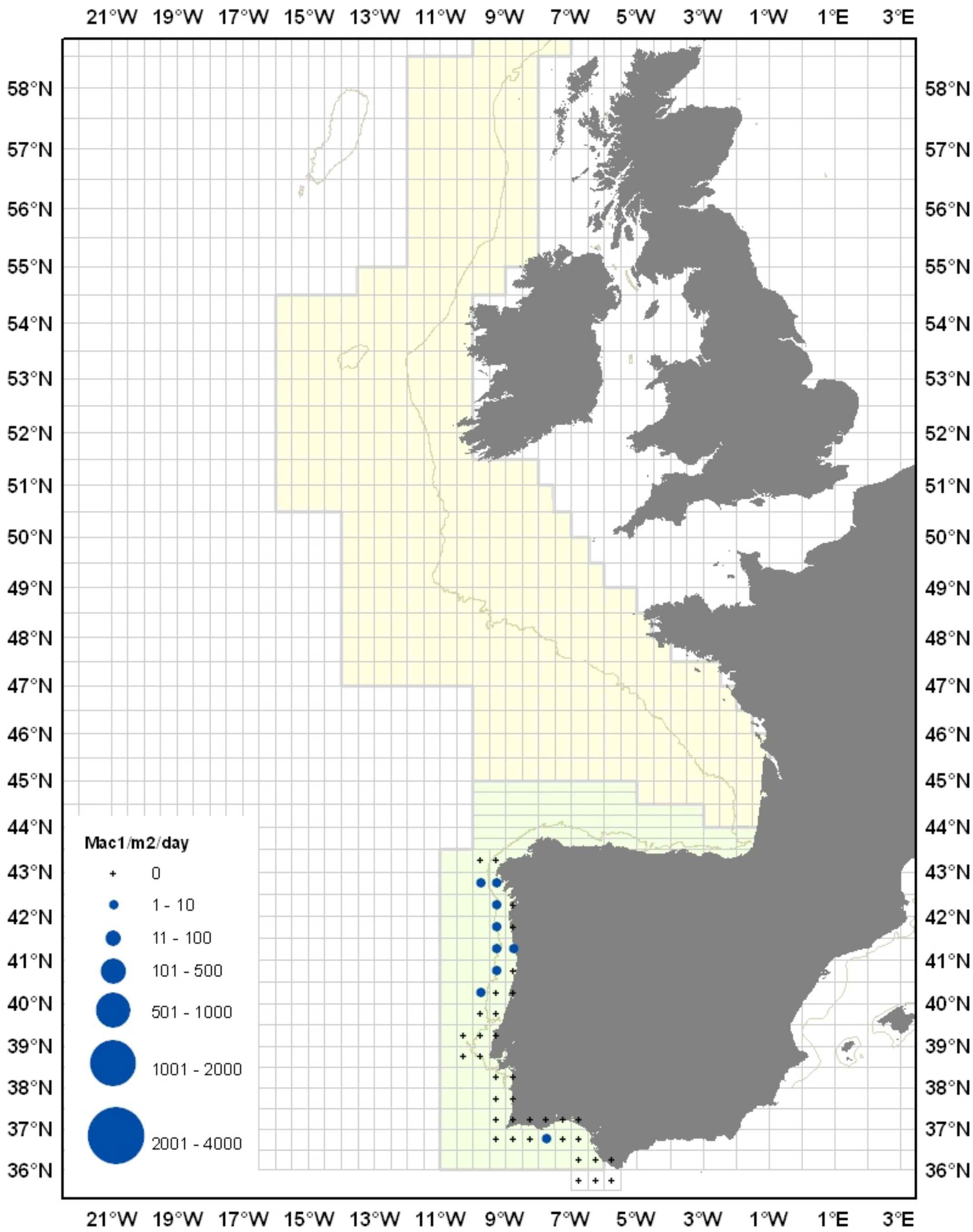

Figure 2.6.1.1: Mackerel spp. egg production by half rectangle for period 1 (30th January – 7 th March). Filled blue circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes,red crosses interpolated zeroes.

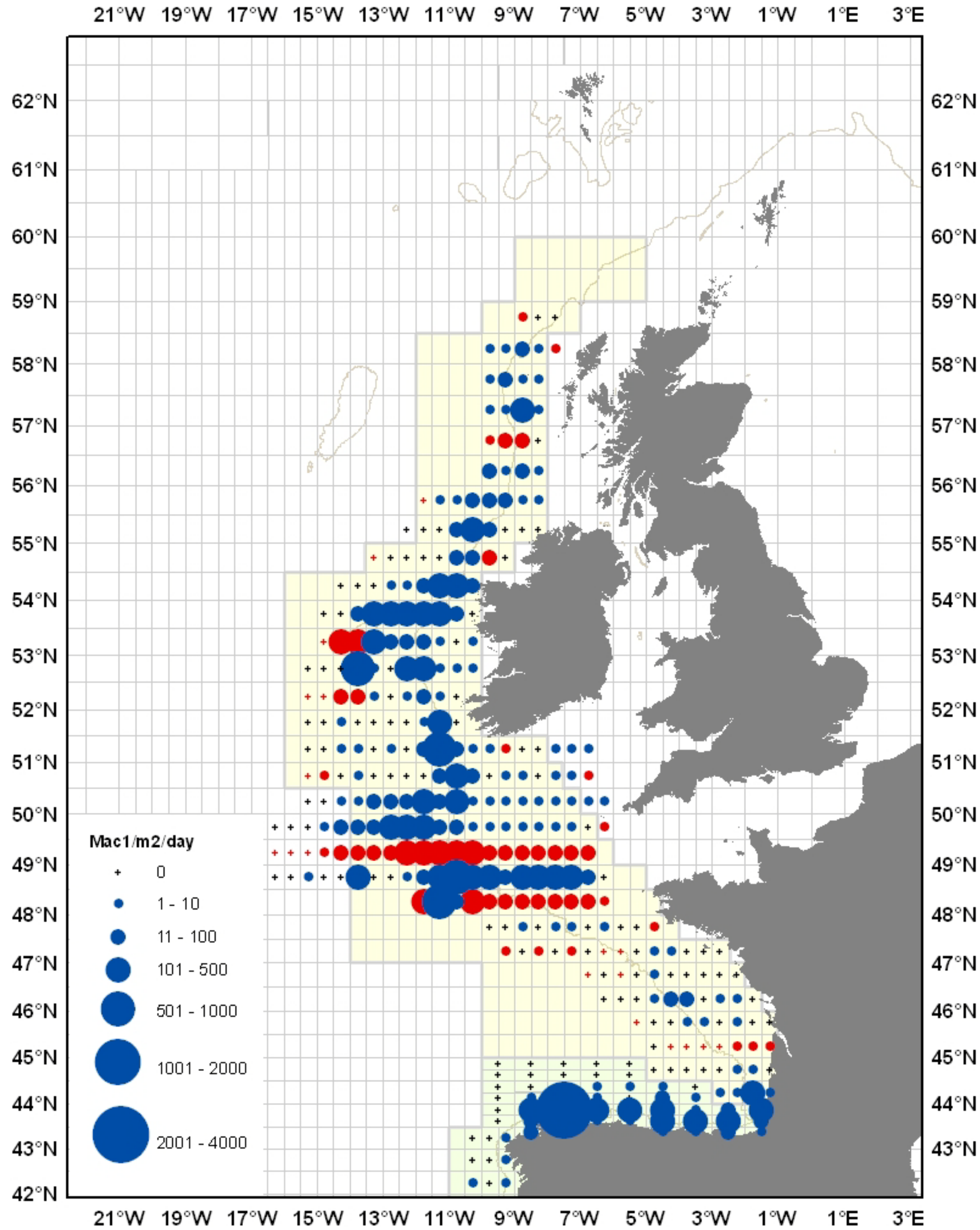

Figure 2.6.1.2: Mackerel egg production by half rectangle for period 2 (8th March – 11th April). Filled blue circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

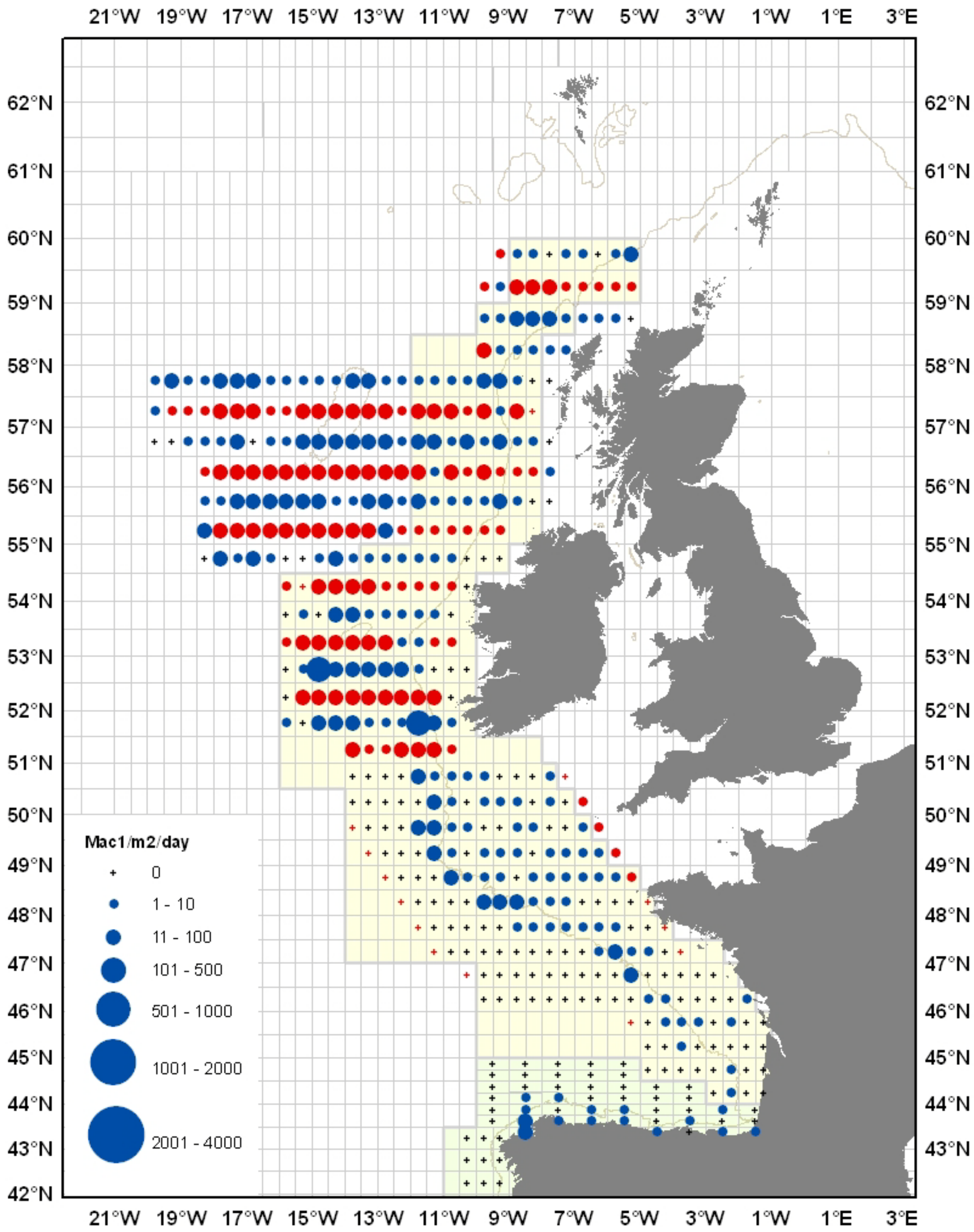

Figure 2.6.1.3: Mackerel egg production by half rectangle for period 3 (12th April – 9th May). Filled blue circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

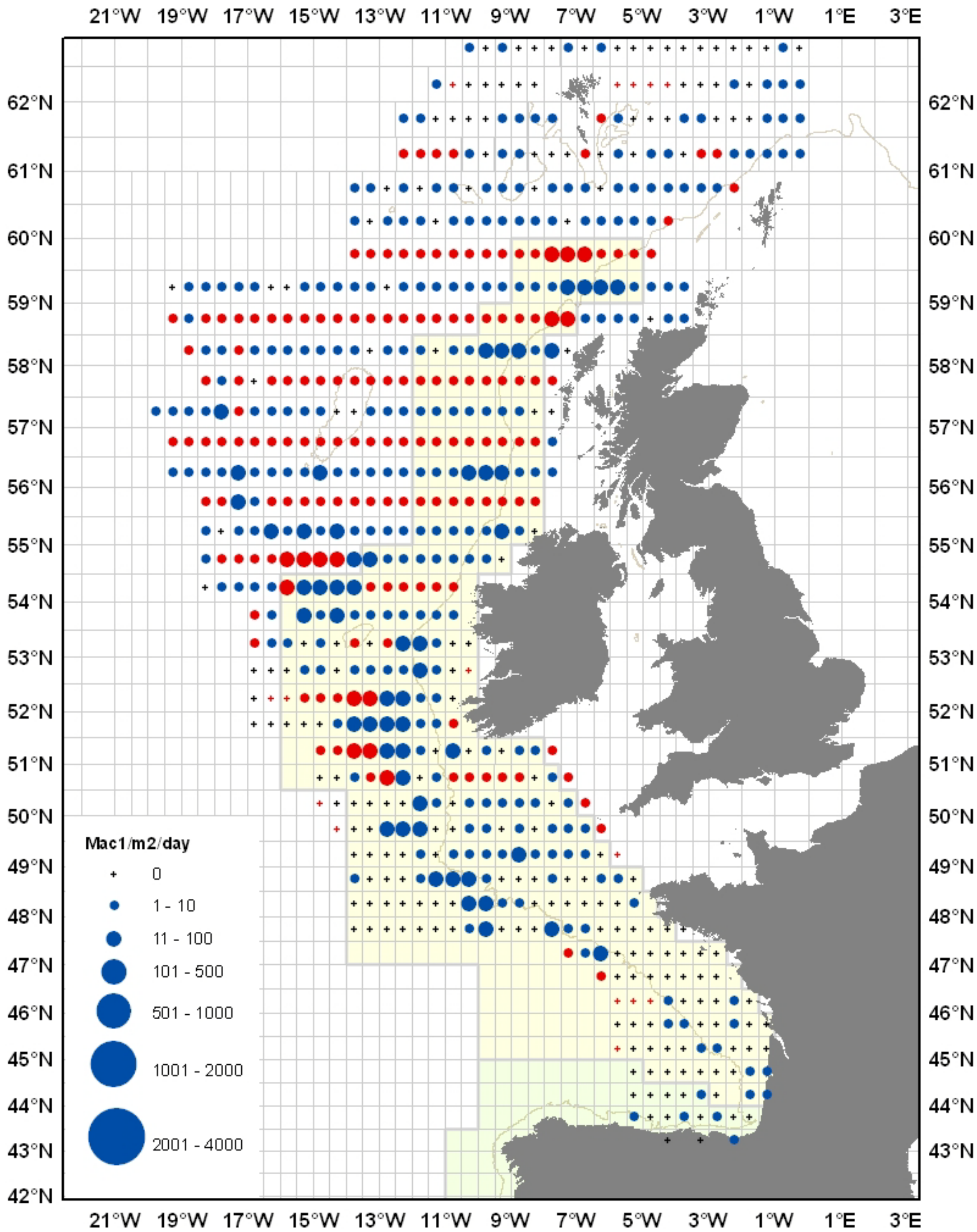

Figure 2.6.1.4: Mackerel egg production by half rectangle for period 4 (10th May – 30th May). Filled blue circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

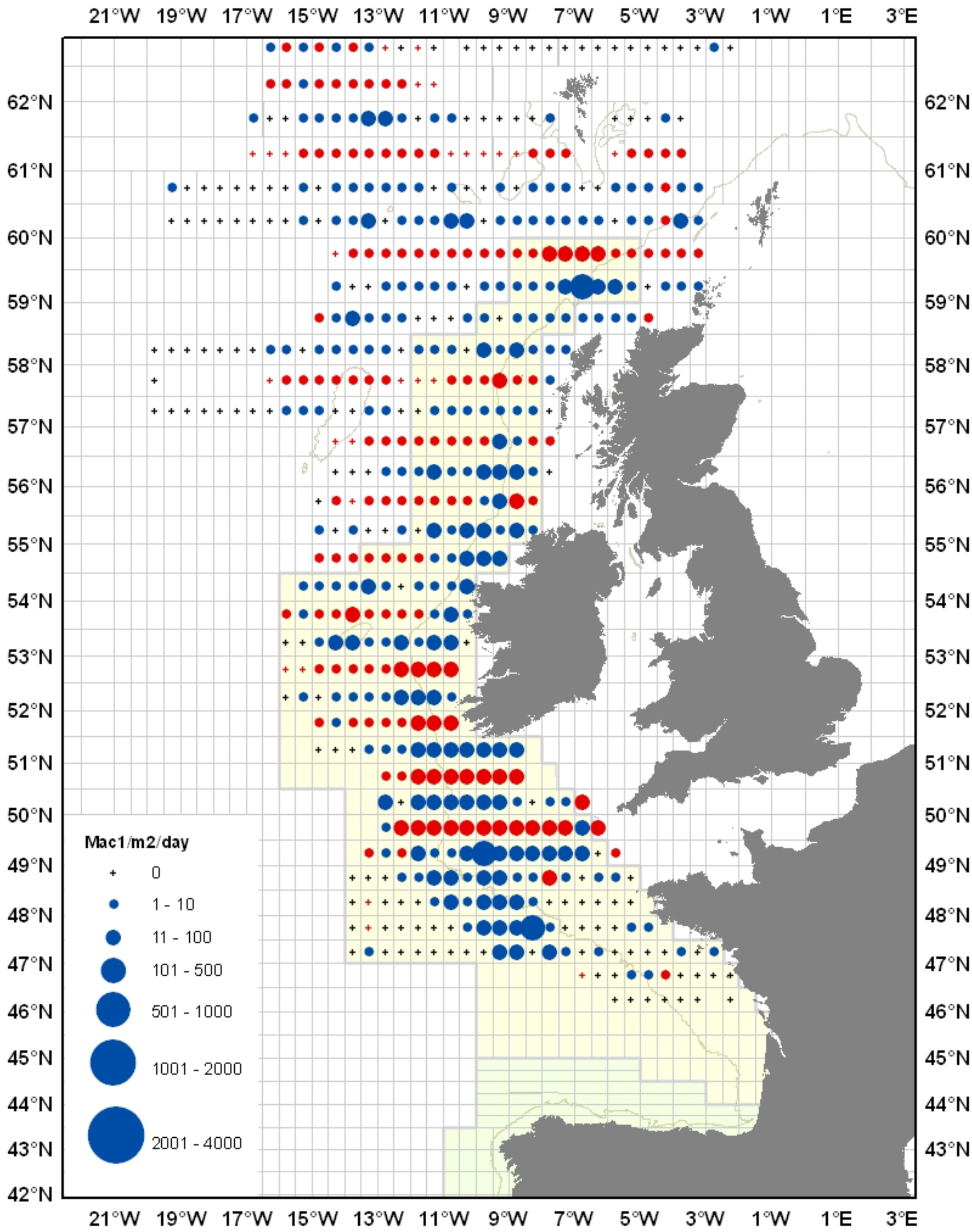

Figure 2.6.1.5: Mackerel egg production by half rectangle for period 5 (31st May – 5th July). Filled blue circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

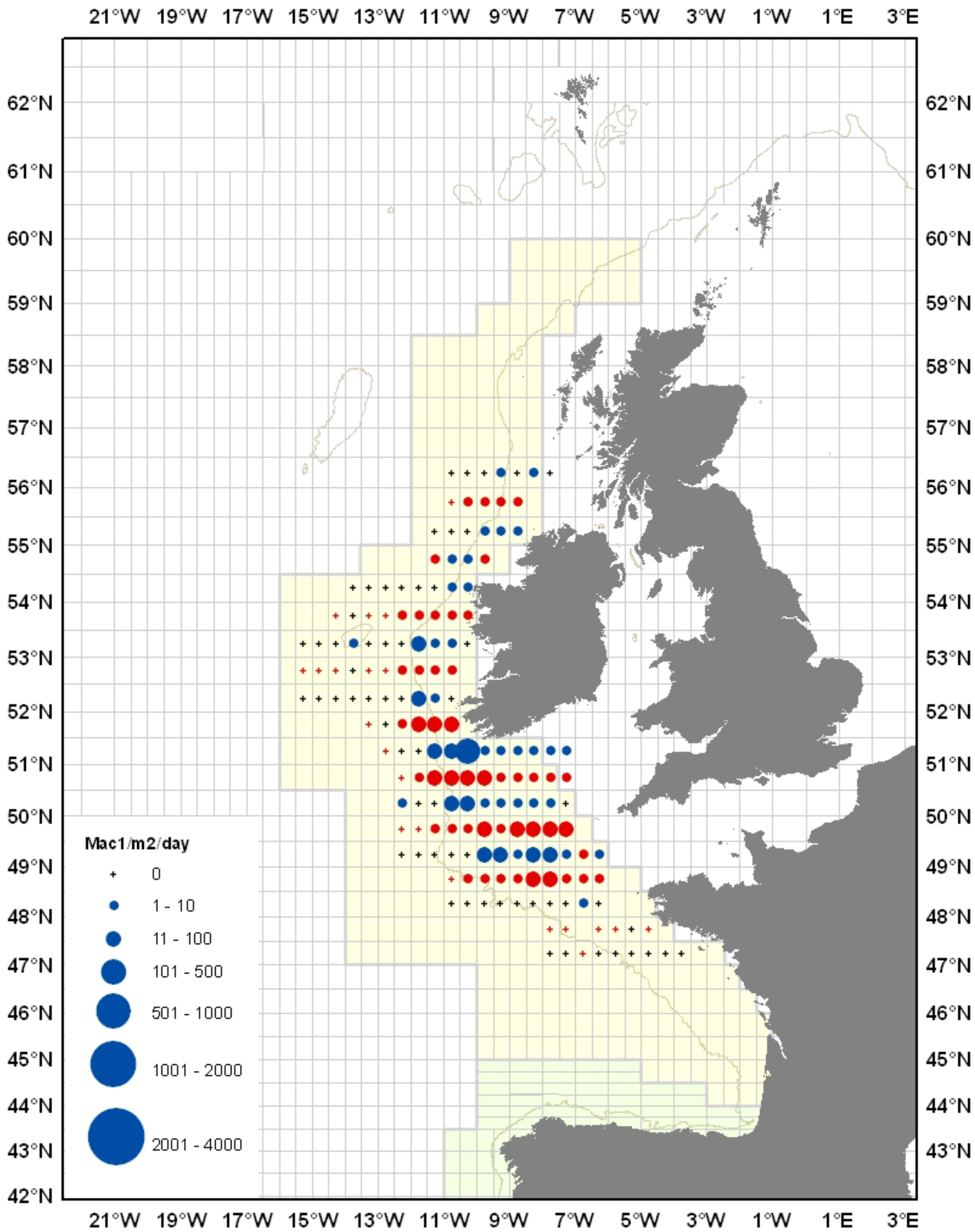

Figure 2.6.1.6: Mackerel egg production by half rectangle for period 6 (5th July – 31st July). Filled blue circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

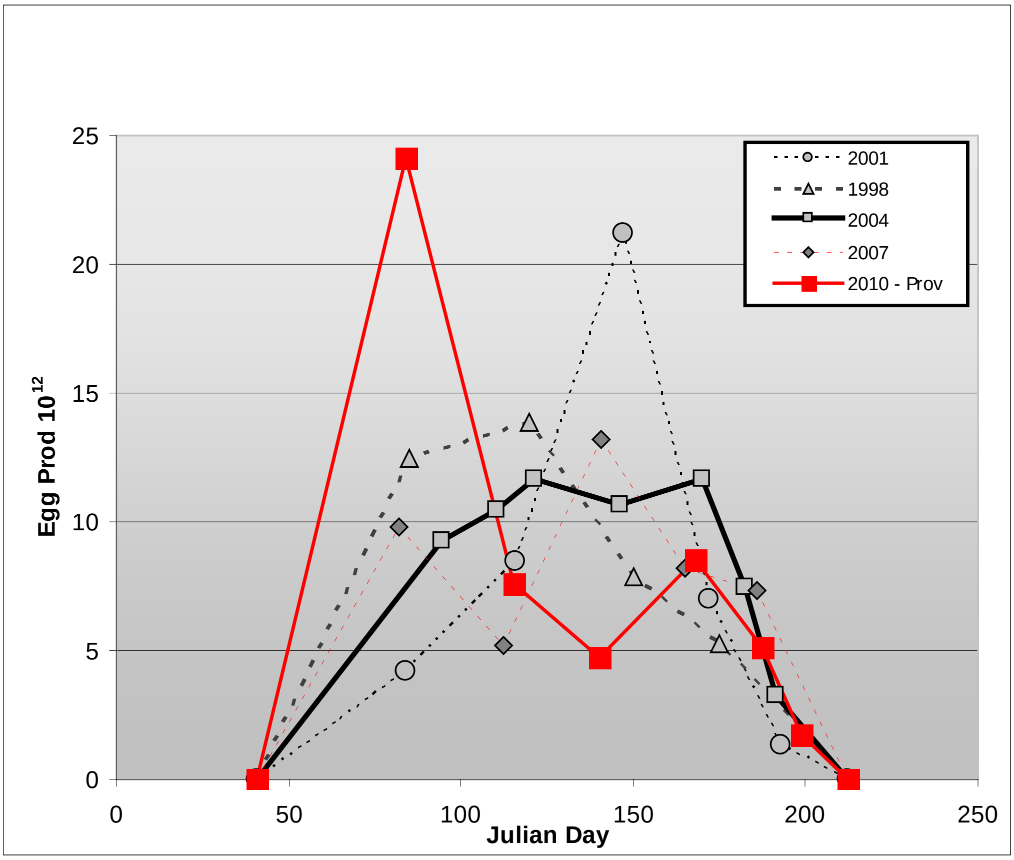

Figure 2.6.1.7: Provisional annual egg production curve for mackerel in the western spawning component. The curve for 1998, 2001, 2004 and 2007 are included for comparison.

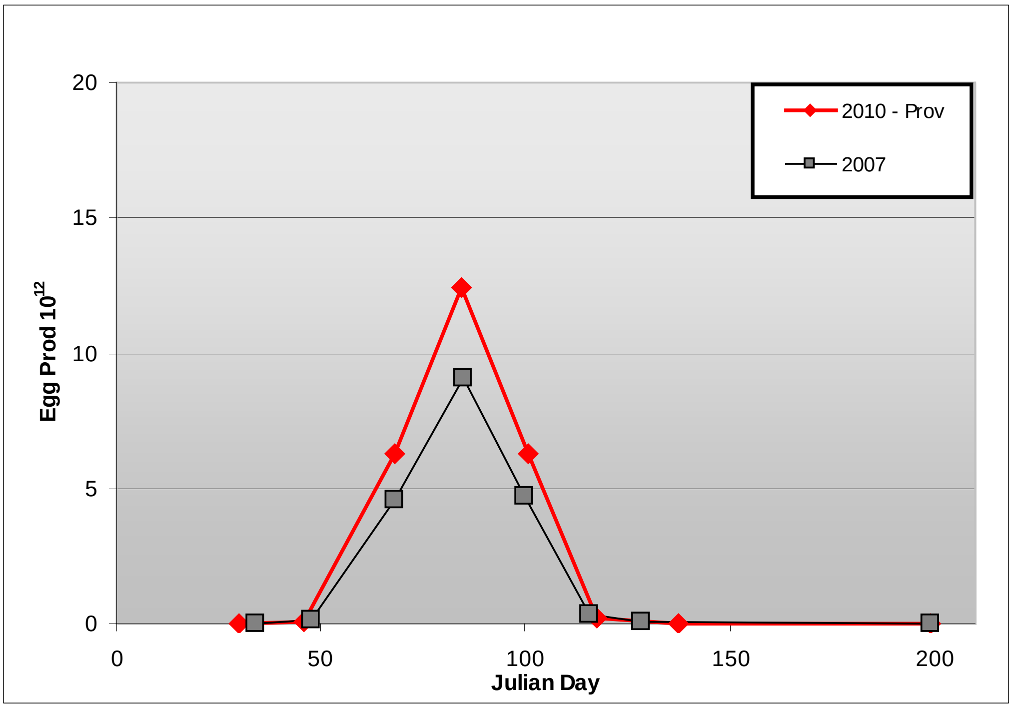

Figure 2.6.1.8: Provisional annual egg production curve for mackerel in the southern spawning component for 2010. The curve for 2007 is included for comparison.

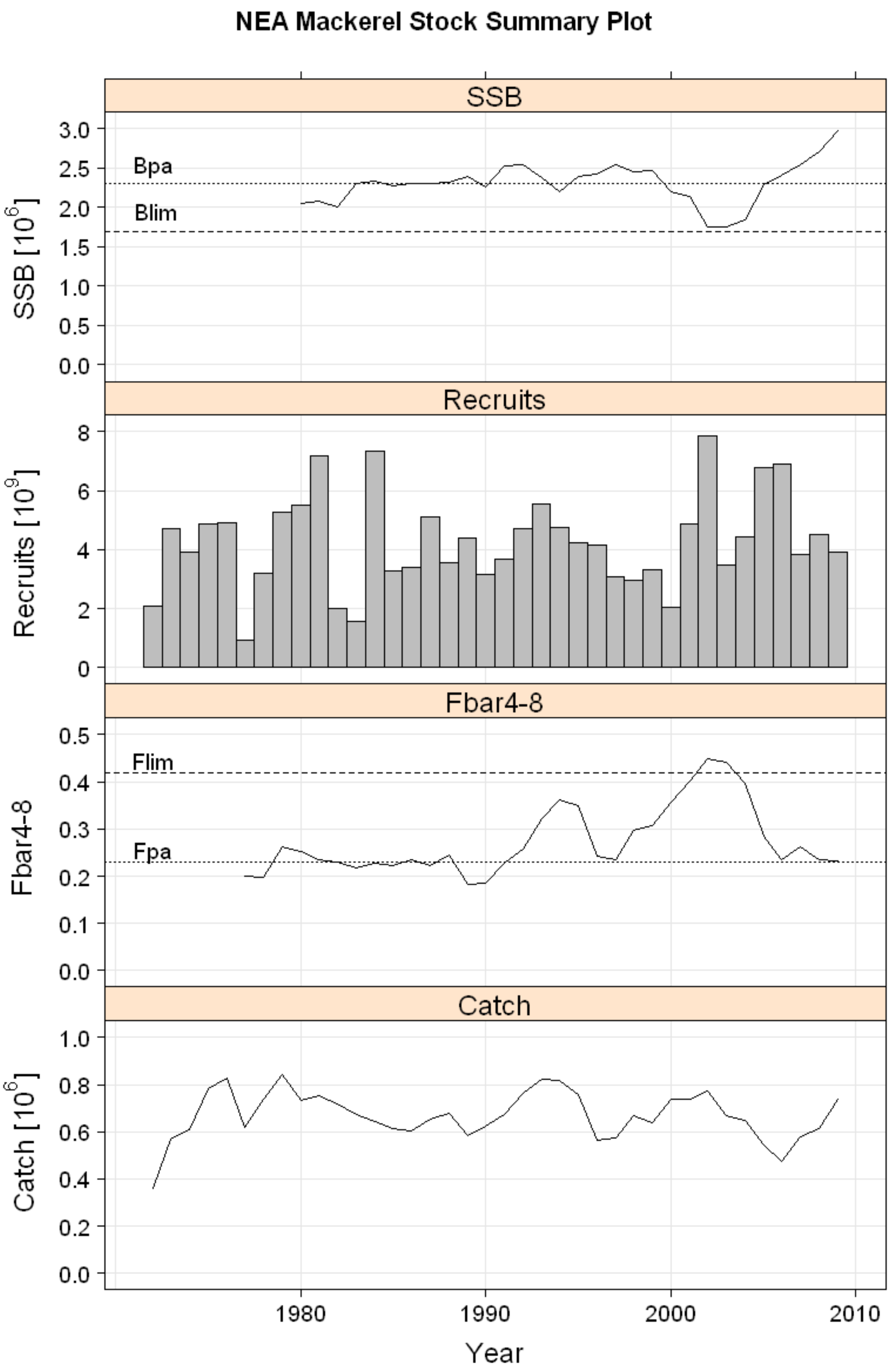

Figure 2.7.1 NE Atlantic Mackerel stock summary (spawning stock biomass, 1980 to 2009, recruitment from 1972-2009, catches from 1972 to 2009 and Fbar4-8 from 1977 to 2009.

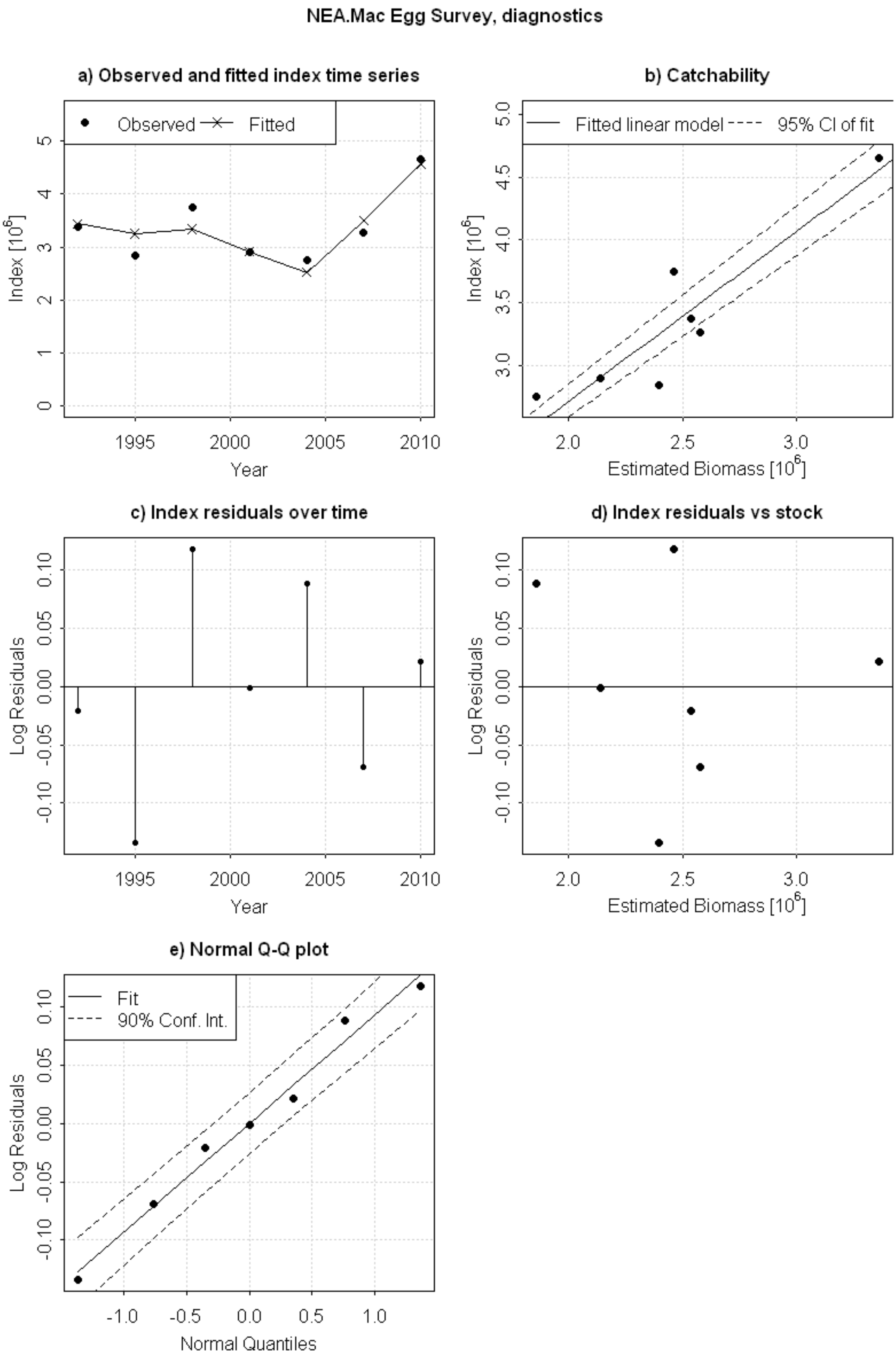

Figure 2.7.2. NE Atlantic mackerel final assessment FLICA diagnostics for fit to mackerel egg survey.

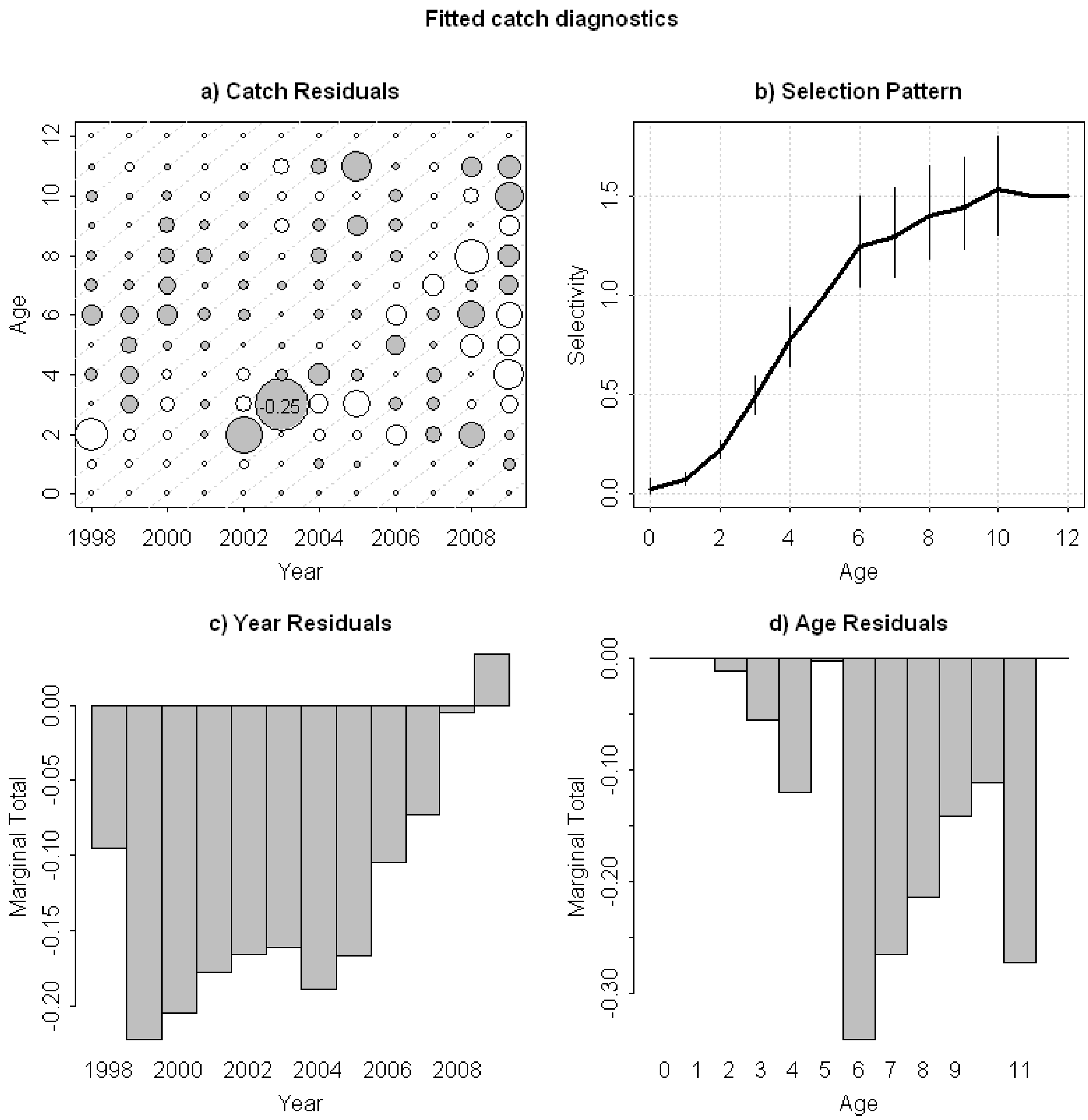

Figure 2.7.3. NE Atlantic mackerel final assessment FLICA diagnostics for fit of catch to the separable period, a) weighted log residuals by year (age, 0 and 1 down weighted). b) fitted selection pattern, sum of the residuals c) by year, d) by age.

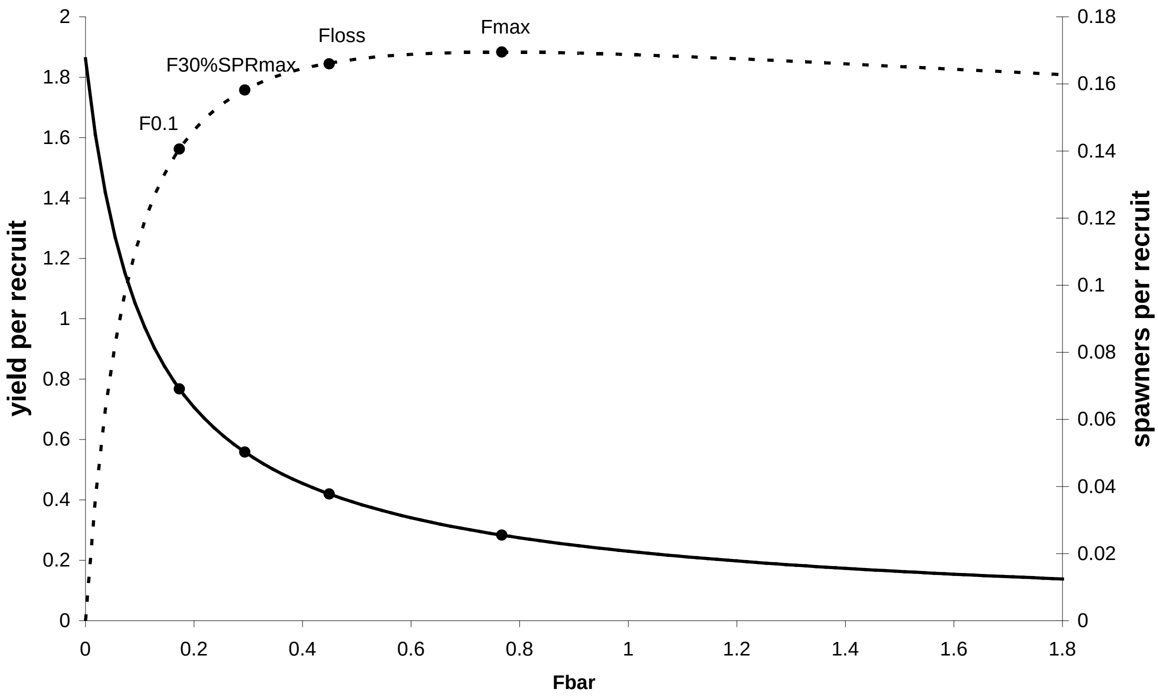

Figure 2.7.4. NEA mackerel. Spawner biomass per recruit and yield per recruit analysis

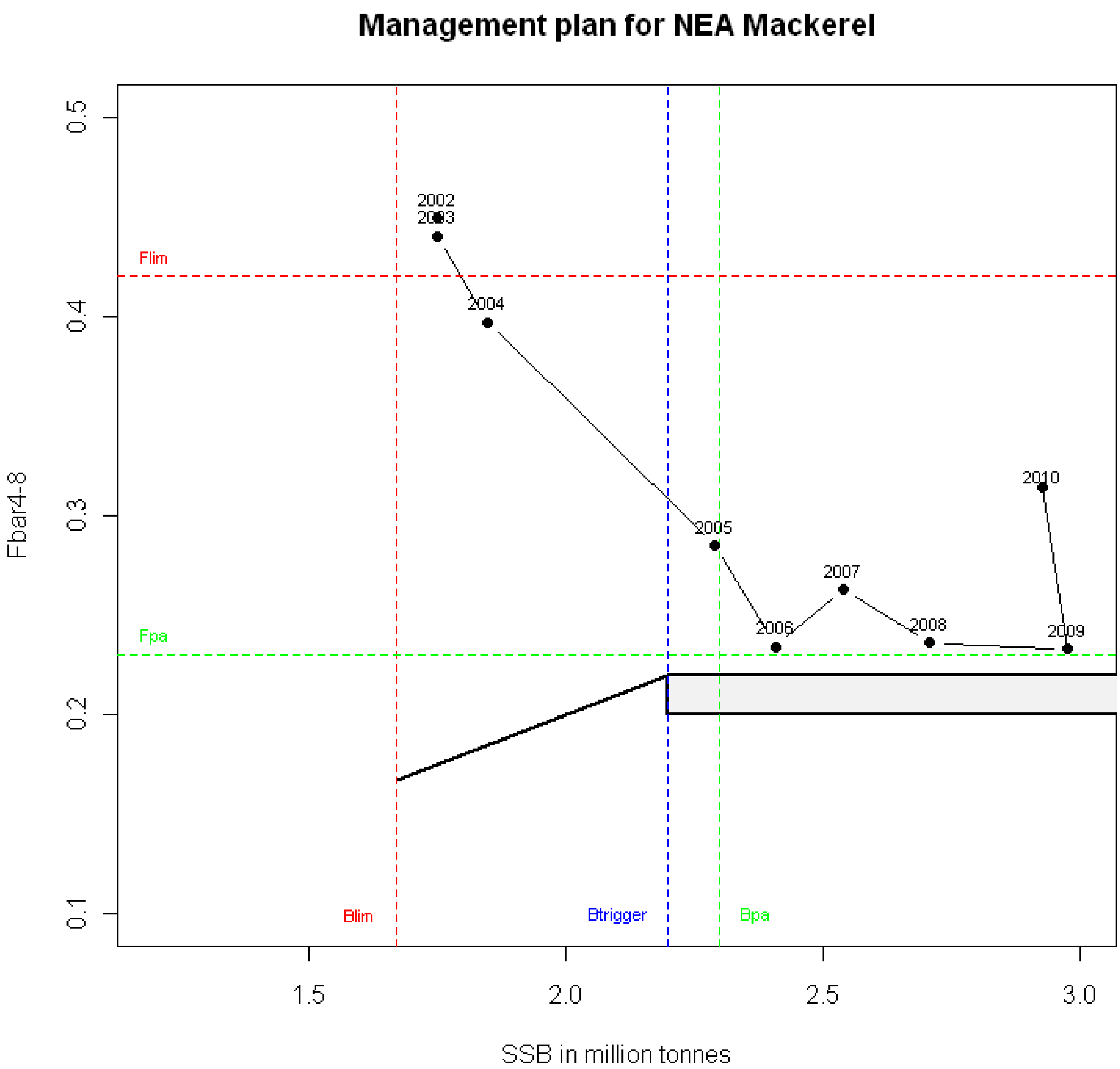

Figure 2.7.5. Recent history of the stock in relation to the management plan. Black dots represent the estimated fishing mortality (Fbar4-8) in relation to the estimated SSB for the years 2001 to 2009. The 2010 point is estimated from the short term forecast (see section 2.9). The grey area represents 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>$B_{trigger}$.

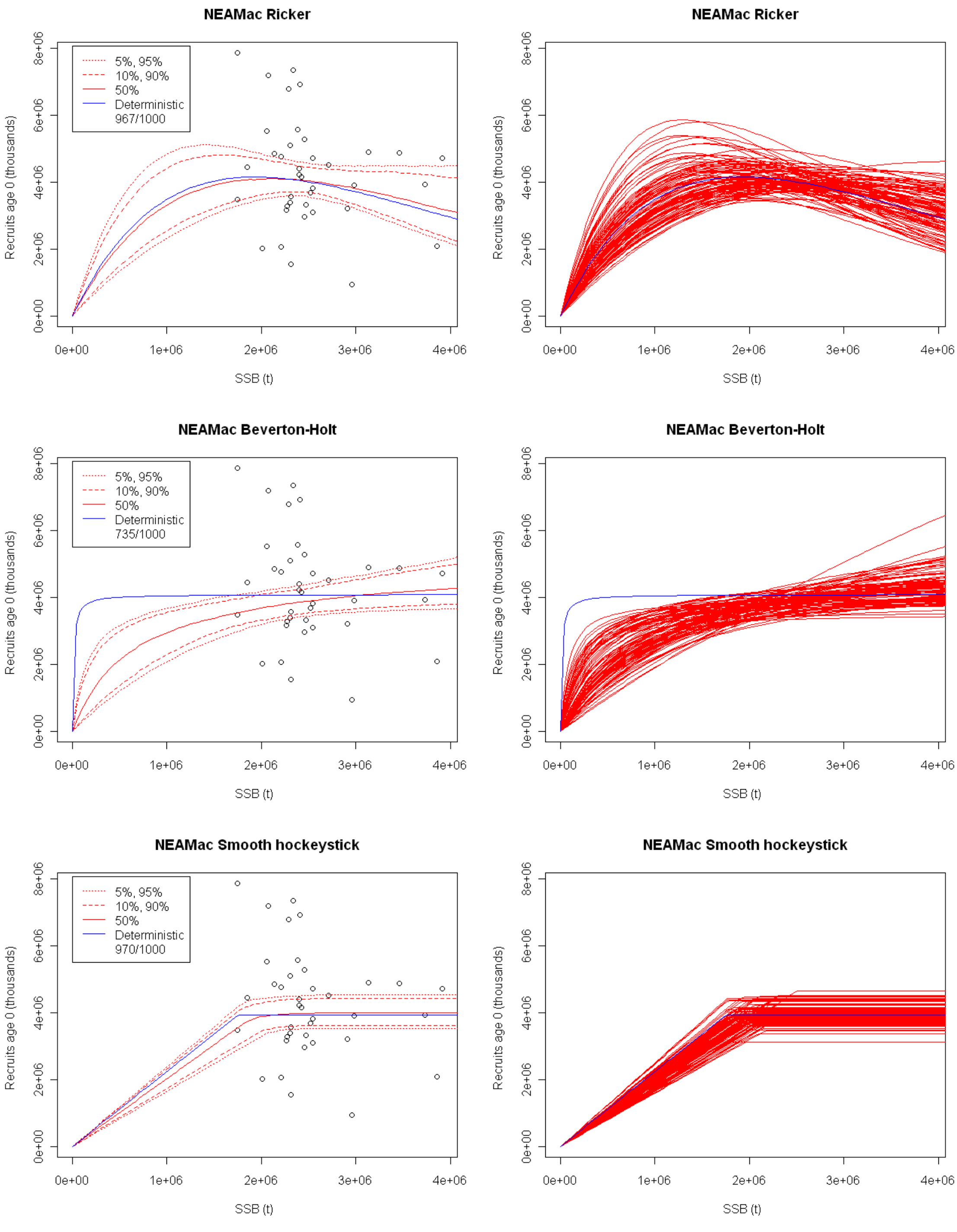

Figure 2.8.1.1. Fit of 3 stock recruitment models (Ricker, Beverton and Holt and smooth hockey stick)for NEA mackerel. The panels on the left show the deterministic fit of the models and the spread of curves estimated the MCMC. The panels on the right show the first 100 MCMC estimates for each model.

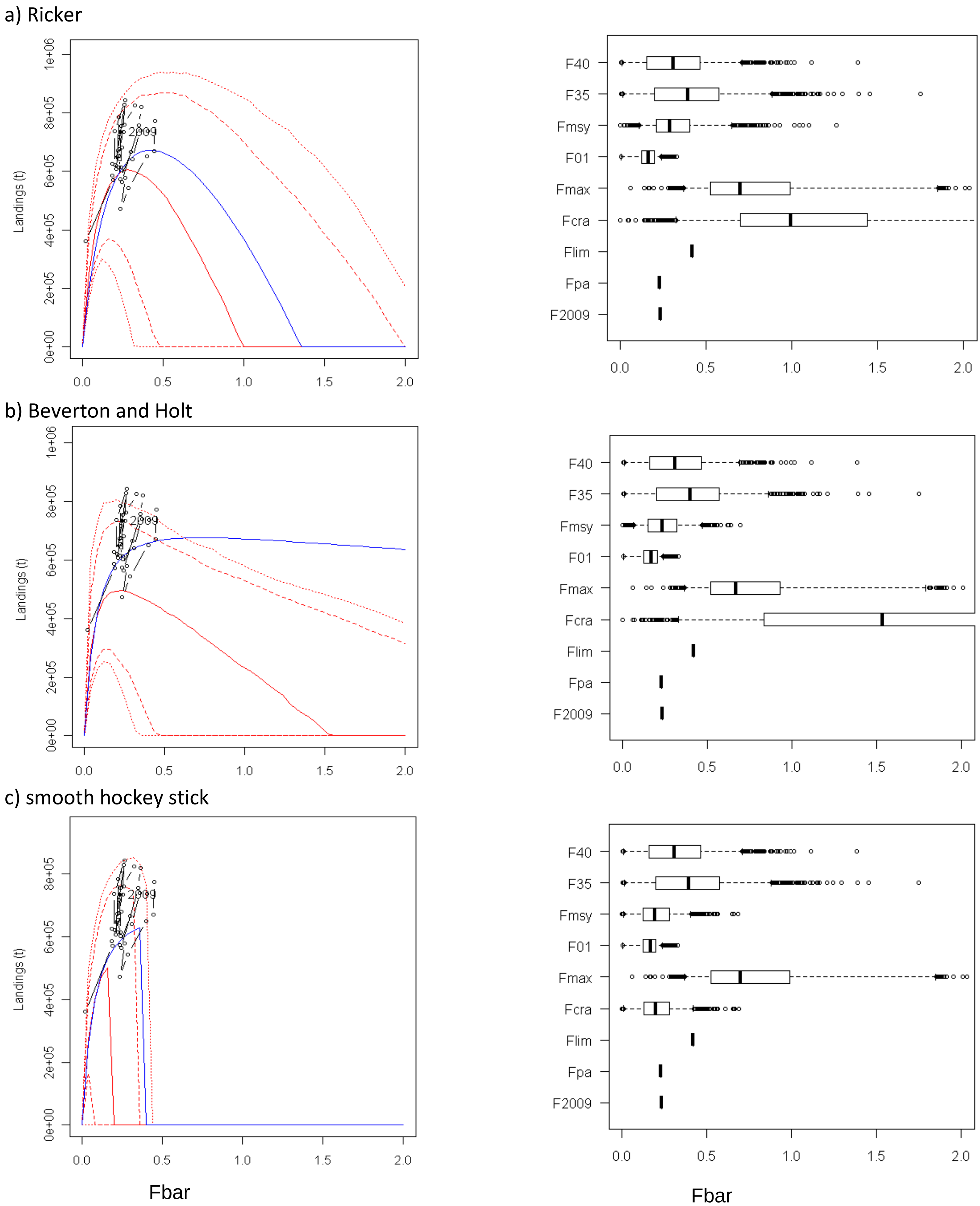

Figure 2.8.1.2. Relationship between the yield and F_{bar} for the 3 stock recruitment model (left panels, deterministic value in blue, distribution of the curves estimated by MCMC estimation in red). The distribution of the F reference values estimated by MCMC is shown by the box plots on the right.

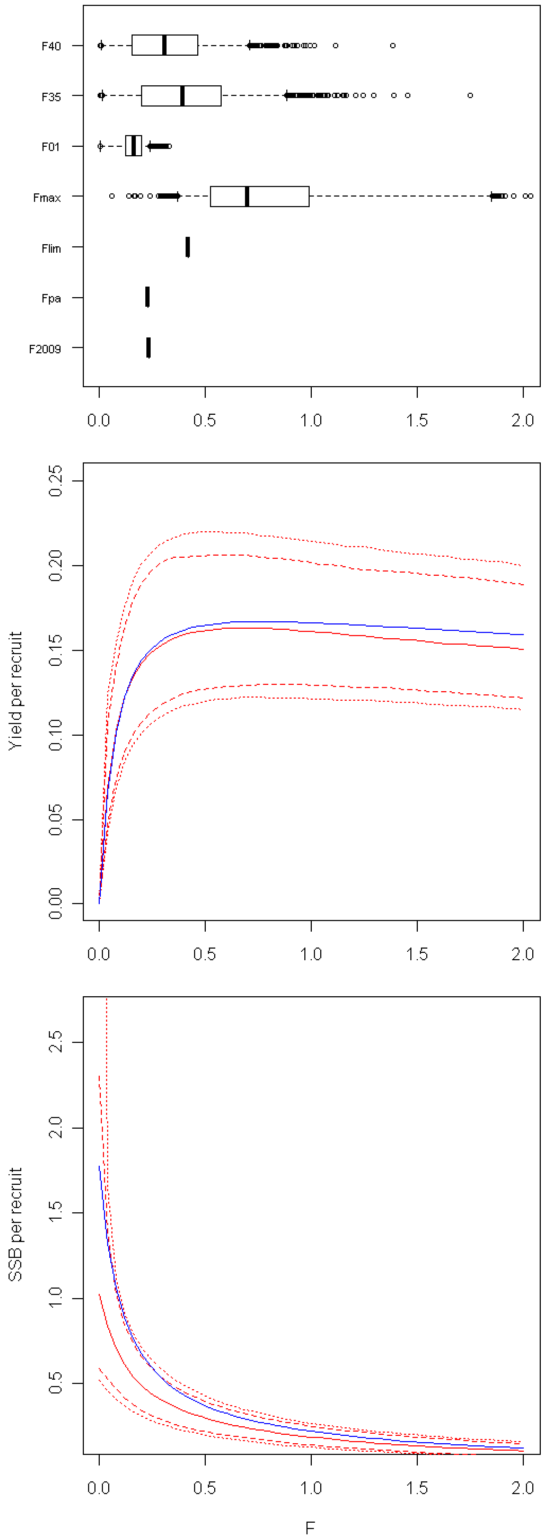

Figure 2.8.1.3. Yield and SSB per recruit as a function of fishing mortality (deterministic and MCMC results) and distribution of the F reference values among the MCMC trials.

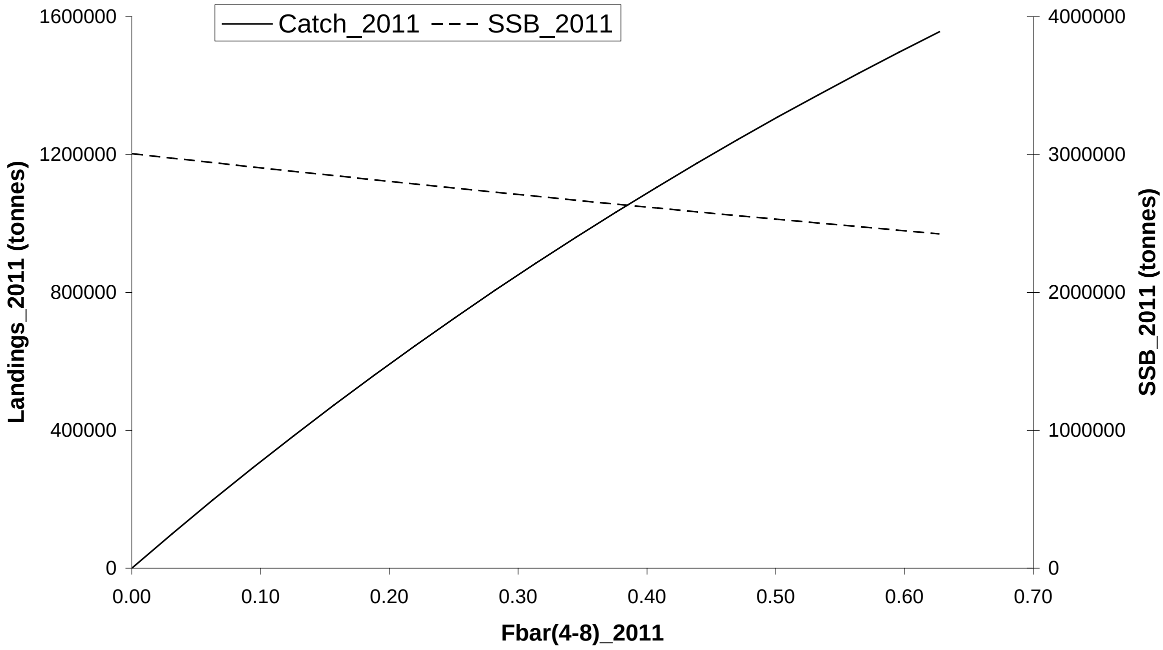

Figure 2.8.2. NEA mackerel short term forecast.

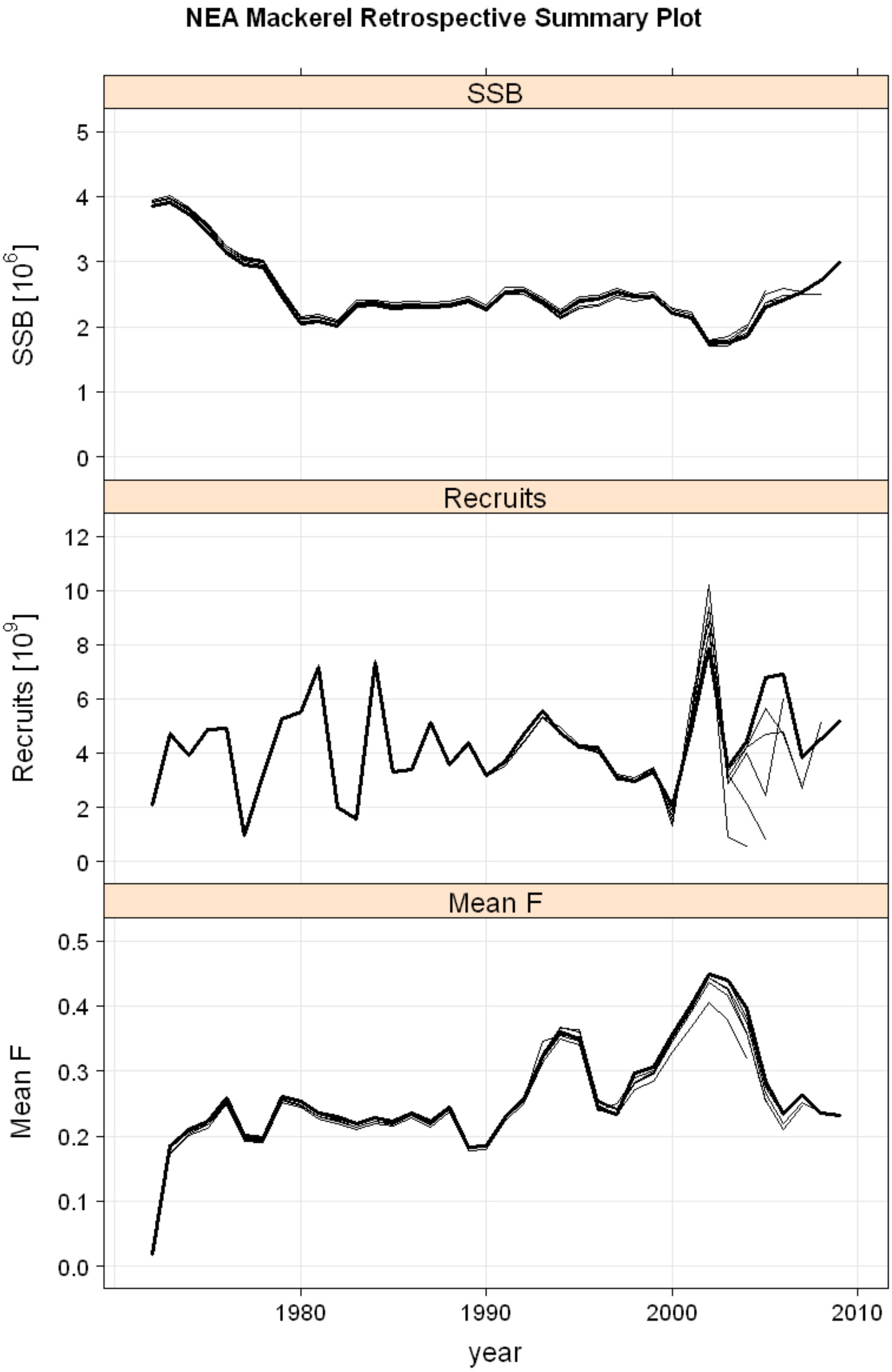

Figure 2.9.1 NE Atlantic mackerel final ICA assessment analytical retrospective of Spawning Stock Biomass (SSB), recruitment age 0 and mean F ages 4 – 8.

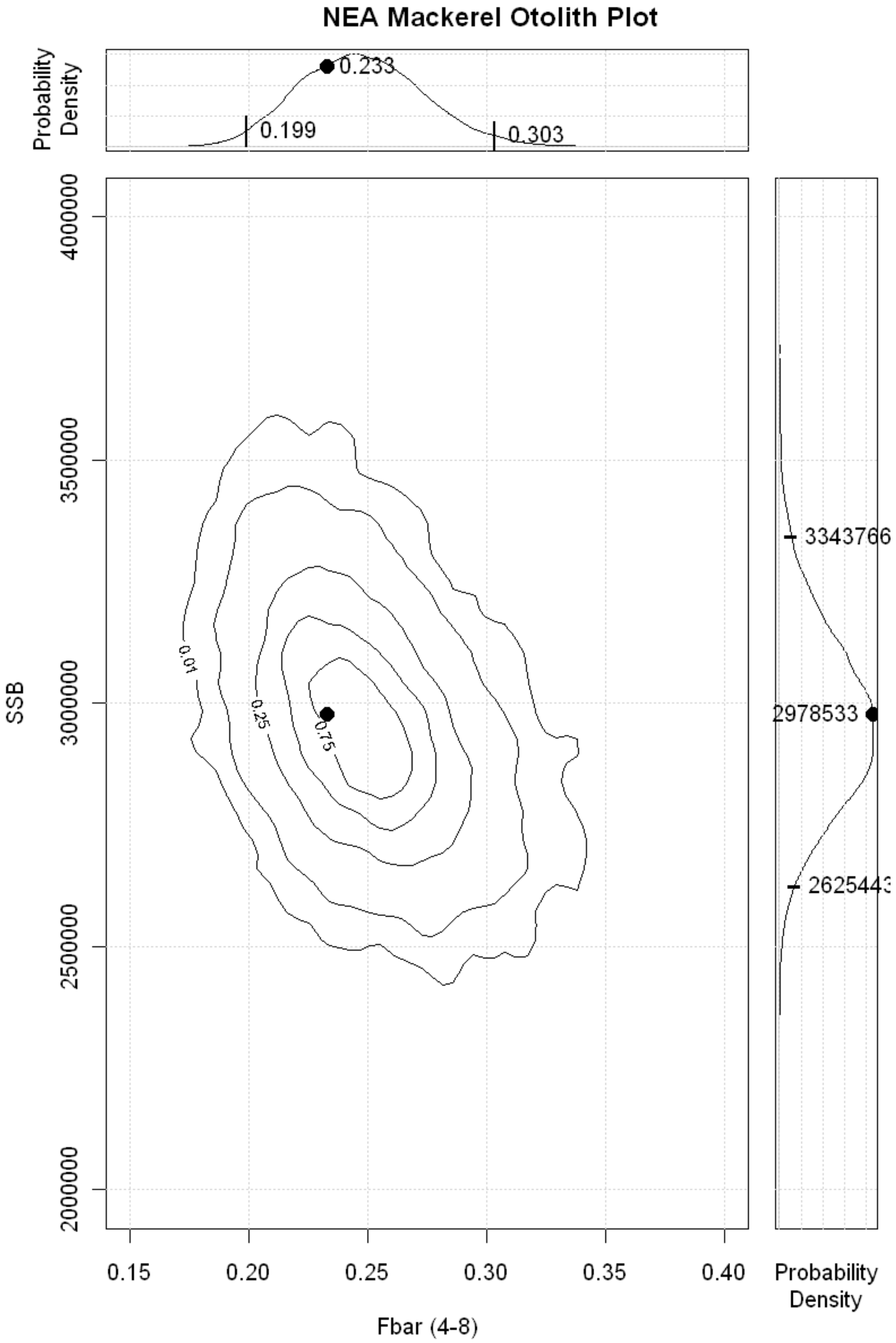

Figure 2.9.2. NE Atlantic mackerel, precision of ICA estimates of SSB and Fbar4–8 in 2009 from bootstrap of parameter residuals in FLICA. Showing percentile contours from 10000 realisations and the point estimates.

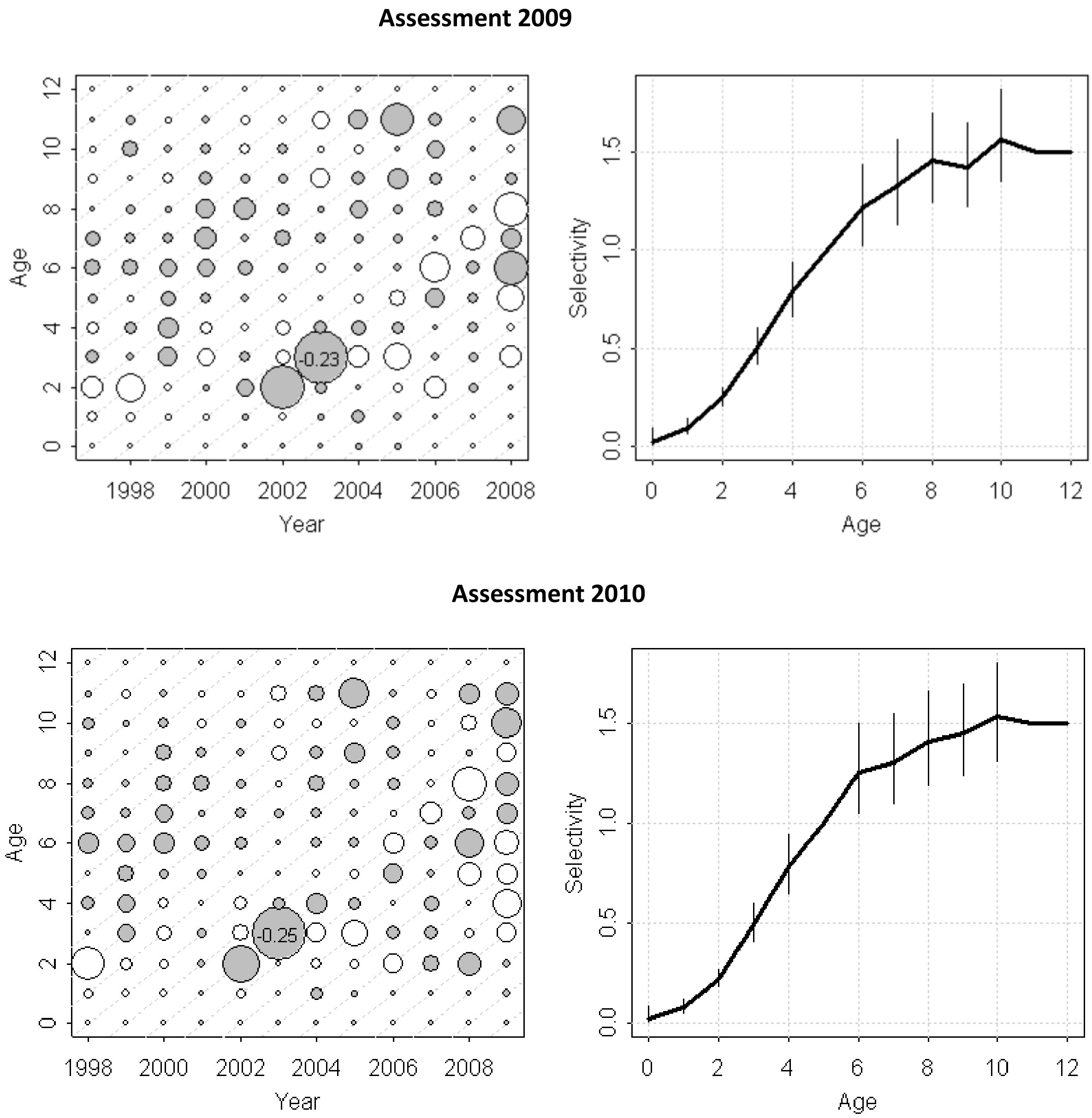

Figure 2.10.1. Comparison of the model fit to the catch data for the separable period between 2009 and 2010 assessments (left panels : log residuals; right panels : selection pattern).

3 Horse Mackerel

3.1 Fisheries in 2009

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 2009 was 247,637 tons which is 50,000 tons more than in 2008 and the highest since 2001. Ireland, Denmark, Scotland, France (no catches reported for 2009), 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 2009 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, Germany, Ireland, Netherlands, Norway, Scotland, Portugal and Spain representing 99 % 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 and central part of the North Sea. The Spanish and Portuguese fleets operated mainly in their respective waters. Lithuania reported catches of horse mackerel for the three years 2006-2008, but no catches were reported for 2009.

First quarter: 49,700 tons, which is the same as in 2007 and 2008. The fishery was mainly carried out west of Scotland, west and south of Ireland, in the Channel, along the Spanish and Portuguese coasts (Figure 3.1.1.a).

Second quarter: 25,800 tons. This is 6,000 tons more than in 2008. 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, in the northern part of the Bay of Biscay, along the Spanish and Portuguese coasts. A few small catches were taken in the south eastern part of the North Sea (Figure 3.1.1.b).

Third quarter: 22,900 tons. This is 8,000 tons less than in 2008. Most of the catches were taken in Portuguese and Spanish waters and south of Ireland. As usual also some small catches were reported from the northern part of the North Sea (Figure 3.1.1.c).

Fourth quarter: This is the main fishing season with a catch of 149,200 tons which is 48,000 tons more than in 2008. The catches were distributed in four main areas (Figure 3.1.1.d):

- Portuguese and Spanish waters,
- Irish waters
- Channel
- northern-central part of the North Sea
- close to the Norwegian coast in Division IIa

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 2009 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 and IVa. 1-4 quarter: IVb,c and VIId.

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 and Figure 3.3.1. The catches by stock and countries for the period 1997-2009 are given in Table 3.3.2-3.3.4 (Iversen, 2010).

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. 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

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 was 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/or *T. picturatus*. *T. mediterraneus* is mainly landed in Spanish ports of the Cantabrian Sea. *T. picturatus* fishery takes place in the southern part of sub- Division IXa and in Subarea X. Landings of *T. mediterraneus* show substantial variability, ranging from about 500t to 7,000 tones. Since 2004 there has been a decrease in landings although in last year there has been a significant increase in landings. Landings of *T. picturatus* show an important decrease in the last years (Table 3.5.1).

Taking into account that the assessment is only made for *T. trachurus*, the Working Group recommends that the TACs and any other management regulations which might be established in the future should be related only to *T. trachurus* and not to *Trachurus spp*. More information is needed about the *Trachurus spp*. before the fishery and the stock can be evaluated.

3.6 Length Distribution by Fleet and by Country:

Ireland, Germany, Netherlands, Norway, Portugal and Spain provided length distribution for their catches in 2009. These length distributions covered 87 % of the total landings and are shown in Table 3.6.1.

References:

Iversen, S.,A. 2010 National catches of the Western, Southern and North Sea Horse Mackerel Stocks 1997-2008. WD for WGWIDE 2010

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	2009[1]
II + Vb	176	30	366	572	1,847
IV + IIIa	40,564	38,911	16,407	15,377	78,591
VI	22,055	15,751	26,279	25,902	17,776
VII	107,475	101,912	93,132	98,746	89,563
VIII	41,495	34,122	28,387	33,892	33,355
IX	23,111	24,557	23,423	23,596	26,496
Total	234,876	215,283	187,994	198,085	247,628

[1]Preliminary.

Table 3.1.2 HORSE MACKEREL general. Quarterly catches (1000 t) by Division and Sub-division in 2009.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	+	-	+	1.8	1.8
III	+	+	+	+	+
IVa	0.1	+	0.3	58.5	58.8
IVbc	1.3	+	0.1	17.9	19.7
VIId	5.0	+	-	19.3	24.4
VIa,b	7.4	+	1.6	8.8	17.8
VIIa–c,e–k	23.5	3.7	4.7	33.3	65.2
VIIIa,b,d,e	5.1	7.3	+	o.1	12.5
VIIIc	2.0	6.0	8.6	4.3	20.9
IXa	5.3	8.6	7.3	5.2	26.5
Sum	49.7	25.8	22.9	149.2	247.6

+ 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
2009	38	72	18,711	1,036	24,366	44,223	1,847	-	58,738	17,775	65,122	12,452	20,903	81	176,918	26,496	247,637

[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 National catches of the Western Horse mackerel stock.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	18	-	-	-	19	-	-	+	+
Denmark	62,897	29,542	22,663	13,084	6,108	10,152	11739	11,480	1,021
Estonia	78	22	-	-	-	-	-	-	-
Faroe Islands	1,095	216	905	824	-	699	59	3,847	3,695
France	39,188	24,267	25,141	20,457	15,145	18,951	10,383	8,060	10,690
Germany, Fed.Rep.	28,533	27,872	17,629	13,348	11,493	12,614	15,826	17,830	16,734
Ireland	74,250	70,811	57,956	55,300	51,874	36,483	35,855	26,431	35,361
Lithuania	-	-	-	-	-	-	-	-	-
Netherlands	82,885	92,535	75,333	57,971	73,439	42,019	47,327	40987	43,445
Norway	45,058	13,363	46,410	2,087	7,956	36,689	20,315	-	25,113
Russia	554	345	121	80	16	3	-	5	-
Spain	31,087	14,882	25,123	22,669	23,053	23,214	24,588	16,272	16,636
Sweden	1,761	10	1,952	1,101	68	575	1,074	568	148
UK (Engl. + Wales)	19,778	12,162	9,257	1,555	7,096	5,971	4,440	4,617	3,560
UK (Northen Ireland)	-	1,158	-	-	-	-	-	-	426
UK (Scotland)	32,865	18,283	11,197	7,230	8,029	2,907	672	1,523	142
Unallocated	48,732	20,145	4,389	823	7,794	3,710	17,905	25,306	24,263
Discard	2,921	830	-	382	-	305	-	701	760
Total	471,700	326,443	298,076	196,911	212,090	194,292	190,183	157,627	181,994

Country	2006	2007	2008	2009[1]
Belgium	-	-	-	-
Denmark	8,353	7,617	5,261	6,009
Estonia	-	-	-	-
Faroe Islands	1,205	478	841	-
France	11,034	12,748	12,626	-
Germany, Fed.Rep.	10,863	5,784	11,708	15,121
Ireland	26,779	30,091	35,612	40,754
Lithuania	6,829	5,467	5,548	-
Netherlands	37,130	29,083	43,648	39,451
Norway	27,114	4,182	1,223	59,764
Russia	-	-	-	-
Spain	13,878	14,257	19,851	21,077

Sweden	-	76	9	258
UK (Engl. + Wales)	3,583	5,482	-	-
UK (Northen Ireland)	224	-	-	-
UK (Scotland)	469	778	1,077	1,413
Unallocated	7,534	7,263	2,294	-7,010
Discard	99	102	43	81
Total	155,094	123,408	139,741	178,918

[1]Preliminary

Table 3.3.3. National catches of the North Sea Horse mackerel stock.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	-	19	21	19	19	30	5	4	6
Denmark	180	1,481	3,377	7,855	17,316	2,310	2,902	8,738	3,987
Faroe Islands	-	-	135	-	-	-	-	-	-
France	3,246	2,399	-	-	1,696	1,246	2,326	2,530	5,236
Germany, Fed.Rep.	7,847	5,844	5,920	3,728	968	3,267	2,936	4,912	2,248
Ireland	-	2,861	27	130	338	-	-	1	-
Lithuania	-	10,711	-	-	-	-	-	-	-
Netherlands	36,855	-	8,117	7,987	13,867	15,187	24,118	26,302	25,579
Norway	-	-	238	-	36	-	-	-	-
Sweden	-	3,401	5	40	46	14	-	97	91
UK (Engl. + Wales)	269	907	11	1,585	3,333	2,323	1,965	1,552	3,859
UK (Scotland)	29	-	-	421	-	-	-	-	-
Unallocated	-28,896	2,794	19,373	26,660	8,737	-1,018	-2,174	-8,982	-11,358
Discard	10	83	-	-	-	20	-	-	62
Total	19,540	30,500	37,224	48,425	46,356	23,379	32,078	35,154	29,711

Country	2006	2007	2008	2009[1]
Belgium	4	6	3	5
Denmark	1,341	255	57	89
Faroe Islands	-	-	-	-
France	4,380	5,349	2,246	-
Germany, Fed.Rep.	1,691	87	1,176	1,299
Ireland	2,077	1	897	-
Lithuania	2,377	296	-	-
Netherlands	27,284	31,154	19,439	22,546
Norway	113	1,243	21	12,855
Sweden	491	53	35	402
UK (Engl. + Wales)	596	-	-	-
UK (Scotland)	300	625	6	4
Unallocated	-5,106	1,956	10,869	5,988
Discard	78	139	-	1,036
Total	35,626	41,164	34,749	44,223

[1]Preliminary

Table 3.3.4. National catches of the Southern Horse Mackerel Stock.

Country	1997	1998	1999	2000	2001	2002	2003	2004	2005
Portugal	16,376	21,334	14,420	15,348	13,760	14,270	11,242	11,875	13,307
Spain	10,906	20,230	13,313	11,812	11,152	9,393	8,324	11,702	9,804
Total	27,642	41,564	27,733	27,160	24,912	23,663	19,566	23,577	23,111

Country	2006	2007	2008	2009[1]
Portugal	14,607	10,381	9,280	10,851
Spain	9,951	13,043	14,303	15,645
Total	24,558	23,424	23,593	26,496

[1]Preliminary

Table 3.5.1 Catches (t) of Trachurus mediterraneus in Divisions VIIIab, VIIIc and IXa and Sub-area VII in the period 1989-2009 and Trachurus picturatus

T. mediterraneus							T. picturatus			
	VII	VIIIab	VIII East	VIII West	Total	TOTAL	IXa	X (Azorean Area	34.1.1 (Madeira's area)	TOTAL
1986	-	-	-	-	-	-	367	3331	2006	5704
1987	-	-	-	-	-	-	181	3020	1533	4734
1988	-	-	-	-	-	-	2370	3079	1687	7136
1989	0	23	3903	0	3903	3926	2394	2866	1564	6824
1990	0	298	2943	0	2943	3241	2012	2510	1863	6385
1991	0	2122	5020	0	5020	7142	1700	1274	1161	4135
1992	0	1123	4804	0	4804	5927	1035	1255	792	3082
1993	0	649	5576	0	5576	6225	1028	1732	530	3290
1994	0	1573	3344	0	3344	4917	1045	1778	297	3120
1995	0	2271	4585	0	4585	6856	728	1822	206	2756
1996	0	1175	3443	0	3443	4618	1009	1715	393	3117
1997	0	557	3264	0	3264	3821	834	1920	762	3516
1998	0	740	3755	0	3755	4495	526	1473	657	2657
1999	0	1100	1592	0	1592	2692	320	690	344	1354
2000	59	988	808	0	808	1854	464	563	646	1672
2001	1	525	1293	0	1293	1820	420	1089	385	1894
2002	1	525	1198	0	1198	1724	663	5000	358	6021
2003	0	340	1699	0	1699	2039	773	1509	572	2854
2004	0	53	841	0	841	894	508	1244	653	2405
2005	1	155	1005	0	1005	1162				0
2006	1	168	794	0	794	963				0
2007	0	126	326	0	326	452				0
2008	0	82	405	0	405	487				0
2009	0	42	1082	0	1082	1124				

(-) Not available

Table 3.6.1 Horse mackerel general. Length distributions (%) catches by fleet and country in 2009. (0.0= <0.05%)

	Neth	Ireland	Norway	Germany	Spain			Portugal
	Pel.trawl	Pel. Trawl	P.seine	Trawl	P.seine	Dem.trawl	Artisanal	All
cm	All	All	IVa	VIa,VIIbcj	All	All	All	IXa
5								
6								
7								
8								
9					0.0			0.0
10					0.6			0.2
11					2.6			0.6
12					5.1			4.0
13					4.2			8.5
14					18.4	0.0		9.5
15					21.1	0.2		9.9
16	0.1				5.3	0.7		7.5
17	0.5				3.5	0.9		8.6
18	1.2				4.5	0.4		11.2
19	3.4				5.6	0.3		6.1
20	8.3				3.0	0.2	1.0	2.4
21	4.0				2.4	0.4	0.3	1.6
22	5.5				2.0	0.9	0.9	2.1
23	7.9				1.3	2.5	2.8	3.3
24	7.8	0.0		0.1	1.1	2.2	1.6	4.2
25	8.7	0.3		0.6	1.2	1.2	2.7	3.4
26	9.0	3.3	0.0	4.9	1.6	1.2	2.8	2.0
27	12.1	11.4	0.0	16.9	2.7	1.5	3.0	1.9
28	10.6	22.1	0.2	26.9	3.8	2.3	4.3	1.4
29	8.8	22.7	0.8	23.3	3.5	2.6	5.9	1.1
30	5.3	15.1	3.1	11.2	2.8	3.9	8.0	1.2
31	2.8	9.2	5.3	7.5	1.4	4.0	6.8	1.8
32	1.6	5.2	8.7	5.1	0.8	6.5	7.7	1.0
33	1.0	3.2	12.7	1.3	0.5	5.7	7.0	1.3
34	0.4	2.3	14.6	1.5	0.3	6.7	7.3	0.8
35	0.4	1.5	18.0		0.2	9.0	7.3	0.5
36	0.3	1.2	14.9		0.1	9.5	8.8	0.5
37	0.2	1.0	10.3		0.1	10.2	6.1	0.7
38	0.0	0.6	5.3		0.1	7.8	4.2	0.8
39	0.0	0.5	3.4		0.1	7.5	4.5	0.6
40	0.0	0.2	1.9		0.1	5.0	3.6	0.7
41	0.0	0.1	0.5		0.0	3.1	1.4	0.6
42+	0.0	0.0	0.2		0.0	3.4	2.0	0.4

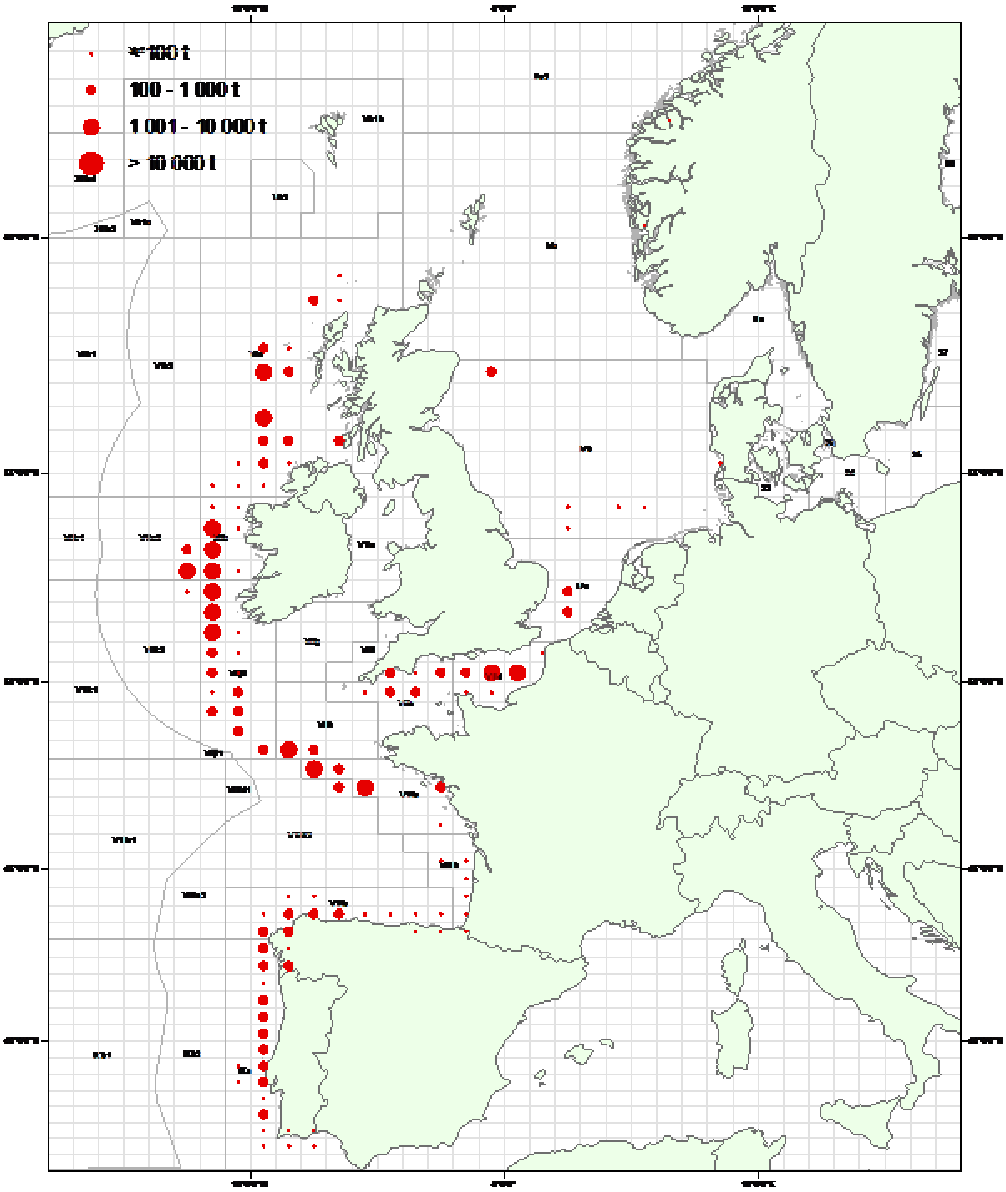

Figure 3.1.1a Horse mackerel catches 1 quarter 2009

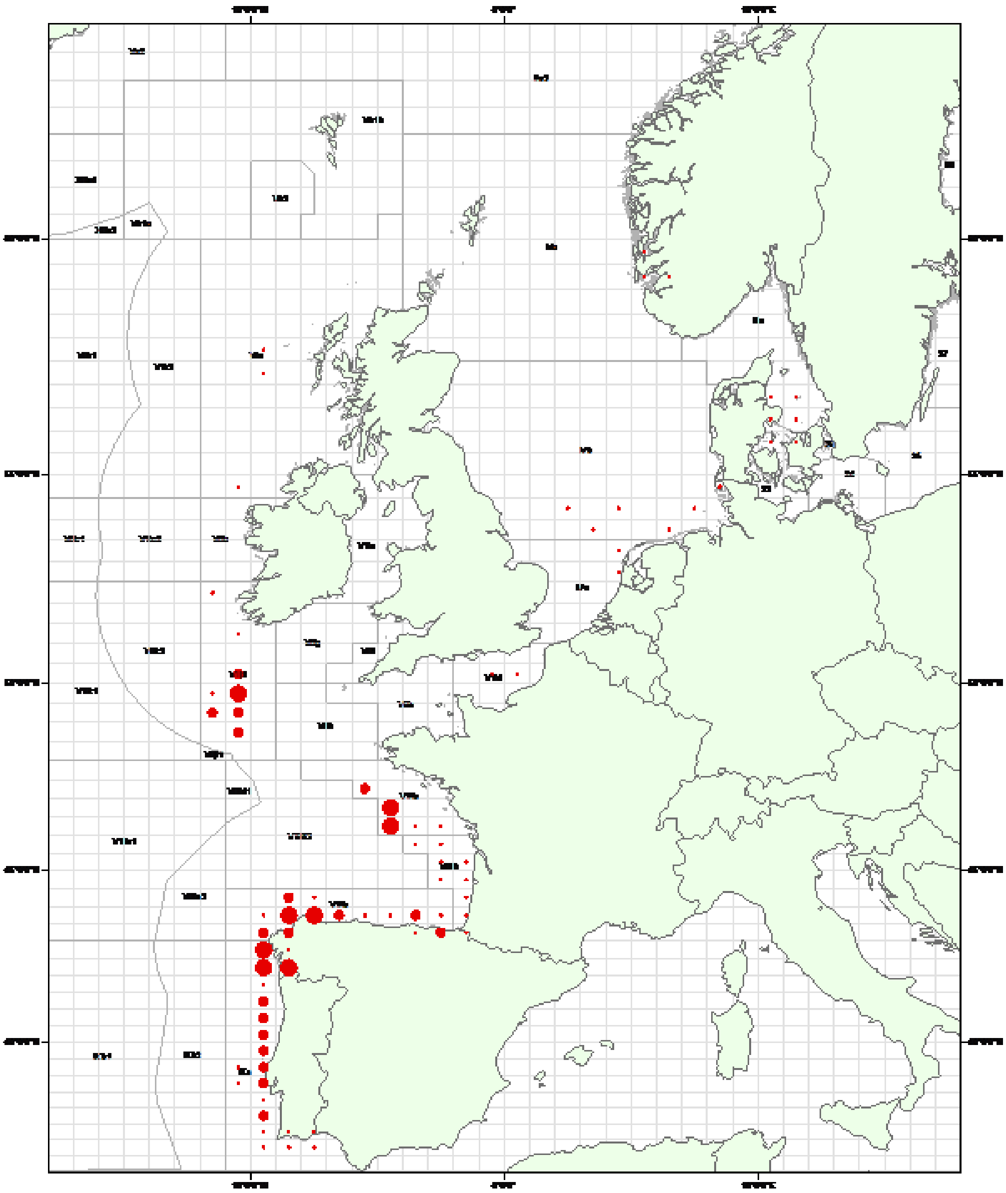

Figure 3.1.1b Horse mackerel catches 2 quarter 2009

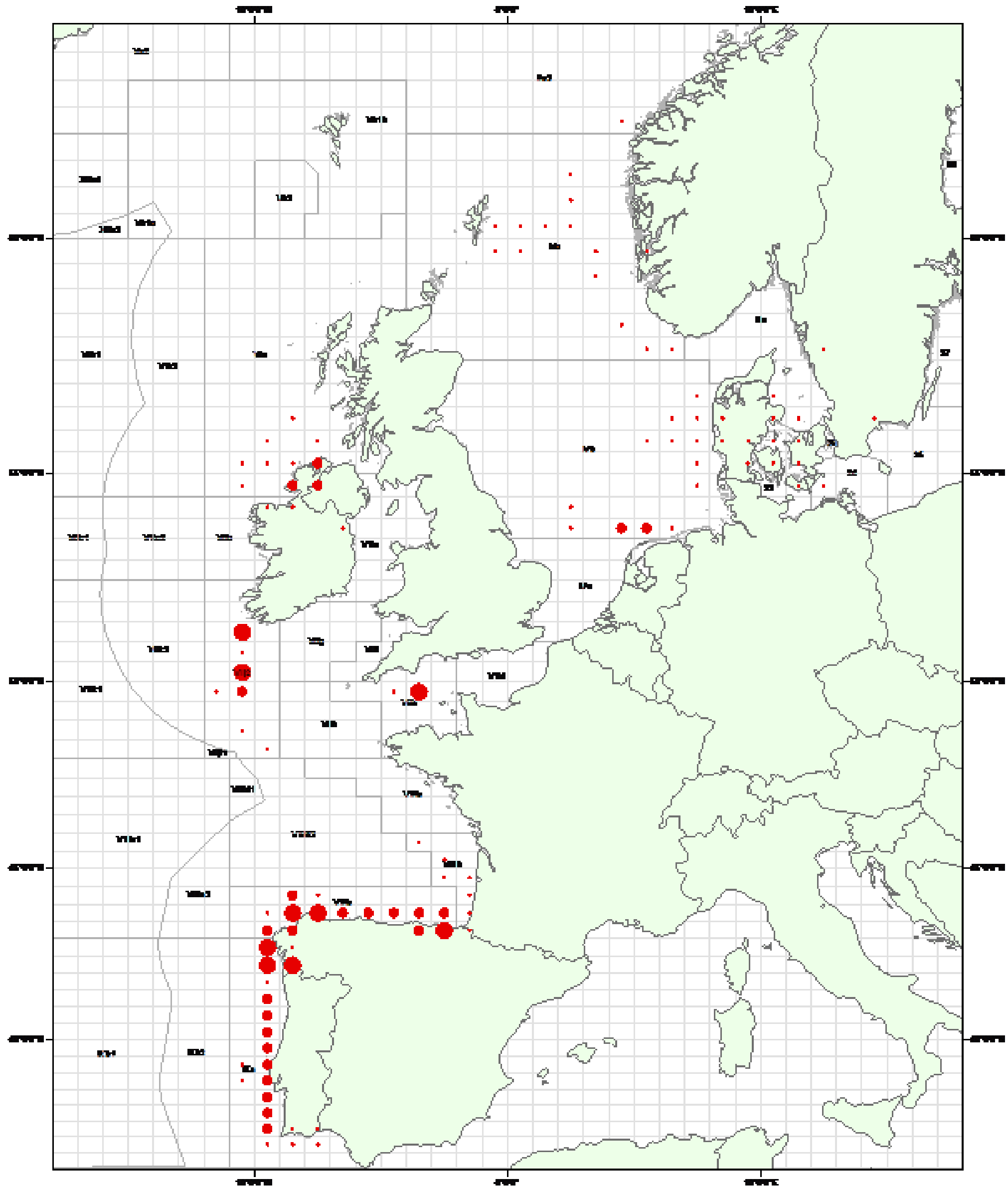

Figure 3.1.1c Horse mackerel catches 3 quarter 2009

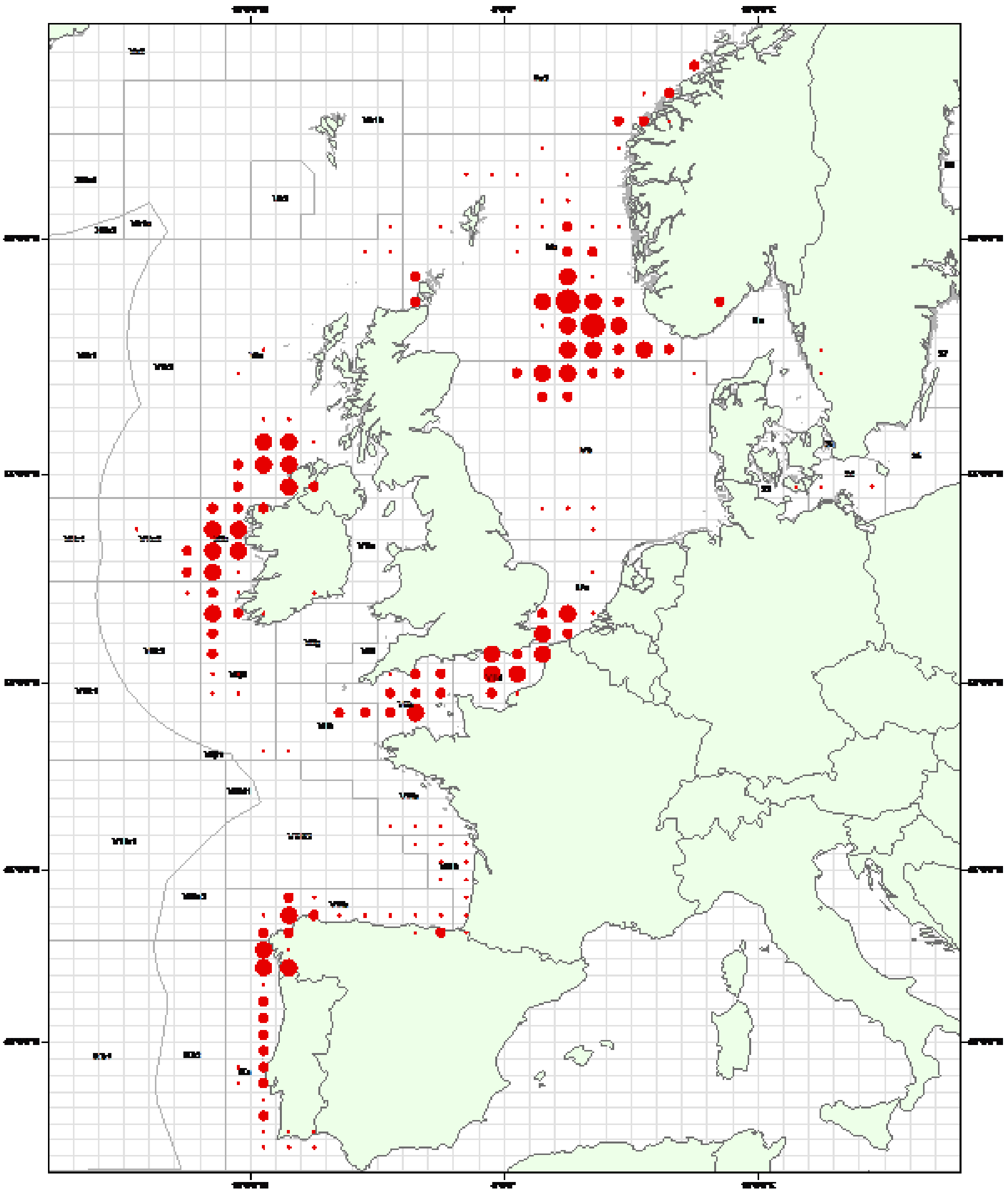

Figure 3.1.1d Horse mackerel catches 4 quarter 2009

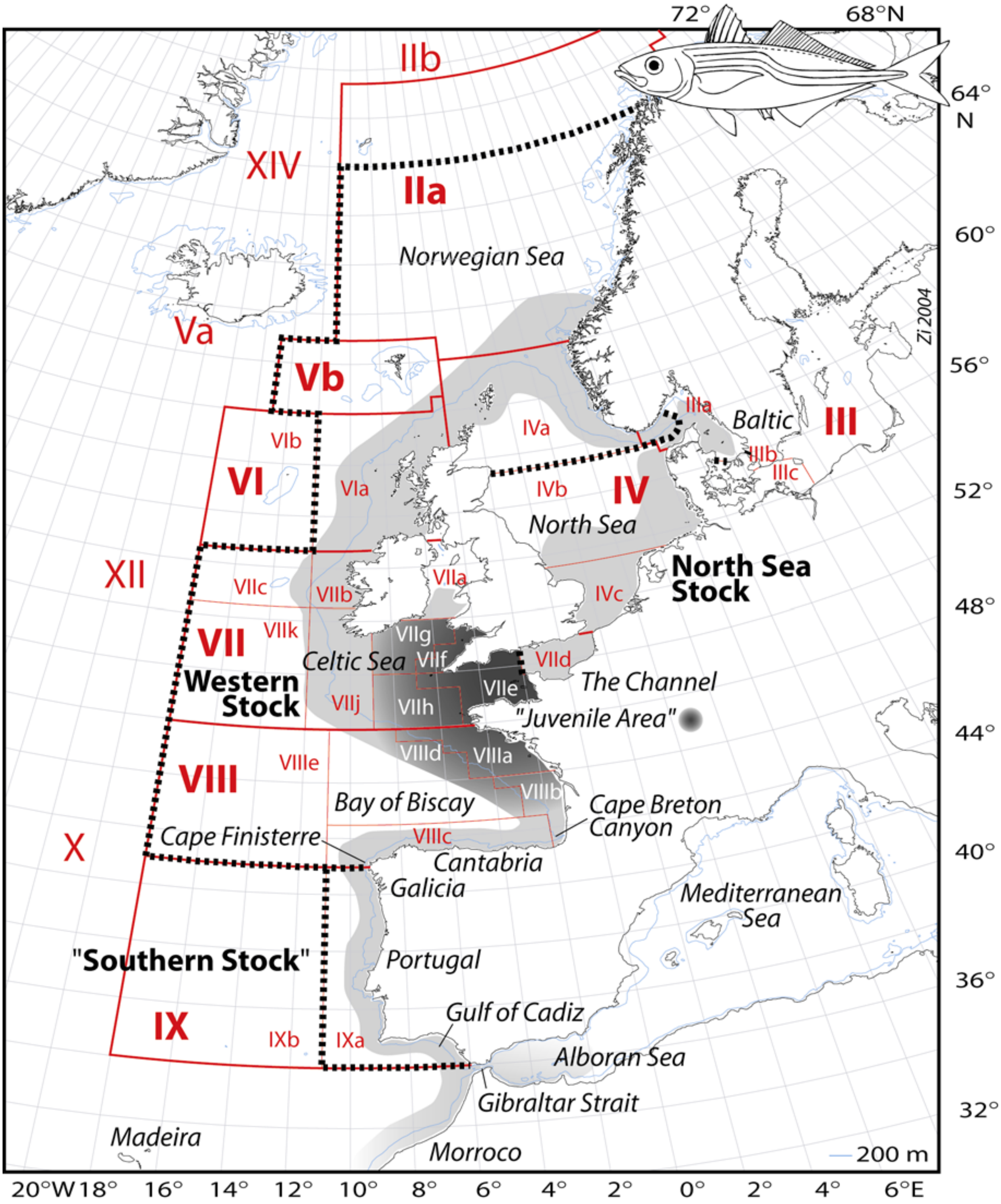

Figure 3.2.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by the 2004 WG MHSA. Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar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

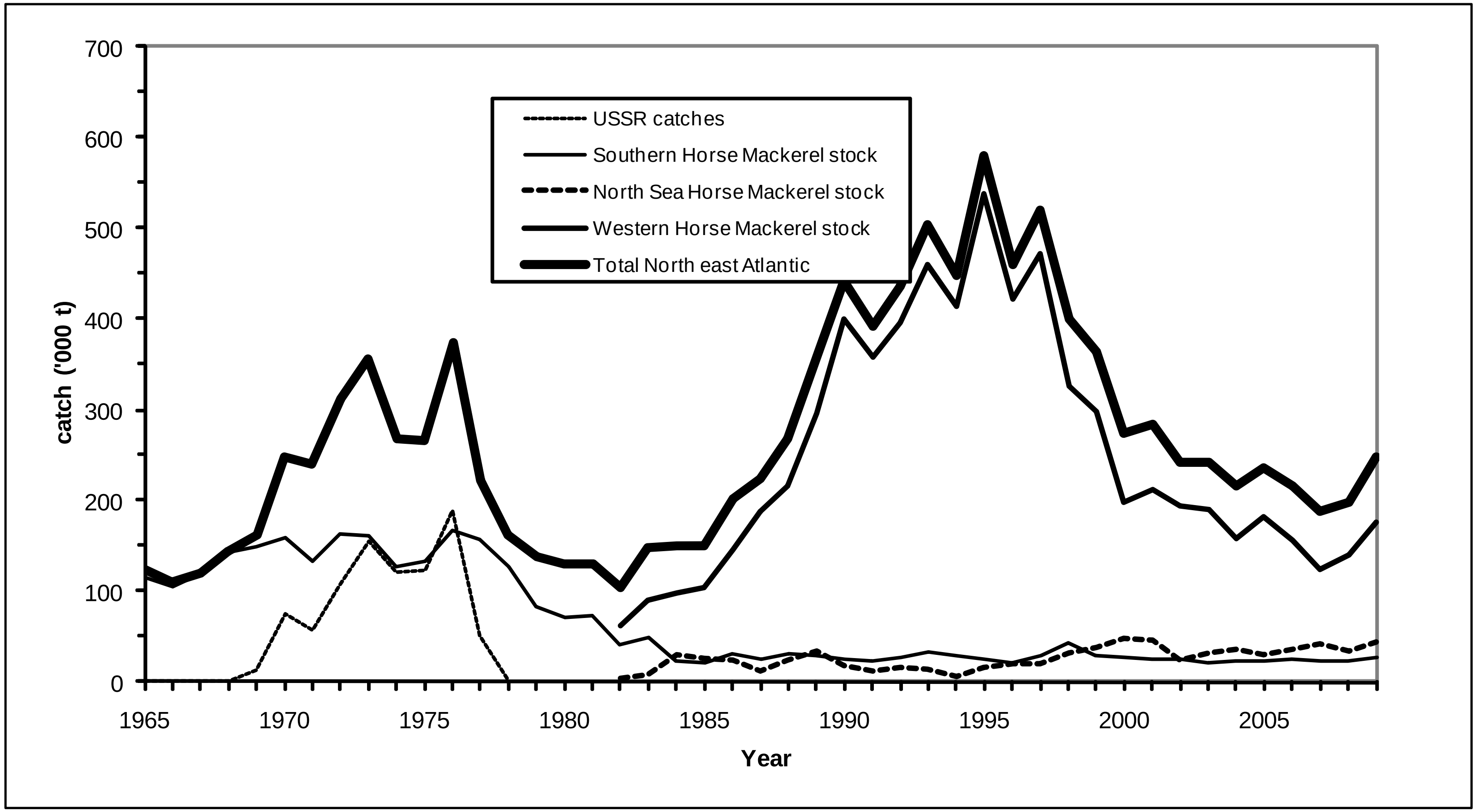

Figure 3.3.1 Horse mackerel general. Total catches in the northeast Atlantic during the period 1965 - 2008. The catches taken by the USSR and catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic. Caches from 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 2009

The ICES advice has been the same since 2002. *Also in 2009 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 2009 on the North Sea stock

Catches taken in Divisions IV a and IIIa during the two first quarters and all year in Divisisons IVb, IVc and VIId are regarded North Sea horse mackerel. Table 3.3.1 shows the reported catches of this stock from 1982–2009. 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). Since then it has varied between 23,400 and 48,400 tons. In 2009 the catch was 44,200 tons, including 12,800 tons taken by Norway in the northern part of Division IVb in the fourth quarter (Figure 3.1.1.c). These catches were taken close to the Norwegian catches in Division IVa in the same quarter which were allocated to the western stock. At least parts of the Norwegian IVb catches might therefore also be of western origin, but all these catches have been allocated to the North Sea stock.

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 2009 were calculated according to Dutch samples from Division IVc (4Q) and VIId (1Q and 4Q) , and Norwegian samples from samples from Divison IVb (4Q). Table 4.4.1.1 shows catch number by quarter and by area in 2009. Annual catch numbers at age for 1995-2009 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 (92%) due to the Dutch and Norwegian data. Due to poor coverages of the catches in earlier periods 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

Table2 4.4.2.1-2 show weight and length by quarter and by area in 2009. 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 4.1.1.1 North Sea Horse Mackerel stock. Catch in numbers (1000) Mean length (Cm) at age by quarter and area in 2009

1Q	IIIa	IVa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.6	1.5	6.7	28.7	136.9	174.4
3	6.8	17.4	80.8	344.6	1643.3	2092.9
4	4.8	12.3	57.3	244.1	1164.0	1482.5
5	12.2	31.1	144.8	617.4	2944.2	3749.7
6	28.3	72.4	336.8	1435.9	6847.1	8720.3
7	18.4	47.0	218.9	933.3	4450.6	5668.2
8	13.0	33.3	154.9	660.5	3149.7	4011.4
9	8.5	21.7	101.0	430.8	2054.1	2616.1
10	6.5	16.7	77.5	330.3	1574.8	2005.7
11	0.9	2.2	10.1	43.1	205.4	261.6
12	0.9	2.2	10.1	43.1	205.4	261.6
13	0.9	2.2	10.1	43.1	205.4	261.6
14	0.3	0.7	3.4	14.4	68.5	87.2
15+	2.5	6.5	30.3	129.2	616.2	784.8
SUM	104.3	267.0	1242.7	5298.4	25265.6	32178.0
2Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.5	0.1	0.1	0.0	0.8
3	0.1	6.1	1.4	1.2	0.2	9.0
4	0.1	4.3	1.0	0.8	0.1	6.4
5	0.2	10.9	2.5	2.1	0.4	16.1
6	0.4	25.4	5.9	4.8	0.8	37.4
7	0.3	16.5	3.8	3.1	0.5	24.3
8	0.2	11.7	2.7	2.2	0.4	17.2
9	0.1	7.6	1.8	1.5	0.3	11.2
10	0.1	5.8	1.4	1.1	0.2	8.6
11	0.0	0.8	0.2	0.2	0.0	1.1
12	0.0	0.8	0.2	0.2	0.0	1.1
13	0.0	0.8	0.2	0.2	0.0	1.1
14	0.0	0.3	0.1	0.1	0.0	0.4
15+	0.0	2.3	0.5	0.4	0.1	3.4
SUM	1.5	93.7	21.8	17.9	3.1	137.8
3Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	44.7	0.0	0.0	0.0	0.0	44.7
2	25.6	0.0	0.0	0.0	0.0	25.6
3	57.5	0.0	0.0	0.0	0.0	57.5
4	25.6	0.0	0.0	0.0	0.0	25.6
5	6.4	0.0	3.0	0.0	0.0	9.4
6	0.0	0.0	50.4	0.0	0.0	50.4
7	0.0	0.0	26.3	0.0	0.0	26.3
8	0.0	0.0	553.3	0.0	0.0	553.3
9	0.0	0.0	30.8	0.0	0.0	30.8
10	0.0	0.0	116.2	0.0	0.0	116.2
11	0.0	0.0	141.2	0.0	0.0	141.2
12	0.0	0.0	108.8	0.0	0.0	108.8
13	0.0	0.0	0.9	0.0	0.0	0.9
14	0.0	0.0	13.4	0.0	0.0	13.4
15+	0.0	0.0	164.2	0.0	0.0	164.2
SUM	159.7	0.0	1208.4	0.0	0.0	1368.1
4Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	1.7	0.0	0.0	13262.0	19722.2	32985.8
2	1.0	0.0	0.0	7577.4	5697.5	13275.9
3	2.2	0.0	0.0	17048.5	8327.1	25377.9
4	1.0	0.0	0.0	7578.5	12271.6	19851.1
5	0.3	0.0	76.0	1895.9	10956.7	12928.8
6	0.0	0.0	1264.1	0.9	5697.5	6962.5
7	0.0	0.0	660.3	2.3	14462.9	15125.5
8	0.0	0.0	13889.5	4.3	27172.8	41066.5
9	0.0	0.0	773.2	1.2	7450.6	8225.0
10	0.0	0.0	2917.4	0.6	3944.4	6862.4
11	0.0	0.0	3544.8	0.5	3067.9	6613.2
12	0.0	0.0	2730.5	0.1	438.3	3168.8
13	0.0	0.0	22.6	0.0	0.0	22.6
14	0.0	0.0	335.8	0.1	438.3	774.1
15+	0.0	0.0	4121.9	0.1	876.5	4998.6
SUM	6.23	0.0	30335.94	47372.15	120524.37	198238.69
1-4Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	46.5	0.0	0.0	13262.0	19722.2	33030.6
2	27.1	2.0	6.9	7606.2	5834.5	13476.7
3	66.6	23.5	82.2	17394.3	9970.6	27537.3
4	31.4	16.6	58.3	7823.4	13435.8	21365.4
5	19.0	42.0	226.4	2515.4	13901.3	16704.0
6	28.7	97.8	1657.1	1441.6	12545.4	15770.5
7	18.6	63.5	909.3	938.7	18914.1	20844.3
8	13.2	45.0	14600.4	667.0	30322.8	45648.3
9	8.6	29.3	906.8	433.4	9505.0	10883.1
10	6.6	22.5	3112.4	332.0	5519.4	8992.9
11	0.9	2.9	3696.3	43.7	3273.3	7017.1
12	0.9	2.9	2849.5	43.3	643.7	3540.3
13	0.9	2.9	33.8	43.2	205.4	286.2
14	0.3	1.0	352.6	14.5	506.8	875.1
15+	2.6	8.8	4316.9	129.8	1492.9	5950.9
SUM	271.8	360.7	32808.7	52688.3	145793.1	231922.6

Table 4.4.1.2 Catch in numbers at age (millions), w eight at age (kg) and length at age (cm) for the North Sea horse mackerel stock 1995-2009

millions — Catch number

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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	33.0
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	13.5
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	27.5
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	21.4
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	16.7
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	15.8
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	20.8
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	45.6
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	10.9
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	9.0
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	7.0
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	3.5
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	0.3
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	0.9
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		1.0	6.0

kg — w eight

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	0.389

cm — length

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	35.12

Table 4.4.2.1 North Sea Horse Mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2009

1Q	IIIa	IVa	IVb	IVc	VIId	Total
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.073	0.073	0.073	0.073	0.073	0.073
3	0.108	0.108	0.108	0.108	0.108	0.108
4	0.132	0.132	0.132	0.132	0.132	0.132
5	0.139	0.139	0.139	0.139	0.139	0.139
6	0.177	0.177	0.177	0.177	0.177	0.177
7	0.210	0.210	0.210	0.210	0.210	0.210
8	0.227	0.227	0.227	0.227	0.227	0.227
9	0.249	0.249	0.249	0.249	0.249	0.249
10	0.269	0.269	0.269	0.269	0.269	0.269
11	0.356	0.356	0.356	0.356	0.356	0.356
12	0.269	0.269	0.269	0.269	0.269	0.269
13	0.364	0.364	0.364	0.364	0.364	0.364
14	0.399	0.399	0.399	0.399	0.399	0.399
15+	0.387	0.387	0.387	0.387	0.387	0.387
Sum	0.199	0.199	0.199	0.199	0.199	0.199
2Q						
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.000	0.000	0.000	0.000	0.000	0.000
2	0.073	0.073	0.073	0.073	0.073	0.073
3	0.108	0.108	0.108	0.108	0.108	0.108
4	0.132	0.132	0.132	0.132	0.132	0.132
5	0.139	0.139	0.139	0.139	0.139	0.139
6	0.177	0.177	0.177	0.177	0.177	0.177
7	0.210	0.210	0.210	0.210	0.210	0.210
8	0.227	0.227	0.227	0.227	0.227	0.227
9	0.249	0.249	0.249	0.249	0.249	0.249
10	0.269	0.269	0.269	0.269	0.269	0.269
11	0.356	0.356	0.356	0.356	0.356	0.356
12	0.269	0.269	0.269	0.269	0.269	0.269
13	0.364	0.364	0.364	0.364	0.364	0.364
14	0.399	0.399	0.399	0.399	0.399	0.399
15+	0.387	0.387	0.387	0.387	0.387	0.387
Sum	0.1974	0.1985	0.1986	0.1987	0.1993	0.1985
3Q						
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.070	0.000	0.000	0.000	0.000	0.070
2	0.084	0.000	0.000	0.000	0.000	0.084
3	0.111	0.000	0.000	0.000	0.000	0.111
4	0.130	0.000	0.000	0.000	0.000	0.130
5	0.169	0.000	0.260	0.000	0.000	0.198
6	0.000	0.000	0.326	0.000	0.000	0.326
7	0.000	0.000	0.353	0.000	0.000	0.353
8	0.000	0.000	0.380	0.000	0.000	0.380
9	0.000	0.000	0.493	0.000	0.000	0.493
10	0.000	0.000	0.449	0.000	0.000	0.449
11	0.000	0.000	0.541	0.000	0.000	0.541
12	0.000	0.000	0.496	0.000	0.000	0.496
13	0.000	0.000	0.600	0.000	0.000	0.600
14	0.000	0.000	0.506	0.000	0.000	0.506
15+	0.000	0.000	0.499	0.000	0.000	0.499
Sum	0.100455		0.433436			0.394557
4Q						
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.070	0.000	0.000	0.070	0.076	0.074
2	0.084	0.000	0.000	0.084	0.092	0.088
3	0.111	0.000	0.000	0.111	0.119	0.113
4	0.130	0.000	0.000	0.130	0.137	0.134
5	0.169	0.000	0.260	0.169	0.149	0.153
6	0.000	0.000	0.326	0.157	0.157	0.187
7	0.000	0.000	0.353	0.180	0.180	0.187
8	0.000	0.000	0.380	0.200	0.200	0.261
9	0.000	0.000	0.493	0.229	0.229	0.254
10	0.000	0.000	0.449	0.252	0.252	0.336
11	0.000	0.000	0.541	0.287	0.287	0.423
12	0.000	0.000	0.496	0.254	0.254	0.462
13	0.000	0.000	0.600	0.000	0.000	0.600
14	0.000	0.000	0.506	0.253	0.253	0.363
15+	0.000	0.000	0.499	0.349	0.349	0.472
Sum	0.1005		0.4334	0.1005	0.1606	0.1880
1-4Q						
0	0.000	0.000	0.000	0.000	0.000	0.000
1	0.070	0.000	0.000	0.070	0.076	0.074
2	0.084	0.073	0.073	0.084	0.091	0.087
3	0.111	0.108	0.108	0.111	0.117	0.113
4	0.130	0.132	0.132	0.130	0.137	0.134
5	0.150	0.139	0.181	0.162	0.147	0.150
6	0.177	0.177	0.295	0.177	0.168	0.182
7	0.210	0.210	0.318	0.209	0.187	0.194
8	0.227	0.227	0.379	0.227	0.203	0.259
9	0.249	0.249	0.465	0.249	0.233	0.253
10	0.269	0.269	0.445	0.269	0.257	0.322
11	0.356	0.356	0.540	0.356	0.291	0.423
12	0.269	0.269	0.495	0.269	0.259	0.449
13	0.364	0.364	0.528	0.364	0.364	0.383
14	0.399	0.399	0.505	0.398	0.273	0.369
15+	0.387	0.387	0.498	0.387	0.365	0.462
Sum	0.139	0.199	0.424	0.110	0.167	0.191

Table 4.4.2.2 North sea Horse Mackerel stock. Mean length (Cm) in catch at age by quarter and area in 2009

1Q	IIIa	IVa	IVb	IVc	VIId	Total
0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0
2	20.8	20.8	20.8	20.8	20.8	20.8
3	23.3	23.3	23.3	23.3	23.3	23.3
4	24.7	24.7	24.7	24.7	24.7	24.7
5	25.8	25.8	25.8	25.8	25.8	25.8
6	27.2	27.2	27.2	27.2	27.2	27.2
7	28.6	28.6	28.6	28.6	28.6	28.6
8	29.3	29.3	29.3	29.3	29.3	29.3
9	30.4	30.4	30.4	30.4	30.4	30.4
10	30.8	30.8	30.8	30.8	30.8	30.8
11	33.3	33.3	33.3	33.3	33.3	33.3
12	30.9	30.9	30.9	30.9	30.9	30.9
13	33.3	33.3	33.3	33.3	33.3	33.3
14	35.8	35.8	35.8	35.8	35.8	35.8
15+	35.1	35.1	35.1	35.1	35.1	35.1
Sum	28.0	28.0	28.0	28.0	28.0	28.0
2Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0
2	20.8	20.8	20.8	20.8	20.8	20.8
3	23.3	23.3	23.3	23.3	23.3	23.3
4	24.7	24.7	24.7	24.7	24.7	24.7
5	25.8	25.8	25.8	25.8	25.8	25.8
6	27.2	27.2	27.2	27.2	27.2	27.2
7	28.6	28.6	28.6	28.6	28.6	28.6
8	29.3	29.3	29.3	29.3	29.3	29.3
9	30.4	30.4	30.4	30.4	30.4	30.4
10	30.8	30.8	30.8	30.8	30.8	30.8
11	33.3	33.3	33.3	33.3	33.3	33.3
12	30.9	30.9	30.9	30.9	30.9	30.9
13	33.3	33.3	33.3	33.3	33.3	33.3
14	35.8	35.8	35.8	35.8	35.8	35.8
15+	35.1	35.1	35.1	35.1	35.1	35.1
Sum	27.9	28.0	28.0	28.0	28.0	28.0
3Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	20.3	0.0	0.0	0.0	0.0	20.3
2	21.5	0.0	0.0	0.0	0.0	21.5
3	23.0	0.0	0.0	0.0	0.0	23.0
4	24.4	0.0	0.0	0.0	0.0	24.4
5	26.8	0.0	27.4	0.0	0.0	27.0
6	0.0	0.0	32.1	0.0	0.0	32.1
7	0.0	0.0	32.3	0.0	0.0	32.3
8	0.0	0.0	33.5	0.0	0.0	33.5
9	0.0	0.0	37.5	0.0	0.0	37.5
10	0.0	0.0	35.5	0.0	0.0	35.5
11	0.0	0.0	37.5	0.0	0.0	37.5
12	0.0	0.0	36.4	0.0	0.0	36.4
13	0.0	0.0	42.0	0.0	0.0	42.0
14	0.0	0.0	37.2	0.0	0.0	37.2
15+	0.0	0.0	36.5	0.0	0.0	36.5
Sum	22.4		34.9			33.4
4Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	20.3	0.0	0.0	20.3	20.4	20.3
2	21.5	0.0	0.0	21.5	21.8	21.6
3	23.0	0.0	0.0	23.0	23.6	23.2
4	24.4	0.0	0.0	24.4	24.7	24.6
5	26.8	0.0	27.4	26.7	25.7	25.9
6	0.0	0.0	32.1	26.2	26.2	27.3
7	0.0	0.0	32.3	27.6	27.6	27.8
8	0.0	0.0	33.5	29.3	29.3	30.7
9	0.0	0.0	37.5	30.7	30.7	31.4
10	0.0	0.0	35.5	31.0	31.0	32.9
11	0.0	0.0	37.5	32.2	32.2	35.0
12	0.0	0.0	36.4	31.3	31.3	35.7
13	0.0	0.0	42.0	0.0	0.0	42.0
14	0.0	0.0	37.2	31.8	31.8	34.1
15+	0.0	0.0	36.5	35.0	35.0	36.2
Sum	22.4		34.9	22.4	26.2	26.6
1-4Q						
0	0.0	0.0	0.0	0.0	0.0	0.0
1	20.3	0.0	0.0	20.3	20.4	20.3
2	21.5	20.8	20.8	21.5	21.7	21.6
3	23.0	23.3	23.3	23.0	23.5	23.2
4	24.4	24.7	24.7	24.4	24.7	24.6
5	26.1	25.8	26.3	26.5	25.7	25.8
6	27.2	27.2	31.1	27.2	26.7	27.2
7	28.6	28.6	31.4	28.5	27.9	28.0
8	29.3	29.3	33.5	29.3	29.3	30.6
9	30.4	30.4	36.7	30.4	30.6	31.1
10	30.8	30.8	35.4	30.8	30.9	32.5
11	33.3	33.3	37.5	33.2	32.2	35.0
12	30.9	30.9	36.4	30.9	31.1	35.4
13	33.3	33.3	39.3	33.3	33.3	34.0
14	35.8	35.8	37.2	35.7	32.3	34.3
15+	35.1	35.1	36.5	35.1	35.1	36.1
Sum	24.5	28.0	34.6	22.9	26.5	26.8

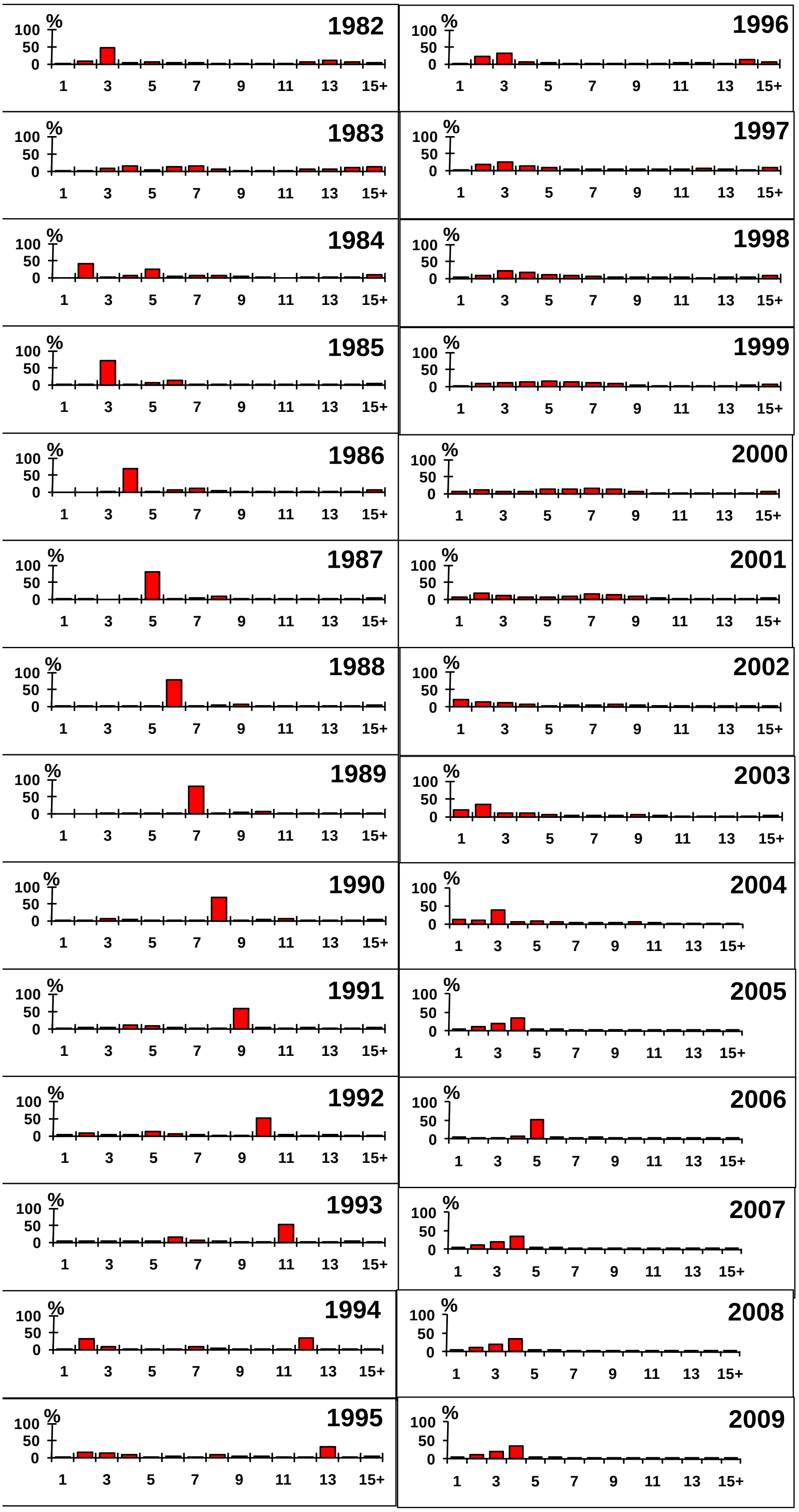

Figure 5.5.1.2 WESTERN HORSE MACKEREL. Age composition in the international catches during 1982-2005.

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 2009 and 2010

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 2009	TAC 2010	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 and 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. 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 2009

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 in 2009 was approximately 177,000 t (Table 3.3.1) which is 38,000 tons more than in 2008. The catches of horse mackerel by country and area are shown in Tables 5.2.1.1-5.

5.2.2 Egg survey estimates

A new egg survey was carried out in the western and southern spawning areas earlier this year. A report with the preliminary results of the survey was distributed to WGWIDE members on time (Ulleweit et al. 2010). Details of this mackerel and horse mackerel egg survey are given in section 2.6 of this report.

Egg abundance plots displaying the spatial distribution of stage 1 western horse mackerel eggs are presented for periods 2 – 6 (Figures 5.2.2.1 – 5.2.2.5).

Figure 5.2.2.6 displays the mean daily stage I egg production estimates (DEP) for each survey period plotted against the mid-period days. The results of 1998, 2001, 2004 and 2007 are also included in the figure for comparison. Period number and duration are the same as those used to estimate the western mackerel stock, as are the dates defining the start and end of spawning. The shape of the egg production curve does not suggest that those dates should be altered for 2010 although it seems likely that some spawning continued after the survey ended. The daily egg production curve revealed an provisional estimate of total annual egg production of 1.01×10^{15} . This is about 30% less than observed in 2007 (1.43×10^{15}). In contrast to 2007 the 2010 results display a bimodal distribution which is almost identical both in shape and scale to that seen in 1998 with peak spawning occurring in periods 3 and 5 and a significant decline in production during period 4.

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 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 (VIIc,e,h,j, VIIIb), Norway (IIa and IVa), Ireland (VIa, and VIIb,c,j), Germany (Via, VIIb,c,j) and Spain (VIIIb,c) provided catch in numbers at age. The catch sampled for age readings in 2009 covered 84% of the total catch compared to 70% in 2008.

The total annual and quarterly catches in numbers for western horse mackerel in 2009 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. Weight at age time-series is shown in Figure 5.2.6.1.

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. Weight at age time-series is shown in Figure 5.2.6.2.

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.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.

5.2.10 Data exploration

Within-cohort consistency of the catch-at-age matrix is investigated in Figure 5.2.8.1, 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 5.2.8.2, 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 5.2.8.2) 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.

5.2.11 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 and was conducted with a 6-year window as in the previous assessment carried out in 2009.

Fits to the available data are given in Figure 5.2.9.1, and model estimates with associated precision in Figures 5.2.9.2-3. Model estimates and residual patterns are similar to those presented in 2009 (ICES 2009/ACOM:13). A comparison with the 2009 assessment is discussed in Section 5.6.

Sensitivity to the length of the separable window is shown in Figure 5.2.9.4. 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, 6-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 5.2.9.5 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, the availability of the new egg production estimates also have had 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 5.2.9.4).

For the second case, 3-year retrospective plots were constructed as before, but this time the starting year of the separable window (2004) 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 5.2.9.6, giving little indication of the retrospective bias problems previously shown in Figure 5.2.9.5. However, estimates of selectivity-at-age in Figure 5.2.9.6 were different for the 2004-2007 window compared to the other window options shown, but in this case precision of the selectivity-at-age estimates was slightly worse than the other cases shown (1.6% and 6.2% worse, on average, than the 2004-2008 and 2004-2009 windows, respectively), and these estimates remain within the confidence bounds of both the 2004-2008 and 2004-2009 window options (see Figure 5.2.9.1a for the latter).

5.3 State of the Stock

5.3.1 Stock assessment

The SAD model with a separable window of 2004-2009 is presented as the final assessment model. Stock numbers-at-age and Fishing mortality-at-age are given in Tables 5.3.1.1 and 5.3.1.2, and a stock-summary is provided in Table 5.3.1.3, and illustrated in Figure 5.3.1.1. SSB peaked in 1988 following the very strong 1982 year class and has since declined, slightly more so with the input of the new 2010 egg estimate, however the decline in SSB is within the confidence bounds of the 2009 assessment. There had been two increases in SSB following the 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) has increased but continues to be low compared to levels in the later half of the 1990s. Selectivity for the 1 year olds has increased, this is mainly driven by the 2010 egg estimate which has resulted in a reduction of the numbers at age in the population.

The overall effect of the new 2010 egg estimate on the assessment is a decline in SSB relative to last year's assessment, although SSB appears to be slightly increasing since 2002. Recruitment in recent years has been low. Although the recruits, age 0, are higher than in the previous 3 years estimate they are still a week year class. Selectivity-at-age for the older ages (seven to ten) has remained similar than estimated previously but, has been increasing for the younger ages. This was more so since the introduction of the new year's data particularly the new 2010 egg estimate.

5.4 Short-term forecast

A short-term forecast was conducted with the ICES standard software MFDP (Multi Fleet Deterministic Projection) version 1a.

Input

Table 5.4.1 lists the input data for the short term predictions. Weight at age in the stock and weight at age in the catch are the 2009 estimates as there is an increasing trend in the observations. These estimates where used due to the trend increase in weights for this year. Selection (exploitation pattern is based on F in 2009 from the most recent assessment is the average of ages 1 to 10, which assumes a fixed selection in the period 2004-2009. Natural mortality is assumed to be 0.15 across all ages. The proportion mature for this stock has been constant since 1998 and values are copied from the assessment input. The expected landings in 2009 are 177 000 t which is close to the TAC set for that year, therefore the input value was set at the TAC level.

Output

A range of Predicted catch and SSB options from the short term forecast are presented in Table 5.4.2.

The proposed management plan results in a target F_{2011} of 0.10 and an annual catch of 181 000 tons for the years 2011-2013. Catch options for precautionary approach take into account SSB on 1st January 2011 which would be above B_{pa}. For SSB to be above Bpa in 2012 the F should be fixed at 0.03. This would lead to a TAC in 2011 of 62 223 t.

Following the ICES MSY framework implies fishing mortality = F_{MSY} = 0.13 resulting in catches of 229 314 tonnes in 2011. This is expected to lead to an SSB of 1 645 276 tonnes in 2012.

Following the transition scheme towards the ICES MSY framework implies fishing mortality would be Fmsy as the calculation applied for the transition results in an F that < Fmsy. This is expected to lead to catches in 2011 of 229 314 thousand tonnes and an SSB of 1 645 276 tonnes in 2012.

5.5 Uncertainties in the assessment and forecast

Fishery-independent data for this stock is extremely limited, with only a single data point for egg production every three years. In addition, the assessment contains a fecundity model which links the egg production to SSB that could be improved if further evidence was obtained on the spawning biology of this stock which at present is considered an indeterminate spawner.

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 32-59% 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 1994 year class at age 0 is the largest since 1982, with a CV of 23%.

The assessment could be improved by the inclusion of information such as survey tuning indices on the numbers at age in the stock. 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 Comparison with previous assessment and forecast

A comparison with the update assessment with the 2009 assessment is shown in Figure 5.6.1. SSB, recruitment and F trajectories show a similar pattern but have been reduced by the incorporation of the new 2010 egg estimate, the increase in the selectivity-at-age curve for the younger ages, 1 to 6 year olds, is largely due to the model taking in to account the 30% decrease in number of eggs as compared to the 2007 estimate, with the model expectations of fewer younger age groups in the catch, relatively these age groups would appear to be targeted more than previously estimated. The 2009 model predictions, however, occur within the uncertainty, confidence bounds, as shown in Figure 5.2.9.1a and b.

5.7 Management Options

5.7.1 MSY FRAMEWORK

Deterministic and stochastic equilibrium analyses were carried out using the 'plotMSY' software (WKFRAME 2010) to determine candidate Fmsy values for the western horse mackerel stock. Stock-recruit pairs from the period 1982-2009, as estimated from the most recent SAD assessment of the stock, were used together with 5-year averages of selectivity, weight and maturity at age , F refers to the mean for ages 1 – 10. Three stock recruit relationships were examined, Ricker, Beverton-Holt and the segmented regression ('smooth hockey stick'), and yield-per-recruit (YPR) analyses were also done. For the stochastic analyses, uncertainty (CVs) in the biological and fishery parameters at age were used to create alternative fits to the stock-recruit relationships (*N*=1000).

The results show a very poor Beverton and Holt fit (Figure 5.7.1.1) to the deterministic data, with an extremely steep slope at the origin and an asymptote at the geometric mean recruitment level. The majority of stochastic stock-recruit model fits fell out of the range of the deterministic fit to the data, and thus it can be concluded that the stock-recruit form is unclear and not suitable for the data and the level of uncertainty associated with the parameters. Given the lack of any clear patterns in the stock-recruit data, a smooth segmented regression model fit, while uncertain around the origin, could provides a most cautious fit to the data. The deterministic segmented regression fit has a shallow slope to the breakpoint, hence the estimated value of Fcrash associated with this function is low. However this slope is determined by very few data points and is therefore poorly estimated. The value for Bmsy is at the breakpoint in the segmented regression, hence F_{msy} is estimated to be the same as Fcrash (Table 5.7.1.1). The uncertainty with regards to the slope at the origin makes this stock-recruitment function unsuitable as a basis for advice on F_{msy}. The Ricker stock recruit relationship fits the data best, and the median of the stochastic fits is in close agreement with the deterministic fit. If this stock recruit relationship is considered to be biologically reasonable, this function could be used in the calculation of F_{msy}. However, there is a very large uncertainty around the fit to the data, as can be seen in the spread of potential stochastic fits. This results in a very high CV around the estimate of F_{msy}, again making this function unsuitable as the basis of advice on the selection of F_{msy}.

Given the poor fits to stock and recruitment data, a yield-per-recruit analysis remains the conducted (Figure 5.7.1.2). The stochastic analysis shows a well defined F_{max}. The uncertainty around this value which results from the associated CVs in the input data and believed to be realistic, provide a potential range of values for consideration of a proxy for F_{MSY}. However, the point estimate of F_{max}= 0.21 is close to Fcrash. Alternatively, $F_{0.1}$= 0.13 is consistent with the findings of the management plan evaluation. This evaluation by simulation showed that catches above 170 000t would result in a risk greater than 10% of depleting the stock. Examination of the fishing mortality time-series suggests that in the absence of extraordinary age classes such catches result from Fs of around 0.1. On that basis $F_{0.1}$ = 0.13 is considered a more suitable candidate for F_{msy} than F_{max}. It is proposed that $F_{0.1}$ = 0.13 be used as a proxy for F_{msy} for this stock. Bpa (1.8Mt) is proposed as MSY Btrigger.

5.7.2 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. This year, the provisional egg survey estimate for 2010 has been applied, resulting in a TAC for 2011-2013 of 181,211t, subject to review in 2011 when the final egg survey results become available.

Although in use for the purposes of setting the TAC, there are several issues related to the implementation of the management plan. The plan has not yet been officially placed into EC regulations as aspects remain under negotiation and the legal structure of the plan is adapted to account for changes under the Lisbon treaty. Aspects of the proposed plan currently under discussion include the realignment of the assessment and management areas for the stock (which has been highlighted for several years as problematic in terms of the management of the fishery) and an annual TAC adjustment to account for estimated discards and slipping in the previous year. The regulation also proposes a formal review of the plan in 2014.

5.8 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, a preliminary egg abundance estimate is available from the 2010 egg survey. This data point has been included in the assessment with the catch data from 2009.

SSB in 2010 was estimated at 2.0Mt, 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. However, B_{pa} is not used as a reference for management but rather the rule in the agreed management plan is used.

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. Note that sub-area 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 sub-areas 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. 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. The rule proposed by the plan was used to set the TAC for 2008-2010 at 180kt. Using the provisional 2010 egg survey result the catch advice for 2011-2013 is 181,211t. 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.

5.9 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.

5.10 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.

5.11 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.

5.12 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.

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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	2009[1]
Faroe Islands	-	-	3	-	-	-
Denmark	-	-	-	-	-	-
France	-	-	-	-	-	-
Germany	-	-	-	-	-	-
Ireland	-	-	-	366[4]	-	-
Norway	42	176	27	-	572	1,847
Russia						-
UK (England + Wales)	-	-	-	-	-	-
Estonia	-	-	-	-	-	-
Total	42	176	30	366	572	1,847

[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	2009[1]
Belgium	5	2	4
Denmark	329	59	279
Faroe Islands	3	55	-
France	457	943	-
Germany, Fed.Rep.	93	1,167	1,299
Ireland	652	1,186	342
Netherlands	20,027	9,400	10,077
Lithuania	98	- 11,652	-
Norway	5.423	45	70,745
Sweden	130	-	660
UK (Engl. + Wales)	2,966	20	-
UK (Scotland)	626	-9,151	51
Unallocated +discards	-14,403		-5,898
Total	16,407	15,377	78,595

[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	2009[1]
Denmark	-	-	-
Faroe Islands	-	573	-
France	-	74	-
Germany	1,835	5,097	635
Ireland	20,341	18,786	16,565
Lithuania	80	641	-
Netherlands	2,177	3,904	2,332
Norway	2	20	27
Russia	-	-	-
Spain	-	-	-
UK (Engl. + Wales)	232	-	-
UK (Scotland)	38	588	243
Unallocated+discards	1,474	-3,781	-2,057
Total	26,279	25,902	17,776

[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	2009[1]
Faroe Islands	475	212	-
Belgium	+	+	1
Denmark	4,806	1,970	2,710
France	6,844	11,008	-
Germany	3.943	5,700	14,204
Ireland	8,039	16,293	23,841
Lithuania	5,585	4,907	-
Netherlands	38,034	43,514	47,741
Spain	-	11	6
Sweden	55	-	-
UK (Engl. + Wales)	9,105	-	-
UK (Scotland)	738	476	1,123
Unallocated+discards	15,460	14,656	-61
Total	93,084	98,746	89,565

[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	2009[1]
Denmark	2,687	3,289	3,109
France	10,741	2,848	-
Germany	-	918	281
Ireland	694	246	-
Lithuania	-	-	-
Netherlands	-	6,269	1,849
Russia	-	-	-
Spain	13,853	19,840	21,071
UK (Engl. + Wales)	-	-	-
UK (Scotland)	-	-	-
Unallocated+discards	412	482	7,045
Total	28,387	33,892	33,355

[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
2010	1005

Table 5.2.5.1 Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2009

1Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0																
1			4338.3	24.7	67.1	6529.6	789.8				320.7	6650.5				18720.7
2			5251.6	29.9	111.3	9106.0	1081.2				1763.9	1773.5				19117.3
3			2107.7	12.0	93.7	436.4	139.3				1924.2	1457.0				6170.3
4			5234.0	29.8	126.2	172.4	225.0				801.8	1773.5			21.4	8384.1
5	0.1		7447.1	42.4	180.4	108.3	307.3		90.5		1135.3	2914.0	134.0	0.7	96.5	12456.5
6	0.5		4601.7	26.2	256.5	199.5	247.8		1428.9	50.0	3220.8	2914.0	1081.8	6.4	449.8	14483.9
7	0.3		2634.6	15.0	283.6	161.9	189.0		720.7	399.9	1131.0	5828.1	832.5	10.8	223.2	12430.5
8	25.3		1686.1	9.6	332.5	203.9	177.6		21976.1	2749.5	1099.9	11656.1	25490.1	178.3	12710.3	78295.4
9	4.9		1317.3	7.5	348.3	264.3	176.4		2228.7	1149.8	653.6	2914.0	2364.5	31.3	947.2	12407.8
10	5.2		1053.8	6.0	354.7	365.9	179.7		1540.8	799.9	176.4	2914.0	2197.7	25.0	1984.6	11603.7
11	3.4		368.8	2.1	121.9	250.3	74.0		1286.9	449.9	7.4	1457.0	1642.6	17.1	1720.4	7401.8
12	3.0		210.8	1.2	52.4	216.7	44.0		62.4	0.0	160.4	1457.0	889.1	4.9	677.6	3779.4
13	0.6		87.8	0.5	46.0	246.8	40.9		280.8	50.0		1457.0	547.5	4.1	553.6	3315.7
14	1.7		35.1	0.2	23.0	112.2	19.1		897.9	50.0	4.5	0.0	59.6	1.1	235.0	1439.3
15+	6.3		105.4	0.6	104.9	299.7	64.9		2057.6	549.9	13.4	1457.0	1378.0	16.7	4440.4	10494.8
SUM	51.1	0.0	36480.2	207.7	2502.5	18673.9	3755.9	0.0	32571.3	6248.9	12413.1	46622.9	36617.4	296.3	24060.0	220501.1

Table 5.2.5.1 cont. Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2009

2Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0																
1			24169.6	1192.8	10247.5	29499.7	2639.3									67748.9
2			11921.2	917.4	2040.8	2557.0	1034.9									18471.3
3			15388.8	9437.0	425.3	687.0	1140.3								0.5	27078.9
4			9155.1	5400.7	409.2	871.0	692.2						225.8		2.8	16756.8
5			662.7	14.9	428.6	875.1	85.4						1030.9		7.1	3104.7
6			1540.8	684.0	494.7	1123.8	154.2						1585.8		6.9	5590.2
7			324.7	7.3	475.3	1084.2	65.4						2232.6		2.1	4191.5
8			235.7	5.3	571.5	1067.4	67.5						8244.5		55.1	10247.0
9			355.8	8.0	613.3	753.0	79.8						4559.6		6.0	6375.5
10			618.2	13.9	637.4	629.6	100.7						928.6		7.1	2935.6
11			475.9	10.7	318.8	376.6	62.3						197.7		4.0	1446.0
12			444.8	10.0	242.6	467.9	53.4						45.9		3.4	1267.8
13			631.5	14.2	229.0	793.5	65.5						31.5		0.7	1766.0
14			306.9	6.9	92.3	388.7	30.2						28.2		1.9	855.0
15+			489.2	11.0	110.8	3570.3	44.9						201.3		7.2	4434.7
SUM	0.0	0.0	66720.8	17734.1	17337.1	44744.8	6316.0	0.0	0.0	0.0	0.0	0.0	19312.5	0.0	104.7	172270.0

Table 5.2.5.1 cont. Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2009

3Q																
Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0				28.5	4674.9	0.0										4703.4
1				2.6	4592.4	5.1					2688.4		0.0			7288.5
2				2.3	3686.3	359.9					1466.4		0.0			5514.9
3				2.7	1211.4	82.3		0.0	0.4		1466.4		0.4		92.3	2855.9
4	0.0	0.1		1.5	1009.7	161.1		0.1	4.3		1710.8		20.4		480.8	3388.7
5	0.0	3.2		4.0	1659.5	997.8		0.1	10.3		1955.2		996.5		1205.0	6831.6
6	0.1	15.5		4.2	1789.9	2110.6		0.4	21.1		1222.0		3306.0		1094.1	9564.0
7	0.5	60.7		2.9	1523.7	3178.4		0.1	25.4		733.2		684.4		306.3	6515.6
8	1.3	167.3		5.3	1333.5	3509.0		0.8	109.4		977.6		8852.3		4545.1	19501.6
9	0.7	90.7		2.5	938.2	3046.6		0.3	14.3				1675.9		83.1	5852.2
10	0.5	66.6		1.0	598.2	1864.7		0.1	5.9				653.2		214.8	3404.9
11	0.6	76.7		1.3	380.8	1163.1		0.0	2.6				3.2		24.2	1652.4
12	0.5	59.8		5.5	85.3	451.5		0.0	2.1				9.5		0.0	614.1
13	0.0	4.1		5.0	90.5	655.5		0.0	1.1				325.8		0.0	1082.0
14	0.1	7.4		2.5	39.3	693.6		0.0	0.7				3.8		0.0	747.3
15+	0.5	64.3		2.8	50.4	3883.8		0.0	2.5				14.5		0.0	4018.9
SUM	4.7	616.3	0.0	74.6	23664.0	22163.0	0.0	2.0	200.0	0.0	12219.9	0.0	16545.6	0.0	8045.7	83535.9

Table 5.2.5.1 cont. Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2009

4Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0				76.3	128.0	41259.4										41463.7
1				40.0	798.9	15137.8					7783.8					23760.5
2				29.1	61.6	987.6					2075.7					3154.0
3				1.7	69.5	8.6			165.1		3113.5				113.0	3471.5
4	1.0	23.3		4.7	211.0	3.1		0.1	1705.3	37.9	2075.7	16.0	28.8	1.3	1143.7	5251.8
5	22.0	703.2		18.0	565.2	14.5		0.8	5363.9	269.1	4151.4	240.8	716.5	13.7	3921.0	16000.0
6	108.0	3462.5		27.7	799.0	30.1		2.2	10935.1	314.6	2594.6	638.0	1570.5	28.7	5547.5	26058.4
7	424.0	13544.9		18.9	915.3	50.2		1.1	9692.0	382.5	3113.5	313.5	933.7	18.4	1371.1	30779.0
8	1168.0	37341.4		38.0	842.9	65.5		8.5	57908.7	1726.9	7783.8	2431.1	5423.9	119.4	25397.4	140255.5
9	633.0	20241.8		10.9	546.9	83.4		5.0	6893.6	462.1	3632.4	1414.3	6134.8	59.1	1539.6	41657.0
10	465.0	14867.3		6.5	396.1	100.6		2.3	2839.0	214.8	518.9	657.1	2810.2	27.5	901.7	23807.1
11	535.0	17118.8		8.9	245.5	177.4		0.2	1600.1	37.9	1037.8	41.9	110.0	2.2	337.5	21253.1
12	417.0	13337.2		40.2	60.3	182.8		0.0	955.4	117.2	518.9			2.2	219.1	15850.3
13	29.0	914.0		38.4	63.2	327.2		0.5	500.0	75.8	0.0	139.6	551.3	6.4	177.6	2822.9
14	52.0	1659.8		31.3	33.2	472.6		0.2	376.6	75.8	0.0	62.8	164.9	3.7	145.2	3078.2
15+	449.0	14346.4		25.3	43.0	1873.8		0.9	1585.4	151.6	518.9	250.6	854.9	11.8	516.8	20628.3
SUM	4303.0	137560.6	0.0	415.9	5779.6	60774.6	0.0	21.8	100520.1	3866.2	38919.0	6205.6	19299.5	294.4	41331.1	419291.2

Table 5.2.5.1 cont. Western Horse Mackerel stock. Catch in numbers (1000) at age by quarter and area in 2009

Q1-4 Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0				104.8	4802.9	41259.4										46167.1
1			28507.9	1260.1	15705.9	51172.2	3429.1				10792.9	6650.5				117518.6
2			17172.8	978.7	5900.0	13010.5	2116.1				5306.0	1773.5				46257.5
3			17496.4	9453.4	1799.9	1214.3	1279.6	0.0	165.5		6504.1	1457.0	0.4		205.9	39576.5
4	1.0	23.4	14389.1	5436.7	1756.1	1207.6	917.2	0.1	1709.5	37.9	4588.2	1789.5	275.0	1.3	1648.6	33781.4
5	22.1	706.4	8109.8	79.3	2833.7	1995.7	392.7	1.0	5464.7	269.1	7241.8	3154.8	2877.9	14.4	5229.6	38392.8
6	108.6	3478.0	6142.5	742.1	3340.1	3464.0	402.0	2.6	12385.2	364.6	7037.3	3552.0	7544.1	35.1	7098.3	55696.5
7	424.7	13605.6	2959.3	44.1	3197.9	4474.7	254.4	1.2	10438.1	782.4	4977.7	6141.5	4683.2	29.3	1902.6	53916.6
8	1194.6	37508.7	1921.9	58.2	3080.4	4845.8	245.1	9.4	79994.2	4476.5	9861.3	14087.2	48010.8	297.7	42707.8	248299.4
9	638.6	20332.5	1673.1	28.9	2446.7	4147.3	256.2	5.2	9136.5	1611.9	4286.0	4328.3	14734.8	90.4	2576.0	66292.4
10	470.7	14933.9	1672.0	27.4	1986.4	2960.8	280.4	2.4	4385.8	1014.7	695.3	3571.2	6589.7	52.4	3108.3	41751.3
11	539.0	17195.5	844.7	23.0	1067.0	1967.4	136.3	0.2	2889.5	487.8	1045.3	1498.9	1953.5	19.3	2086.0	31753.4
12	420.4	13396.9	655.5	56.9	440.6	1318.9	97.3	0.0	1019.9	117.2	679.3	1457.0	944.5	7.1	900.1	21511.6
13	29.7	918.1	719.4	58.1	428.7	2023.0	106.5	0.5	781.8	125.8		1596.6	1456.1	10.5	731.9	8986.6
14	53.7	1667.2	342.0	40.9	187.8	1667.1	49.3	0.2	1275.2	125.8	4.5	62.8	256.4	4.8	382.1	6119.8
15+	455.8	14410.7	594.6	39.7	309.1	9627.6	109.8	0.9	3645.5	701.5	532.3	1707.7	2448.6	28.5	4964.3	39576.7
SUM	4358.8	138176.9	103201.0	18432.3	49283.2	146356.3	10071.9	23.7	133291.3	10115.2	63551.9	52828.4	91775.0	590.7	73541.5	895598.1

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
2009	46167	117519	46258	39576	33781	38393	55696	53917	248299	66292	41751	107948

Table 5.2.6.1.: Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2009.

1Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0																
1			0.046	0.046	0.049	0.048	0.048				0.053	0.054				0.050
2			0.056	0.056	0.064	0.060	0.060				0.068	0.082				0.062
3			0.112	0.112	0.101	0.082	0.098				0.100	0.118				0.107
4	0.135		0.127	0.127	0.118	0.103	0.116				0.124	0.120			0.135	0.124
5	0.157		0.142	0.142	0.146	0.135	0.141		0.137		0.143	0.129	0.140	0.140	0.157	0.139
6	0.180		0.156	0.156	0.164	0.166	0.162		0.164	0.151	0.157	0.127	0.162	0.165	0.180	0.153
7	0.204		0.173	0.173	0.181	0.182	0.179		0.158	0.172	0.213	0.141	0.179	0.176	0.204	0.162
8	0.271		0.190	0.190	0.198	0.201	0.197		0.199	0.187	0.204	0.154	0.189	0.191	0.243	0.196
9	0.302		0.206	0.206	0.213	0.217	0.212		0.227	0.222	0.266	0.182	0.221	0.221	0.319	0.221
10	0.325		0.215	0.215	0.229	0.236	0.227		0.275	0.234	0.280	0.161	0.210	0.218	0.345	0.234
11	0.359		0.245	0.245	0.249	0.265	0.253		0.293	0.247	0.317	0.152	0.282	0.265	0.398	0.280
12	0.336		0.265	0.265	0.271	0.289	0.275		0.433	0.000	0.226	0.291	0.216	0.219	0.389	0.289
13	0.409		0.280	0.280	0.302	0.322	0.301		0.298	0.289		0.179	0.364	0.327	0.409	0.277
14	0.345		0.266	0.266	0.297	0.331	0.298		0.300	0.215	0.339	0.000	0.258	0.237	0.354	0.306
15+	0.378		0.285	0.285	0.432	0.417	0.378		0.376	0.282	0.417	0.209	0.323	0.302	0.421	0.361
SUM	0.304		0.127	0.127	0.194	0.083	0.119		0.221	0.212	0.148	0.138	0.203	0.208	0.305	0.176

Table 5.2.6.1. cont.: Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2009.

2Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0																
1			0.051	0.052	0.032	0.031	0.046									0.039
2			0.060	0.067	0.057	0.053	0.059									0.059
3			0.094	0.090	0.097	0.095	0.095								0.152	0.093
4			0.115	0.108	0.114	0.120	0.115						0.145		0.154	0.114
5			0.140	0.140	0.142	0.142	0.141						0.167		0.171	0.150
6			0.149	0.139	0.164	0.163	0.152						0.179		0.186	0.160
7			0.178	0.178	0.181	0.179	0.179						0.192		0.198	0.186
8			0.201	0.201	0.199	0.195	0.200						0.194		0.247	0.195
9			0.220	0.220	0.214	0.205	0.218						0.211		0.274	0.211
10			0.240	0.240	0.230	0.224	0.237						0.235		0.288	0.233
11			0.265	0.265	0.260	0.264	0.263						0.261		0.317	0.263
12			0.291	0.291	0.285	0.296	0.289						0.334		0.336	0.293
13			0.326	0.326	0.311	0.332	0.321						0.325		0.409	0.327
14			0.339	0.339	0.312	0.343	0.330						0.407		0.345	0.340
15+			0.399	0.399	0.331	0.474	0.376						0.319		0.378	0.454
SUM			0.088	0.095	0.083	0.102	0.087						0.200		0.255	0.104

Table 5.2.6.1. cont.: Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2009.

3Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0				0.035	0.033											0.033
1				0.048	0.061	0.104					0.056					0.059
2				0.099	0.094	0.106					0.088					0.093
3				0.117	0.119	0.120		0.119	0.147		0.125		0.119		0.152	0.123
4		0.250		0.137	0.136	0.156		0.148	0.175		0.136		0.148		0.172	0.142
5		0.287		0.148	0.154	0.165		0.170	0.187		0.145		0.167		0.185	0.161
6		0.297		0.168	0.168	0.177		0.168	0.194		0.159		0.167		0.191	0.172
7		0.341		0.212	0.186	0.191		0.152	0.200		0.167		0.120		0.191	0.181
8		0.376		0.223	0.202	0.205		0.197	0.210		0.172		0.201		0.200	0.202
9		0.414		0.244	0.221	0.223		0.206	0.236				0.204		0.219	0.220
10		0.445		0.280	0.243	0.245		0.237	0.231				0.241		0.214	0.246
11		0.491		0.288	0.261	0.262		0.280	0.260				0.280		0.232	0.272
12		0.473		0.245	0.301	0.313		0.258	0.230				0.258			0.325
13		0.435		0.269	0.305	0.334		0.244	0.235				0.219			0.297
14		0.458		0.300	0.368	0.391		0.317	0.276				0.317			0.390
15+		0.536		0.297	0.409	0.490		0.256	0.251				0.256			0.488
SUM	0.425	0.425		0.141	0.115	0.267		0.191	0.209		0.120		0.191		0.195	0.181

Table 5.2.6.1. cont.: Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2009.

4Q Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0				0.044	0.045	0.031										0.031
1				0.055	0.059	0.038					0.054					0.044
2				0.070	0.080	0.083					0.082					0.082
3				0.127	0.128	0.103			0.147		0.096				0.151	0.101
4	0.250	0.250		0.139	0.141	0.149		0.158	0.174	0.149	0.120	0.158	0.158	0.154	0.169	0.151
5	0.287	0.287		0.149	0.158	0.164		0.189	0.183	0.166	0.145	0.189	0.181	0.183	0.183	0.177
6	0.297	0.297		0.170	0.172	0.178		0.188	0.195	0.179	0.145	0.188	0.189	0.186	0.196	0.203
7	0.341	0.341		0.205	0.189	0.194		0.195	0.200	0.191	0.184	0.195	0.199	0.194	0.205	0.262
8	0.376	0.376		0.217	0.202	0.208		0.214	0.212	0.221	0.163	0.214	0.214	0.216	0.217	0.256
9	0.414	0.414		0.246	0.222	0.227		0.224	0.235	0.225	0.239	0.224	0.224	0.225	0.240	0.323
10	0.445	0.445		0.283	0.243	0.255		0.248	0.238	0.281	0.247	0.248	0.214	0.256	0.260	0.371
11	0.491	0.491		0.292	0.261	0.285		0.313	0.256	0.319	0.160	0.313	0.313	0.316	0.279	0.448
12	0.473	0.473		0.252	0.302	0.319		0.000	0.242	0.224	0.169			0.224	0.258	0.441
13	0.435	0.435		0.301	0.307	0.353		0.340	0.245	0.293		0.340	0.388	0.328	0.283	0.360
14	0.458	0.458		0.338	0.372	0.386		0.415	0.276	0.268		0.415	0.415	0.342	0.243	0.405
15+	0.536	0.536		0.343	0.411	0.481		0.290	0.269	0.307	0.307	0.290	0.292	0.295	0.306	0.484
SUM	0.425	0.425		0.183	0.176	0.055		0.224	0.211	0.221	0.138	0.224	0.223	0.223	0.213	0.255

Table 5.2.6.1. cont.: Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2009.

Q1-4 Ages	IIa	IVa	VIIIa	VIIIb	VIIIc E	VIIIc W	VIIId	VIIa	VIIb	VIIc	VIIe	VIIh	VIIj	VIIk	VIa	Total
0				0.042	0.034	0.031										0.032
1			0.050	0.052	0.042	0.035	0.046				0.054	0.054				0.043
2			0.059	0.067	0.080	0.062	0.060				0.079	0.082				0.066
3			0.097	0.090	0.113	0.092	0.095	0.119	0.147		0.104	0.118	0.119		0.151	0.098
4	0.247	0.250	0.119	0.108	0.130	0.122	0.115	0.153	0.174	0.149	0.127	0.121	0.147	0.154	0.169	0.125
5	0.286	0.287	0.142	0.143	0.153	0.153	0.141	0.186	0.183	0.166	0.145	0.134	0.169	0.181	0.183	0.159
6	0.297	0.297	0.154	0.141	0.168	0.172	0.158	0.185	0.191	0.175	0.153	0.138	0.173	0.182	0.195	0.180
7	0.341	0.341	0.174	0.190	0.186	0.188	0.179	0.190	0.197	0.181	0.188	0.143	0.181	0.187	0.203	0.223
8	0.374	0.376	0.192	0.212	0.201	0.202	0.198	0.212	0.209	0.200	0.168	0.164	0.195	0.201	0.223	0.230
9	0.413	0.414	0.209	0.228	0.218	0.220	0.214	0.223	0.233	0.223	0.243	0.196	0.217	0.223	0.269	0.284
10	0.444	0.445	0.224	0.246	0.236	0.240	0.230	0.248	0.251	0.244	0.255	0.177	0.218	0.238	0.311	0.313
11	0.490	0.491	0.256	0.275	0.259	0.265	0.258	0.311	0.272	0.253	0.161	0.157	0.282	0.271	0.377	0.391
12	0.472	0.473	0.283	0.258	0.289	0.304	0.283	0.258	0.254	0.224	0.183	0.291	0.222	0.221	0.357	0.402
13	0.434	0.435	0.321	0.304	0.308	0.335	0.314	0.335	0.264	0.291	0.000	0.193	0.340	0.328	0.378	0.315
14	0.455	0.458	0.331	0.335	0.333	0.374	0.318	0.411	0.293	0.247	0.339	0.415	0.376	0.318	0.312	0.370
15+	0.534	0.536	0.379	0.355	0.389	0.480	0.377	0.288	0.330	0.287	0.310	0.221	0.312	0.299	0.409	0.448
SUM	0.424	0.425	0.102	0.097	0.115	0.105	0.099	0.221	0.214	0.215	0.136	0.148	0.205	0.216	0.241	0.200

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
2009	0.000	0.000	0.085	0.125	**0.15**	**0.177**	**0.168**	0.169	0.205	0.223	0.217	0.316

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
2009	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 5.3.1.1 Western horse mackerel. Final assessment. Numbers-at-age (thousands).

	0	1	2	3	4	5	6	7	8	9	10	11+
1982	72968000	745398	1854650	3389430	489946	442168	353361	263486	40932.3	44356.1	48731.9	2402210
1983	508231	62804200	638125	1576770	2792300	411017	368334	293248	218576	33699	37793.6	2032620
1984	1464150	437439	54048700	547134	1326610	2353710	339530	275707	203534	171502	25951.8	1503090
1985	2696370	1260200	376507	46296200	466805	1108150	1886890	271501	201823	143621	133923	1092620
1986	3904260	2320790	1083150	319516	39288100	397642	914997	1530940	221953	158707	117864	977472
1987	5277960	3360430	1997520	932276	273574	33188200	334157	727105	1215870	167182	116952	811471
1988	2117200	4542790	2892260	1718820	802418	232730	27738200	285700	587265	962258	133003	728920
1989	2258540	1821480	3884620	2483720	1477460	686563	182715	23000800	234664	468434	765258	683426
1990	2068440	1943940	1567760	3343520	2118490	1254700	586006	143812	18612500	190802	348117	1101270
1991	4025170	1780320	1654230	1307600	2748910	1766400	1049040	494593	104662	14735100	129888	976218
1992	7939440	3445350	1501200	1340580	1104090	2173270	1387620	834512	402165	66348.3	11551100	763224
1993	9965120	6819730	2752340	1258390	1079120	898093	1632970	1076470	672793	328470	35351.8	9510160
1994	14630100	8577020	5768530	2281290	1067580	870621	685128	1111100	792363	513471	252386	7011480
1995	7356710	12588800	7325940	4119190	1856160	869579	707888	553728	750402	583177	404098	5126410
1996	3628950	6329470	10681800	5868990	3151530	1397710	693685	525016	443520	418366	391435	3502840
1997	3134420	3113520	5429480	8582820	4252710	2539700	1123690	549406	400647	332219	307088	2827690
1998	4505130	2693320	2577640	4241470	6704560	3279370	1959270	856710	354444	220070	183927	1671380
1999	4636890	3876910	2233260	2047480	3197320	5436570	2618800	1540340	623651	229463	126084	1126260
2000	4094090	3977260	3246370	1844520	1598150	2505340	4443170	2057130	1152060	400099	125423	751311
2001	19753200	3523220	3350100	2672540	1538690	1308950	2016400	3666190	1605460	867927	287240	638169
2002	4210640	16947300	2968050	2654750	2159530	1233020	1032600	1627030	2937660	1192740	650576	688974
2003	2659930	3611420	14158900	2443200	2131910	1741530	1001480	823983	1312790	2407600	947437	1065640
2004	1368060	2287710	2826600	11643300	1949180	1693820	1416430	808688	666908	1084030	1986180	1633290
2005	1061950	1157790	1837890	2309040	9413630	1592560	1369930	1160330	663541	547053	894595	3020570
2006	634660	912856	912492	1479740	1834690	7580870	1265960	1106930	939502	537066	446210	3239430
2007	998625	544493	739187	749893	1204990	1508000	6175200	1042960	913252	774922	445357	3086710
2008	1364910	855272	438219	604664	607279	985860	1221620	5065200	856837	750065	640206	2950010
2009		1147040	674537	353007	480747	489302	784171	987583	4103200	693853	612057	2971480
2010			878499	531429	273290	378865	379031	620744	783903	3255390	556144	2927240

Table 5.3.1.2 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	0.036	0.037	0.044	0.010	0.037	0.037
1983	0.000	0.000	0.004	0.023	0.021	0.041	0.140	0.215	0.093	0.111	0.170	0.170
1984	0.000	0.000	0.005	0.009	0.030	0.071	0.074	0.162	0.199	0.097	0.186	0.186
1985	0.000	0.001	0.014	0.014	0.010	0.042	0.059	0.052	0.090	0.048	0.077	0.077
1986	0.000	0.000	0.000	0.005	0.019	0.024	0.080	0.080	0.133	0.155	0.150	0.150
1987	0.000	0.000	0.000	0.000	0.012	0.029	0.007	0.064	0.084	0.079	0.092	0.092
1988	0.000	0.007	0.002	0.001	0.006	0.092	0.037	0.047	0.076	0.079	0.082	0.082
1989	0.000	0.000	0.000	0.009	0.013	0.008	0.089	0.062	0.057	0.147	0.124	0.124
1990	0.000	0.011	0.031	0.046	0.032	0.029	0.020	0.168	0.084	0.235	0.245	0.245
1991	0.006	0.021	0.060	0.019	0.085	0.091	0.079	0.057	0.306	0.093	0.221	0.221
1992	0.002	0.075	0.026	0.067	0.057	0.136	0.104	0.065	0.052	0.480	0.108	0.108
1993	0.000	0.017	0.038	0.014	0.065	0.121	0.235	0.156	0.120	0.113	0.159	0.159
1994	0.000	0.008	0.187	0.056	0.055	0.057	0.063	0.242	0.157	0.090	0.199	0.199
1995	0.000	0.014	0.072	0.118	0.134	0.076	0.149	0.072	0.434	0.249	0.307	0.307
1996	0.003	0.003	0.069	0.172	0.066	0.068	0.083	0.120	0.139	0.159	0.170	0.170
1997	0.002	0.039	0.097	0.097	0.110	0.109	0.121	0.288	0.449	0.441	0.479	0.479
1998	0.000	0.037	0.080	0.133	0.060	0.075	0.091	0.168	0.285	0.407	0.349	0.349
1999	0.003	0.027	0.041	0.098	0.094	0.052	0.091	0.140	0.294	0.454	0.361	0.361
2000	0.000	0.022	0.045	0.031	0.050	0.067	0.042	0.098	0.133	0.181	0.168	0.168
2001	0.003	0.021	0.083	0.063	0.071	0.087	0.065	0.072	0.147	0.138	0.145	0.145
2002	0.004	0.030	0.045	0.069	0.065	0.058	0.076	0.065	0.049	0.080	0.079	0.079
2003	0.001	0.095	0.046	0.076	0.080	0.057	0.064	0.061	0.041	0.042	0.059	0.059
2004	0.017	0.069	0.052	0.063	0.052	0.062	0.049	0.048	0.048	0.042	0.031	0.031
2005	0.001	0.088	0.067	0.080	0.067	0.080	0.063	0.061	0.061	0.054	0.039	0.039
2006	0.003	0.061	0.046	0.055	0.046	0.055	0.044	0.042	0.043	0.037	0.027	0.027
2007	0.005	0.067	0.051	0.061	0.051	0.061	0.048	0.047	0.047	0.041	0.030	0.030
2008	0.024	0.087	0.066	0.079	0.066	0.079	0.063	0.061	0.061	0.053	0.039	0.039
2009	0.000	0.117	0.088	0.106	0.088	0.105	0.084	0.081	0.081	0.071	0.052	0.052

Table 5.3.1.3 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)	F(1-10)
1982	72968000	1394070	1625760	61197	0.044	0.021	0.035	0.028
1983	508231	1390420	1618519	90442	0.065	0.009	0.102	0.082
1984	1464150	1308030	3934806	96744	0.074	0.005	0.107	0.083
1985	2696370	2385130	4879058	103843	0.044	0.010	0.051	0.041
1986	3904260	3168430	5176652	145999	0.046	0.002	0.067	0.065
1987	5277960	3835900	5156979	187338	0.049	0.000	0.039	0.037
1988	2117200	4395240	5046084	214729	0.049	0.003	0.052	0.043
1989	2258540	4064270	4850490	296037	0.073	0.003	0.046	0.051
1990	2068440	3442980	4202233	398645	0.116	0.030	0.066	0.090
1991	4025170	3311910	4030285	357288	0.108	0.033	0.124	0.103
1992	7939440	2745600	3317491	394793	0.144	0.056	0.083	0.117
1993	9965120	2595260	3236405	458628	0.177	0.023	0.139	0.104
1994	14630100	2187890	2970597	413022	0.189	0.084	0.115	0.111
1995	7356710	1714980	2658730	538131	0.314	0.068	0.173	0.162
1996	3628950	1675880	2908105	420942	0.251	0.081	0.095	0.105
1997	3134420	1645220	2897254	471700	0.287	0.078	0.216	0.223
1998	4505130	1668230	2555514	326443	0.196	0.083	0.135	0.168
1999	4636890	1859800	2540547	298076	0.160	0.056	0.134	0.165
2000	4094090	1948020	2508147	196911	0.101	0.032	0.078	0.084
2001	19753200	1422400	2006053	212090	0.149	0.056	0.088	0.089
2002	4210640	1737890	2358729	194292	0.112	0.048	0.062	0.062
2003	2659930	1710510	2853862	190183	0.111	0.072	0.061	0.062
2004	1368060	1823480	3111072	157627	0.086	0.061	0.052	0.052
2005	1061950	2356290	3220811	181994	0.077	0.078	0.066	0.066
2006	634660	2251270	2731731	155094	0.069	0.054	0.046	0.046
2007	998625	1955010	2290703	123408	0.063	0.060	0.051	0.050
2008	1364910	2095550	2412230	139741	0.067	0.078	0.066	0.065
2009	3046490[1]	2276680	2627135	177000	0.078	0.104	0.088	0.087
2010		2009260						

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

1. R(age 0) in 2009 is the geometric mean of the time series 1983 to 2008

Table 5.4.1 Western Horse Mackerel. Short term prediction: INPUT DATA

2010	Stock abundance	Natural mortality	Maturity ogive	Prop. Of F before spw.	Prop. Of M before spw.	Weights in the Stock	Explotation pattern	Weights in the catch
0	3046490	0.15	0.00	0.45	0.45	0.000	0	0.032
1	2622138	0.15	0.00	0.45	0.45	0.000	0.117	0.043
2	878499	0.15	0.05	0.45	0.45	0.085	0.088	0.066
3	531429	0.15	0.25	0.45	0.45	0.125	0.106	0.098
4	273290	0.15	0.70	0.45	0.45	0.150	0.088	0.125
5	378865	0.15	0.95	0.45	0.45	0.177	0.105	0.159
6	379031	0.15	1.00	0.45	0.45	0.168	0.084	0.180
7	620744	0.15	1.00	0.45	0.45	0.169	0.081	0.223
8	783903	0.15	1.00	0.45	0.45	0.205	0.081	0.230
9	3255390	0.15	1.00	0.45	0.45	0.223	0.071	0.284
10	556144	0.15	1.00	0.45	0.45	0.217	0.052	0.313
11	2927240	0.15	1.00	0.45	0.45	0.316	0.052	0.407

2011	Stock abundance	Natural mortality	Maturity ogive	Prop. Of F before spw.	Prop. Of M before spw.	Weights in the Stock	Explotation pattern	Weights in the catch
0	3046490	0.15	0.00	0.45	0.45	0.000	0	0.032
1	.	0.15	0.00	0.45	0.45	0.000	0.117	0.043
2	.	0.15	0.05	0.45	0.45	0.085	0.088	0.066
3	.	0.15	0.25	0.45	0.45	0.125	0.106	0.098
4	.	0.15	0.70	0.45	0.45	0.150	0.088	0.125
5	.	0.15	0.95	0.45	0.45	0.177	0.105	0.159
6	.	0.15	1.00	0.45	0.45	0.168	0.084	0.180
7	.	0.15	1.00	0.45	0.45	0.169	0.081	0.223
8	.	0.15	1.00	0.45	0.45	0.205	0.081	0.230
9	.	0.15	1.00	0.45	0.45	0.223	0.071	0.284
10	.	0.15	1.00	0.45	0.45	0.217	0.052	0.313
11	.	0.15	1.00	0.45	0.45	0.316	0.052	0.407

2012	Stock abundance	Natural mortality	Maturity ogive	Prop. Of F before spw.	Prop. Of M before spw.	Weights in the Stock	Explotation pattern	Weights in the catch
0	3046490	0.15	0.00	0.45	0.45	0.000	0	0.032
1	.	0.15	0.00	0.45	0.45	0.000	0.117	0.043
2	.	0.15	0.05	0.45	0.45	0.085	0.088	0.066
3	.	0.15	0.25	0.45	0.45	0.125	0.106	0.098
4	.	0.15	0.70	0.45	0.45	0.150	0.088	0.125
5	.	0.15	0.95	0.45	0.45	0.177	0.105	0.159
6	.	0.15	1.00	0.45	0.45	0.168	0.084	0.180
7	.	0.15	1.00	0.45	0.45	0.169	0.081	0.223
8	.	0.15	1.00	0.45	0.45	0.205	0.081	0.230
9	.	0.15	1.00	0.45	0.45	0.223	0.071	0.284
10	.	0.15	1.00	0.45	0.45	0.217	0.052	0.313
11	.	0.15	1.00	0.45	0.45	0.316	0.052	0.407

Table 5.4.2 Western Horse Mackerel Short term prediction single option table. Catch constraint of 185 Kt in 2010 and F status quo for 2011 and 2012

Year:	2010	F multiplier: 1.0255		Fbar:	0.0895				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	3046490	0	0	0	0	0
1	0.12	275730	11856	2622138	0	0	0	0	0
2	0.0902	70478	4630	878499	74672	43925	3734	39424	3351
3	0.1087	50902	4988	531429	66429	132857	16607	118257	14782
4	0.0902	21925	2734	273290	40994	191303	28695	171700	25755
5	0.1077	35964	5733	378865	67059	359922	63706	320515	56731
6	0.0861	29083	5241	379031	63677	379031	63677	340819	57258
7	0.0831	45996	10271	620744	104906	620744	104906	558938	94460
8	0.0831	58086	13354	783903	160700	783903	160700	705851	144699
9	0.0728	212485	60346	3255390	725952	3255390	725952	2944815	656694
10	0.0533	26837	8392	556144	120683	556144	120683	507517	110131
11	0.0533	141257	57455	2927240	925008	2927240	925008	2671292	844128
Total		968743	185000	16253163	2350080	9250459	2213668	8379128	2007990

Year:	2011	F multiplier: 1		Fbar:	0.0873				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	3046490	0	0	0	0	0
1	0.117	269248	11578	2622138	0	0	0	0	0
2	0.088	156757	10299	2001710	170145	100086	8507	89920	7643
3	0.106	64611	6332	690881	86360	172720	21590	153926	19241
4	0.088	32130	4007	410289	61543	287203	43080	258033	38705
5	0.105	19919	3175	214924	38042	204178	36140	182043	32222
6	0.084	21930	3952	292803	49191	292803	49191	263538	44274
7	0.081	21647	4834	299308	50583	299308	50583	269757	45589
8	0.081	35562	8176	491691	100797	491691	100797	443146	90845
9	0.071	39554	11233	620929	138467	620929	138467	562149	125359
10	0.052	122663	38357	2605172	565322	2605172	565322	2378806	516201
11	0.052	133837	54437	2842478	898223	2842478	898223	2595492	820176
Total		917859	156378	16138814	2158674	7916567	1911900	7196812	1740255

Year:	2012	F multiplier: 1		Fbar:	0.0873				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	3046490	0	0	0	0	0
1	0.117	269248	11578	2622138	0	0	0	0	0
2	0.088	157226	10330	2007701	170655	100385	8533	90190	7666
3	0.106	147550	14460	1577754	197219	394438	49305	351519	43940
4	0.088	41884	5223	534840	80226	374388	56158	336364	50455
5	0.105	29972	4778	323391	57240	307222	54378	273915	48483
6	0.084	12474	2248	166548	27980	166548	27980	149903	25184
7	0.081	16759	3742	231713	39159	231713	39159	208836	35293
8	0.081	17182	3950	237572	48702	237572	48702	214117	43894
9	0.071	24861	7061	390274	87031	390274	87031	353329	78792
10	0.052	23439	7329	497809	108025	497809	108025	454554	98638
11	0.052	209585	85246	4451248	1406594	4451248	1406594	4064474	1284374
Total		950181	155945	16087478	2222832	7151598	1885866	6497200	1716719

Table 5.4.3 Western Horse Mackerel. Short term prediction; single area management option table. OPTION: Catch constraint 185 Kt in 2010.

2010				
Biomass	SSB	FMult	FBar	Landings
2350080	2007990	1.0255	0.090	185000

2011					2012		Implied changes in:	
TSB	SSB	FMult	FBar	Landings	Biomass	SSB	SSB	Landings
2158674	1787106	0	0	0	2377400	1872961	5%	-100%
.	1782362	0.1	0.0087	16108	2361420	1856676	4%	-91%
.	1777631	0.2	0.0175	32110	2345559	1840543	3%	-83%
.	1772913	0.3	0.0262	48006	2329815	1824558	3%	-74%
.	1768678	0.39	0.034	62223	2315746	1810298	2%	-66%
.	1768208	0.4	0.0349	63797	2314189	1808721	2%	-66%
.	1763517	0.5	0.0437	79484	2298679	1793030	2%	-57%
.	1758838	0.6	0.0524	95067	2283283	1777484	1%	-49%
.	1754173	0.7	0.0611	110547	2268002	1762081	0%	-40%
.	1749520	0.8	0.0698	125925	2252833	1746821	0%	-32%
.	1744881	0.9	0.0786	141202	2237777	1731700	-1%	-24%
.	1743955	0.92	0.0803	144245	2234779	1728693	-1%	-22%
.	1743029	0.94	0.0821	147285	2231786	1725691	-1%	-20%
.	1741179	0.98	0.0856	153351	2225812	1719704	-1%	-17%
.	1740255	1	0.0873	156378	2222832	1716719	-1%	-15%
.	1739793	1.01	0.0882	157891	2221344	1715228	-1%	-15%
.	1738869	1.03	0.0899	160912	2218370	1712251	-2%	-13%
.	1735641	1.1	0.096	171455	2207997	1701875	-2%	-7%
.	1732880	1.16	0.1013	180453	2199149	1693035	-2%	-2%
.	1732420	1.17	0.1021	181950	2197678	1691566	-2%	-2%
.	1731500	1.19	0.1039	184939	2194740	1688633	-3%	0%
.	1731041	1.2	0.1048	186433	2193272	1687168	-3%	1%
.	1726453	1.3	0.1135	201312	2178655	1672596	-3%	9%
.	1724622	1.34	0.117	207236	2172839	1666804	-3%	12%
.	1723249	1.37	0.1196	211669	2168487	1662475	-4%	14%
.	1722792	1.38	0.1205	213145	2167039	1661034	-4%	15%
.	1721878	1.4	0.1222	216094	2164146	1658157	-4%	17%
.	1720052	1.44	0.1257	221979	2158372	1652419	-4%	20%
.	1717772	1.49	0.1301	229314	2151179	1645276	-4%	24%
.	1717316	1.5	0.131	230778	2149744	1643851	-4%	25%
.	1712767	1.6	0.1397	245367	2135447	1629676	-5%	33%
.	1708230	1.7	0.1484	259860	2121255	1615631	-6%	40%
.	1703706	1.8	0.1571	274258	2107168	1601714	-6%	48%
.	1699195	1.9	0.1659	288563	2093184	1587924	-7%	56%
.	1694696	2	0.1746	302773	2079303	1574260	-8%	64%

Table 5.7.1.1. Results from PlotMSY indicating deterministic fits and the range of values estimated from 1000 iterations of the programme. Results are presented from the Ricker, Beverton and Holt and Smooth hockey stick models.

Ricker

893/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.12	0.06	1338280	91237	1.02	0.50	3.20E+00	3.60E-07
Mean	0.09	0.04	424270	91027	1.17	0.59	4.35E+00	4.23E-07
5%ile	0.00	0.00	-2861848	0	0.75	0.15	1.74E+00	1.07E-07
25%ile	0.01	0.01	102415	2056	0.93	0.40	2.71E+00	2.85E-07
50%ile	0.08	0.04	687309	54697	1.12	0.58	3.84E+00	4.14E-07
75%ile	0.14	0.07	1120450	130062	1.34	0.77	5.31E+00	5.54E-07
95%ile	0.24	0.12	2356160	262958	1.72	1.05	8.62E+00	7.56E-07
CV	93%	95%	1261%	252%	27%	46%	55%	46%

Beverton-Holt

893/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.27	0.10	905221	110012	0.73	0.94	3.63E+06	4.05E+05
Mean	0.14	0.04	2544368	134236	0.56	1.15	1.33E+07	7.86E+06
5%ile	0.00	0.00	-3660430	0	0.12	0.81	2.74E+06	8.88E+04
25%ile	0.00	0.00	-129014	0	0.37	0.97	3.48E+06	4.89E+05
50%ile	0.07	0.03	340840	32466	0.56	1.12	4.73E+06	1.26E+06
75%ile	0.19	0.07	784156	99008	0.76	1.29	7.13E+06	3.10E+06
95%ile	0.53	0.15	5209918	207019	0.96	1.62	2.24E+07	1.48E+07
CV	141%	112%	2139%	1401%	47%	22%	767%	979%

Smooth hockeystick

893/1000 Iterations resulted in feasible parameter estimates

	Fcrash	Fmsy	Bmsy	MSY	ADMB Alpha	ADMB Beta	Unscaled Alpha	Unscaled Beta
Deterministic	0.05	0.05	1667670	100386	0.49	0.72	9.34E-01	1.67E+06
Mean	0.02	0.02	299023	53188	0.47	1.00	8.98E-01	2.33E+06
5%ile	0.00	0.00	-2465258	0	0.32	0.59	5.98E-01	1.37E+06
25%ile	0.00	0.00	-1392270	0	0.39	0.71	7.40E-01	1.65E+06
50%ile	0.00	0.00	-850815	0	0.46	0.90	8.69E-01	2.10E+06
75%ile	0.03	0.03	1677300	80144	0.54	1.23	1.02E+00	2.86E+06
95%ile	0.10	0.09	3515386	242052	0.68	1.71	1.28E+00	3.98E+06
CV	170%	168%	1230%	176%	24%	35%	24%	35%

Per recruit

	F35	F40	F01	Fmax	Bmsypr	MSYpr
Deterministic	0.12	0.10	0.13	0.21	0.54	0.03
Mean	0.16	0.13	0.12	0.22	0.50	0.01
5%ile	0.05	0.05	0.01	0.07	0.21	0.00
25%ile	0.11	0.10	0.10	0.18	0.31	0.00
50%ile	0.16	0.14	0.13	0.21	0.41	0.00
75%ile	0.20	0.17	0.15	0.25	0.54	0.02
95%ile	0.26	0.22	0.18	0.34	0.76	0.06
CV	41%	41%	37%	66%	124%	163%

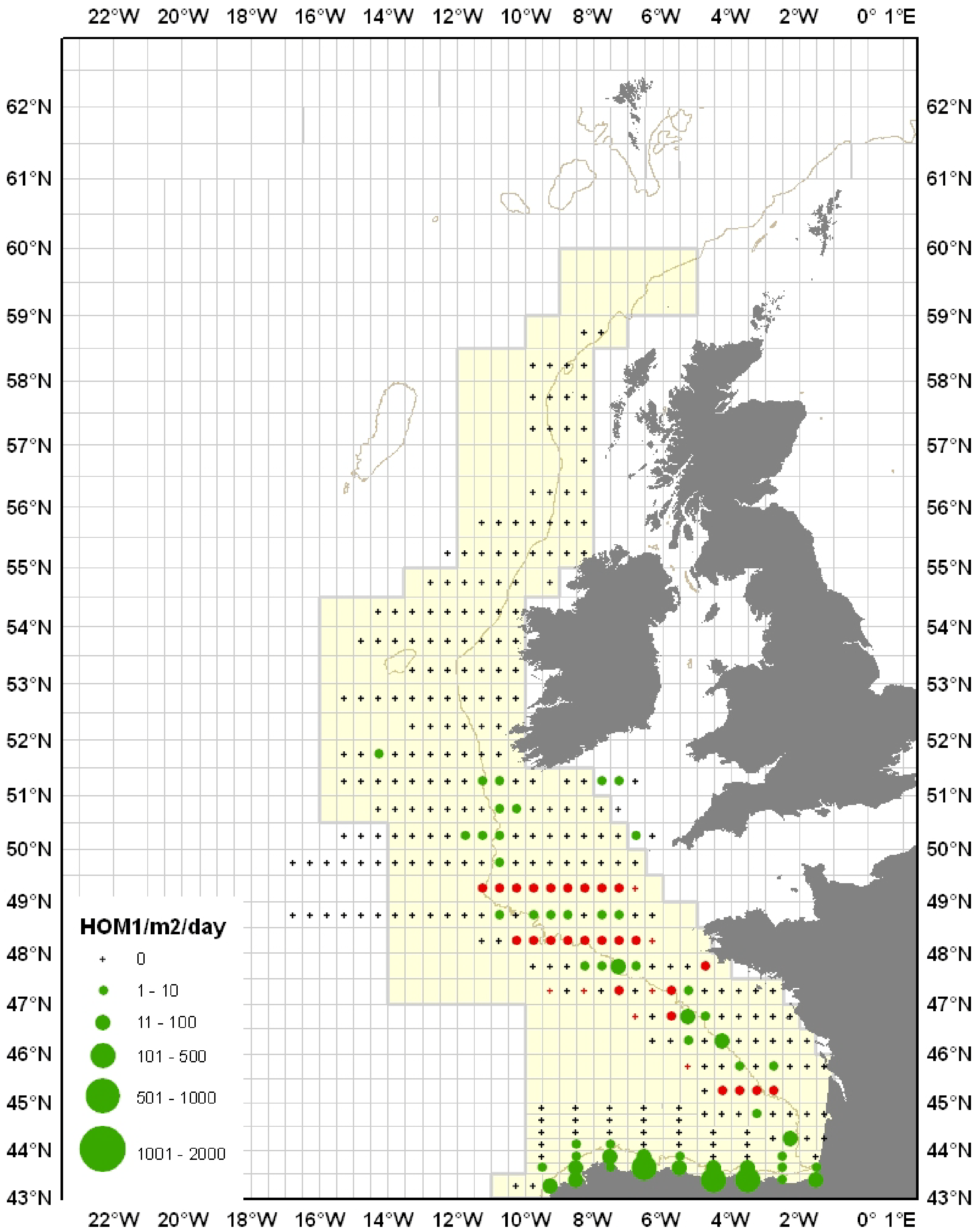


Fig. 5.2.2.1: Horse mackerel egg production by half rectangle for period 2 (8th March – 11 th April). Filled green circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

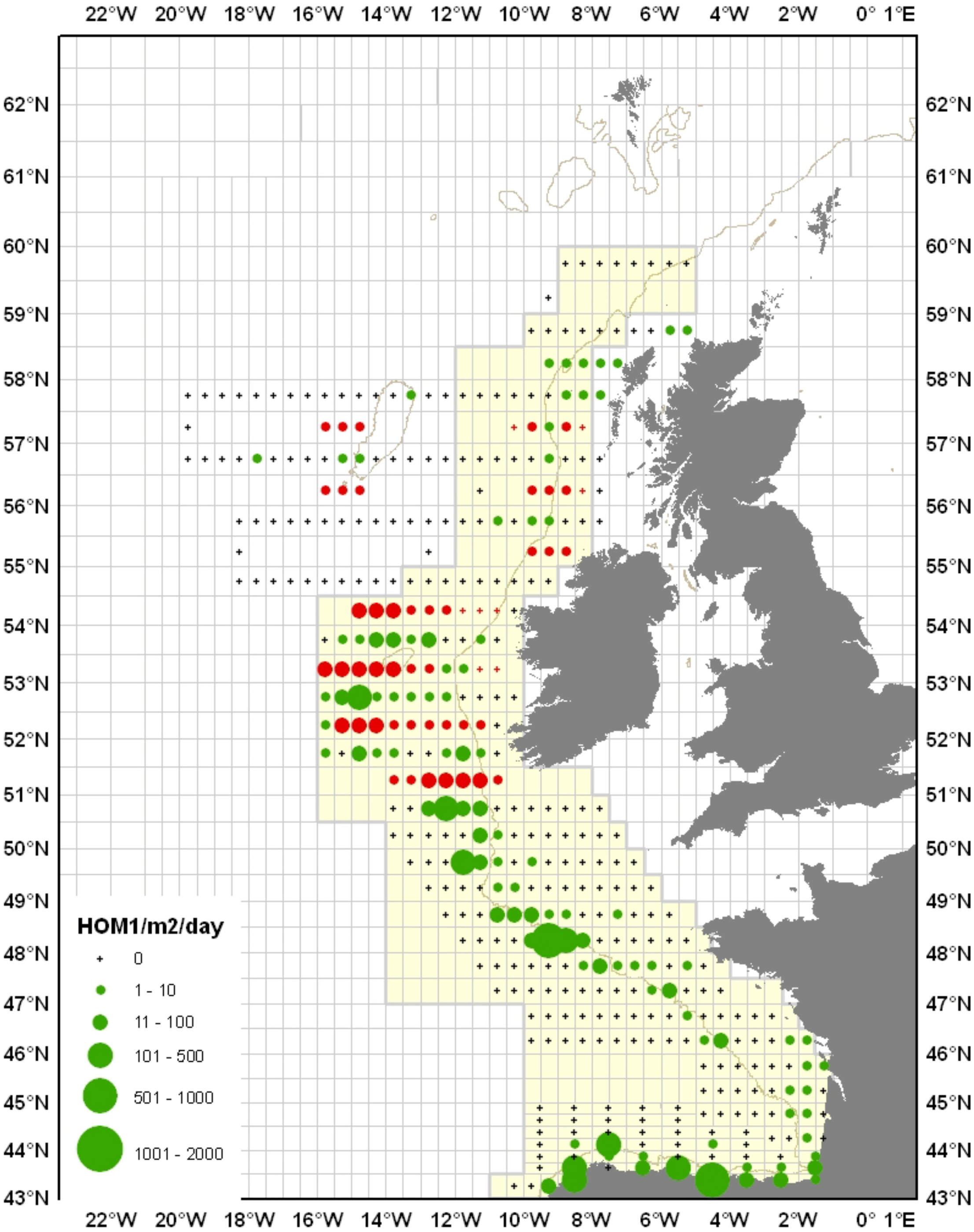


Fig. 5.2.2.2: Horse mackerel egg production by half rectangle for period 3 (12th April – 9th May). Filled green circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

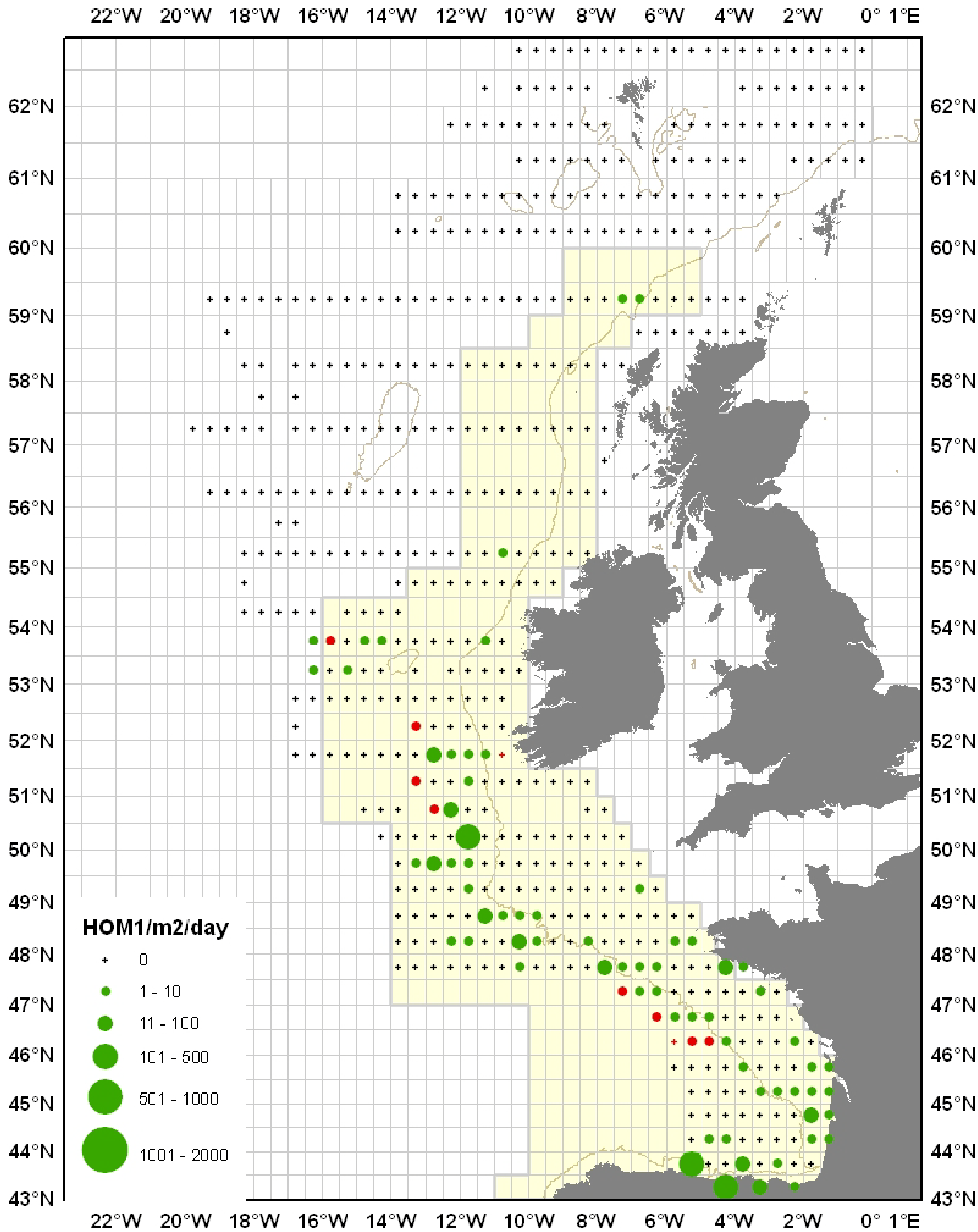


Fig. 5.2.2.3: Horse mackerel egg production by half rectangle for period 4 (10th May – 30th May). Filled green circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

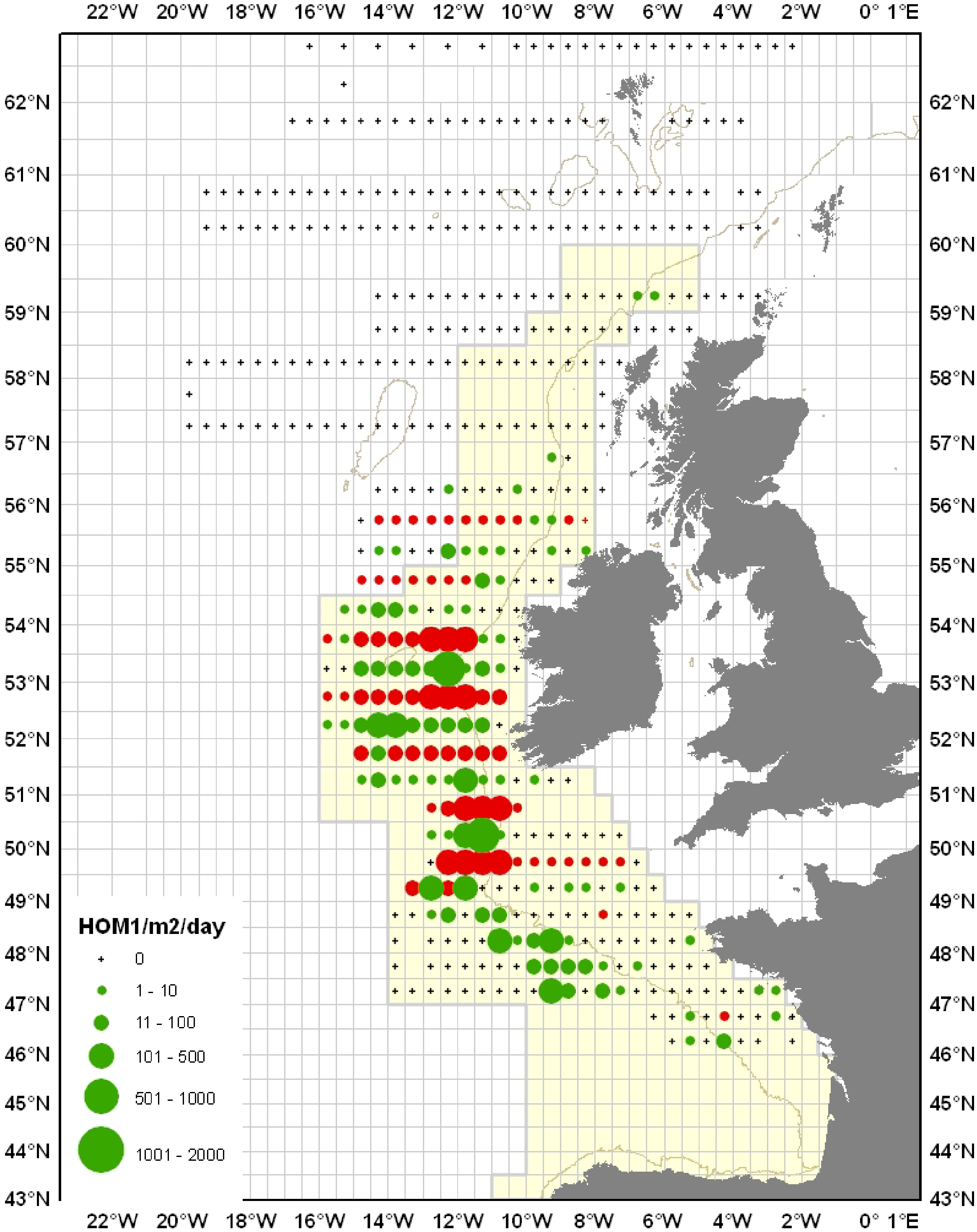


Fig. 5.2.2.4: Horse mackerel egg production by half rectangle for period 5 (31st May – 5th July). Filled green circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

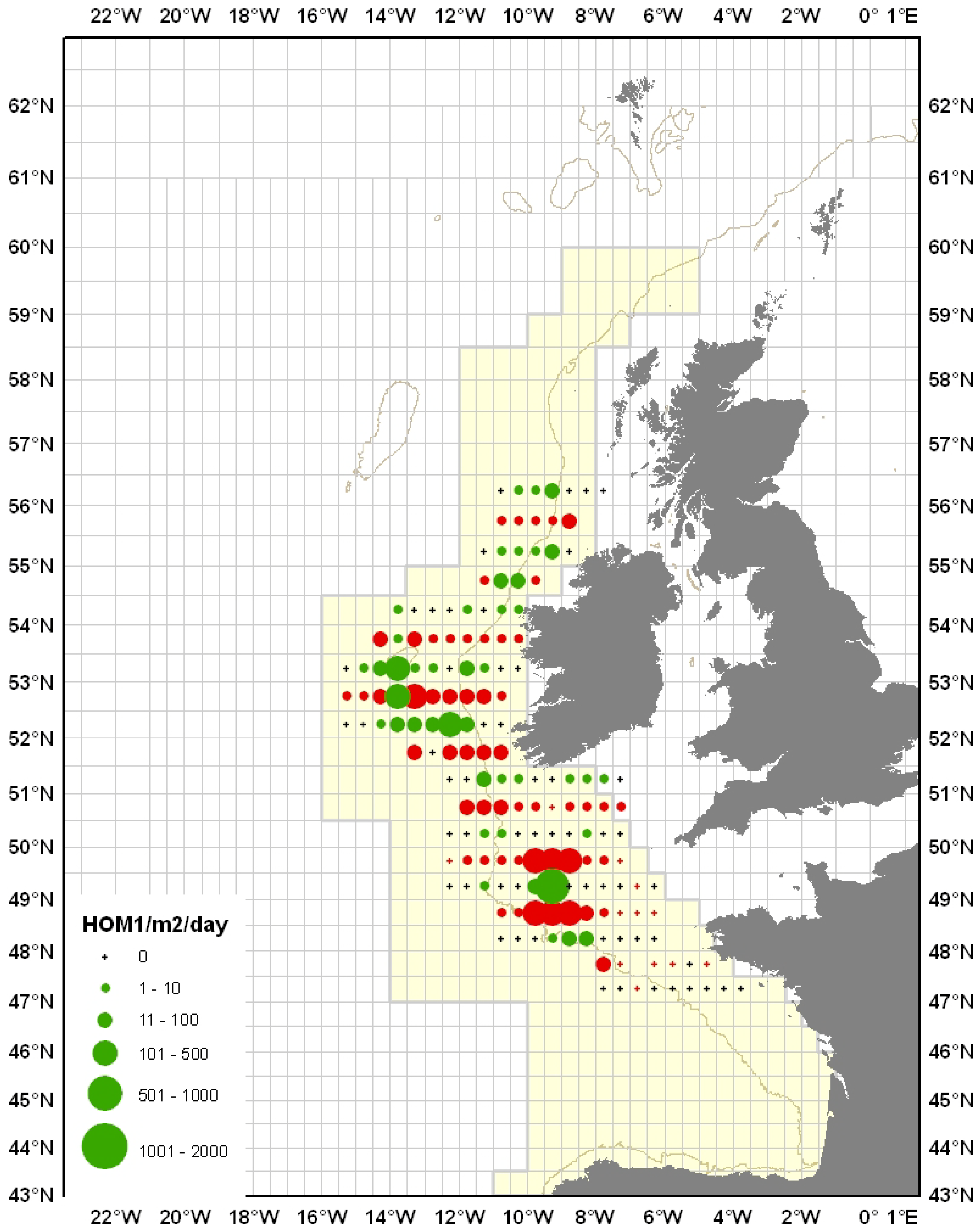


Fig. 5.2.2.5: Horse mackerel egg production by half rectangle for period 6 (5th July – 31st July). Filled green circles represent observed values, filled red circles represent interpolated values, black crosses represent observed zeroes, red crosses interpolated zeroes.

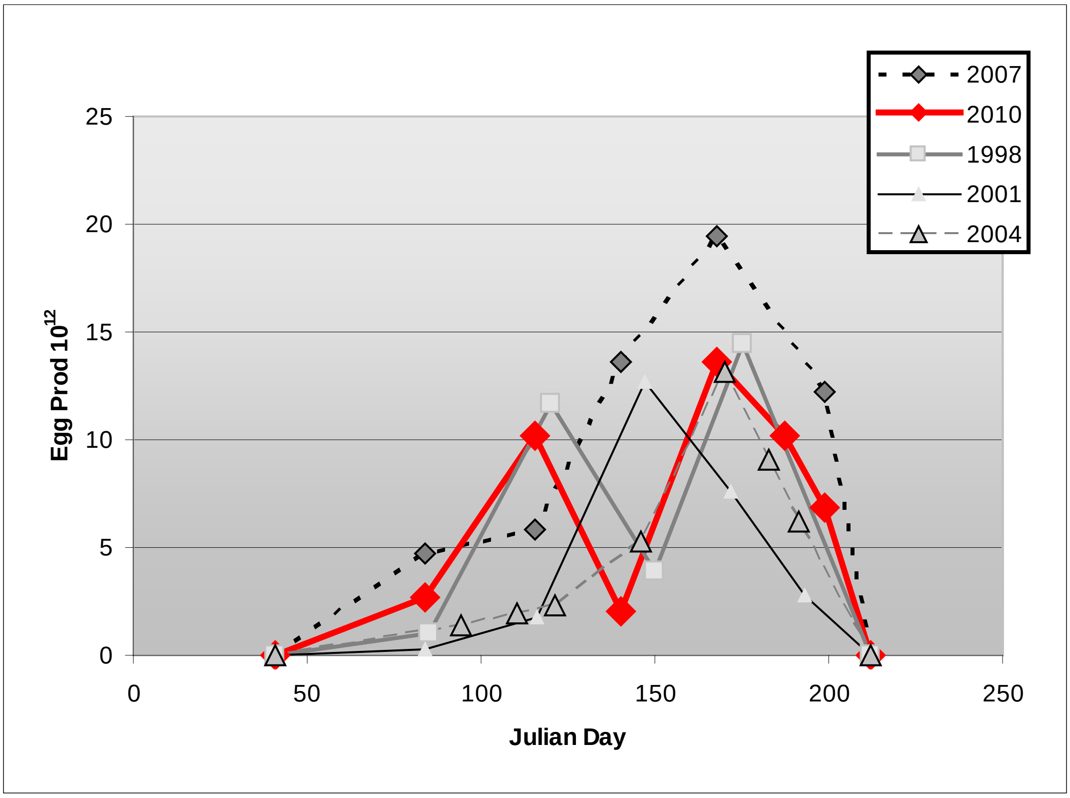


Fig. 5.2.2.6: Provisional annual egg production curve for western horse mackerel. The curves for 1998, 2001, 2004 and 2007 are included for comparison.

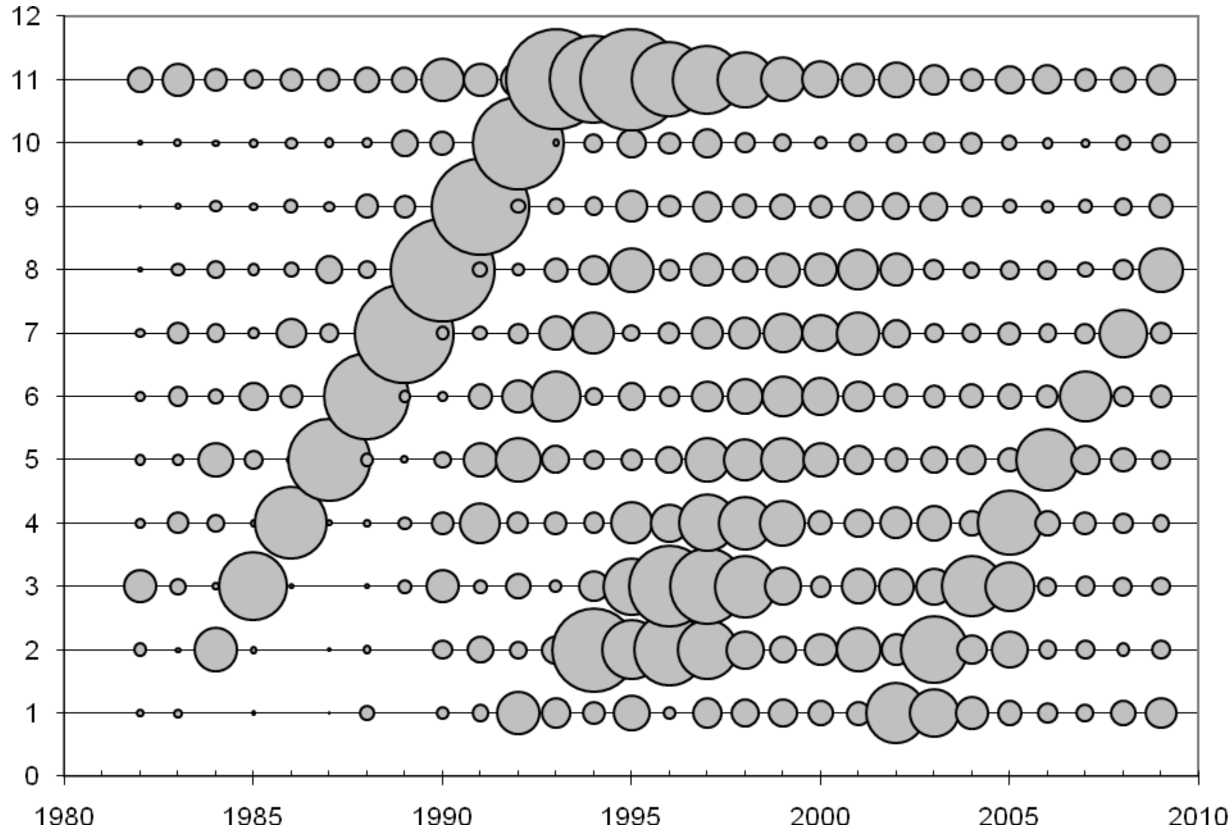


Figure 5.2.5.1: Western horse mackerel. Catch-at-age matrix, expressed as numbers (thousands). The area of bubbles is proportional to the catch number. Note that age 11 is a plusgroup.

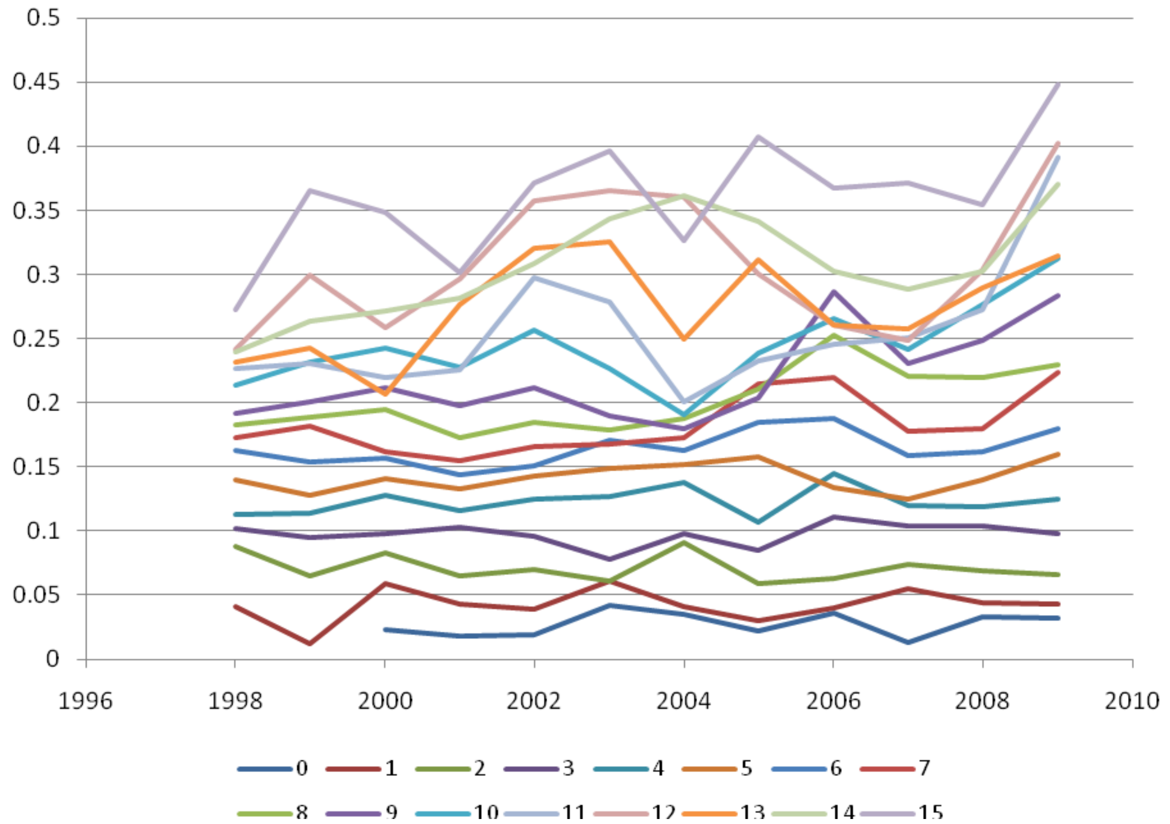


Figure 5.2.6.1: Western horse mackerel. Weight in the catch by year.

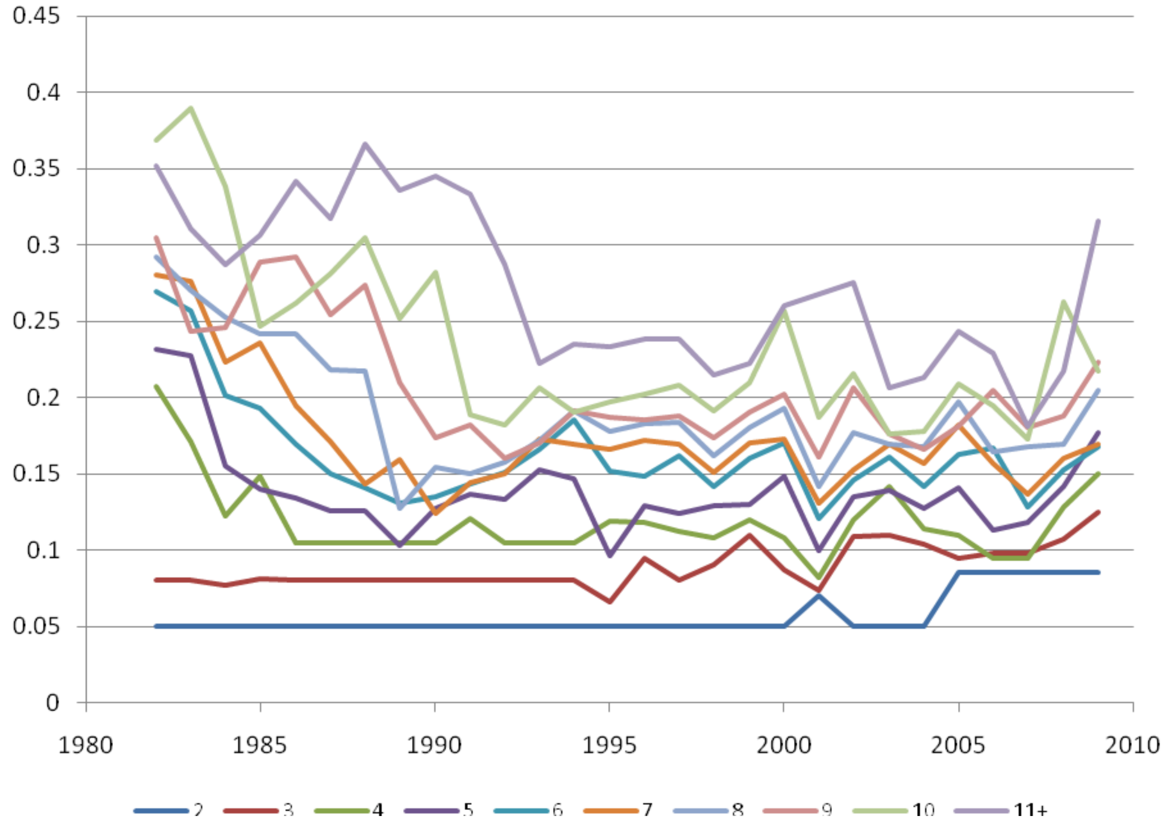


Figure 5.2.6.2: Western horse mackerel. Weight in the stock by year.

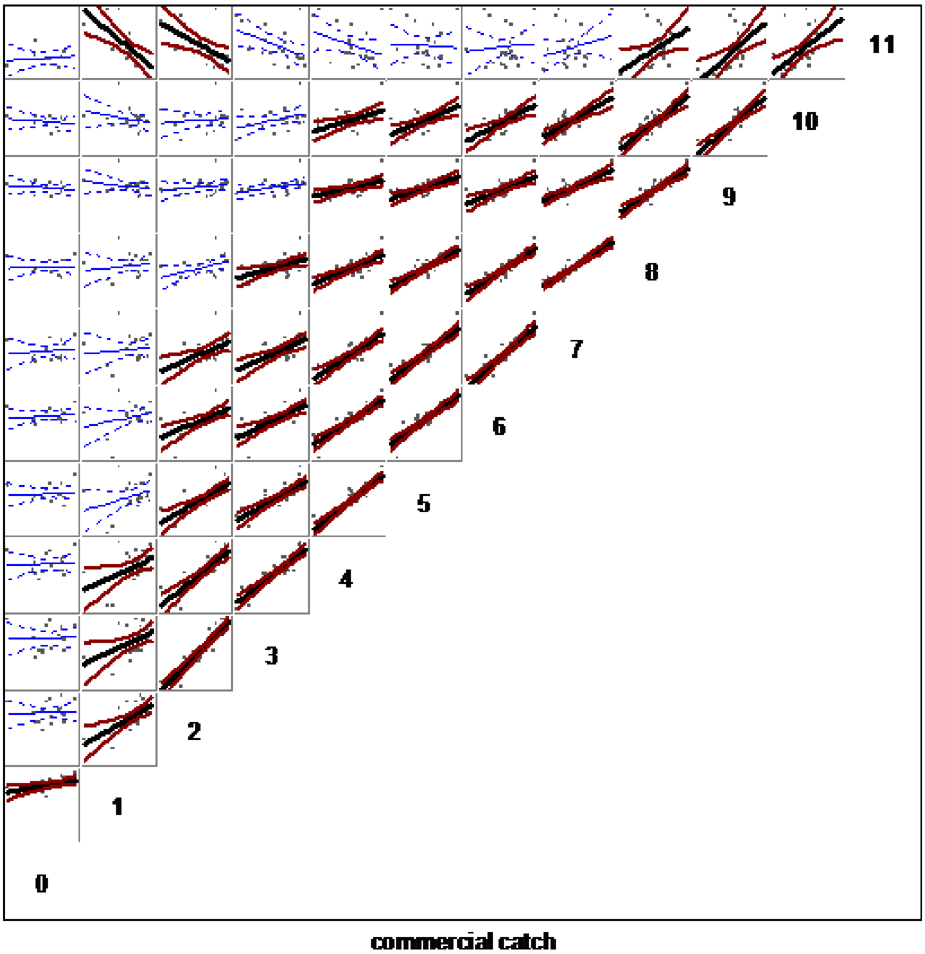


Figure 5.2.8.1: Western horse mackerel. Data exploration. Within-cohort consistency in the catch-at-age matrix, shown by plotting the log-catch of a cohort at a particular age against the log-catch of the same cohort at subsequent ages. Thick lines represent a significant ($p<0.05$) regression and the curved lines are approximate 95% confidence intervals.

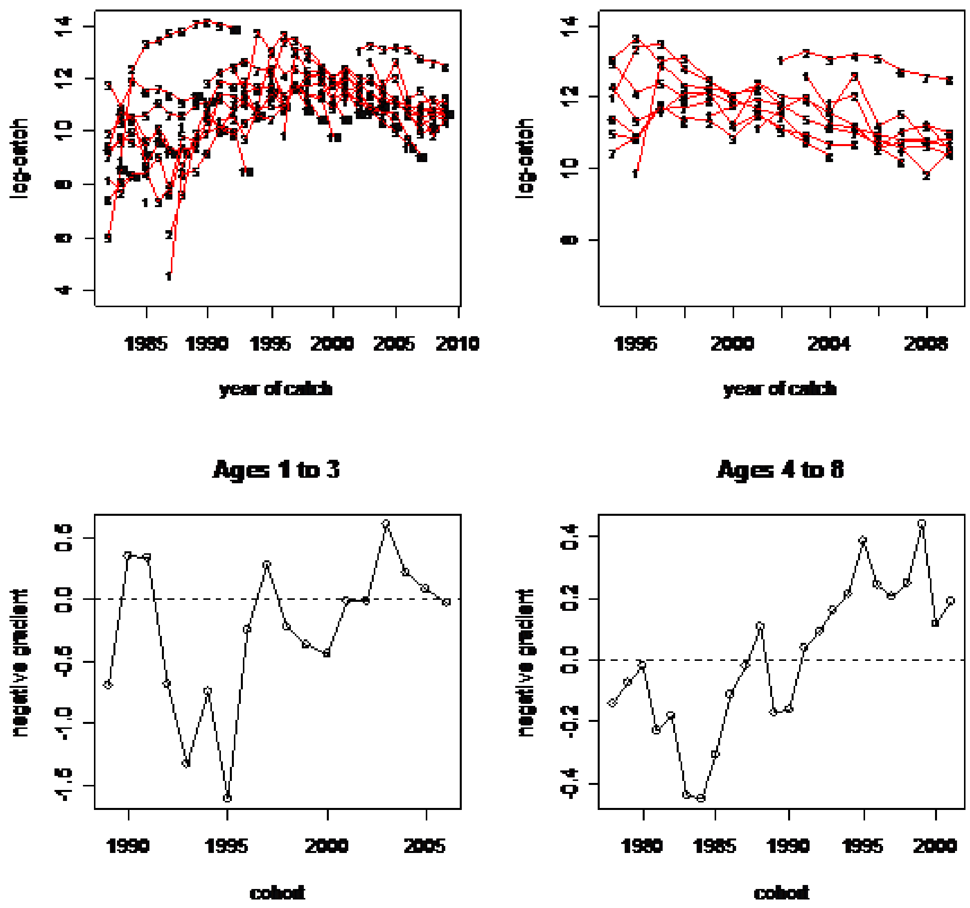


Figure 5.2.8.2: Western horse mackerel. Data exploration. Log-catch cohort curves (top row shows the full time series on the left, and the most recent period for ages 1-8 on the right) and the associated negative gradients for each cohort across the reference fishing mortality of ages 1-3 (bottom left and 4-8 (bottom right).

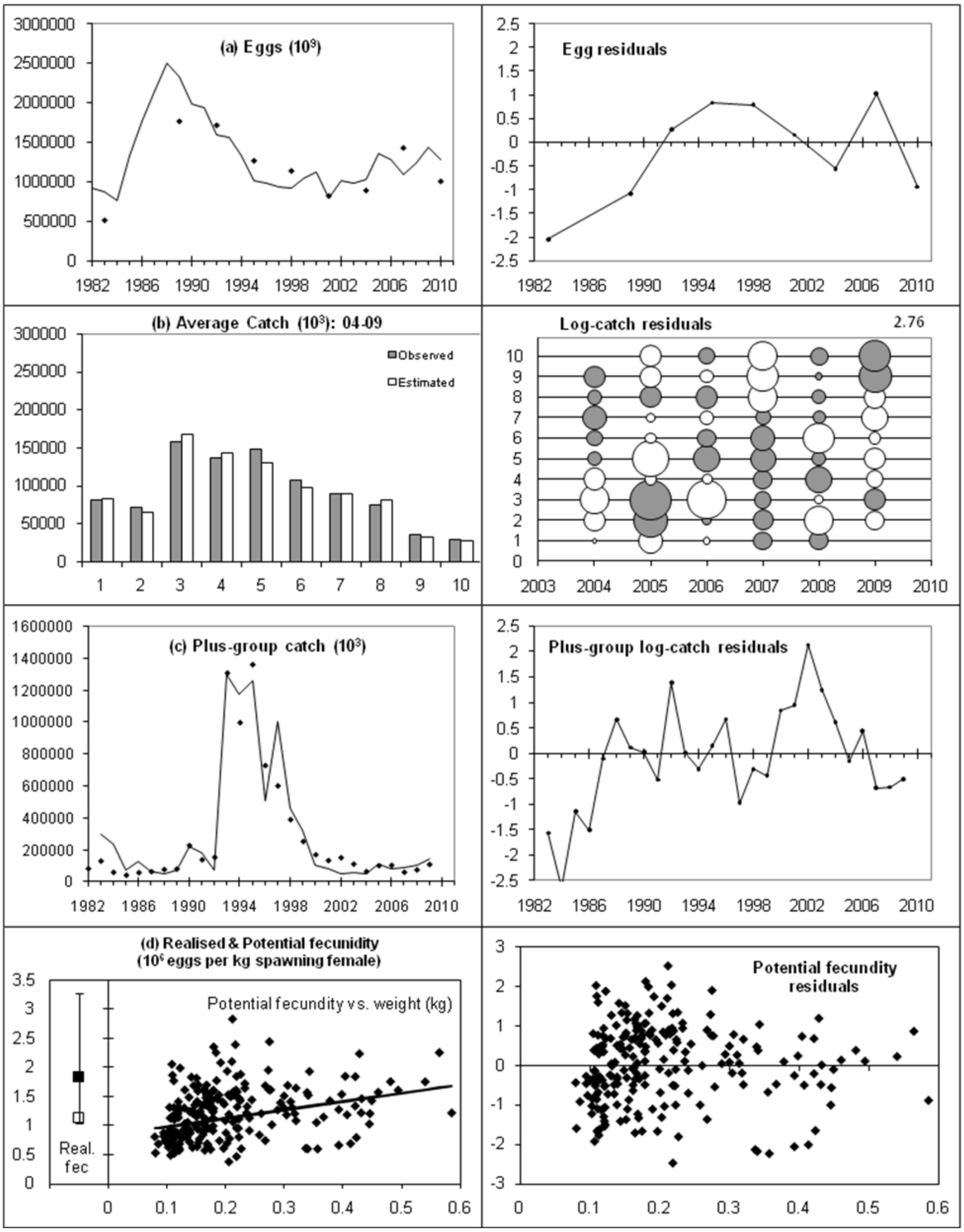


Figure 5.2.9.1: Western horse mackerel. SAD model with 2004-2009 separable window. Model fits to data for the five components of the likelihood, corresponding to (a) the egg estimates, (b) the catches in the separable period, (c) to the catches in the plus-group, and (d) population-mean realised fecundity (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.

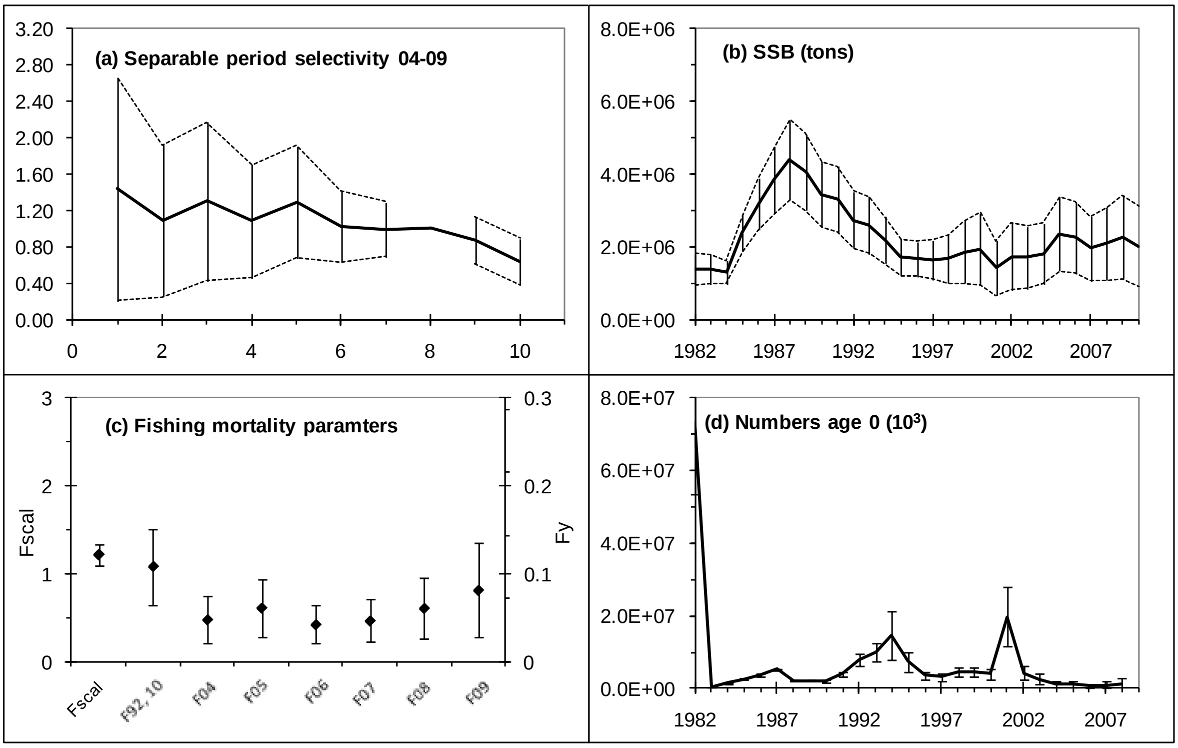


Figure 5.2.9.2: Western horse mackerel. Model with 2004-2009 separable window. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year effects for the separable period, F_y), and (d) numbers at age 0. The error bars are two standard deviations (indicating roughly 95% confidence bounds). The final SSB estimate assumes the same fishing mortality as in the previous year.

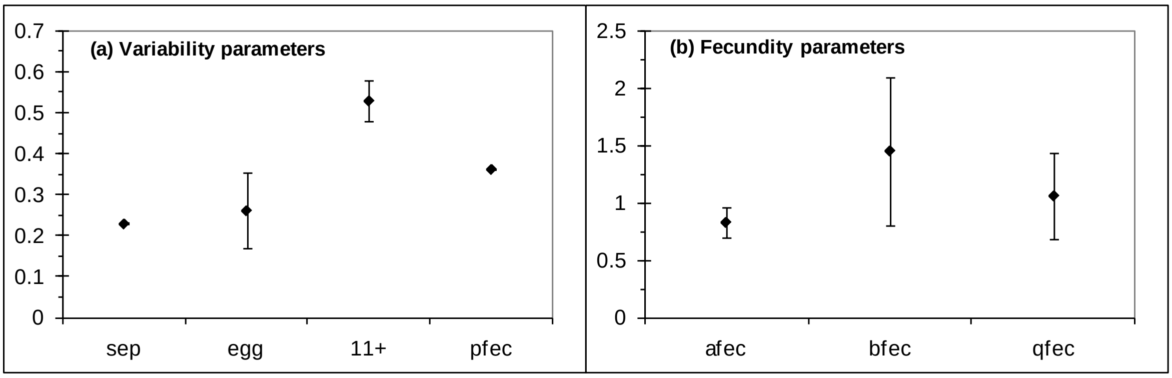


Figure 5.2.9.3: Western horse mackerel. Model with 2004-2009 separable window. Estimates for some key parameters, with (a) corresponding to variability parameters, plotted as standard deviations, for four components of the likelihood (σ_{sep}, σ_{egg}, σ_{11+} and σ_{pfec}), and (b) the fecundity parameters a_{fec}, b_{fec}, q_{fec}. The error bars are two standard deviations (indicating roughly 95% confidence bounds).

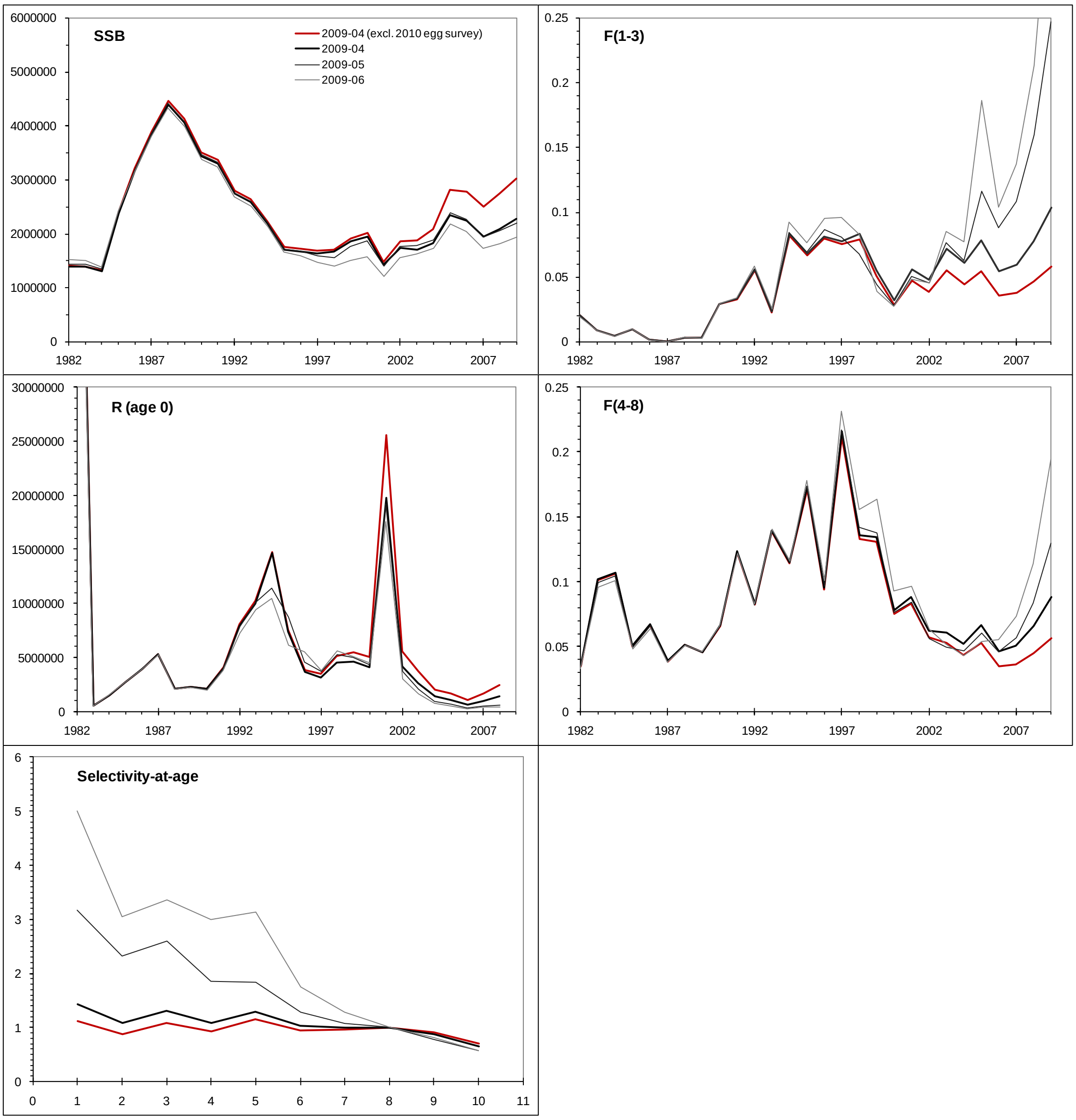


Figure 5.2.9.4: Western horse mackerel. Sensitivit of the SAD model to the length of the separable window. Trajectories of SSB, recruitment (age 0), F(1-3) and F(4-8) are shown in the top four plots, while the bottom plot shows selectivity-at-age.

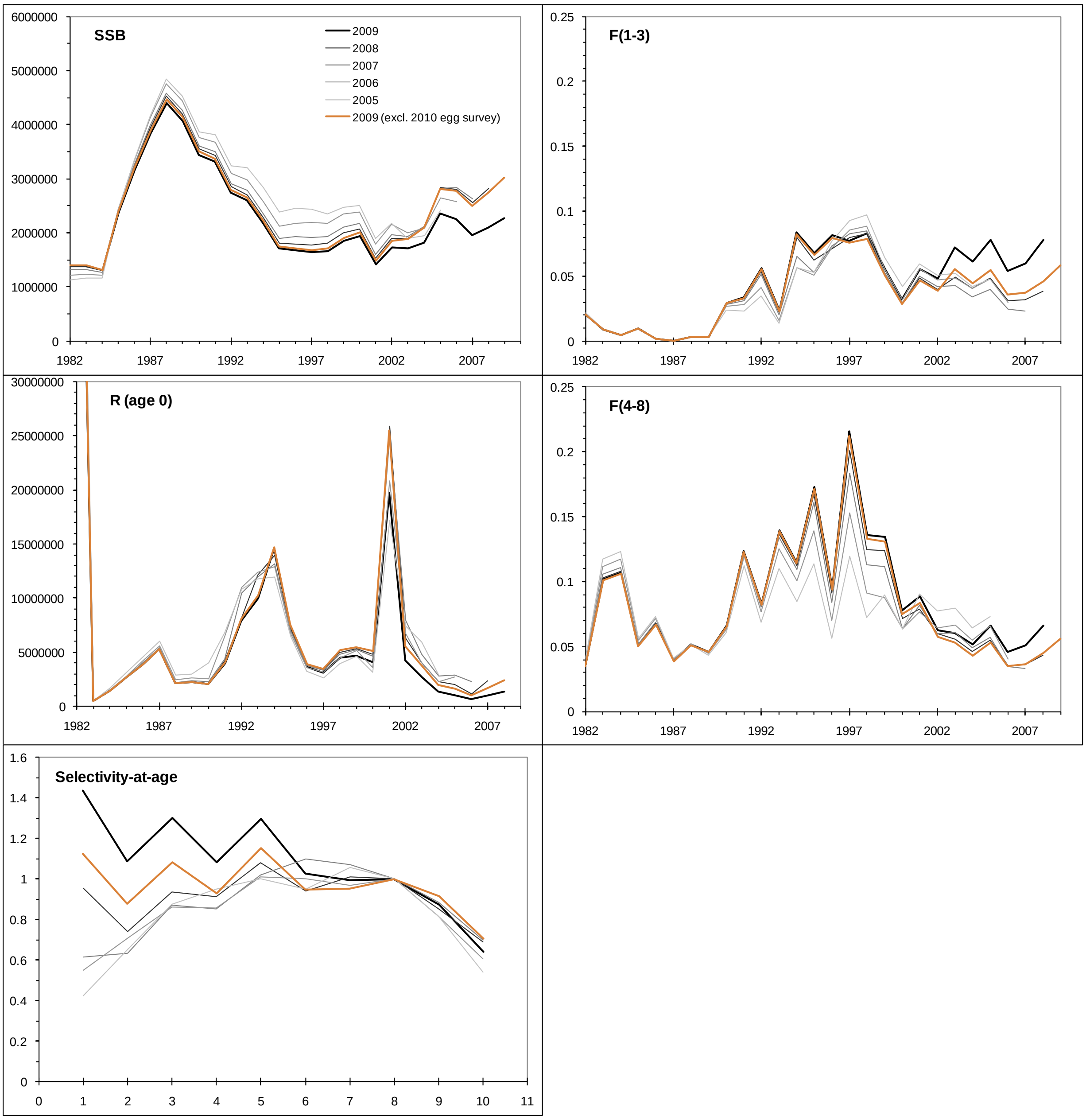


Figure 5.2.9.5: Western horse mackerel. 5-year retrospective bias for the case where the length of the separable window is kept at 6 years (the year shown is the final year shown of the window). For comparison purposes the 2009 assessment is shown with the exclusion of the 2010 egg estimate. Trajectoris 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.

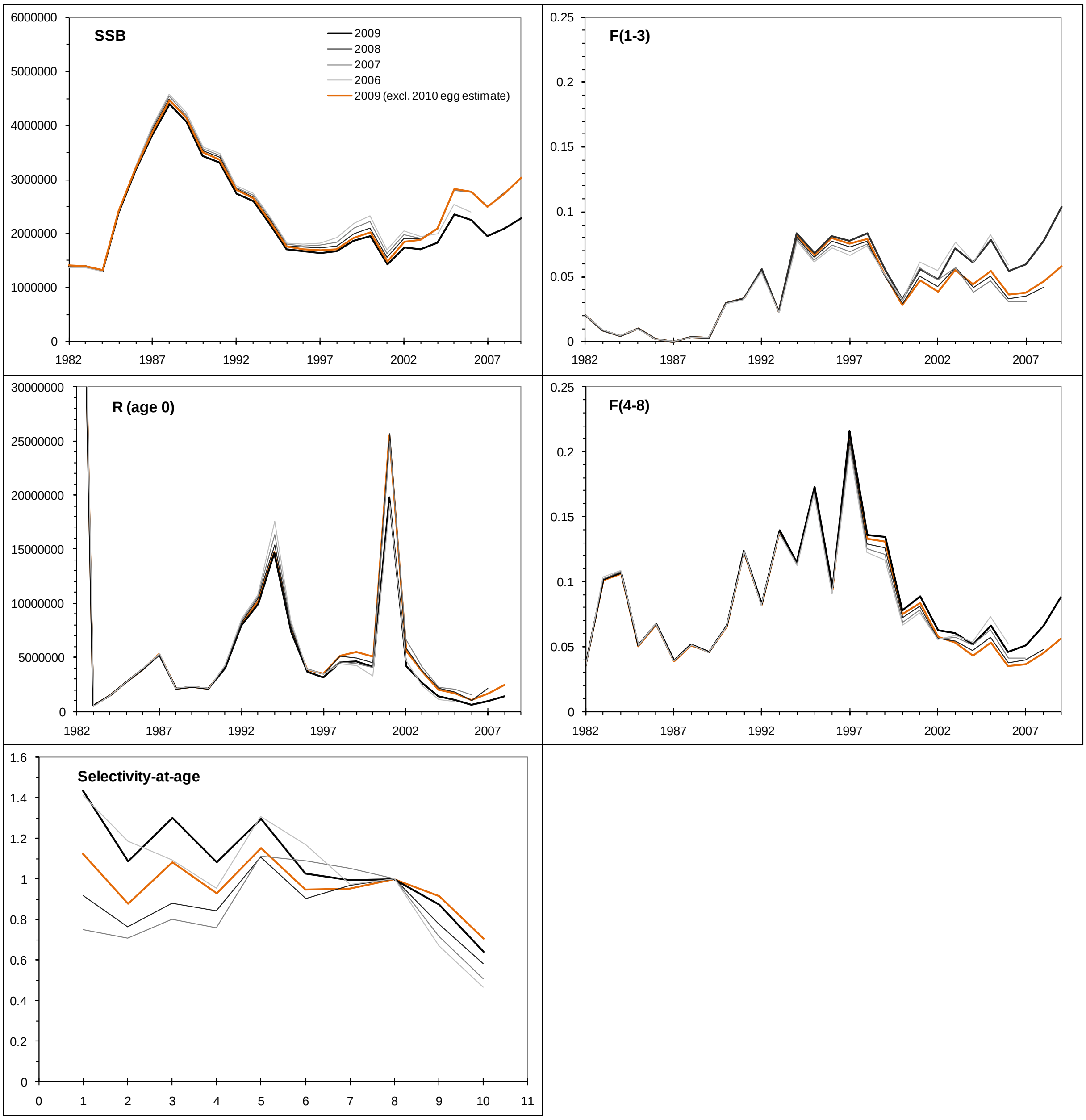


Figure 5.2.9.6: Western horse mackerel. 3-year retrospective bias for the case where the starting year of the separable window is kept at 2004, so that the window decreases in length as more years are dropped (the year shown is the final year of the window). For comparison purposes the 2009 assessment is shown with the exclusion of the 2010 egg estimate. 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.

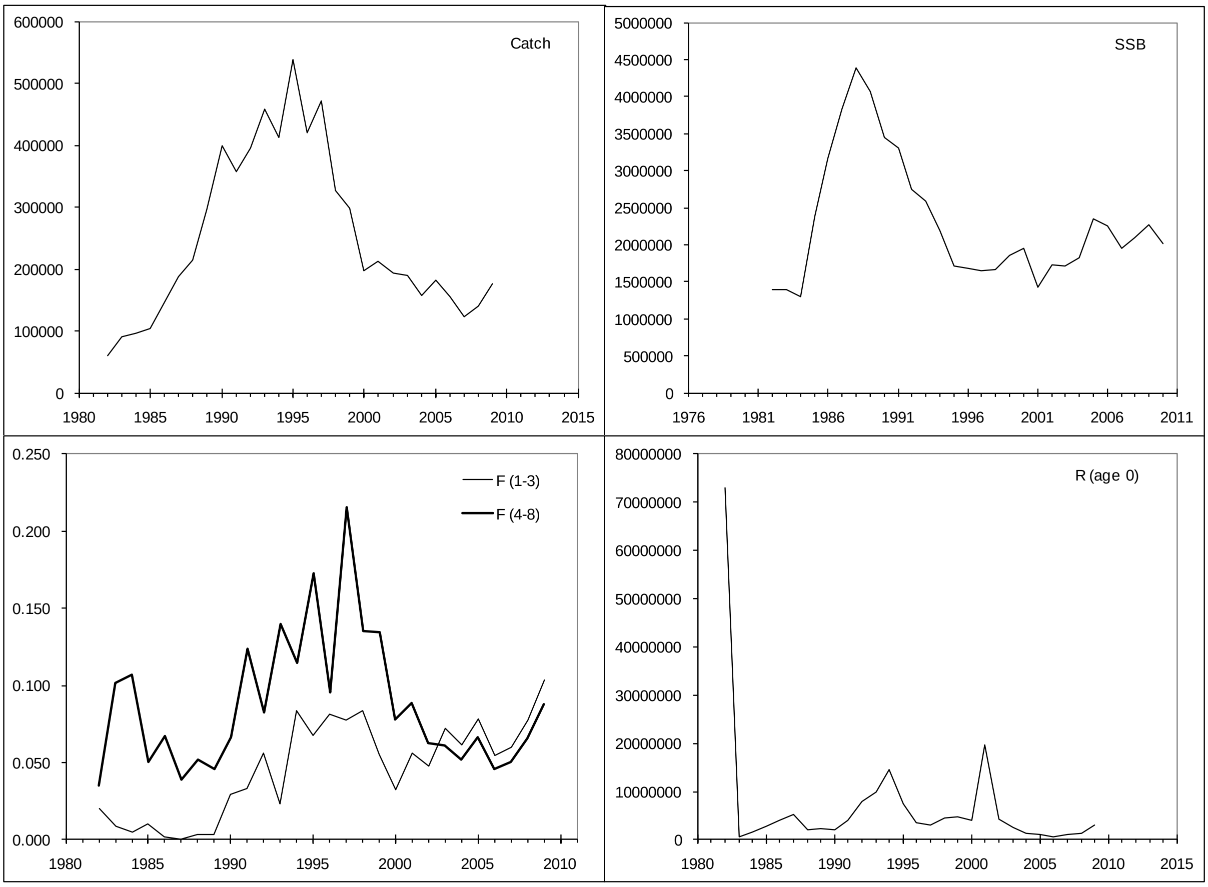


Figure 5.3.1.1: Western horse mackerel. Final assessment. Stock summary. Plots of catch, SSB, recruitment (age 0) and fishing mortality (average for 1-3 and 4-8). SSB and catch are in tons, and recruitment is in thousands. The final SSB estimate assumes the same fishing mortality as in the previous year.

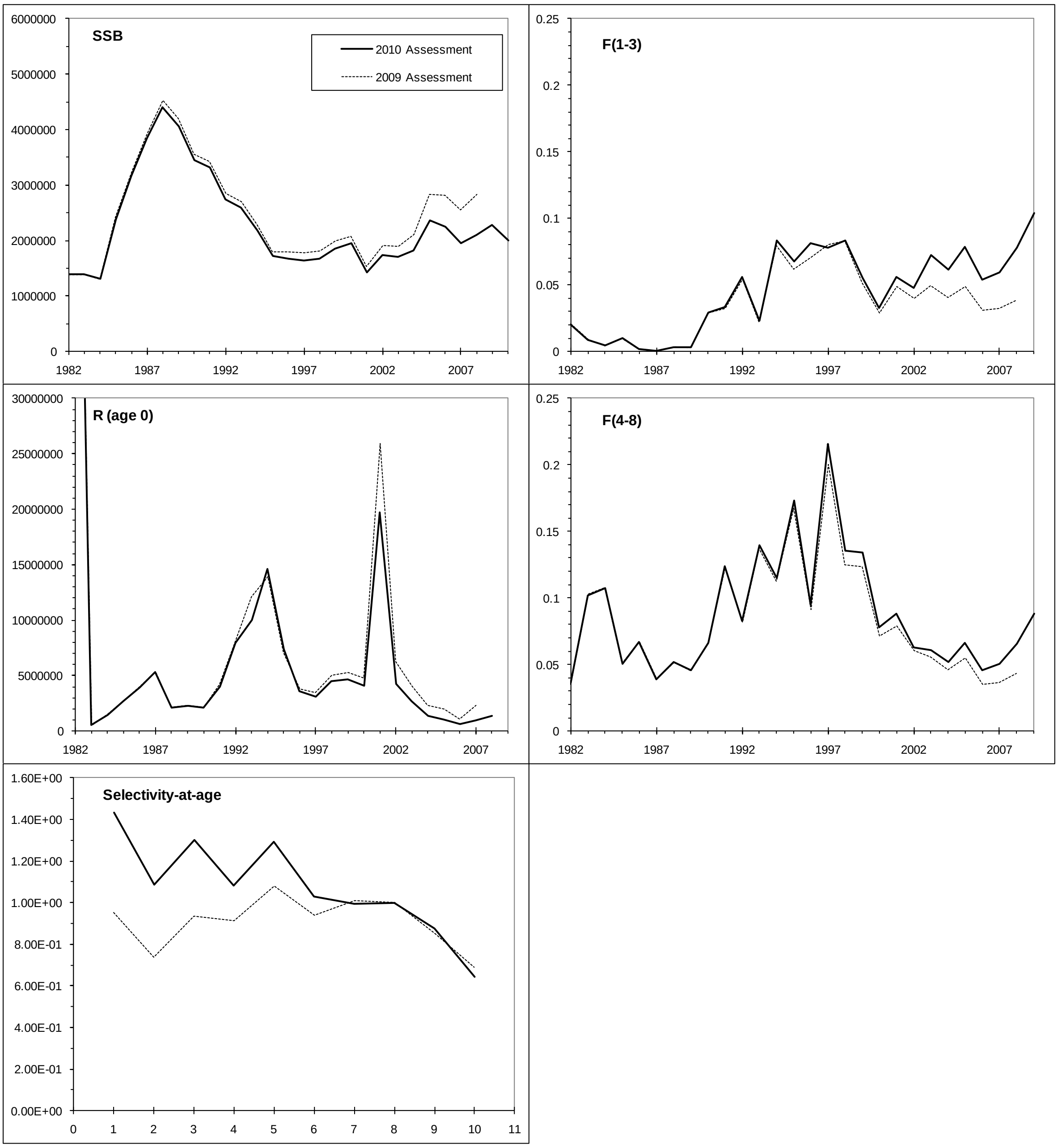


Figure 5.6.1: Western horse mackerel. Comparison of the final assessment this year with that of last year. Plots of SSB, recruitment (age 0), fishing mortality (average for ages 1-3 and 4-8) and selectivity-at-age for the separable period (2003-2008 for the 2008 assessment, and 2004-2009 for the 2009 assessment). SSB values are in tons, and recruitment is in thousands.

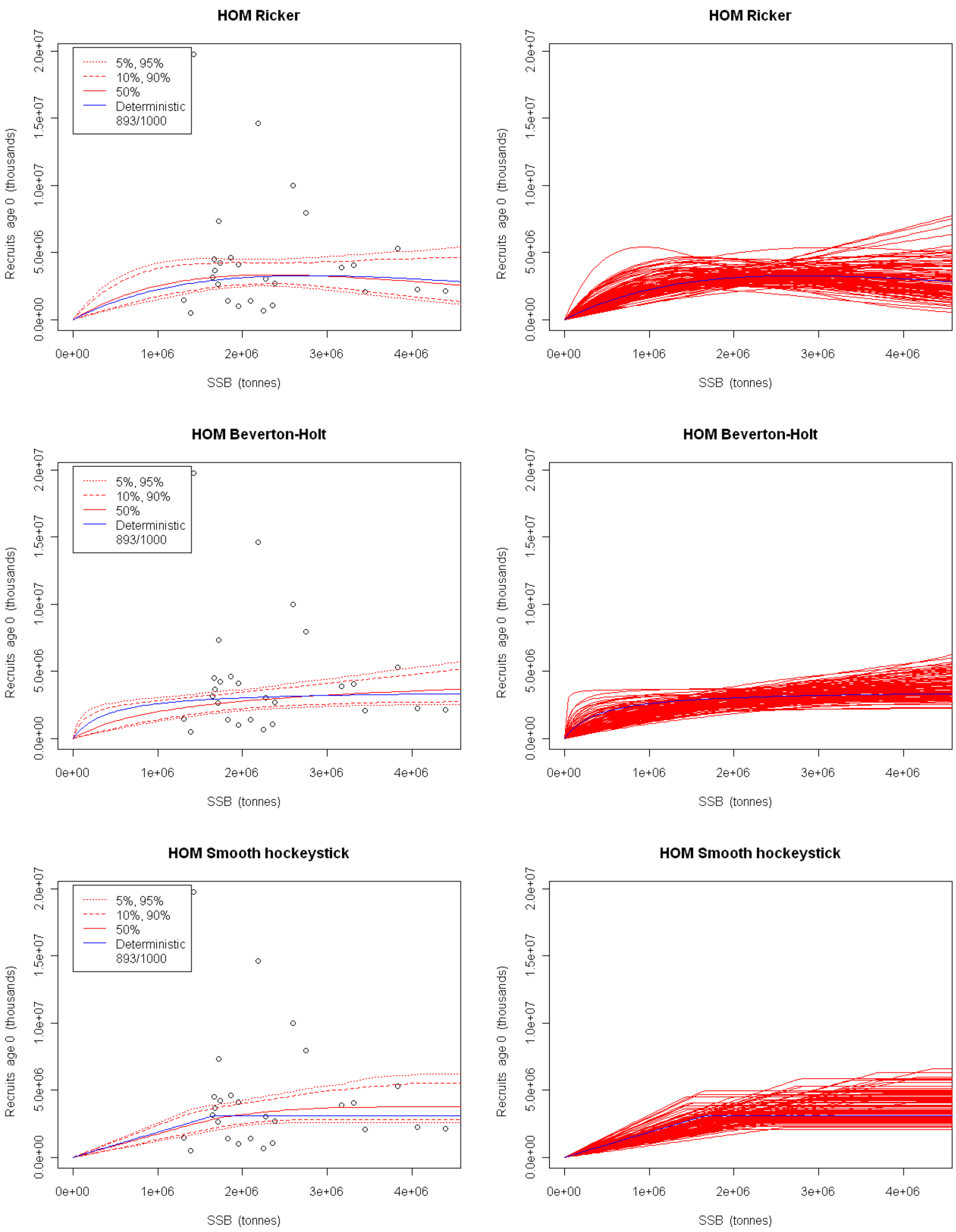
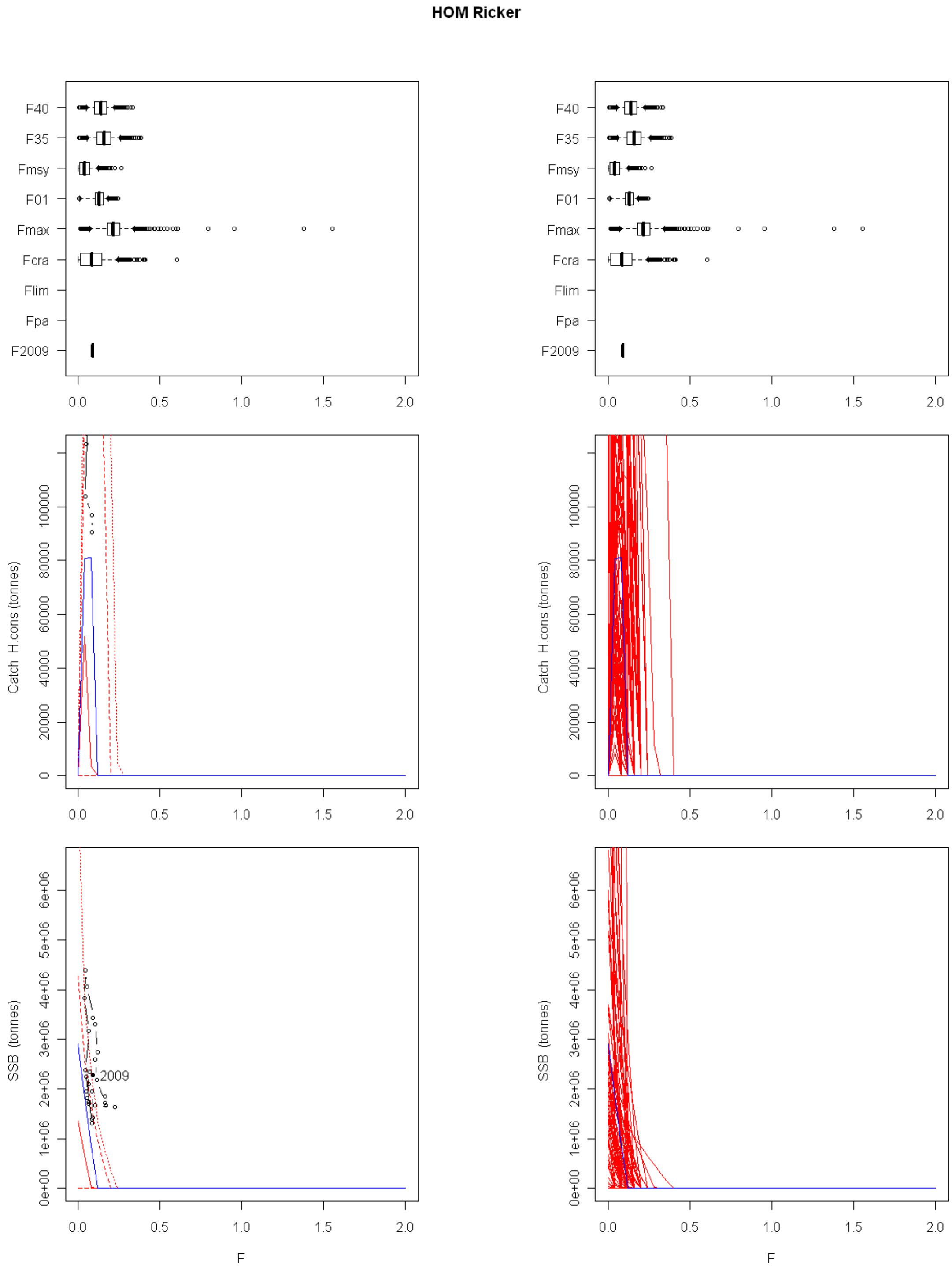
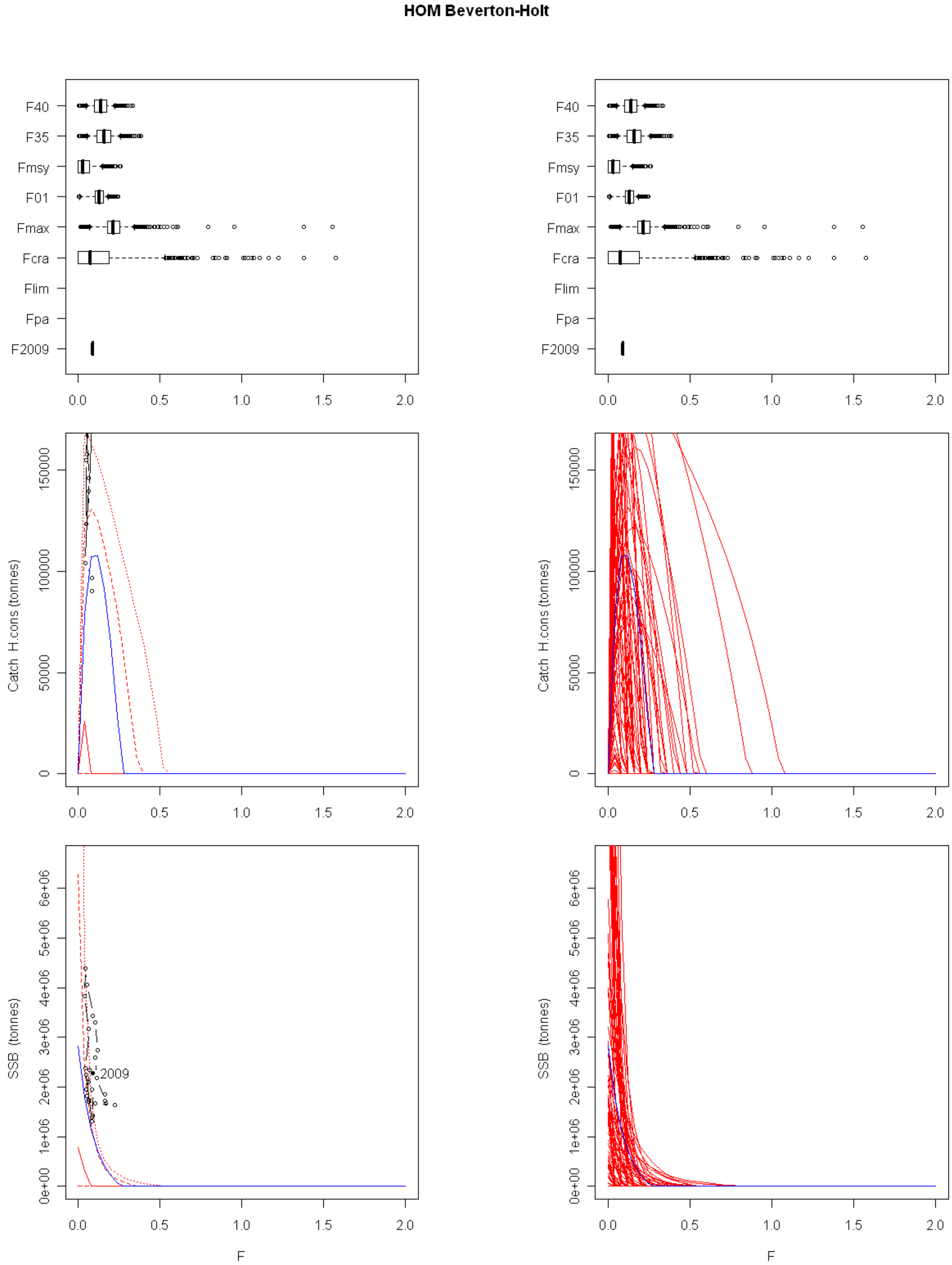


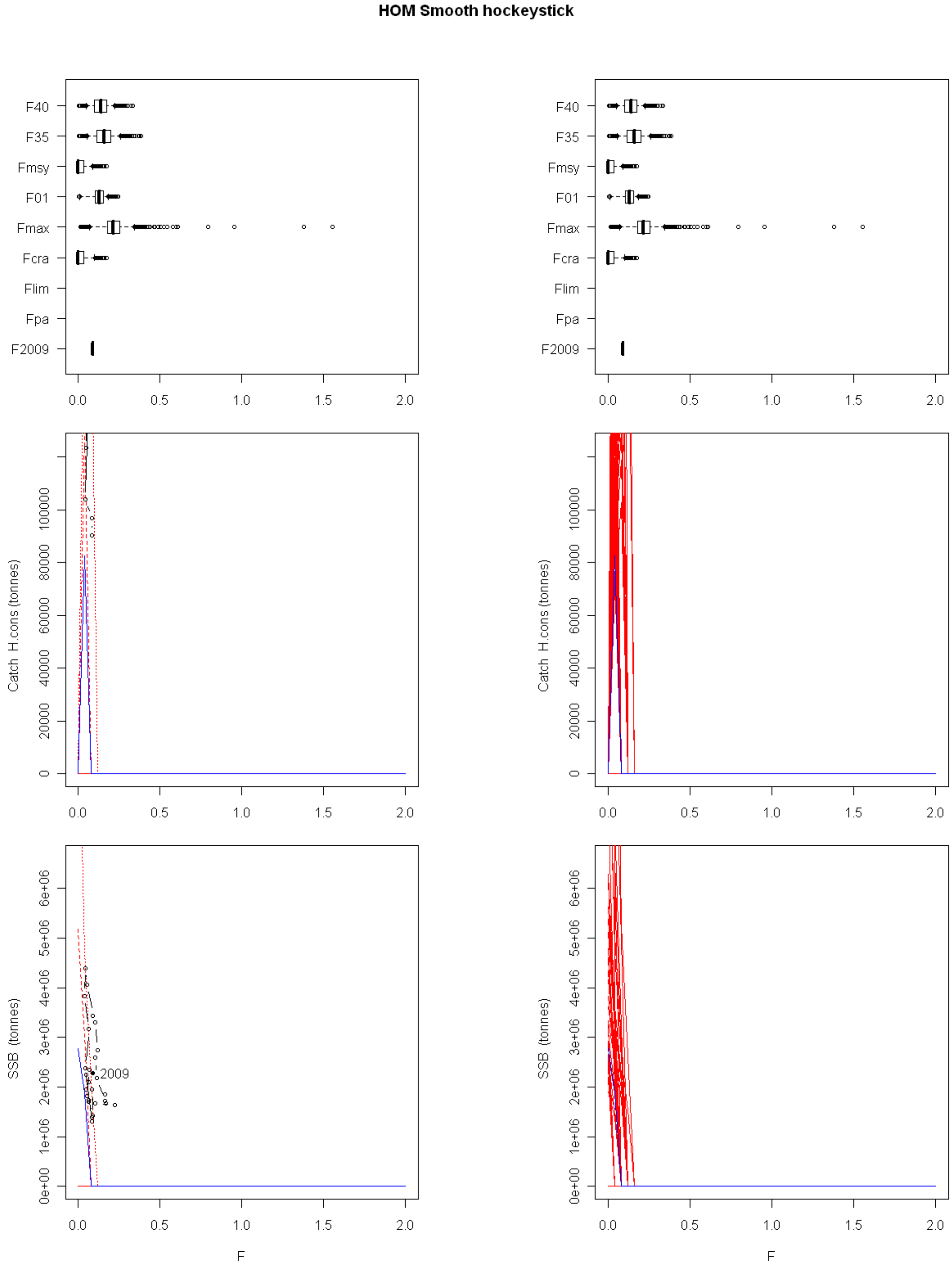
Fig. 5.7.1.1. Deterministic and stochastic (taking into account uncertainty in weights, selectivity and maturity at age) stock recruit relationship fits for the western horse mackerel. Stock-recruit pairs are from the period 1983-2009.


HOM Ricker
F40
F35
Fmsy
F01
Fmax
Fcra
Flim
Fpa
F2009
Catch H.cons (tonnes)
SSB (tonnes)
2009
F

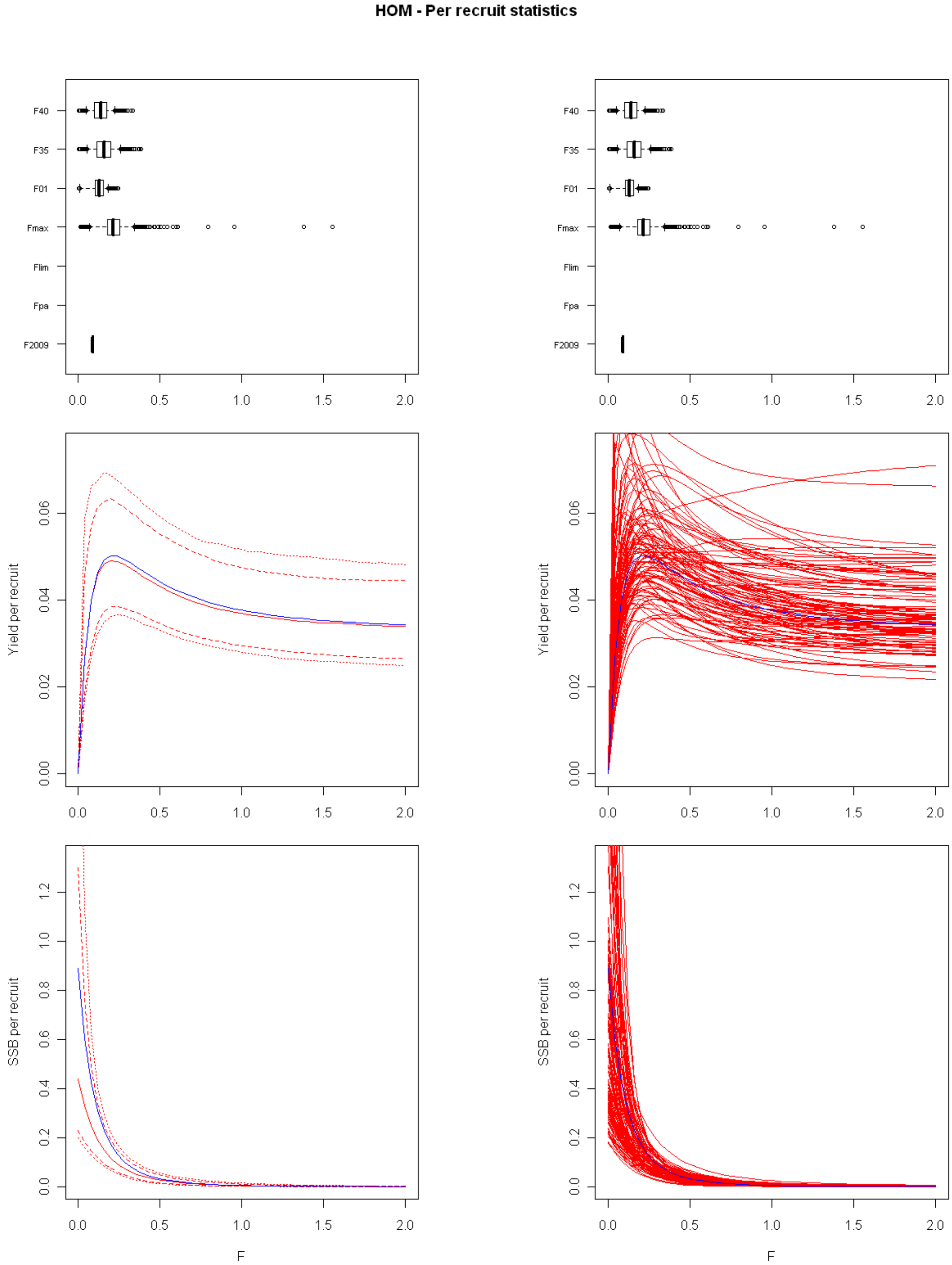
a. Ricker



b) Beverton and Holt



c) Smooth Hockystick



d) Yield-per-recruit curve

Fig. 5.7.1.2. The relationship between F and yield-per-recruit (YPR) and spawning stock biomass (SSB) per recruit for the western horse mackerel stock for the 3 stock recruit models a) Ricker, b) Beverton and Holt and c) Smooth hockeystick. and d) the yield-per-recruit curve.

6 Southern Horse Mackerel (Division IXa)

6.1 ICES advice applicable to 2009 and 2010

In 2009 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. ICES further stated that the recent level of catches does not seem to be detrimental to the stock. ICES therefore recommends that catches in 2010 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 Management applied in 2009 and 2010

In 2009, the horse mackerel TAC for Divisions IXa and VIIIc was set at 57750 tons. In 2010 the EU followed ICES advice and established separate TACs for Div. VIIIc and IX, corresponding the latter to the southern stock of horse mackerel. This TAC for 2010 was set at 31142 tons.

6.3 Scientific data

6.3.1 The fishery in 2009

Catch allocation between Subdivisions for this stock is described in the Stock Annex. The definition of the ICES Subdivisions was set in 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 – 2009, 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 stock 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 2009 showed an increase of 3000 t in relation to 2008.

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

No series of catch-per-unit-effort is currently available to be used for stock assessment.

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 2009, there is not a clear pattern, with some ages showing a decrease and others an increase 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 6.3.4.2).

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 (Figure 6.3.1.2). 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 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

Given that last year's stock assessment has been rejected by the Advice Drafting Group and a benchmark assessment is scheduled for early 2011, no definitive stock assessment was done in this year's meeting. Therefore, the data exploration carried out is part of the preparatory work for the forthcoming benchmark assessment.

The model used in last year's assessment has been updated with one more year of data, and the assessment was run using the same parameterisation. As in last year, the catch data was separated by fishing fleet (6 fleets) and a catchability parameter, constant in time, was estimated for each age. The assessment diagnostics were very similar to last year’s ones, with a clear lack of fitting to the catch data of one of the fishing fleets (Spanish bottom-trawl) and also high residuals in the fitting of the abundance indices from the combined bottom-trawl survey. The Hessian matrix estimated from the model fitting appeared not to be definite positive, indicating a lack of convergence to a local minimum.

Given the lack of an acceptable fit with this model/parameterisation, the Group suggested that several different models, with different parameterisations, should be applied during this meeting and their results compared. Therefore, as suggested by the Group, the following methods were applied to this stock:

- Extended Survivors Analysis (XSA)
- Integrated Catch-at-age Analysis (ICA)

- ASAP with aggregated catch-at-age data and different parameterisations for the abundance data.

The XSA trials provided results similar to the ones obtained several years ago, with a dataset with less years of data. Convergence of the model was only obtained with an F-shrinkage of 0.4. Several runs were made with different options (with or without tappered time-weighting, with or without shrinkage for the young ages, etc), but the pattern of the catchability residuals of the bottom-trawl survey remained similar, with high residuals and a clear year-effect (some years with all negative residuals while other years had all positive residuals).

With ICA, two trials were made with different ways of using the abundance data. In the first trial, no age disaggregated data was used, and the catch in number/hour of the bottom-trawl survey was turned into biomass and aggregated for each year. Runs with different age-weighting were made: firstly giving lower weights to ages 0 and 1, and then giving equal weights to all ages. Age-weighting did not have a noticeable influence in the final result, as the diagnostics from these runs were similar. The second trial was made using the survey data as an age-structured abundance index. In this trial, the same weight was given to all ages. In these trials, separability was assumed for the whole assessment period. Further experiments with shorter separable periods provided much worse fitting diagnostics. Figure 6.5.1 shows the catch-at-age and survey data residuals from the two trials carried out with ICA. In both cases there are clear patterns and very high residuals, especially in the survey data. The age-structured survey data also shows year-effects, with residuals mostly negative or positive in given years.

Finally, one trial was made with ASAP, but in order to reduce the number of parameters (avoiding a possible over-parameterisation), the catch-at-age data were not disaggregated by fleet. Regarding the survey data, and given that the assumption of different catchability for different ages, but constant in time, resulted in a poor fitting to the survey data, a different parameterisation was tried. As it is clear from Figure 6.5.2, there are clear year-effects in the abundance indices from the bottom-trawl surveys, while different ages most probably have different catchabilities. Therefore, a parameterisation assuming separability in the survey data was used, meaning that the parameters that relate observed abundance with the estimated one were the result of a year-effect and an age-effect. Equal weighting was given to all sources contributing to the objective (likelihood) function, except for total catch per year, which was given a weight 100 times higher than for the other sources of data. This weighting did not mean that the objective function was dominated by the total catch residuals, due to the fact that the number of data points is much lower for the total catch than, for example for catch proportions at age or for the age-structured survey data. Therefore, all these three sources of information contributed significantly to the objective function to be minimised. This exploratory assessment made with ASAP provided a good fitting to the total catch (Figure 6.5.3), while the catch proportions at age showed no pattern in the residuals, which were mostly of low absolute value, but the positive residuals outnumbered the negative ones (Figure 6.5.3). The same was observed for the survey residuals. The indices of total abundance per year showed no pattern and low residuals (Figure 6.5.4), but the proportion at age of the abundance indices had more positive residuals than negative ones, although without a clear pattern (Figure 6.5.4). The estimated fishing mortality and SSB from this exploratory assessment are shown in Figure 6.5.5.

6.6 Uncertainties in the stock evaluation

There are typically several sources 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.

From the exploratory analyses carried out so far, we can conclude that a satisfactory fitting of an assessment model was not yet completely achieved. Survey indices, which are the noisiest data source, also show strong year effects, which must be taken into account when choosing a model parameterisation. 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 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, seems 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 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.

6.7 Management considerations

This stock has supported a stable exploitation level for a long time period. 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. 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 is a migratory pattern of southern horse mackerel that makes age classes not evenly distributed along the stock area, with old fish mostly present in the waters of Galicia and northern Portugal. 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 SSB estimates from the bottom-trawl survey (Figure 6.7.1) indicate that there can be a recent increase in the stock abundance.

6.8 Ecosystem considerations

There is no specific information for this stock regarding this point.

6.9 Regulations and their effects

According to the Council Regulation (EU) No 23/2010 of 14 January 2010 the horse mackerel quota for Spanish fleets in area IX is 8,000 tons which may limit or invert the current trend in catches observed for those fleets.

6.10 Changes in fishing technology and fishing patterns

Traditionally this fishery is characterised 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.

6.11 Changes in the environment

No specific information for this stock.

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)*
2009	10,841	14,886 // (15,646)*	25,737 // (26,497)*

(*) 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.

Gear Year	Bottom trawl		Purse seine		Artisanal	
	Portugal	Spain	Portugal	Spain	Portugal	Spain
1992	13,000	1,651	7,354	2,409	3,445	-
1993	16,783	3,877	4,683	2,321	3,841	-
1994	10,466	2,655	5,369	6,724	3,202	-
1995	12601	3,010	2,947	4,440	2,137	-
1996	10,674	2,705	2,085	3,642	1,228	-
1997	12,446	2,130	4,385	8,776	1,800	-
1998	13,170	3,773	5,901	16,458	2,287	-
1999	6,868	3,238	5,707	10,074	1,855	-
2000	7,970	4,727	4,210	7,027	2,169	58
2001	7,690	4,536	4,788	6,260	1,281	356
2002	8,126	4,181	4,271	3,959	1,873	96
2003	6,887	3,229	2,112	4,411	2,243	5
2004	8,625	7,501	2,042	3,658	2,441	217
2005	8,319	5,710	2,444	3,596	2,545	76
2006	9,485	5,534	1,754	3,676	3,368	77
2007	5,706	7,999	2,683	4,092	1,992	316
2008	5,790	6,590	1,090	6,580	2,410	539
2009	4,850	10,225	2,200	4,469	3,792	192

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

	Portuguese October Survey											
Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11+
1992	522.2433	568.2876	182.2559	63.5430	28.2969	11.0128	7.4246	7.7533	4.1195	3.4621	4.7167	2.3386
1993	2065.4426	277.9102	279.0535	171.6586	40.6898	5.3466	3.1123	1.9390	1.1076	1.2692	0.7797	2.9203
1994	4.0670	10.2110	70.5896	64.5655	26.8742	6.6428	2.9994	2.0481	1.0044	0.5510	0.3451	0.1791
1995	22.8973	90.5000	129.6341	78.5573	34.9839	6.6355	1.3651	1.6019	0.4966	0.2400	0.2387	1.6041
1996	1613.2587	11.3420	18.4573	29.8236	29.9718	5.6756	2.2938	0.9104	0.3289	0.1802	0.0623	0.2895
1997	1306.6102	92.1578	152.1887	45.4040	73.8544	42.7363	8.6522	6.8750	2.7440	3.1068	1.1317	0.5125
1998	115.7542	48.9083	137.4453	19.8992	7.3852	4.1001	2.2007	2.1897	0.3411	0.0651	0.0299	0.0539
1999	147.2168	31.3117	58.8573	69.3633	5.8232	2.0045	1.0510	0.2537	0.0636	0.0969	0.0268	0.0154
2000	3.5097	22.7048	30.5421	34.3248	16.7005	9.3181	4.8150	1.4691	0.7455	0.1017	0.0548	0.1248
2001	726.8029	1.1545	4.7081	3.7012	5.1126	7.2639	8.7959	13.9616	7.6053	2.4691	1.3707	0.8481
2002	41.5849	2.6346	8.8535	14.5696	11.5922	5.9654	1.8800	1.2608	0.8624	0.5182	1.0152	0.8030
2003	82.4589	10.4742	10.5063	20.3363	18.0913	5.1662	2.8067	1.7227	1.0957	0.6309	0.2667	0.0278
2004	63.0787	39.3341	140.6628	55.2227	11.5710	4.9846	2.3551	5.9047	7.7122	1.2177	0.2491	0.0253
2005	383.5094	1475.1982	237.2061	81.0509	39.8305	17.2338	20.2720	20.5971	15.7765	8.1961	4.9993	14.0825
2006	93.1133	95.2280	253.4003	63.1362	3.7573	12.1072	8.7453	7.1924	2.9255	1.6050	0.7272	0.2015
2007	40.7900	0.8700	28.1853	45.6567	34.2721	8.5803	2.8825	1.7015	0.1696	0.5715	1.6229	3.3875
2008	51.7000	26.6500	41.0700	23.6600	30.4000	21.0600	2.9200	0.9800	1.4300	2.0100	1.3700	5.1100
2009	1725.2100	81.5300	121.1560	44.4500	36.0000	9.9700	2.7100	1.5200	1.1540	0.6800	0.6100	4.7000

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

	Spanish October Survey (only Subdivision IXa North)											
Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11+
1992	6.58	0.00	0.00	0.00	0.09	0.00	0.01	0.20	0.18	0.30	3.39	7.11
1993	92.07	1.65	5.16	3.95	0.35	0.00	1.15	5.18	5.72	8.72	5.23	16.07
1994	0.15	0.00	0.48	0.00	0.00	0.00	0.00	0.19	0.57	1.43	2.63	36.75
1995	0.09	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.34	0.18	0.76	19.90
1996	33.65	0.00	0.00	0.00	0.00	0.03	0.26	0.35	0.90	2.71	0.56	10.26
1997	2.03	0.01	0.00	0.00	0.02	0.13	0.25	0.98	1.16	1.71	0.78	5.02
1998	0.98	0.00	0.00	0.00	0.00	0.00	0.13	0.93	0.54	0.25	0.15	0.45
1999	0.04	0.00	0.00	0.00	0.00	0.00	0.17	0.27	0.63	2.18	3.17	11.11
2000	0.48	0.00	0.00	0.00	0.00	0.01	0.37	2.79	3.69	3.24	0.72	2.56
2001	12.74	2.86	0.00	0.00	0.00	0.19	0.41	2.54	4.41	4.13	3.15	4.15
2002	0.14	0.00	0.00	0.00	0.00	0.00	0.59	1.24	7.29	7.09	8.95	22.03
2003	8.78	0.00	0.00	0.00	0.00	0.03	0.06	0.19	0.11	0.81	0.88	1.68
2004	89.97	1.19	2.50	16.22	5.39	4.60	1.71	1.31	0.65	0.29	0.80	0.62
2005	3520.44	0.05	0.00	0.00	0.35	0.41	0.26	0.25	0.52	0.48	0.14	1.27
2006	28.40	0.10	0.03	0.11	0.06	0.07	0.04	0.03	0.04	0.07	0.16	0.86
2007	1.39	0.00	0.00	0.01	0.09	0.21	0.96	1.26	1.63	0.76	0.62	1.41
2008	17.98	0.00	0.00	0.03	0.00	0.06	0.08	0.23	0.37	0.37	0.26	0.55
2009	84.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.16	2.05

Table 6.3.2.1.2. Time series of CPUE at age from Portuguese and Spanish combined bottom trawl (85% PT + 15% SP). It is showed with the period and the age plus to be considered in the benchmark assessment.

Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11+
1992	444.8938	483.0445	154.9175	54.0115	24.0658	9.3609	6.3124	6.6203	3.5286	2.9878	4.5177	3.0543
1993	1769.4367	236.4712	237.9695	146.5023	34.6388	4.5446	2.8179	2.4252	1.7995	2.3868	1.4472	4.8927
1994	3.4794	8.6793	60.0732	54.8807	22.8431	5.6464	2.5495	1.7694	0.9392	0.6828	0.6878	5.6647
1995	19.4762	76.9250	110.1890	66.7737	29.7363	5.6401	1.1633	1.3647	0.4731	0.2310	0.3169	4.3485
1996	1376.3174	9.6407	15.6887	25.3500	25.4761	4.8287	1.9887	0.8264	0.4145	0.5596	0.1370	1.7850
1997	1110.9231	78.3356	129.3604	38.5934	62.7792	36.3454	7.3919	5.9908	2.5064	2.8973	1.0789	1.1886
1998	98.5381	41.5721	116.8285	16.9143	6.2774	3.4850	1.8901	2.0008	0.3709	0.0928	0.0480	0.1133
1999	125.1403	26.6149	50.0287	58.9588	4.9498	1.7038	0.9189	0.2562	0.1486	0.4094	0.4983	1.6795
2000	3.0553	19.2991	25.9608	29.1760	14.1954	7.9219	4.1482	1.6672	1.1872	0.5725	0.1546	0.4901
2001	619.6935	1.4103	4.0019	3.1460	4.3457	6.2028	7.5380	12.2483	7.1260	2.7183	1.6376	1.3434
2002	35.3682	2.2394	7.5254	12.3842	9.8533	5.0706	1.6865	1.2577	1.8266	1.5040	2.2054	3.9871
2003	71.4071	8.9031	8.9303	17.2859	15.3776	4.3957	2.3947	1.4928	0.9478	0.6578	0.3587	0.2756
2004	67.1124	33.6125	119.9384	49.3723	10.6439	4.9269	2.2583	5.2155	6.6528	1.0785	0.3317	0.1145
2005	854.0490	1253.9260	201.6251	68.8932	33.9085	14.7102	17.2702	17.5450	13.4881	7.0387	4.2704	12.1606
2006	83.4063	80.9588	215.3947	53.6823	3.2027	10.3017	7.4395	6.1180	2.4926	1.3747	0.6421	0.3003
2007	34.8800	0.7395	23.9575	38.8097	29.1448	7.3248	2.5941	1.6353	0.3887	0.5998	1.4725	3.0909
2008	46.6420	22.6525	34.9100	20.1149	25.8405	17.9097	2.4942	0.8668	1.2715	1.7643	1.2041	4.4256
2009	1479.0450	69.3005	102.9826	37.7825	30.6000	8.4745	2.3035	1.2920	0.9809	0.5866	0.5430	4.3028

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

Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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	0.019	0.026	0.043	0.072	0.115	0.148	0.167	0.183	0.220	0.241	0.253	0.281	0.284	0.309	0.286	0.412
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
2009	0.025	0.031	0.060	0.092	0.111	0.128	0.148	0.172	0.184	0.212	0.243	0.275	0.285	0.353	0.376	0.442

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

Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
1992	14.931	15.594	17.471	19.843	23.180	25.785	27.384	28.648	29.601	31.152	31.534	32.642	33.284	33.929	34.699	36.815
1993	13.957	15.538	17.405	18.891	21.284	28.235	29.558	31.086	31.701	31.662	32.051	32.451	34.081	34.723	35.814	37.178
1994	13.368	14.584	18.114	21.084	22.665	24.757	27.012	29.532	31.151	31.713	32.383	32.190	33.267	34.173	34.372	36.462
1995	16.038	15.444	19.883	21.769	23.115	24.487	28.645	26.538	30.141	30.901	31.610	32.614	33.945	33.995	35.233	36.943
1996	13.293	18.989	19.683	21.820	24.676	26.323	28.016	28.561	30.336	30.740	31.473	31.951	33.421	32.542	36.151	37.004
1997	13.359	15.813	18.894	20.718	24.274	26.303	27.625	29.455	31.151	32.399	31.881	33.051	34.638	34.824	35.448	38.542
1998	14.493	13.916	15.924	20.449	23.513	25.517	28.313	30.306	26.860	31.690	31.982	32.734	33.439	34.537	36.446	39.077
1999	13.410	16.394	18.968	22.274	24.476	26.201	27.515	28.983	30.291	31.703	32.691	33.264	33.876	34.738	37.315	39.585
2000	13.610	16.373	18.434	21.682	24.757	25.996	27.229	28.573	30.219	30.796	31.524	32.280	32.656	34.228	34.494	34.992
2001	14.111	15.618	20.240	21.851	22.462	25.444	27.364	28.731	29.592	30.854	31.180	32.985	32.843	33.989	34.732	38.228
2002	15.049	15.691	17.509	20.337	23.062	25.383	26.600	28.010	29.581	30.863	31.760	32.601	34.202	34.681	35.433	36.876
2003	12.996	15.723	18.750	20.699	23.143	26.076	26.728	29.192	29.999	31.213	31.956	32.897	33.554	33.927	38.856	35.310
2004	16.172	14.426	17.228	21.174	24.045	26.666	28.076	29.398	30.473	31.616	32.291	32.228	33.047	32.249	36.367	35.881
2005	12.497	13.928	16.624	20.082	23.536	25.924	27.119	28.094	30.021	31.137	31.636	32.785	32.578	33.548	32.586	37.223
2006	14.615	14.659	17.043	19.209	22.207	24.622	25.631	27.208	28.720	30.329	31.476	33.220	34.002	35.863	36.705	36.999
2007	14.601	17.486	18.534	20.015	22.086	23.639	26.897	28.724	30.635	30.325	30.921	31.831	33.424	32.164	34.486	35.742
2008	12.962	17.262	20.483	22.252	23.970	25.422	26.539	27.660	28.778	29.640	30.481	31.276	32.231	33.527	35.584	37.227
2009	12.962	17.262	20.483	22.252	23.970	25.422	26.539	27.660	28.778	29.640	30.481	31.276	32.231	33.527	35.584	37.227

Table 6.3.6.1. Southern horse mackerel. Time series of catch at age data in number (thousands).

Year \ Age	0	1	2	3	4	5	6	7	8	9	10	11+
1992	11684.24	95185.57	145732.07	40736.29	12170.81	9102.01	5017.53	6864.39	5154.79	4761.40	13972.98	14353.80
1993	6480.06	66211.26	137089.49	100515.08	35417.75	13367.17	12938.11	10494.65	6596.95	5551.62	4496.98	14441.57
1994	12713.15	63230.39	86717.50	96253.08	28761.10	7627.58	4398.41	3433.14	5208.61	4834.44	6047.03	12264.05
1995	7229.62	55379.99	31265.08	52029.83	28198.80	11009.52	4003.36	3139.46	2719.92	3352.42	2529.55	31343.17
1996	69650.71	13797.72	14021.05	28125.41	33936.54	9860.73	6610.50	4500.78	4164.37	5503.63	3306.32	14242.50
1997	5056.44	295328.97	112210.32	26235.69	17168.28	12886.19	7780.26	7169.46	3937.53	3866.88	2424.85	8846.71
1998	22916.81	95949.89	320720.59	68437.68	18769.57	11317.34	9712.04	20627.38	12759.90	6685.77	6211.66	11323.09
1999	51659.09	29794.90	26230.63	66703.76	42959.83	15700.49	13840.18	7554.82	4175.40	4790.48	2474.75	7416.62
2000	12246.35	72936.38	23546.62	41617.74	35967.57	18643.03	17253.50	12118.45	7915.04	5227.03	3123.67	3556.61
2001	105759.25	77363.81	31260.71	24103.94	23721.48	16794.25	15391.49	14963.98	9795.06	3309.64	2022.74	3988.87
2002	18444.15	94401.72	84378.75	26482.09	13161.27	11396.22	10262.62	12500.64	10156.43	7524.70	3607.40	4433.43
2003	40032.60	6829.50	36753.61	28558.84	21930.75	12789.88	14750.66	13581.86	10630.91	6492.09	3530.78	2332.73
2004	7101.35	126796.54	58054.25	18242.52	8327.52	13585.80	11835.86	14878.06	10542.00	3876.11	5257.60	5318.47
2005	21015.07	108070.25	49196.71	24288.80	17877.43	11334.03	11178.72	7927.13	9124.35	7444.63	5502.22	11419.69
2006	3329.06	92562.88	92895.82	22665.24	6738.02	13176.14	11891.95	6028.63	7302.85	8070.42	8947.28	15321.83
2007	2885.02	16419.45	27667.44	44357.24	20534.04	8187.28	4459.25	3563.18	5975.22	4748.47	4943.43	30000.93
2008	48379.96	54167.44	31951.01	28057.84	16616.44	7193.99	4781.65	3660.10	4579.32	3974.94	4536.51	24989.61
2009	22617.94	85414.54	32415.59	8482.06	9773.68	7161.72	3289.29	2860.46	2790.94	3579.46	4235.60	39095.64

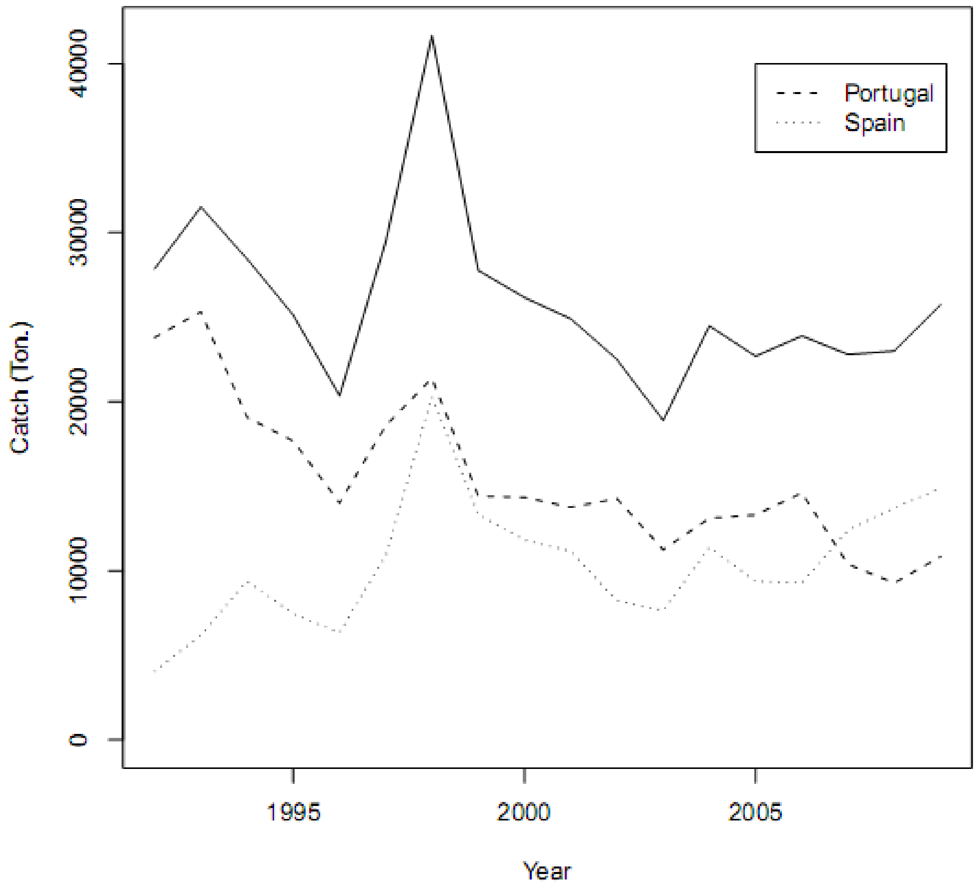


Figure 6.3.1.1. Southern horse mackerel. Historical series of the stock landings including the landings by country.

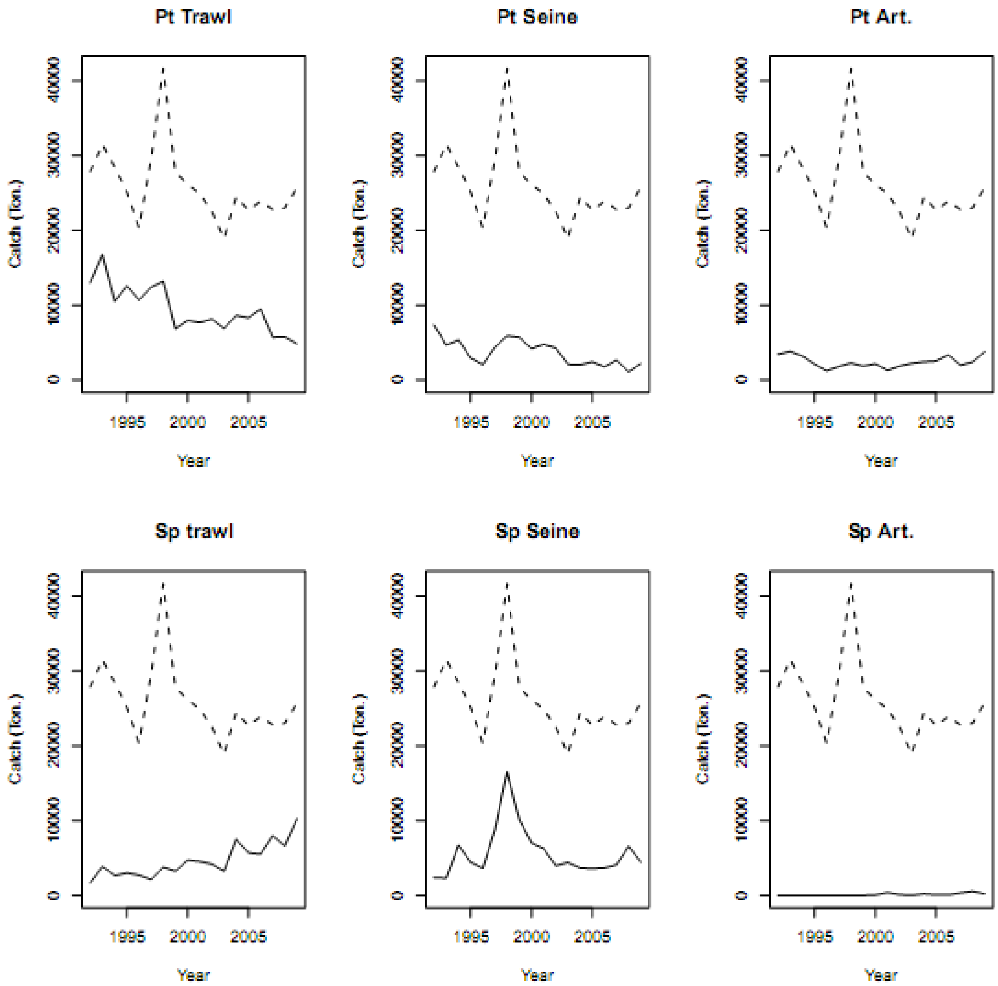


Figure 6.3.1.2. Southern horse mackerel. Historical series of catches by gear and country (Pt = Portugal; Sp = Spain). Dashed line corresponds to the total landings.

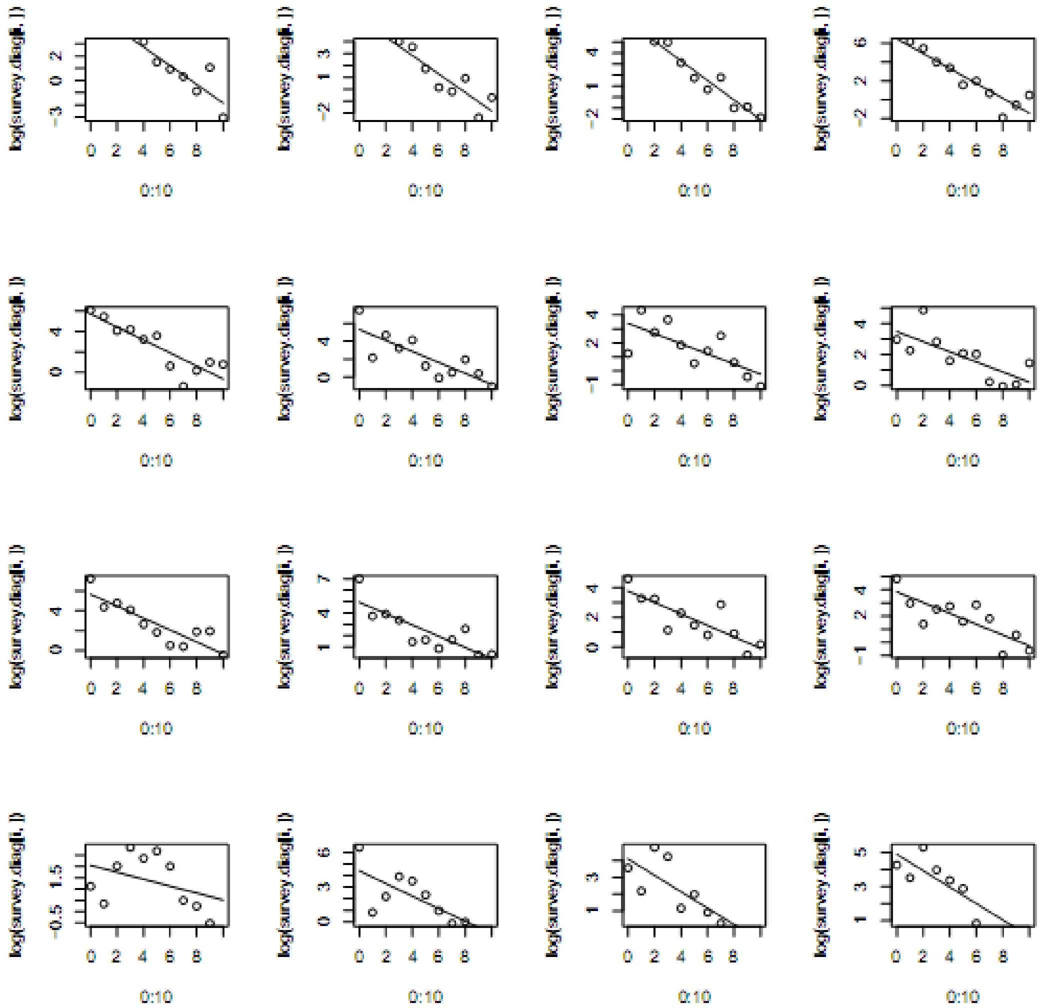


Figure 6.3.2.1.1. Southern horse mackerel. Evolution of several year classes in the survey combined dataset.

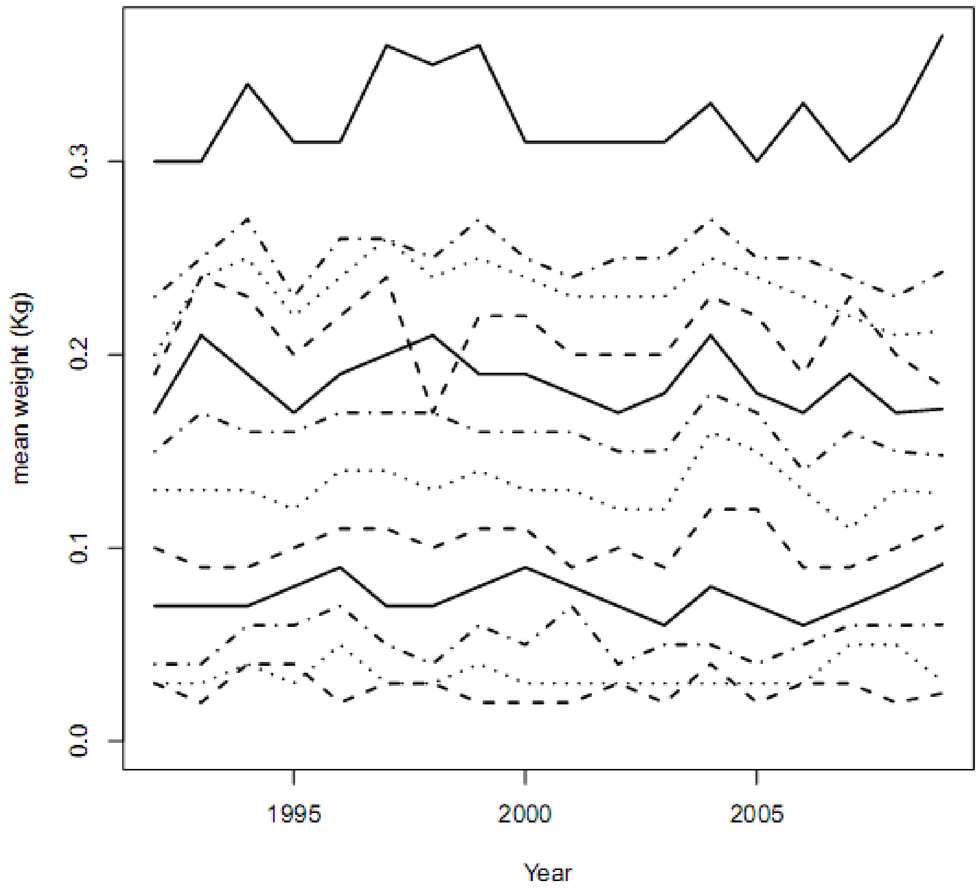


Figure 6.3.4.1. Southern horse mackerel. Time series of mean weight at age in the catch (from age 1 to 11).

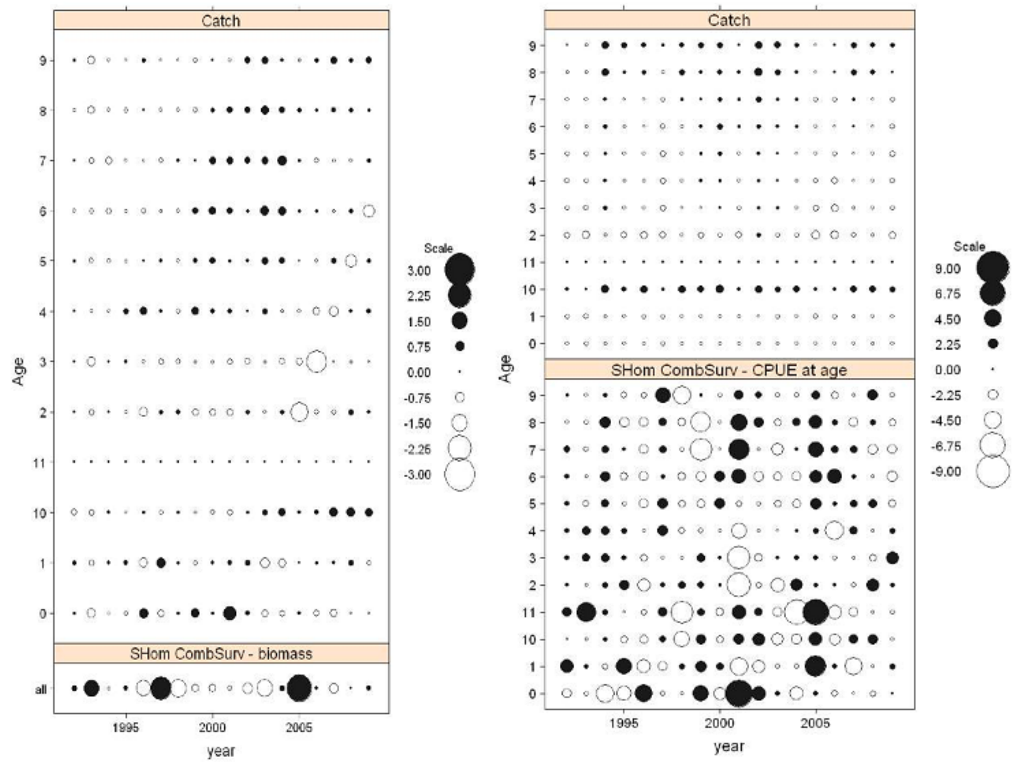


Figure 6.5.1. Catch at age and survey data residuals from the two ICA runs (left hand plot corresponds to trial and right one to the second one).

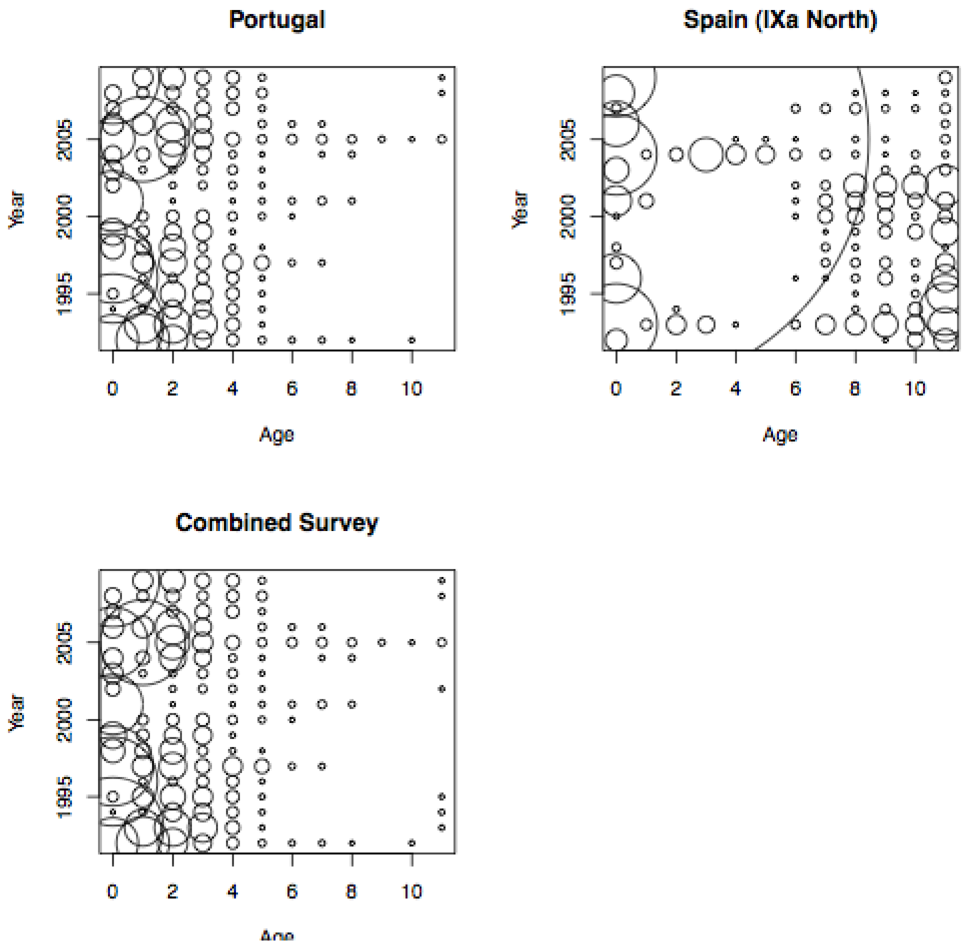


Figure 6.5.2. Relative importance of the abundance indices (catch in numbers at age per hour) of the Portuguese and Spanish bottom-trawl surveys, and of the combined data set. Circles area is proportional to abundance. Circles are comparable only within each panel.

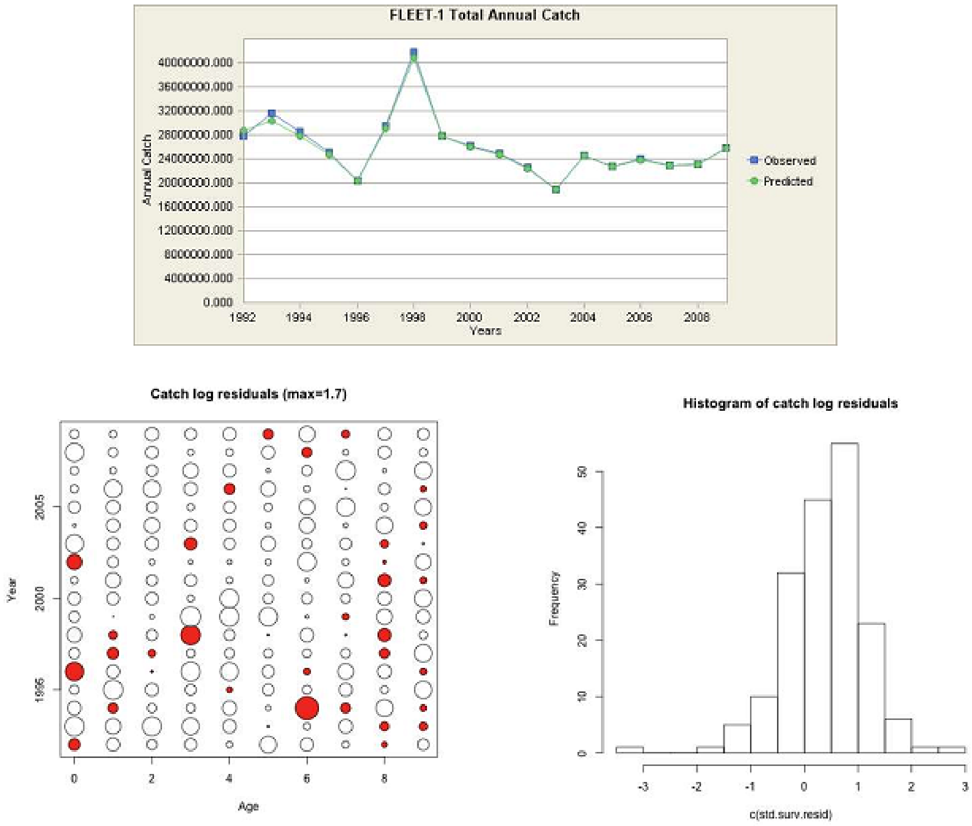


Figure 6.5.3. Fitting of the total catch given by the exploratory assessment performed with ASAP, assuming separability in the survey data.

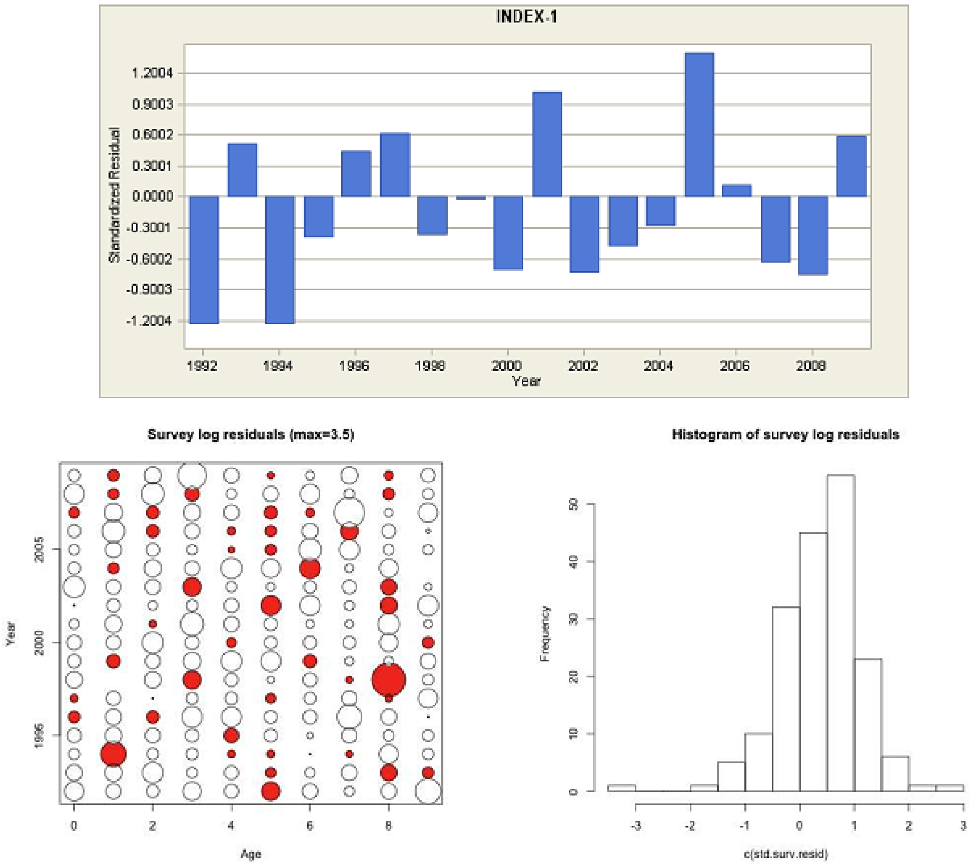


Figure 6.5.4. Fitting of the index of abundance given by the exploratory assessment performed with ASAP, assuming separability in the survey data.

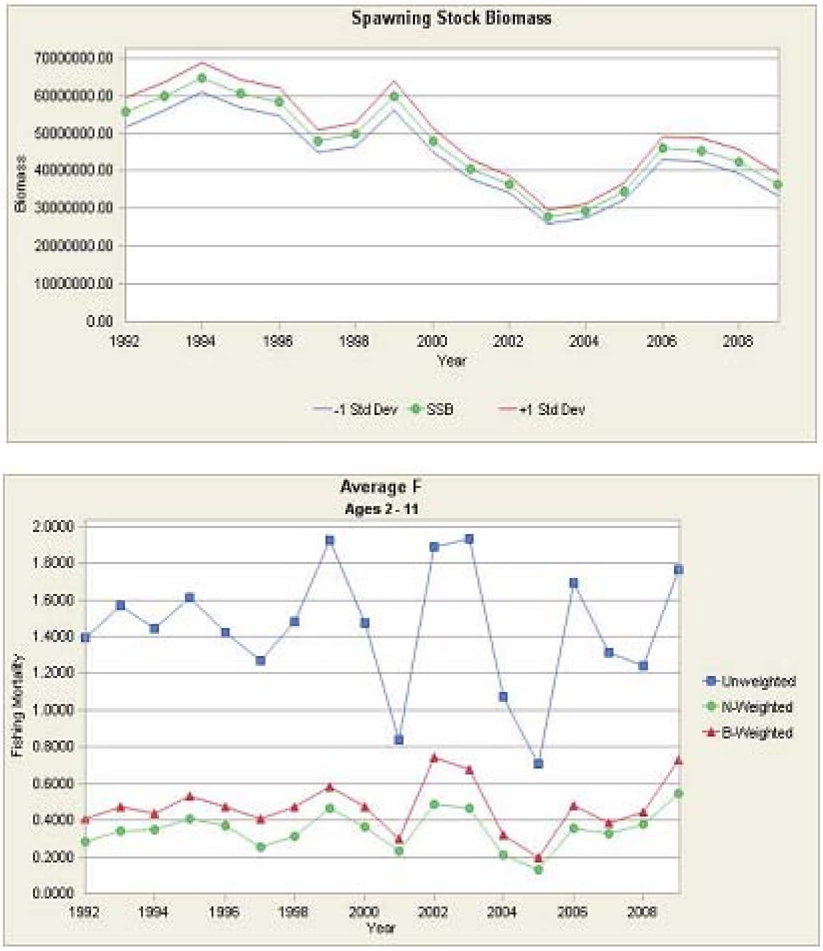


Figure 6.5.5. SSB and F estimated in the exploratory assessment performed with ASAP, assuming separability in the survey data.

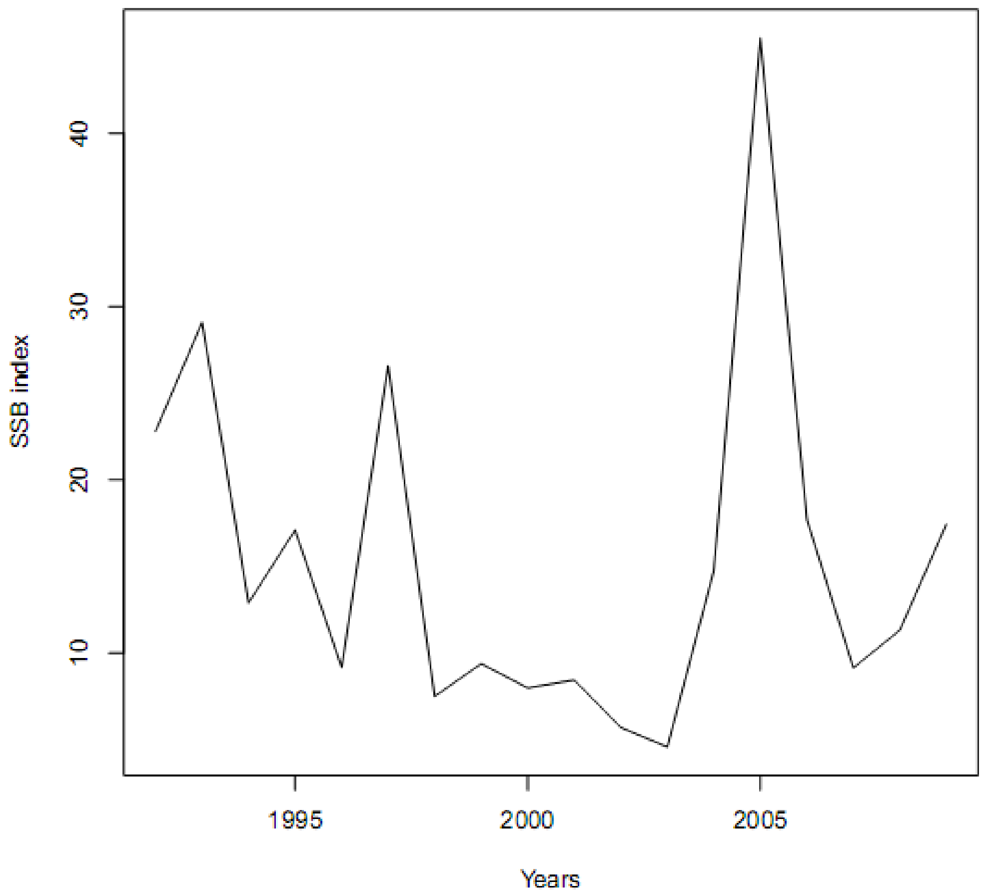


Figure 6.7.1. SSB estimates from the bottom-trawl survey.

7 Norwegian spring spawning herring

7.1 ICES advice in 2009

In 2009 ICES stated that "Based on the most recent estimates of SSB (in 2009) ICES classifies the stock as having full reproductive capacity. Based on the most recent estimate of fishing mortality (in 2008) ICES classifies the stock as being harvested sustainably. SSB in 2009 is well above Bpa and is estimated as one of the highest in the time-series. 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 after 2004 have been of low abundance".

A long term management plan, agreed by the Coastal States is operational. The management plan implies maximum catches of 1 483 000 t in 2010, which is expected to leave a spawning stock of 10.8 million tonnes in 2010. ICES considers that the current long-term management plan is consistent with the precautionary approach.

7.2 Management in 2009 and 2010

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 2007-2009 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 (Blim) 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 (Bpa), 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 Bpa (5 000 000 t) to 0.05 at Blim (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 2009[1] 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

[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 2009 (London, 13 November 2008)

tonnes for Iceland, 1 002 230 tonnes for Norway and 210 633 tonnes for the Russian Federation.

The agreed TAC for 2010[2] was 1 483 000 tonnes. The agreed shares of the Parties are 96 543 tonnes for the European Community, 76 523 tonnes for Faroe Islands, 215 183 tonnes for Iceland, 904 630 tonnes for Norway and 190 121 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% beyond 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 2009

7.3.1 Description and development of the fisheries

Traditionally in earlier years the fishing pattern followed the clockwise migration pattern of the herring, now also including the catches in the Jan Mayen area in the Norwegian Sea. As last 2 years, 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 2009 by ICES rectangles is shown in Figure 7.3.1.1 (total whole year) and in Figure 7.3.1.2 (by quarter). In 2009 the data provided as catch by rectangle represented more than 99 % of the total WG catch.

In 2009 there were not limitations for countries to enter the EEZs of other countries and the fleets given free access to any zone according with bilateral negotiations. As last year 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 herring's fishery was stop in the end of year on a wintering area.

The migration pattern, together with environmental factors, was mapped in 2009 during the ICES WGNAPES (Working Group on Northeast Atlantic Pelagic Ecosystem Surveys) investigations (ICES 2010/RMC:).

7.3.1.1 Denmark

The Danish fishery of Norwegian spring spawning herring in 2009 carried out by purse seiners and trawlers was 32 321 t. The fishery took place in the first quarter (17 503 t) and fourth quarter (14 818 t). 90% of the landings were landed in Denmark.

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[2] 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 2010 (London, 22 October 2009)

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.

7.3.1.4 Faroe Islands

Contrary to the recent years the summer fishery in the Faroese, Icelandic, and Jan Mayen zones (Divisions Vb, Va and IIa) lasted for a much shorter time period in 2009 (July to August) as compared to 2008 (May to August). The amount caught in this fishery was significantly less in 2009. The Faroese catches mostly consisted of large herring. The fishery started in January along the Norwegian coast in the Lofoten area down to Møre in February. In June some catches were taken in the Faroese area moving gradually into the Icelandic area and Jan Mayen by end of August. In September the fishery concentrated in the northern area (Division IIa in International, Svalbard, and Norwegian zones). The fishery continued in this area, mostly in the Norwegian zone until December.

7.3.1.5 Iceland

The Icelandic catch quota for Norwegian springspawning herring in 2009 was set at 238 000 tonnes. The Icelandic fishery started in May in the Icelandic zone and lasted there through September. 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 198 000 t, which is the highest annual catch there since the 1960s. About 5 000 t were taken in Faroese waters, 18 000 t in the International zone, 4 000 t in the Jan Mayen zone and about 40 000 t in the Norwegian zone. The total catch of the Icelandic fleet in 2009 was 265 480 tonnes.

In 2009, as well as in 2007 and 2008, 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.

7.3.1.6 Ireland

The Irish fishery for Norwegian spring spawning herring took place in February off the Norwegian coast. A total of 8 vessels participated in the fishery and recorded landings in the region of 10 000 tonnes. The fleet is comprised of 8 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. Landings were made mainly into Norwegian ports.

7.3.1.7 Netherlands

The fishery for Norwegian spring spawning herring by the Netherlands in 2009 was conducted by 5 freezer trawlers using large pelagic trawls. The fishery took place in the 3rd and 4th quarter in ICES Division IIa and IIb but mostly in IIa. A total catch was 26 770 tonnes was reported in 2009 from 8 fishing trips. In 2008 (3 trips) and 2009 (1 trip) were attended by a scientific observer. Discards of herring in these trips (in weight) were estimated to be very low and estimated to be 2.% in 2008 and 1% in 2009. There are also records of small amounts of mackerel present in the catches in the 3rd quarter from this fishery.

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. Due to the reduced availability of herring for the coastal fleet in the wintering area in recent years, the fishery on the spawning migration and in the spawning areas during first quarter increased between 2006 and 2008. The total catch during the first quarter in 2009 was 440 689 tonnes, which is at the same level as 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 9 869 tonnes in 2009. This herring consists of a mix of NSSH and 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 oceanic wintering area north of Vesterålen. A total of 76 701 tonnes were caught in this quarter. The Norwegian catch in quarter 4 was 489 416 tonnes in 2009.

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 32 461 t.

In the II quarter, the several 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 2 551 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. 105 202 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. 69 891 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 210 105 t. The entire Russian catch was utilized for human consumption.

7.3.2 UK (Scotland)

Fourteen Scottish vessels took part in the IIa NSSH fishery in 2009. Gear was predominantly single trawl pelagic, although two vessels used pair trawl pelagic gear.

Approximately 5.5 thousand tonnes were landed into Scotland. Nearly 20,000 tonnes were landed abroad, in either Norway or Denmark. The majority of the catch (approx 19.5 thousand tonnes) was taken in February.

7.3.3 Information on by-catch

In recent years the Faroes has reported on problems with mackerel caught as by-catch in the directed herring fishery north of the Faroes. However, in 2010 the fishery was directed towards herring and mackerel in the Faroese zone, and was thus a result of legal activity.

In 2010 there seem to have been a change in horizontal species segregation between herring and mackerel, with the herring distributed more in the cooler waters in the western part of the distribution area in 2010, resulting in less mixing between the species (see section 7.17). Thus creating less by-catch problems in the Icelandic and Faroese fishery for Norwegian spring-spawning herring in summer 2010 than previous years.

7.4 Stock Description and management units

7.4.1 Stock description

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. The hydrographic situation in the Norwegian Sea in the 2010 was broadly much the same as observed in 2009 with some cooling in the surface layer that can at least partly be explained with the low air temperatures during the strong winter of 2009/10. Recent years decrease in zooplankton biomass is dramatic in the sense that biomass in the cold water has decreased by 80% since 2003, while in the warmer water biomass has decreased by 55% since 2002. This could explain the slight north-eastward displacement of the centre of gravity (Figure 7.4.2.1) of the herring distribution observed in May 2010, beside the fact that the feeding migration is still ongoing during the survey period.

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 2009. 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 2009.

The total working group catch in 2009 was 1 687 373 t (Table 7.5.1.1). For 2009 ICES had recommended a catch of 1 643 000 t. The catches were taken in 7 ICES areas: I, IIa, IIb, IVa, Va, Vb and XIVa. The majority of the catches were taken in area IIa (87%). Area Va was next in the rank with 6% and the rest in the remaining areas.

Samples were provided by Denmark, Faroe Islands, Iceland, Ireland, Norway, The Netherlands and Russia (text table in section 1.3.1). Length samples were provided from Scotland, but they were not used. Sampled catches accounted for 94% of the total catches. The sampling levels of the catch in 2009 by country is shown in Table 7.5.1.2. The positions, mean weights and mean lengths from the sampled catches were plotted (WD, Gudmundsdottir). On the basis of them allocations were done. The program SALLOC (ICES 1998/ACFM:18) was used to provide catches in numbers (Table 7.5.1.2).

7.5.2 Discards

In 2008, 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 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 and 2009 of about 2% in weight were provided by the Netherlands only.

During the Norwegian fishery in first quarter the stock is migrating fast southward in dense aggregations. This is a challenge to the fleet by increasing the risk of slipping of the catch or breaking of the net during fishing operations due to extremely large catches. There are no data to estimate the amount of slipping. However, a report from the Norwegian coast guard this year concludes that the fishery during this period was conducted in what they consider a satisfactory way. The coast guard followed the fishery with several vessels and a plane. Few observations of slipping were made and no observations net breaking.

7.5.3 Length and age composition of the catch

The year classes from 2002-2004 account for about 70% of the catches both in numbers and in weight. The big year class from 1999 is fading out. Last year it was assumed that more would be caught of the 2002 year class in 2009 and less of almost all other year classes, especially the 2003 and 2004 year classes.

This was the second year in a row that unexpected high catches in numbers of age 2 were observed. They were taken in area IIa and quarters III and IV. So high catches have not been observed since the 1983 year class was fished at age 2 in 1985.

The catch at age data are given in Table 2.5.1 4. Lengths 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 2009 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 in the catch are presented in Figure 7.5.4.1. The mean weights at age for age groups 5 and older are at similar levels as the years before, excluding the year 2007. The mean weight at age for age 3 has risen from last year, but is at similar level as in mid 2000s.

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 for age groups 4-11 in the year 2009 was derived from samples taken in the fishery in the same area and at the same time as the wintering surveys were conducted in. In 2010 the same procedure was used as in 2009, except for age groups 4-12, with increased sampling intensity. 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 for ages 6-12 are lower in 2010 than in 2009. The weight at age in the stock are given in Table 7.5.4.2.

It is noted that the year classes 1998-2002 have not gained much weight in the last year. This fits with the observation made from the Icelandic fishery in 2010 that the fat content is much lower than in recent years (section 7.15, Figure 7.15.1). This is likely a cause of lower plankton biomass in the Norwegian Sea in summer and that the herring has to migrate over longer distance to feed.

7.5.5 Maturity at age

In 2010 a Workshop (WKHERMAT)[3] was held to evaluate existing maturity at age data. The Workshop was held because data on maturation were not available and considered in the benchmark assessment in 2008. The work of the Workshop therefore concludes the benchmark process. Three sources of maturity information were considered. The three different data sources were: a) maturity ogive used in assessment, b) survey data on maturity staging collected during surveys 4 and 5 and c) back-calculated maturity ogive using Gulland's method. In addition, data on maturity cycle in Norwegian spring spawning herring were presented and guidelines for sampling of maturity data were discussed in accordance with PGCCDBS.

The maturity matrix used in the ICES assessment goes back to 1907. Documentation on the source of information and the justification of changes is almost absent and the lack of documentation is a general problem in this data set. The data cannot be reproduced because the sources are unknown and most changes which have been made in the past cannot be explained.

The May surveys may potentially provide data to construct updated maturity ogives for the most recent years. The surveys indicate that most (but not all) herring in the Norwegian Sea are mature and most (but not all) herring in the Barents Sea are immature. However, the time series is short and there are some problems. For the age groups which occur both in the Norwegian Sea and Barents Sea, quantitative information on annual abundance is required for a the calculated weighted average maturity representative for the stock in both areas combined. The available information on the distribution of these age groups in not very reliable because there appear to be differences in the catchability in the survey between the Norwegian Sea and the Barents Sea. This needs to be addressed further before data from the survey can be used for maturity ogive estimations.

[3] Report of the Workshop on estimation of maturity ogive in Norwegian spring spawning herring (WKHERMAT). 1-3 March 2010 Bergen, Norway. ICES CM 2010/ACOM:51 REF. PGCCDBS

The back calculation data set indicates that maturation of ages 3, 4 and 5 has varied considerable over time and that maturation of large year classes is slower than for others. This applies to a lesser extend to the 2002 year class. However, the estimates for this year class are suggesting that at least a correction needs to be considered in the maturation assumed for this year class in previous assessments by ICES. WKHERMAT considered the data set derived by back calculation as a suitable potential candidate for use in the assessment because it is conceived in a consistent way over the whole time period and can meet standards required in a quality controlled process. However, the back calculation estimates cannot be used for recent years. Since the surveys do not provide suitable data at the moment, assumptions have to be made for recent year classes.

WGWIDE considered the results of WKHERMAT and adopted the maturity o-gives derived from back calculation of scales for the historical time period (years 1950-2007) in the assessment. WGWIDE recommends that this data set remains updated in future years. For the years after 2007 for which no data are available from this method (including the years considered in the forecast) the following default maturity o-gives will be assumed. For 'normal' classes (average, median and weak year classes), an average maturity at age will be assumed from the periods 1983-2007 from the back calculation data set excluding the strong year classes 1983, 1991, 1992, 1998, 1999, 2002. For year classes which are considered strong, preliminary estimates will be assumed to be the average of the recent strong year classes 1983, 1991, 1992, 1998, 1999, 2002 in the data set.

The default maturity o-gives used for 'normal' and strong year classes are given in the text table below.

AGE	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
normal yc	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
strong yc	0	0	0	0	0.1	0.6	0.9	1	1	1	1	1	1	1	1	1

A comparison of the old and new time series in given in the WKHERMAT report. The maturity ogives used in the present assessment are presented in Table 7.5.5.1 and Figure 7.5.5.1. The maturity ogives used in previous assessments are given in Table B.2.4.1 in the stock annex.

Except for those periods where strong year classes enter the stock, the revision of the maturity at age matrix affects has little effect on the estimates of SSB in the historical time series. Because strong year classes show slower maturation, the SSB estimates in periods where strong year classes recruit in the stock have been revised downwards compared to previous ICES assessments. The effect of the revision on the SSB time series is shown in Figure 7.5.5.2. Further, the revised SSB affects the SSB/recruitment plot and S/R models derived from it.

7.5.6 Natural mortality

In this year's (2010) 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.

7.5.7 Survey data

7.5.7.1 Survey 1 Norwegian acoustic survey on spawning grounds in February/March

No new information but the years 1994-2005 are used in the tuning (see stock annex 4)

7.5.7.2 Survey 2 Norwegian acoustic survey in November/December

No new information but the years 1992-2001 are used in the tuning (see stock annex 4)

7.5.7.3 Survey 3 Norwegian acoustic survey in January

No new information but the years 1991-1999 are used in the tuning (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 2010.

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 2010, the coverage of Norwegian spring spawning herring was considered adequate and in line with previous years.

Herring was recorded throughout the survey area, except for the north-eastern part and the Jan Mayen zone (Figure 7.5.7.4.1), which is the main difference from the survey in 2009. The highest values were recorded in the central Norwegian Sea and the at the eastern edge of the cold waters of the East Icelandic Current. Compare to 2009, there were less herring in the western most area presumably causing a slight eastward displacement of the centre of gravity of the acoustic recordings in 2010 as compared to 2009 (Figure 7.4.2.1), which has been calculated since 1996. As in previous years, the smallest and youngest fish were found in the north-eastern area and both size and age increased south-westward. According to the survey, the herring stock is now dominated by 6 year old herring (2004 year class) in number but 8, 7 year old herring (2002 and 2003 year classes) are also numerous (Figure 7.5.7.4.2). No strong *year class*es 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 biomass of Norwegian spring-spawning herring was estimated to 6.0 million tons which is only around 2/3 of the estimate from 2009 (10.7 million tons) and 2008 (10 million tons).

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 2010 the survey was carried out from 6-22 April. The number of herring larvae was estimated to be 42.7×10^{12}, resulting in a Larvae Production Index (LPI) of 140.2. This is the second lowest number of larvae and larvae production recorded since 2003 when the survey was severely hampered by bad weather (Table 7.5.7.6.1). The weighted mean size of the larvae was 10.6 mm which is the lowest mean size recorded in the time series.

Herring larvae were observed throughout the sampling area (Figure 7.5.7.6.1) and zero values were not found either on the northernmost or the southernmost section, although low concentrations (less than 50 larvae m^{-2}) were found on the southernmost survey transect. The offshore extent of the larval distributions were, however, found on all transects. Similar to 2009, in 2010 there was spawning activity (information from the fishery) on the traditional spawning grounds close to Karmøy in the southern part of Norway (around 59°N). This area could, however, not be covered due to time limitation. The highest abundance of herring larvae were found on the Møre spawning grounds.

Acoustic registrations were recorded during the survey and the data was scrutinized using the IMR post-processing acoustic survey package, Large Scale Survey System (LSSS) to major groups (demersal fish, pelagic fish and plankton). However, in the northern part, registrations clearly identified as herring school were observed and in these cases herring was recorded separately. Since no trawling was performed to obtain species and size composition of the registrations, the data cannot be used to make an abundance estimate. The acoustic data was therefore used only to produce distribution maps of pelagic fish and herring in the survey area in order to study the overlap between these groups and the larval distribution.

7.5.7.7 Survey 9 International ecosystem survey in the Norwegian Sea in July-August

The survey (formerly called "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 but was extended to the whole Norwegian Sea, Icelandic waters, and Faroese waters in 2009. The objectives of the survey are to obtain estimates of 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 2010 were presented to the WG. Four vessels participated in the survey in 2010, two Norwegians, one Faroese and one Icelandic. The survey was carried out during 9 July to 20 August 2010. The acoustic estimate of NSSH biomass within the area covered in the survey (Figure 7.5.7.7.1) came to 10.7 million tons and consisted of 35.6 billion individuals. The distribution of the herring is given in Figure 7.5.7.7.2. The average weight of herring was 300.7 g and mean length was 32.6 cm.

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 – 2010, 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 – 2009, and projected forwards through 2010 assuming Fs in 2010 equal to those in 2009, to include survey data from 2010.

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

Two years ago an extensive catch curve analyses was done (Report of the working group on widely distributed stocks (WGWIDE), ICES CM 2008/ACOM:13).

Catch curve analyses on commercial catches

Figures 7.7.1.1 and 7.7.1.2 show the catch in weight and in numbers by age in the years 1986-2009. Each year only few year classes dominate the catches. The 3 year classes from 2002-2004 account for about 70% of the catches in 2009 both in numbers and in weight. The big year class from 1999 is fading out. Last year it was assumed that more would be caught of the 2002 year class and less of almost all other year classes, especially the 2003 and 2004 year classes.

Figures 7.7.1.3 and 7.7.1.4 show the disaggregated catch in numbers plotted on a log scale. On Figure 7.7.1.3 age is on the x-axis, but in Figure 7.7.1.4 year is on the x-axis. For comparison lines corresponding to Z=0.3 are drawn in the background. It is tempting to draw the conclusion that the catch curves shows the exploitation of the big year classes in the periods of relatively constant effort, but the poor year classes exhibit just noise. For the most recent year classes these curves provide hardly any information. Nothing strikingly is noticed in these two figures.

Catch curve analyses on survey catches

Survey 4 (juveniles in Barents Sea, May/June)

There are only two age groups used from this survey, 1 and 2 year old, Figure 7.7.1.5. It looks like that when a year class is big at age 1 then the survey picks it up and it is also big at age 2. This can be seen for the big year classes seen in the other surveys, the 1990, 1991, 1992, 1998, 1999 and the 2004 year class. The value for the 1999 year class as 1 year old is considered unrealistic. The values in 2010 are low.

Survey 5 (feeding area, May)

The age distribution in this survey is shown in Figure 7.7.1.6. Few year classes are prominent at a time. Since 2005 the 2002 year class has been prominent in the survey, together with the year classes from 2003 and 2004 since 2008. In 2010 the number of all age groups decreased unexpectedly. It is seen as a drop in the catch curves in Figures 7.7.1.7 and 7.7.1.8.

Further exploration of catch at age data

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.

It is noted that the 2002 year class has been numerous in the catches since it reached age 4 and it was at its maximum, so far at least, in number in the catches at age 6_in 2008_while the adjacent year classes (1998-2001) were at maximum at age 7-9 (Figure 7.17.1). It could mean that the fishing effort in the 2002 year class has been relatively high compared to other year classes at the same time. Moreover, this apparent high fishing pattern of the 2002 year class is supported by the sharp decrease in the survey estimates of the year class in 2010 (see section 7.5.7), which indicate that it is lasting in the fishery for a shorter period than adjacent year classes. Thus, if this high fishing effort of the 2002 year class is real, the assessment models have been systematically overestimating the strength of the year class in recent years because it was considered to follow the average fishing pattern. At this point, it is however not considered possible or feasible to verify with enough confidence if and how big this overestimation was.

7.7.2 data exploration with TISVPA

The TASACS assessment framework was developed aiming to provide an agreed assessment model for Norwegian spring spawning herring. TASACS was implemented by WGWIDE in 2008 when a "bench mark" assessment was carried out for this stock. A VPA-like procedure in TASACS was chosen as the basic one for the "bench-mark" assessment, and the same was used this year in the "update" assessment, Despite the fact that an ISVPA-like assessment procedure is implemented in the TASACS framework, this procedure does not include some essential features of the TISVPA model. TASACS does not take account for cohort effects what may be important for some generations of herring. That is why, this year additional exploratory runs using the "original" TISVPA model were also done.

WGWIDE 2010 carried out some exploratory assessments with the TISVPA model, using the same version which was used by the Working Group in 2006 and later years. The model can represent fishing mortality coefficients (more precisely – exploitation rates) as a product of three parameters: f(year)*s(age)*g(cohort). The purpose is to better reflect in the selection pattern possible systematic effects of higher or lower availability to fishery of different year classes (generations). Such an effect can originate from changes in spatial distribution of very abundant or poor generations, from higher attitude to fish more abundant schools composed of species from more abundant generations, or caused by any other reasons, like errors in aging, etc.

In the model the generation dependent g-factors are not applied to all age groups, but to a to be defined age "window". This helps (1) to be closer to real situations (when it is known that only some range of age groups have peculiarities in their distribution) and (2) to diminish the influence of age groups having data of lower quality (usually - youngest and oldest ages). The age range for estimation (and application) of g-factors was stated as from 4 to 12.

The main model settings were used the same as before: the catch-controlled version, attributing the residuals in cohort model to violations of stability of selection pattern, with constraint of unbiased model approximation of logarithmic catch-at-age.

The surveys data are taken the same as in the TASACS model run: the survey on spawning grounds along the Norwegian coast (survey 1); in wintering area in Vestfjorden in November-December (survey 2); in wintering area in Vestfjorden in January (survey 3); of young herring in the Barents Sea in May (survey 4); in feeding areas in the Norwegian Sea in May (survey 5); joint IMR-PINRO ecosystem survey in August-September (survey 6); Indices for 0 group (survey 7); and larvae index of SSB (survey 8). In contrast to the benchmark assessment, no data points were downweighted. Also the new maturity ogives were applied.

Profiles of the components of the TISVPA loss function with respect to SSB in 2010 are shown on Figure 7.7.2.1. As it can be seen, catch-at-age data and surveys 2,4 and 5 indicate the SSB value in 2010 to about or somewhat lower than 10 million tonnes, while surveys 1,3,7, and 8 indicate a higher SSB. Survey 6 gives no distinct minimum. The contradictions between the above mentioned two groups of signals makes the solution to be rather intrinsically uncertain, while the overall model objective function, the weighted sum of respective components, has single minimum near 10 million tonnes (Figure 7.7.2.1).

Figure 7.7.2.2 presents the estimates of the TISVPA-derived selection matrix. For some generations it reveals apparent peculiarities.

Retrospective runs (Figure 7.7.2.3) may indicate some tendency of stock underestimation with such TISVPA settings.

Figure 7.7.2.4 represents the estimates of the uncertainty in the results (conditional parametric bootstrap with respect to catch-at-age, surveys were noised with log-normal noise with std=0.3) which is rather high in terminal years because of contradiction in signals between some surveys.

The results of NSS herring stock assessment by means of TISVPA are given in Table 7.7.2.1.

7.7.3 TASACS assessment following benchmark

7.7.3.1.1 data exploration with TASACS

During this year's assessment, the maturity ogive was updated using back-calculated values (see chapter 7.5.5). This will affect the estimates of SSB. However, since the larval survey is used to tune the SSB, a change in maturity ogive may potentially also affect the N-values from the output of the assessment. In order to explore the effect of on the N-values from the assessment, two runs were made; one using the old maturity ogive from last year's assessment and one using the newly introduced maturity ogive. Figure 7.7.3.1.1.1 shows the total stock size for the two runs and there are minor differences between them for the whole time series presently used in the assessment, indicating that the change in maturity ogive made in 2010 have very little impact on the N-values.

7.7.3.1.2 benchmark 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 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, 7 and 8. It was noted that there was a conflict between the assessment and survey 5 (feeding survey in the Norwegian Sea in May) for the year classes 1997, 1998, 1999, 2002 (Figure 7.7.3.1). Theses year class seems to have a more pronounced downward trend in the survey than in the assessment. This is discussed further in chapter 7.11.

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, 2009 and 2010. 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. In 2010, survey 5 again contributed most to the SSQ while the contribution of survey 7 and survey 6 is reduced. The surveys 6 and 7 are on the juvenile herring and 0-group and are considered noisier. In Figure 7.7.3.4 weighted residuals for the surveys are shown. In survey 5 there are some large negative residuals for the year-classes from 2002 and older in the 2010 survey indicating a year-affect on older fish in this survey.

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 (F5 – 14weighted weighted by stock numbers) in recent years has fluctuated between 0.10 and 0.16 and is estimated in 2009 at 0.154. The SSB in 2010 is estimated to 8.9 million tonnes, which is a substantial reduction from last year's prediction for 2010 (12.2 million tonnes). This reduction is mostly due to the low indices from survey 5 in 2010.

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, log-normally 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 but the 2010 assessment is gives a lower SSB and a higher F compared to the three previous years for the period 2003 to present. A run for 2010 without including the May survey was done and the results from that run show that it is the low estimate from this survey that contributes to the deviation of the 2010 assessment compared to the retrospective runs.

7.8 NSSH reference points

7.8.1 PA reference points

The PA 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 Blim=2.5 million t and proposes that Bpa=5.0 million t. and Fpa=0.150.

7.8.2 MSY reference points

Following the advice from WKFRAME (ICES 2010, WKRAME) three approaches to define MSY reference points for Norwegian spring spawning herring have been used:

a stochastic simulation model HCS (version HCS10_2, available at http://www.ices.dk/datacentre/software.asp, see also WD, Skagen) parameterized for NSSH, an equilibrium analysis (PlotMSY; ICES 2010/WKFRAME) and a yield-per-recruit analysis.

In the equilibrium analysis, the structure of the stock and recruitment pairs as estimated from the most recent assessment does not lead to any clear definition of an optimum yield equilibrium fishing mortality level. Given this uncertainty it is more appropriate to select an Fmsy proxy tested by a stochastic simulation model that takes into account the long term trends in the stock biomass. The simulation model results presented in this report and in the stock annex provide a more appropriate method for the determining a viable long term target, and the values from this analysis could be put forward as potential Fmsy targets. However, it should be noted that it is clear that the estimation of MSY reference points is very sensitive to the choice of stock-recruitment function and the approach chosen to estimate the reference points. This is in accordance with previous analyses by Skagen (WD 2010) and by WKFRAME (ICES 2010, WKFRAME).

The stochastic model uses unweighted F values, which have historically been found to be slightly lower than the unweighted values (Figure 7.8.2.fvalues in the annex). Therefore, a weighted Fmsy of 0.15 corresponding to the unweighted 0.16 Fmsy proxy from the simulation analyses is proposed for this stock. This is in agreement with the current simulation-tested management plan Fpa level and should ensure high long term yield with a low risk to the stock. A precautionary reference biomass B_{pa} for this stock is defined as 5 million tonnes (ICES 1998, ICES 1999). In the ICES MSY framework B_{pa} is proposed as the default trigger biomass $B_{trigger}$.

7.8.3 Management reference points

In the long term management plan the Coastal States have then agreed a target reference point defined at F_{target}=0.125 when the stock is above Bpa. If the SSB is below Bpa, a linear reduction in the fishing mortality rate will be applied from 0.125 at Bpa to 0.05 at Blim.

7.9 State of the stock

The stock is considered to be within safe biological limits and well above B_{pa}. In the past decade, the productivity of the stock has been high. The stock contains a number of good year classes. In the last 12 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. Fishing mortality in 2008 and 2009 is estimated to slightly above F_{pa} (2%) and is higher than the target F defined in the management plan.

7.10 NSSH Catch predictions for 2010

7.10.1 Input data for the forecast

Input data for the forecast

Input stock numbers in 2011 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 1988–2006 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 2 and 3 in 2009 (year classes 2008 and 2007) 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 88-06
2007	3	1 041	2 281	5 300
2008	2	5 005	7 000	14 000
2009	1	-		36 200
2010	0	-		97 200
2011	0	-		97 200
2012	0			

The Working Group adopted the VPA values for age 2 and 3 to be used in the forecast because the VPA year classes already include the survey information which is used in RCT3. Both year classes 2007 and 2008 are weak and the estimation of these have little effect on the predicted Yield and SSB in the prognoses 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 (2007–2009). For the weight-at-age in the stock, the values for 2010 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 (2008–2010) was used.

Standard values for natural mortality were used. Maturity at age was based on the new information presented in section 7. For all year classes born after 2004 the default maturity ogive for normal year classes were used

Because the exploitation pattern estimated in the assessment deviates from the preceding years, the exploitation pattern used in the forecast was taken as the average of the last 5 years (2005–2009). In previous years it was based on the average over the last 3 years. The average fishing mortality defined as 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 1 483 000 tonnes is taken in 2010, it is expected that the SSB will decline from 9 million tonnes in 2010 to 8 million tonnes in 2011. 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 million tonnes. The expected remaining SSB in 2011 is about 10.0 million tonnes.

7.11 Uncertainties in assessment and forecast

7.11.1 Uncertainty in the assessment

The present assessment differs considerable from the ones presented in previous years. The main sources of the change are the introduction of a revised maturity at age matrix for the historical time series (see section 7.5.5) and the 2010 results of major survey used in the assessment.

The introduced changes in maturity at age data only affect the proportion of the stock which is mature in each year. The effect of introducing the revised data on the SSB appears to be small in most years except in years where large year classes are recruiting to the stock. Because the new maturity information indicates that large year classes mature more slowly than the other smaller year classes, SSB those years is estimated lower than in previous year. The revision and inclusion of biological information to the maturity data matrix are considered to have improved the maturity estimates and thereby the SSB values estimated by the assessment. The revision of the maturity at age matrix does not affect the estimates of the total stock size, recruitment and fishing mortality and the prognoses of yield in the forecast. The new maturity ogive does not change the SSB estimate in the last year of the assessment.

The main survey (survey 5) used in the assessment, estimates the stock at 5.8 million tonnes in 2010 compared to 10.4 million tonnes in 2009. The abundance indices in 2010 of all year classes before 2005 decreased with about 40-70%. Such large reductions in the stock have not been observed in previous years in this survey. The effect of the low indices on assessment is lower SSB estimates in recent years compared to previous assessments in the order of 10-20%.

There is no clear explanation for the sharp decrease in the stock as indicated by the survey. The survey in 2010 has been carried without any problems and covered all areas planned in the Norwegian Sea and Barents Sea. Several hypotheses for the discrepancy were discussed at the meeting of WGNAPES (ICES, WGNAPES 2010) and WGWIDE including: (1) that the distribution area was not fully covered; (2) a mass mortality had taken place since last year´s survey; (3) that the herring have different behaviour. There is only little information to support or reject any of the hypotheses considered.

The catch in 2009 was 1.6 million tonnes and there are no indications that higher catches have been taken that can explain the much larger reduction in the stock as suggested by the survey.

Increased natural mortality as explanation for a reduction of the stock can also be excluded as an explanation. There is no indication that natural mortality has been higher than in other years. Natural mortally may increase, for instance because of infection caused by Ichtyophonus as recently observed in Icelandic summer spawning herring or increased predation by large predators. However, during the surveys there were no indications of high prevalence of Ichtyophonus and it is unlikely that whales and other predators consumed more than 3 million tonnes more than in other years.

In the past the herring stock has shown changes in the migration. In the last decade older herring migrates to more western feeding grounds in summer. In principle it is possible that part of the stock had migrated outside the area covered by the May survey even if the survey coverage was comparable to recent years and there were zero values on all the peripheries of the area. In July/August 2010, another survey (survey

9) was carried out in the Norwegian Sea and adjoining waters. The survey was carried out for the 2nd time in 2010 and does not provide a time series yet. The survey area in 2010 was extended in order to cover all areas where herring may occur and might have been missed by the May survey. Most of the herring observed was on the expected grounds and the total acoustic herring biomass was estimated at 10.7 million tonnes. This compared to 13.6 million tonnes observed in 2009 obtained in a smaller area. The age distribution of the survey catches in 2010 was similar in both surveys, although slightly more 2002- and older year classes were found in July/August survey compared to the May survey. Thus, the observed decline in the July/August survey is in agreement with the observations found in the May survey. Also a larvae survey, carried out in spawning time, produced a lower index, suggesting a lower spawning stock.

It would be possible that the stock has been overestimated in previous surveys. However, this is considered unlikely because the survey estimates have been very consistent in successive years.

The lower abundance index in 2010 could possibly be explained by a reduced catchability to the acoustic survey gear caused by changes in the behaviour of herring. It was reported that during both surveys most of the herring was dispersed in the top layer in the water column and that little schools were observed. This behaviour may be related to the feeding conditions and the temperature. Estimation of dispersed herring high in the water column by acoustic methods is more problematic than when they appear in schools at greater depths. In the absence of detailed acoustic recordings, the Working Group could not compare the distribution with other years. Since this is the only possible hypothesis remaining for the moment, this should be further investigated with priority.

The downward revision of SSB by the 2010 assessment in recent years compared to previous assessments are mainly caused by the inclusion of the 2010 results of the May survey. In the past this survey has provided a consistent time series and the 2010 values were obtained in the same way as in previous years. There is no explanation for the reduction in the stock estimate from the survey so there are no arguments to exclude the 2010 survey results from the assessment.

The retrospective analyses show that the present assessment model provides very consistent estimates of the SSB and F in recent assessment. However, including the 2010 survey data changes this picture and estimates reduced SSBs and higher Fs in the most recent years. An exploratory assessment has been made excluding the 2010 survey and compared with retrospective assessments. The SSB results are shown in Figure 7.11.1.1. The exploratory assessment without the 2010 survey is now consistent with the retrospective assessment. This indicates that the retrospective pattern is highly influenced by the 2010 survey data (survey 5).

7.11.2 Uncertainty in the forecast

The spawning stock in recent years increased due to a number good year classes and a moderate exploitation. It reached a peak in 2009 but will according to the forecast decline in the near future. This can be expected since the last strong year class stems from 2004 and thereafter all year classes are much lower.

Recruitment estimates from surveys of the most recent year classes indicate that they are weak. However the estimates are uncertain. 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 2006-2010 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, 2009 and 2010 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. However, following the recommendation from WKHERMAT, a new maturity ogive was used in the 2010 assessment, which changed the perception of the SSB back in time (see chapter 7.5.5).

The results from this year's assessment deviate from the results from previous years. This is partly because of the change in maturity ogive, but the reduction in SSB and increase in F for the most recent years is caused by low values from the main survey (survey 5) in 2010.

The SSB in 2009 was estimated at 9.8 million tonnes in the present assessment compared to 13.3 million tonnes last year. Weighted F 5-14 in 2008 is estimated at 0.153 compared to 0.125 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. Between 1998 and 2004 the stock has produced a number strong year classes which lead to an increase in SSB. The SSB for the year 2009 was estimated 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 has declined in 2010 and 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 9 million tonnes in 2010 to 7.9 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 but these were higher than the agreed target fishing mortality in the Management Plan due to changed level of the fishing mortality estimated in this year's assessment. If exploitation will follow the management plan, 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 in summer. As consequence mackerel catches have been taken in that area as bycatch and in new directed fisheries.

In the past decade, 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. Juvenile 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-August 2009 and 2010. The following discussion will in particular concentrate on the situation in the feeding areas (ICES PGNAPES 2009, ICES WGWIDE 2010).

Herring were recorded throughout the survey area, except for the north-eastern part and the Jan Mayen zone in May 2010, which is the main difference from the survey in 2009. Compared to 2009, there were less herring in the western most area, presumably causing a slight eastward displacement of the centre of gravity of the acoustic recordings in 2010 as compared to in 2009 (Figure 7.4.2.1). As in previous years, the smallest and youngest fish were found in the north-eastern area and both size and age increased south-westward.

In both July 2009 and 2010, 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 in 2010 were found in the northern and western region, while there was practically an empty hole in the central area. This is a typical distribution, which has been observed at this time of the year during the last few years, although not as pronounced as documented in summer 2010. Similarly to May, the biggest and oldest fish were found in the western, northern and south-western parts of the survey area. The herring was predominantly distributed in small school and aggregations in the upper 40-50 m of the water column above the pronounced thermocline. The low number of marine mammals sighted in summer 2009 and 2010 could be due to low and unfavourable densities and school size of herring providing less cost efficient feeding opportunities for marine mammals such as humpback whale, fin whale and minke whale.

The average biomass of zooplankton in the total area in May has been on a decreasing trend since 2002. In May 2010 zooplankton biomass distribution was shifted eastward compared to 2009. Zooplankton biomass was lower in most areas and particularly so in the cold water of the East Icelandic current. The highest zooplankton biomasses were observed in the eastern Norwegian Sea in May 2010, close to the coast of Northern Norway, while the biomass in the Barents Sea was low. The July survey 2010 agreed with the May survey, indicating low biomass of zooplankton. The highest concentrations were found in the southernmost region of the Norwegian Sea, whereas the remaining regions showed very low plankton concentration. Thus, from a situation with relatively good feeding conditions throughout the Norwegian Sea, the area can now be considered to have poor feeding conditions. This apparent low concentration of zooplankton in the Norwegian Sea has seemingly consequences on the Norwegian spring spawning herring because its total fat content is much lower in 2010 than in previous summers (Figure 7.15.1).

The strong and persistent decrease in available plankton resources for all the pelagic fish stocks in the Norwegian Sea must be regarded a major ecological factor at present and should be followed very 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 Fpa. 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 summer survey in the Nordic Seas in July-August 2010 (see section 2.1.1, Figure 2.5.2.1.7) suggested a stronger horizontal species segregation between herring and mackerel in 2010 than previous years, with the herring distributed more in the cooler waters influenced by the East-Icelandic Current in the western part of the distribution area in 2010. This has resulted in less mixing between the species in 2010 than in previous years.

The apparent change in horizontal distributions was also seen in the distribution of the commercial catches of mackerel in the Faroese and Icelandic zones 2010 with no or only very small proportions of herring in the catches for mackerel in the area as com-pared to last year.

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 Atlantic 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 North Atlantic Oscillation (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 and 2010 about normal. However, the increased Arctic influence in the western areas of the Norwegian Sea was still observed both in 2009 and 2010.

The temperature in the western and northern Norwegian Sea in 2010 is close to and in some areas less than the 1995-2010 average. In the central and eastern parts of the

Norwegian Sea the temperature is still warmer than the 20 year average, but colder than in 2009.

In the south-western part, east off Iceland, the sea temperature in the spring 2010 was close to the long term average while it was above average south and north off Iceland. Later, in middle of July, the temperature of the surface waters in the south western was however observed to be far above (1-3°C) the 20 year average. That anomalously high sea surface temperature, as in the north-western Icelandic waters in the summer 2009, is mainly reflecting the weather condition prior to the measurements and thus consequence of strong atmospheric warming of the surface layers.

Annex: References

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Annex: MSY reference points for Norwegian spring spawning herring

HCS Simulation model analysis

HCS is a stochastic simulation model for studying different management scenarios. The parameterization of HCS for NSSH is described in a working document sent for WGWIDE in 2010 (WD, Skagen; the values for weights, natural mortality and initial N-values can be found in ICES 2009, WGWIDE Table 7.10.1.3, input to short term prediction; see also Skagen 2010, WD WKFRAME). Two stock-recruitment relationships, Beverton-Holt and hockey stick, are explored:

Beverton-Holt: $R = a*SSB/(SSB+b)$

Hockey stick: $S>b: R = a$

$S<b: R = a*SSB/b$

The stock-recruitment parameters are shown in Table 7.8.2. params, and a plot of these together with the data is shown in Figure 7.8.2.srstoch. A plot of the data together with model output for Beverton-Holt function is show in Figure 7.8.2. srmodeldata, and the cumulative distribution of recruitment in data and model output is shown in Figure 7.8.2.cumdist. The long term sustained yields with Beverton-Holt recruitment function are shown in Figure 7.8.2.catch. A similar figure for hockey stick recruitment function can be found in Skagen 2010 (WD, Skagen).

In WKHERMAT in 2010 a new maturity ogive matrix for NSSH based on a back calculation methods was estimated (ICES 2010, WKHERMAT). This is used in the assessment in 2010. There appears to be a difference in the maturation ogive between strong and weak year classes such that strong year classes tend to mature at later age compared to weak year classes (Engelhart & Heino 2004, ICES 2010, WKFRAME). However, the model used here currently allows only static maturity ogive, and in order to take into account the effect of variation in maturation of strong and weak year classes for MSY and F_{MSY} we have run the analysis using the standard maturity ogive used in assessment the latest years, an ogive estimated for weak year classes and an ogive estimated for strong year classes (Table 7.8.2.modelparams). Furthermore, in year 2009 the selection pattern is different to the historical period, appearing more dome-shaped than the historical sigmoidal selection pattern (Table 7.8.2.modelparams). We have not been able to identify any reason why the selection pattern would have changed, as there have been no changes in gear or fishery in general. Nevertheless, we also studied the effect of possible change in selection pattern by using alternatively the historical (old) or the selection curve from 2009 (Table 7.8.2.modelparams).

The results of the simulation analysis suggest that the MSY, for all the scenarios and with both stock-recruitment functions, is within the same range: between 1 and 1.2 million tonnes (Figure 7.8.2.msyBH, 7.8.2.msyHS, and Table 7.8.2.results). Even though the different scenarios result in MSY within the same range, the F_{MSY} has more variation (Figure 7.8.2.fmsy and Table 7.8.2.results). When Beverton-Holt recruitment function is used, the risk of stock going below B_{lim} (2.5 million t.) and $B_{trigger}$ (4 million t.) at F_{MSY} are both very low, whereas with the Hockey stick recruitment function the risk of the stock falling below $B_{trigger}$ at F_{MSY} is relatively high (Table 7.8.2.results). Hockey stick recruitment function appears not to be very useful in modelling population dynamics, as the spawning stock size where MSY is reached is the same point where stock reproductive capacity starts decreasing (see also the discussion in the equilibrium analysis below). When Beverton-Holt recruitment function is used, unweighted F_{MSY} using the historical fishery selection pattern is 0.16 (for all maturity ogive scenarios), and adopting the 2009 selection pattern suggests of F_{MSY} 0.12 (for all maturity ogive scenarios). In NSSH management weighted F values are used, and the weighted values tend to be somewhat lower than unweighted values (Figure 7.8.2.fvalues). As we have no reason to believe that the selection pattern has really changed, we consider unweighted F_{MSY} to be 0.16. This unweighted F value is in close agreement with the reference values originating from an analysis carried out in 1998 (ICES 2008/ACOM 13), where a weighted F_{pa} is defined as 0.150.

Equilibrium and YPR analyses

Deterministic and stochastic equilibrium analyses were carried out using the 'plot-MSY' software (ICES 2010, WKFRAME) to determine candidate F_{MSY} values for the Norwegian spring spawning herring stock. Stock-recruitment pairs from the period 1988-2009, as outputted from the most recent assessment of the stock, were used together with 5-year averages of selectivity, weight and maturity at age (back-calculated ogive). Two stock recruit relationships were examined, Beverton and Holt and the ('smooth hockey stick' (segmented regression), and yield-per-recruit (YPR) analyses were also done. For the stochastic analyses, uncertainty (CVs) in the biological and fishery parameters at age were used to create alternative fits to two stock-recruit relationships (*N*=1000).

While the Beverton and Holt fit is reasonable under using the old maturity ogive to estimate SSB (results not shown), the majority of stochastic stock-recruit model fits fell out of the range of the deterministic fit to the data, and thus it can be concluded that the stock-recruit form is unclear and not suitable for the data and the level of uncertainty associated with the parameters. Using the new back-calculated maturity ogive, as has been decided by the working group for the assessment of this stock, results in an very poor Beverton and Holt fit (Figure 7.8.2. sr), with an extremely steep slope at the origin and an asymptote at the geometric mean recruitment level. Given the lack of any clear patterns in the stock-recruit data, a hockey stick model fit, while uncertain around the origin, probably provides the most cautious fit to the data. For the hockey stick, the slope at the origin is the descending limb of the stock-recruit curve, which for this stock is relatively shallow, hence F_{crash} is low. The value for B_{msy} is at the breakpoint in the hockey stick, hence F_{msy} is estimated to be the same as F_{crash} (Table 7.8.2. msy). The uncertainty with regards to the slope at the origin makes this stock-recruitment function unsuitable as a basis for advice on F_{msy}. In such cases the slope is more useful as an indication of F_{pa} or F_{lim}.

Given the poor fits to stock recruitment functions, a yield-per-recruit analysis was conducted (Figure 7.8.2. ypr). The stochastic analysis shows a high degree of uncertainty and a very poorly defined F_{max}. That both the hockey stick and per-recruit analysis suggests a high degree of uncertainty with regards to F_{max} could be down to the assumptions made about the uncertainties input into the analyses, though these assumptions are believed to be realistic given the information on the stock. This would preclude the use of F_{max} as an F_{msy} proxy, although $F_{0.1}$ may remain a viable, safer alternative. The YPR curve shows that F values in the range 0.125-0.15 are likely to result in high long term yields.

Conclusions

In the equilibrium analysis, the structure of the stock and recruitment pairs as estimated from the most recent assessment does not lead to any clear definition of an optimum yield equilibrium fishing mortality level. Given this uncertainty it is more appropriate to select an F_{msy} proxy tested by a stochastic simulation model that takes into account the long term trends in the stock biomass. The simulation model results presented in this report and in the stock annex provide a more appropriate method for the determining a viable long term target, and the values from this analysis could be put forward as potential F_{msy} targets. However, it should be noted that it is clear that the estimation of MSY reference points is very sensitive to the choice of stock-recruitment function and the approach chosen to estimate the reference points. This is in accordance with previous analyses by Skagen (WD 2010) and by WKFRAME (ICES 2010, WKFRAME).

The stochastic model uses unweighted F values, which have historically been found to be slightly lower than the unweighted values (Figure 7.8.2.fvalues). Therefore, a weighted F_{msy} of 0.15 corresponding to the unweighted 0.16 F_{msy} proxy from the simulation analyses is proposed for this stock. This is in agreement with the current simulation-tested management plan F_{pa} level and should ensure high long term yield with a low risk to the stock.

References:

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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
2009	1016675	210105	32320	85098	265479	10014	24021	3730	25477	14452	0	0	0	1687371

****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 2009 data.

Summary of Sampling by Country

AREA : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	873.00	873.00	12	1150	360	100.16
Total 1	873.00	873.00	12	1150	360	100.16

Sum of Offical Catches :	873.00
Unallocated Catch :	0.00
Discards :	0.00
Working Group Catch :	873.00

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	32320.00	32320.00	13	1576	338	100.16
Faroe Islands	61920.00	74145.00	13	737	172	99.99
Germany	1996.00	6739.00	4	1470	355	95.92
Greenland	0.00	3730.00	0	0	0	0.00
Iceland	154908.00	154908.00	74	3158	1958	100.03
Ireland	10014.00	10014.00	2	180	158	99.96
Norway	971239.00	971239.00	279	14147	3299	100.00
Russia	141845.00	174307.00	55	11840	844	100.00
Scotland	0.00	25477.00	0	0	0	0.00
The Netherlands	2744.00	18386.00	35	3936	875	100.11
Total IIa	1376986.00	1471265.00	475	37044	7999	100.00

Sum of Offical Catches :	1471265.00
Unallocated Catch :	1064.00
Discards :	0.00
Working Group Catch :	1472329.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	6421.00	6421.00	3	266	44	100.03
Germany	7714.00	7714.00	18	7235	1003	98.32
Russia	35798.00	35798.00	56	14076	520	100.08
The Netherlands	4571.00	5190.00	10	1104	250	100.03
Total IIb	54504.00	55123.00	87	22681	1817	99.77

Sum of Offical Catches :	55123.00
Unallocated Catch :	-619.00
Discards :	0.00
Working Group Catch :	54504.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	44563.00	44563.00	21	1622	574	100.07
Total IVa	44563.00	44563.00	21	1622	574	100.07

Sum of Offical Catches :	44563.00
Unallocated Catch :	0.00
Discards :	0.00
Working Group Catch :	44563.00

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	0.00	2332.00	0	0	0	0.00
Iceland	96356.00	96356.00	55	2420	1075	99.94
Total Va	96356.00	98688.00	55	2420	1075	99.94

Sum of Offical Catches : 98688.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 98688.00

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Iceland	240.00	240.00	2	100	96	99.96
Total Vb	240.00	240.00	2	100	96	99.96

Sum of Offical Catches : 240.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 240.00

AREA : XIVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	0.00	2201.00	0	0	0	0.00
Iceland	13975.00	13975.00	11	519	344	100.00
Total XIVa	13975.00	16176.00	11	519	344	100.00

Sum of Offical Catches : 16176.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 16176.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	17503.00	17503.00	3	378	78	100.11
Faroe Islands	0.00	13219.00	0	0	0	0.00
Iceland	4111.00	4111.00	2	100	98	100.01
Ireland	10014.00	10014.00	2	180	158	99.96
Norway	440689.00	440689.00	121	4084	1039	100.00
Russia	0.00	32461.00	0	0	0	0.00
Scotland	0.00	20356.00	0	0	0	0.00
Period Total	472317.00	538353.00	128	4742	1373	100.00

Sum of Offical Catches : 538353.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 538353.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	1411.00	1419.00	4	149	54	99.96
Iceland	58853.00	58853.00	45	1837	1148	99.95
Norway	9869.00	9869.00	18	1530	624	100.01
Russia	2551.00	2551.00	7	822	217	99.78
Period Total	72684.00	72692.00	74	4338	2043	99.96

Sum of Offical Catches : 72692.00
Unallocated Catch : 0.00
Discards : 0.00
Working Group Catch : 72692.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	28534.00	32065.00	9	588	118	99.93
Germany	9710.00	9710.00	22	8705	1358	97.83
Iceland	158609.00	158609.00	90	3995	2054	100.00
Norway	76701.00	76701.00	36	2706	979	100.09
Russia	105201.00	105202.00	66	15860	738	100.00
The Netherlands	7315.00	8305.00	45	5040	1125	100.06
Period Total	386070.00	390592.00	268	36894	6372	99.96

Sum of Offical Catches : 390592.00
Unallocated Catch : -990.00
Discards : 0.00
Working Group Catch : 389602.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	14817.00	14817.00	10	1198	260	100.21
Faroe Islands	38396.00	38396.00	3	266	44	100.04
Germany	0.00	4743.00	0	0	0	0.00
Greenland	0.00	3730.00	0	0	0	0.00
Iceland	43906.00	43906.00	5	265	173	100.03
Norway	489416.00	489416.00	137	8599	1591	100.01
Russia	69891.00	69891.00	38	9234	409	100.01
Scotland	0.00	5121.00	0	0	0	0.00
The Netherlands	0.00	15271.00	0	0	0	0.00
Period Total	656426.00	685291.00	193	19562	2477	100.01

Sum of Offical Catches : 685291.00
Unallocated Catch : 1435.00
Discards : 0.00
Working Group Catch : 686726.00

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	32320.00	32320.00	13	1576	338	100.16
Faroe Islands	68341.00	85099.00	16	1003	216	99.99
Germany	9710.00	14453.00	22	8705	1358	97.83
Greenland	0.00	3730.00	0	0	0	0.00
Iceland	265479.00	265479.00	142	6197	3473	100.07
Ireland	10014.00	10014.00	2	180	158	99.96
Norway	1016675.00	1016675.00	312	16919	4233	100.01
Russia	177643.00	210105.00	111	25916	1364	100.00
Scotland	0.00	25477.00	0	0	0	0.00
The Netherlands	7315.00	23576.00	45	5040	1125	100.06
Total for Stock	1587497.00	1686928.00	663	65536	12265	99.99

Sum of Offical Catches : 1686928.00
Unallocated Catch : 445.00
Discards : 0.00
Working Group Catch : 1687373.00

DETAILS OF DATA FILLING-IN

Filling-in for record : (10) Russia 1 IIa
Using Only
>> (3) Norway 1 IIa

Filling-in for record : (32) Scotland 1 IIa
Using Only
>> (27) Ireland 1 IIa

Filling-in for record : (37) Faroe Islands 1 IIa
Using Only
>> (3) Norway 1 IIa

Filling-in for record : (44) Faroe Islands 1 Va
Using Only
>> (22) Iceland 2 Va

Filling-in for record : (42) Faroe Islands 2 XIVa
Using Only
>> (25) Iceland 2 XIVa

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  Filling-in for record : ( 43)   Faroe Islands          3 XIVa
Using Only
  >>  ( 26)  Iceland               3 XIVa

  Filling-in for record : ( 45)   Faroe Islands          3 Va
Using Only
  >>  ( 23)  Iceland               3 Va

  Filling-in for record : ( 29)   The Netherlands        4 IIa
Mean Weighted by Number of Samples of:
  >>  ( 13)  Russia                4 IIa
  >>  ( 17)  Denmark               4 IIa
  >>  ( 21)  Iceland               4 IIa

  Filling-in for record : ( 33)   Scotland               4 IIa
Using Only
  >>  (  6)  Norway                4 IIa

  Filling-in for record : ( 35)   Germany                4 IIa
Unweighted Mean of :
  >>  ( 13)  Russia                4 IIa
  >>  ( 17)  Denmark               4 IIa
  >>  ( 21)  Iceland               4 IIa

  Filling-in for record : ( 31)   Greenland              4 IIa
Using Only
  >>  ( 21)  Iceland               4 IIa
```

Catch Numbers at Age by Area

For Periods 1 to 4

Ages	1	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	3467.91	0.00	0.00	0.00	0.00	0.00	3467.91
2	0.00	113171.45	69.00	0.00	183.17	0.00	0.00	113423.63
3	67.00	187490.09	3801.00	0.00	1282.48	0.00	0.00	192640.58
4	147.00	142090.09	4097.00	1600.00	671.36	8.00	461.25	149074.70
5	1135.00	1100839.75	65472.00	17978.00	7635.74	17.00	702.93	1193780.50
6	446.00	783191.81	55083.00	22784.00	43485.92	133.00	9624.03	914747.75
7	864.00	1679019.25	44372.00	91134.00	106001.81	382.00	7858.08	1929631.13
8	55.00	113161.80	3636.00	4971.00	17347.19	50.00	3709.86	142930.84
9	45.00	202519.14	2455.00	8296.00	37872.53	83.00	10766.06	262036.73
10	101.00	349641.63	3233.00	11643.00	47476.20	66.00	11810.87	423971.72
11	70.00	204991.27	156.00	11845.00	18393.13	50.00	2668.51	238173.92
12	13.00	41063.67	143.00	517.00	2933.73	0.00	848.38	45518.78
13	0.00	6979.36	0.00	1034.00	976.41	8.00	339.16	9336.92
14	0.00	8251.45	0.00	0.00	1222.24	0.00	679.57	10153.26
15	0.00	63731.90	0.00	2216.29	3910.14	0.00	679.57	70537.89

Mean Weight at Age by Area (Kg)

For Periods 1 to 4

Ages	1	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0400	0.0000	0.0000	0.0000	0.0000	0.0000	0.0400
2	0.0000	0.1559	0.1574	0.0000	0.2300	0.0000	0.0000	0.1561
3	0.2160	0.1825	0.2018	0.0000	0.2667	0.0000	0.0000	0.1835
4	0.2320	0.2194	0.2350	0.1790	0.2926	0.3300	0.2982	0.2200
5	0.2680	0.2505	0.2701	0.2043	0.2900	0.2850	0.2825	0.2512
6	0.3010	0.2906	0.3066	0.2374	0.3058	0.2990	0.2761	0.2908
7	0.3300	0.3128	0.3281	0.2563	0.3295	0.2880	0.3052	0.3114
8	0.3280	0.3393	0.3612	0.2576	0.3505	0.3150	0.3231	0.3380
9	0.3500	0.3497	0.3586	0.2736	0.3524	0.3170	0.3298	0.3470
10	0.3500	0.3656	0.3670	0.2942	0.3652	0.3240	0.3454	0.3631
11	0.3990	0.3778	0.4016	0.3021	0.3911	0.3320	0.3950	0.3753
12	0.3990	0.3819	0.4260	0.2870	0.4062	0.0000	0.3480	0.3819
13	0.0000	0.3791	0.0000	0.3170	0.4062	0.3240	0.3664	0.3746
14	0.0000	0.3740	0.0000	0.0000	0.3990	0.0000	0.3361	0.3745
15	0.0000	0.3859	0.0000	0.3792	0.4023	0.0000	0.3737	0.3865

Mean Length at Age by Area (cm)

For Periods 1 to 4

Ages	1	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	17.8000	0.0000	0.0000	0.0000	0.0000	0.0000	17.8000
2	0.0000	25.2938	25.1652	0.0000	27.0000	0.0000	0.0000	25.2965
3	28.5000	27.3186	28.5086	0.0000	30.5006	0.0000	0.0000	27.3637
4	28.8000	28.9151	29.4190	29.0000	31.7279	32.0000	32.0534	28.9523
5	30.2000	30.1860	31.1476	29.9405	31.0395	32.0000	32.3788	30.2418
6	31.2000	31.6854	32.3252	31.3501	32.4160	32.7000	32.5252	31.7590
7	32.2000	32.4043	33.0647	32.2000	32.8457	32.4000	32.9999	32.4364
8	32.7000	33.5517	33.8639	32.6800	33.8000	33.5000	33.8942	33.5680
9	33.6000	33.8987	34.2913	33.3000	34.2276	34.2000	34.4575	33.9540
10	33.3000	34.2634	34.6986	34.1822	34.4850	33.9000	34.5000	34.2956
11	34.1000	34.5393	36.1346	34.4077	34.5761	34.2000	35.0000	34.5416
12	34.0000	35.2142	36.7000	35.0000	35.5939	0.0000	35.0000	35.2365
13	0.0000	35.6581	0.0000	35.0000	36.1259	35.0000	35.3563	35.6226
14	0.0000	35.1512	0.0000	0.0000	36.3000	0.0000	36.2150	35.3607
15	0.0000	36.3654	0.0000	36.4578	36.2701	0.0000	36.1787	36.3613

Catch Numbers at Age by Area

For Period 1

Ages	1	IIa	IIb	IVa	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	0.00	4644.32	0.00	0.00	10.17	0.00	0.00	4654.50
3	0.00	35198.58	0.00	0.00	20.29	0.00	0.00	35218.87
4	0.00	8682.34	0.00	1600.00	20.29	0.00	0.00	10302.63
5	0.00	298351.16	0.00	15548.00	101.56	0.00	0.00	314000.72
6	0.00	250017.56	0.00	19928.00	700.66	0.00	0.00	270646.22
7	0.00	805360.31	0.00	84440.00	1066.22	0.00	0.00	890866.50
8	0.00	41588.48	0.00	4639.00	233.53	0.00	0.00	46461.01
9	0.00	64508.30	0.00	7778.00	507.70	0.00	0.00	72794.00
10	0.00	143698.20	0.00	10608.00	396.02	0.00	0.00	154702.23
11	0.00	93600.18	0.00	10937.00	121.85	0.00	0.00	104659.03
12	0.00	23742.20	0.00	517.00	10.17	0.00	0.00	24269.37
13	0.00	2925.23	0.00	1034.00	20.29	0.00	0.00	3979.52
14	0.00	2399.44	0.00	0.00	0.00	0.00	0.00	2399.44
15	0.00	33169.61	0.00	2154.00	30.46	0.00	0.00	35354.08

Mean Weight at Age by Area (Kg)

For Period 1

Ages	1	IIa	IIb	IVa	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	0.0000	0.0660	0.0000	0.0000	0.2300	0.0000	0.0000	0.0664
3	0.0000	0.1374	0.0000	0.0000	0.2860	0.0000	0.0000	0.1375
4	0.0000	0.1641	0.0000	0.1790	0.2880	0.0000	0.0000	0.1667
5	0.0000	0.2017	0.0000	0.2080	0.2740	0.0000	0.0000	0.2020
6	0.0000	0.2495	0.0000	0.2410	0.2930	0.0000	0.0000	0.2490
7	0.0000	0.2838	0.0000	0.2590	0.3000	0.0000	0.0000	0.2815
8	0.0000	0.3207	0.0000	0.2600	0.3210	0.0000	0.0000	0.3147
9	0.0000	0.3220	0.0000	0.2750	0.3160	0.0000	0.0000	0.3169
10	0.0000	0.3403	0.0000	0.2970	0.3270	0.0000	0.0000	0.3373
11	0.0000	0.3513	0.0000	0.3040	0.3400	0.0000	0.0000	0.3464
12	0.0000	0.3701	0.0000	0.2870	0.3040	0.0000	0.0000	0.3683
13	0.0000	0.3350	0.0000	0.3170	0.3380	0.0000	0.0000	0.3303
14	0.0000	0.3510	0.0000	0.0000	0.0000	0.0000	0.0000	0.3510
15	0.0000	0.3576	0.0000	0.3810	0.3490	0.0000	0.0000	0.3590

Mean Length at Age by Area (cm)

For Period 1

Ages	1	IIa	IIb	IVa	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	0.0000	20.6000	0.0000	0.0000	27.0000	0.0000	0.0000	20.6140
3	0.0000	25.7013	0.0000	0.0000	30.0000	0.0000	0.0000	25.7038
4	0.0000	27.4112	0.0000	29.0000	31.5000	0.0000	0.0000	27.6660
5	0.0000	29.0577	0.0000	29.9000	31.8000	0.0000	0.0000	29.1003
6	0.0000	30.9235	0.0000	31.3000	32.7000	0.0000	0.0000	30.9558
7	0.0000	31.9758	0.0000	32.2000	32.6000	0.0000	0.0000	31.9978
8	0.0000	33.2081	0.0000	32.7000	33.8000	0.0000	0.0000	33.1603
9	0.0000	33.4641	0.0000	33.3000	34.0000	0.0000	0.0000	33.4503
10	0.0000	33.8708	0.0000	34.2000	34.4000	0.0000	0.0000	33.8947
11	0.0000	34.3051	0.0000	34.4000	34.4000	0.0000	0.0000	34.3151
12	0.0000	35.1822	0.0000	35.0000	34.0000	0.0000	0.0000	35.1778
13	0.0000	34.4912	0.0000	35.0000	35.5000	0.0000	0.0000	34.6286
14	0.0000	34.0000	0.0000	0.0000	0.0000	0.0000	0.0000	34.0000
15	0.0000	36.4000	0.0000	36.5000	36.7000	0.0000	0.0000	36.4063

Catch Numbers at Age by Area

For Period 2

Ages	1	IIa	IIb	IVa	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	0.00	12192.00	0.00	0.00	173.00	0.00	0.00	12365.00
3	20.00	7827.00	0.00	0.00	345.00	0.00	0.00	8192.00
4	45.00	3004.00	0.00	0.00	345.00	8.00	218.32	3620.32
5	346.00	11077.00	0.00	2418.00	1727.00	17.00	218.32	15803.32
6	136.00	39476.00	0.00	2842.00	11914.00	133.00	7198.46	61699.46
7	263.00	22378.00	0.00	6661.00	18130.00	382.00	1308.90	49122.90
8	17.00	8900.00	0.00	330.00	3971.00	50.00	1527.22	14795.22
9	14.00	27256.00	0.00	515.00	8633.00	83.00	4580.65	41081.66
10	31.00	18874.00	0.00	1030.00	6734.00	66.00	2836.12	29571.12
11	21.00	5526.00	0.00	904.00	2072.00	50.00	0.00	8573.00
12	4.00	1522.00	0.00	0.00	173.00	0.00	0.00	1699.00
13	0.00	1077.00	0.00	0.00	345.00	8.00	218.32	1648.32
14	0.00	952.00	0.00	0.00	0.00	0.00	436.63	1388.63
15	0.00	3151.00	0.00	62.00	518.00	0.00	436.63	4167.63

Mean Weight at Age by Area (Kg)

For Period 2

Ages	1	IIa	IIb	IVa	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	0.0000	0.2014	0.0000	0.0000	0.2300	0.0000	0.0000	0.2018
3	0.2160	0.2496	0.0000	0.0000	0.2860	0.0000	0.0000	0.2510
4	0.2320	0.2147	0.0000	0.0000	0.2880	0.3300	0.2440	0.2239
5	0.2680	0.2333	0.0000	0.1809	0.2740	0.2850	0.2170	0.2303
6	0.3010	0.2757	0.0000	0.2124	0.2930	0.2990	0.2670	0.2752
7	0.3300	0.2874	0.0000	0.2217	0.3000	0.2880	0.2960	0.2836
8	0.3280	0.2960	0.0000	0.2236	0.3210	0.3150	0.2890	0.3004
9	0.3500	0.3180	0.0000	0.2522	0.3160	0.3170	0.3080	0.3156
10	0.3500	0.3220	0.0000	0.2658	0.3270	0.3240	0.3120	0.3202
11	0.3990	0.3273	0.0000	0.2791	0.3400	0.3320	0.0000	0.3255
12	0.3990	0.3485	0.0000	0.0000	0.3040	0.0000	0.0000	0.3441
13	0.0000	0.3490	0.0000	0.0000	0.3380	0.3240	0.3290	0.3439
14	0.0000	0.3370	0.0000	0.0000	0.0000	0.0000	0.3200	0.3317
15	0.0000	0.3527	0.0000	0.3170	0.3490	0.0000	0.3380	0.3502

Mean Length at Age by Area (cm)

For Period 2

Ages	1	IIa	IIb	IVa	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	0.0000	26.7949	0.0000	0.0000	27.0000	0.0000	0.0000	26.7978
3	28.5000	28.7466	0.0000	0.0000	30.0000	0.0000	0.0000	28.7988
4	28.8000	28.7915	0.0000	0.0000	31.5000	32.0000	31.0000	29.1900
5	30.2000	30.0080	0.0000	30.2000	31.8000	32.0000	31.0000	30.2533
6	31.2000	32.4206	0.0000	31.7000	32.7000	32.7000	32.5000	32.4485
7	32.2000	32.6464	0.0000	32.2000	32.6000	32.4000	33.5000	32.5872
8	32.7000	33.5493	0.0000	32.4000	33.8000	33.5000	33.6000	33.5951
9	33.6000	34.1005	0.0000	33.3000	34.0000	34.2000	34.4000	34.1028
10	33.3000	34.4057	0.0000	34.0000	34.4000	33.9000	34.5000	34.3970
11	34.1000	34.3606	0.0000	34.5000	34.4000	34.2000	0.0000	34.3832
12	34.0000	35.4074	0.0000	0.0000	34.0000	0.0000	0.0000	35.2607
13	0.0000	36.2000	0.0000	0.0000	35.5000	35.0000	35.0000	35.8887
14	0.0000	36.0000	0.0000	0.0000	0.0000	0.0000	35.5000	35.8428
15	0.0000	36.0143	0.0000	35.0000	36.7000	0.0000	36.0000	36.0829

Catch Numbers at Age by Area

For Period 3

Ages	1	IIa	IIb	IVa	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	0.00	31394.05	67.00	0.00	0.00	0.00	0.00	31461.05
3	47.00	44938.34	3670.00	0.00	917.19	0.00	0.00	49572.53
4	102.00	30261.20	4020.00	0.00	306.07	0.00	242.93	34932.20
5	789.00	219278.23	63955.00	12.00	5807.17	0.00	484.61	290326.06
6	310.00	151032.61	53758.00	14.00	30871.26	0.00	2425.57	238411.45
7	601.00	214429.73	43060.00	33.00	86805.59	0.00	6549.17	351478.50
8	38.00	18922.08	3600.00	2.00	13142.66	0.00	2182.64	37887.38
9	31.00	37865.14	2399.00	3.00	28731.83	0.00	6185.40	75215.37
10	70.00	31611.04	3127.00	5.00	40346.18	0.00	8974.75	84133.96
11	49.00	16684.04	151.00	4.00	16199.28	0.00	2668.51	35755.82
12	9.00	1461.00	138.00	0.00	2750.55	0.00	848.38	5206.94
13	0.00	1227.01	0.00	0.00	611.12	0.00	120.84	1958.97
14	0.00	2190.00	0.00	0.00	1222.24	0.00	242.93	3655.18
15	0.00	1954.00	0.00	0.29	3361.67	0.00	242.93	5558.90

Mean Weight at Age by Area (Kg)

For Period 3

Ages	1	IIa	IIb	IVa	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	0.0000	0.1938	0.1574	0.0000	0.0000	0.0000	0.0000	0.1937
3	0.2160	0.2126	0.2019	0.0000	0.2590	0.0000	0.0000	0.2127
4	0.2320	0.2281	0.2350	0.0000	0.2980	0.0000	0.3470	0.2303
5	0.2680	0.2751	0.2701	0.1809	0.2950	0.0000	0.3120	0.2744
6	0.3010	0.3141	0.3066	0.2124	0.3110	0.0000	0.3030	0.3119
7	0.3300	0.3420	0.3281	0.2217	0.3360	0.0000	0.3070	0.3382
8	0.3280	0.3498	0.3610	0.2236	0.3600	0.0000	0.3470	0.3542
9	0.3500	0.3588	0.3586	0.2522	0.3640	0.0000	0.3460	0.3597
10	0.3500	0.3676	0.3671	0.2658	0.3720	0.0000	0.3560	0.3684
11	0.3990	0.3748	0.4019	0.2791	0.3980	0.0000	0.3950	0.3870
12	0.3990	0.4114	0.4260	0.0000	0.4130	0.0000	0.3480	0.4023
13	0.0000	0.4369	0.0000	0.0000	0.4470	0.0000	0.4340	0.4399
14	0.0000	0.3675	0.0000	0.0000	0.3990	0.0000	0.3650	0.3779
15	0.0000	0.3846	0.0000	0.3170	0.4110	0.0000	0.4380	0.4029

Mean Length at Age by Area (cm)

For Period 3

Ages	1	IIa	IIb	IVa	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	0.0000	26.5922	25.1672	0.0000	0.0000	0.0000	0.0000	26.5892
3	28.5000	28.1573	28.5125	0.0000	30.7000	0.0000	0.0000	28.2310
4	28.8000	29.0519	29.4136	0.0000	32.0000	0.0000	33.0000	29.1460
5	30.2000	30.7837	31.1463	30.2000	30.8000	0.0000	33.0000	30.8660
6	31.2000	32.1358	32.3233	31.7000	32.3000	0.0000	32.6000	32.2028
7	32.2000	32.9548	33.0636	32.2000	32.9000	0.0000	32.9000	32.9522
8	32.7000	33.5688	33.8585	32.4000	33.8000	0.0000	34.1000	33.7062
9	33.6000	34.0909	34.2888	33.3000	34.3000	0.0000	34.5000	34.2105
10	33.3000	34.2503	34.6985	34.0000	34.5000	0.0000	34.5000	34.4125
11	34.1000	34.3710	36.1391	34.5000	34.6000	0.0000	35.0000	34.5288
12	34.0000	35.6721	36.7000	0.0000	35.7000	0.0000	35.0000	35.6017
13	0.0000	36.0505	0.0000	0.0000	36.5000	0.0000	36.0000	36.1876
14	0.0000	34.9932	0.0000	0.0000	36.3000	0.0000	37.5000	35.5968
15	0.0000	35.8811	0.0000	35.0000	36.2000	0.0000	36.5000	36.1009

Catch Numbers at Age by Area

For Period 4

Ages	1	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	3467.91	0.00	0.00	0.00	0.00	0.00	3467.91
2	0.00	64941.08	2.00	0.00	0.00	0.00	0.00	64943.08
3	0.00	99526.15	131.00	0.00	0.00	0.00	0.00	99657.15
4	0.00	100142.55	77.00	0.00	0.00	0.00	0.00	100219.55
5	0.00	572133.38	1517.00	0.00	0.00	0.00	0.00	573650.38
6	0.00	342665.66	1325.00	0.00	0.00	0.00	0.00	343990.66
7	0.00	636851.25	1312.00	0.00	0.00	0.00	0.00	638163.25
8	0.00	43751.25	36.00	0.00	0.00	0.00	0.00	43787.25
9	0.00	72889.72	56.00	0.00	0.00	0.00	0.00	72945.72
10	0.00	155458.38	106.00	0.00	0.00	0.00	0.00	155564.38
11	0.00	89181.05	5.00	0.00	0.00	0.00	0.00	89186.05
12	0.00	14338.48	5.00	0.00	0.00	0.00	0.00	14343.48
13	0.00	1750.12	0.00	0.00	0.00	0.00	0.00	1750.12
14	0.00	2710.01	0.00	0.00	0.00	0.00	0.00	2710.01
15	0.00	25457.29	0.00	0.00	0.00	0.00	0.00	25457.29

Mean Weight at Age by Area (Kg)

For Period 4

Ages	1	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0400	0.0000	0.0000	0.0000	0.0000	0.0000	0.0400
2	0.0000	0.1355	0.1570	0.0000	0.0000	0.0000	0.0000	0.1355
3	0.0000	0.1796	0.1990	0.0000	0.0000	0.0000	0.0000	0.1796
4	0.0000	0.2217	0.2340	0.0000	0.0000	0.0000	0.0000	0.2217
5	0.0000	0.2669	0.2690	0.0000	0.0000	0.0000	0.0000	0.2669
6	0.0000	0.3119	0.3080	0.0000	0.0000	0.0000	0.0000	0.3119
7	0.0000	0.3406	0.3290	0.0000	0.0000	0.0000	0.0000	0.3406
8	0.0000	0.3613	0.3770	0.0000	0.0000	0.0000	0.0000	0.3613
9	0.0000	0.3814	0.3570	0.0000	0.0000	0.0000	0.0000	0.3814
10	0.0000	0.3939	0.3650	0.0000	0.0000	0.0000	0.0000	0.3939
11	0.0000	0.4093	0.3940	0.0000	0.0000	0.0000	0.0000	0.4093
12	0.0000	0.4020	0.4260	0.0000	0.0000	0.0000	0.0000	0.4020
13	0.0000	0.4310	0.0000	0.0000	0.0000	0.0000	0.0000	0.4310
14	0.0000	0.4126	0.0000	0.0000	0.0000	0.0000	0.0000	0.4126
15	0.0000	0.4269	0.0000	0.0000	0.0000	0.0000	0.0000	0.4269

Mean Length at Age by Area (cm)

For Period 4

Ages	1	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	17.8000	0.0000	0.0000	0.0000	0.0000	0.0000	17.8000
2	0.0000	24.7199	25.1000	0.0000	0.0000	0.0000	0.0000	24.7199
3	0.0000	27.3995	28.4000	0.0000	0.0000	0.0000	0.0000	27.4008
4	0.0000	29.0079	29.7000	0.0000	0.0000	0.0000	0.0000	29.0084
5	0.0000	30.5487	31.2000	0.0000	0.0000	0.0000	0.0000	30.5504
6	0.0000	31.9581	32.4000	0.0000	0.0000	0.0000	0.0000	31.9598
7	0.0000	32.7524	33.1000	0.0000	0.0000	0.0000	0.0000	32.7531
8	0.0000	33.8714	34.4000	0.0000	0.0000	0.0000	0.0000	33.8718
9	0.0000	34.1080	34.4000	0.0000	0.0000	0.0000	0.0000	34.1083
10	0.0000	34.6117	34.7000	0.0000	0.0000	0.0000	0.0000	34.6117
11	0.0000	34.8277	36.0000	0.0000	0.0000	0.0000	0.0000	34.8277
12	0.0000	35.2000	36.7000	0.0000	0.0000	0.0000	0.0000	35.2005
13	0.0000	37.0000	0.0000	0.0000	0.0000	0.0000	0.0000	37.0000
14	0.0000	36.0000	0.0000	0.0000	0.0000	0.0000	0.0000	36.0000
15	0.0000	36.4011	0.0000	0.0000	0.0000	0.0000	0.0000	36.4011

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
2009	0	3468	113424	192641	149075	1193781	914748	1929631	142931	262037	423972	238174	45519	9337	10153	70538

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
2009	0	0.04	0.156	0.184	0.22	0.251	0.291	0.311	0.338	0.347	0.363	0.375	0.382	0.375	0.375	0.387

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
2010****	0.001	0.01	0.044	0.077	0.188	0.22	0.251	0.286	0.308	0.333	0.344	0.354	0.373	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.**

******derived from catch data from the wintering area north of 69°N during January 2010 for age groups 4-12**

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
2010	7.724	1.966	0.091	0	0

[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
2010	81	364	1195	3329	2156	8282	4146	4519	390	513	804	331	45	17	25	26857	5777

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
2009	1.5	0.4	

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
2009	18916

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
2010	42.7	140.2

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 7.7.5.1. Norwegian Spring-spawning herring. Revised proportion mature at age.

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1950	0	0	0	0	0.2	0.8	1	1	1	1	1	1	1	1	1	1
1951	0	0	0	0	0.2	0.8	1	1	1	1	1	1	1	1	1	1
1952	0	0	0	0	0.1	0.6	1	1	1	1	1	1	1	1	1	1
1953	0	0	0	0	0.3	0.4	0.9	1	1	1	1	1	1	1	1	1
1954	0	0	0	0	0.1	0.7	0.9	1	1	1	1	1	1	1	1	1
1955	0	0	0	0.1	0.4	0.4	1	1	1	1	1	1	1	1	1	1
1956	0	0	0	0	0.5	0.7	0.6	1	1	1	1	1	1	1	1	1
1957	0	0	0	0	0.3	0.8	0.8	0.7	1	1	1	1	1	1	1	1
1958	0	0	0	0	0.3	0.5	0.9	0.9	1	1	1	1	1	1	1	1
1959	0	0	0	0	0.7	0.8	1	0.9	1	1	1	1	1	1	1	1
1960	0	0	0	0	0.3	0.9	0.9	1	1	1	1	1	1	1	1	1
1961	0	0	0	0	0.1	0.8	1	0.9	1	1	1	1	1	1	1	1
1962	0	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1
1963	0	0	0	0	0.1	0.4	1	1	1	1	1	1	1	1	1	1
1964	0	0	0	0	0.1	0.4	0.8	1	1	1	1	1	1	1	1	1
1965	0	0	0	0	0.5	0.4	0.9	0.8	1	1	1	1	1	1	1	1
1966	0	0	0	0	0.5	0.7	0.9	1	1	1	1	1	1	1	1	1
1967	0	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1
1968	0	0	0	0	0	0.7	0.9	1	1	1	1	1	1	1	1	1
1969	0	0	0	0.1	0.2	0.3	1	1	1	1	1	1	1	1	1	1
1970	0	0	0	0	0.4	0.3	0.4	1	1	1	1	1	1	1	1	1
1971	0	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1
1972	0	0	0	0	0.4	0.3	1	1	1	1	1	1	1	1	1	1
1973	0	0	0	0.1	0.6	1	1	1	1	1	1	1	1	1	1	1
1974	0	0	0	0	0.6	0.9	1	1	1	1	1	1	1	1	1	1
1975	0	0	0	0.1	0.5	0.9	1	1	1	1	1	1	1	1	1	1
1976	0	0	0	0.1	0.9	0.9	1	1	1	1	1	1	1	1	1	1
1977	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1	1
1978	0	0	0	0.2	0.9	1	1	1	1	1	1	1	1	1	1	1
1979	0	0	0	0.1	0.9	1	1	1	1	1	1	1	1	1	1	1
1980	0	0	0	0.1	0.9	1	1	1	1	1	1	1	1	1	1	1
1981	0	0	0	0.1	1	1	1	1	1	1	1	1	1	1	1	1
1982	0	0	0	0.1	0.8	1	1	1	1	1	1	1	1	1	1	1
1983	0	0	0	0.1	0.9	1	1	1	1	1	1	1	1	1	1	1
1984	0	0	0	0.1	0.7	1	1	1	1	1	1	1	1	1	1	1
1985	0	0	0	0.1	0.8	0.9	1	1	1	1	1	1	1	1	1	1
1986	0	0	0	0	0.5	0.9	0.9	1	1	1	1	1	1	1	1	1
1987	0	0	0	0	0.1	0.8	0.9	0.9	1	1	1	1	1	1	1	1
1988	0	0	0	0	0.2	0.7	0.9	1	1	1	1	1	1	1	1	1
1989	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
1990	0	0	0	0.2	0.5	0.9	1	1	1	1	1	1	1	1	1	1
1991	0	0	0	0	0.9	0.9	1	1	1	1	1	1	1	1	1	1
1992	0	0	0	0	0.8	1	1	1	1	1	1	1	1	1	1	1
1993	0	0	0	0	0.5	1	1	1	1	1	1	1	1	1	1	1
1994	0	0	0	0	0.1	0.9	1	1	1	1	1	1	1	1	1	1
1995	0	0	0	0	0	0.6	1	1	1	1	1	1	1	1	1	1
1996	0	0	0	0	0	0.5	0.9	1	1	1	1	1	1	1	1	1
1997	0	0	0	0.1	0	0.4	0.9	1	1	1	1	1	1	1	1	1
1998	0	0	0	0	0.6	0.4	0.9	1	1	1	1	1	1	1	1	1
1999	0	0	0	0	0.3	0.9	0.9	1	1	1	1	1	1	1	1	1

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2000	0	0	0	0	0.2	0.8	1	1	1	1	1	1	1	1	1	1
2001	0	0	0	0	0.3	0.9	0.9	1	1	1	1	1	1	1	1	1
2002	0	0	0	0	0.1	0.9	1	1	1	1	1	1	1	1	1	1
2003	0	0	0	0	0.2	0.7	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
2005	0	0	0	0	0.3	0.9	1	1	1	1	1	1	1	1	1	1
2006	0	0	0	0	0.3	0.8	1	1	1	1	1	1	1	1	1	1
2007	0	0	0	0	0.1	0.7	0.9	1	1	1	1	1	1	1	1	1
2008	0	0	0	0	0.1	0.6	0.9	1	1	1	1	1	1	1	1	1
2009	0	0	0	0	0.4	0.6	0.9	1	1	1	1	1	1	1	1	1
2010	0	0	0	0	0.4	0.8	0.9	1	1	1	1	1	1	1	1	1

Table 7.7.2.1. Norwegian spring-spawning herring. The stock summary of the exploratory TISVPA run.

Year	Recruits at age 0	Total Biomass)	SSB (Jan.1)	F 5-14 weighted by abundance
1986	12753	1900.7	336.1	1.015534
1987	10497	3288.8	377.3	0.28442
1988	25740	3613.0	2094.7	0.044597
1989	68011	4311.8	3399.5	0.028616
1990	126064	4886.9	4066.5	0.020226
1991	338119	5593.1	3995.1	0.021858
1992	386234	6697.4	4073.0	0.025444
1993	120352	7809.4	3955.4	0.059798
1994	41243	8986.6	4085.4	0.12482
1995	12401	9905.8	4120.7	0.20944
1996	53611	10005.8	4772.6	0.174144
1997	37716	9954.8	6189.5	0.165864
1998	179220	8698.5	6919.9	0.139601
1999	169179	9370.8	7155.0	0.167696
2000	72324	8866.3	6071.9	0.193273
2001	39001	7455.7	4964.9	0.166573
2002	447677	7485.6	4280.5	0.178057
2003	196362	9288.3	4699.4	0.141784
2004	284261	11682.2	5656.7	0.121397
2005	55853	12121.5	5725.8	0.161071
2006	181292	13188.1	6118.6	0.171727
2007	520693	13362.3	7075.9	0.128023
2008	140386	15296.4	8056.7	0.154852
2009		16260.6	9336.1	0.154903
2010			9035.7	

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	28.985	4.673	2.988	5.945	0.904	14.826	0.046	0.017	0.014	0.027	0.012	0.012	0.007	0.005	0.005	0.002
1989	73.561	11.774	1.898	1.209	5.058	0.755	12.250	0.030	0.011	0.007	0.010	0.002	0.007	0.003	0.002	0.003
1990	109.168	29.903	4.786	0.756	1.038	4.350	0.645	10.243	0.023	0.009	0.005	0.005	0.001	0.006	0.003	0.004
1991	320.794	44.384	12.157	1.936	0.633	0.891	3.733	0.545	8.606	0.019	0.006	0.002	0.002	0.000	0.005	0.004
1992	384.383	130.425	18.043	4.941	1.658	0.542	0.766	3.200	0.461	7.205	0.014	0.005	0.002	0.001	0.000	0.007
1993	121.504	156.277	53.027	7.335	4.241	1.397	0.462	0.658	2.743	0.391	5.992	0.010	0.004	0.002	0.000	0.006
1994	41.672	49.396	63.538	21.555	6.287	3.551	1.121	0.390	0.563	2.333	0.319	4.777	0.008	0.003	0.001	0.005
1995	19.595	16.943	20.083	25.827	18.522	5.309	2.719	0.812	0.321	0.477	1.974	0.242	3.513	0.004	0.002	0.005
1996	58.549	7.967	6.888	8.164	22.176	15.621	3.992	1.748	0.485	0.262	0.396	1.634	0.131	2.177	0.000	0.005
1997	42.855	23.804	3.239	2.781	6.995	18.425	11.987	2.563	1.128	0.321	0.220	0.334	1.345	0.096	1.098	0.004
1998	231.808	17.423	9.678	1.303	2.273	5.770	14.193	8.468	1.500	0.668	0.220	0.171	0.257	1.074	0.065	0.604
1999	202.951	94.246	7.084	3.882	1.056	1.732	4.624	10.583	6.116	0.937	0.454	0.150	0.124	0.218	0.820	0.522
2000	64.439	82.514	38.318	2.877	3.214	0.876	1.365	3.582	7.620	4.184	0.536	0.293	0.116	0.069	0.181	1.020
2001	40.457	26.199	33.548	15.570	2.398	2.246	0.722	1.072	2.708	5.353	2.632	0.260	0.185	0.084	0.039	0.891
2002	450.764	16.449	10.652	13.638	13.306	1.915	1.537	0.585	0.834	2.055	3.829	1.795	0.156	0.138	0.069	0.725
2003	173.095	183.267	6.688	4.291	11.554	10.856	1.411	1.020	0.476	0.631	1.524	2.680	1.230	0.085	0.107	0.610
2004	297.365	70.375	74.509	2.716	3.624	9.644	8.666	1.052	0.722	0.388	0.474	1.110	1.781	0.855	0.037	0.566
2005	48.295	120.899	28.611	30.265	2.315	3.033	7.903	6.796	0.802	0.494	0.310	0.359	0.798	1.160	0.541	0.098
2006	59.917	19.635	49.154	11.619	25.634	1.905	2.453	6.205	4.986	0.577	0.311	0.231	0.249	0.558	0.679	0.411
2007	16.716	24.360	7.982	19.955	9.931	21.386	1.564	1.952	4.667	3.575	0.415	0.196	0.171	0.160	0.356	0.726
2008	30.296	6.796	9.901	3.240	16.967	8.207	16.733	1.204	1.455	3.341	2.603	0.313	0.145	0.133	0.115	0.749
2009	68.790	12.317	2.738	3.947	2.755	14.094	6.442	12.272	0.851	1.014	2.331	1.897	0.242	0.091	0.092	0.568
2010	1.000	27.968	5.006	1.041	3.218	2.233	11.023	4.696	8.773	0.600	0.630	1.613	1.412	0.166	0.070	0.501

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	0.005	0.012	0.030	0.041	0.253	0.273	0.612	0.875	1.475	0.308	0.672	0.862	0.453	0.453
1989	0.000	0.000	0.021	0.003	0.001	0.008	0.029	0.131	0.083	0.118	0.458	0.934	0.106	0.113	0.167	0.167
1990	0.000	0.000	0.005	0.027	0.003	0.003	0.018	0.024	0.062	0.211	0.575	0.682	1.856	0.035	0.292	0.292
1991	0.000	0.000	0.000	0.005	0.005	0.002	0.004	0.018	0.028	0.157	0.086	0.039	0.392	-1.000	0.062	0.062
1992	0.000	0.000	0.000	0.003	0.022	0.010	0.002	0.004	0.014	0.034	0.218	0.157	0.142	-1.000	0.049	0.049
1993	0.000	0.000	0.000	0.004	0.028	0.070	0.020	0.006	0.012	0.053	0.077	0.000	0.000	0.000	0.042	0.042
1994	0.000	0.000	0.000	0.002	0.019	0.117	0.173	0.044	0.016	0.017	0.128	0.157	0.469	0.181	0.087	0.087
1995	0.000	0.000	0.000	0.002	0.020	0.135	0.292	0.366	0.054	0.037	0.039	0.467	0.328	-1.000	0.133	0.133
1996	0.000	0.000	0.007	0.005	0.035	0.115	0.293	0.288	0.261	0.024	0.020	0.045	0.157	0.535	0.093	0.093
1997	0.000	0.000	0.011	0.052	0.043	0.111	0.198	0.386	0.374	0.229	0.103	0.111	0.075	0.242	0.452	0.452
1998	0.000	0.000	0.014	0.060	0.122	0.071	0.144	0.175	0.320	0.235	0.234	0.174	0.015	0.120	0.098	0.098
1999	0.000	0.000	0.001	0.039	0.037	0.088	0.106	0.179	0.230	0.408	0.290	0.110	0.429	0.036	0.124	0.124
2000	0.000	0.000	0.001	0.032	0.208	0.044	0.092	0.130	0.203	0.314	0.573	0.306	0.165	0.436	0.149	0.149
2001	0.000	0.000	0.000	0.007	0.075	0.229	0.060	0.102	0.126	0.185	0.233	0.364	0.148	0.046	0.098	0.098
2002	0.000	0.000	0.009	0.016	0.054	0.155	0.260	0.057	0.129	0.149	0.207	0.228	0.457	0.103	0.115	0.115
2003	0.000	0.000	0.001	0.019	0.031	0.075	0.144	0.195	0.053	0.136	0.167	0.259	0.213	0.674	0.085	0.085
2004	0.000	0.000	0.001	0.010	0.028	0.049	0.093	0.121	0.230	0.077	0.127	0.180	0.279	0.308	1.670	1.670
2005	0.000	0.000	0.001	0.016	0.045	0.063	0.092	0.160	0.179	0.314	0.142	0.218	0.208	0.386	0.292	0.292
2006	0.000	0.000	0.002	0.007	0.031	0.048	0.078	0.135	0.183	0.181	0.311	0.153	0.289	0.299	0.256	0.256
2007	0.000	0.000	0.002	0.012	0.041	0.095	0.111	0.144	0.184	0.168	0.131	0.151	0.102	0.180	0.218	0.218
2008	0.000	0.009	0.020	0.012	0.036	0.092	0.160	0.197	0.211	0.210	0.166	0.108	0.312	0.214	0.269	0.269
2009	0.000	0.000	0.067	0.054	0.060	0.096	0.166	0.186	0.200	0.326	0.218	0.145	0.227	0.117	0.126	0.126

Negative fishing mortality -1 means that the fishing mortality was not defined, see TASACS manual

Table 7.7.3.4 Norwegian spring spawning herring. Final stock summary table.

	recruitment age 0 in year	total biomass	spawning stock biomass	landings	unweighted f	weighted F
year	billions	million tons	million tons	thous. tons	5-14	5-14
1988	28.985	3.921	2.115	135	0.582	0.046
1989	73.561	4.783	3.594	104	0.215	0.029
1990	109.168	5.445	4.519	86	0.376	0.019
1991	320.794	6.096	4.518	85	0.088	0.020
1992	384.383	7.203	4.657	104	0.07	0.023
1993	121.504	8.246	4.528	232	0.028	0.053
1994	41.672	9.323	4.638	479	0.139	0.113
1995	19.595	10.084	4.509	906	0.206	0.207
1996	58.549	10.118	4.934	1220	0.183	0.184
1997	42.855	9.977	6.161	1427	0.228	0.175
1998	231.808	8.805	6.877	1223	0.159	0.148
1999	202.951	9.812	7.079	1235	0.2	0.180
2000	64.439	9.462	6.115	1207	0.241	0.210
2001	40.457	7.941	5.052	766	0.159	0.179
2002	450.764	8.286	4.483	808	0.186	0.189
2003	173.095	10.186	5.235	790	0.2	0.130
2004	297.365	12.480	6.511	794	0.313	0.109
2005	48.295	12.811	6.524	1003	0.205	0.144
2006	59.917	13.887	7.022	969	0.193	0.148
2007	16.716	13.199	8.059	1267	0.148	0.121
2008	30.296	12.992	8.833	1546	0.194	0.153
2009*	68.790	12.106	9.871	1687	0.181	0.154
2010*		10.286	8.967			

*** Recruitment value has been replaced by GM mean 1988-2006**

Table 7.8.2.params. Norwegian spring spawning herring. Stock recruitment parameters used in the simulation model and their fit to the data (Skagen 2010).

	a-parameter	b-parameter	SSQ
Beverton-Holt	180805	6986	81.85
Hockey stick	88803	3957	81.47

Table 7.8.2.modelparams. Norwegian spring spawning herring. Age-specific maturation probabilities, exploitation patterns and weight at age in stock and in catches used in the different stochastic simulation scenarios.

	Maturity ogive			Exploitation pattern		Weight at age	
Age	historic	weak year class	Strong year class	Old	2009	stock	catch
0	0	0	0	0.00	0.00	0.001	0
1	0	0	0	0.05	0.00	0.01	0.052
2	0	0	0	0.04	0.87	0.033	0.115
3	0	0	0	0.05	0.26	0.077	0.159
4	0.3	0.4	0.1	0.18	0.29	0.141	0.225
5	0.9	0.8	0.6	0.41	0.47	0.215	0.264
6	1	1	0.9	0.67	0.84	0.27	0.301
7	1	1	1	1.03	0.93	0.306	0.32
8	1	1	1	1.10	1.01	0.336	0.338
9	1	1	1	0.81	1.65	0.346	0.359
10	1	1	1	1.03	1.10	0.364	0.366
11	1	1	1	0.77	0.73	0.369	0.375
12	1	1	1	1.42	1.14	0.411	0.391
13	1	1	1	1.36	0.59	0.353	0.397
14	1	1	1	1.39	0.56	0.389	0.396
15	1	1	1	1.39	0.56	0.393	0.406

Table 7.8.2.results. Norwegian spring spawning herring. MSY and FMSY values provided by HCS model for different scenario combinations. Risk B_{lim} refers to the probability that SSB < B_{lim} in the last year (2.5 million tonnes), and Risk $B_{trigger}$ refers to the probability that SSB < $B_{trigger}$ ($B_{trigger}$ = 5 million tonnes, risk calculated as risk B_{lim}).

		Beverton-Holt				Hockey stick			
Ogive	selection pattern	F_{MSY}	MSY	Risk Blim	Risk Btrigger	F_{MSY}	MSY	Risk Blim	Risk Btrigger
Historical	old	0.16	1120.1	0	0.026	0.32	1180.1	0.067	0.354
	2009	0.12	1071.5	0.006	0.064	0.2	1135.7	0.088	0.431
Weak year class	old	0.16	1132.8	0	0.022	0.32	1193.4	0.058	0.321
	2009	0.12	1083.4	0.006	0.051	0.2	1149.4	0.075	0.401
Strong year class	old	0.16	1093.3	0.002	0.045	0.26	1157.9	0.04	0.232
	2009	0.12	1046.4	0.007	0.086	0.16	1117.9	0.017	0.203

Table 7.8.2. msy. Deterministic and stochastic estimates of *F* and biomass reference points form two stock recruit relationships and yield-per-recruit analysis for the Norwegian spring spawning herring stock (*=poorly defined).

Beverton-Holt

	Fcrash	Fmsy	Bmsy	MSY
Deterministic	*	*	0.25	1.06
50%ile	0.52	0.15	3.11	0.61
CV	1.09	0.60	0.72	0.61

Hockey Stick

	Fcrash	Fmsy	Bmsy	MSY
Deterministic	0.18	0.18	4.25	0.70
50%ile	0.20	0.20	3.88	0.90
CV	0.71	0.69	0.39	0.49

Per recruit

	F01	Fmax
Deterministic	0.23	*
50%ile	0.19	0.77
CV	0.39	0.58

Table 7.10.1.1. Norwegian spring spawning herring. Input file for RCT3.

NSSH:	VPA and acoustic survey data					
5	24	2				
'Yearcl'	'VPAage2'	'Sur70'	'Sur41'	'Sur42'	'sur61'	'sur62'
1986	2.988	7	-11	-11	-11	-11
1987	1.898	2	-11	-11	-11	-11
1988	4.786	8686	-11	-11	-11	-11
1989	12.157	4196	-11	5.2	-11	-11
1990	18.043	9508	24.3	14	-11	-11
1991	53.027	81175	32.6	25.8	-11	-11
1992	63.538	37183	102.7	59.2	-11	-11
1993	20.083	61508	6.6	7.7	-11	-11
1994	6.888	14884	0.5	0.25	-11	-11
1995	3.239	1308	0.1	0.04	-11	-11
1996	9.678	57169	2.6	4.7	-11	-11
1997	7.084	45808	9.5	4.9	-11	-11
1998	38.318	79492	49.5	27.9	-11	11.5
1999	33.548	15931	-11	7.6	14.7	10.5
2000	10.652	49614	0.3	3.9	0.5	-11
2001	6.688	844	0.5	-11	-11	4.3
2002	74.509	23354	-11	-11	99.9	36.5
2003	28.611	28579	-11	4.5	14.3	16.1
2004	49.154	133350	23.3	35	46.4	5.5
2005	7.982	26332	3.7	3.7	1.6	2.6
2006	9.901	66819	2.1	-11	3.9	1.62
2007	2.738	22481	-11	0.47	0.03	0.4
2008	-11	15727	0.19	2	1.5	-11
2009	-11	18916	7.7	-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 24 years : 1986 - 2009

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 2006

	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	.50	-1.84	1.09	.469	20	11.11	3.73	1.187	.040
Sur41	.66	1.45	.50	.779	13	1.13	2.19	.566	.175
Sur42									
sur61	.52	1.97	.21	.951	6	1.59	2.80	.286	.686
sur62	1.40	.06	.75	.611	7	.96	1.40	1.139	.043
					VPA Mean =		2.72	.994	.057

Yearclass = 2007

	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	.51	-2.01	1.12	.440	21	10.02	3.13	1.212	.052
Sur41									
Sur42	.81	1.21	.43	.800	15	.39	1.52	.513	.290
sur61	.57	1.80	.26	.923	7	.03	1.82	.389	.504
sur62	1.21	.58	.67	.658	8	.34	.98	1.020	.073
					VPA Mean =		2.71	.971	.081

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	.58	-2.71	1.31	.376	22	9.66	2.90	1.407	.033
Sur41	.65	1.47	.47	.782	14	.17	1.58	.557	.211
Sur42	.83	1.15	.43	.825	16	1.10	2.07	.480	.284
sur61	.64	1.59	.32	.922	8	.92	2.17	.402	.405
sur62									
					VPA Mean =		2.64	.993	.066

Yearclass = 2009

	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	.58	-2.71	1.31	.376	22	9.85	3.00	1.407	.099
Sur41	.65	1.47	.47	.782	14	2.16	2.88	.530	.701
Sur42									
sur61									
sur62									
					VPA Mean =		2.64	.993	.199

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2006	14	2.66	.24	.20	.74	10	2.39
2007	6	1.81	.28	.24	.75	3	1.32
2008	7	2.07	.26	.16	.38		
2009	17	2.84	.44	.08	.03		

Table 7.10.1.3 Norwegian Spring-spawning herring. Input to short-term prediction.

2010

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	97200	0.9	0.00	0	0	0.001	0.000	0.000
1	36200	0.9	0.00	0	0	0.010	0.003	0.047
2	5005	0.9	0.00	0	0	0.044	0.030	0.133
3	1040	0.15	0.00	0	0	0.077	0.026	0.164
4	3218	0.15	0.40	0	0	0.188	0.045	0.219
5	2232	0.15	0.80	0	0	0.220	0.094	0.259
6	11022	0.15	0.90	0	0	0.251	0.146	0.301
7	4695	0.15	1.00	0	0	0.286	0.176	0.320
8	8772	0.15	1.00	0	0	0.308	0.198	0.340
9	600	0.15	1.00	0	0	0.333	0.235	0.353
10	630	0.15	1.00	0	0	0.344	0.172	0.362
11	1613	0.15	1.00	0	0	0.354	0.135	0.374
12	1412	0.15	1.00	0	0	0.373	0.213	0.389
13	166	0.15	1.00	0	0	0.353	0.170	0.390
14	70	0.15	1.00	0	0	0.389	0.204	0.389
15	501	0.15	1.00	0	0	0.393	0.204	0.400

2011 and 2012

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	97200	0.9	0.00	0	0	0.001	0.000	0.000
1		0.9	0.00	0	0	0.010	0.003	0.047
2		0.9	0.00	0	0	0.044	0.030	0.133
3		0.15	0.00	0	0	0.077	0.026	0.164
4		0.15	0.40	0	0	0.158	0.045	0.219
5		0.15	0.80	0	0	0.216	0.094	0.259
6		0.15	1.00	0	0	0.263	0.146	0.301
7		0.15	1.00	0	0	0.294	0.176	0.320
8		0.15	1.00	0	0	0.324	0.198	0.340
9		0.15	1.00	0	0	0.343	0.235	0.353
10		0.15	1.00	0	0	0.355	0.172	0.362
11		0.15	1.00	0	0	0.365	0.135	0.374
12		0.15	1.00	0	0	0.398	0.213	0.389
13		0.15	1.00	0	0	0.353	0.170	0.390
14		0.15	1.00	0	0	0.389	0.204	0.389
15		0.15	1.00	0	0	0.393	0.204	0.400

Table 7.10.2.1. Norwegian spring spawning herring. Short term prediction.

Basis: Landings (2010) = 1483 (=TAC); $\mathbf{F}_w(2010)^{1)}$ = 0.159; SSB(2010) = 9 million t.; SSB(2011)= 8 million t.
The fishing mortality applied according to the agreed management plan (F(management plan)) is 0.125.

Rationale	Landings (2011)	Fmult	Basis	F(2011)	SSB(2012)
Zero catch	0	0	F=0	0.000	7.7
Status quo	1199	1.04	F(2009)	0.154	6.6
Agreed management plan	105	0.08	F(management plan)*0.1	0.013	7.6
	260	0.20	F(management plan)*0.25	0.031	7.4
	517	0.41	F(management plan)*0.50	0.063	7.2
	756	0.61	F(management plan)*0.75	0.094	7.0
	900	0.73	F(management plan)*0.90	0.113	6.8
	988	0.81	F(management plan)	0.125	6.8
	1088	0.90	F(management plan)*1.1	0.138	6.7
	1218	1.01	F(management plan)*1.25	0.156	6.6
Precautionary limits	1173	0.97	F_{pa}	0.150	6.6

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 2010, F is management plan (0.125) in 2011 and 2012

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	97200	97200	97	97	0	0	0.000	0.000	0
1	36200	36200	362	362	0	0	0.002	49.329	2
2	5005	5005	220	220	0	0	0.019	61.218	8
3	1040	1040	80	80	0	0	0.021	19.912	3
4	3218	3218	605	605	242	242	0.043	127.271	28
5	2232	2232	491	491	393	393	0.081	160.603	42
6	11022	11022	2767	2767	2490	2490	0.124	1199.622	361
7	4695	4695	1343	1343	1343	1343	0.168	676.093	217
8	8772	8772	2702	2702	2702	2702	0.196	1451.843	494
9	600	600	200	200	200	200	0.245	121.612	43
10	630	630	217	217	217	217	0.198	105.517	38
11	1613	1613	571	571	571	571	0.159	220.005	82
12	1412	1412	527	527	527	527	0.233	273.216	106
13	166	166	59	59	59	59	0.245	33.589	13
14	70	70	27	27	27	27	0.238	13.792	5
15	501	501	197	197	197	197	0.238	98.714	39
	174376	174376	10464	10464	8966	8966	0.159	4612.3	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	97200	97200	97	97	0	0	0.000	0	0
1	39519	39519	395	395	0	0	0.001	36	2
2	14687	14687	646	646	0	0	0.013	121	16
3	1997	1997	154	154	0	0	0.014	26	4
4	877	877	139	139	56	56	0.029	24	5
5	2652	2652	572	572	458	458	0.054	130	34
6	1772	1772	467	467	467	467	0.084	133	40
7	8377	8377	2460	2460	2460	2460	0.113	834	267
8	3416	3416	1106	1106	1106	1106	0.132	393	134
9	6208	6208	2131	2131	2131	2131	0.165	880	310
10	404	404	144	144	144	144	0.134	47	17
11	445	445	162	162	162	162	0.107	42	16
12	1185	1185	472	472	472	472	0.157	160	62
13	963	963	340	340	340	340	0.165	136	53
14	112	112	44	44	44	44	0.160	15	6
15	387	387	152	152	152	152	0.160	53	21
	180200	180200	9480	9480	7990	7990	0.125	3031	988
	(millions)	(millions)	(thousands)	(thousands)	(thousands)	(thousands)	(WF 5-14)	(millions)	(thousands)

Table 7.10.2.2 (Cont'd)

				2012					
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	97200	97200	97	97	0	0	0.000	0	0
1	39519	39519	395	395	0	0	0.001	35	2
2	16045	16045	706	706	0	0	0.012	128	17
3	5897	5897	454	454	0	0	0.014	74	12
4	1695	1695	268	268	107	107	0.028	44	10
5	733	733	158	158	126	126	0.052	35	9
6	2162	2162	569	569	569	569	0.081	156	47
7	1403	1403	412	412	412	412	0.109	135	43
8	6438	6438	2084	2084	2084	2084	0.127	715	243
9	2577	2577	885	885	885	885	0.159	353	125
10	4529	4529	1609	1609	1609	1609	0.129	509	184
11	304	304	111	111	111	111	0.103	28	10
12	344	344	137	137	137	137	0.151	45	17
13	872	872	308	308	308	308	0.159	119	47
14	703	703	273	273	273	273	0.154	94	36
15	366	366	144	144	144	144	0.154	49	19
	180784	180784	8611	8611	6765	6765	0.125	2517	822
	(millions)	(millions)	(thousands)	(thousands)	(thousands)	(thousands)	(WF 5-14)	(millions)	(thousands)

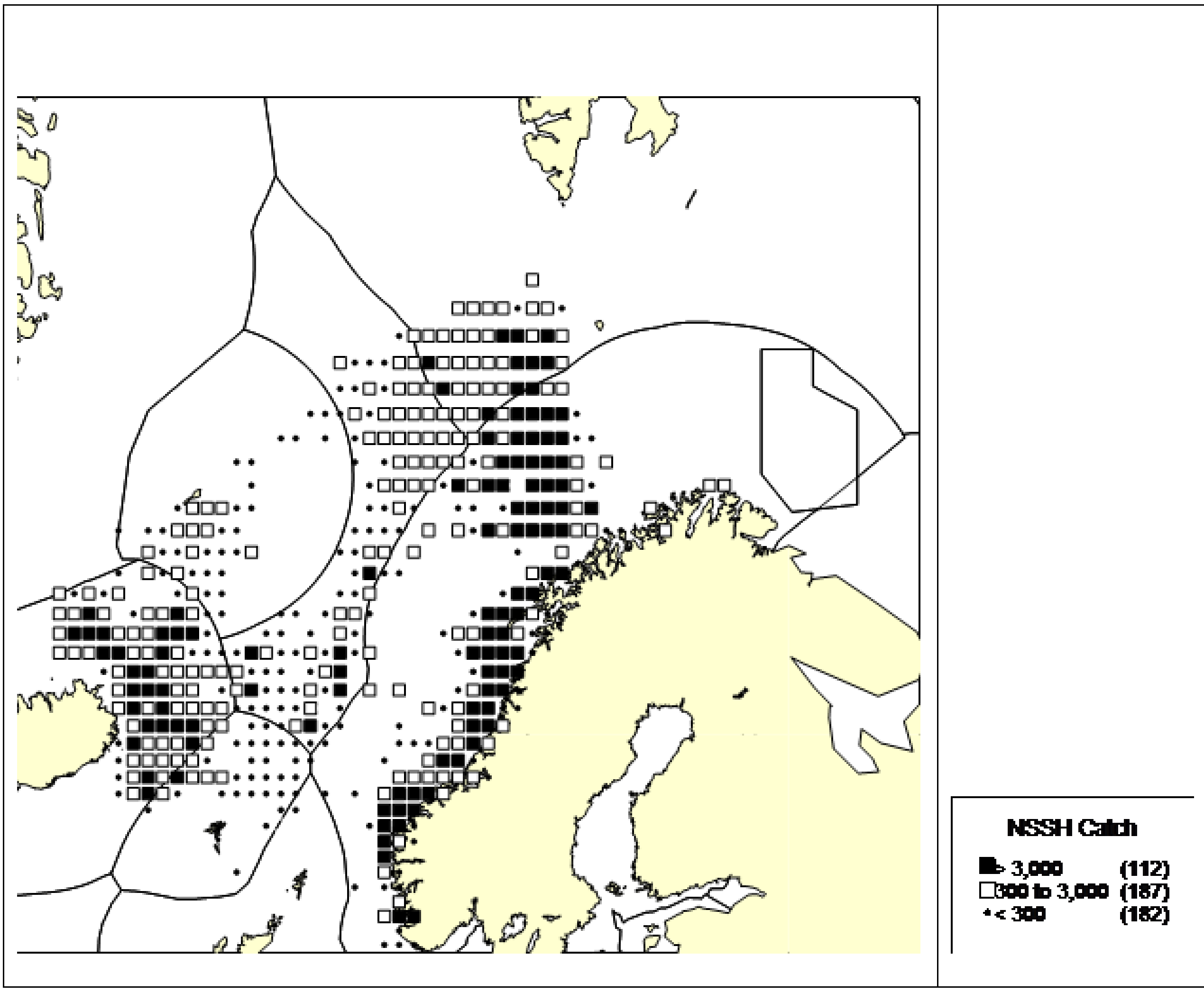
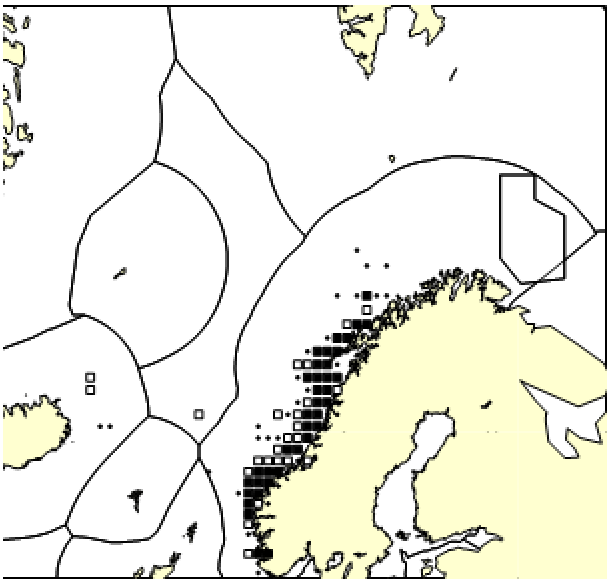
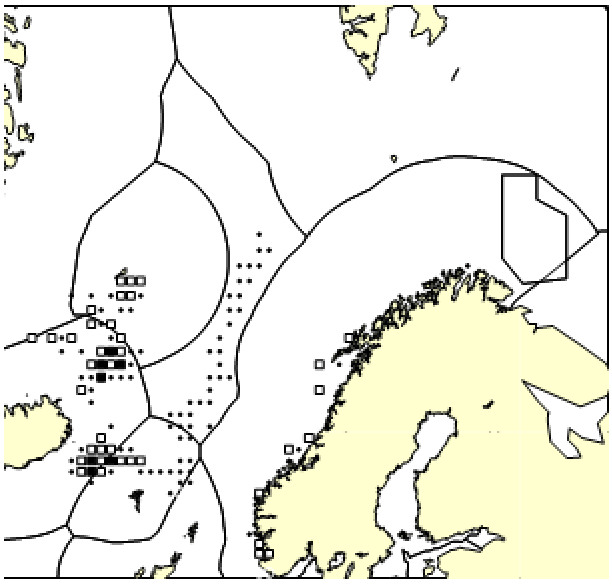


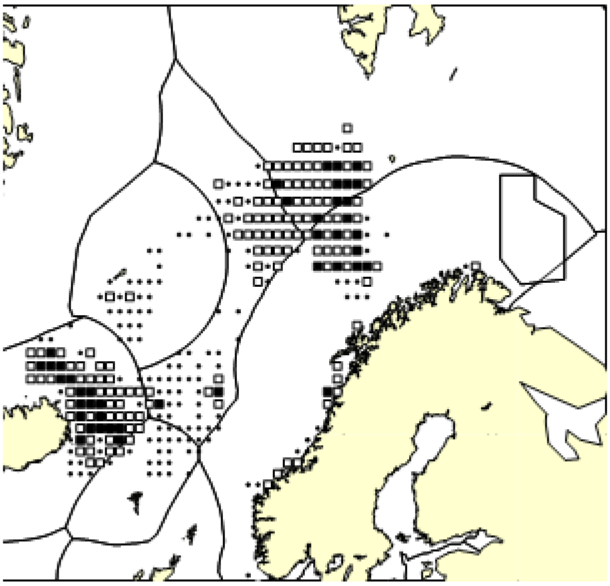
Figure 7.3.1.1. Total reported catches of Norwegian spring-spawning herring in 2009 by ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300–3000 t, and black squares > 3000 t.



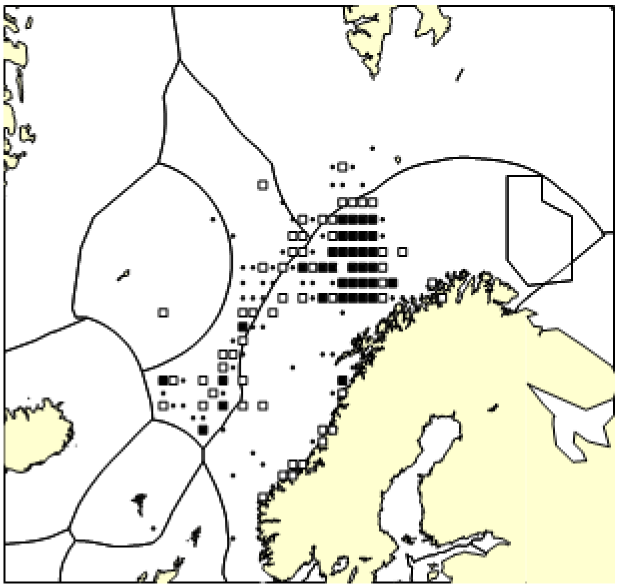
Quarter 1



Quarter 2



Quarter 3



Quarter 4

Figure 7.3.1.2. Total reported catches of Norwegian spring-spawning herring in 2009 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.

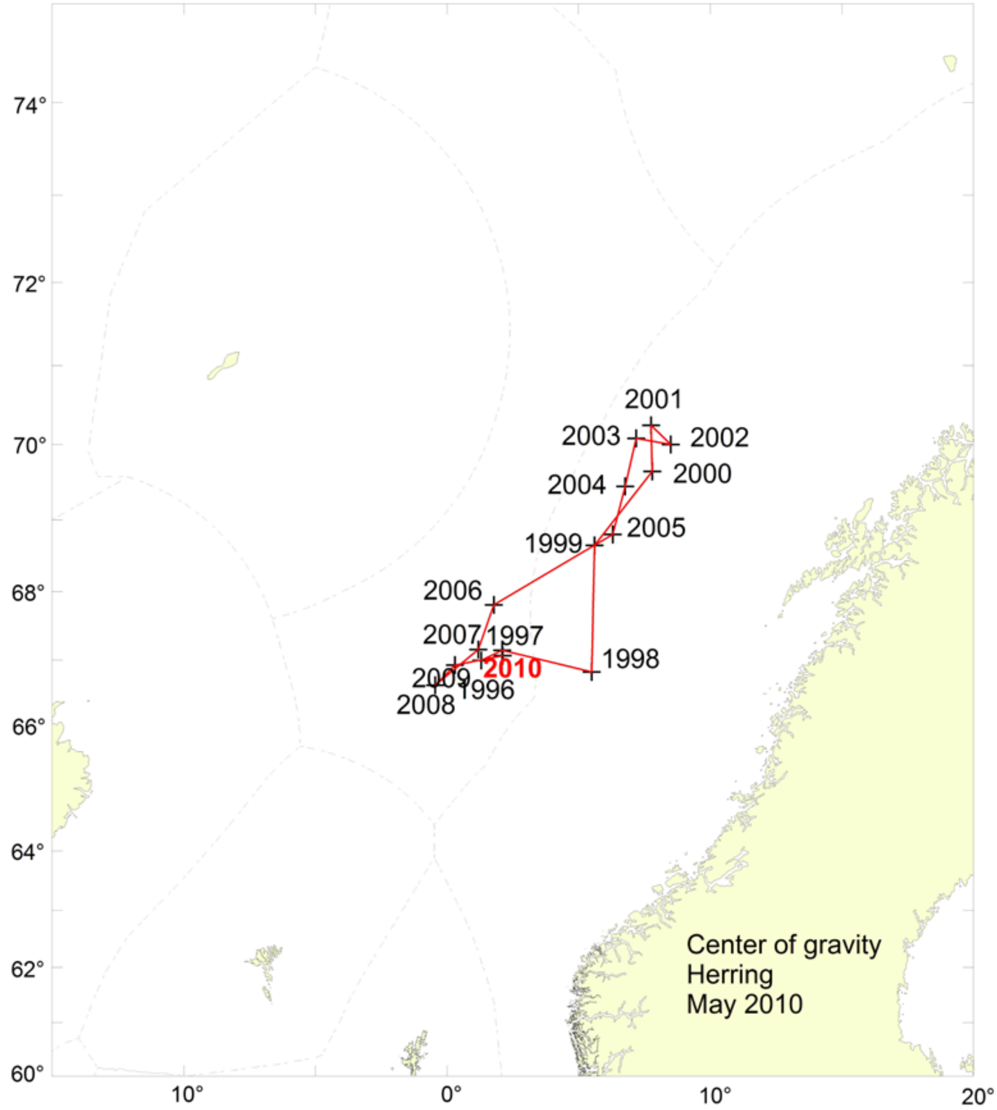


Figure 7.4.2.1 Centre of gravity of herring during the period 1996-2010 derived from acoustic. Acoustic data from area II and III only, i.e. west of 20°E.

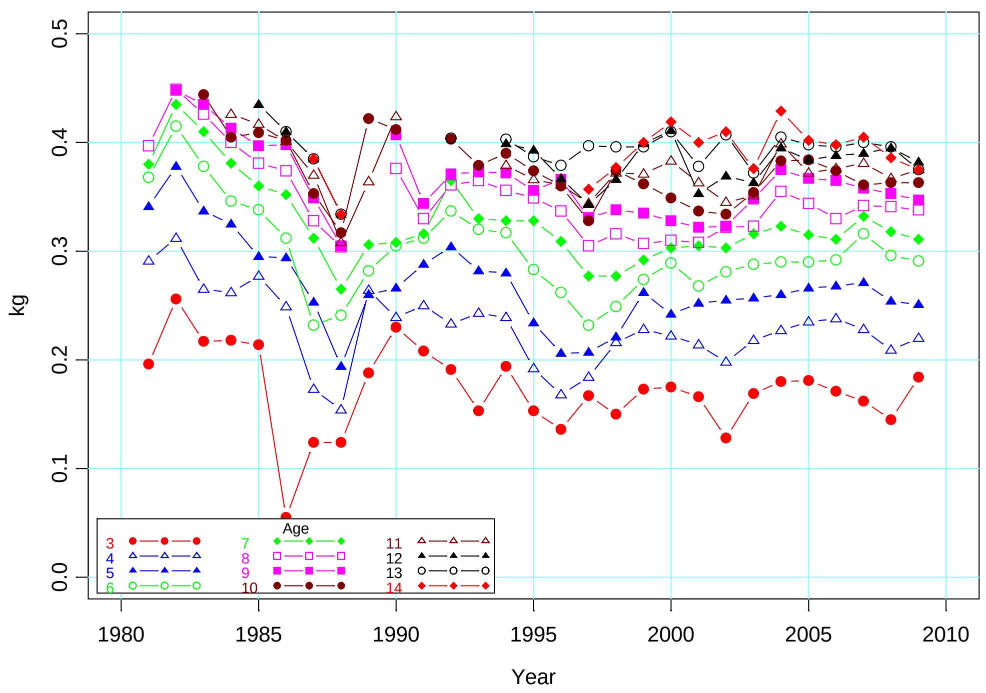


Figure 7.5.4.1. Norwegian spring spawning herring. Mean weight at age by age groups 3-14 in the years 1980-2009 in the catch (weight at age for zero catch numbers were omitted).

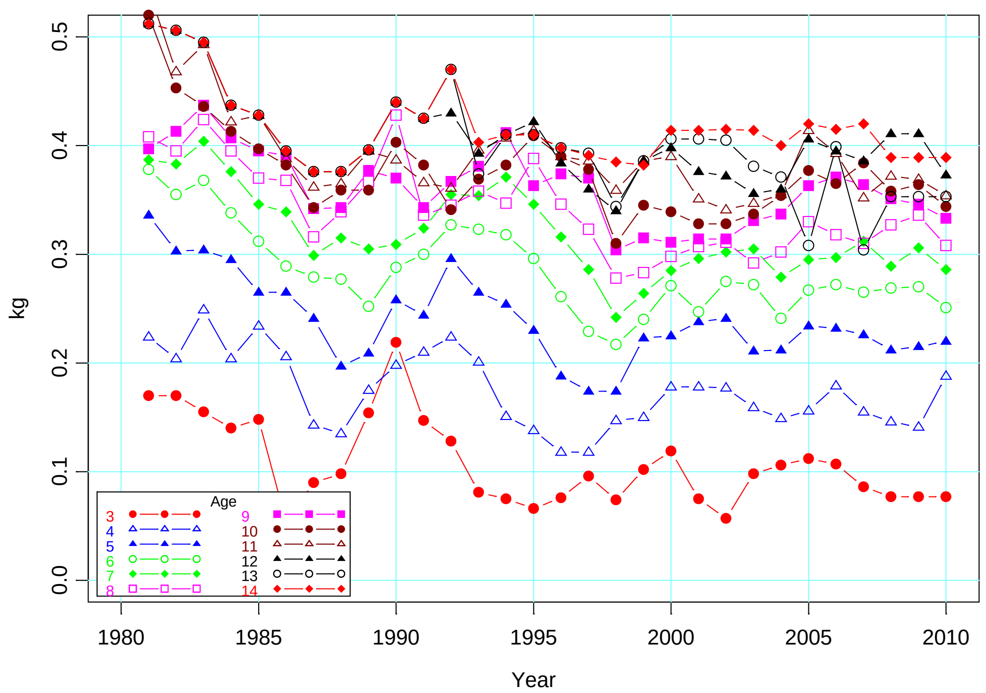
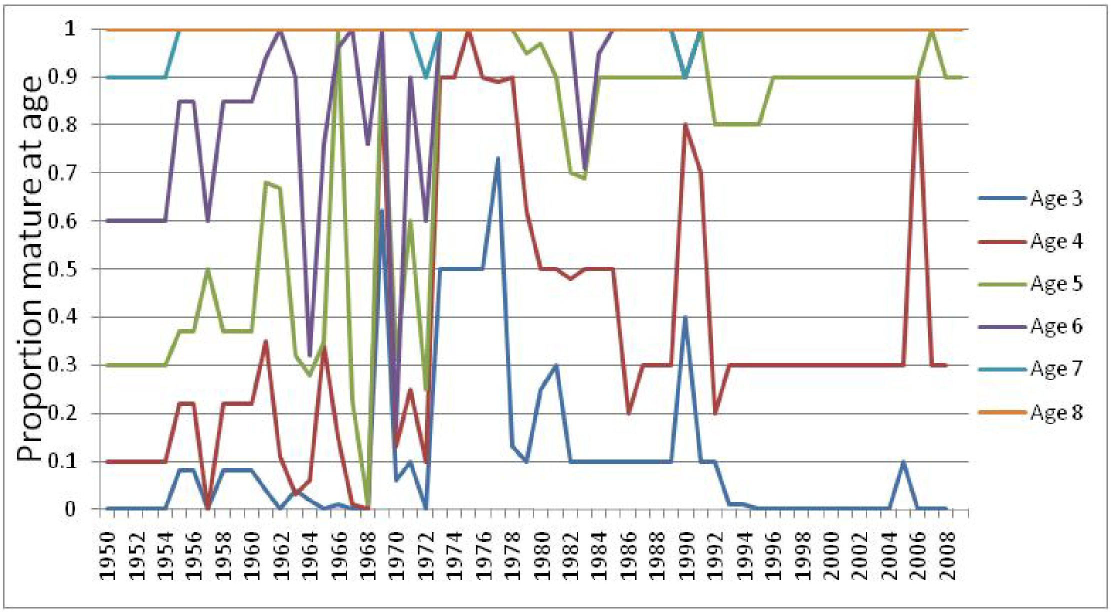


Figure 7.5.4.2. Norwegian spring-spawning herring. Mean weight at age in the stock 1981-2010.



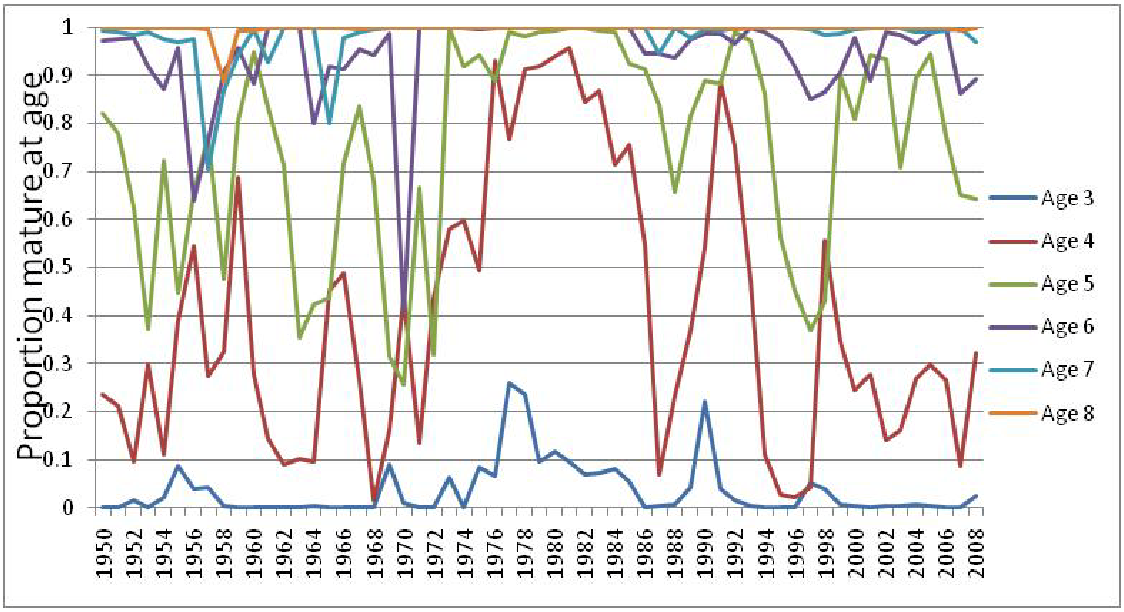


Figure 7.5.5.1 Norwegian spring spawning herring. Comparison of the maturity ogives used in the assessment prior to 2010 (top) and the new maturity ogive used in the 2010 assessment (bottom) based on WKHERMAT (2010)

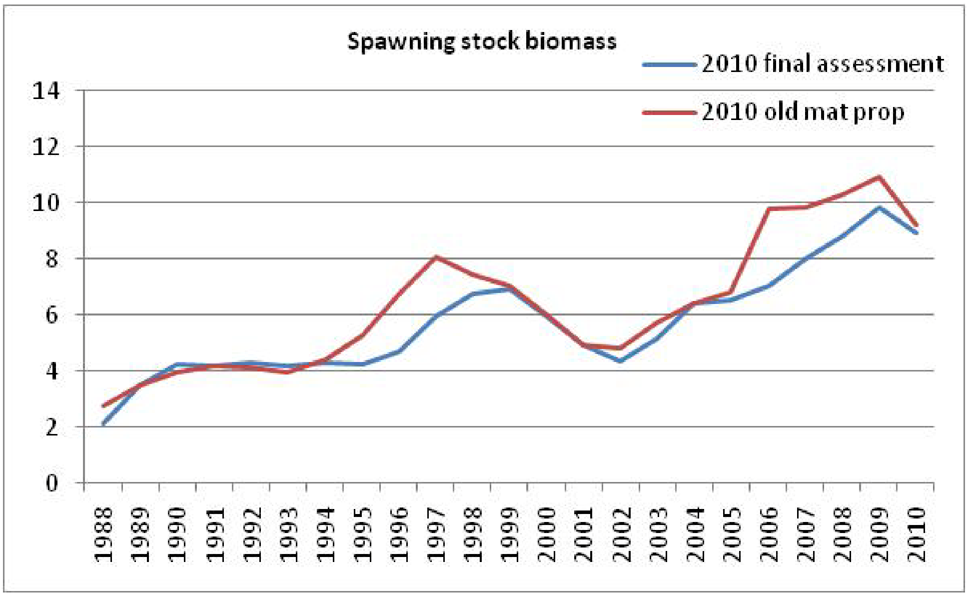
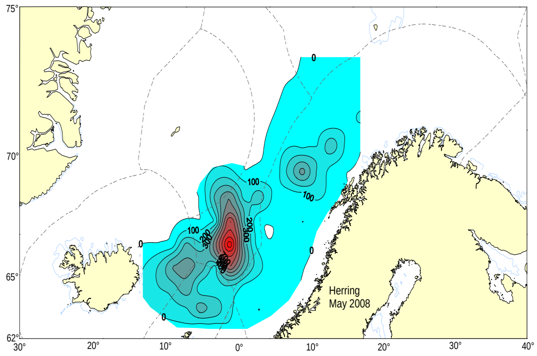
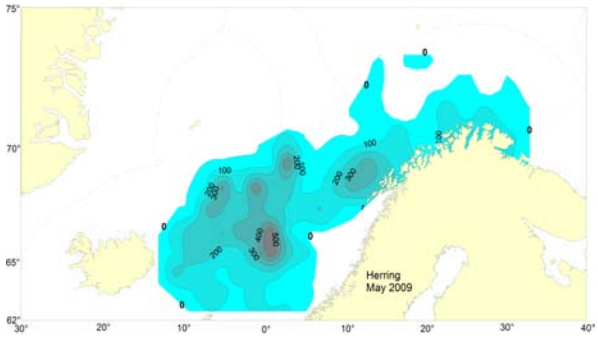


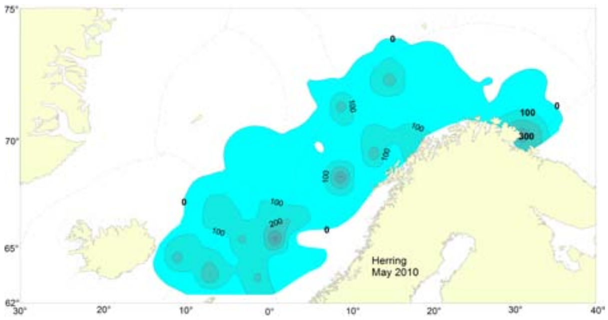
Figure 7.5.5.2 Norwegian spring spawning herring. Comparison of estimated SSB in the 2010 assessment using the old and the new (back-calculated) maturity ogive.



2008



2009



2010

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, 2009 and 2010. Note the incomplete coverage of the Barents Sea in 2008.

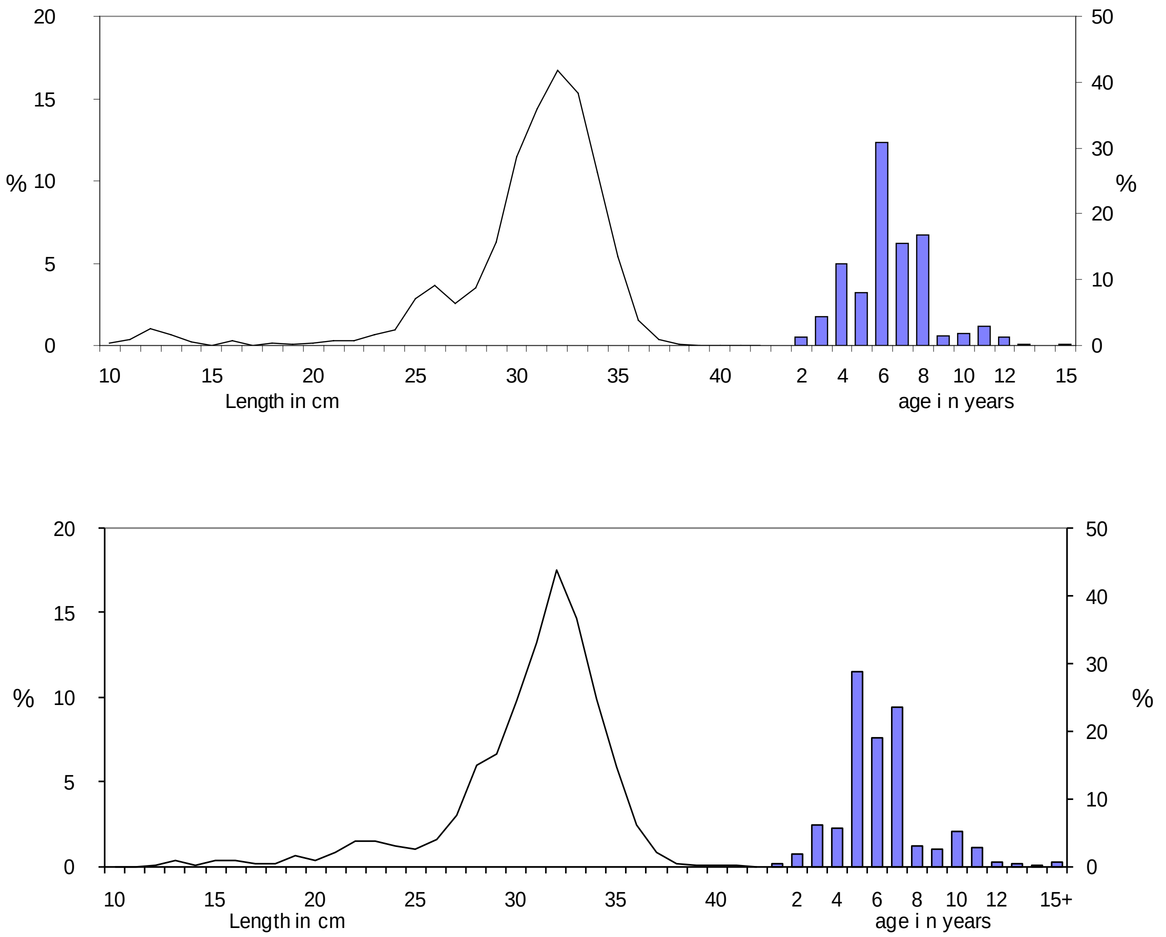


Figure 7.5.7.4.2. Length and age distribution of Norwegian spring spawning herring in the area in the Norwegian Sea in May 2010 (upper panel) and in 2009 (lower panel).

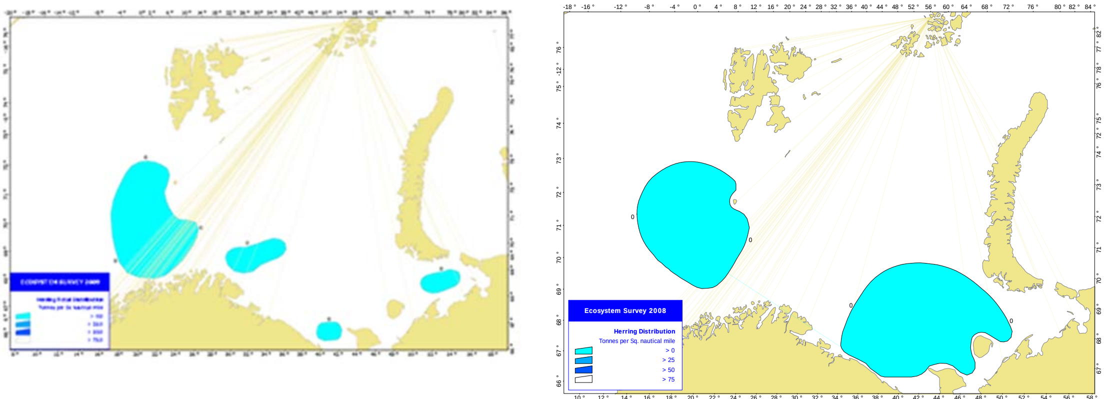


Figure 7.5.7.5.1. Norwegian Spring-Spawning herring. Estimated total density of herring (tonnes/nautical mile^2) in August-September 2009 (left panel) and 2008 (right panel) in Barents Sea. *Survey 6.*

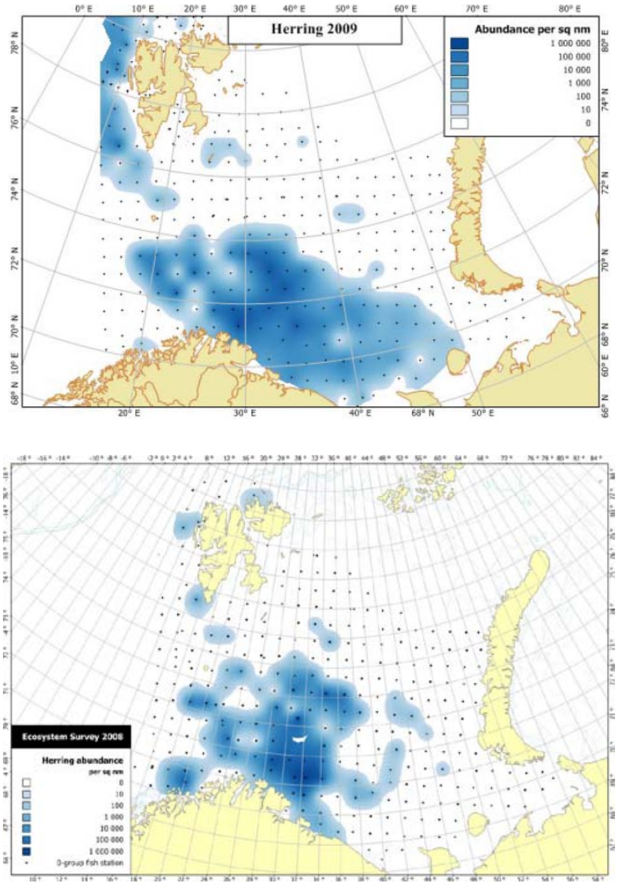


Figure 7.5.7.5.2. Norwegian Spring-Spawning herring. O–group surveys in August/September in the Barents Sea in 2009 (upper panel) and 2008 (lower panel). ***Survey 7.***

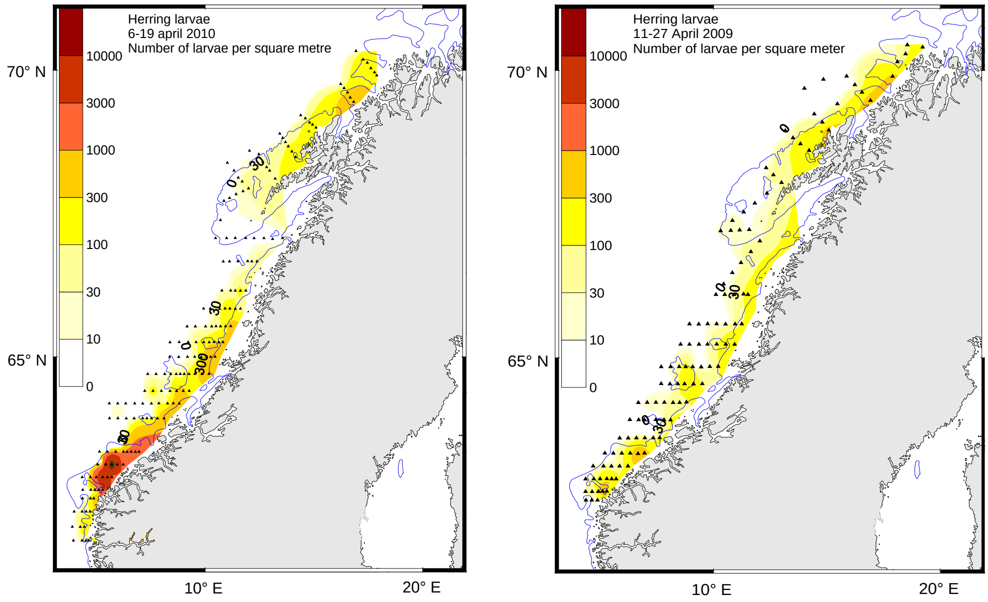


Figure 7.5.7.6.1. Norwegian Spring-Spawning herring. Distribution of herring larvae on the Norwegian shelf in 2010 (left panel) and 2009 (right panel). The 200 m depth line is also shown. ***Survey 8.***

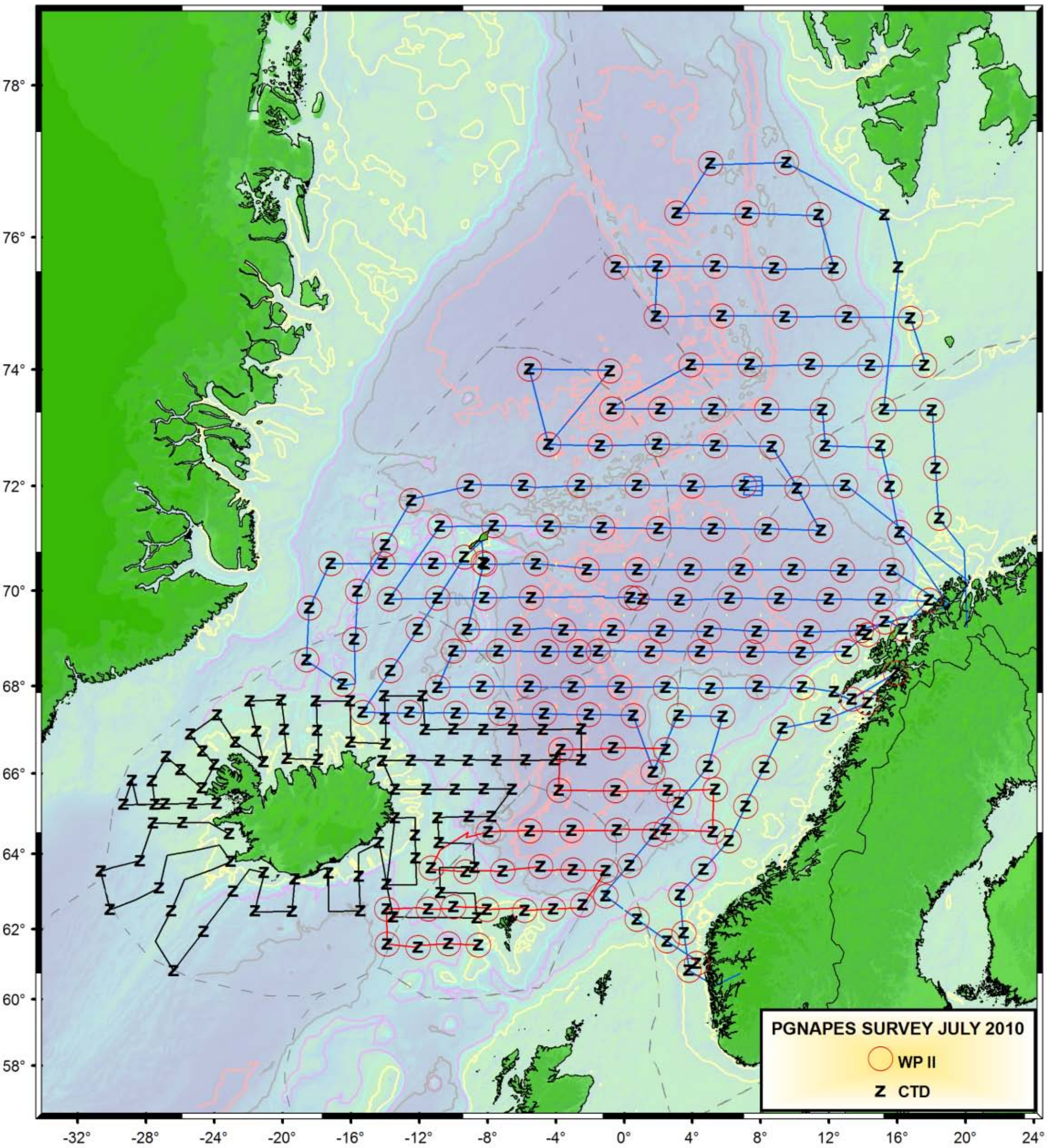


Figure 7.5.7.7.1. Norwegian spring-spawning herring. Survey lines along the cruise tracks with pre-defined CTD stations (0-500 m) and WP2 samples (0-200 m) for M/V"Libas", M/V"Brennholm", M/V"Finni Fridur" and R/V"Arni Fridriksson", 9 July – 20 August 2010. This large ocean area included the following 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*.

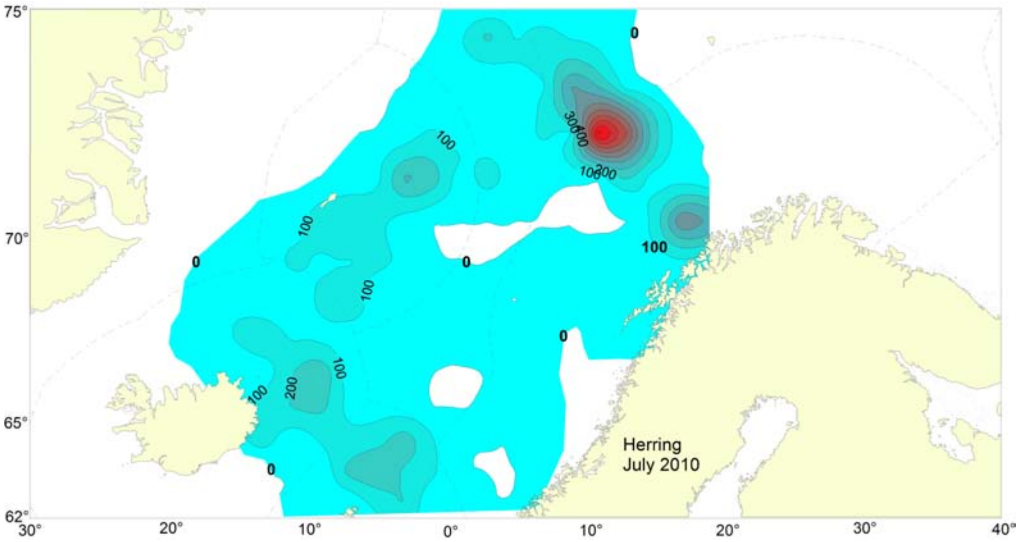


Figure 7.5.7.7.2. Norwegian spring-spawning herring. Sa or Nautical Area Scattering Coefficient (NASC) values of herring along the cruise track. ***Survey 9.***

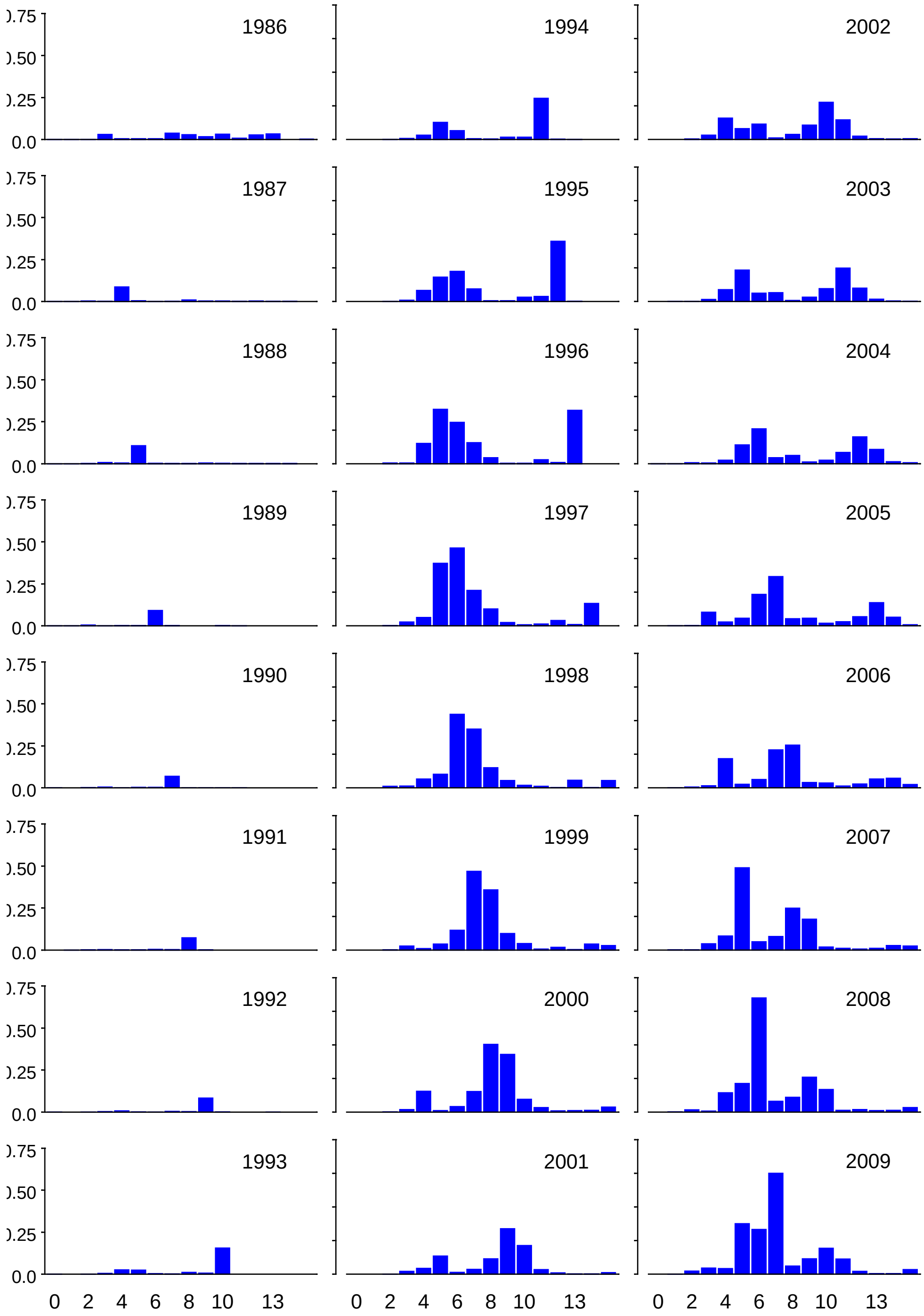


Figure 7.7.1.1. Norwegian spring spawning herring. Catch in weight (million tonnes) by age and years.

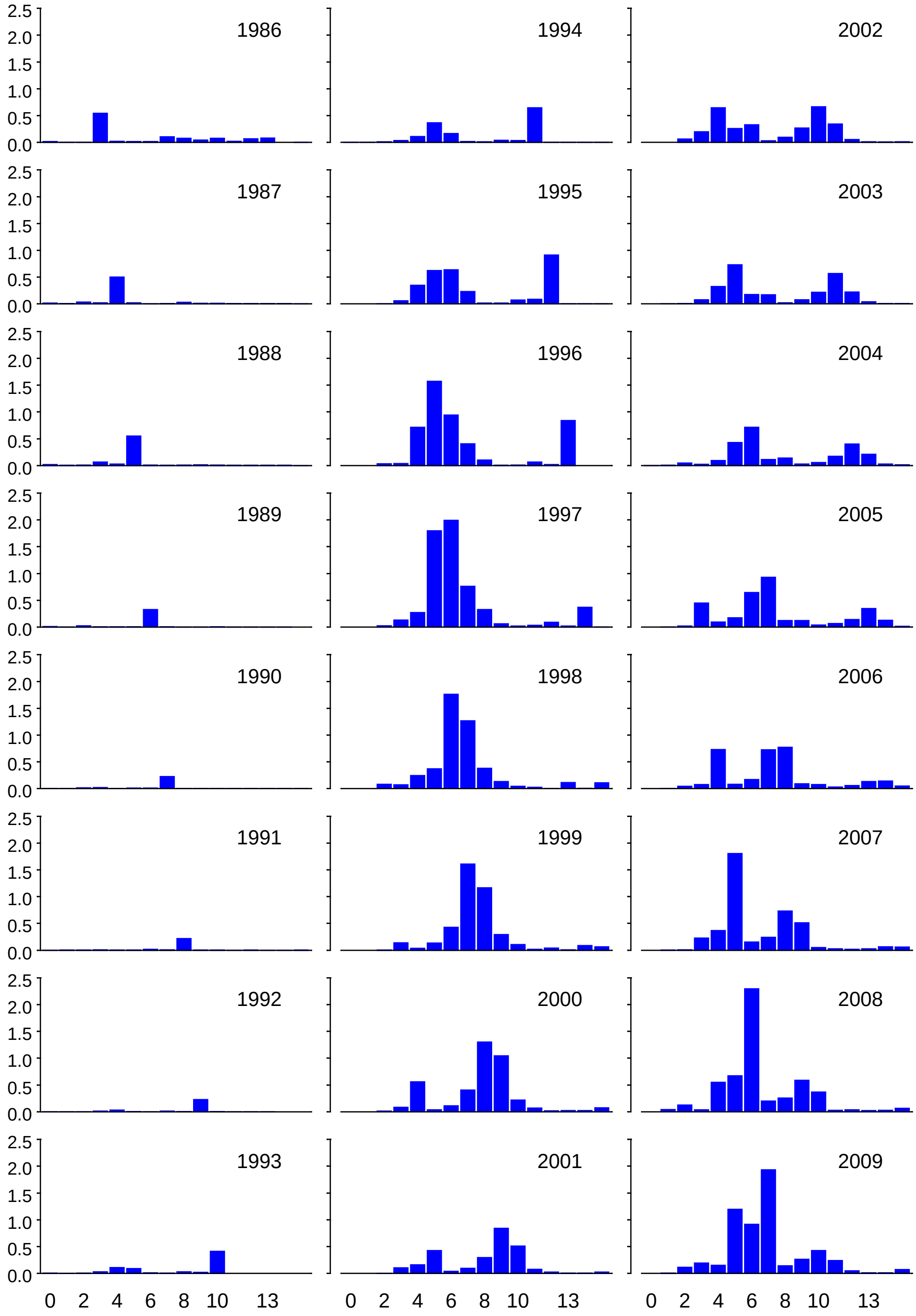


Figure 7.7.1.2. Norwegian spring spawning herring. Catch in numbers (billions) by age and years.

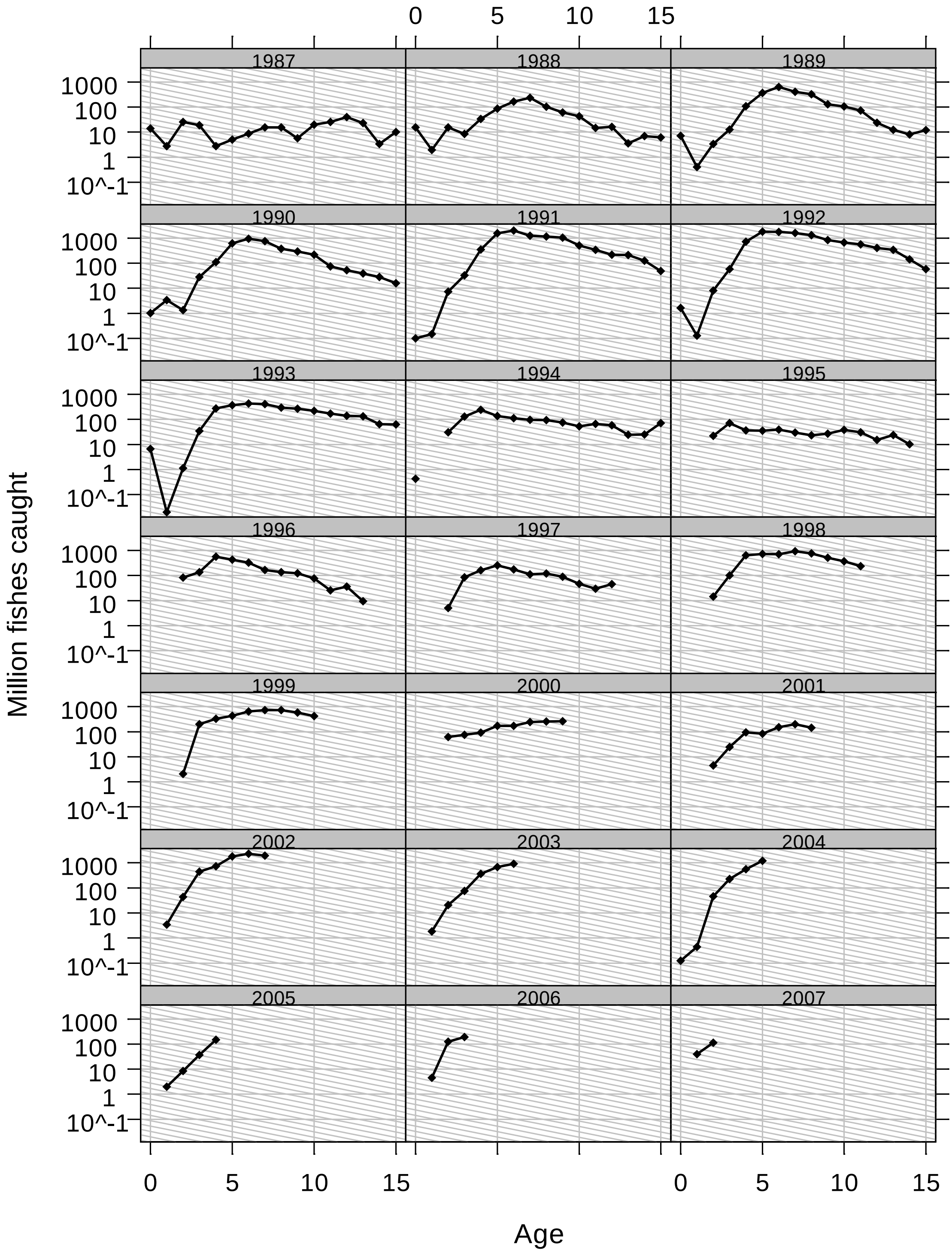


Figure 7.7.1.3. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted on a log scale. Age is on x-axis. The labels above each figure indicate year classes. They grey lines correspond to Z=0.3.

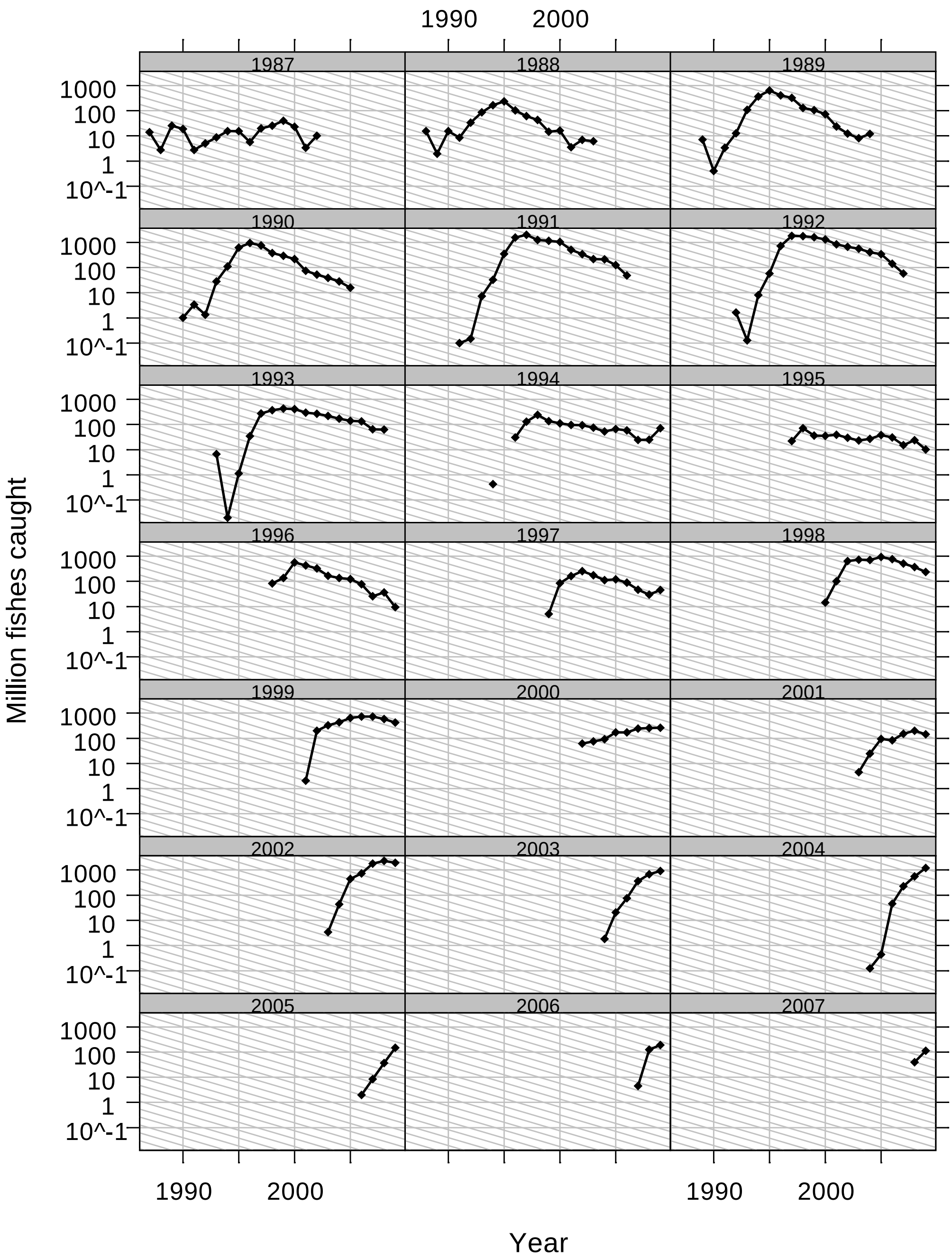


Figure 7.7.1.4. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted on a log scale. Year is on the x-axis. The labels above each figure indicate year classes. They grey lines correspond to Z=0.3.

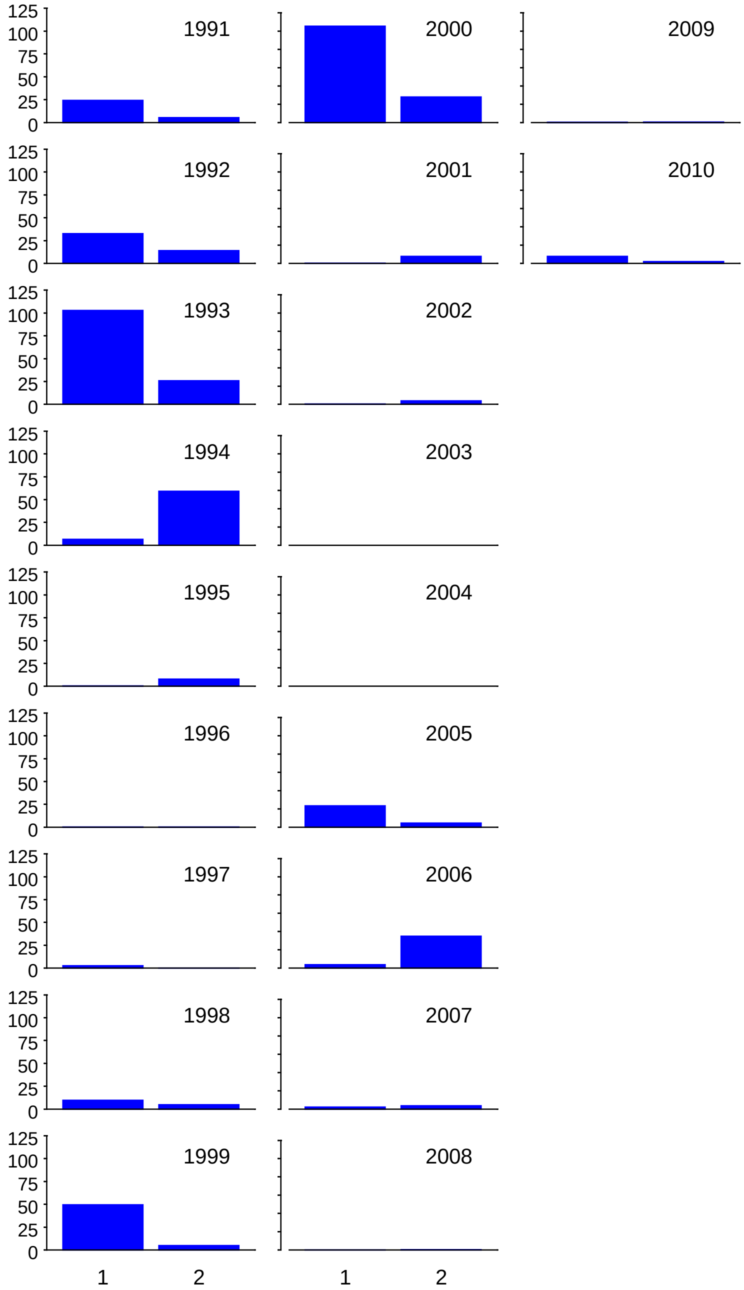


Figure 7.7.1.5. Norwegian spring spawning herring. Age disaggregated abundance indices from the acoustic surveys in the Barents Sea in May/June. Survey 4.

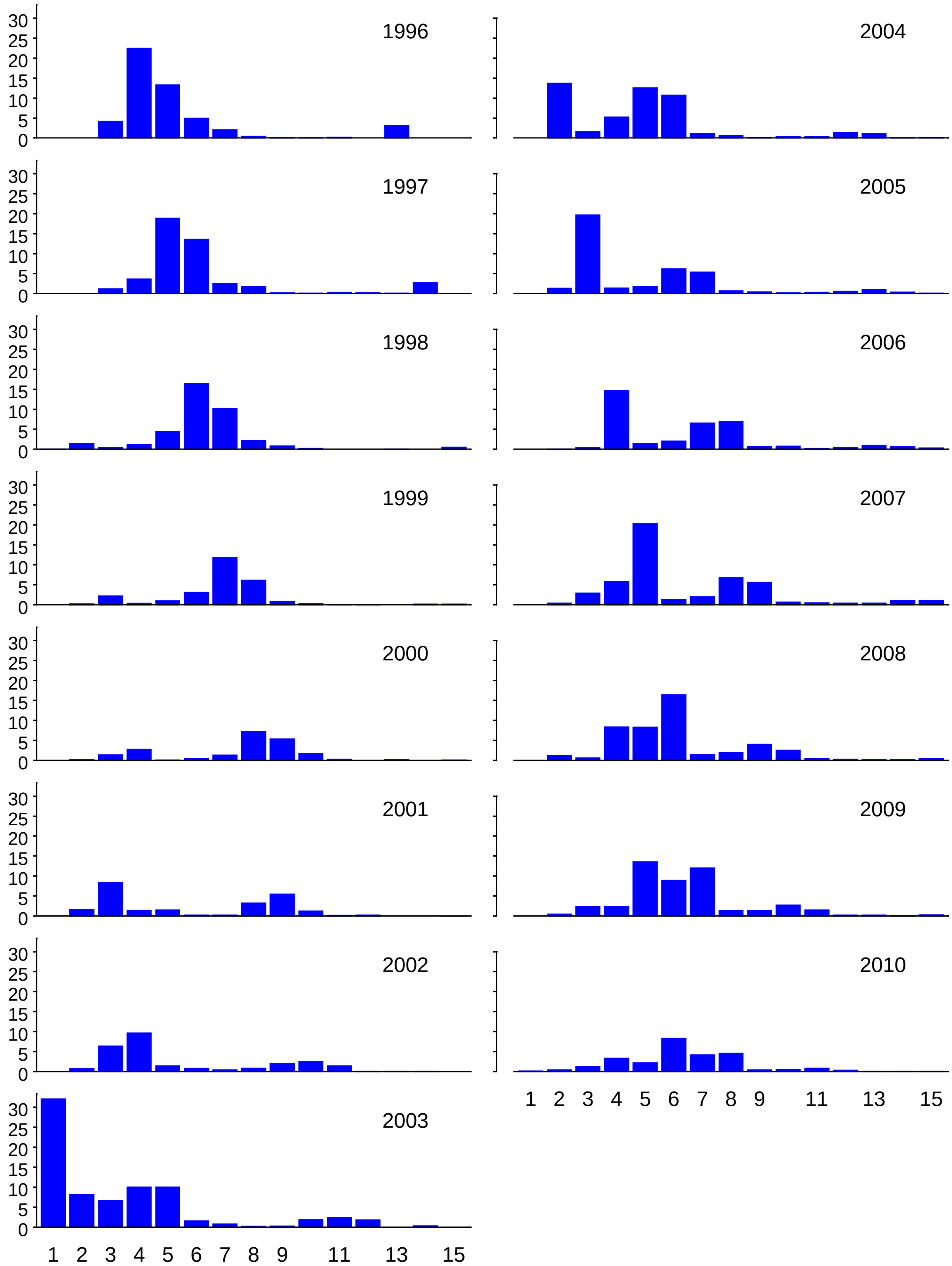


Figure 7.7.1.6. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) in the years 1996-2010.

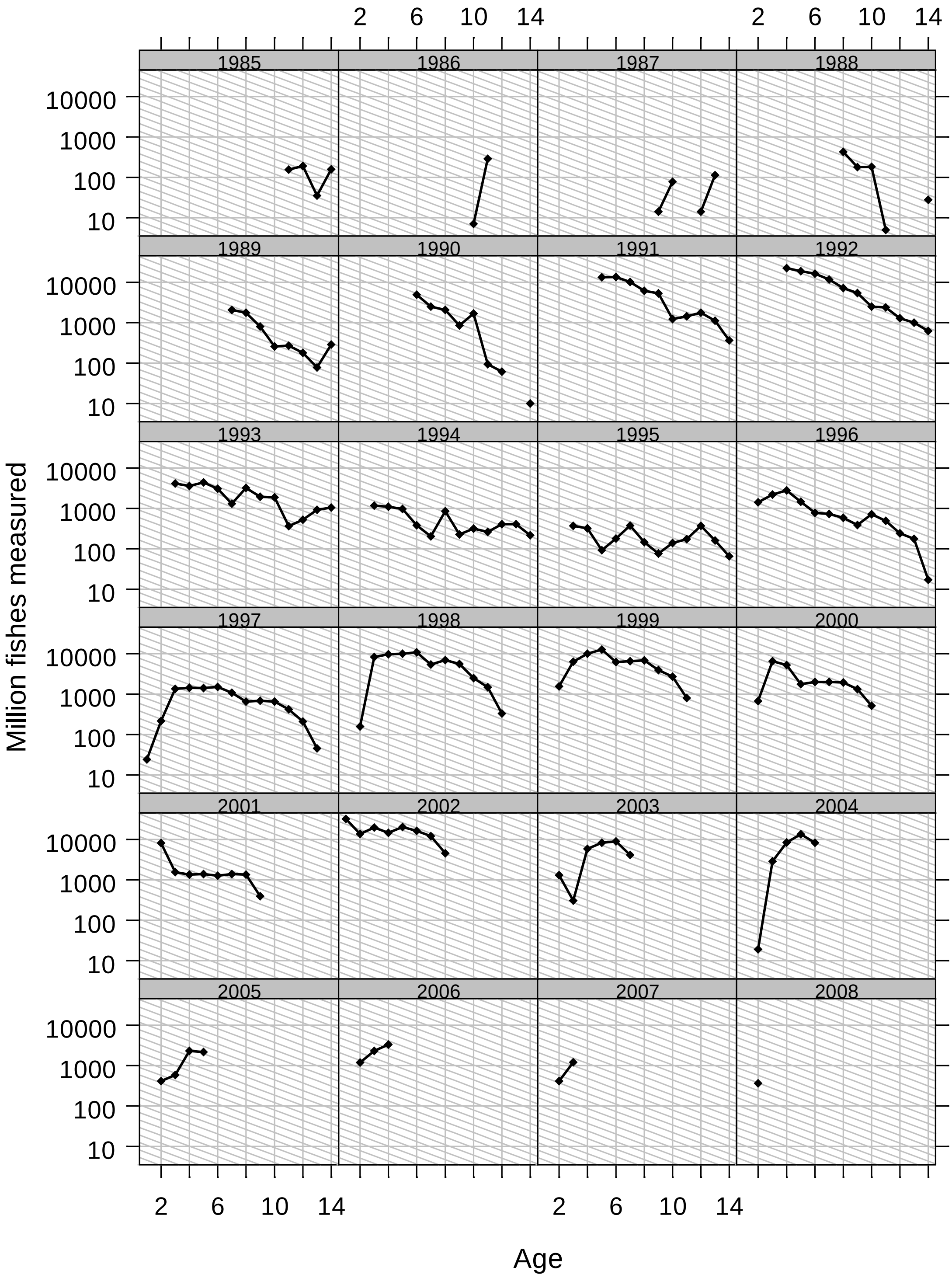


Figure 7.7.1.7. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale. The labels above each figure indicate year classes. The grey lines correspond to Z=0.3.

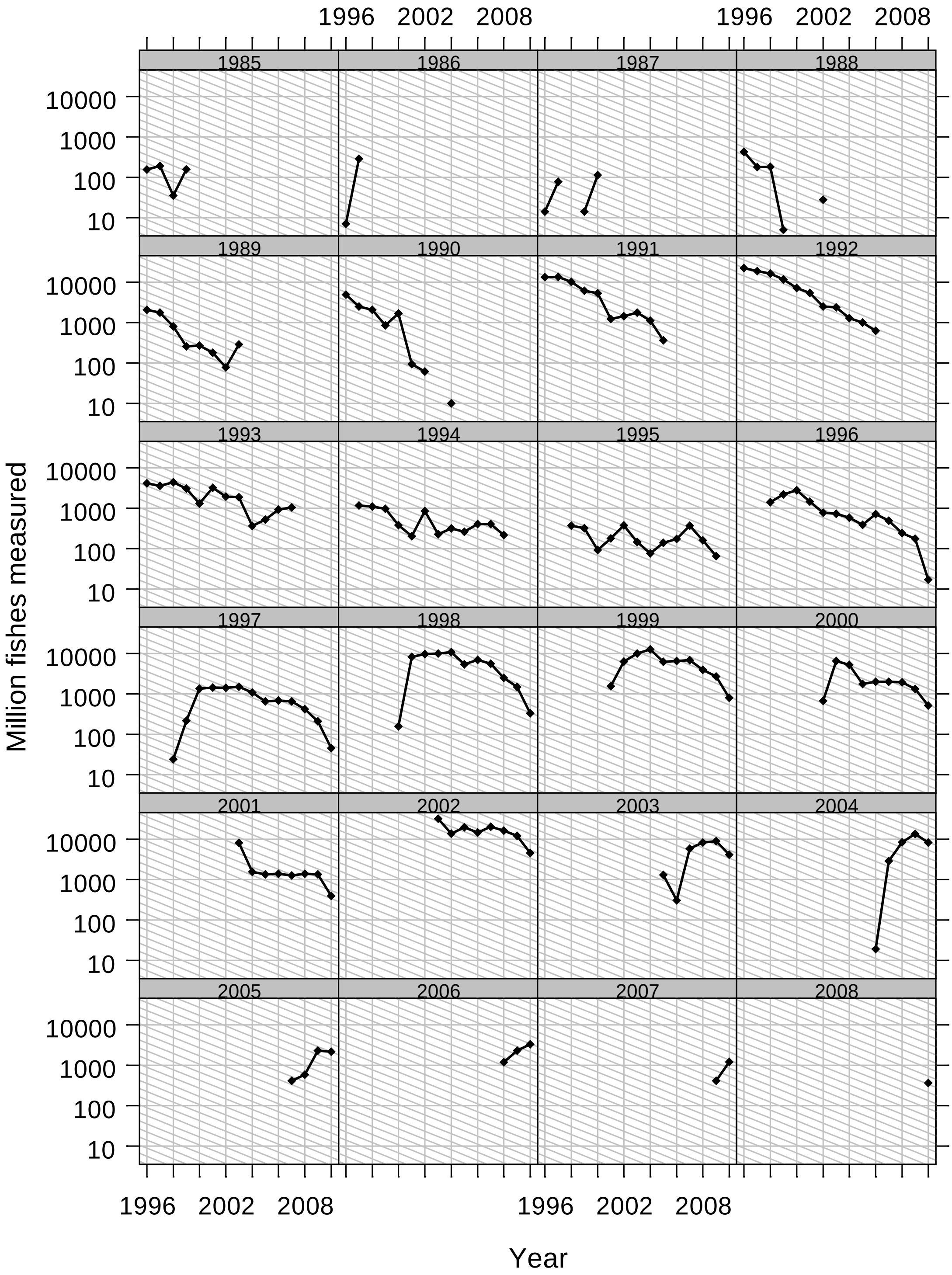


Figure 7.7.1.8. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale. The labels above each figure indicate year classes. The grey lines correspond to Z=0.3.

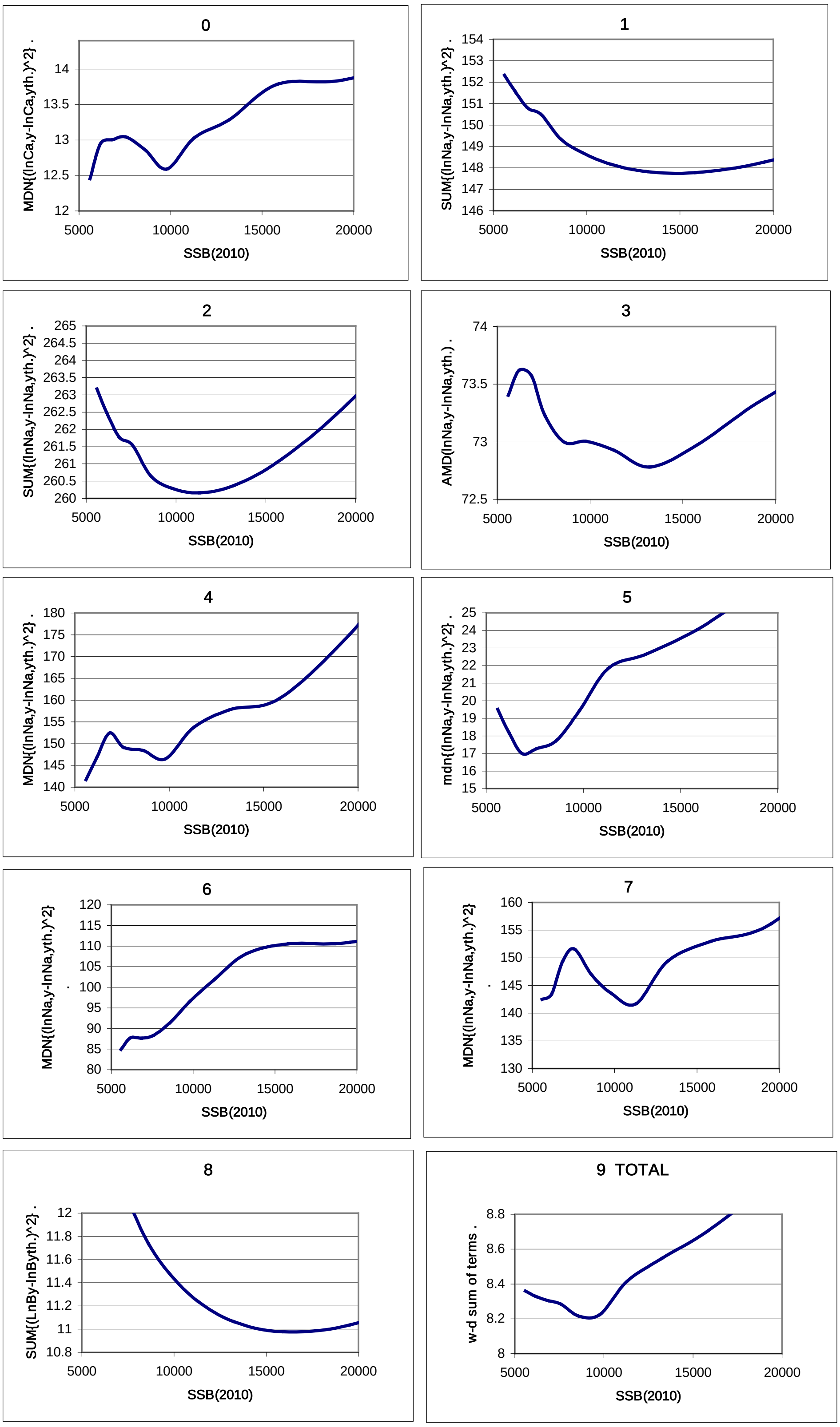


Figure 7.7.2.1. Norwegian spring-spawning herring. Profiles of components of the TISVPA loss function for "the best choice" of exploratory runs: 0 - signal from catch-at-age alone; 1-7 - signals from "surveys" from 1 to 8 respectively (see explanation for numbering of the "surveys" in the text). Survey 8 excluded in the final run.

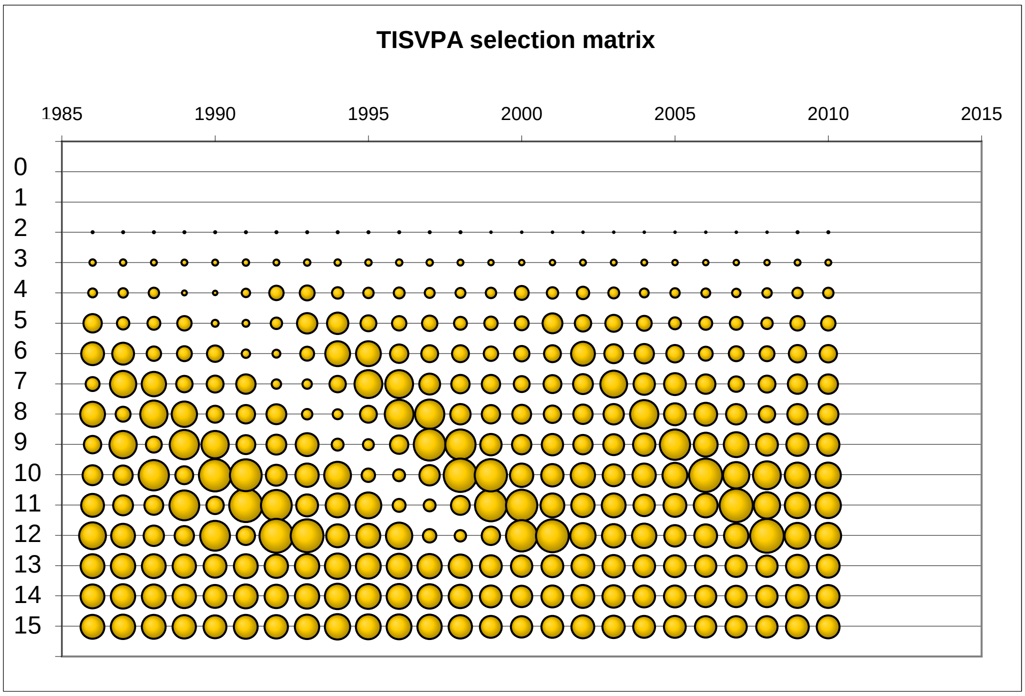


Figure 7.7.2.2. Norwegian spring-spawning herring. TISVPA selection matrix.

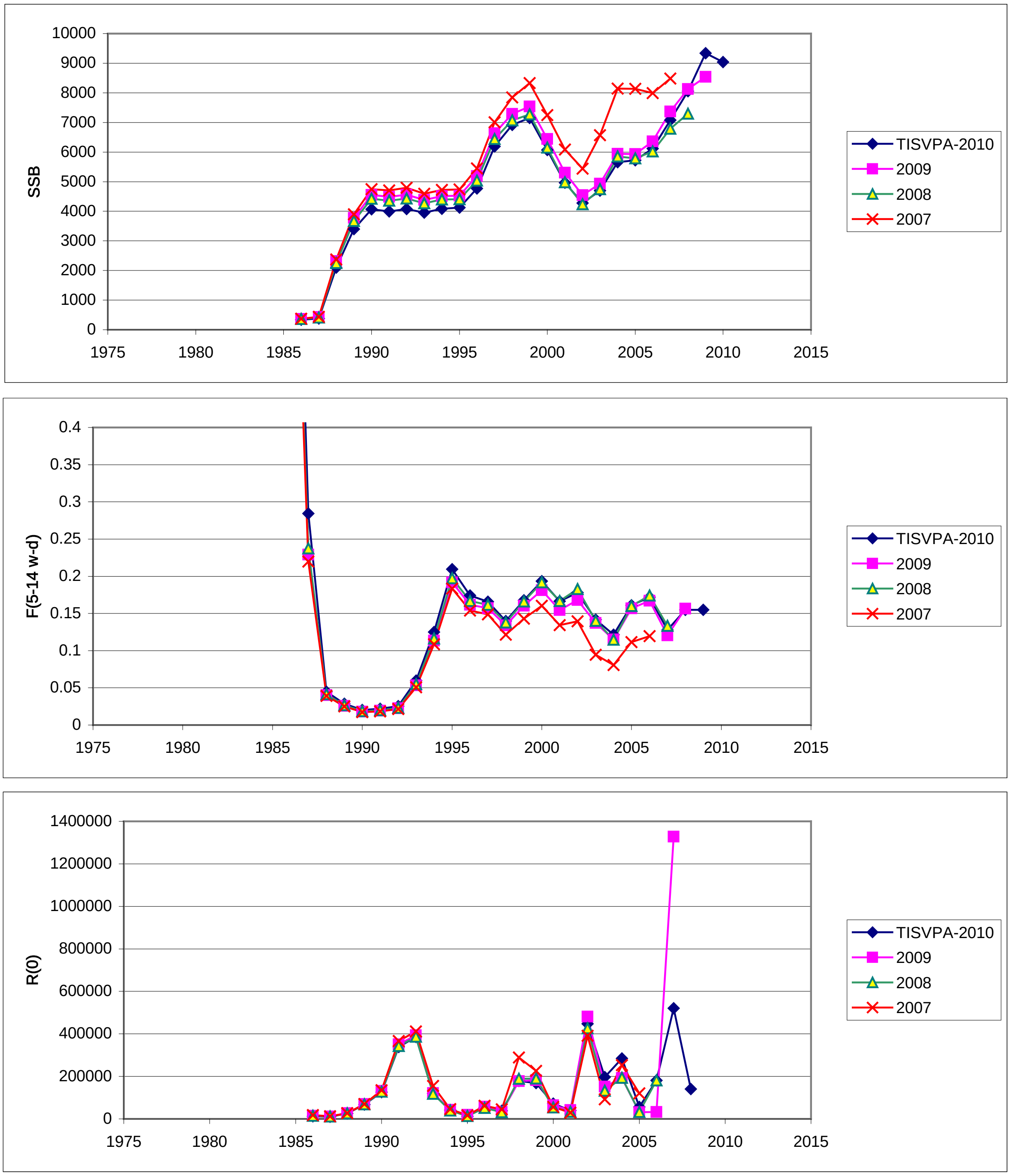


Figure 7.7.2.3. Norwegian spring-spawning herring. Comparison of the exploratory TISVPA results to the previous assessment made by this model.

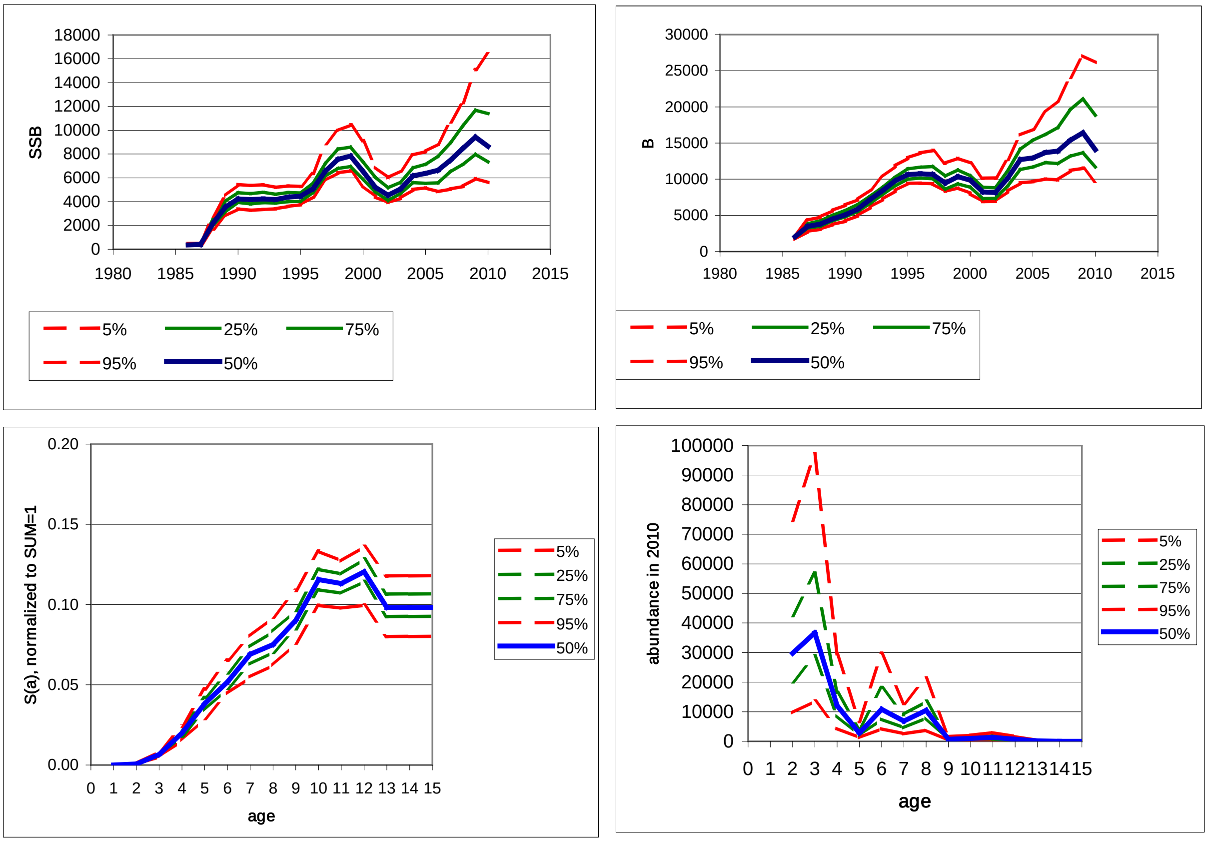
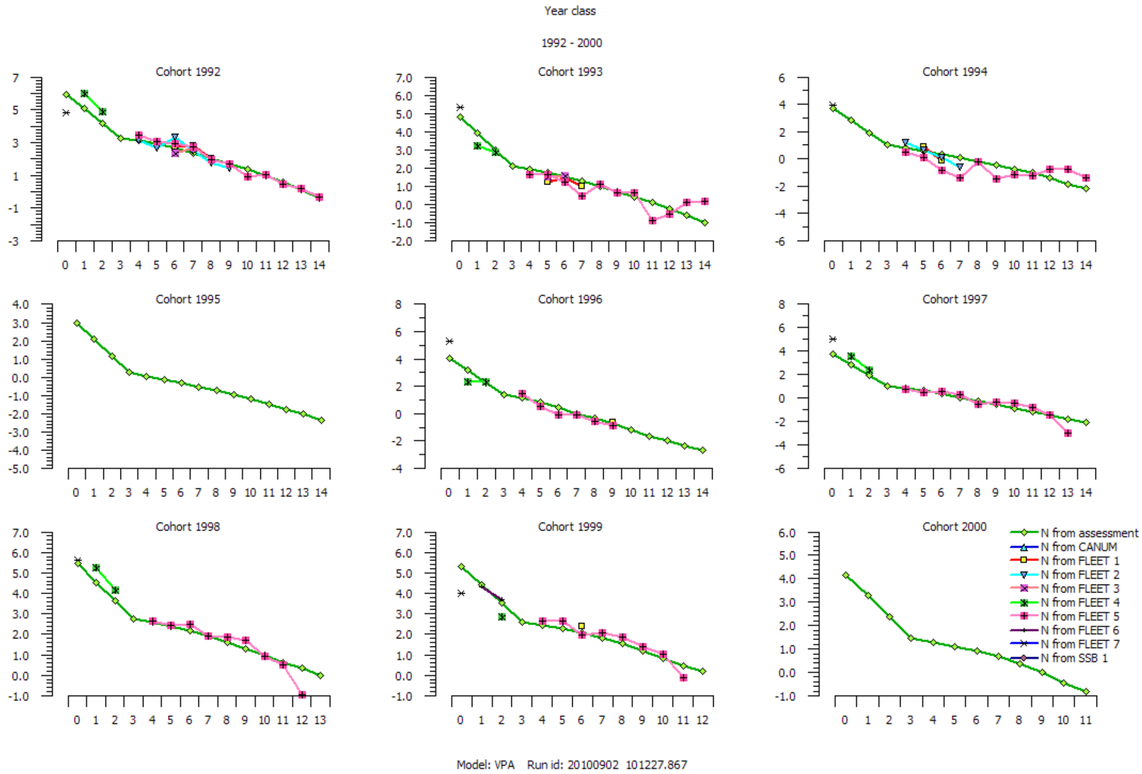


Figure 7.7.2.4. Norwegian spring-spawning herring. Comparison of the exploratory TISVPA results to the previous assessment made by this model.



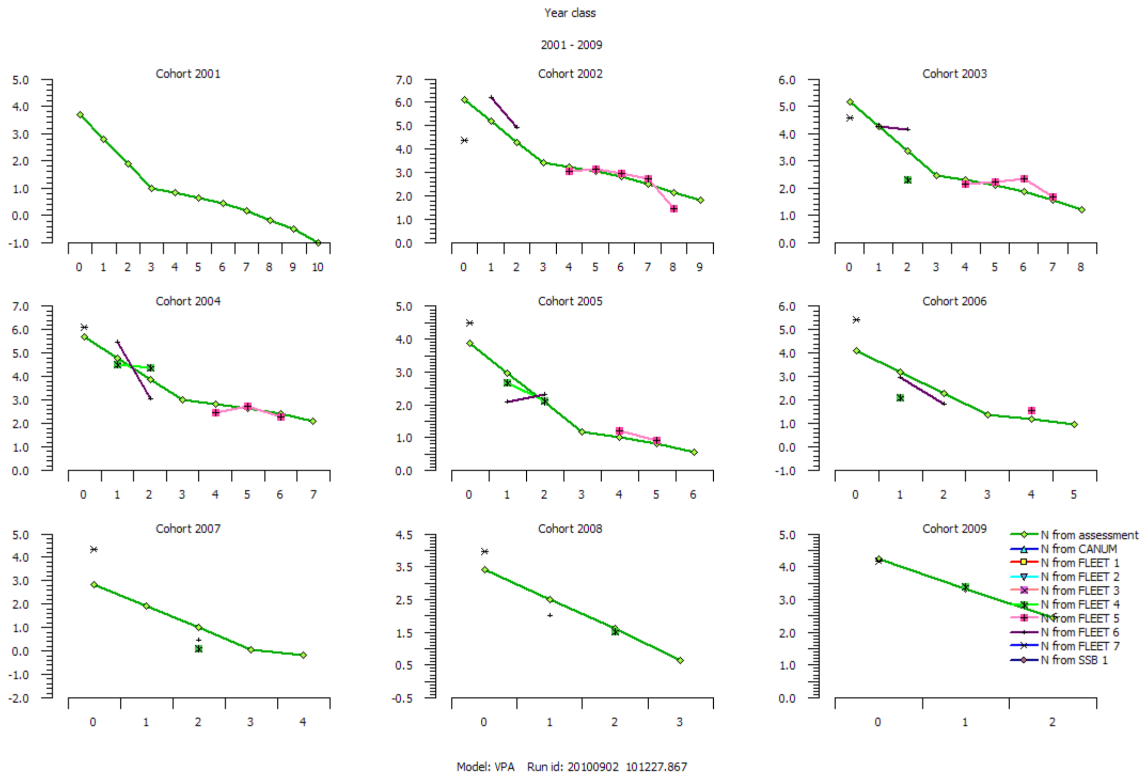


Figure 7.7.3.1 Norwegian spring spawning herring. Year class Ns, excluding values with zero weight.

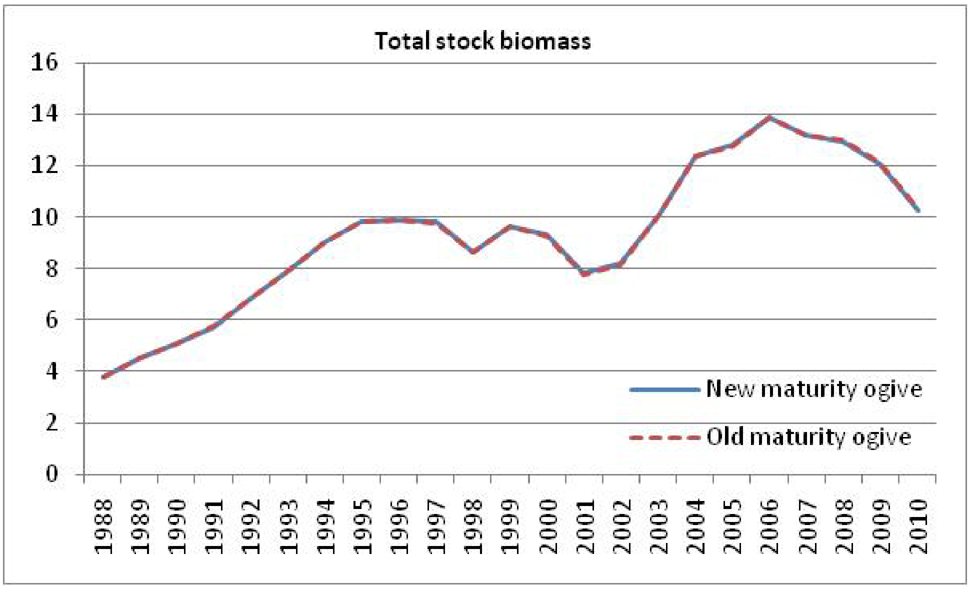


Figure 7.7.3.1.1 Norwegian spring spawning herring. Total stock biomass from 2010 assessment using old and new maturity ogive.

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	0	1
2010	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
2010	0	0	0	1	1	1	1	1	0	0	1	1	1	0	0

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	0	1
2009	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
2009	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.

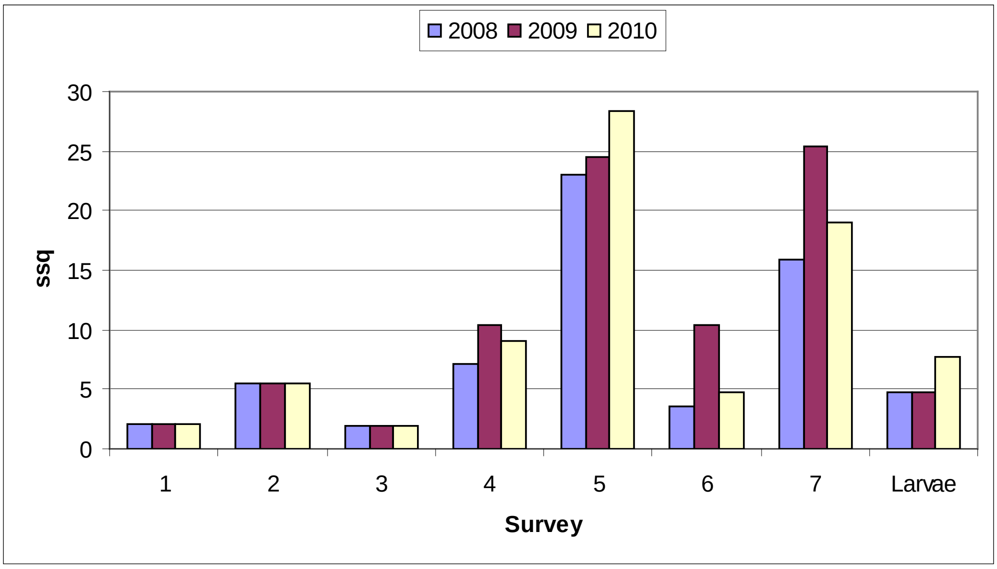


Figure 7.7.3.3. Norwegian spring-spawning herring. Residual sum of squares in the surveys separately from TASACS in 2008 and 2009.

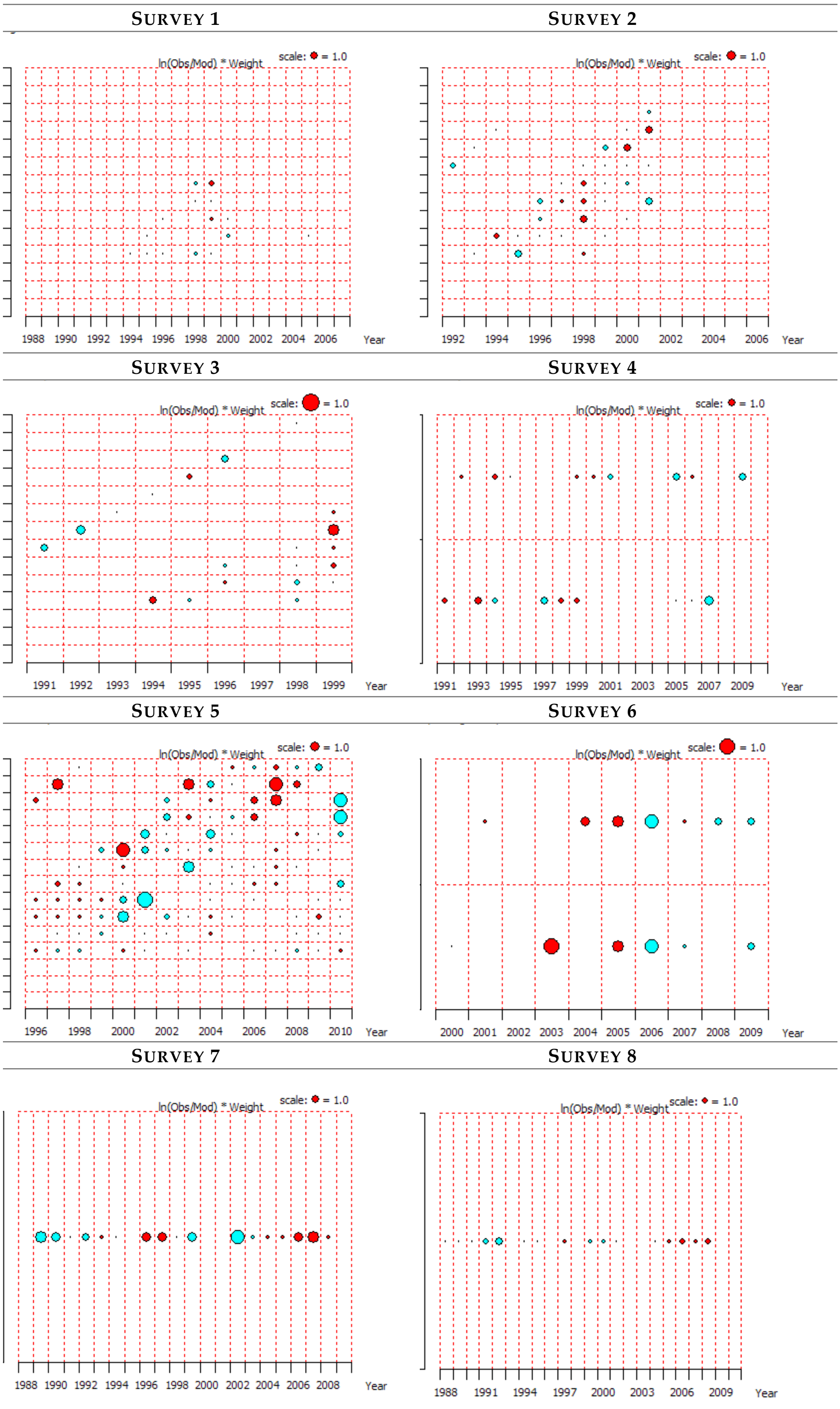


Figure 7.7.3.4 Norwegian spring-spawning herring. VPA weighted residuals for the different surveys.

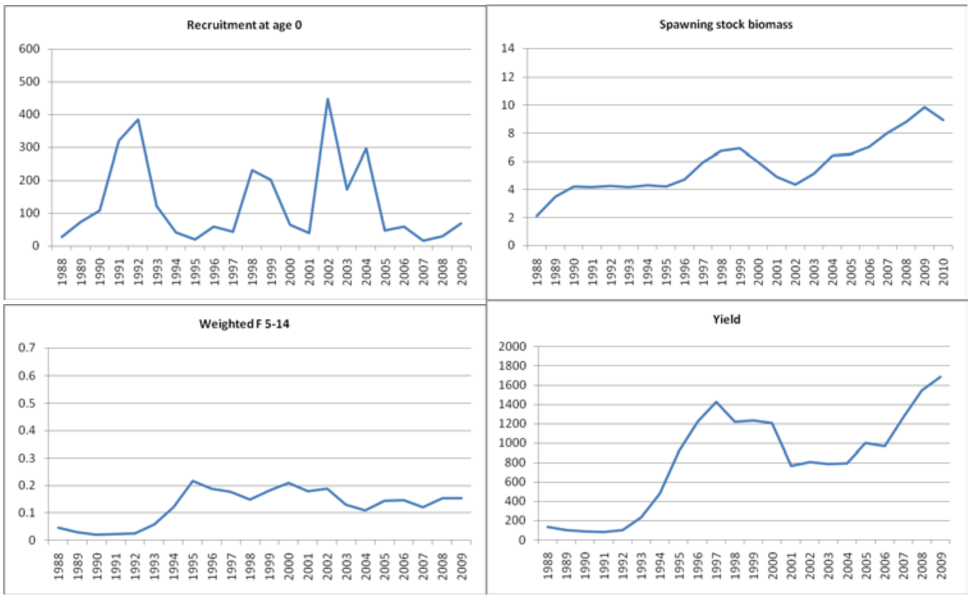


Figure 7.7.3.5. Norwegian spring-spawning herring. Standard plots from final assessment (VPA) in 2010.

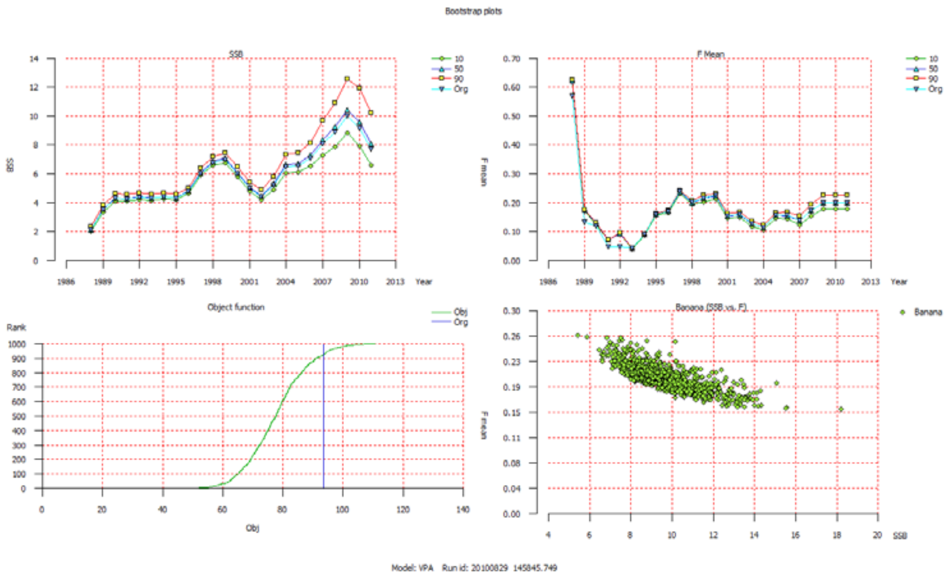
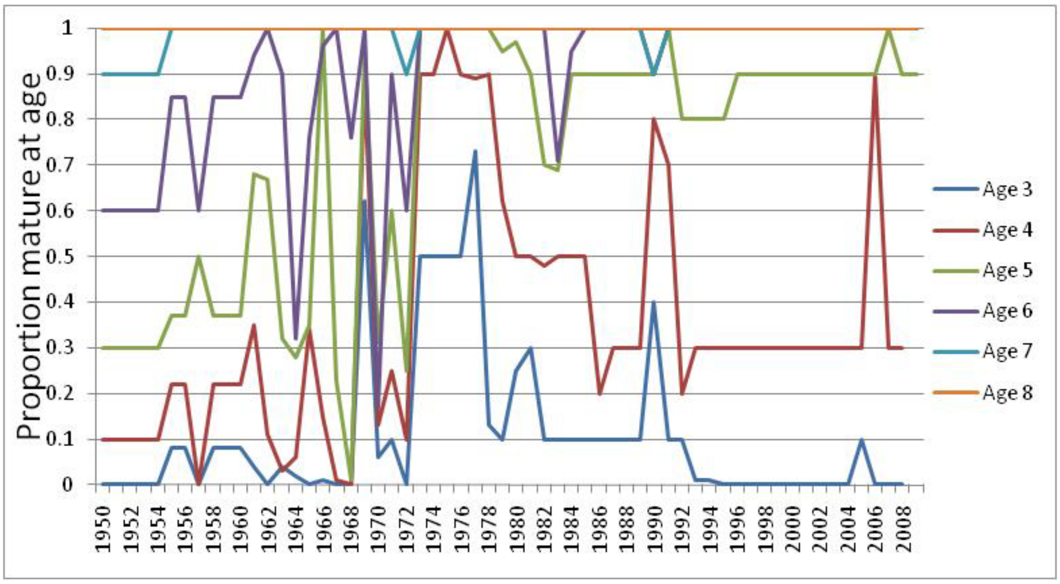


Figure 7.7.4.1. Norwegian spring-spawning herring. Percentiles for spawning stock biomass (top left), mean F 5-10 (top right), SSQ (bottom left) and "Banana"-plot (bottom right) from bootstrap results for final assessment.



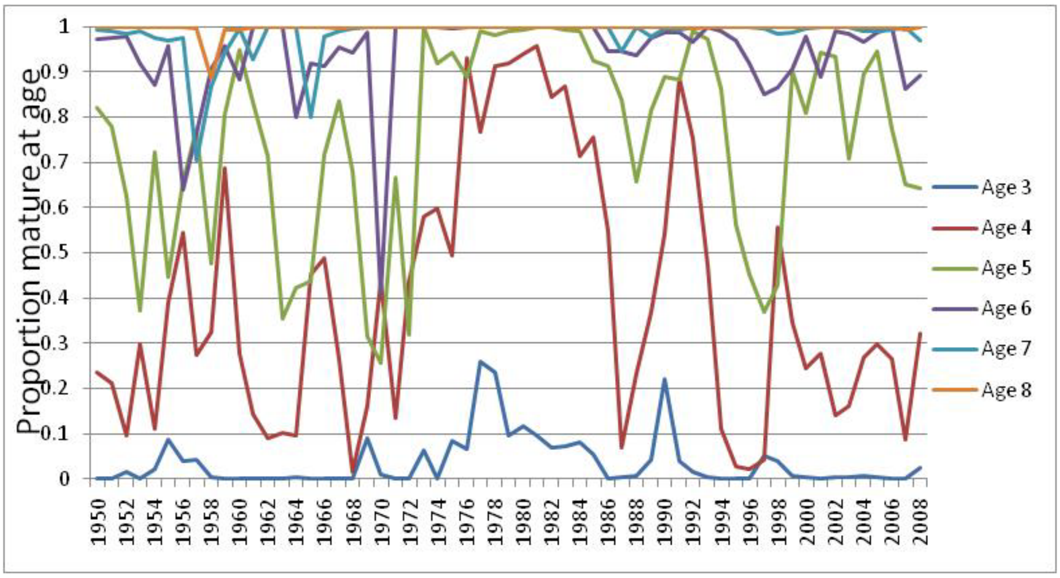


Figure 7.7.5.1 Norwegian spring spawning herring. Comparison of the maturity ogives used in the assessment prior to 2010 (top) and the new maturity ogive used in the 2010 assessment (bottom) based on WKHERMAT (2010)

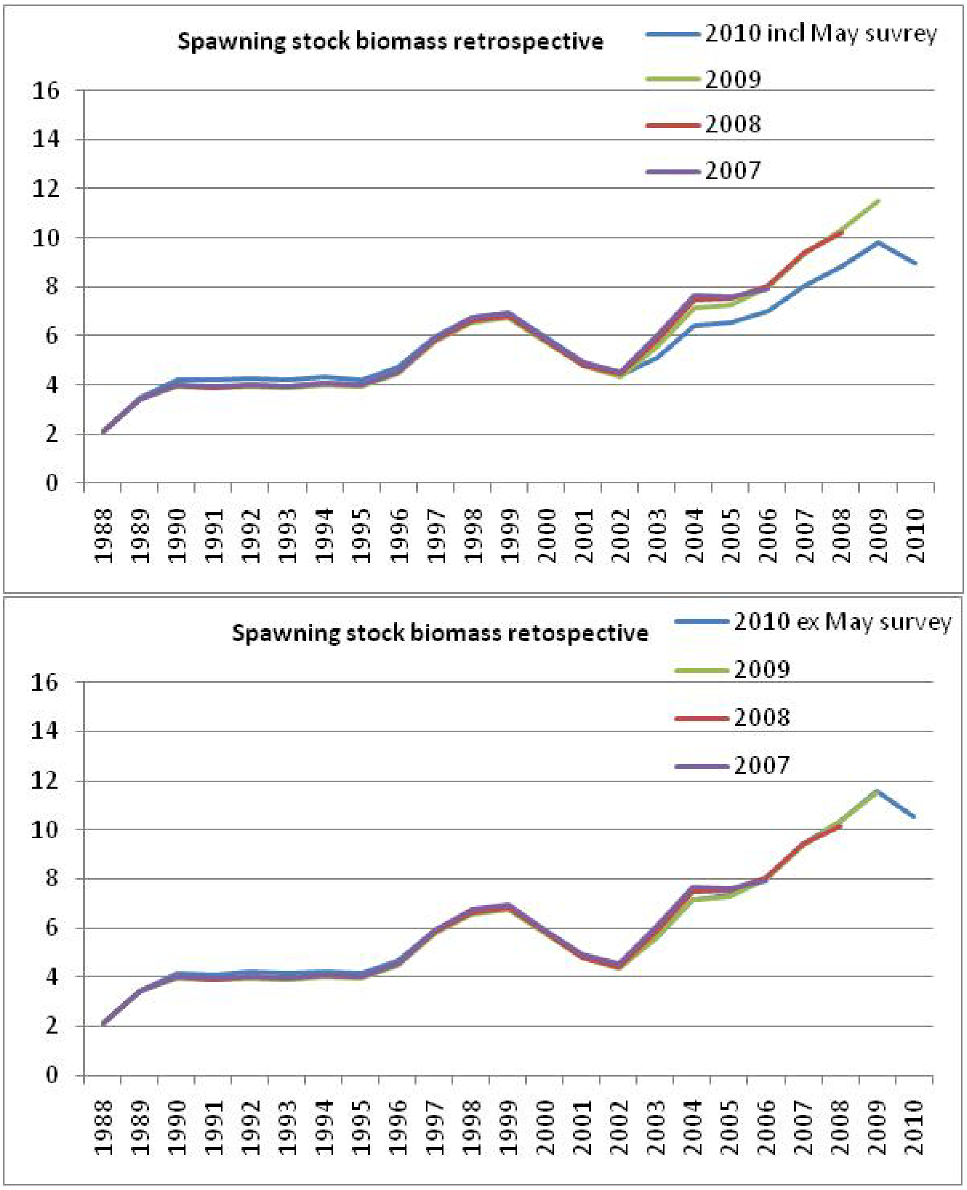


Figure 7.11.1.1. Norwegian spring-spawning herring. Retrospective run for VPA, SSB with including (upper) and excluding (lower panel) the May survey (survey 5).

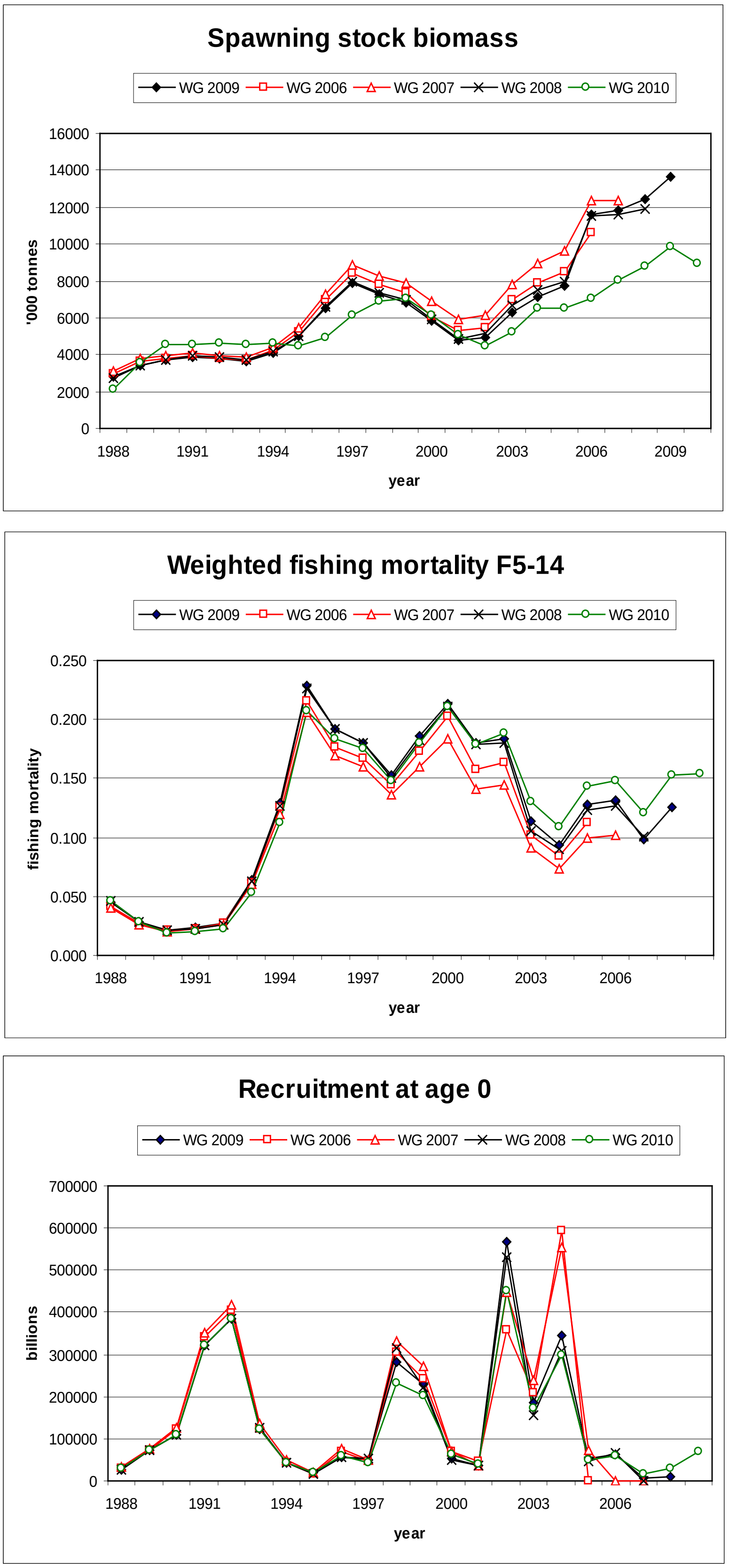


Figure 7.12.1. Norwegian spring spawning herring. Comparisons of spawning stock, weighted fishing mortality F5-14 and recruitment at age 0 with previous assessments.

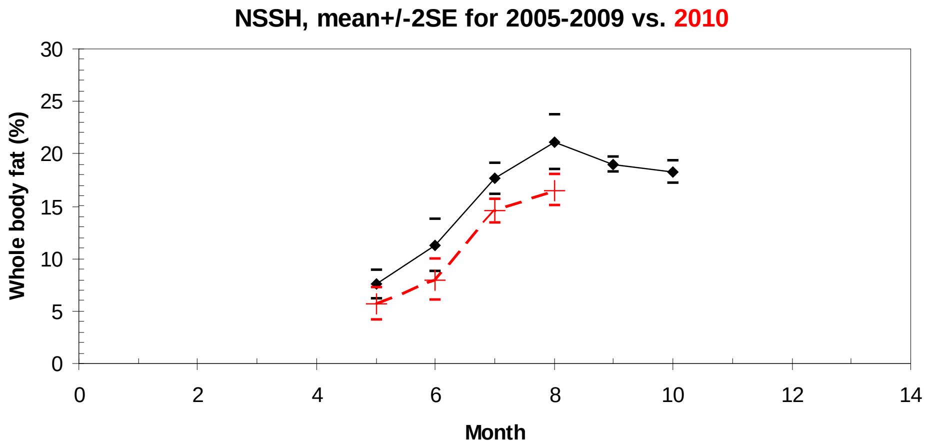


Figure 7.15.1. Norwegian spring spawning herring. The mean±2SE of whole body fat content (%) during 2005-2009 (•) and in 2010 (+) as measured from herring taken to processing plants in Iceland.

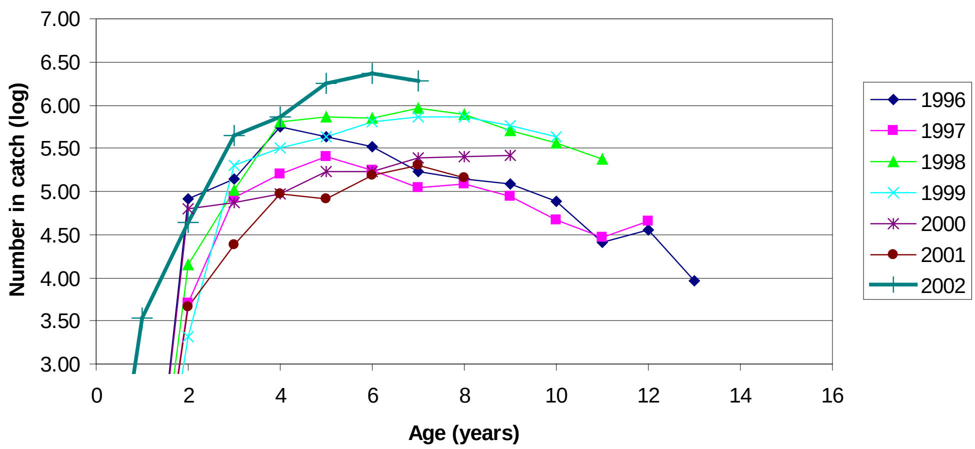


Figure 7.17.1. Norwegian spring-spawning herring. Number at age (log-transformed) in the catch for the year classes 1996-2002.

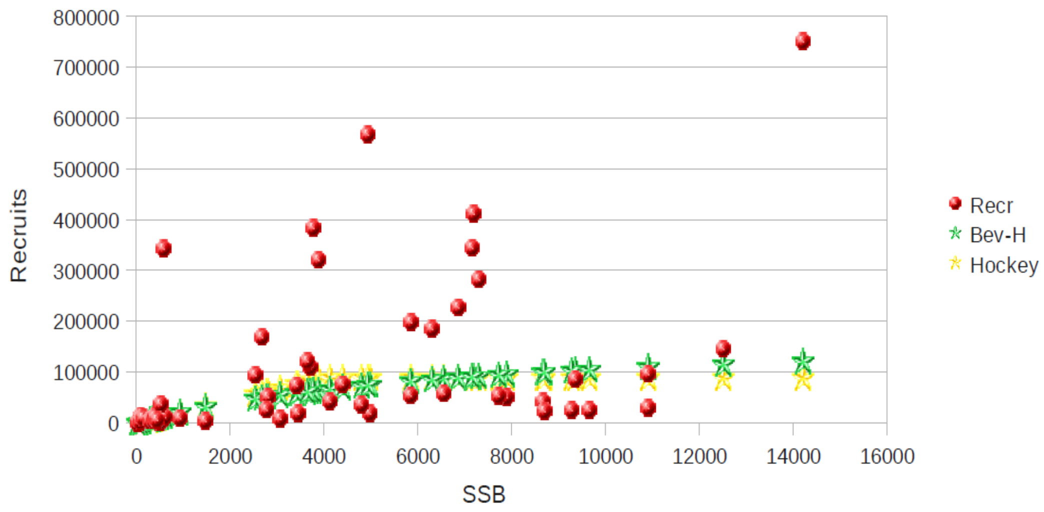


Figure 7.8.2. srstoch. Stock recruitment relationship used in the simulation model. Red dots show the recruitment from data, green stars the fitted Beverton-Holt function and yellow stars the fitted hockey stick function. Figure show also in Skagen 2010 (WD, Skagen).

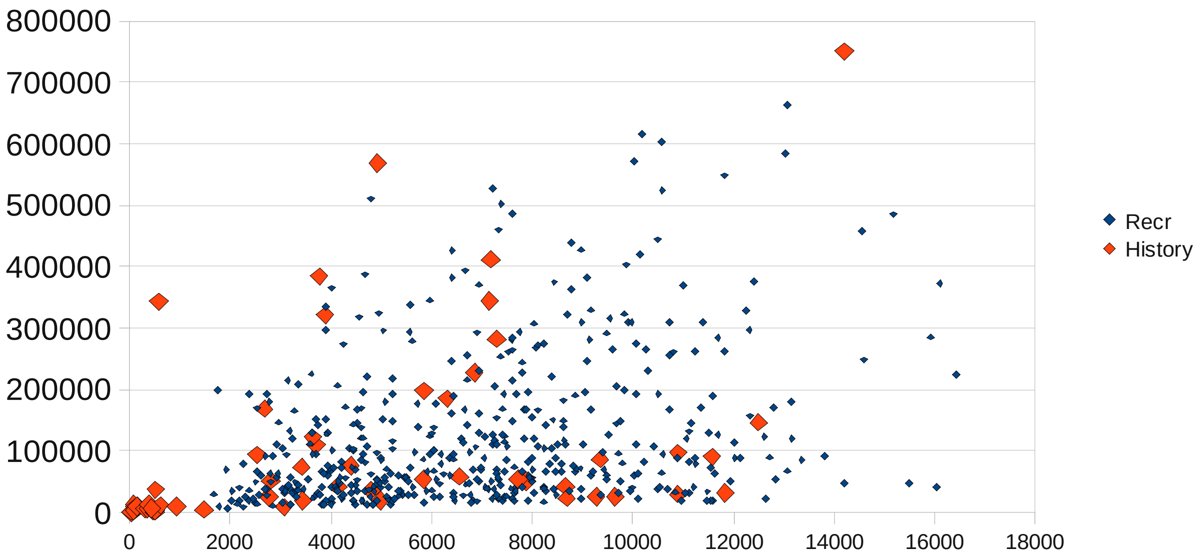


Figure 7.8.2.srmodeldata. Norwegian spring spawning herring. Stock-recruitment of NSSH from data (big red diamonds) and produced by the model (blue small diamonds) using Beverton-Holt recruitment function.

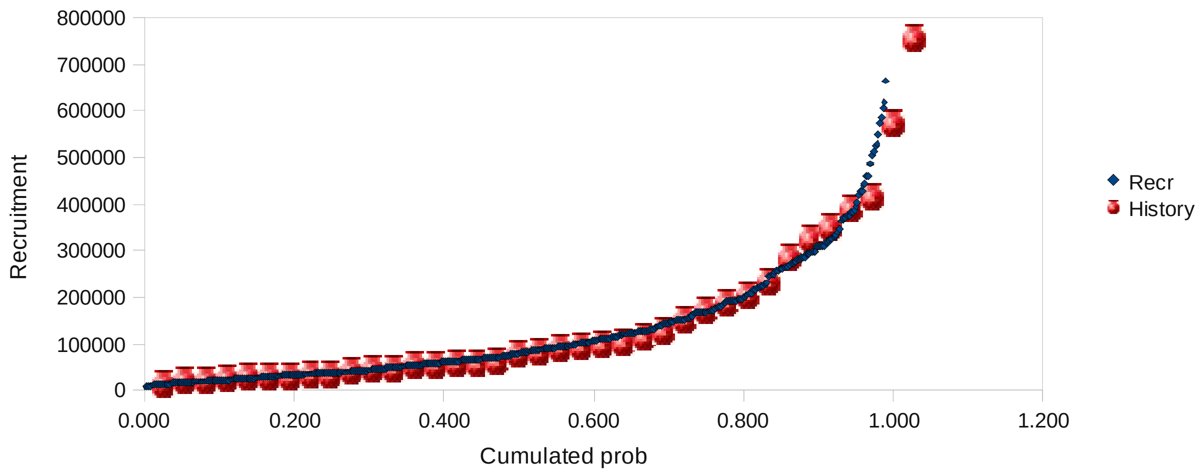


Figure 7.8.2.cumdist. Norwegian spring spawning herring. Cumulative probability of recruitment values of NSSH from the data (red dots) and produced by the model (small blue diamonds) using Beverton-Holt recruitment function.

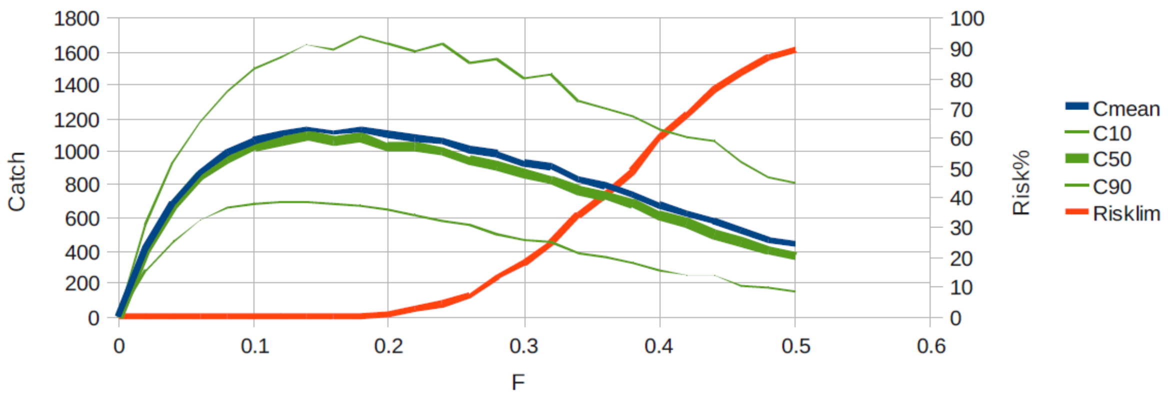


Figure 7.8.2.catch. Norwegian spring spawning herring. Yield (catch) and the probability of the stock being below Blim (2.5. million tonnes) after 50 years at target F for NSSH using Beverton-Holt recruitment function. C10, C50 and C90 show the 10, 50 and 90 percentiles of catch. Risklim shows the probability of stock falling below B_{lim} as a percentage of the model runs. For similar figure for hockey stick recruitment function see WD Skagen 2010.

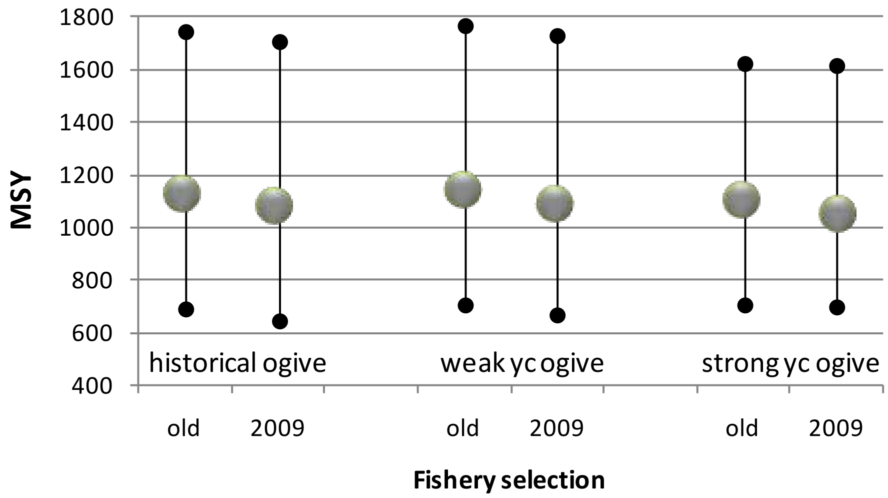


Figure 7.8.2.msyBH. Norwegian spring spawning herring. The MSY for three different maturity ogives and two different fishery selection patterns with 10 and 90 percentiles using Beverton-Holt recruitment function. See text for further details.

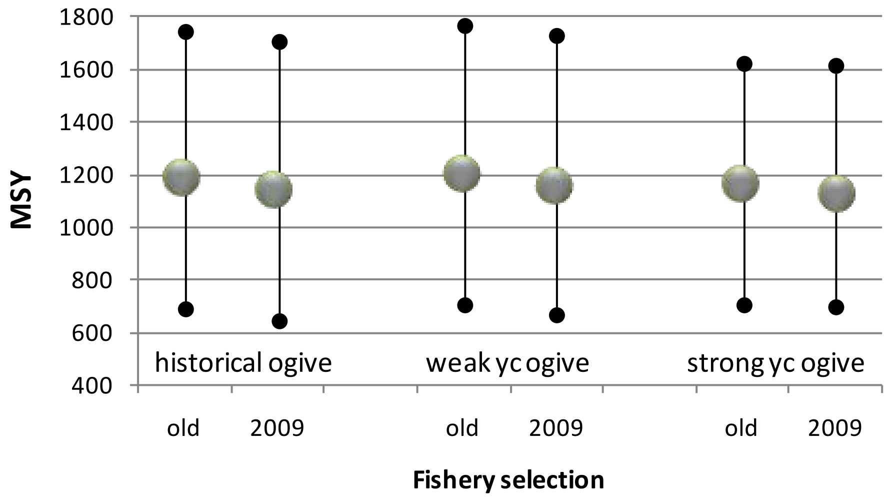


Figure 7.8.2.msyHS. Norwegian spring spawning herring. The MSY for three different maturity ogives and two different fishery selection patterns with 10 and 90 percentiles using hockey stick recruitment function. See text for further details.

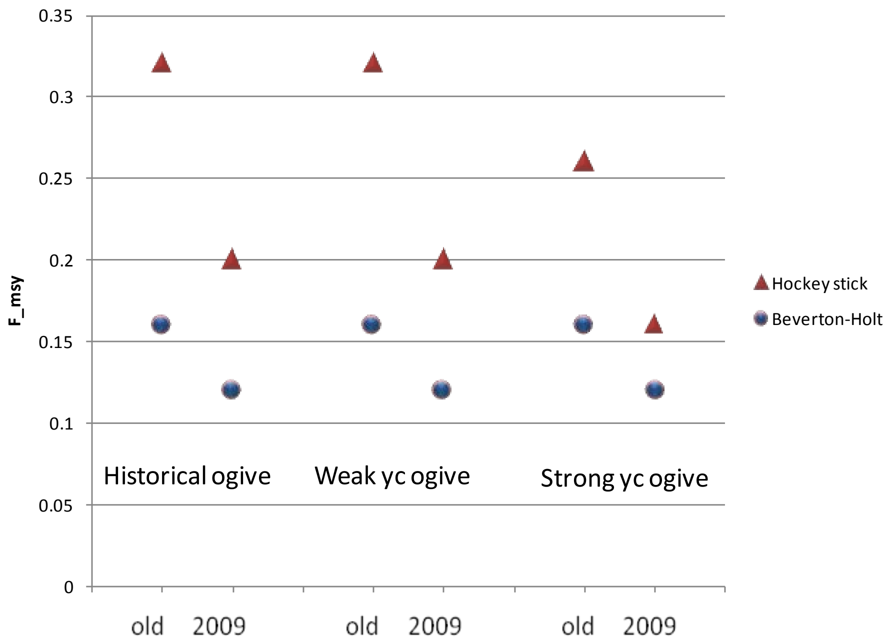


Figure 7.8.2.fmsy. Norwegian spring spawning herring. F_{MSY} for three different maturity ogives and two different fishery selection patterns with Beverton-Holt and hockey stick recruitment function. See text for further details.

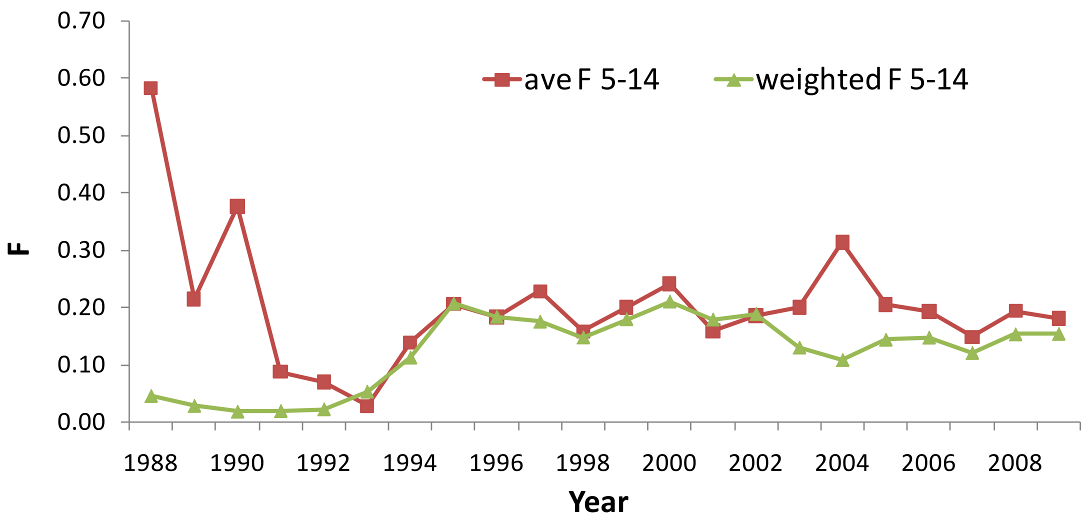


Figure 7.8.2.fvalues. Norwegian spring spawning herring. Unweighted (red squares) and weighted (green triangles) average F values from the current assessment.

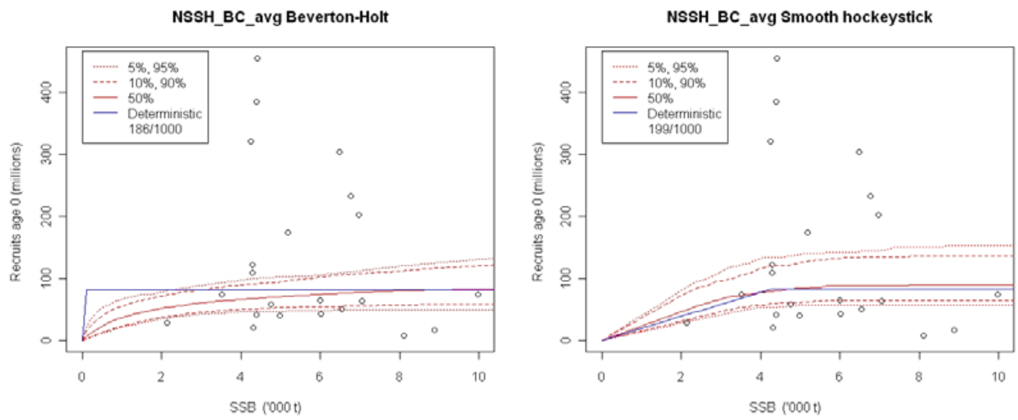


Figure 7.8.2. sr. Deterministic and stochastic (taking into account uncertainty in weights, selectivity and maturity at age) stock recruit relationship fits for the Norwegian spring spawning herring stock. Stock-recruit pairs are from the period 1988-2009.

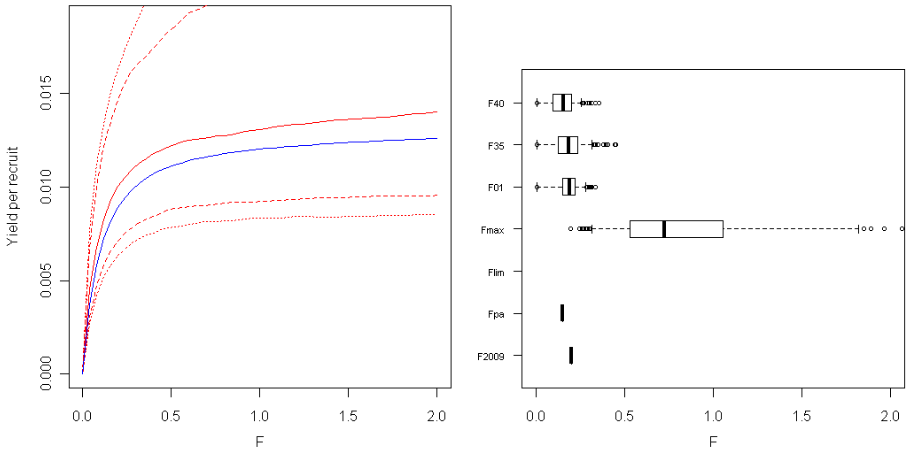


Figure. 7.8.2. ypr. The yield-per-recruit (YPR) curve for the Norwegian spring spawning herring stock (left) and resulting stochastic estimates of *F* reference points (right).

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 2009

Based on the most recent estimates of SSB (in 2009) and, fishing mortality (in 2008), ICES classifies the stock as having full reproductive capacity and being harvested sustainably (F=0.29). Year classes 2005-2008 are among the lowest observed. Due to recent low recruitment, SSB has declined from its historical peak in 2003-2004 of more than 7 million tonnes to 3.6 million tonnes at the beginning of 2009, and the decline is expected to continue in the short-term.

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).

8.2 The fishery in 2009

This main fisheries on blue whiting took place in the Faroese 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. Twelve countries reported blue whiting landings in 2009. 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

Danish landings of blue whiting in 2009 were less than 250 tonnes as the main part of the Danish quota was swapped with other species.

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 consists 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. In 2007 there were 11 larger purse-seiners/trawlers plus three smaller vessels, but by end of 2009 only five larger vessels were left and only one smaller vessel has been operating. The fishing pattern in 2009 did not resemble the pattern of the previous years, as the fishery was greatly reduced in the summer and autumn period of the year, especially in the northern areas (i.e. northern part of the Faroe zone, Icelandic and international waters). In January the Faroese vessels follow the pre-spawning blue whiting on their migration southwards in the south-eastern part of the Faroese zone (Vb1) and north in the EU zone (VIa). The fishery then continues in the spawning area west of the Hebrides (VIa) and to a lesser extent on the Porcupine Bank (VIIc). In March some catches were taken south-west of the Hatton-Rockall Plateau in International waters (VIIc). 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 in the Faroese area lasted for a relatively short time period and was finished by end of May when the quota was nearly finished. No fishery on blue whiting was in operation until the end of the year when some small catches were taken of pre-spawning fish in the south-eastern part of the Faroe zone (Vb1) in December. All catches are taken with pelagic trawl.

8.2.4 Iceland

The Icelandic directed fishery started in January in the Faroese EEZ and in International waters west of the British Isles. 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 the years prior to 2006, almost all of the catch was taken outside of Icelandic EEZ: 71 000 tonnes in the Faroese EEZ, 49 000 tonnes in the International zone and less than 1 000 tonnes in the Icelandic EEZ.

8.2.5 Ireland

The Irish fishery for blue whiting began in February 2009 with the majority of landings taken in quarter 1 and quarter 2. A total of 8 boats took part in this fishery and reported landings of 8 775 t. This is a decline from 2008 when the Irish landings were 22 852 t. Irish landings of blue whiting have been declining since 2005. In 2009 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 and VIIb. Fishing was concentrated along the shelf-edge and in deeper waters between 300 m and 600 m.

8.2.6 Netherlands

The Dutch fleet targeting blue whiting in European waters consisted of 15 freezer trawlers in 2009 (2 pair midwater trawlers and 13 single midwater trawlers), up five from 2008. However, total catches almost halved from 2008 to 2009 (78 447t to 35 686t). In both years all the directed catches were landed almost exclusively in the first two quarters, with almost two thirds landed in the first quarter. The majority of the catches in 2009 originated from ICES Divisions VIIc (mainly first quarter) and VIa (mainly second quarter).

8.2.7 Norway

After the coastal states agreement in 2008 and quota transfers in other international agreements, the Norwegian TAC for 2009 was set to 231 973 t (up to 160 114 t could be taken in the EU zone and up to 76 514 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 Faroe 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).

8.2.8 Russia

Ten Russian trawlers started fishing for blue whiting in the southern part of the Faroese zone at the beginning of January 2009 and finished in this area in the middle of February. The fishery in the Porcupine area began in the middle of February. The majority of the trawling positions were located to the south of 54°N. This number of vessels taking part in this fishery was considerably less than in 2008 and the amount of time spent fishing in the spawning grounds also decreased. At the beginning of April the vessels returned to the Faroese area. At the end of May the majority of the trawlers moved to the international waters of the Norwegian Sea. In the north of the Faroese area the fishery began again in the middle of December. The total catch of blue whiting in 2009 was 149 650 t.

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 bycatch 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 2009 having a total landing of 20 600 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 2009 were provided by members of the WG. The data provided as catch by rectangle represented approximately 99% of the total WG catch in 2009. The total catch by country for the period 1988 to 2009 is presented in Table 8.3.1.1.

For the fourth consecutive year, total catch has declined, with the total catch almost halving from 2008 to 2009 (Figure 8.3.1.1 A). Total catch for 2009 was estimated to be about 0.635 million tones, the majority of this coming from the spawning area (Figure 8.3.1.1 B). The spatial and temporal allocation in catch for the period 2000–2009 are shown in Figures 8.3.1.2 and 8.3.1.3, respectively. Since 2003 there has been a shift in 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 (first two quarters). Catches by nations and area for 2009 are given in Table 8.3.1.2 and catches by quarter and area are presented in Table 8.3.1.3. In the first two quarters catches are taken 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) and Division V. 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 704 samples were collected from the fisheries in 2009. 79 400 fish were measured and 18 092 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 109 tonnes, followed by the mixed fishery with one sample for every 422 tonnes, and lastly the directed fishery where there was one sample for every 1 311 tonnes caught. This is an almost two-fold increase in samples per ton by the directed fishery compared to 2008. 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 Denmark, Germany, France and the UK/Scotland, all with relatively small landings. 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 2009 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, 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 20–34 cm in length. This range represents a slight shift to shorter fish compared to the previous year. The mean length in the fishery was 28.5 cm, which is 4 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 13–48 cm with 95% of fish ranging from 23-39cm. The mean length was 29.2 cm, up 27mm 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 12–38 cm with 95% of fish ranging from 15-30cm (Table 8.3.1.3.3). This distribution is slightly narrower than last year. The mean length was 23.5cm, 4mm longer than the previous year. This fishery tends to catch shorter fish than the other two fisheries, with the upper bound to its length frequency lower than that of the other two fisheries.

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 is clearly seen in the decreasing proportion of younger fish. 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 2009 are higher for all ages, which indicate that the decreasing trend in mean weight for the last 10-15 years has ended. 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 (IBWSSS) 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 amount of trawl and hydrographical stations. The survey is coordinated by WGNAPES (ICES CM 2010/ SSGESST:20).

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 IBWSSS survey have been used in the assessment since 2007.

Quality of the survey

During the 2010 survey, a mismatch in temporal alignment from the pre-agreed survey plan (ICES CM2009/RMC:06, section 5.1) led to a 15 day time lag between the Russian and other participant vessels. This time lag was deemed too large to produce a single synoptic survey estimate as in previous years. As a result the survey estimate was based an estimate made up of data from the Faroes, the Netherlands, Norway and Ireland. However this led to a gap in coverage in north Porcupine and south Hebrides areas attributed to poor weather and the temporal mismatch between vessels. Information from the commercial fleet showed that they were fishing in this area at that time.

A review of the survey abundance estimate was carried out during the WGNAPES meeting and it was decided to accept the estimate as a valid extension of the survey time series. It was agreed within WGNAPES that the gap in area coverage occurred in an area of concentrated fishing effort and thus contained a high but un-quantified biomass. Mean acoustic density for the un-surveyed rectangles within the core spawning area was determined by means of interpolation from surrounding surveyed rectangles following established methods.

Uncertainties in spawning stock estimates based on bootstrapping of available data have been assessed again in 2010. At present, only one source of uncertainty is considered namely the spatio-temporal variability in acoustic recordings. In 2010 mean acoustic density the lowest observed since 2004 (Figure 8.3.5.1.1A). Relating these data to the stock estimate results show that the observed decline in biomass between 2006–2010 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 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 highest concentrations of blue whiting were recorded in the Hebrides core area which remains consistent with the results from previous surveys. 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 2010 international survey on the spawning grounds was 3.01 million tonnes, representing an abundance of 19.2×10^9 individuals. The spawning stock was estimated at 2.9 million tonnes and 18.6×10^9 individuals. In comparison to the results in 2009, there is a significant decrease (about 50%) in the observed stock biomass.

The stock in the survey area is dominated by age 6 and 7, the 2003 and 2004 year classes respectively, contributing above 50% of the spawning stock biomass.

Age and length distributions from the five last years (Figure 8.3.5.1.3) show an increase in mean age and size through the period as a result of the steep decrease in recruitment.

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 (mainly immature fish) in the Norwegian Sea. Estimates in 2000–2010 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 WGNAPES (ICES CM 2010/ SSGESST:20).

Use of this survey in stock assessment

Indices of age 1 and 2 (from the standard area) are used as a tuning time series in the assessment. Moreover, the age 1 indices are also 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 2010 survey was 0.26 million tonnes, which is very low. The stock estimate in number for 2010 is 1.7 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. However this year's estimate gave no 1 and 2 group blue whiting in this area. 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 6 year old blue whiting.

The observed distribution of blue whiting has decreased as compared to earlier years, 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 are regularly caught as a bycatch species in these surveys, and have in some years been among the numerically dominant species (Heino et al., 2003). This survey has in earlier years given 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 2010 is very low (0.10), as in 2009 which were the lowest observed.

Use of this survey in blue whiting assessment

The survey provides recruitment estimates for 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.

The International Survey in Nordic Seas and adjacent waters in July-August is an expansion of the Norwegian Sea summer survey (Stock Annex), however the coverage and main focus has changed. Blue whiting is not main target, but the survey gives useful information of the stock in this period. This survey started in 2009 and was conduced for a second time in 2010.

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 five 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.

8.4.1 Data exploration in SMS

The data exploration using the Stochastic Multi-Species (SMS) model (Lewy and Vinther, 2004) focussed on the uncertainties in the fishery independent data.

8.4.1.1 Sensitivity analysis, IBWSSS

The 2010 estimate from The International Blue Whiting Spawning Stock Survey (IBWSSS) is likely to be an underestimate of the SSB (see section 8.3.5.1), however this is the only survey available covering the spawning stock, and the 2010 observations are important for the assessment.

The IBWSSS provides data for the stock at the beginning of 2010, where the final year in the assessment is 2009. To use the 20010 IBWSSS data, it is assumed that the survey takes place on the 1st. January, before the stock has been subjected to any mortality.

To investigate the effect of the 2010 data the assessment was first carried out without the 2010 IBWSSS, using the time series 2004-2009. The 2009 data provide information from the stock before most of the fishery has taken place and the 2009 data is sufficient to make an assessment. In Figure 8.4.1.1 show the result from this run compared with a run using the 2010 IBWSSS (default setting). Compared to the final 2009 assessment, the 2010 run without the 2010 IBWSS estimates of SSB in 2008 are slightly lower and F is slightly higher, however the addition of the 2009 catch data does not change much. When the 2010 IBWSSS data are used, F is estimated considerably higher in 2006-2009 and SSB considerably lower since 2003.

The residuals (Figure 8.4.1.2, upper panel) for the run without the 2010 IBWSSS show the same pattern with a clear year effect as observed last year. The survey has clearly underestimated the stock in 2008 and overestimated it in 2009. Residuals are small in general and SMS estimate a CV at 19% for all ages. When the 2010 IBWSSS data are used (Figure 8.4.1.2 lower panel) the year effect for 2008 becomes less clear, but the 2009 overestimation becomes even more pronounced. The 2010 residuals show a clear year effect, with an underestimation of the stock. Residuals are in general larger and the CV is now estimated to be 31%. Catch at age residuals from the two runs are quite similar (not shown). The SMS model without the 2010 IBWSS data has the best fit. The average negative log- likelihood contribution per type of observation is shown in the table below. Survey data obtain the best fit when the 2010 IBWSSS data are not used, however using this data gives a better fit for catch at age data.

Configuration	Catch	Survey
No 2010 IBWSSS	-0.69	-0.08
All data	-0.68	-0.05

A final check for any side effects of the potential underestimation of the stock from the 2010 IBWSSS data 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 8.4.1.3 shows there is practically no effect on F and SSB in 2009 of *a prior* weighting, but it has a small (side) effect for F in 2006-2008, indicating that the signal is not the same for the two kinds of data sources.

The retrospective analysis (Figure 8.4.1.4) using all available data shows a highly variable estimate of F and SSB, but the short retrospective window (2007-2009) shows no bias.

To conclude: The IBWSSS data from 2010 is probably an underestimate. Including the IBWSSS data from the year after the last assessment year (as normally done in the Blue Whiting assessment) gives a slightly worse model fit, a relatively high F for 2009 and a large upward shift in F for both 2007 and 2008. The group decided to continue the default used of the IBWSSS data, as there is no alternative data available and no strong arguments to reject the conclusions made by ICES WGNAPES on the best use of survey data this year.

8.4.1.2 Sensitivity analysis, the International ecosystem survey in the Nordic Sea

The International ecosystem survey in the Nordic Sea has since 2007 provided estimates of age 1 and age 2 close to zero Table 8.3.5.2.1. This should be compared with indices mainly above 20 000 for the period before 2007. Recruitment has decreased considerably, but it seems as if the survey underestimates recruitment in a period with low recruitment. This might be due to a change in density dependent distribution of juveniles, where the density in the northern part of the distribution areas becomes disproportionally low in a low recruitment regieme.

Due to the large reduction in the indices, which is not fully supported by other sources, the survey obtains a very high variance for the catchability estimate, and is therefore automatically down weighted in SMS. The effect of removing the survey from the analysis is investigated (Figure 8.4.1.5). Some of the indices are zero and can as such not be used in the model as it assumes a log-normal error distribution. To investigate the effect of these zero values, those were replaced by the lowest observed values in the time series This sensitivity analysis (Figure 8.4.1.5) shows that the survey has practically no effect on the assessment results, even though recruitment is estimated slightly higher when the survey is excluded. CV of the recruitment in 2008 and 2009 are almost the same for the two runs and very high (~28% and ~49% for the two years). Changing the zero observations to a very low value had no effect. As this is an "update assessment" it was as agreed to include the survey in the assessment with the values as observed.

Final configuration of SMS

The final SMS configuration (see the Stock annex for details) is the same as last year. The terminal period for constant age-selection in catches was extended from 1999–2008 to 1999–2009.

Examination of the catch residuals from the final SMS run (Figure 8.4.1.6) showed no appreciable patterns, even though clusters of positive or negative residuals occur. The residuals from the survey observations (Figure 8.4.1.7) showed significant year effects in the IBWSSS and Norwegian spawning stock survey, a well-known phenomenon with acoustic surveys. There is a pronounced year effect in IBWSSS, where the survey overestimated the stock in 2009 and underestimated it in 2010. The residuals from the International Ecosystem Survey in Nordic Seas are very large and biased as explained in the previous section.

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 increases 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 groups. 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.

Compared to last year the catchability of age 5+ for the IBWSSS has increased by 29%. This shows that the low 2010 survey indices, in addition to the low stock estimated for final assessment year, affects the historical stock size as well. The effect of an "outlier" in the time series becomes large due the shortness of the time series.

Comparison of the observed and fitted catches from the SMS runs (Figure 8.4.1.7) in combination with the catch residual plot (Figure 8.4.1.6) did not provide strong evidence that the separability assumption has been violated.

Due to the short IBWSSS time series the retrospective analysis (Figures 8.4.1.4) should only be run for the last three years. It shows a highly variable estimate of F and SSB, but the short retrospective window (2007-2009) shows no bias. With the addition of the 2009 data a higher F is estimated for the most recent years.

The comparison of the final assessment results in 2009 and the final SMS this year is presented in Figure 8.4.1.1 and is discussed in section 8.4.1.2

The final SMS run (Figure 8.4.1.9) shows a decreasing trend in fishing mortality since 2004, however F in 2009 (0.39) is more than twice as high as the target F (0.18) in the management plan. Recruitment has decreased since 2000 associated with a strong decreasing SSB since 2004. SSB in 2010 is estimated to be below B_{lim}. Year classes since 2005 are at historic low levels.

The overall level of uncertainty of SSB and mean *F* is at the same level as estimated last year (Figure 8.4.1.10), but the uncertainty in the final assessment year is actually slightly lower this year.

Stock summary results with added 95% confidence limits (Figure 8.4.1.11) show that the overall decrease in F since 2000 is not really that significant. The decreases in recruitment and SSB are however very significant.

8.4.2 Data exploration in TISVPA

As in the previous assessments (2006 -2009), the "triple-separable version of the ISVPA model (TISVPA) was used for exploratory runs. This version takes into account possible cohort-dependent peculiarities in the selection pattern that could originate from interactions of different cohorts with the fishing fleet, or by possible aging errors within a cohort or some other unrevealed reasons.

The model settings chosen were those that gave the least contradicting signals from all available data (catch-at-age and 3 surveys: Norwegian spawning acoustic (survey 1); Norwegian Sea May acoustic (survey 2), and International blue whiting spawning stock survey (survey 3)) in order to retain the meaningful input into the solution from all sources. The following settings were used:

- the "mixed" version (residuals in catch-at-age are attributed both to violations of selection pattern stability and to errors in catch-at-age data) with the condition of unbiased separable representation of fishing mortalities (more correctly - of exploitation rates)
- window for estimation of cohort-factors from age 1 to age 8
- the measure of closeness of fit for catch-at-age was the absolute median deviations (AMD) in residuals in logarithmic catch-at-age. For survey 2 the AMDs in residuals between logarithmic abundance-at-age from the survey and their model-derived values were minimized, for surveys 1 and 3 the measure of closeness of fit was sum of squared residuals in abundance-at-age. Catchability coefficients were estimated for all surveys. The overall objective function was the weighted sum of the above mentioned components.

The year of the change in selection pattern was the same as in the previous assessment - 1994 (first year of the second selection pattern in the model), as corresponding to the best fit to catch-at-age data.

Profiles of the components of the model objective function with respect to SSB in 2010 are presented in Figure 8.4.2.1. All sources of data gave minima in similar positions, except survey 2, which indicates lower stock in the terminal year.

The selection pattern estimated by the TISVPA model is shown on figure 8.4.2.2.

Figure 8.4.2.3 represents the model residuals by data source.

Retrospective runs (figure 8.4.2.4) show reasonable historical stability of the results.

Figure 8.4.2.5 represents the estimates of the uncertainty in the results (conditional parametric bootstrap with respect to catch-at-age and surveys with lognormal noise with SD=0.3).

Generally speaking, the TISVPA-derived results (see figure 8.4.2.5) show a rapid decrease in stock biomass towards the historical minimum level.

8.4.3 Data exploration in XSA

Two versions of XSA configurations were explored this year. The default version uses data up to 2009, and does not make use of the 2010 IBWSSS data. In a new XSA configuration data from the IBWSS survey was back-shifted one year to allow the use of the 2010 observations. Technically the survey was assumed to have taken place at the very end of the year, such that observations for e.g. age 3 in 2010 at spawning time, are assigned to age 2 the 31 December 2009. The other XSA settings were the same as applied last year.

The results from the two configurations are similar, however SSB in 2009 is estimated slightly lower and F higher in the XSA using back-shifted IBWSS data.

For the back-shifted XSA configuration, the residuals in the NSSS-survey seem to be without trend. A year effect is however clearly seen in the residuals from the IBWSSS with overestimations for 2008 (actually 2009 observations due to the back-shifting) and underestimations in 2009 (actually 2010 observations). This pattern is also found in the results found by other models.

The IESNS plays a relatively important role in the fitting of the young age groups, but the absolute values of residuals have increased compared to last year’s assessment. XSA cannot make use of the zero observation for age 1 in 2009.

The retrospective analysis (Figure 8.4.3.2) shows that the inclusion of 2009 data gives a steep increase in F for 2006-2008 and a high F in 2009.

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-back-shifted). For all the models there is a steep decrease in recruitment from the large 2000-2002 year classes to very low recruitments of the 2005-2008 year classes. All the models estimate a large reduction in SSB since 2006 with SSB below B_{lim} at the beginning of 2010. Estimates of mean *F* for the period since 2005 are more variable between models, where SMS in general estimates the lowest F. The annual variation in F is similar for XSA and TISVPA. F in 2009 is estimated to be between 0.42 (XSA) and 0.34 (TISVPA) with SMS in between (0.40).

The retrospective runs (Figures 8.4.1.4 for SMS, 8.4.2.4 for TISVPA and 8.4.3.2 for XSA) show a steep increase in F for 2007-2008 with the addition of the 2009 data. This clearly shows that the upward revision of F and downward revision of SSB observed this year is due to the additional data this year, where the low 2010 stock estimate from IBWSSS has the greatest effect.

WGWIDE decided to 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 the method. SMS has been used for the last five years.

8.5 Final assessment

Input data are catch numbers at age (Table 8.3.1.3.4), mean weight-at-age in the stock 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 2006-2009 can be found in the Stock annex. The only change this year is the second separable period has been extended with 2009, so it now includes 1999-2009.

The model was run until 2009. The SSB January 1st in 2010 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 8.4.1.9 Residuals of the model fit are shown in Figures 8.4.1.6 and 8.4.1.7 and discussed in Section 8.4.1. Uncertainties of mean *F* and SSB are shown in Figure 8.4.1.10. Stock summary results with added 95% confidence limits (Figure 8.4.1.11) show that the overall decrease in F since 2000 is not really that significant. The decreases in recruitment and SSB are however very significant.

8.5.1 State of the Stock

A combination of very low year classes since 2005 and an F (around 0.4) which is twice the target F for the management plan for the last decade have led to a steep decline in SSB from its historical peak in 2003-2004. This peak in SSB was 7 million tonnes and has been reduced to 1.34 million tonnes at the beginning of 2010, which is below B_{lim}.

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; however there are no indications of a high incoming recruitment. The very low recruitment in the last 5-6 years means that there is no immediate recovery for the stock even without fishery.

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.

8.6.1 MSY reference points

A lot of analyses have previously been made to identify the maximum sustainable yield of blue whiting in the formulation and evaluation of the current management plan for blue whiting. The results of the work are outlined below together with a new analysis based on the 'plotMSY' software (WKFRAME 2010) to explore candidate Fmsy values.

Based on those analyses WGWIDE proposes to use the results from the management plan evaluation which suggests $F_{0.1}$ at 0.18 as a proxy for F_{MSY} and to use B_{pa} (2.25 million tonnes) as value for MSY $B_{trigger}$

8.6.1.1 MSY and management plan evaluation

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 Fs 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. The group concluded that $F_{0.1}$ at 0.18 can be used as a proxy for F_{MSY}. The group did not recommend one specific harvest control rule but concluded that if an F-based rule is applied the target F should be less than 0.3 and the spawning biomass trigger value should be greater than 2.5 million tonnes. The target F relates to the size of the trigger biomass, such that a high target F will require a large trigger biomass, implying that the F according to the harvest rule often will be set well below the target.

The stochastic evaluation mentioned above resulted in an agreed management plan, which has been approved by ICES as being precautionary. The plan uses 0.18 as target F for SSB above B_{pa} is in accordance with high yield and low risk for the stock.

8.6.1.2 "plotMSY" analysis

Deterministic and stochastic equilibrium analyses were carried out using the 'plotMSY' software (WKFRAME 2010) to explore candidate Fmsy values for the blue whiting stock. Stock-recruit pairs from the period 1981-2009 (without considering "high" and "low" recruitment regimes), as outputted from the most recent SMS assessment of the stock, were used together with the selectivity pattern, proportion mature at age and 5-year averages of stock and catch weight at age. Three stock recruit relationships were examined, Ricker, Beverton-Holt and the segmented regression ('smooth hockey stick'), and yield-per-recruit (YPR) analyses were also done. For the stochastic analyses, uncertainty (CVs) in the biological and fishery parameters at age were used to create alternative fits to the stock-recruit relationships (*N*=1000).

The results (Figure 8.6.1) show a very poor Beverton and Holt fit to the deterministic data, with a steep slope at the origin and an asymptote at the geometric mean recruitment level. The majority of stochastic stock-recruit model fits fall out of the range of the deterministic fit to the data, and thus it can be concluded that the stock-recruit form is unclear and not suitable for the data and the level of uncertainty associated with the parameters. The Bmsy estimated by the segmented regression fit is near to the breakpoint. As a result this estimate is close to the Fcrash value associated with this curve (dependent on the slope of the fit) and hence has a high potential risk to the stock. The uncertainty with regards to the slope at the origin makes this stock-recruitment function unsuitable as a basis for advice on Fmsy. The Ricker stock recruit relationship fits the data best, and the median of the stochastic fits is in close agreement with the deterministic fit. However, there is a very large amount of uncertainty around the fit to the data, as can be seen in the spread of potential stochastic fits. This results in a very high CV around the estimate of Fmsy (Table 8.6.1), again making this function unsuitable as the basis of advice on the selection of Fmsy.

Given the poor fits to stock recruitment functions, a yield-per-recruit analysis was conducted (Figure 8.6.2). The stochastic analysis shows a high degree of uncertainty and a very poorly defined Fmax. This would preclude the use of Fmax as an Fmsy proxy, although F0.1 may remain a viable, safer alternative.

The structure of the stock and recruitment pairs do not lead to any clear definition of an optimum yield equilibrium fishing mortality level. Given this uncertainty it is more appropriate to select an Fmsy proxy tested by a stochastic simulation model. The current simulation-tested management plan Fpa level was determined by this means and therefore provides a more reliable estimate of an F value resulting in high long term yield with a low risk to the stock.

8.7 Short term forecast

8.7.1 Recruitment estimates

A survey-based estimate of recruitment using the standard ICES software, RCT3 was carried out. The method uses the most recent available information from the International ecosystem survey standard area index (Tables 8.3.5.2.1) and the Barents Sea bottom trawl time series (Table 8.3.5.3.1). Both recruitment indices indicate that the incoming 2008 and 2009 year classes are very weak and are orders of magnitude lower than earlier in the series.

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 estimates produced by RCT3 and from SMS may be unrealistically low compared to the catch data. The working group therefore made the assumption that recruitment at age 1 in 2009 and 2010 is equal to the lowest observed value in the time series which is 1.759 billion.

The text table below shows alternative recruitment assumptions. Values used in the short term prediction are underlined.

Year class	Age in 2010	SMS	RCT3	GM 81–96	Lowest Obs (08)	GM 81–09
2008	2	0.694	1.156	8.809	**1.759**	11.36
2009	1		0.838	8.809	**1.759**	11.36
2010–2011	0			8.809	**1.759**	11.36

8.7.2 Short term forecast

Short term forecasts were conducted with the ICES standard software MFDP (Multi Fleet Deterministic Projection) version 1a and also with SMS.

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 (2007–2009). Selection (exploitation pattern) is based on F in 2009 from the most recent assessment, which assumes a fixed selection in the period 1999-2009. 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 548,000 t which corresponds to the expected outtake.

Output

A range of predicted catch and SSB options from the short term forecast are presented in Table 8.7.2.2.

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. The short term forecast shows that the SSB in 2011 will be below B_{pa} and also below B_{lim}. In this case the management plan states that TAC should be fixed according to an F of 0.05. This will lead to a TAC in 2011 of 40,138 tonnes.

Following the ICES MSY framework implies fishing mortality be reduced to 0.06 (35% of F_{MSY} because SSB in 2011 is 35% of MSY $B_{trigger}$), resulting in landing of 50,719 t in 2011. This is expected to lead to an SSB of 789,822 t in 2012.

Following the transition scheme towards the ICES MSY framework implies fishing mortality be reduced to 0.16 (lower than F_{MSY}), resulting in landings of 118,457 t in 2011. This is expected to lead to an SSB of 723,252 t in 2012.

8.8 Uncertainties in assessment and forecast

The assessments presented this year should be considered as uncertain with respect to the absolute estimates of stock metrics, and certain in the conclusion on the steep decline in both SSB and recruitment in the most recent years.

Assessment results for blue whiting are highly dependent on the quality of the only survey that covers the spawning stock (IBWSSS). The stock estimate from this survey is just 50% of what the survey estimated for 2009. This reduction is crucial for the assessment result this year. As shown in section 8.4.1.1, with the use of the IBWSSS 2004-2009 time series (without the 2010 observations data) the assessment halved the estimated fishing mortality in 2009 and doubled SSB for 2010.

The precision of the IBWSSS survey is in general believed to be low (PGNAPES, ICES CM 2009/RMC:06). Two main factors are assumed to be important to the uncertainty of this cruise, namely 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.

The mismatch in temporal and spatial coverage in 2010 has increased the uncertainties for the IBWSSS estimate for 2010. Based on the observations from 4 vessels and data interpolation for areas not covered, the SSB was estimated to 2.9 million tonnes. This is more than a 50% reduction compared to the estimate for 2009. Data from the Russian vessel were not used in the survey estimate in 2010 as the vessel participation was 2 weeks later than planned, because of the risk of double counting the population. However, the estimate from the Russian vessel alone that covered the main parts of the total survey area was 3.65 million tonnes which is 25% higher than the results from the international coverage.

Results from other surveys are not conclusive. The International ecosystem survey in the Nordic Sea done in May 2010 showed a record low stock estimate of both juveniles and older fish, but this survey is normally just used for estimation of juveniles. The International Survey in Nordic Seas (July-August) in 2010 has a preliminary estimate of the total stock biomass of blue whiting at 3.46 million tonnes for the area north of 62°. This is higher than the survey estimate for 2009, but as the survey has only been conducted for two years, the estimate cannot be evaluated yet.

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 2006−2010. 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 in most recent years, but there is no doubt that recruitment has been very low since 2006.

The three assessment models applied this year give a consistent picture of the state of the stock. The downward revision of the stock made this year is due to the use of 2010 survey data and the choice of the final assessment model has a very limited influence on the historical stock size and forecast results.

8.8.1 Comparison with previous assessment and forecast

Comparison of the final assessment results in 2009 and the final SMS this year (Figure 8.4.1.1 and the table below) shows that this year's assessment estimate a much higher F and a much lower SSB in the most recent years.

Text table. Comparison of the 2009 and the 2010 assessments for Recruits (millions), Spawning stock biomass (1000 tonnes) and fishing mortality.

	2009 assessment			2010 assessment			Ratio 2010:2009		
Year	Recruits	SSB	F	Recruits	SSB	F	Recruits	SSB	F
2003	55104	7352	0.473	51438	6836	0.511	93%	93%	108%
2004	49376	7445	0.539	40514	6772	0.566	82%	91%	105%
2005	27925	7049	0.429	22607	6210	0.478	81%	88%	112%
2006	8127	7129	0.331	5635	5932	0.411	69%	83%	124%
2007	4862	5995	0.323	2431	4631	0.436	50%	77%	135%
2008	6617	4749	0.288	1759	3255	0.476	27%	69%	165%
2009		3588		1759	2096	0.399		58%	

In the 2009 assessments the residuals from IBWSSS in 2009 showed that the survey overestimated the stock size for all ages in 2008, a well-known phenomenon with acoustic surveys. It was decided to fully use the information from the survey in the assessment, even though the time series was relatively short (6 years). The result of accepting the use of the IBWSSS 2009 data was an upward revision of stock by around one million tonnes. In this year's assessment we have the opposite situation. The residuals from the 2010 IBWSSS show that the survey underestimates the stock size in 2009 and still overestimates the stock in 2008. To fit the full time series, the survey catchability is increased by 29% by the assessment model, which in addition to the high F in 2009 produces a much lower historical stock size.

The most recent recruitment has also been revised downwards this year. The absolute number is still very uncertain, but the estimate this year confirms a historical low recruitment.

In 2009 ICES advised on the basis of the agreed management plan (F=0.18) that catches in 2010 should be 540 000 tonnes. This advice has been followed quite closely (TAC 548 000 tonnes). The management plan will give a TAC at 40 000 tonnes in 2011 if the present assessment is used.

8.9 Management considerations

In 2008 ICES advised a TAC of 384 000 tonnes on the basis of the precautionary approach. The TAC agreed by managers was 606 000 tonnes.

The advice from ICES to reduce F to the target F (0.18) from the management plan was followed for setting the TAC for 2010.

The downward revision of SSB from the assessment this year shows that the absolute estimate of SSB is uncertain, and highly dependent on the result from one survey measuring the population on the spawning grounds. This survey shows that the population has been halved from 2009 to 2010. This has probably not been the case, and model results show that the 2009 stock estimate was likely to be an overestimate and the 2010 an underestimate. Right now it is however not possible to quantify the bias. All model results show a very steep decline in recruitment and SSB. All available information also shows that the recruitment (age 1 fish) has been at a very low level since 2006, so there is no immediate source for rebuilding the stock. The advice in accordance with the management plan will give a TAC in 2010 at 40 000t, given an F at 0.05. The SSB in 2011 is predicted to be well below B_{lim} and an F at 0.05 will just increase SSB by 1% in one year.

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 and mackerel. Blue whiting has consequently played 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 on 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. In order to investigate this further, all vessels participating in the triennial mackerel and horse mackerel egg survey sampled mackerel stomachs to be sent to The Faroe Marine Research Institute to be analysed.

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.

Recent work carried out by Hátún, *et al* 2009b found that changes in the distribution of blue whiting are caused by variable stock size and by shifts in the migration pattern, and that the subpolar gyre influences this process either by:

1. Directly regulating the currents and or hydrographic conditions that will influ-ence the migration routes

or

2. Indirectly via trophodynamics.

This work also suggests that recent advances in simulating the dynamics of the SPG 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 "Coastal States" EU, Norway, Iceland and the Faroe Island. No minimum landing size is associated with blue whiting.

8.11.1 Management plans and evaluations

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 reduction to F=0.18 was followed by managers for setting the 2010 TAC. The full text of the management plan is presented in the stock annex.

8.12 Benchmark workshop

The present assessment has significantly changed the perception of the blue whiting stock compared with last year's assessment due to the extension of the time series. The time series from the Survey on the spawning grounds is still rather short and has apparently a high uncertainty on the abundance of all age-group in a given year, which has caused significant revisions of the historical stock size for the last two years. The Nordic Sea ecosystem survey seems not to cover the present distribution area for juveniles and gives probably a biased (too low) estimate of recent recruitment. In addition, it has been shown that the assessment method is sensitive to changes in model structure. This happens in a period when there is an almost total collapse in recruitment to the stock and the spawning stock is reduced below safe biological limits. On this background the working group will propose that a benchmark assessment be done for this stock. See section 9.2 for details.

8.12.1 Stock identity

In 2009 ACOM advised that a benchmark for blue whiting should be postponed until the stock structure issues are clarified. A Study Group might be created to examine the information available regarding blue whiting stock identity and to propose a way forward if further analyses or/ and research were required.

WGWIDE has considered the management implications of considering blue whiting sub-stocks as an alternative to the current single stock unit. Since the late 70s biological studies of blue whiting have shown that the stock consists of many local populations. Ideally, the best practice would be to make independent assessments of each local population, to avoid the possibility of local depletion. Independent assessments may be unrealistic, because with the present knowledge it is impossible to define an unambiguous border between local populations or stock components. This is because fish in the same area may belong to different components, depending on the season or the year. Blue whiting is a highly migratory species, and the various components experience some mixing when they spawn west of the British Isles. Information on blue whiting stock structure including various genetic studies was collated in 2008 and full details of this are presented in the stock annex.

The first assessments of blue whiting in the 80's were based on two stocks separated into a Northern and Southern Stock with the border in the Porcupine Bank. The Southern area was excluded from the assessment for many years because of the lack of catch at age data for that area. Results from an assessment of the component in the southern area showed a stock about to collapse while the fishery data were showing that catches were sustainable. This component represents less than 1% of the total biomass and corresponds mainly to a juvenile area. For the other component the assessment would have been quite the same as in the present assessment although more noisy (ICES 1994). Reducing noise was the justification for merging stock components into the so called blue whiting combined stock.

Catch-at-Age data by quarter and ICES Division are available for the period 2000 – 2010 and could provide input data to assess the stock by component. But, as outlined above fish caught in the same quarter and division may belong to different components in different quarters and/or years. This would make the allocation of catches to sub-stocks very difficult . On this basis, WGWIDE recommends that the assessment of blue whiting continues to be carried out on the combined stock.

Table 8.3.1.1. Blue whiting landings (tonnes) by country for the period 1988–2009, 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	2009
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	248
Estonia					6 156	1 033	4 342	7 754	10 982	5 678	6 320						**					
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	58354
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	8831
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	5044
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	120202
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	8776
Japan					918	1 742	2 574															
Latvia					10 742	10 626	2 582															
Lithuania						2 046													4 635	9 812	5 338	
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	35686
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	225995
Poland	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	2043
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	20637
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		
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	173
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	225 163	149650
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	635 639

* 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 2009 in tonnes, as estimated by the Working Group.

Area	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Netherlands	Norway	Portugal	Russia	Spain	UK/Scotland	Grand Total
IIa	20	1 411			498		33	2 346		41 589		18	45 915
IIb										271			271
IIIa	117							14					131
IVa	106	221			312			16 334		5 228		33	22 234
IVb	5							17					22
Va					433								433
Vb		16 427	2 296		40 432		101	1 623		54 577			115 456
VIa		27 727		2 557	33 679	3 836	12 149	123 351		15 099		116	218 514
VIb		1 924			34 166		203	17 320		20 509			74 122
VIIb						355							355
VIIc		3 937	4 670	2 456	7 065	4 585	23 195	58 904		6 198			111 010
VIIg										1 692			1 692
VIIIa			1 865				3						1 868
VIIIc											20 637		20 637
VIIj				31			2					6	39
VIIk					562			5 786					6 348
IXa*									2 043				2 043
XII		6 707			3 045			300		4 487			14 539
XIVa					10								10
Grand Total	**248**	**58 354**	**8 831**	**5 044**	**120 202**	**8 776**	**35 686**	**225 995**	**2 043**	**149 650**	**20 637**	**173**	**635 639**

* Note: the value for IXa is summed across CN, CS and S subdivisions of this area.

Table 8.3.1.3. Blue whiting total landings of by quarter and area for 2009 in tonnes, as estimated by the Working Group.

Area	1	2	3	4	Grand Total
IIa	618	25 038	14 047	6 212	45 915
IIb			253	18	271
IIIa	9		122		131
IVa	3 984	12 979	2 725	2 546	22 234
IVb		15	5	2	22
Va			308	125	433
Vb	25 617	82 397		7 442	115 456
VIa	45 724	171 497		1 293	218 514
VIb	67 700	6 420	2		74 122
VIIb	355				355
VIIc	109 807	1 203			111 010
VIIg	1 692				1 692
VIIIa			2	1 866	1 868
VIIIc	4 151	7 479	6 312	2 695	20 637
VIIj	6	21	10	2	39
VIIk	6 348				6 348
IXa	444	782	709	108	2 043
XII	14 539				14 539
XIVa			10		10
Total	280 994	307 831	24 505	22 309	635 639

Table 8.3.1.2.1. Sampling intensity for blue whiting from the commercial catches by fishery in 2009.

Quarter	Fisheries	Directed	Mixed*	Southern	Total
1	No. of samples	124	0	44	168
	WG Catch	275 864	535	4 595	280 459
2	No. of samples	280	41	84	364
	WG Catch	286 774	12796	8 261	295 035
3	No. of samples	42	0	48	90
	WG Catch	14 423	2753	7 021	21 444
4	No. of samples	8	0	33	41
	WG Catch	18 166	1215	2 803	20 969
Total No. of samples		454	41	209	704
Total WG Catch		595 227	17 299	22 680	635 206
tonnes per sample		1 311	422	109	902

* 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 2009.

Country	Quarter	Landings (t)	No. Samples	No. Fish aged	No. Fish measured
Denmark	1	39	0	0	0
	2	0	0	0	0
	3	175	0	0	0
	4	34	0	0	0
	Total	248	0	0	0
Faroe Islands	1	32 687	8	579	1 028
	2	17 867	7	292	626
	3	837	1	12	12
	4	6 963	2	100	206
	Total	58 354	18	983	1 872
France	1	4 670	0	0	0
	2	2 296	0	0	0
	3	0	0	0	0
	4	1 865	0	0	0
	Total	8 831	0	0	0
Germany	1	3 413	0	0	0
	2	1 621	0	0	0
	3	10	0	0	0
	4	0	0	0	0
	Total	5 044	0	0	0
Iceland	1	58 067	27	1 295	2 134
	2	61 194	45	1 448	2 604
	3	466	0	0	0
	4	42	0	0	0
	Total	119 769	72	2 743	4 738
Ireland	1	6 924	6	606	1 268
	2	1 852	1	100	168
	3	0	0	0	0
	4	0	0	0	0
	Total	8 776	7	706	1 436
The Netherlands	1	23 207	63	1 625	13 030
	2	12 441	3	75	654
	3	12	0	0	0
	4	26	0	0	0
	Total	35 686	66	1 700	13 684
Norway	1	106 480	10	229	996
	2	114 658	165	673	7 596
	3	2 840	0	0	0
	4	2 017	0	0	0
	Total	225 995	175	902	8 592
Portugal	1	444	10	1 164	1 120
	2	782	12	1 185	1 374
	3	709	8	2 031	664
	4	108	7	1 725	412
	Total	2 043	37	6 105	3 570
Russia	1	40 790	10	280	1 244
	2	87 641	100	1 665	20 866
	3	12 836	41	700	9 434
	4	8 383	6	407	50
	Total	149 650	157	3 052	31 594
Spain	1	4 151	34	266	3 210
	2	7 479	72	190	5 590
	3	6 312	40	603	3 174
	4	2 695	26	842	1 940
	Total	20 637	172	1 901	13 914
UK/Scotland	1	122	0	0	0
	2	0	0	0	0
	3	0	0	0	0
	4	51	0	0	0
	Total	173	0	0	0
Grand Total		635 206	704	18 092	79 400

Table 8.3.1.3.1. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the directed fishery in 2009.

Length (cm)	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16	420				420
17	11 402	242			11 644
18	42 041	196			42 237
19	57 482	2 214			59 696
20	40 492	2 562	286	43	43 383
21	18 767	3 310	882	43	23 002
22	22 466	4 005	733	51	27 254
23	23 203	5 951	316	24	29 494
24	32 436	8 169	54	44	40 703
25	40 082	23 284	160	202	63 728
26	74 834	93 794	426	708	169 762
27	230 772	267 249	2 397	2 729	503 147
28	343 987	429 307	10 962	4 937	789 193
29	292 106	449 553	20 335	8 201	770 195
30	207 243	373 678	22 620	12 478	616 020
31	129 236	200 791	12 855	10 781	353 663
32	70 915	108 474	7 710	8 872	195 970
33	35 038	48 799	2 023	4 620	90 480
34	31 316	26 498	554	2 321	60 689
35	12 773	11 653	225	1 378	26 029
36	10 549	6 162	81	647	17 439
37	10 007	1 758	27	147	11 939
38	1 653	2 687	1	96	4 437
39	399	812	17	47	1 275
40	598	244	1	98	940
41	56	487	1	10	554
42	1	45		131	176
43				43	43
44	1	222		88	311
45					
46					
47					
48	174				174
49					
50					
TOTAL numbers	1 740 451	2 072 145	82 666	58 738	3 954 000

Table 8.3.1.3.2. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the mixed fishery in 2009.

Length (cm)	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13	1	54	11	3	69
14					
15	1	54	11	3	69
16					
17	11	434	91	23	559
18	15	596	126	32	769
19	8	325	68	18	419
20	10	272	58	22	362
21	10	379	80	20	489
22	19	545	117	42	723
23	43	984	212	97	1 336
24	106	2 195	475	244	3 020
25	173	3 513	762	399	4 847
26	259	5 912	1 274	591	8 036
27	388	8 065	1 748	889	11 090
28	504	9 197	2 008	1 169	12 878
29	425	8 138	1 772	983	11 318
30	458	9 440	2 046	1 053	12 997
31	277	7 366	1 577	623	9 843
32	197	5 130	1 100	443	6 870
33	110	2 891	619	246	3 866
34	81	1 753	379	184	2 397
35	60	1 796	383	133	2 372
36	56	1 901	403	122	2 482
37	23	708	151	51	933
38	21	654	140	48	863
39	11	380	80	23	494
40	15	596	126	32	769
41	8	218	47	19	292
42	1	54	11	3	69
43	3	108	23	6	140
44	1	54	11	3	69
45	1	1		3	5
46	1	54	11	3	69
47					
48	1	54	11	3	69
49					
50					
TOTAL numbers	3 298	73 821	15 931	7 533	100 583

Table 8.3.1.3.3. Blue whiting landings in numbers ('000) by length group (cm) and quarter for the southern fishery in 2009.

Length (cm)	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12				32	32
13	53	56	449	573	1 131
14		125	1 798	1 918	3 841
15	53	85	8 097	3 464	11 699
16	106	220	8 988	4 660	13 975
17	117	78	1 798	2 316	4 308
18	485	91	4 051	1 341	5 969
19	863	49	1 354	530	2 796
20	2 612	260		213	3 084
21	4 562	1 847	243	182	6 835
22	7 901	6 430	2 470	15	16 816
23	8 823	15 654	3 914	253	28 645
24	10 292	21 053	6 702	1 046	39 093
25	6 812	17 840	8 045	2 335	35 032
26	3 923	11 868	8 146	2 622	26 559
27	1 767	6 415	7 796	2 932	18 910
28	1 365	3 328	5 498	2 490	12 680
29	955	1 269	3 664	1 436	7 324
30	609	534	2 053	894	4 090
31	404	718	1 478	987	3 586
32	348	299	770	564	1 980
33	206	215	598	174	1 193
34	139	160	313	169	782
35	45	55	89	81	271
36	33	51	21	66	172
37	5	7			12
38		6			6
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
TOTAL numbers	52 477	88 714	78 336	31 293	250 821

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
2009	61	156	232	595	1596	1157	592	252	89	49	5.40

Table 8.3.1.4. Blue whiting landings (tonnes) from the main fisheries, 1988–2009, 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**
2009	46 629	533 996	22 387	**603 012**	32 627	**635 639**

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	0.117
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	0.115
2009	0.056	0.085	0.105	0.119	0.124	0.138	0.149	0.179	0.214	0.251	0.130
arith. mean	0.050	0.076	0.100	0.121	0.143	0.164	0.183	0.200	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 2004–2010.

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
2010	622	1290	627	931	2425	5258	4836	2608	468	131	19196

Total stock biomass

Year	2004	2005	2006	2007	2008	2009	2010
TSB (1000t)	11105	8004	10394	11193	7958	6070	3015

Table 8.3.5.2.1. Estimated blue whiting stock numbers from the International Norwegian Sea ecosystem survey, 2000–2010. 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
2010	0	0	0	107	165	68	98					448

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
2010	3.19	0.10

Table 8.4.1. Blue Whiting survey indices used in the assessment.

Fleet catch for CPUE data BLUE WHITING-COMBINED, 2010 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 ecosystem survey 2000-2010
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
1	0	0	#2010

##

International BW spawning stock survey 2004-2010
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
1	624	931	2426	5258	4838	2608	#2010

Table 8.4.1.1. Blue whiting SMS data exploration. SMS diagnostics output from the final run.

```
objective function (negative log likelihood):  -203.059
Number of parameters: 97
Number of observations used in likelihood: 455
Maximum gradient: 3.10405e-005
Akaike information criterion (AIC):   -212.119
Bayesian information criterion (BIC): 187.55

Number of observations used in the likelihood:
                            Catch    CPUE     S/R Stomach     Sum
                             290     136      29       0     455

objective function weight:
                          Catch  CPUE   S/R
                          1.00  1.00  0.01

unweighted objective function contributions (total):
                Catch    CPUE    S/R    Stom.  Penalty     Sum
             -196.9    -6.3    16.4     0.0 0.00e+000    -186.9

unweighted objective function contributions (per observation):
                Catch   CPUE     S/R   Stomachs
              -0.68   -0.05    0.56    0.00


contribution by fleet:
----------------------
Norw. Spawning Stock Surv.  total:  -0.931   mean:  -0.013
Intl. Surv. in Nord. Seas.  total:  23.517   mean:   1.120
IBWSSS                      total: -28.918   mean:  -0.689


F, Year effect:
---------------

1981:    1.000
1982:    0.812
1983:    0.933
1984:    1.223
1985:    1.373
1986:    1.833
1987:    1.402
1988:    1.377
1989:    1.807
1990:    1.762
1991:    0.856
1992:    0.753
1993:    0.776
1994:    0.683
1995:    0.905
1996:    1.213
1997:    1.215
1998:    1.685
1999:    1.000
2000:    1.290
2001:    1.148
2002:    1.087
2003:    1.223
2004:    1.356
2005:    1.145
2006:    0.984
2007:    1.045
2008:    1.140
2009:    0.957

F, age effect:
--------------
                1       2       3       4       5       6       7       8       9
10
1981-1998:   0.068   0.099   0.172   0.223   0.262   0.330   0.390   0.413   0.413
0.413
1999-2009:   0.067   0.085   0.211   0.397   0.469   0.524   0.486   0.534   0.534
0.534
```

```
Exploitation pattern (scaled to mean F=1)
-----------------------------------------
                1      2      3      4      5      6      7   8-10
1981-1998:  0.246  0.361  0.625  0.810  0.951  1.199  1.415  1.498
1999-2009:  0.160  0.205  0.506  0.951  1.124  1.255  1.164  1.279

sqrt(catch variance) ~ CV:
--------------------------

 1       0.468
 2       0.367
 3-6     0.173
 7-10    0.470


Survey catchability:
--------------------          age 1    age 2    age 3    age 4    age 5    age
6-8    Norw. Spawning Stock Surv.                         1.727    2.209    1.260
1.260     Intl. Surv. in Nord. Seas.    0.232    0.215
IBWSSS                                                   1.148    1.902    2.544
2.544

sqrt(Survey variance) ~ CV:
---------------------------    age 1    age 2    age 3    age 4    age 5    age
6-8
 Norw. Spawning Stock Surv.                               0.45      0.45      0.67
0.67
 Intl. Surv. in Nord. Seas.     1.41     1.41
 IBWSSS                                                    0.30      0.30      0.30
0.30

Average F:
----------

1981:    0.276
1982:    0.224
1983:    0.257
1984:    0.337
1985:    0.378
1986:    0.505
1987:    0.386
1988:    0.380
1989:    0.498
1990:    0.486
1991:    0.236
1992:    0.207
1993:    0.214
1994:    0.188
1995:    0.249
1996:    0.334
1997:    0.335
1998:    0.464
1999:    0.417
2000:    0.538
2001:    0.479
2002:    0.454
2003:    0.511
2004:    0.566
2005:    0.478
2006:    0.411
2007:    0.436
2008:    0.476
2009:    0.399


Recruit-SSB                                      alfa       beta        recruit s2
recruit s
Bl. whiting   Geometric mean:                    16.291                      1.184
1.088
```

Table 8.4.1.2 Blue whiting : Fishing mortality at age by 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	0.099	0.172	0.223	0.262	0.330	0.390	0.413	0.413	0.413	0.276
1982	0.055	0.081	0.140	0.181	0.213	0.268	0.317	0.335	0.335	0.335	0.224
1983	0.063	0.093	0.161	0.208	0.244	0.308	0.364	0.385	0.385	0.385	0.257
1984	0.083	0.122	0.210	0.273	0.320	0.404	0.477	0.505	0.505	0.505	0.337
1985	0.093	0.137	0.236	0.307	0.360	0.454	0.536	0.567	0.567	0.567	0.378
1986	0.124	0.182	0.316	0.409	0.480	0.606	0.715	0.757	0.757	0.757	0.505
1987	0.095	0.139	0.241	0.313	0.367	0.463	0.547	0.579	0.579	0.579	0.386
1988	0.093	0.137	0.237	0.308	0.361	0.455	0.537	0.569	0.569	0.569	0.380
1989	0.122	0.180	0.311	0.404	0.473	0.597	0.705	0.746	0.746	0.746	0.498
1990	0.119	0.175	0.303	0.394	0.462	0.582	0.687	0.728	0.728	0.728	0.486
1991	0.058	0.085	0.147	0.191	0.224	0.283	0.334	0.353	0.353	0.353	0.236
1992	0.051	0.075	0.130	0.168	0.197	0.249	0.294	0.311	0.311	0.311	0.207
1993	0.053	0.077	0.134	0.173	0.203	0.256	0.303	0.320	0.320	0.320	0.214
1994	0.046	0.068	0.118	0.152	0.179	0.226	0.266	0.282	0.282	0.282	0.188
1995	0.061	0.090	0.156	0.202	0.237	0.299	0.353	0.374	0.374	0.374	0.249
1996	0.082	0.121	0.209	0.271	0.318	0.401	0.473	0.501	0.501	0.501	0.334
1997	0.082	0.121	0.209	0.271	0.318	0.401	0.474	0.502	0.502	0.502	0.335
1998	0.114	0.168	0.290	0.376	0.441	0.557	0.657	0.696	0.696	0.696	0.464
1999	0.067	0.085	0.211	0.397	0.469	0.524	0.486	0.534	0.534	0.534	0.417
2000	0.086	0.110	0.273	0.512	0.605	0.675	0.627	0.688	0.688	0.688	0.538
2001	0.077	0.098	0.243	0.456	0.538	0.601	0.558	0.613	0.613	0.613	0.479
2002	0.073	0.093	0.230	0.431	0.510	0.569	0.528	0.580	0.580	0.580	0.454
2003	0.082	0.105	0.259	0.485	0.574	0.641	0.594	0.653	0.653	0.653	0.511
2004	0.091	0.116	0.287	0.538	0.636	0.710	0.659	0.724	0.724	0.724	0.566
2005	0.077	0.098	0.242	0.454	0.537	0.600	0.556	0.611	0.611	0.611	0.478
2006	0.066	0.084	0.208	0.391	0.462	0.516	0.478	0.525	0.525	0.525	0.411
2007	0.070	0.089	0.221	0.415	0.490	0.547	0.508	0.558	0.558	0.558	0.436
2008	0.076	0.097	0.241	0.452	0.534	0.597	0.554	0.608	0.608	0.608	0.476
2009	0.064	0.082	0.202	0.380	0.449	0.501	0.465	0.511	0.511	0.511	0.399

Table 8.4.1.3 Blue whiting : Stock numbers (millions) and mean age in the stock as 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	3266	3766	4532	2461	2340	2205	1841	1771	1504	3037	4.87
1982	4093	2499	2791	3123	1612	1474	1297	1021	960	2460	4.56
1983	14535	3172	1887	1987	2133	1067	923	774	598	2002	3.08
1984	18127	11172	2367	1316	1321	1368	642	525	431	1448	2.45
1985	10466	13663	8100	1570	820	785	748	326	260	929	2.57
1986	8562	7808	9758	5236	946	468	408	358	151	552	2.76
1987	8966	6192	5328	5828	2847	479	209	164	138	270	2.78
1988	6676	6676	4410	3427	3488	1614	247	99	75	187	2.94
1989	9372	4980	4767	2849	2063	1991	838	118	46	122	2.79
1990	24739	6790	3407	2860	1558	1052	897	339	46	65	2.02
1991	8691	17978	4666	2059	1579	804	481	369	134	44	2.38
1992	5660	6715	13518	3296	1393	1033	496	282	212	102	2.89
1993	5341	4404	5101	9722	2281	936	660	303	169	189	3.29
1994	5757	4149	3338	3655	6693	1524	593	399	180	213	3.49
1995	8345	4501	3174	2430	2569	4583	996	372	246	243	3.33
1996	23781	6427	3368	2224	1625	1659	2782	573	210	276	2.39
1997	45472	17936	4664	2238	1389	969	910	1419	284	241	1.85
1998	28649	34290	13014	3098	1397	827	531	464	704	260	2.13
1999	24102	20928	23745	7973	1741	736	388	225	189	394	2.39
2000	38710	18455	15730	15737	4389	892	357	195	108	280	2.33
2001	59250	29071	13532	9806	7723	1963	372	156	80	160	2.08
2002	54901	44920	21576	8692	5090	3691	881	174	69	106	2.15
2003	51438	41793	33513	14039	4623	2503	1710	425	80	81	2.31
2004	40514	38802	30820	21187	7074	2133	1080	773	181	68	2.52
2005	22607	30291	28291	18946	10128	3067	858	458	307	99	2.84
2006	5635	17142	22487	18183	9846	4847	1378	403	203	180	3.42
2007	2431	4319	12902	14953	10073	5081	2370	699	195	186	4.06
2008	1759	1856	3234	8470	8086	5052	2407	1168	328	178	4.63
2009	694*	1334	1379	2081	4412	3880	2277	1133	520	226	5.19
2010		533**	1007	922	1165	2306	1924	1171	556	366	

***substituted by 1759 in forecast**

**** substituted by 1350 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.

Year	Recruits (million)	TSB (tonnes)	SSB (tonnes)	Yield- SOP (tonnes)	Mean F ages 3-7
1981	3266	3416910	2941620	922980	0.276
1982	4093	2854080	2425600	550643	0.224
1983	14535	2831560	1975980	553344	0.257
1984	18127	2902640	1721480	615569	0.337
1985	10466	3134440	1987460	678214	0.378
1986	8562	3247810	2296380	847145	0.505
1987	8966	2932370	1984250	654718	0.386
1988	6676	2605620	1788070	552264	0.380
1989	9372	2624510	1711380	630316	0.498
1990	24739	2963370	1541930	558128	0.486
1991	8691	3547730	1977740	364008	0.236
1992	5660	3650940	2642320	474592	0.207
1993	5341	3427890	2567540	475198	0.214
1994	5757	3266990	2486790	457696	0.188
1995	8345	3225650	2306970	505176	0.249
1996	23781	3465440	2152840	621104	0.334
1997	45472	5064690	2237090	639681	0.335
1998	28649	6214410	3207220	1131950	0.464
1999	24102	6735100	3876780	1261030	0.417
2000	38710	7495860	4168130	1412450	0.538
2001	59250	9034050	4550790	1771810	0.479
2002	54901	10775100	5546270	1556950	0.454
2003	51438	11840200	6836070	2365320	0.511
2004	40514	10716100	6771820	2400790	0.566
2005	22607	9049390	6210260	2018340	0.478
2006	5635	7694430	5932350	1956240	0.411
2007	2431	5476240	4631470	1612270	0.436
2008	1759	3735480	3255380	1251850	0.476
2009	694*	2340630	2095890	634978	0.399
2010			1339320		
arith. mean	18708	5043780	3172240	1016371	0.383
geo. mean	11366				

*Substituted by 1759 in prediction

Table 8.6.1 Deterministic and stochastic estimates of F reference points for the Blue Whiting stock (*=poorly defined).

	SRR Fmsy			YPR	
	Ricker	Beverton-Holt	Hockeystick	F01	Fmax
Deterministic	0.20	0.31	0.37	0.20	1.57*
Stochastic median	0.22	0.16	0.26	0.20	1.29*
CV	0.75	0.68	0.75	0.34	0.51

Table 8.7.1.1 Blue whiting 1 group RCT3 Input.

```
BLUE WHITING DATA 1 GROUP
2  30  2
'YEAR'     'VPA'   'Barents_idx'   'IES_idx'
1980   3266       -11              -11
1981   4093        0.010144928     -11
1982   14535       0.456467662     -11
1983   18127       2.473336705     -11
1984   10466       0.772955488     -11
1985   8562        0.893334361     -11
1986   8966        0.020615577     -11
1987   6676        0.96928982      -11
1988   9372        0.175609756     -11
1989   24739       16.37007012     -11
1990   8691        2.105831953     -11
1991   5660        0.056229538     -11
1992   5341        0.005464481     -11
1993   5757        -11             -11
1994   8345        0.100640739     -11
1995   23781       5.812809481     -11
1996   45472       175.2618555     -11
1997   28649       0.209994558     -11
1998   24102       0.70887144      -11
1999   38710       120.9015612        48927
2000   59250       233.7569233        85772
2001   54901       9.6862936          15251
2002   51438       15.1463275         35688
2003   40514       36.73747791        49254
2004   22607       90.23164366        54660
2005   5635        3.524569802        570
2006   2431        0.160115526        21
2007   1759        0.013165266        29
2008   694          0                 0
2009   -11         0.1                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 30 years : 1980 - 2009

Regression type = C

Tapered time weighting applied

power = 3 over 20 years

Survey weighting not applied

Final estimates shrunk towards mean

Minimum S.E. for any survey taken as .20

Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

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
Barent	.86	7.74	1.30	.506	26	.00	7.74	1.564	.135
IES_id	.44	6.03	.45	.921	9	.00	6.03	.710	.653
						VPA Mean =	9.75	1.245	.213

Yearclass = 2009

	I-----------Regression----------I					I-----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Barent	1.01	7.29	1.46	.548	27	.10	7.38	1.742	.086
IES_id	.41	6.28	.42	.950	10	.00	6.28	.572	.801
						VPA Mean =	9.48	1.526	.112

Year Class Prediction	**Weighted Average**	**Log WAP**	**Int Std**	**Ext Std Error**	**Var Ratio Error**	**VPA**	**Log VPA**
2000	34044	10.44	0.62	1.1	3.17	59251	10.99
2001	19654	9.89	0.57	0.16	0.08	54902	10.91
2002	24332	10.1	0.63	0.18	0.08	51439	10.85
2003	32981	10.4	0.65	0.32	0.24	40514	10.61
2004	41437	10.63	0.61	0.43	0.49	22608	10.03
2005	22695	10.03	0.63	0.77	1.5	5635	8.64
2006	7143	8.87	0.64	1.05	2.71	2431	7.8
2007	3889	8.27	0.55	0.73	1.76	1760	7.47
2008	1156	7.05	0.57	1.07	3.47	695	6.54
2009	838	6.73	0.51	0.73	2.01		

Table 8.7.2.1. Blue Whiting input to short term projection.

Age	Weights in the Stock	Weights in the catch	Proportion Mature	Exploitation Pattern	Stock Numbers 2010
1	0.054	0.054	0.11	0.064	1759061
2	0.074	0.074	0.40	0.082	1350912
3	0.099	0.099	0.82	0.202	1006690
4	0.109	0.109	0.86	0.380	921984
5	0.120	0.120	0.91	0.449	1165490
6	0.134	0.134	0.94	0.501	2306190
7	0.147	0.147	1	0.465	1924460
8	0.169	0.169	1	0.511	1171240
9	0.196	0.196	1	0.511	556378
10	0.236	0.236	1	0.511	366418

Table 8.7.2.2. Blue Whiting. Short term projection. Biomass and catch in tonnes

2010							
Biomass	SSB	FMult	FBar	Landings			
1520700	1313230	1.27	0.51	548000			
Rationale	Catch(2011)	Basis	F(2011)	SSB(2011)	SSB(2012)	%SSB change	%TAC change
	0	F=0	0	795660	839885	6	-100
	32206	F2009*0.1	0.04	795660	808075	2	-94
	40138	Management plan	0.05	795660	800252	1	-93
	50719	MSY Framework	0.06	795660	789822	-1	-91
	77955	F2009*0.25	0.10	795660	763013	-4	-86
	118457	ICES MSY transition	0.16	795660	723252	-9	-78
	134804	FMSY	0.18	795660	707241	-11	-75
	147887	F2009*0.50	0.20	795660	694444	-13	-73
	210710	F2009*0.75	0.30	795660	633212	-20	-62
	222920	F=Fpa	0.32	795660	621356	-22	-59
	222920	EC MSY transition	0.32	795660	621356	-22	-59
	267121	Fsq=F2009	0.40	795660	578574	-27	-51
Rationale	Catch(2012)	Basis	F(2012)	SSB(2012)	SSB(2013)	%SSB change	
	0	F=0	0	839885	951846	13	
	32731	F2009*0.1	0.04	808075	890283	10	
	40365	Management plan	0.05	800252	875564	9	
	50288	MSY Framework	0.06	789822	856198	8	
	74465	F2009*0.25	0.10	763013	807770	6	
	106812	ICES MSY transition	0.16	723252	739493	2	
	118659	FMSY	0.18	707241	713190	1	
	127646	F2009*0.50	0.20	694444	692652	0	
	164742	F2009*0.75	0.30	633212	600323	-5	
	170806	F=Fpa	0.32	621356	583570	-6	
	189703	Fsq=F2009	0.40	578574	526099	-9	
	197498	EC MSY transition	0.44	556937	498791	-10	

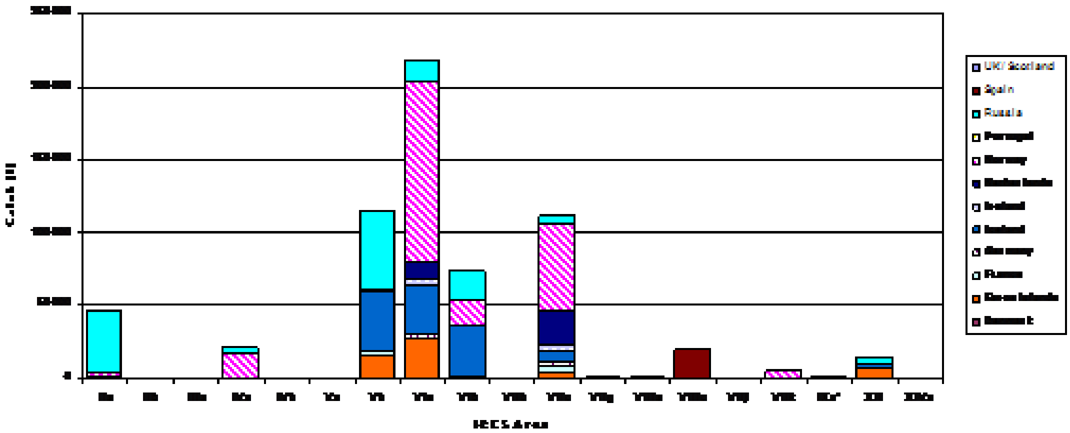


Figure 8.2.1. Blue whiting landings (tonnes) in 2009 presented by ICES area and country.

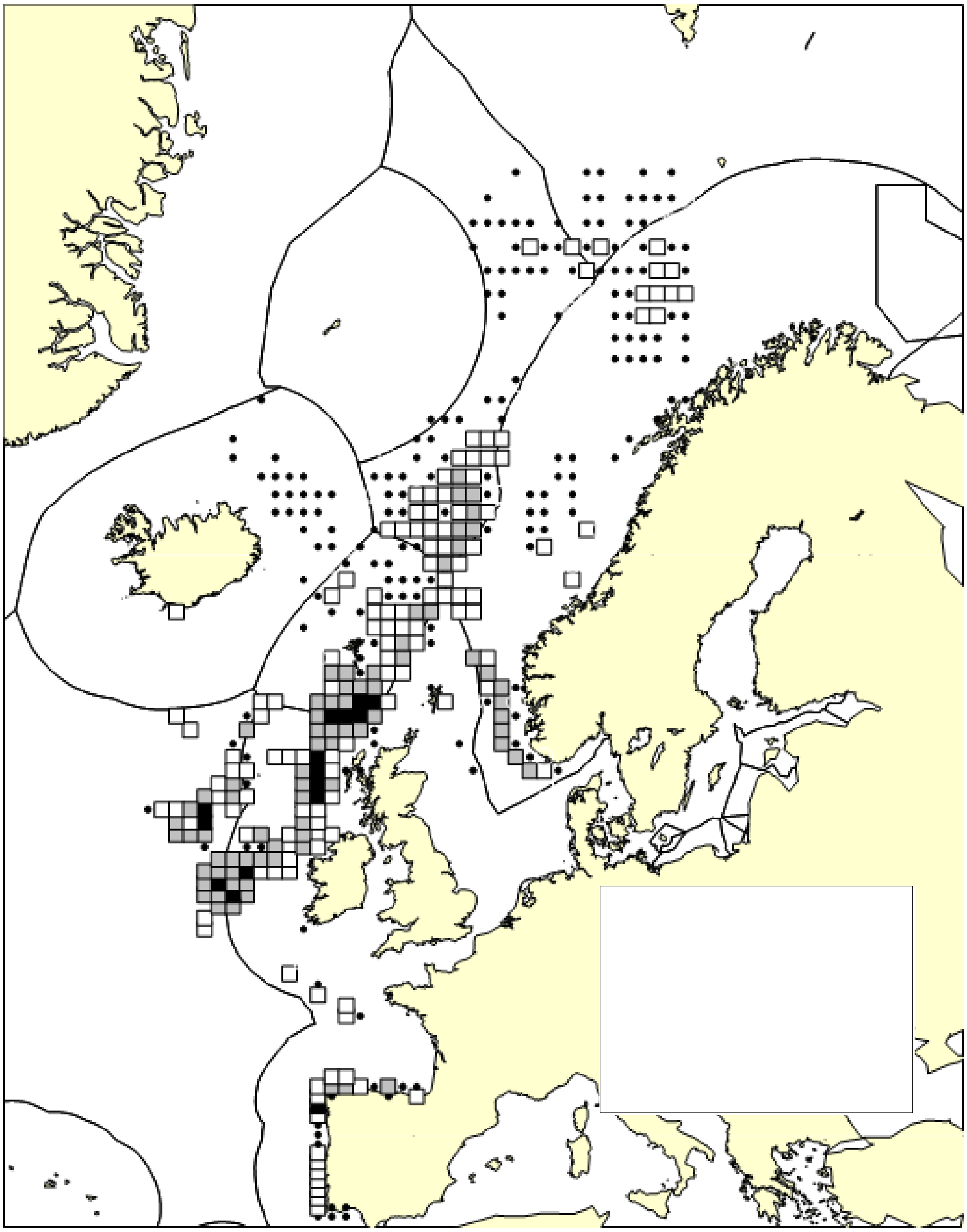
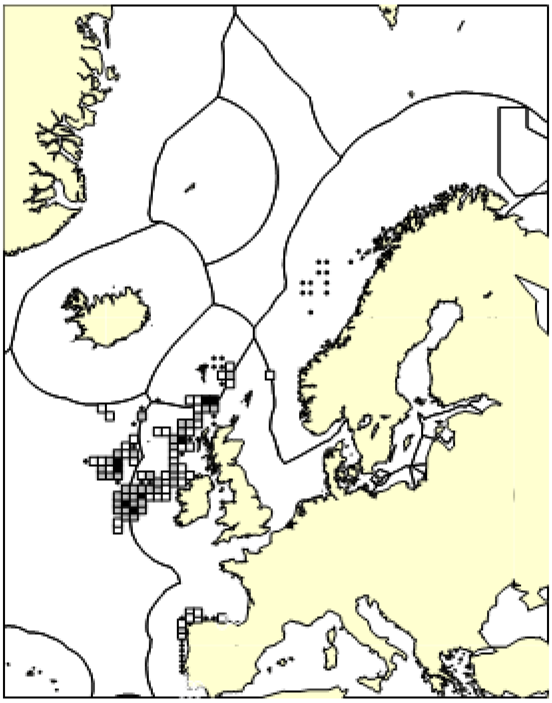
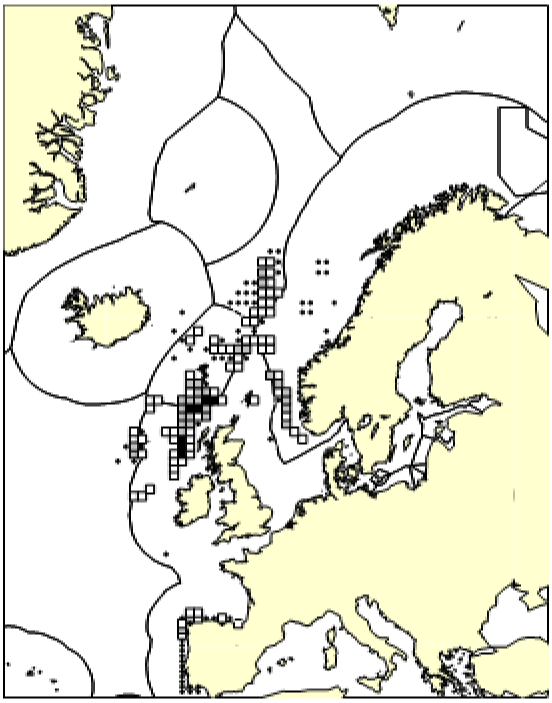


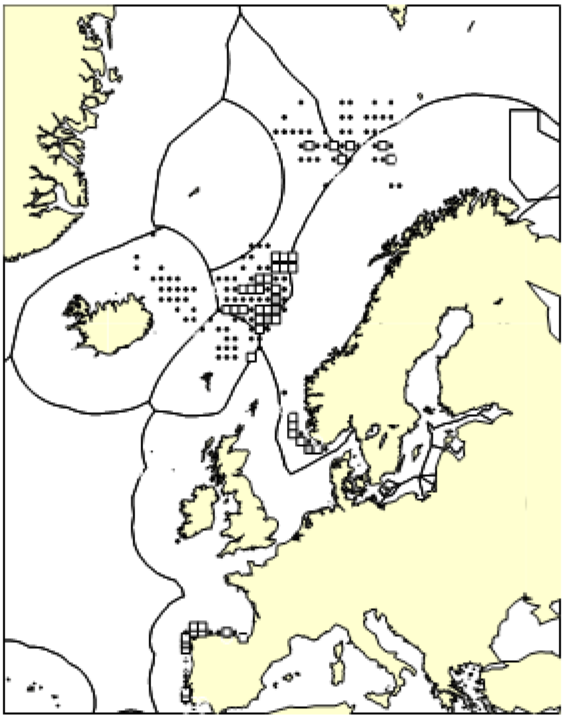
Figure 8.2.2. Total blue whiting catches (t) in 2008 by ICES rectangle. Catches below 10 t are not shown on the map.



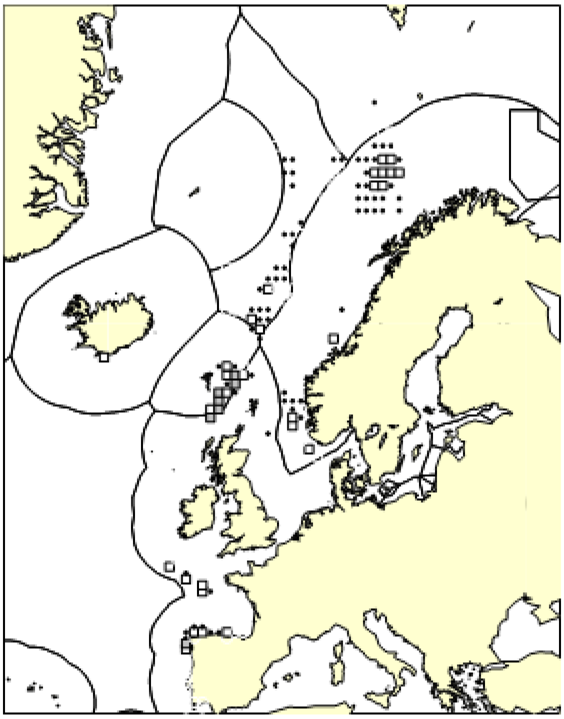
Quarter 1



Quarter 2



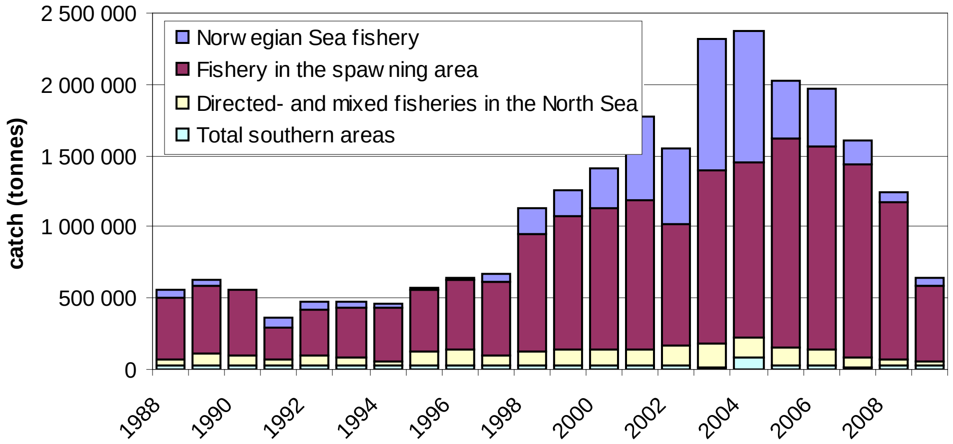
Quarter 3



Quarter 4

Figure 8.2.3. Blue whiting total 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.

A



B

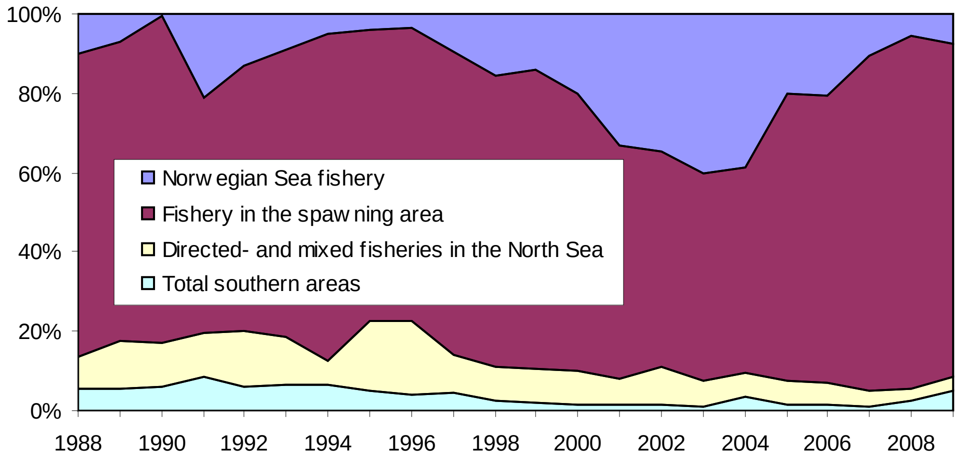


Figure 8.3.1.1. (A) Annual catch (tonnes) of blue whiting by fishery sub-areas from 1998-2009 and (B) the percentage contribution to the overall catch by fishery sub-area over the same period.

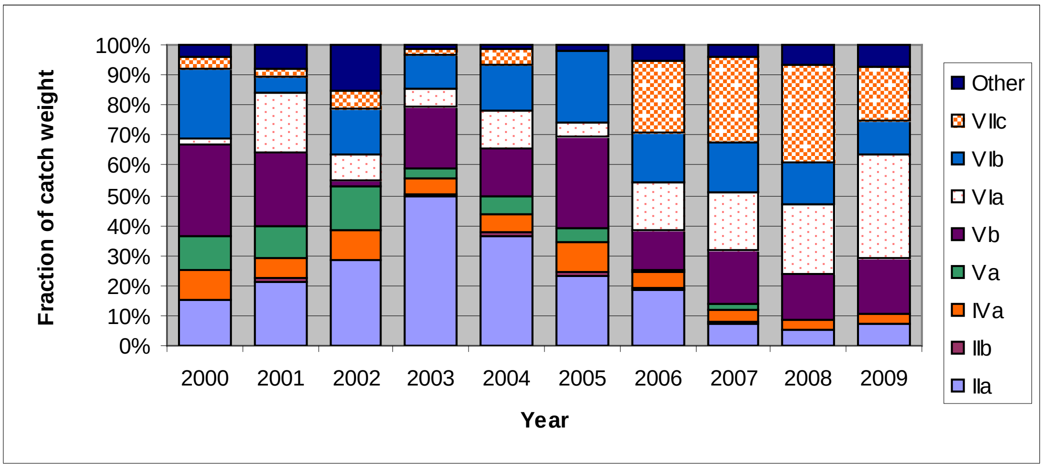


Figure 8.3.1.2. Distribution of total landings of blue whiting by ICES sub-area.

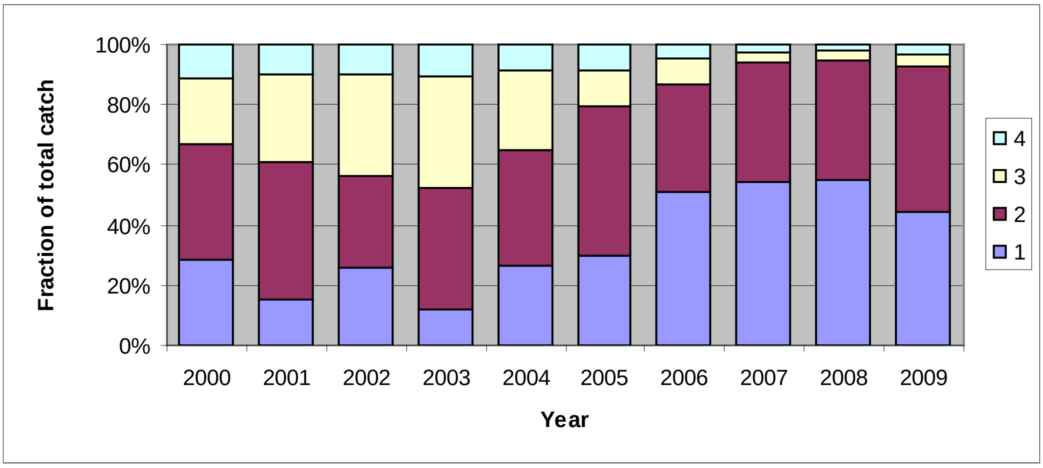


Figure 8.3.1.3. Distribution of total landings of blue whiting by quarter.

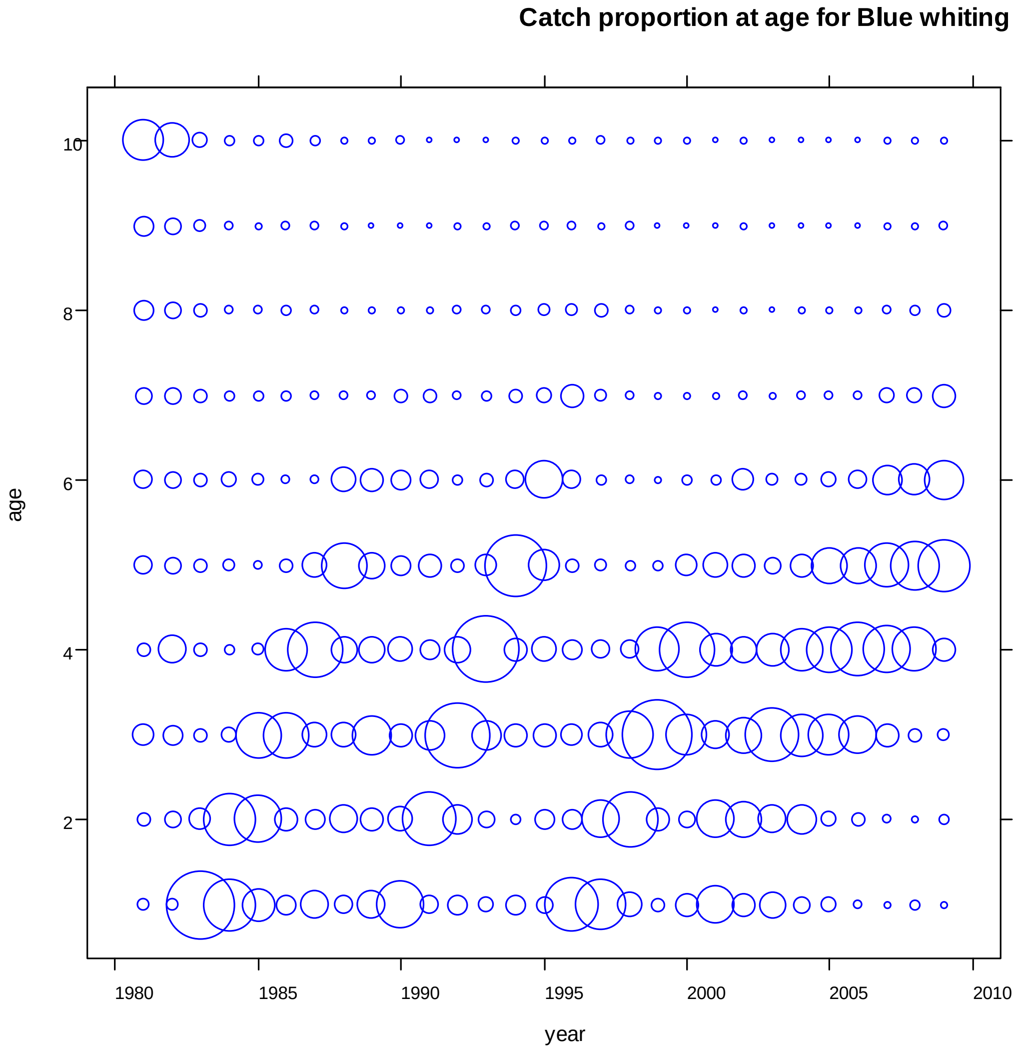


Figure 8.3.1.3.1 Catch proportion at age of blue whiting in the International catch from 1981-2009.

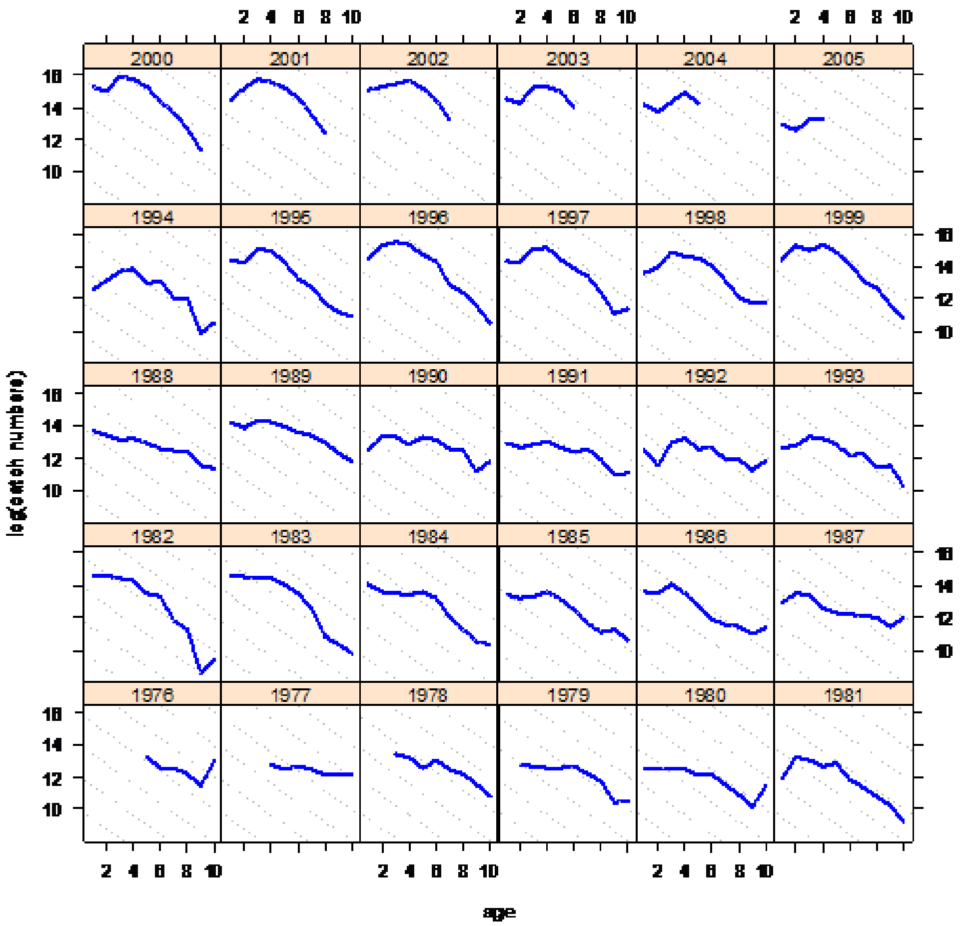


Figure 8.3.1.3.2. Blue whiting. Age disaggregated blue whiting catch (numbers) plotted on log scale. The labels behind each panel indicate year classes. The grey dotted lines correspond to *Z*=0.6.

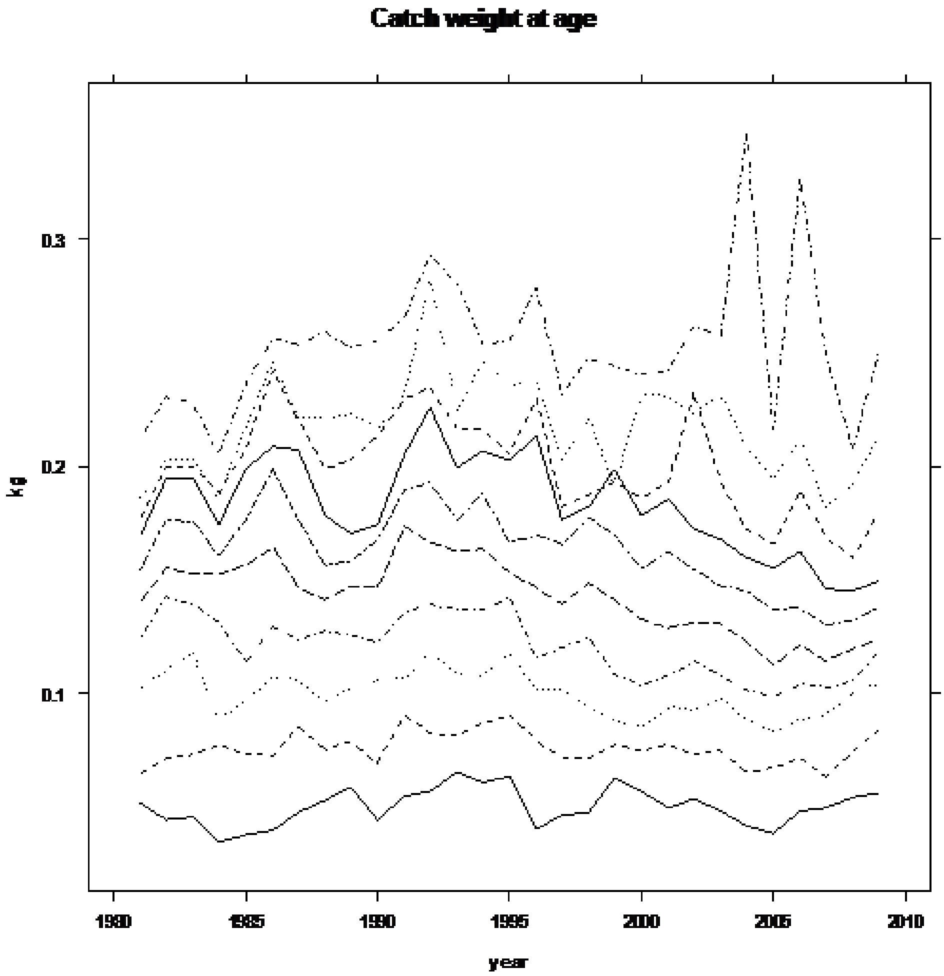


Figure 8.3.3.1. Mean catch weight (kg) at age of blue whiting by year.

A B

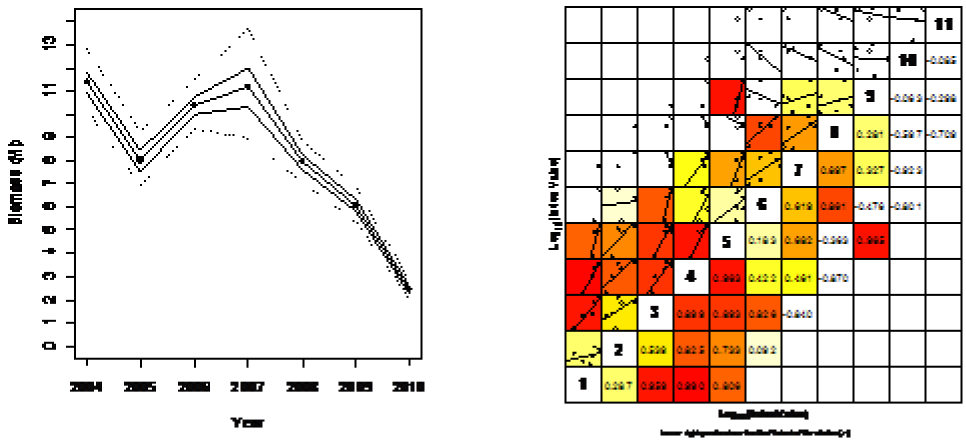
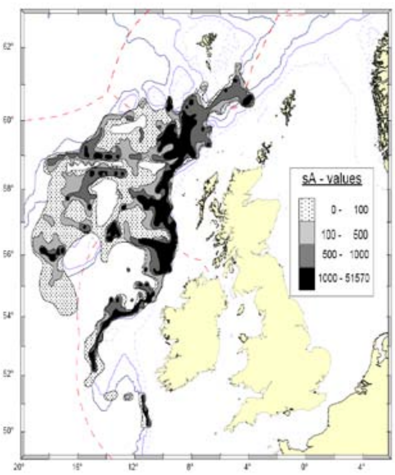
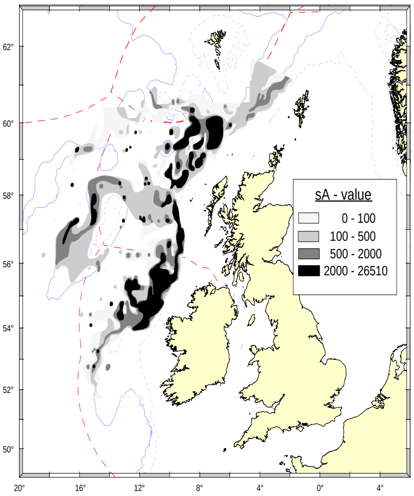


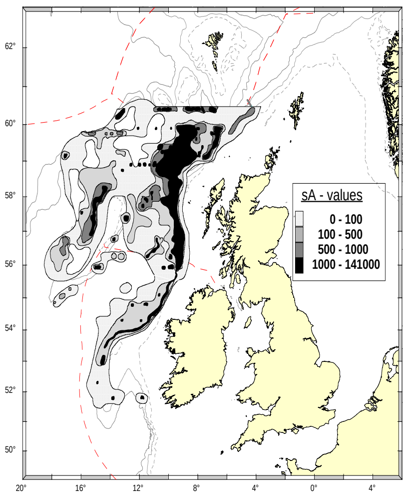
Figure 8.3.5.1.1. (A) Approximate 50% and 95% confidence limits for blue whiting biomass estimates. The confidence limits are based on the assumption that confidence limits for annual estimates of mean acoustic density can be translated to confidence limits of biomass estimates by expressing them as 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.



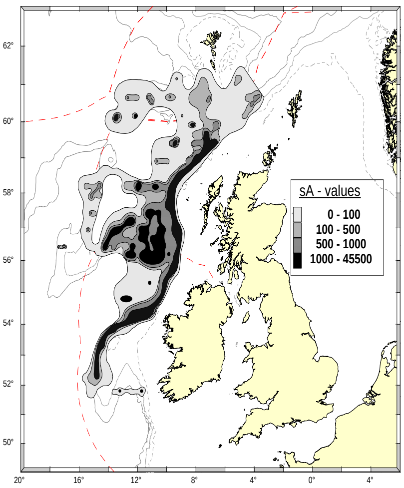
2007



2008



2009



2010

Figure 8.3.5.1.2. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the spawning survey in spring 2007-2010.

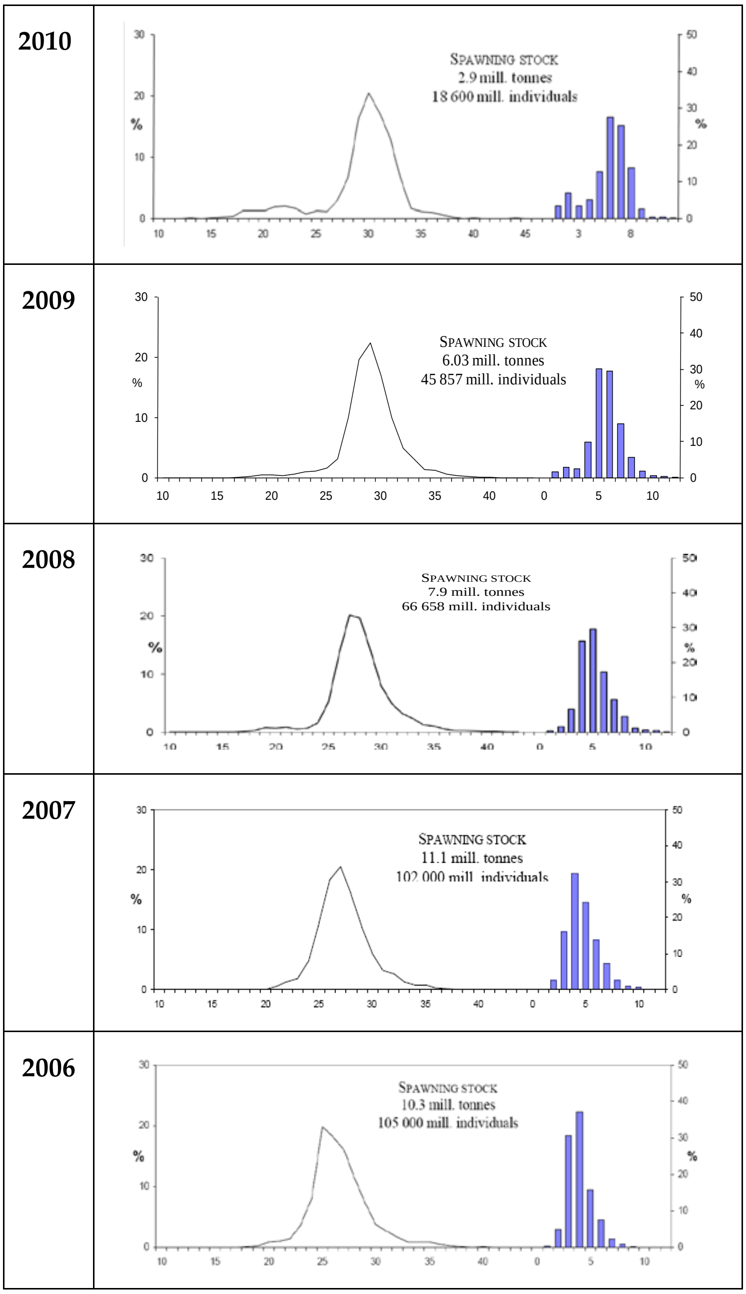


Figure 8.3.5.1.3. Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2006 (lower panel) to 2010 (upper panel).

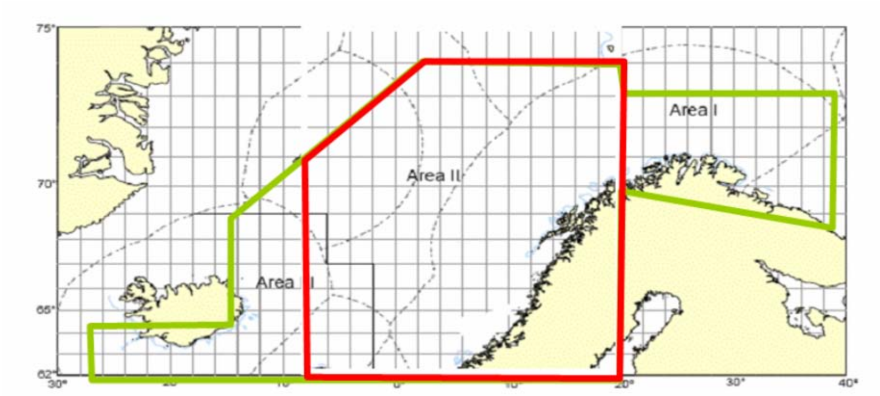


Figure 8.3.5.2.1. Areas defined for acoustic estimation of blue whiting and Norwegian spring spawning herring in the International Ecosystem survey in the Nordic Seas. The dark red box in the middle represents the standard area (8°W–20°E and north of 63°N) of which blue whiting data is used for assessment. The outer green box represents the total survey area.

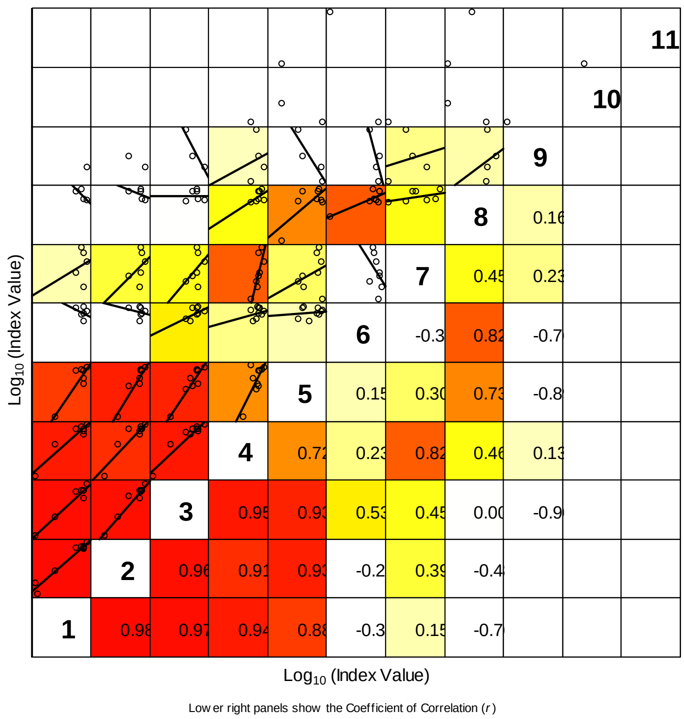


Figure 8.3.5.2.2. Internal consistency within the International Ecosystem survey in the Nordic Seas for blue whiting. The upper left part of the plots shows the relationship between log index-at-age within a cohort. Linear regression line shows the best fit to the log-transformed indices. The lower-right 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.

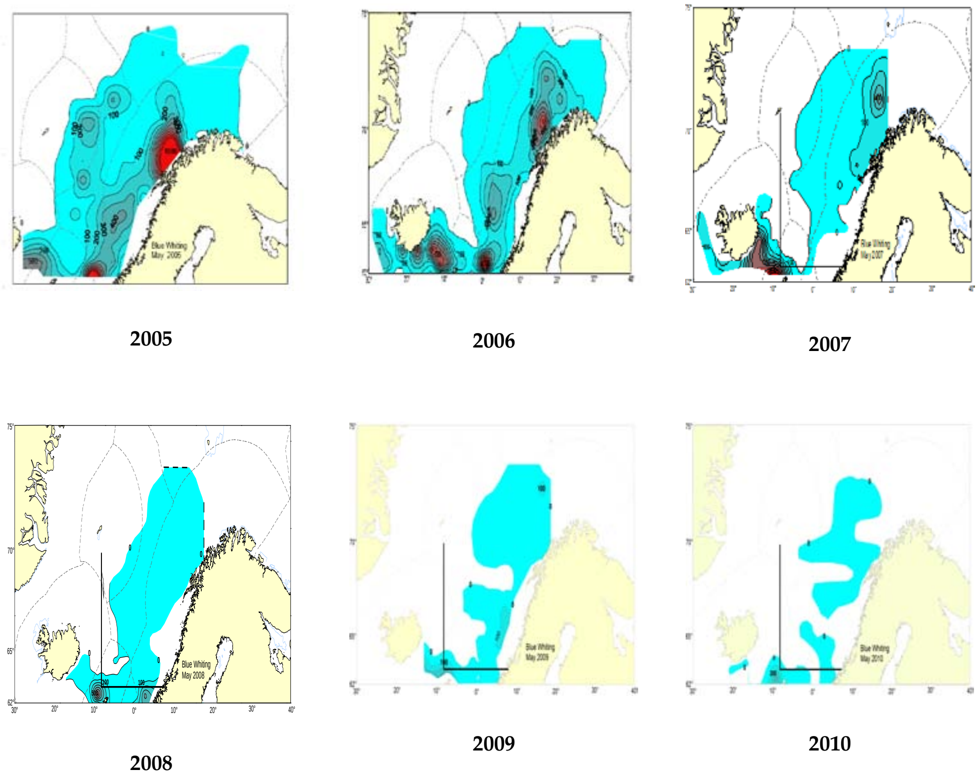


Figure 8.3.5.2.3. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the International Ecosystem survey in the Nordic Seas in spring 2005–2010.

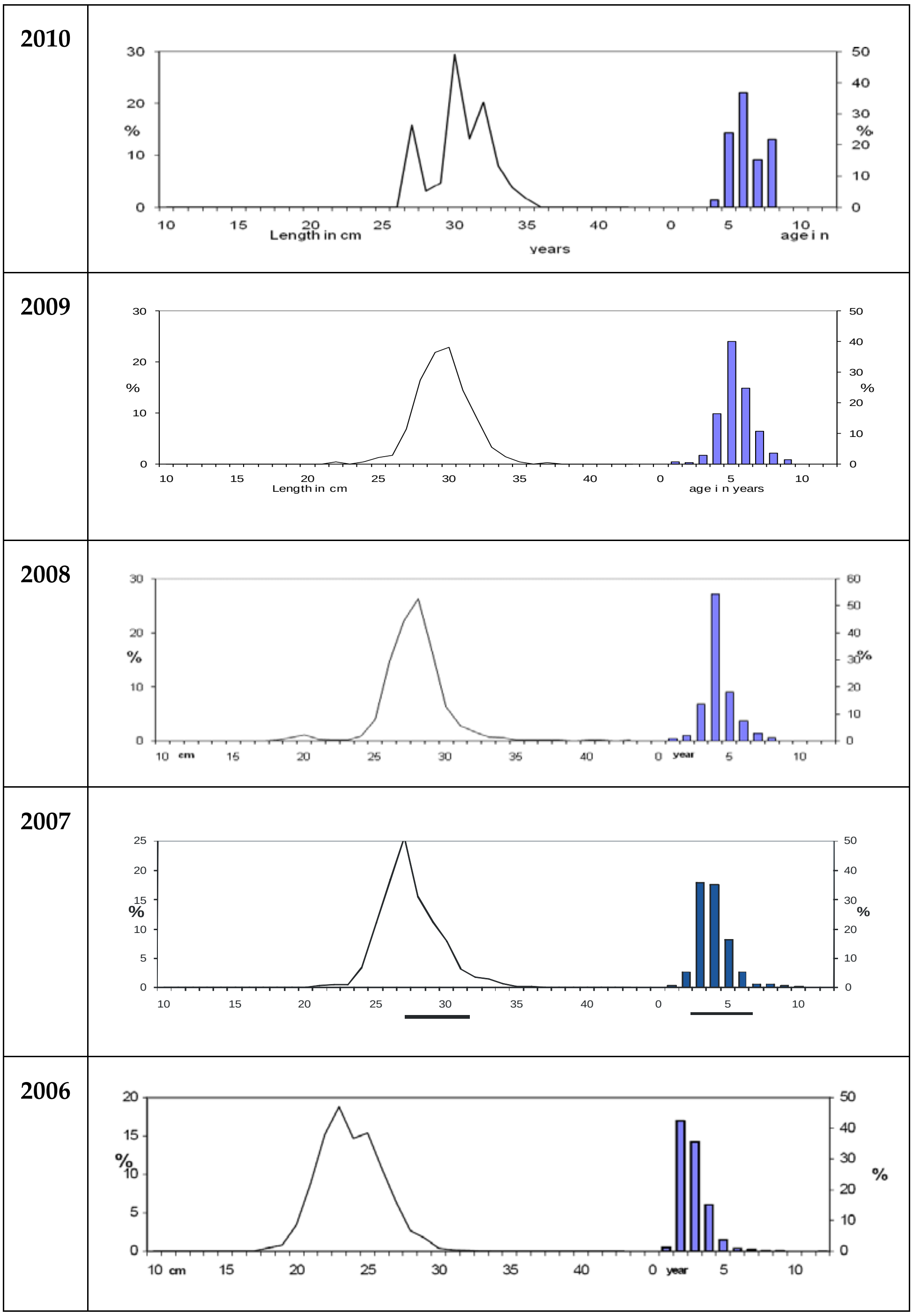


Figure 8.3.5.2.4. Estimated length (line) and age (bar) distributions of blue whiting in the International Ecosystem Survey in the Nordic Seas in May–June for 2006-2010 based on the "standard survey area" between 8°W-20°E and north of 63°N.

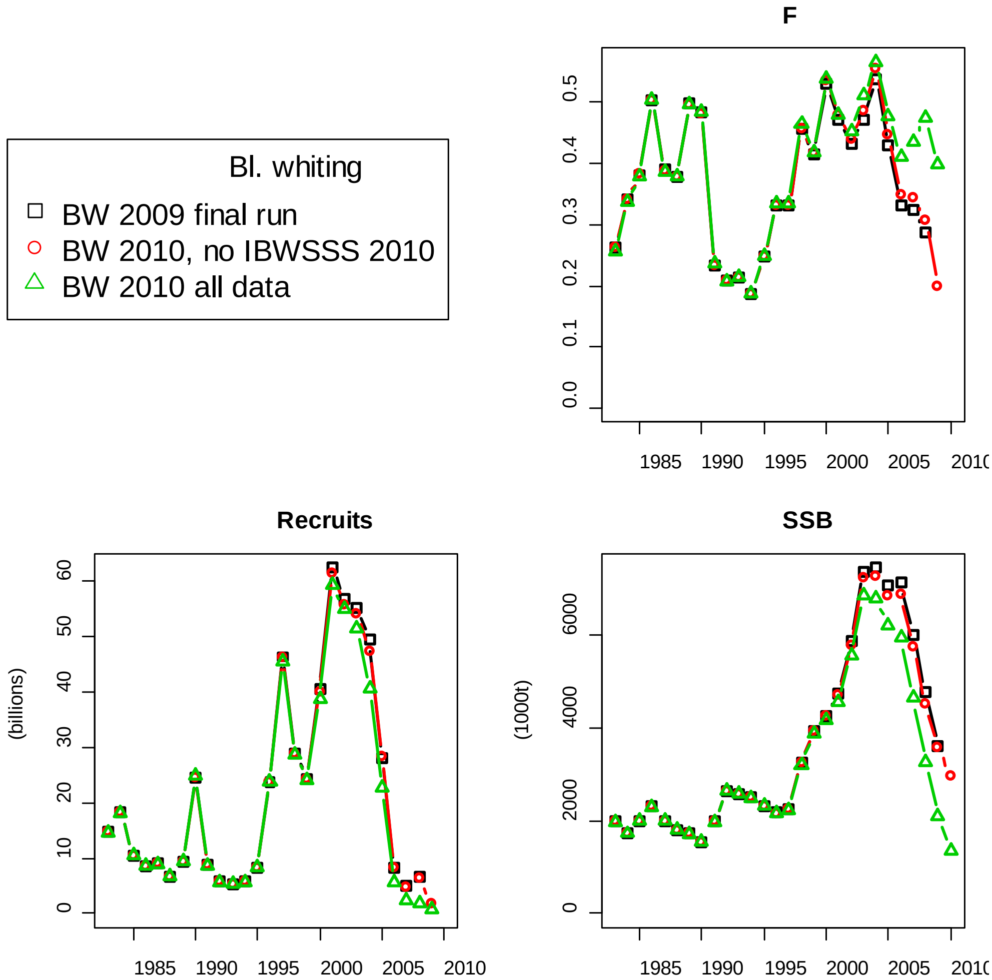


Figure 8.4.1.1 Blue Whiting SMS data exploration. Comparison of SMS run. The final 2009 assessment is compared with the 2010 assessment with and without data from the 2010 IBWSSS.

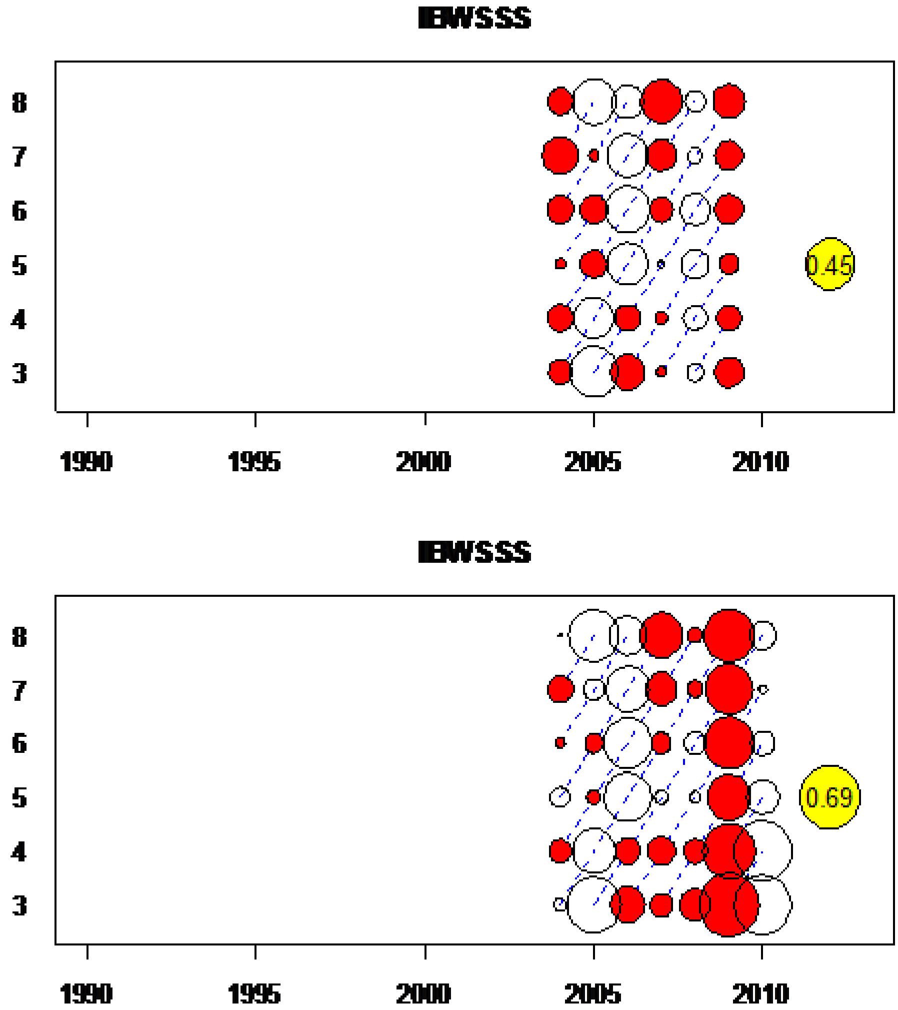


Figure 8.4.1.2 Blue Whiting SMS data exploration. Residuals from the IBWSSS survey for the without the use of the 2010 data (upper panel) and with the 2010 IBWSS data (lower panel).

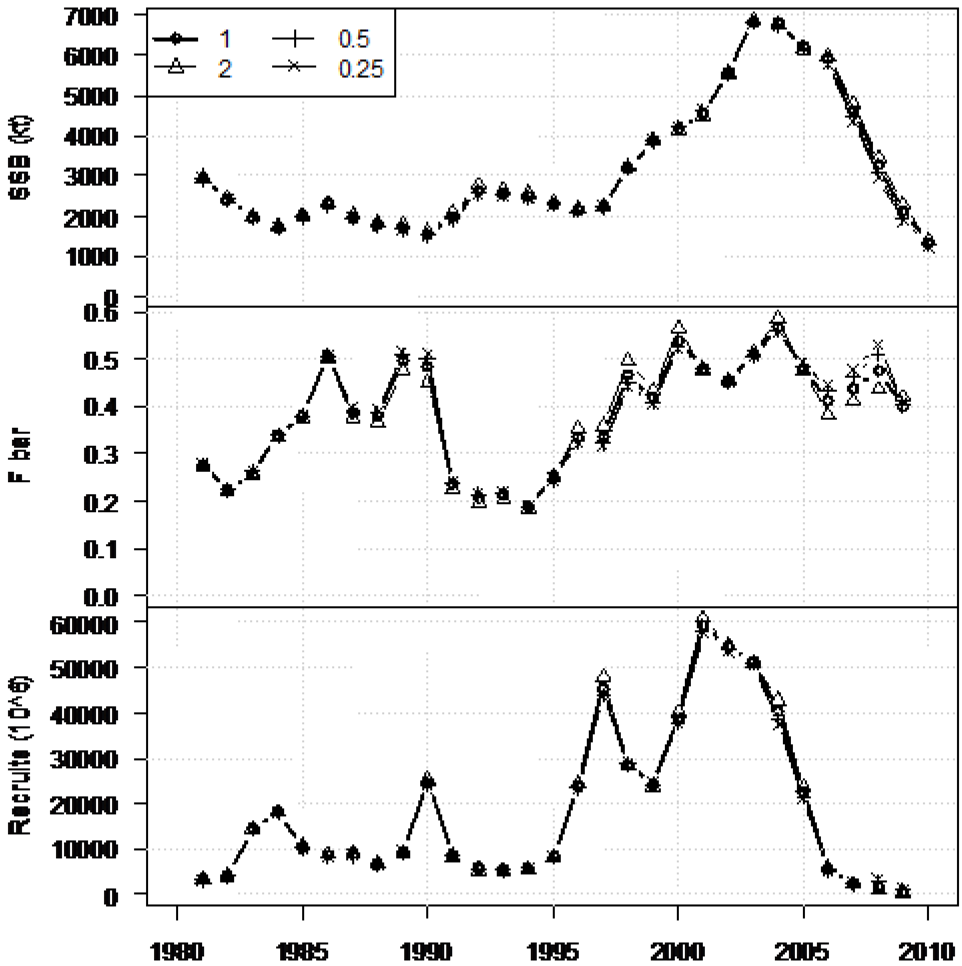


Figure 8.4.1 3. Blue Whiting SMS data exploration, 2010 all data used configuration: effect on SSB (top panel), mean fishing mortality *F* bar (ages 3–7; middle panel) and estimated recruitment (bottom panel) of changing the a priori weighting on the survey observations. The *a priori* weight on catch 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.

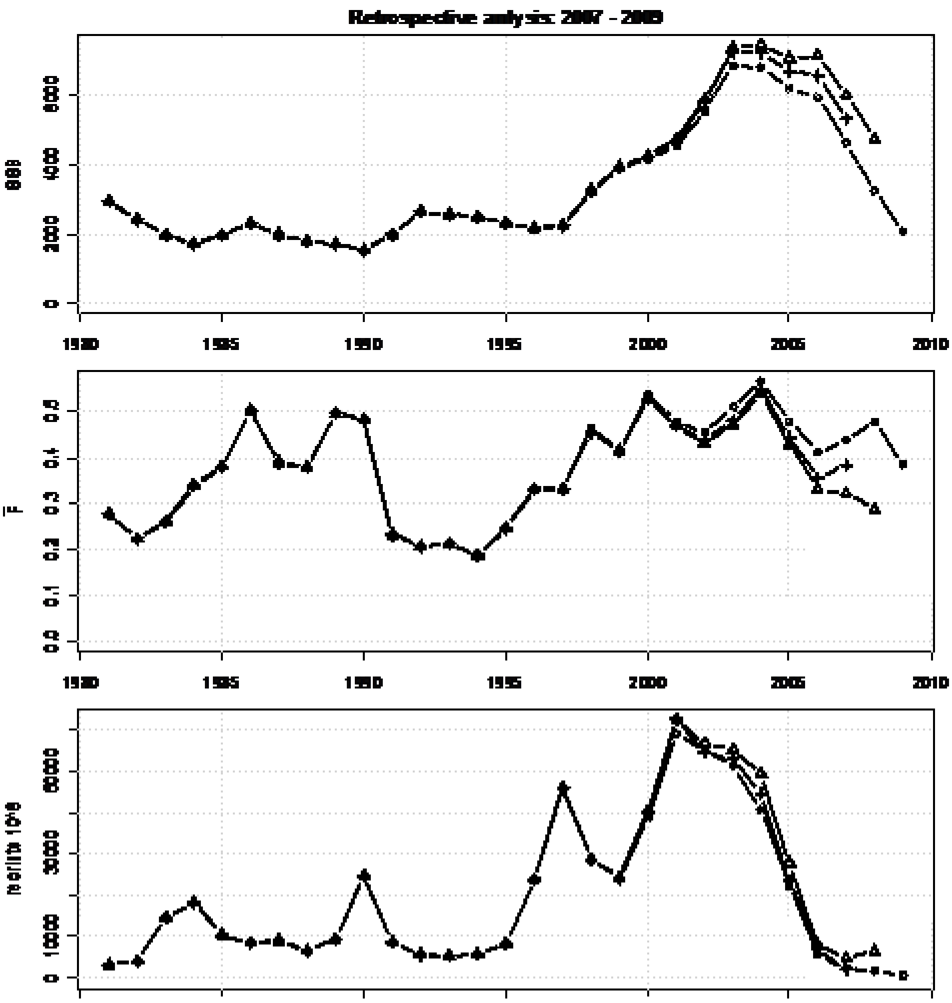


Figure 8.4.1.4 Blue Whiting SMS data exploration Retrospective analysis of SSB, F and recruitment (age 1) using all available data.

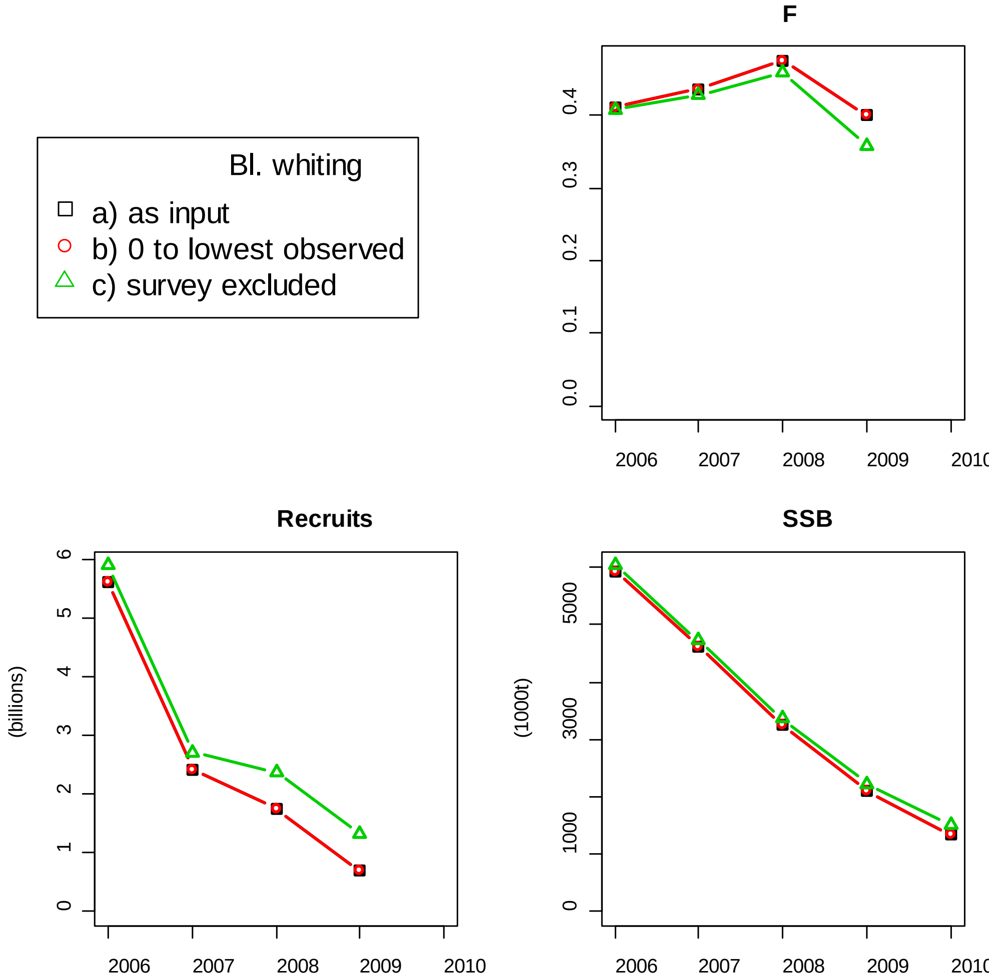


Figure 8.4.1.5 Blue Whiting SMS data exploration. Sensitivity analysis for the use of The International ecosystem survey in the Nordic Sea. Run a) uses the survey indices as they are (including zero-observations); in run b) zero values are replaced by the lowest observed value >0; and in run c) the survey is not used at all.

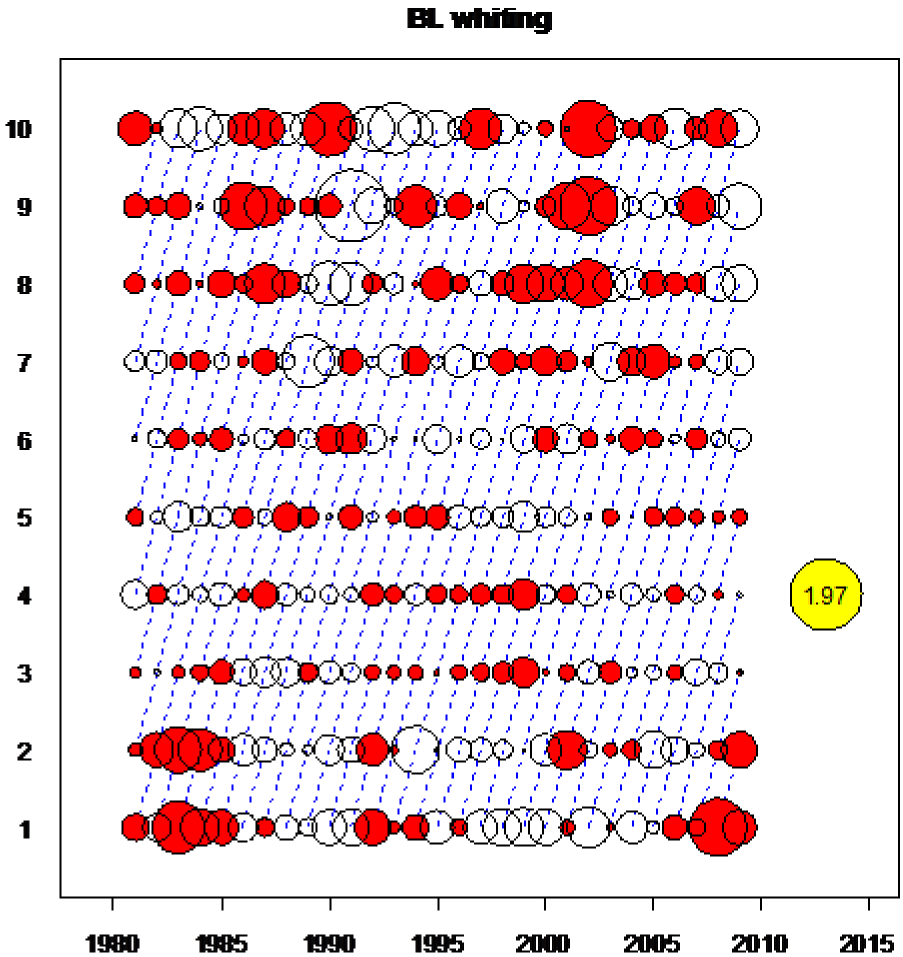


Figure 8.4.1.6. Blue Whiting SMS final run. Red (dark) bubbles show that the observed value is larger than the expected value. The bubble at right is the size of the largest residual.

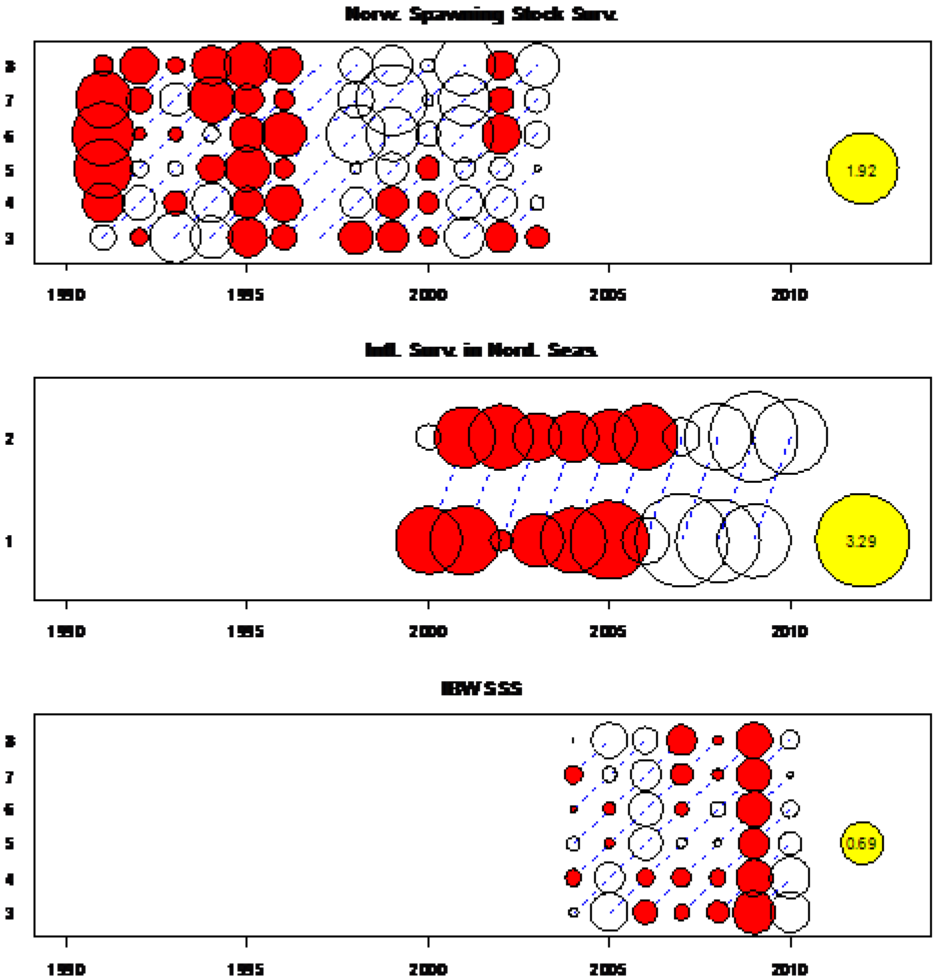


Figure 8.4.1.7. **Blue Whiting SMS final run: survey residuals for survey observations for the Norwegian spawning stock survey (top panel), the International ecosystem survey in the Nordic seas (middle panel) and the International Blue Whiting Spawning Stock Survey (IBWSSS; bottom panel). Red (dark) 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.**

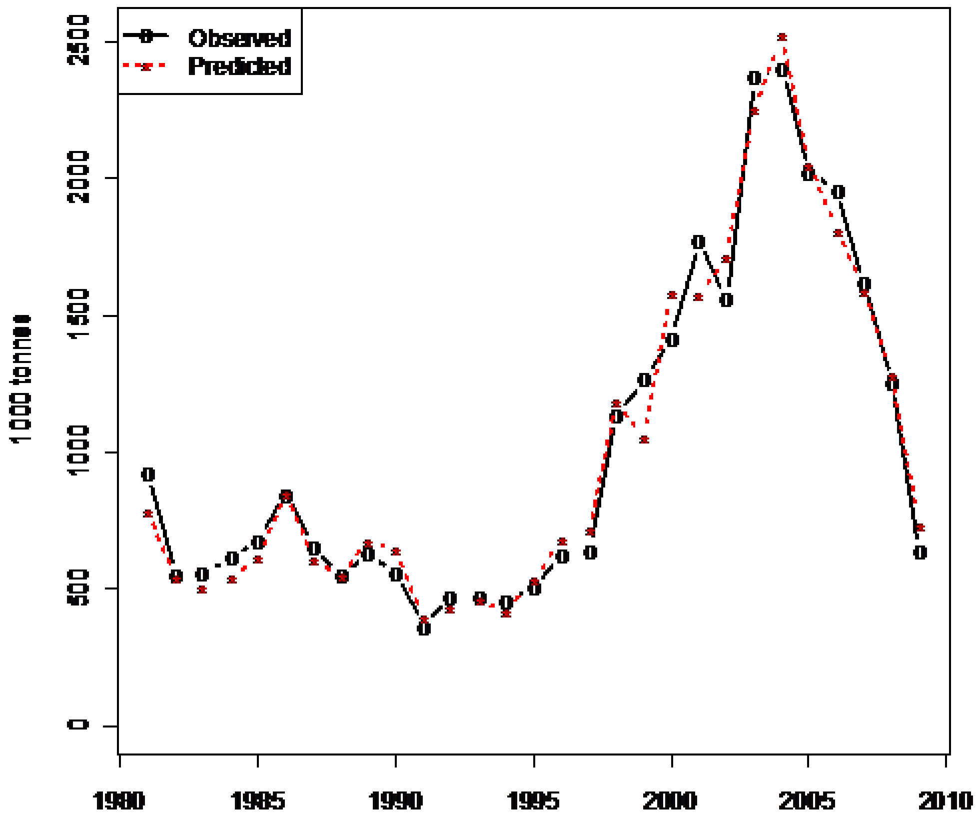


Figure 8.4.1.8. Blue whiting SMS final run: comparison of observed and predicted catch weight from the SMS run.

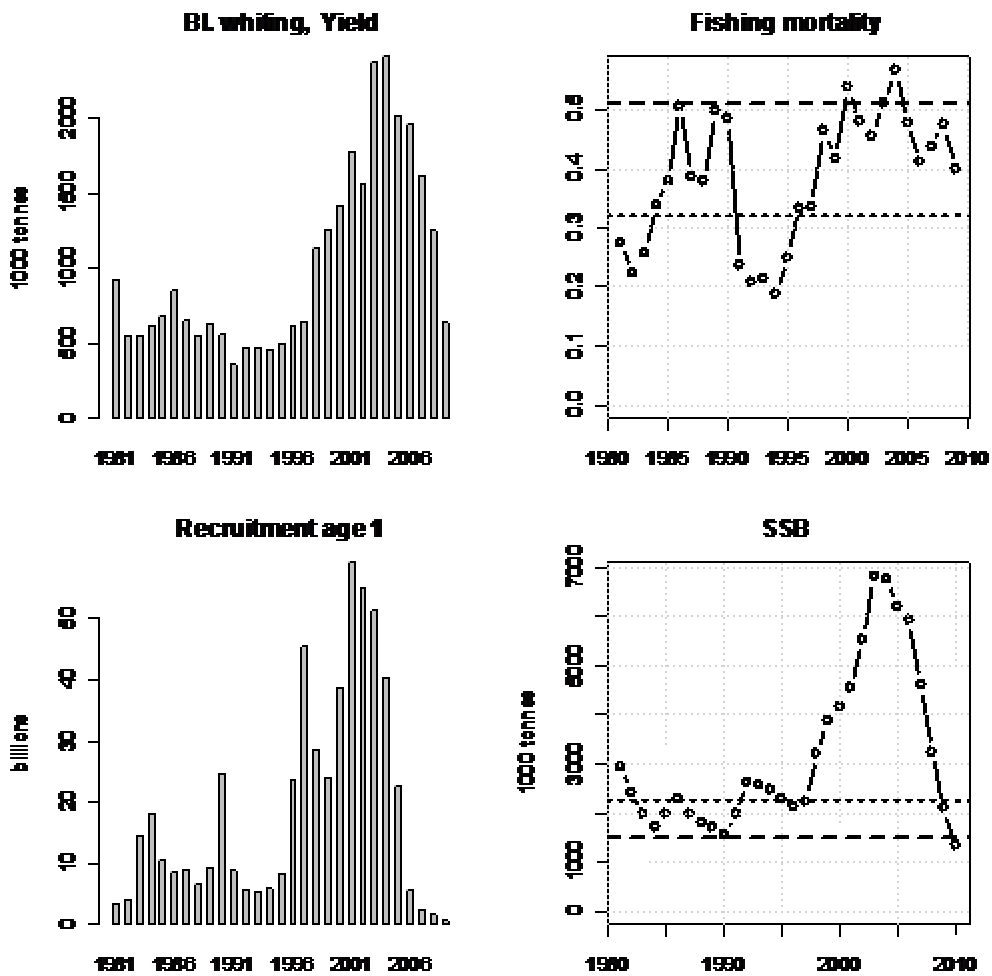


Figure 8.4.1.9. Blue whiting SMS final run: Stock summary. SSB at 1st January 2010 does not include age 1.

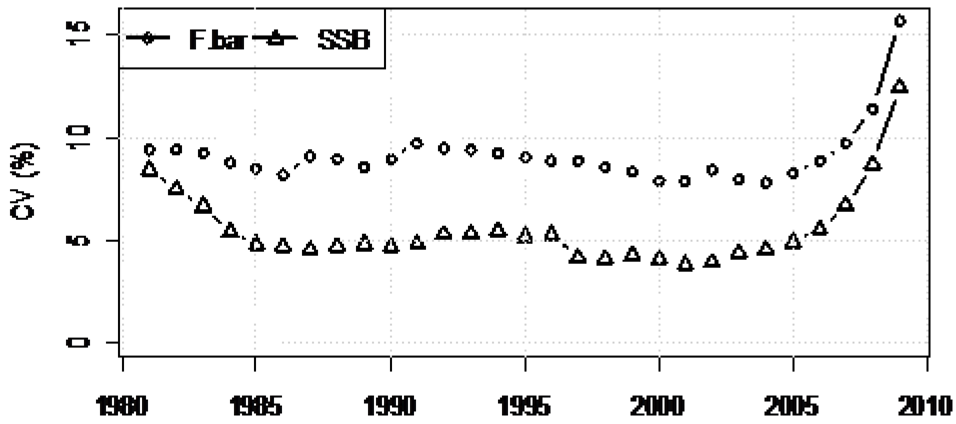


Figure 8.4.1.10. Blue whiting SMS final run: Estimates of CV of mean F and SSB.

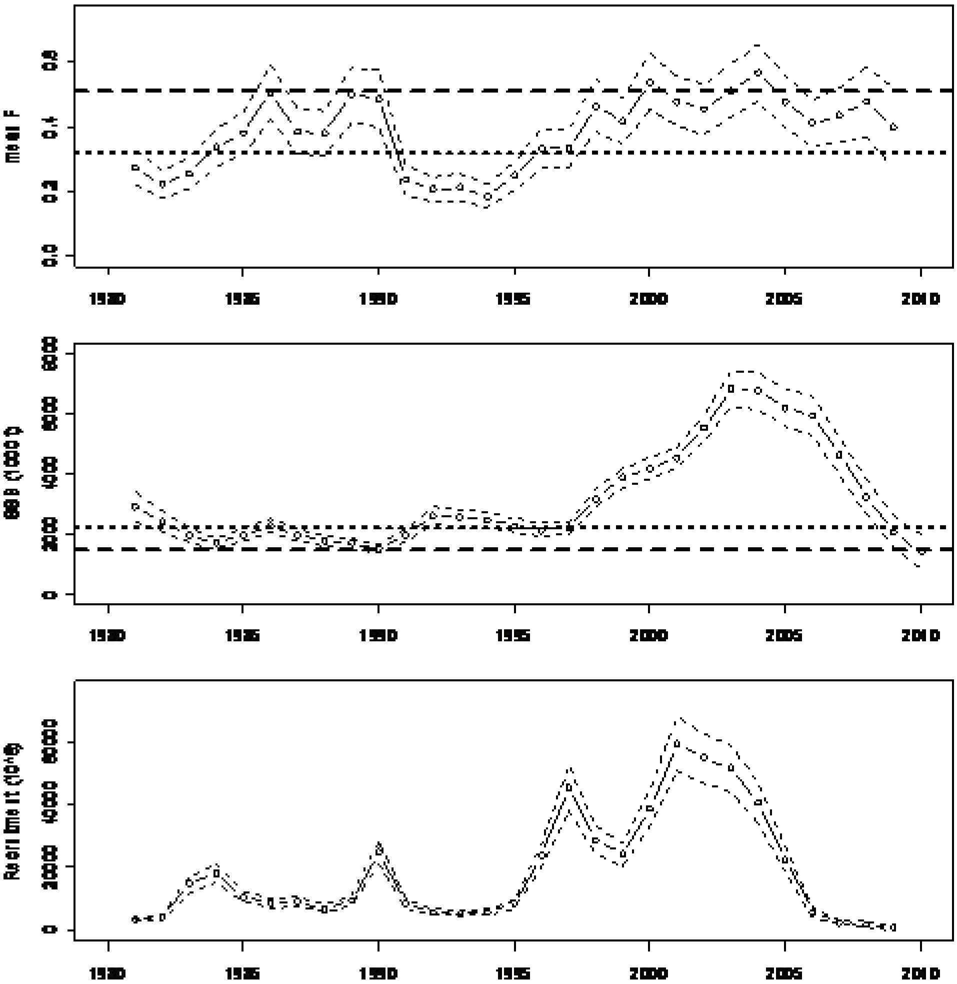


Figure 8.4.1.11. Blue whiting SMS final run: Stock summary with mean value and 95% confidence interval. SSB at 1st January 2010 does not include age 1.

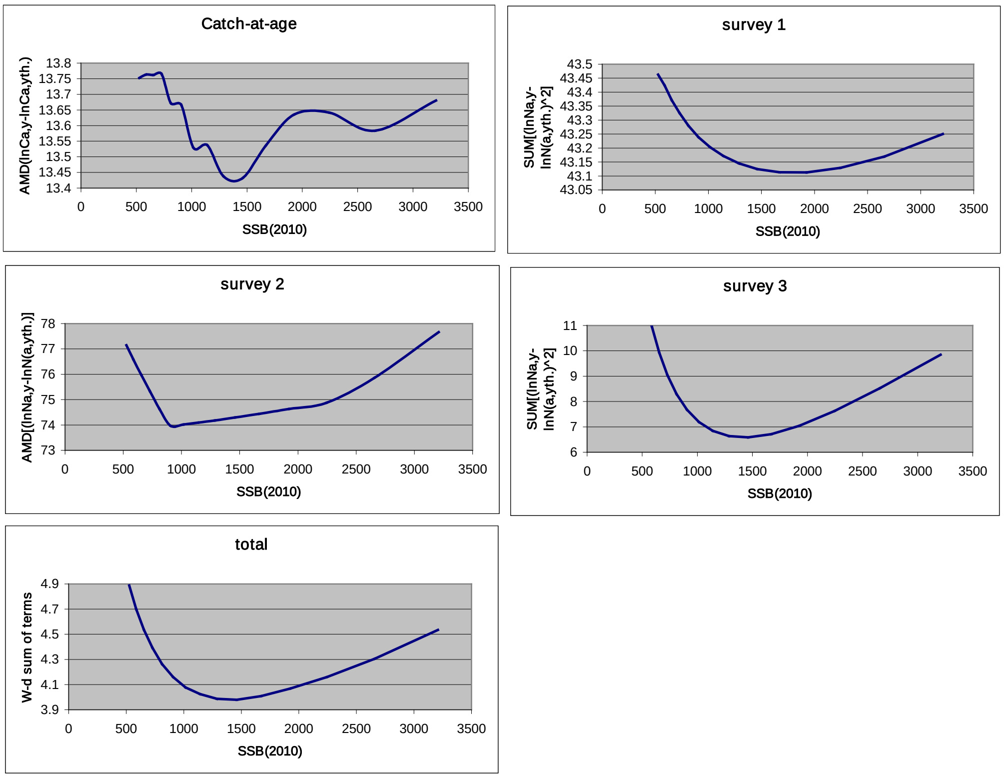


Figure 8.4.2.1. Blue whiting TISVPA data exploration Profiles of components of the TISVPA loss function. Survey 1 = Norwegian Spawning Stock Survey, survey 2 = International Survey in the Nordic Seas and survey 3 = IBWSSS.

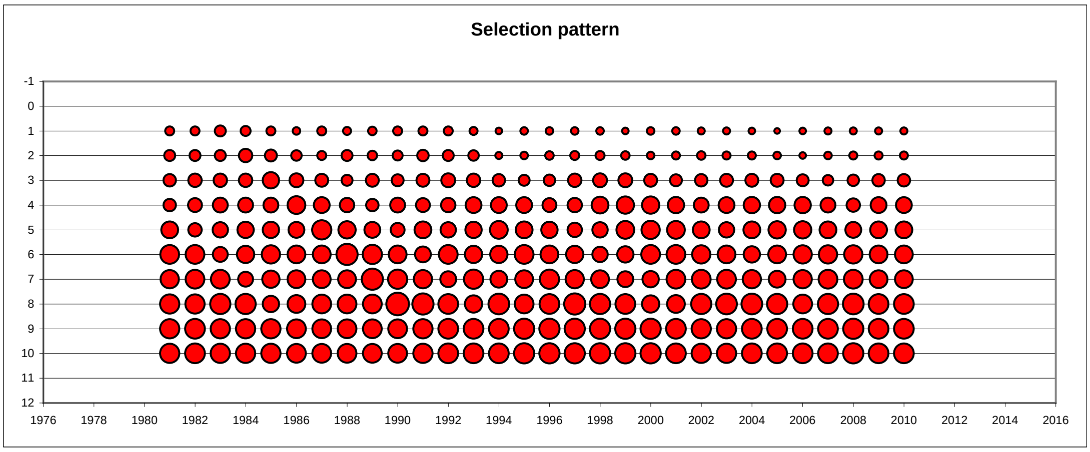


Figure 8.4.2.2. Blue whiting TISVPA data exploration: estimated selection pattern

Figure 8.4.2.3. Blue whiting TISVPA data exploration: model residuals for catch at age data and the three blue whiting surveys.

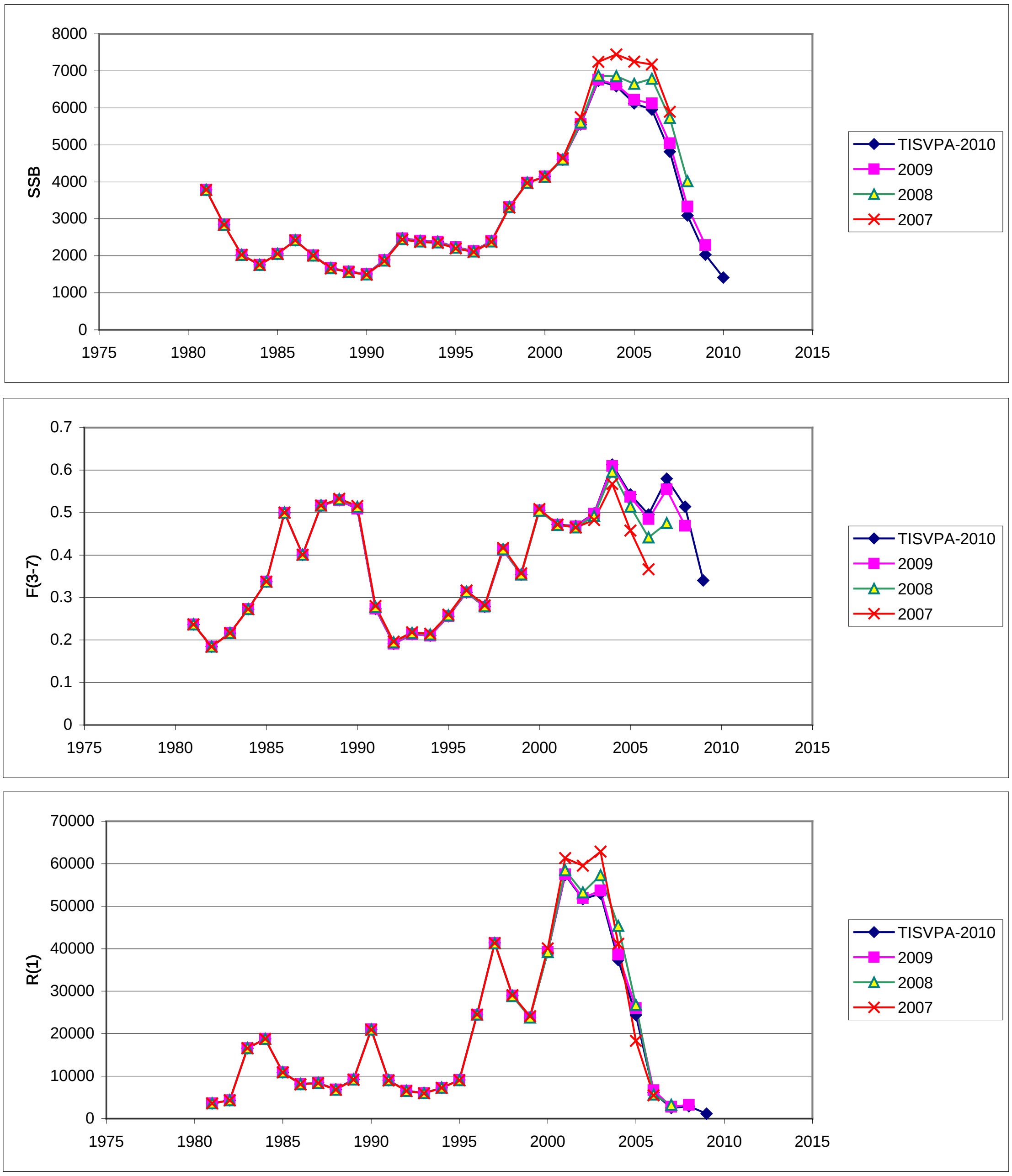


Figure 8.4.2.4 Blue Whiting TISVPA data exploration: retrospective analysis for SSB (upper panel), *F*-bar (ages 3-7) and recruitment (age 1).

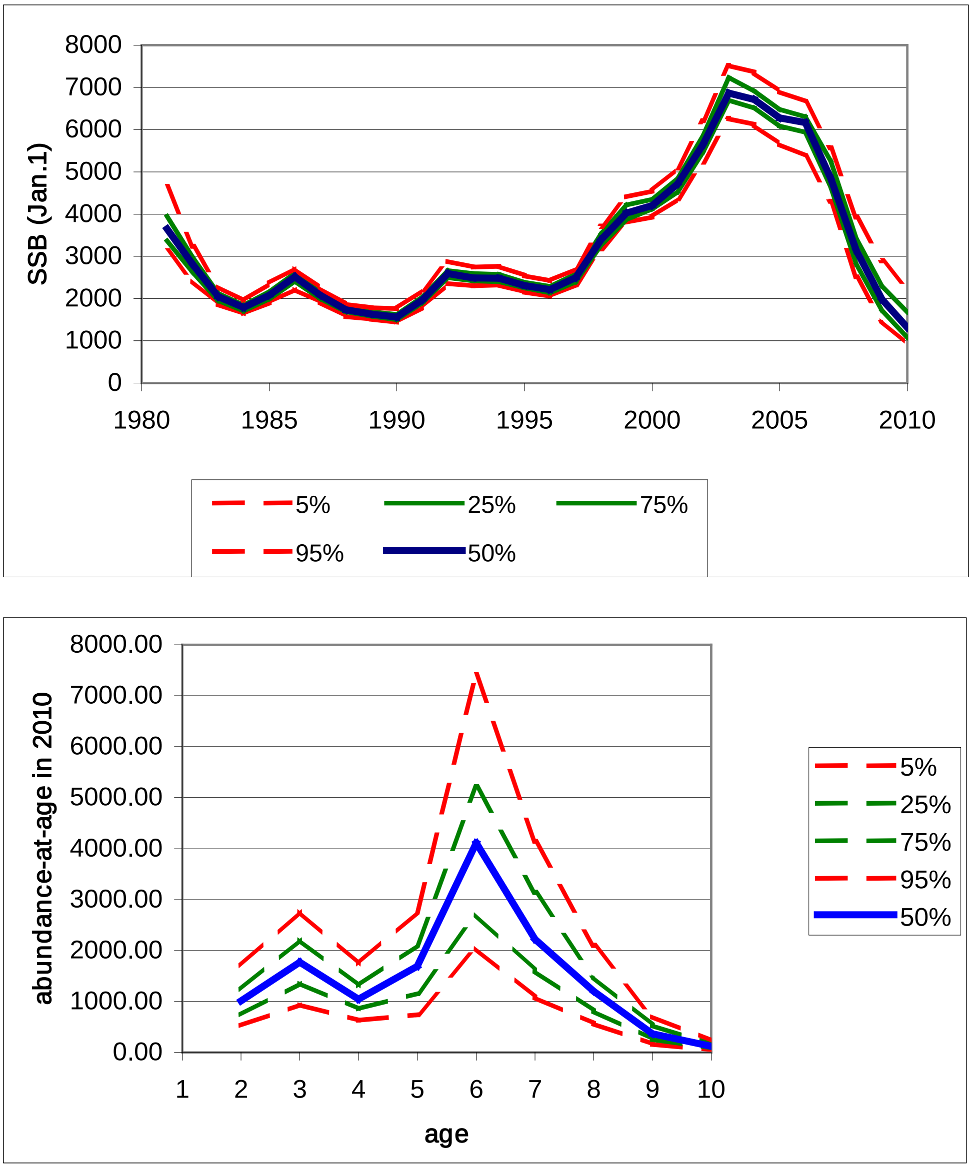


Figure 8.4.2.5. Blue whiting TISVPA data exploration: Estimates of uncertainty of the results

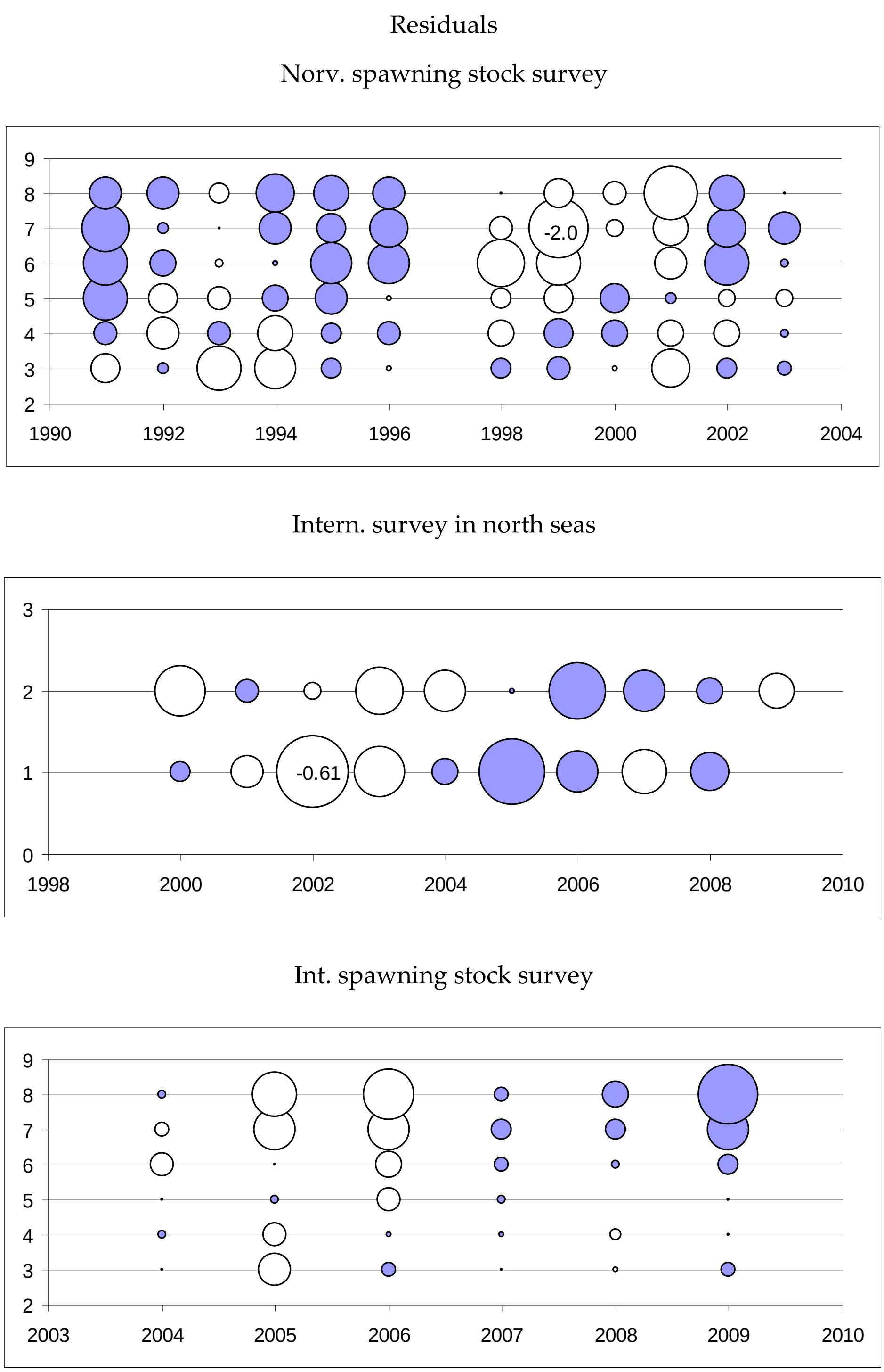


Figure 8.4.3.1. Blue whiting XSA data exploration: survey residuals.

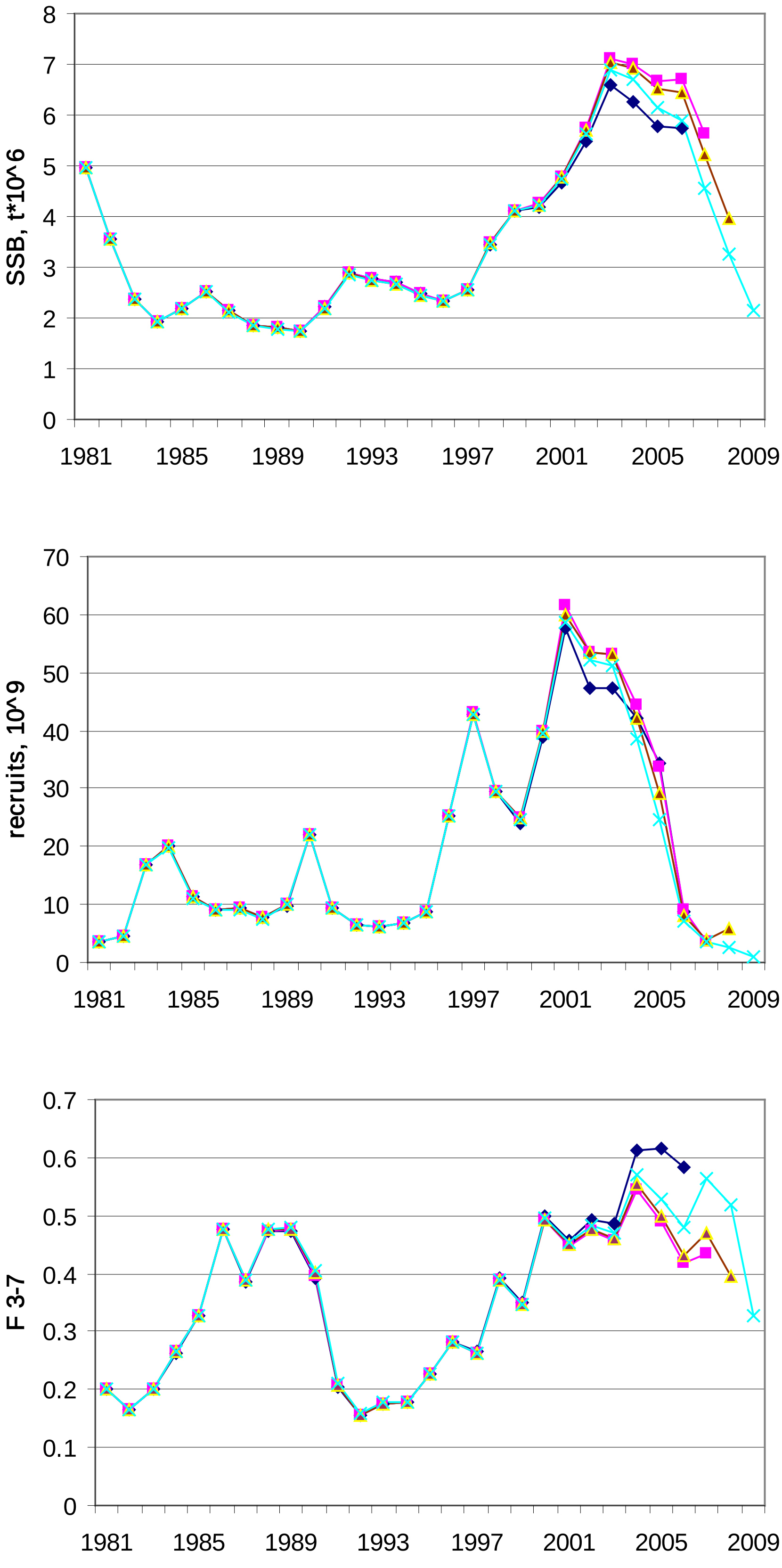


Figure 8.4.3.2. Blue whiting XSA data exploration: retrospective analysis.

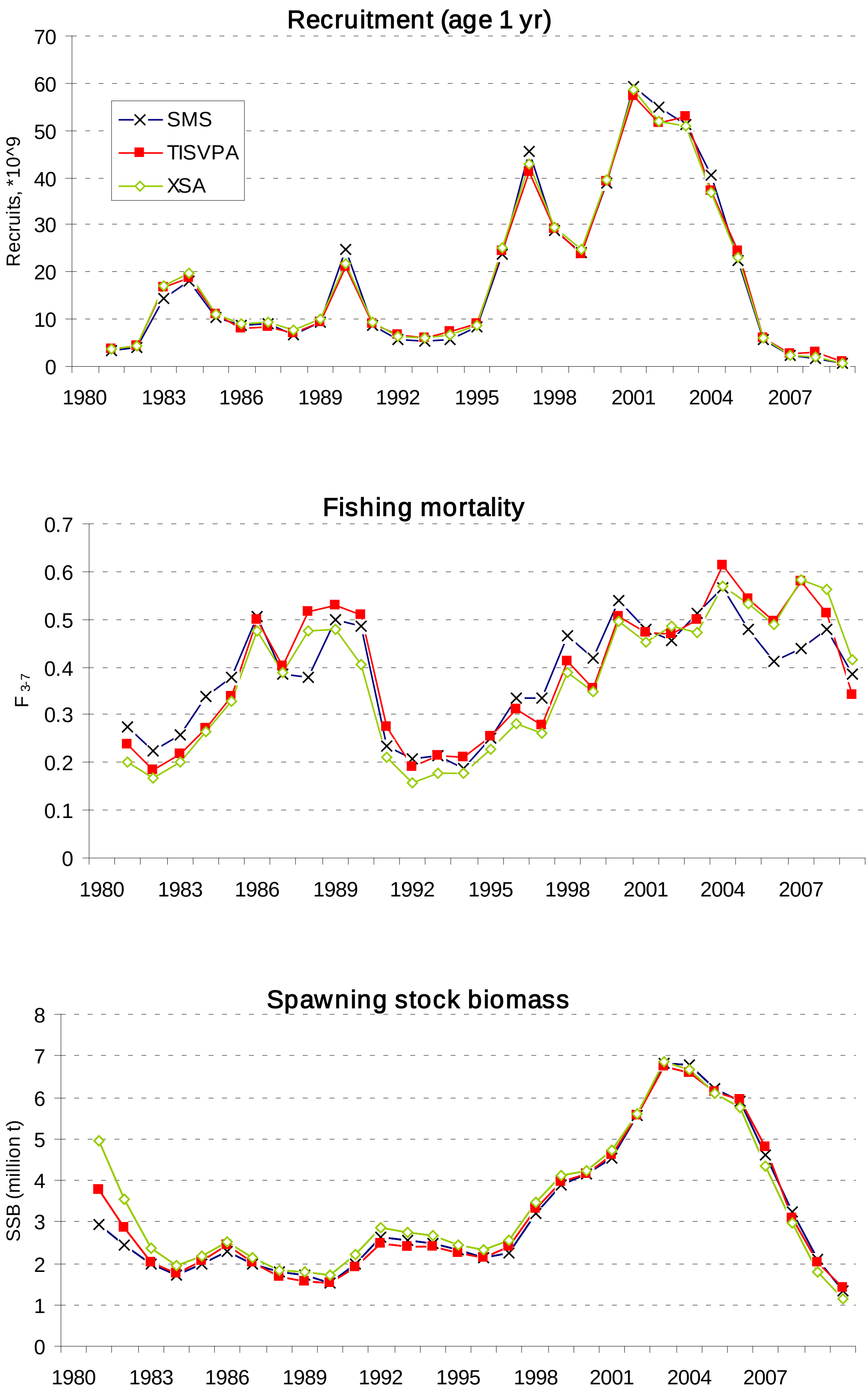


Figure 8.4.4.1. Blue whiting data exploration: comparison between final exploratory SMS, TISVPA and XSA-backshifted assessments estimates of recruitment (age 1), F bar (ages 3-7) and SSB.

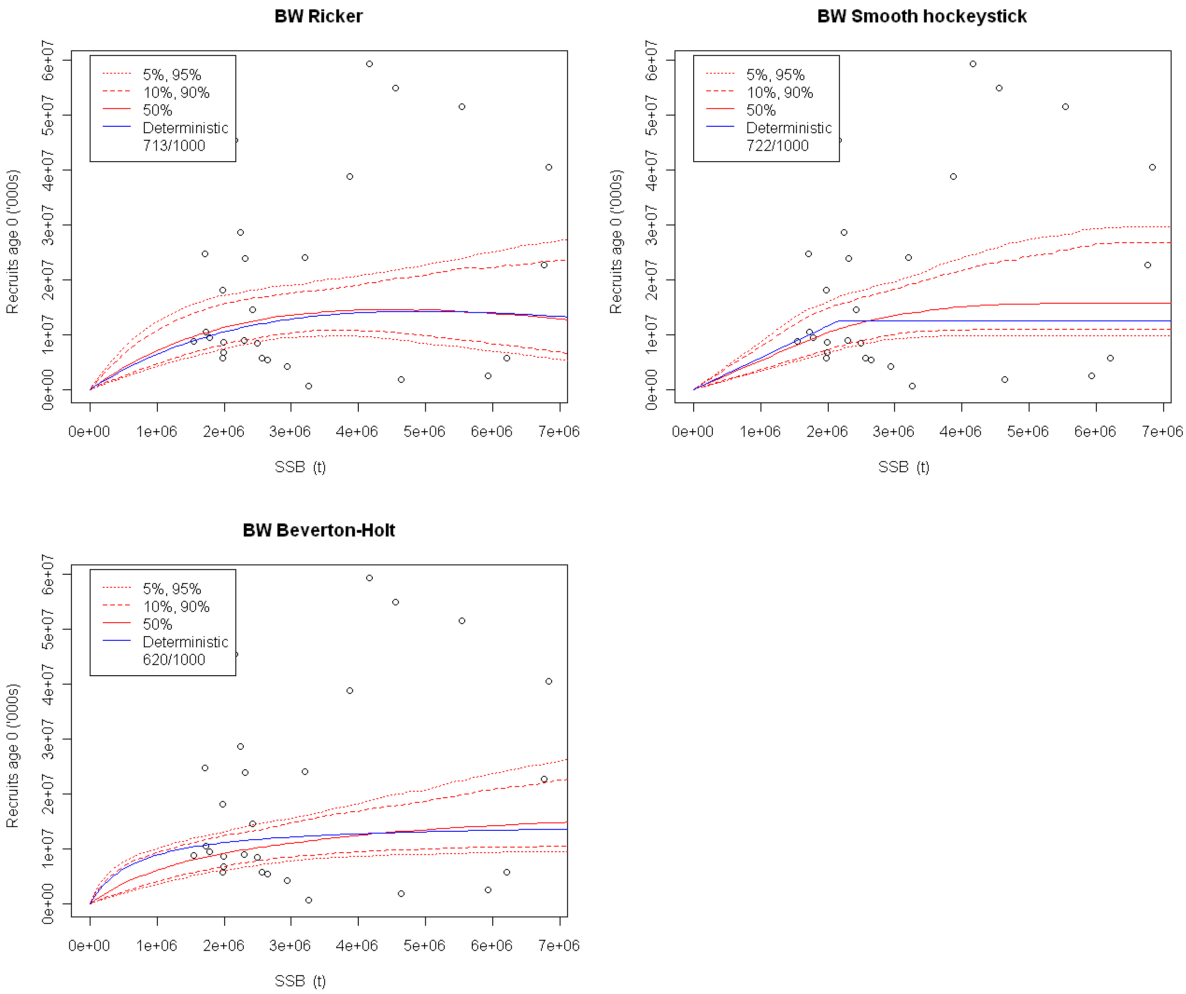


Figure 8.6.1. Deterministic and stochastic (taking into account uncertainty in weights, selectivity and maturity at age) stock recruit relationship fits for the Blue Whiting stock. Stock-recruit pairs are from the period 1981-2009.

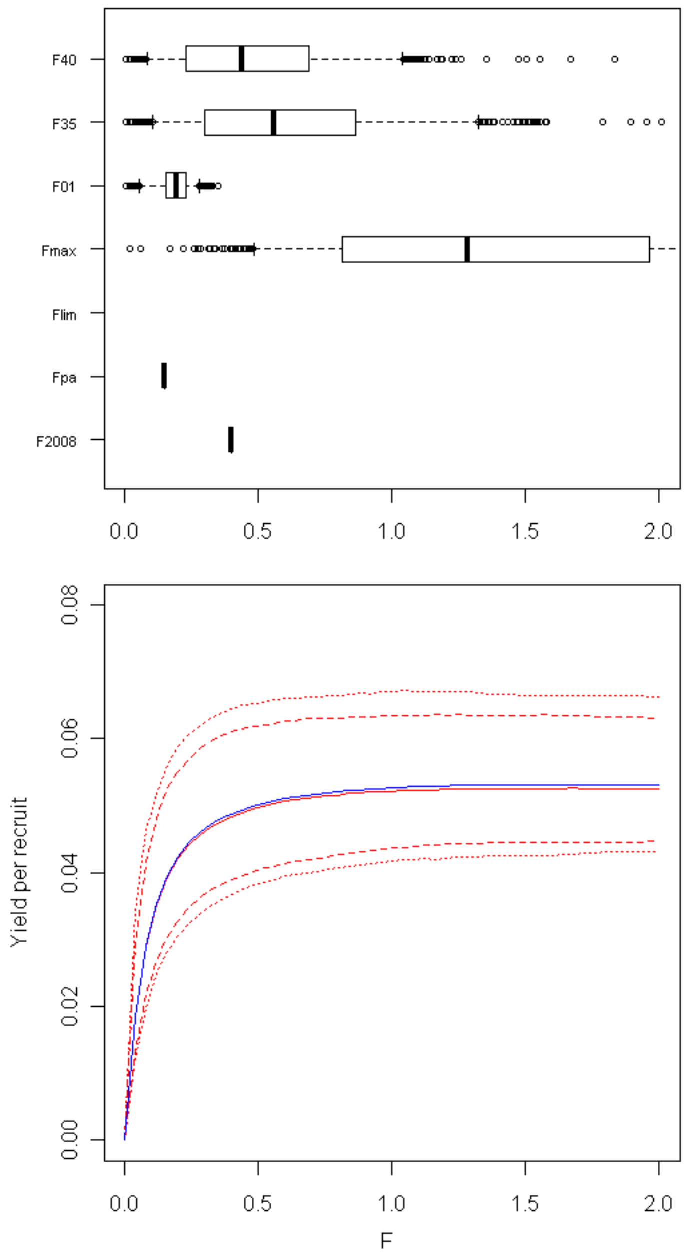


Figure 8.6.2. The yield-per-recruit (YPR) curve for the Blue Whiting stock (bottom) and resulting stochastic estimates of F reference points (top).

9 Recommendations :

9.1 Mackerel

To MKAMAC: Investigate aging problems as the reason for 1) Mean weight at age 1 in 2008-2009 equals mean weight at age in previous years 2) Two recent strong YC in assessment is 2005-2006 in contrast to 2004-2005.

To WGMEGS: Investigate lab effect on fecundity estimation

To Mackerel benchmark group: Raise discards from the available samples to total catches.

To Mackerel benchmark group: Develop and test new state based assessment model that do not depend on the separability assumption.

To WGNAPES: Standardize sampling and review calculations for the pelagic trawl summer survey in the Nordic seas

To National institutes: Improve collection of mean weight at age in the stock at the time of spawning.

To Mackerel benchmark group: Reanalyse existing data and look for new indicators that could be used to quantify recruitment and juveniles.

To Mackerel benchmark group: Raise timeseries of MES to whole area including North Sea and NW.

To Mackerel benchmark group: Update analysis of unaccounted mortality and explore novel methods for identification of the source and variation in unaccounted mortality.

To IMARES (Netherlands): Re-analyse otoliths from samples used for WEST in 2008-2009.

To WGWIDE: Update time series of WEST given correction of aging from IMARES.

To Mackerel benchmark group: Include aging uncertainty estimated by WKAMAC in new assessment model.

WGWIDE recommends applying the tagging time series as additional fishery independent information for tuning the NEA mackerel stock assessment. Due to the considerable changes in migration pattern of NEA mackerel observed in later years and to improve the time series WGWIDE further recommends that tagging/screening has to be continued on an international basis.

Carried on from last year:

To SCICOM: 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.

To Mackerel benchmark group: 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.

To ACOM and NATIONAL DELEGATES: 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.

To Norway, Denmark and Germany: That acoustic data on mackerel from the North Sea herring cruise are stored and made available for scrutinizing by acoustic experts

9.2 Blue whiting

The assessment model has changed and assessment settings have also been altered in recent years. A consistent assessment method with well defined settings is needed for this stock. This should be examined in detail by the benchmark assessment which is planned for 2011. There is a also a need to investigate other possible recruitment indices. The Barents Sea index shows close correlations with the recruitment estimates that are generated from the assessment. Other surveys which catch juvenile blue whiting should also be examined. A discussion over allowable effort on the spawning grounds as a means to limit disturbance to recruitment could also be discussed.

In 2009 ACOM advised that a benchmark for blue whiting should be postponed until the stock structure issues are clarified. The WG believes assessments of individual components of the stock will not be feasible. It would be very difficult to organise what needs to be done, locate relevant expertise and allocate the work before a benchmark in early 2011. If this could be done over the next year, this stock should be an ideal candidate for a benchmark in 2012.

The working group proposes that a benchmark assessment takes place prior to the WGWIDE meeting in 2012.

Benchmark information for Blue Whiting.

Stock	whb-comb: Blue whiting in Subareas I-IX, XII and XIV (Combined stock)			
Stock coordinator	Name: Manuel Meixide	Email: manolo.meixide@vi.ieo.es		
Stock assessor	Name: Morten Vinther	Email: mv@aqua.dtu.dk		
Data contact	Name: ???	Email:		
Issue	Problem/Aim	Work needed / possible direction of solution	Data needed to be able to do this: are these available / where should these come from?	External expertise needed at benchmark
Tuning series	The precision of the IBWSSS survey is in general believed to be low (PGNAPES, ICES CM 2009/RMC:06). The assessment appears sensitive to the survey data (to the extension of the IBWSSS time series).	??	IBWSSS survey results (PGNAPES)	Survey experts.
	Poor indices of the incoming year classes in recent years (mismatch between survey indices and the amounts caught from these year classes later on)	Investigate other possible recruitment indices. Other surveys which catch juvenile blue whiting should also be examined.	The Barents Sea index shows close correlations with the recruitment estimates that are generated from the assessment.	Survey experts.
Discards	N/A – expected to be low.			N/A
Biological Parameters	Recruitment. Total collapse in recruitment. Has there been a Change in location of juveniles? It could be possible to merge available data on the occurrence of young fish in the commercial and	Analyse spatial distribution of juveniles.		

Stock	whb-comb: Blue whiting in Subareas I-IX, XII and XIV (Combined stock)			
	other catches at time of the low stock level in the past, then adapt the traditional surveys to the new conditions.			
	Stock identification. The stock identification methods working group (SIMWG) recommendeds that the blue whiting populations in areas VIIk and VIIj and further south be management as a separate unit from all other NE populations			
	Maturity at age used in the assessment is 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.	Evaluate available data on maturity at age for trends over time.	Maturity data.	
	Possible causal relations for the visible reductions in mean weight at age were investigated by WGWIDE in 2008. Ecosystem conditions could be responsible for the change in mean weight at age. An in depth analysis of the causes of these changes in mean weights, which would be needed for any kind of forecast is needed (ICES, 2008a) .			

Stock	whb-comb: Blue whiting in Subareas I-IX, XII and XIV (Combined stock)			
Assessment method	The assessment method (SMS) is sensitive to changes in model structure. It is difficult to obtain stable and consistent estimates of the recent stock abundance and mortality. A consistent assessment method with well defined settings is needed for this stock (Skagen 2010 WP*)	Modelling work.	Catch at age, survey data as above.	Stock assessment.
Biological Reference Points	Currently used reference point are based on management strategy evaluation simulations and are believed to be valid. However, these values may need to be re-evaluated should the perception of the stock change significantly with a new assessment.	Simulation modelling / yield per recruit analyses.	Assessment outputs, weights at age.	Management strategy evaluation.

*Skagen WP, WGWIDE 2010. “On the assessment of Blue Whiting”

9.3 Southern Horse Mackerel

The catches of the southern horse mackerel stock come exclusively from mixed-fisheries. Horse mackerel in ICES IXa subdivision is mainly caught by bottom-trawl, together with hake and other demersal fish, and by purse-seine, by the same fleet that targets sardine, chub mackerel and other pelagic species. Part of the catches also come from artisanal fleets. Given the increasing importance of a mixed-fisheries approach for fishery management, and the move towards multi-fleet/multi-species management plans in Iberian waters, it would be convenient that the southern horse mackerel stock assessment is carried out in a WG dealing with other stocks caught in the same fisheries. Therefore, WGWIDE recommends that ICES moves the southern horse mackerel stock to an assessment WG dealing with Iberian stocks that are caught together with southern horse mackerel.

10 Abstracts of Working Documents

Cruise report from the coordinated ecosystem survey with M/V ”Libas” and M/V ”Brennholm”, M/V “Finnur Fridi” and R/V “Arni Fridriksson” in the Norwegian Sea and surrounding waters, 9 July- 20 August 2010

Norway (Nøttestad *et al.*), Faroes (Jacobsen *et al.*) and Iceland (Sveinbjørnsson *et al.*)

Abstract

Two chartered Norwegian fishing vessels M/V “Libas” and M/V “Brennholm”, one chartered Faroese vessel M/V “Finnur Fridi” and the research vessel R/V “Arni Fridriksson” performed an ecosystem survey from 9 July until 20 August 2010 in the Norwegian Sea and adjacent waters. 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. The total acoustical estimate of biomass of mackerel was 12.1 million tons, while swept area estimate from trawl catches was 4.5 million tons. Mackerel was distributed over larger areas than previously documented for the Nordic Seas in July-August. Furthermore, a central and western distribution was pronounced in July 2010. Repeated offshore catches of two year’s old individuals indicate that the Norwegian Sea is increasingly showing to be an important nursery and feeding ground for immature mackerel. The 2005- and 2006 year classes dominated with 24% and 31% of total catches, respectively. Estimated biomass of herring was 10.7 million tons. Herring had rather periphery distribution in the Norwegian Sea and surrounding waters, and the majority of individuals were distributed feeding in the colder and frontal waters in the western, northwestern and northeastern parts of the Norwegian Sea. Herring also ate adult capelin, representing new scientific knowledge. The 2002 and 2004 year classes were most abundant representing 20% and 27% of the acoustical estimates, respectively. Estimated biomass of blue whiting was 3.46 million tons in the Norwegian Sea in July. The 2004 year class dominated with 36 % of the *the* acoustical estimates followed by the 2003 year class with 23% of the acoustical estimates. No major young year classes less than four years of age were found during the survey. A total of nine salmon were caught in the epi-pelagic trawl hauls. Lumpsucker were caught in vast areas of the covered areas. Horse mackerel were caught in the southernmost area of the Norwegian Sea.

Surface waters in the eastern, central and northern Norwegian Sea were colder compared to the last year, but still warmer than average temperature the last two decades. Extremely warm temperatures were found in the southern and southwestern part off Iceland.

Zooplankton concentrations including *Calanus finmarchicus*, krill and amphipods were generally low, except a few locations in the southernmost areas.

Fewer marine mammals were generally present in the Norwegian Sea in July 2010, compared to previous years. 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.

Key words: Norwegian Sea, planktivorous fish, herring, mackerel, blue whiting, abundance, distribution, spatial overlap, feeding ecology, schooling behavior, predator-prey interactions.

Jens Ulleweit[1], Finlay Burns[2], Cindy van Damme[4], Merete Fonn[5], Matthias Kloppmann[1], Steve Milligan[3], Anders Thorsen[5]: 2010 International Mackerel and Horse Mackerel Egg Survey - Preliminary Results

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Abstract

The working document describes and discusses the preliminary results of the 2010 international mackerel and horse mackerel egg survey.

On the assessment of Blue whiting

Dankert Skagen (IMR)

The assessment of Blue whiting has presented difficulties at the time of obtaining stable and consistent estimates of the recent stock abundance and mortality. More recently, the estimates of incoming year classes has been an additional problem. This WD attempts to sort out the sources of the instability and proposes possible ways out. The signals in the data are examined to identify conflicts and, assessment formulations with assumptions that are in accordance with the signals in the data are considered.

Catch at age and acoustic survey data, one on the spawning grounds in spring, and one in the Norwegian sea in summer, are analysed. In the most recent years, when the recruitment has been poor, there has been a mismatch between survey indices and the amounts caught from these year classes in subsequent years; questions are raised about whether this survey can be used as an indicator of recruitment. Estimates of the state of the stock in the most recent year appear driven by the noise in the catch data. The separability assumption in the current assessment model may be contributing to that effect.

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Annex 2 – 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, Updated 30 August 2010
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 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 overlap 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 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:

Spawning component	Western	Southern	North Sea
Spawning Areas	VI, VII, VIIIa,b,d,e.	VIIIc, IXa.	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 the wide mackerel distribution and between the seasons due to migration, spawning, feeding and over-wintering. 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 came from the west of Orkney to the west of Ireland; the fourth quarter fishery moved to the west of Scotland and the 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 division 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), 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 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 and Pearre 1987). Feeding patterns vary seasonally, spatially and with size. Mackerel stop feeding almost completely during winter. Main zooplankton prey species in the North Sea are: Copepods (mainly *Calanus finmarchicus*), euphasids (mainly *Meganyctiphanes norvegica*), while primary fish prey species 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 of 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 remain 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 to the north through the 80s and 90s, declining in the south and rising in the north (Beare and Reid 2002). In the North Sea there is 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).

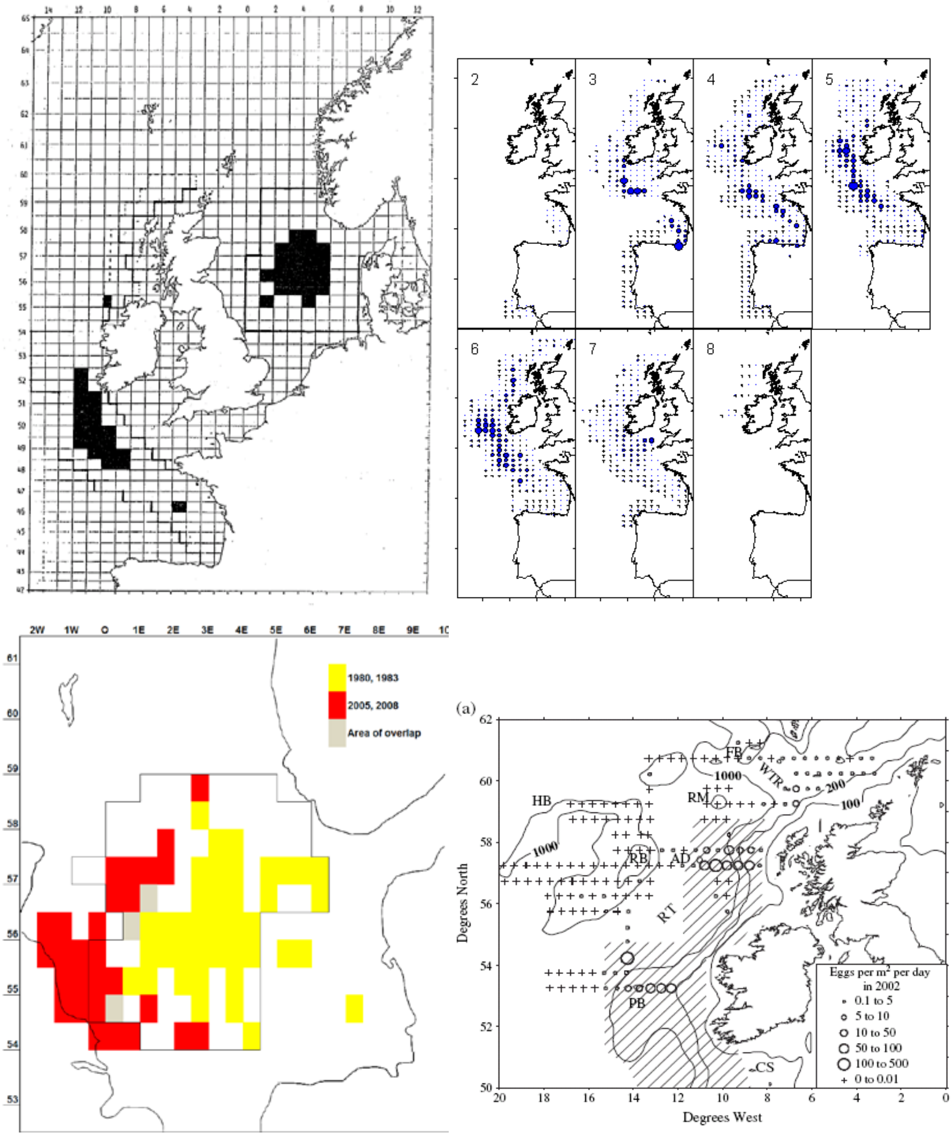

Figure A.3.2.1. NEA mackerel spawning areas. Upper left: Shaded areas indicate > 100 eggs/m2 in at least two of the years in the period 1977-1988 (from (ICES 1990)). Upper right: Average distribution of mackerel eggs by ICES statistical rectangle in 1992-2007, each map represents a survey between February 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 over-wintering 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 southern/western component do 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.).

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. They 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.

However, 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 also indications of variation in spawning time: 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 occurs earlier each year (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 the east and beyond Iceland in the west. The dynamics and environmental drivers of the mackerel distribution are not yet uncovered. Surveys in recent years indicate substantial inter-annual variation and provides hypothesis on relations to temperature and food (Anon 2002, Anon 2003, Anon 2005, Gill *et al.* 2004, Holst and Iversen 1992, Holst and Iversen 1999, ICES 2006b, ICES 2007a, ICES 2009).

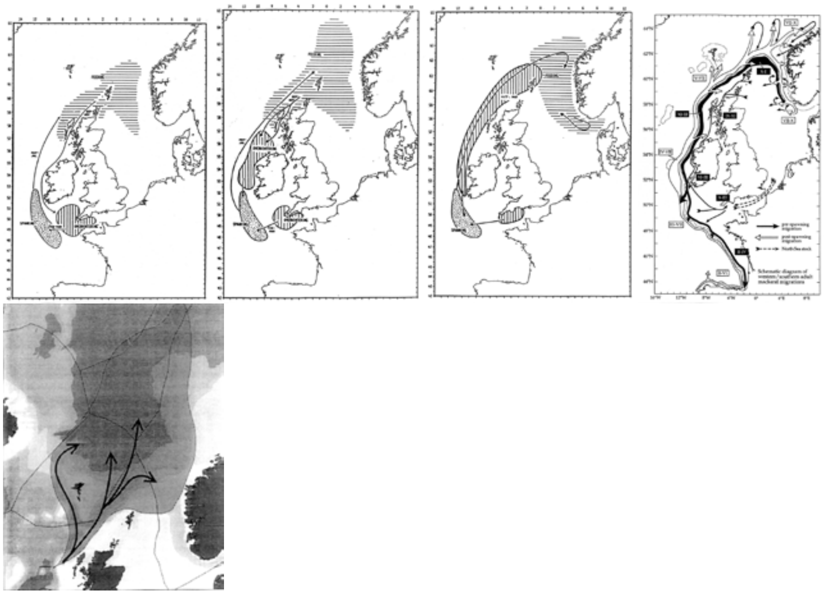

Figure A.3.3.1. Schematic outline of the migration of the western (+ southern in right map) adult mackerel through time. From left: late 1970s (ICES 1990), early 1980s (ICES 1990), latter half of 1980s (ICES 1990), mid 1990 (Anon 1997) and (Belikov *et al.* 1998).

North Sea stock

Due to the inability to separate individuals from the North Sea stock 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 return to the surface layer for feeding, and migrate 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)

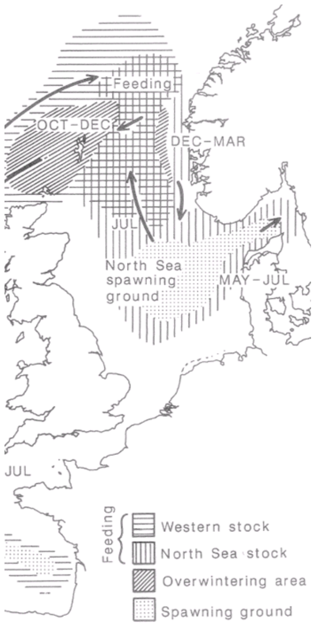

Figure A.3.3.2. Assumed migration and area distribution of the North Sea mackerel. From (ICES 1990).

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 was 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. The variation could be due to:

- Fish that escape from fishing, but 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 are 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.

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 weights 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 WGWIDE reports since then.

Available samples from the commercial fishery have been supplemented by samples from the egg surveys. The egg survey samples have been applied to the year before the survey year as well as in the survey year. Since selectivity of the applied gear might affect the weight at age estimate; outlier samplings (e.g. from scientific vessels with small trawls and low engine power) are not used.

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,h,j 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

Natural mortality (M) has been fixed at 0.15 for decades. The basis for this number can be found in Hamre (1980). The first mackerel working group report where this value was given in was 1983 (ICES 1984).

To calculate proportions of F and M before spawning; the time of spawning each year was set to be the julian day where 50% of the egg spawning had occurred. Subsequently, the time of spawning was taken as the mean of the annual estimates.

Interannual variation was observed to be low at the time of the benchmark in 2007. However, later estimates challenge this fixed assumption.

Natural mortality (M) was assumed to be constant through the year, so the proportion of natural mortality happening before spawning was readily calculated by multiplying M by the proportion of the year before the mean date of spawning.

Catch numbers were by quarter. The quarter 2 data partitioned in the observed catch before and after the mean date of spawning. Partial F's were calculated using the output from the last assessment and the estimated catch was 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 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.

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). The SSB is estimated using information on sex ratio and fecundity of the females. 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 on 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 was:

[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.

$$\sum_{a=0}^{12+}\sum_{y=Y-12}^{Y}\lambda_{ca}\left(\ln\left(C_{a,y}\right)-\ln\left(\hat{C}_{a,y}\right)\right)^2+\sum_{y\in\{\text{Y\_Egg}\}}\lambda_{MES}\left(\ln\left(q_{MES}S\hat{S}B_y\right)-\ln\left(MES_y\right)\right)^2$$

where

a and *y*	age and year
C	catch
$\hat{C}$	catch estimated by the separable model
$S\hat{S}B$	spawning stock biomass estimated by the model
MES	Mackerel Eggs Survey index (biomass index) triennialy
q_{MES}	catchability of mackerel egg survey
λ_{ca} and λ_{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.)

The λ_{ca} and λ_{MES} were defined to give the same weighting to the catch at age and to the survey for fitting the model. This was done by giving a weight of 0.33 to each year and age in the catch matrix (except for ages 0 and 1 which were down weighted by a factor 100 and 10 respectively). The weight given to the catch for a period of 3 years (interval between survey) is 3 years * 10 age classes * 0.33 = 10. Therefore, a weight of 10 was given to each survey value (setting in FLICA : index.var=0.1).

With ICA, it is possible to use a survey index related to the assessment year (Y), even if the last catch data available (and therefore the last population numbers at age estimated) are for the year previous to the assessment (Y-1). In this case, the survivors are projected until the time of spawning and the corresponding SSB is calculated, assuming that maturity, weights and fishing mortality at age in the year Y are the same as in the year Y-1.

Note that the specific case of using the weighting described as above, results in giving a slightly higher weight to the survey than to the catch at age.

Implementation of the method is done by using R2.8.1, with 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
Fprop	Proportion of fishing mortality before spawning	1972 - Y-1	0-12+	No, fixed at 0.421
Matprop	Proportion mature at age	1972 - Y-1	0-12+	Yes
Natmor	Natural mortality	1972 - Y-1	0-12+	No, fixed at 0.15

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	0.0033333, 0.033333, 0.33333, 0.33333, 0.33333, 0.33333, 0.33333, 0.33333, 0.33333, 0.33333,0.33333,0.33333,0.33333	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)

Due to the high uncertainty in the recruitment estimates for the terminal year for the NEA Mackerel, the value estimated by ICA is arbitrarily replaced by the geometric mean of recruitment over the period 1972 to two year before assessment year.

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 can not be correctly estimated when the plus group was smaller than 8 (before 1977), and SSB can not be correctly estimated when the plus group was smaller than 12 (before 1980). Recruitment and total catch estimates are not affected by this problem.

D. Short-Term Projection

Deterministic short-term predictions are calculated using the stf routine in the FLAssess package. Projections are done three years ahead: assessment year (Y) to Y +2. For the intermediate year (= Y) an assumed catch is used (see below for more details). A range of management options for Y +1 are then tested.

In 2009 and 2010 the short term forecast was run in parallel comparing the stf routine with MDFP v.1a. The test showed that the two programs gave the same results.

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 three years before the assessment year (i.e. 1972 – Y-3) is used for the recruitment at age 0 for Y-1 – Y in the predictions.
ICA estimates of recruitment in Y-1 and Y-2 are considered too uncertain be used in the geometric mean, because these year classes have not yet grown into the fishery. Recruitment in Y-2 is kept as estimated by ICA in order to be consistent with previous assessments, but changing this to a historically based value should be considered during next benchmark assessment.

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.

The stf routine then use the same relative selection pattern in Y to Y+2.

Maturity at age, weight at age in the catch and weight at age in the stock:

The 3 year average of Y-3 to 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 estimated from declared quotas modified by e.g. paybacks (e.g.EU COMMISSION REGULATION (EC) No 147/2007), discards, interannual transfers and expected overcatch.

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:

- $Catch_{Y+1}$ = zero
- $Catch_{Y+1} = TAC_Y - 20\%$
- $Catch_{Y+1} = TAC_Y$
- $Catch_{Y+1} = TAC_Y + 20\%$
- $Fbar_{Y+1} = 0.20$
- $Fbar_{Y+1} = 0.21$
- $Fbar_{Y+1} = 0.22$

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:*

   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.

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:	6 September 2010
Revised by	WGWIDE (first draft)

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

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 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, [weight for age 3 and 4 estimated by WGWIDE (Svein)] 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. In contrast to 2007 the 2010 results display a bimodal distribution which is almost identical both in shape and scale to that seen in 1998 with peak spawning occurring in periods 3 and 5 and a significant decline in production during period 4

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 to 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, and 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.

B.5. Other relevant data

None

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*. (2010). 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	2009 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.* (2010).

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 (1 040-3 280 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 2010, the separable window was 6 years long (2004-2009) (ICES 2008/ACOM:13). Decisions about whether to shift the window along (keeping it 6 years long) or whether to extend the window (keeping the starting date at 2003) depend on whether 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

Software used: MFDP (Multi Fleet Deterministic Projections)

Initial stock size: Stock numbers from the assessment

Recruitment: At the 2010 working group recruitment estimates for input to the short term forecast were based on the geometric mean of the estimated time series for the period 1983 to 2008. There is no indication that a large recruitment similar to that of 1982 will enter the stock.

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 for 2009.

F and M before spawning: Spawning is assumed to take place in April/March.

Weight at age in the stock and weight at age in the catch: Weight at age in the stock and weight at age in the catch are the 2009 estimates.

Exploitation pattern: This is based on F in the final, where the final year of data is calculated from the most recent assessment. The assessment assumes a fixed selection from 2004 to the final year of data.

Natural Mortality: Natural mortality is assumed to be 0.15 across all ages.

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.

Reference point	B_{lim}	B_{pa}	F_{lim}	F_{pa}	$F_{0.1}$
Value	1.4 mill t	1.8 mill. t			0.13
Basis	Biomass that produced the extraordinary 1982 year class	**B_{lim}*** exp(1.645* σ), with σ= 0.16.	Not defined	Not defined	Yield per recruit (WGWIDE, 2008)

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 15%. 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_{4-10} to F_{1-10} 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.

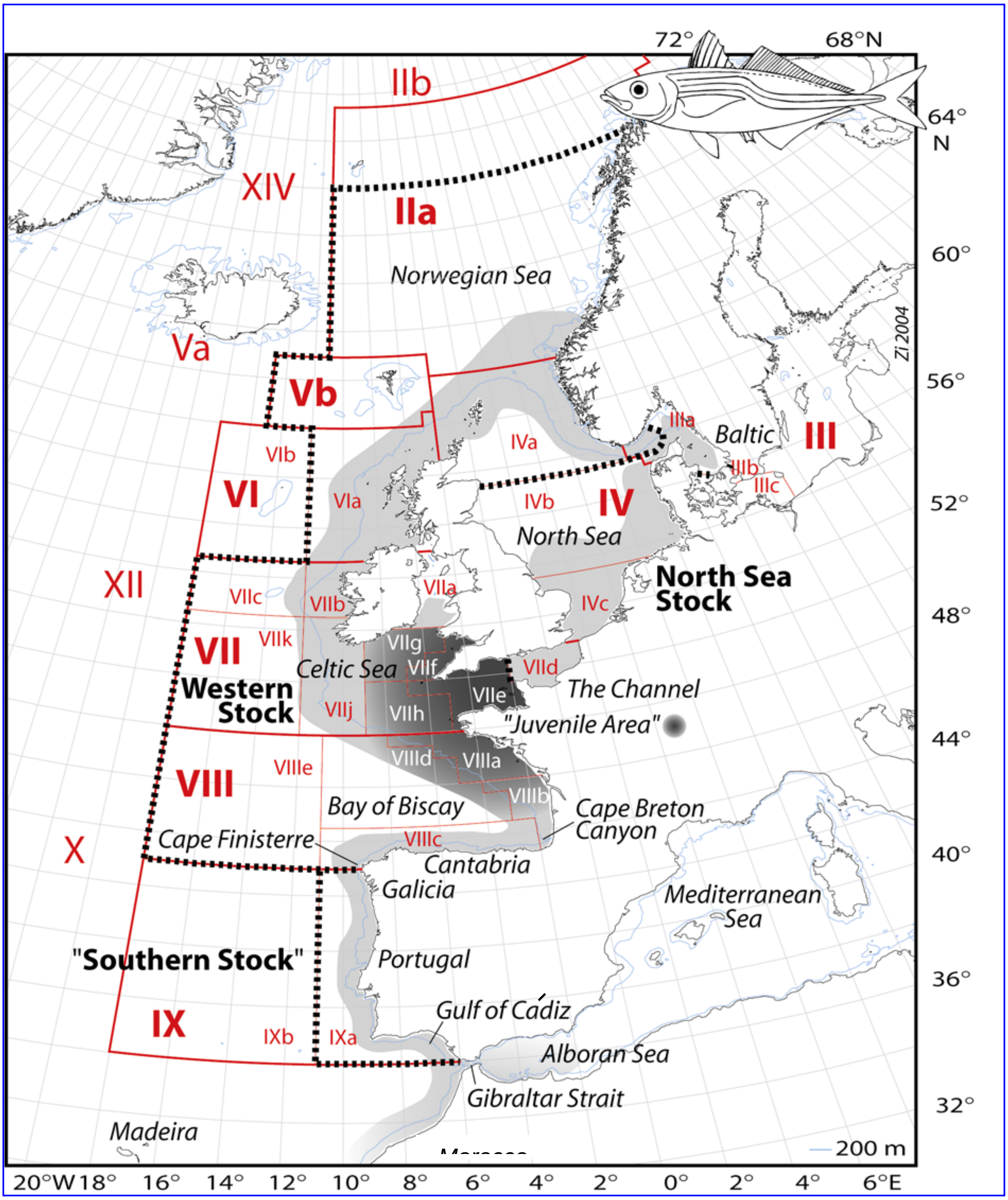

Figure B.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by ICES (2005). Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar projection, 200m depth contour drawn.

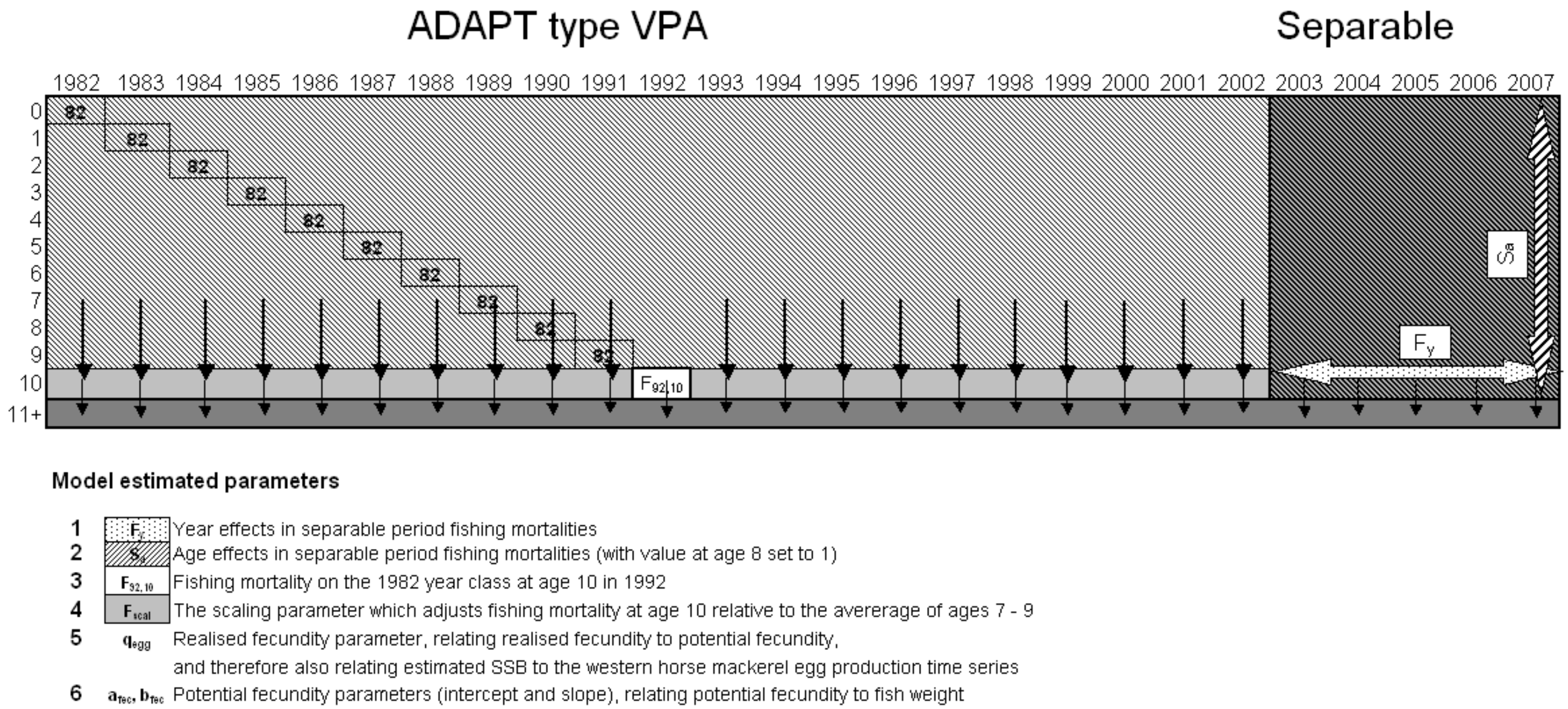

Figure B.2. Western Horse Mackerel. An illustration of the SAD model structure used for the assessment of the Western horse mackerel stock and the "free" parameters estimated by maximum likelihood.

Quality Handbook ANNEX:__C__

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 2010
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:

$var(I) = A^2 \cdot var(Q) + Q^2 \cdot var(A)$,

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 $var(Q) = p \cdot (1-p)$, 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

D. Short-Term Projection

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

I. References

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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:	3 September 2010 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 A.1.1.1 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 2010 sampling of data on weight at age in the stock in this period and area has increased to improve 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

In 2010 WKHERMAT evaluated the information on maturity for this stock. This work was planned to be carried out in the benchmark assessment in 2008 but at that time this information was not available. WKHERMAT proposed to used maturity o-gives based on back calculation of rings on the scale. This information provided a long time series which is reproducable. WGWIDE introduced this times series in the 2010 assessment. The old time series is not longer used and is presented in the stock annex. The text in italics in the folowing paragraphs in this section is old text and no longer valid

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.3.7 Survey 9 Coordinated ecosystem survey in Norwegian Sea and adjoining waters in July-August

Background and status

This ecosystem survey initiated in 2004 by Norway and have since then been gradually expanded in geographical coverage and scientific complexity (e.g. Nøttestad and Jacobsen 2009). In 2009, and 2010, the survey coverage was expanded further with participations of vessels from Iceland and the Faroese in addition to two vessles from Norway. The main objective of the survey is to study abundance, spatiotemporal distribution, aggregation and feeding ecology of Northeast Atlantic mackerel, Norwegian spring-spawning herring, blue whiting and other pelagic species in relation to oceanographic conditions, prey communities and marine mammals. Two different types and independent abundance estimates for herring can de derived from the survey, an acoustic estimate, and swept area estimate from pre-defined surface trawl stations.

Results

The survey was extended very much in 2009, so the acoustic estimates for herring since then (Table B.3.7.1) are not comparable to the previous estimates. An example of the coverage of the survey (2010) is given in Figure B.3.7.1.

Use of this survey in stock assessment

The time series where the herring stock has been coveraged adequately goes only back to 2009. Thus, the survey has not been used directly in the assessment of NSSH.

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, version

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	

The stock summary from the 2009 assessment is included in table 9.4.5.3. The TASACS assessment covers the perio 1988 to the present. The data prior to 1988 originate from the Sea Star assessment carried out in 2007?

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.

MSY reference points (included in 2010)

<u>HCS Simulation model analysis</u>

HCS is a stochastic simulation model for studying different management scenarios. The parameterization of HCS for NSSH is described in a working document sent for WGWIDE in 2010 (WD, Skagen; the values for weights, natural mortality and initial N-values can be found in ICES 2009, WGWIDE Table 7.10.1.3, input to short term prediction; see also Skagen 2010, WD WKFRAME). Two stock-recruitment relationships, Beverton-Holt and hockey stick, are explored:

Beverton-Holt: $R = a*SSB/(SSB+b)$

Hockey stick: $S>b: R = a$

$S<b: R = a*SSB/b$

The stock-recruitment parameters are shown in Table 7.8.2. params, and a plot of these together with the data is shown in Figure 7.8.2.srstoch. A plot of the data together with model output for Beverton-Holt function is show in Figure 7.8.2. srmodeldata, and the cumulative distribution of recruitment in data and model output is shown in Figure 7.8.2.cumdist. The long term sustained yields with Beverton-Holt recruitment function are shown in Figure 7.8.2.catch. A similar figure for hockey stick recruitment function can be found in Skagen 2010 (WD, Skagen).

In WKHERMAT in 2010 a new maturity ogive matrix for NSSH based on a back calculation methods was estimated (ICES 2010, WKHERMAT). This is used in the assessment in 2010. There appears to be a difference in the maturation ogive between strong and weak year classes such that strong year classes tend to mature at later age compared to weak year classes (Engelhart & Heino 2004, ICES 2010, WKFRAME). However, the model used here currently allows only static maturity ogive, and in order to take into account the effect of variation in maturation of strong and weak year classes for MSY and F_{MSY} we have run the analysis using the standard maturity ogive used in assessment the latest years, an ogive estimated for weak year classes and an ogive estimated for strong year classes (Table 7.8.2.modelparams). Furthermore, in year 2009 the selection pattern is different to the historical period, appearing more dome-shaped than the historical sigmoidal selection pattern (Table 7.8.2.modelparams). We have not been able to identify any reason why the selection pattern would have changed, as there have been no changes in gear or fishery in general. Nevertheless, we also studied the effect of possible change in selection pattern by using alternatively the historical (old) or the selection curve from 2009 (Table 7.8.2.modelparams).

The results of the simulation analysis suggest that the MSY, for all the scenarios and with both stock-recruitment functions, is within the same range: between 1 and 1.2 million tonnes (Figure 7.8.2.msyBH, 7.8.2.msyHS, and Table 7.8.2.results). Even though the different scenarios result in MSY within the same range, the F_{MSY} has more variation (Figure 7.8.2.fmsy and Table 7.8.2.results). When Beverton-Holt recruitment function is used, the risk of stock going below B_{lim} (2.5 million t.) and $B_{trigger}$ (4 million t.) at F_{MSY} are both very low, whereas with the Hockey stick recruitment function the risk of the stock falling below $B_{trigger}$ at F_{MSY} is relatively high (Table 7.8.2.results). Hockey stick recruitment function appears not to be very useful in modelling population dynamics, as the spawning stock size where MSY is reached is the same point where stock reproductive capacity starts decreasing (see also the discussion in the equilibrium analysis below). When Beverton-Holt recruitment function is used, unweighted F_{MSY} using the historical fishery selection pattern is 0.16 (for all maturity ogive scenarios), and adopting the 2009 selection pattern suggests of F_{MSY} 0.12 (for all maturity ogive scenarios). In NSSH management weighted F values are used, and the weighted values tend to be somewhat lower than unweighted values (Figure 7.8.2.fvalues). As we have no reason to believe that the selection pattern has really changed, we consider unweighted F_{MSY} to be 0.16. This unweighted F value is in close agreement with the reference values originating from an analysis carried out in 1998 (ICES 2008/ACOM 13), where a weighted F_{pa} is defined as 0.150.

Equilibrium and YPR analyses

Deterministic and stochastic equilibrium analyses were carried out using the 'plot-MSY' software (ICES 2010, WKFRAME) to determine candidate F_{MSY} values for the Norwegian spring spawning herring stock. Stock-recruitment pairs from the period 1988-2009, as outputted from the most recent assessment of the stock, were used together with 5-year averages of selectivity, weight and maturity at age (back-calculated ogive). Two stock recruit relationships were examined, Beverton and Holt and the (‘smooth hockey stick’ (segmented regression), and yield-per-recruit (YPR) analyses were also done. For the stochastic analyses, uncertainty (CVs) in the biological and fishery parameters at age were used to create alternative fits to two stock-recruit relationships (*N*=1000).

While the Beverton and Holt fit is reasonable under using the old maturity ogive to estimate SSB (results not shown), the majority of stochastic stock-recruit model fits fell out of the range of the deterministic fit to the data, and thus it can be concluded that the stock-recruit form is unclear and not suitable for the data and the level of uncertainty associated with the parameters. Using the new back-calculated maturity ogive, as has been decided by the working group for the assessment of this stock, results in an very poor Beverton and Holt fit (Figure 7.8.2.XXXsr), with an extremely steep slope at the origin and an asymptote at the geometric mean recruitment level. Given the lack of any clear patterns in the stock-recruit data, a hockey stick model fit, while uncertain around the origin, probably provides the most cautious fit to the data. For the hockey stick, the slope at the origin is the descending limb of the stock-recruit curve, which for this stock is relatively shallow, hence F_{crash} is low. The value for B_{msy} is at the breakpoint in the hockey stick, hence F_{msy} is estimated to be the same as F_{crash} (Table 7.8.2.XXXmsy). The uncertainty with regards to the slope at the origin makes this stock-recruitment function unsuitable as a basis for advice on F_{msy}. In such cases the slope is more useful as an indication of F_{pa} or F_{lim}.

Given the poor fits to stock recruitment functions, a yield-per-recruit analysis was conducted (Figure 7.8.2.XXXypr). The stochastic analysis shows a high degree of uncertainty and a very poorly defined F_{max}. That both the hockey stick and per-recruit analysis suggests a high degree of uncertainty with regards to F_{max} could be down to the assumptions made about the uncertainties input into the analyses, though these assumptions are believed to be realistic given the information on the stock. This would preclude the use of F_{max} as an F_{msy} proxy, although $F_{0.1}$ may remain a viable, safer alternative. The YPR curve shows that F values in the range 0.125-0.15 are likely to result in high long term yields.

<u>Conclusions</u>

In the equilibrium analysis, the structure of the stock and recruitment pairs as estimated from the most recent assessment does not lead to any clear definition of an optimum yield equilibrium fishing mortality level. Given this uncertainty it is more appropriate to select an F_{msy} proxy tested by a stochastic simulation model that takes into account the long term trends in the stock biomass. The simulation model results presented in this report and in the stock annex provide a more appropriate method for the determining a viable long term target, and the values from this analysis could be put forward as potential F_{msy} targets. However, it should be noted that it is clear that the estimation of MSY reference points is very sensitive to the choice of stock-recruitment function and the approach chosen to estimate the reference points. This is in accordance with previous analyses by Skagen (WD 2010) and by WKFRAME (ICES 2010, WKFRAME).

The stochastic model uses unweighted F values, which have historically been found to be slightly lower than the unweighted values (Figure 7.8.2.fvalues). Therefore, a weighted F_{msy} of 0.15 corresponding to the unweighted 0.16 F_{msy} proxy from the simulation analyses is proposed for this stock. This is in agreement with the current simulation-tested management plan F_{pa} level and should ensure high long term yield with a low risk to the stock.

Table 7.8.2.params. Norwegian spring spawning herring. Stock recruitment parameters used in the simulation model and their fit to the data (Skagen 2010).

	a-parameter	**b-parameter**	**SSQ**
Beverton-Holt	180805	6986	81.85
Hockey stick	88803	3957	81.47

Table 7.8.2.modelparams. Norwegian spring spawning herring. Age-specific maturation probabilities, exploitation patterns and weight at age in stock and in catches used in the different stochastic simulation scenarios.

	Maturity ogive			Exploitation pattern		Weight at age	
Age	historic	weak year class	Strong year class	Old	2009	stock	catch
0	0	0	0	0.00	0.00	0.001	0
1	0	0	0	0.05	0.00	0.01	0.052
2	0	0	0	0.04	0.87	0.033	0.115
3	0	0	0	0.05	0.26	0.077	0.159
4	0.3	0.4	0.1	0.18	0.29	0.141	0.225
5	0.9	0.8	0.6	0.41	0.47	0.215	0.264
6	1	1	0.9	0.67	0.84	0.27	0.301
7	1	1	1	1.03	0.93	0.306	0.32
8	1	1	1	1.10	1.01	0.336	0.338
9	1	1	1	0.81	1.65	0.346	0.359
10	1	1	1	1.03	1.10	0.364	0.366
11	1	1	1	0.77	0.73	0.369	0.375
12	1	1	1	1.42	1.14	0.411	0.391
13	1	1	1	1.36	0.59	0.353	0.397
14	1	1	1	1.39	0.56	0.389	0.396
15	1	1	1	1.39	0.56	0.393	0.406

Table 7.8.2.results. Norwegian spring spawning herring. MSY and FMSY values provided by HCS model for different scenario combinations. Risk B_{lim} refers to the probability that SSB < B_{lim} in the last year (2.5 million tonnes), and Risk $B_{trigger}$ refers to the probability that SSB < $B_{trigger}$ ($B_{trigger}$ = 5 million tonnes, risk calculated as risk B_{lim}).

		Beverton-Holt				Hockey stick			
Ogive	selection pattern	FMSY	MSY	Risk Blim	Risk Btrigger	FMSY	MSY	Risk Blim	Risk Btrigger
Historical	old	0.16	1120.1	0	0.026	0.32	1180.1	0.067	0.354
	2009	0.12	1071.5	0.006	0.064	0.2	1135.7	0.088	0.431
Weak year class	old	0.16	1132.8	0	0.022	0.32	1193.4	0.058	0.321
	2009	0.12	1083.4	0.006	0.051	0.2	1149.4	0.075	0.401
Strong year class	old	0.16	1093.3	0.002	0.045	0.26	1157.9	0.04	0.232
	2009	0.12	1046.4	0.007	0.086	0.16	1117.9	0.017	0.203

Table 7.8.2.msy. Deterministic and stochastic estimates of *F* and biomass reference points form two stock recruit relationships and yield-per-recruit analysis for the Norwegian spring spawning herring stock (*=poorly defined).

Beverton-Holt

	Fcrash	Fmsy	Bmsy	MSY
Deterministic	*	*	0.25	1.06
50%ile	0.52	0.15	3.11	0.61
CV	1.09	0.60	0.72	0.61

Hockey Stick

	Fcrash	Fmsy	Bmsy	MSY
Deterministic	0.18	0.18	4.25	0.70
50%ile	0.20	0.20	3.88	0.90
CV	0.71	0.69	0.39	0.49

Per recruit

	F01	Fmax
Deterministic	0.23	*
50%ile	0.19	0.77
CV	0.39	0.58

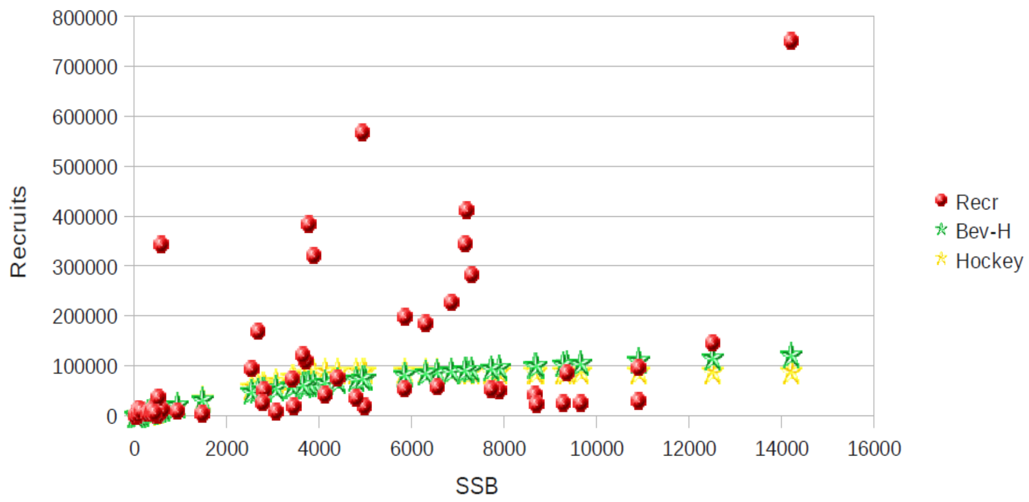

Figure 7.8.2. srstoch. Stock recruitment relationship used in the simulation model. Red dots show the recruitment from data, green stars the fitted Beverton-Holt function and yellow stars the fitted hockey stick function. Figure show also in Skagen 2010 (WD, Skagen).

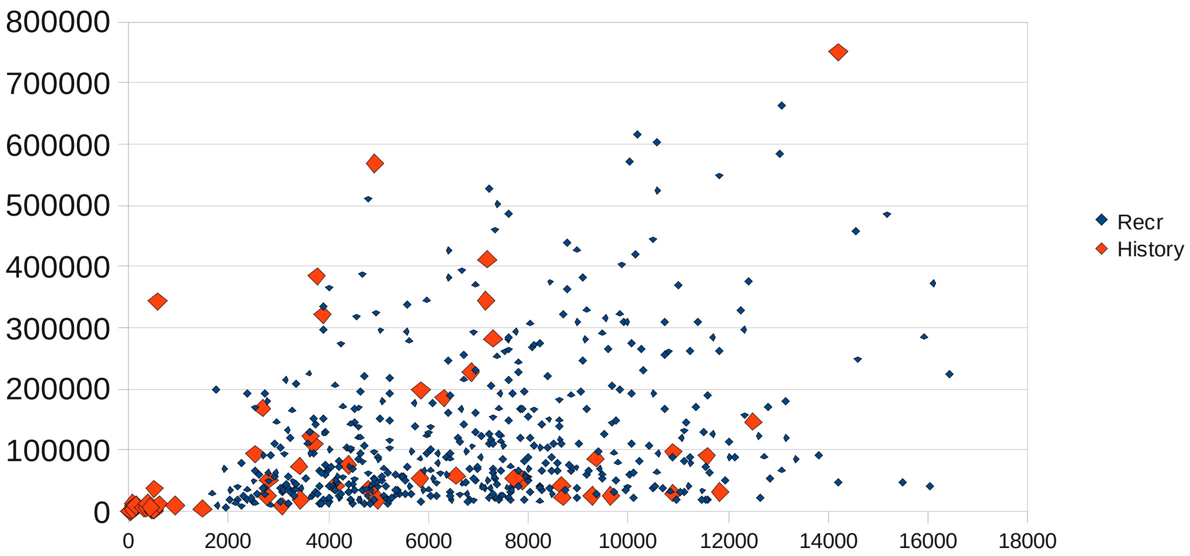

Figure 7.8.2.srmodeldata. Norwegian spring spawning herring. Stock-recruitment of NSSH from data (big red diamonds) and produced by the model (blue small diamonds) using Beverton-Holt recruitment function.

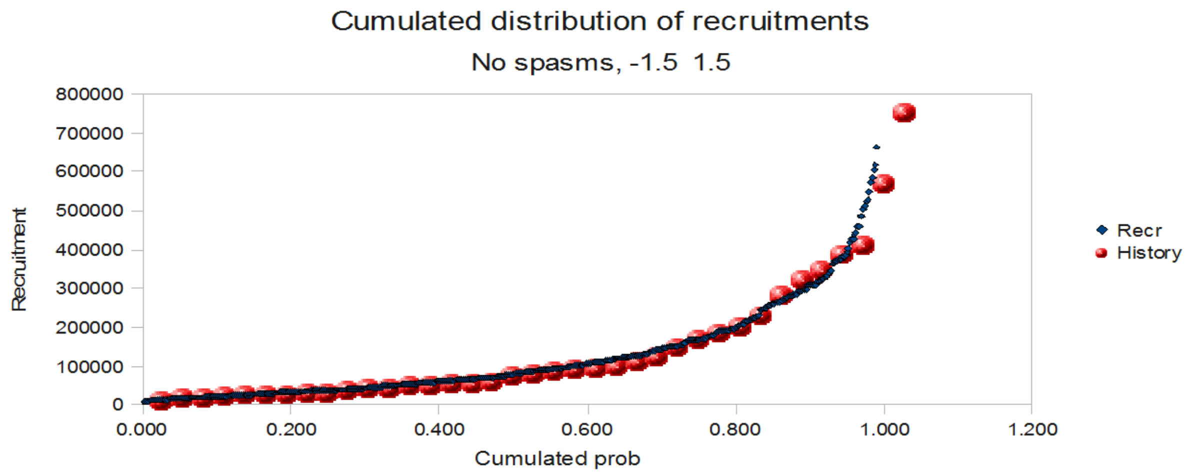

Figure 7.8.2.cumdist. Norwegian spring spawning herring. Cumulative probability of recruitment values of NSSH from the data (red dots) and produced by the model (small blue diamonds) using Beverton-Holt recruitment function.

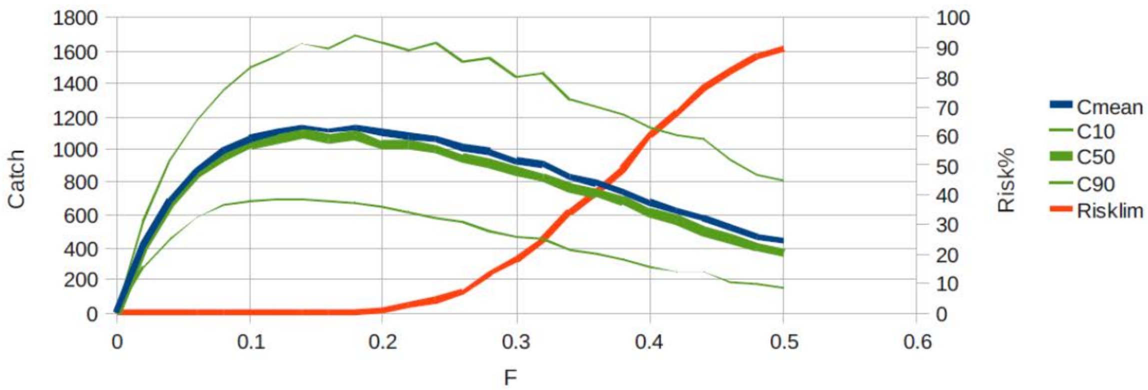

Figure 7.8.2.catch. Norwegian spring spawning herring. Yield (catch) and the probability of the stock being below Blim (2.5. million tonnes) after 50 years at target F for NSSH using Beverton-Holt recruitment function. C10, C50 and C90 show the 10, 50 and 90 percentiles of catch. Risklim shows the probability of stock falling below B_{lim} as a percentage of the model runs. For similar figure for hockey stick recruitment function see WD Skagen 2010.

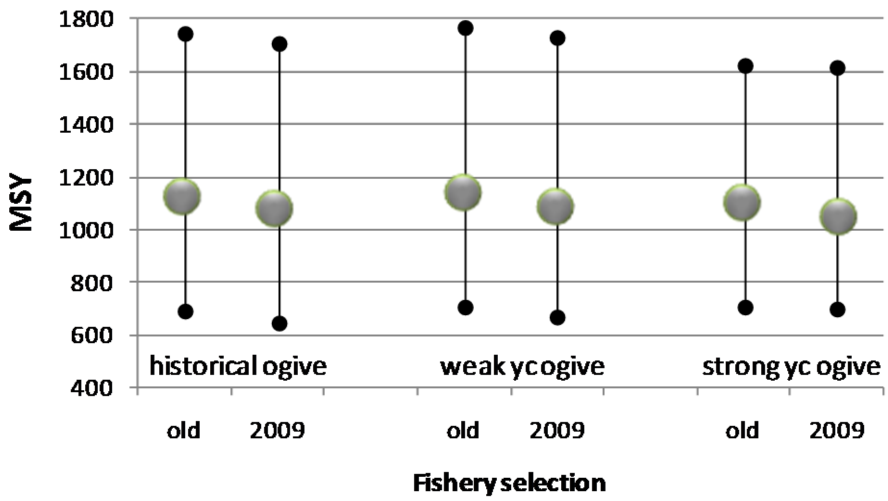

Figure 7.8.2.msyBH. Norwegian spring spawning herring. The MSY for three different maturity ogives and two different fishery selection patterns with 10 and 90 percentiles using Beverton-Holt recruitment function. See text for further details.

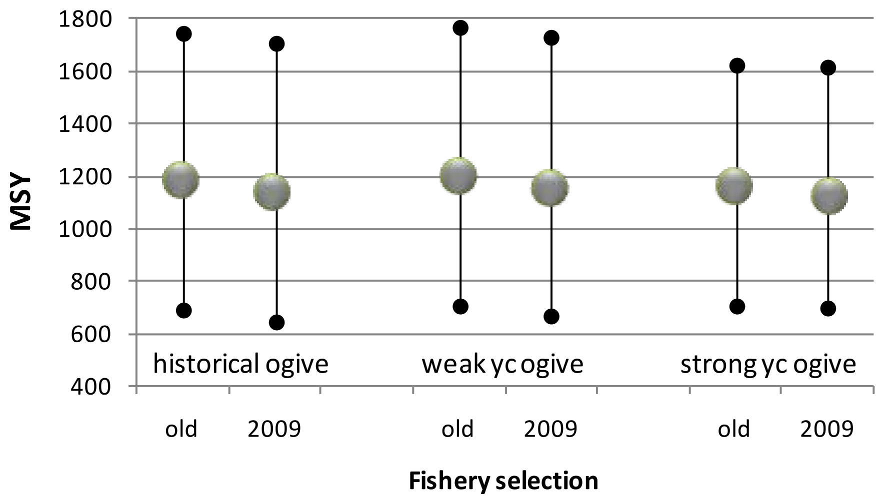

Figure 7.8.2.msyHS. Norwegian spring spawning herring. The MSY for three different maturity ogives and two different fishery selection patterns with 10 and 90 percentiles using hockey stick recruitment function. See text for further details.

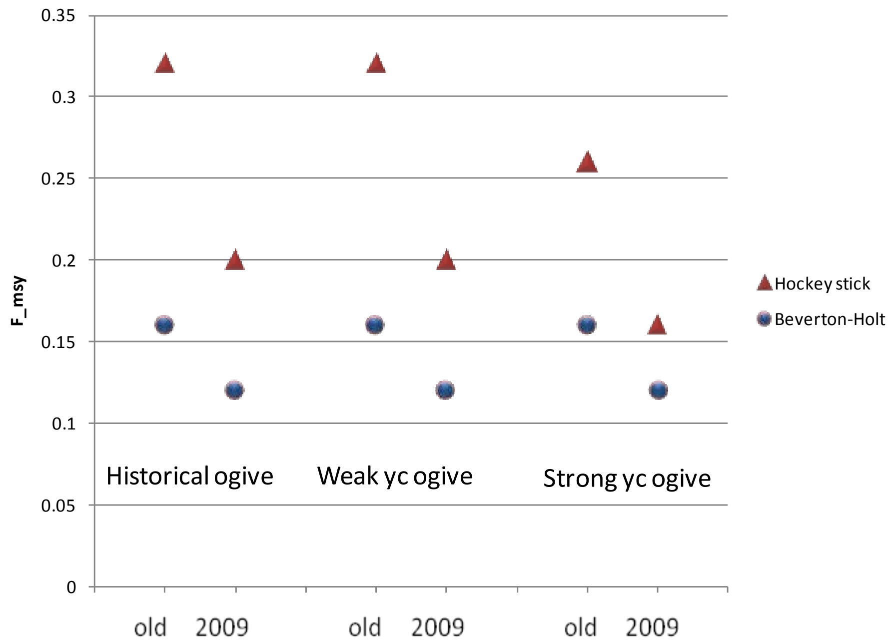

Figure 7.8.2.fmsy. Norwegian spring spawning herring. F_{MSY} for three different maturity ogives and two different fishery selection patterns with Beverton-Holt and hockey stick recruitment function. See text for further details.

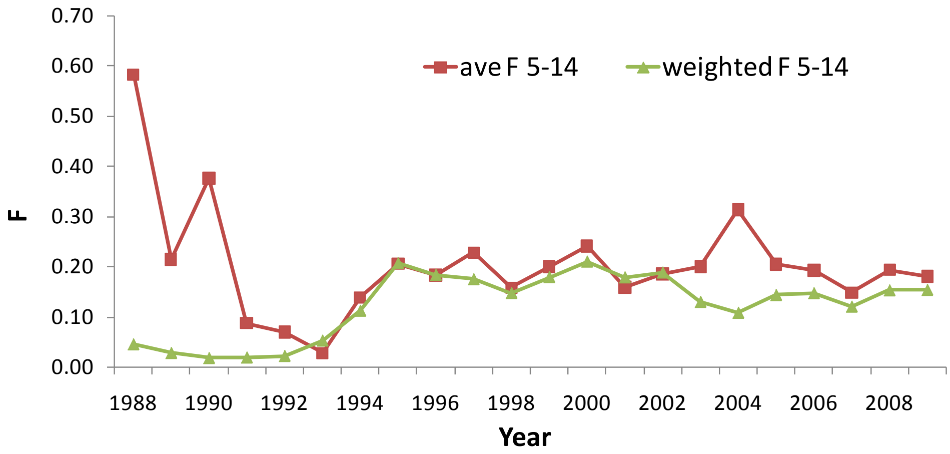

Figure 7.8.2.fvalues. Norwegian spring spawning herring. Unweighted (red squares) and weighted (green triangles) average F values from the current assessment.

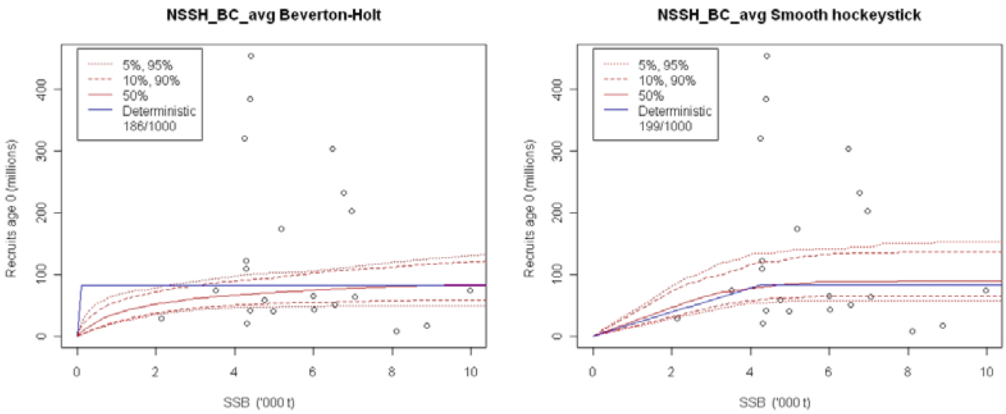

Figure 7.8.2.sr. Deterministic and stochastic (taking into account uncertainty in weights, selectivity and maturity at age) stock recruit relationship fits for the Norwegian spring spawning herring stock. Stock-recruit pairs are from the period 1988-2009.

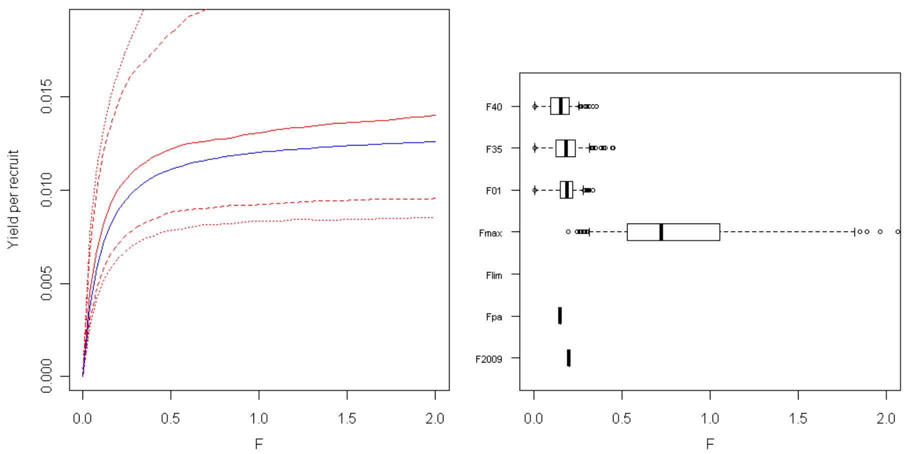

Figure 7.8.2 ypr. The yield-per-recruit (YPR) curve for the Norwegian spring spawning herring stock (left) and resulting stochastic estimates of *F* reference points (right).

G.3. 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

Table B.2.4.1. Norwegian spring spawning herring. Maturity at age information used in the assessments before the 2010 assessments.

	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 assessments before the 2010 assessments.

	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**

Table B.3.7.1. Norwegian spring spawning herring. Acoustic estimates from the coordinated ecosystem survey in Norwegian Sea and adjoining waters in July-August. Numbers in millions. Biomass in thousands. ***Survey 9.***

	survey 9						Age									Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	Biomass
2009	0	415	4136	3522	12448	7479	12362	1223	2144	1761	410	0	157	75	756	46888	13603
2010	543	327	1309	2631	2500	10141	6619	6471	1163	2310	804	422	166	87	144	35637	10717

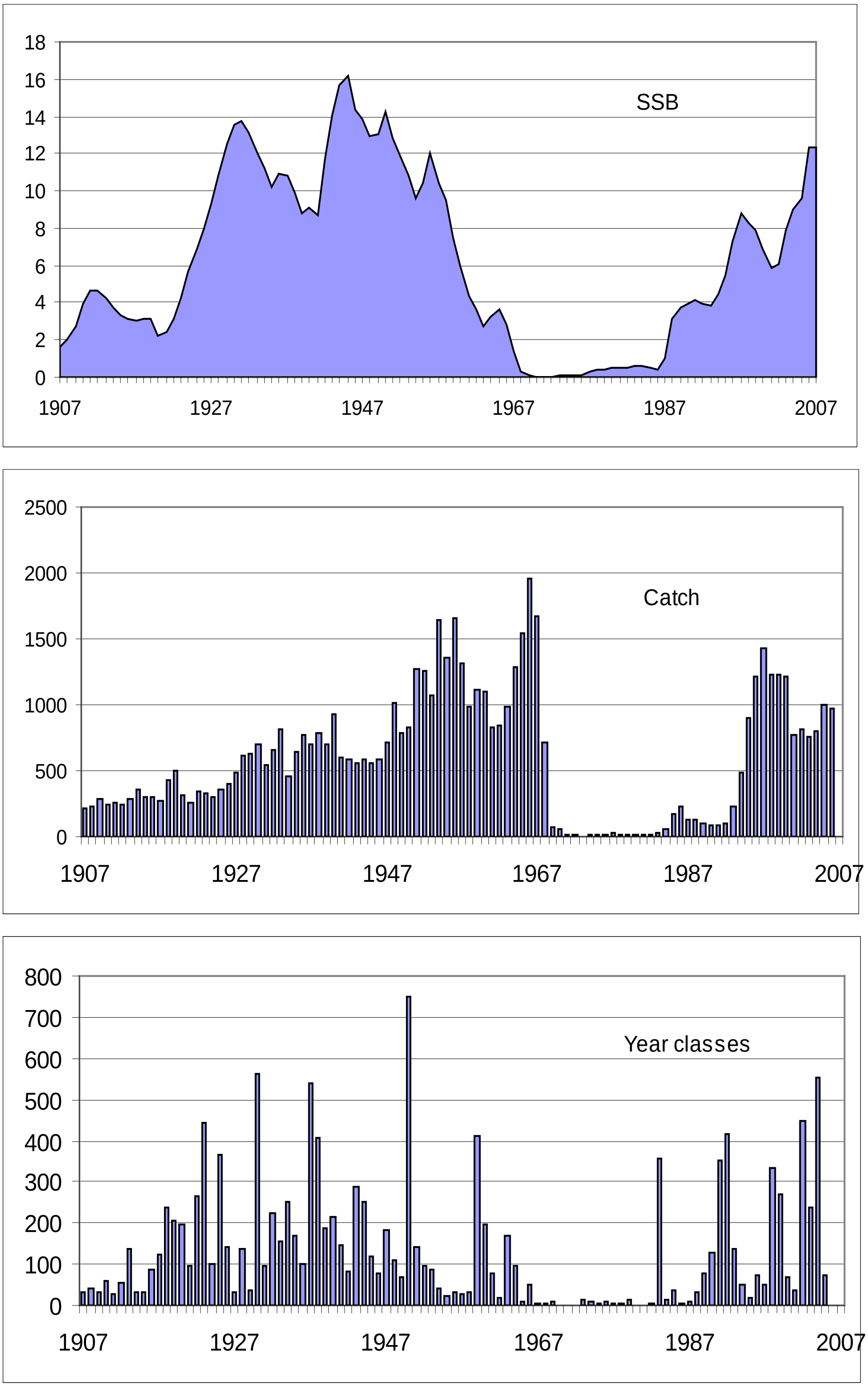

Figure A.1.1.1. Norwegian spring spawning herring. Long term trends in spawning stock, catches and recruits (1907-1988 from Toresen and Østvedt; 1989-2007 from WGNPBW 2007).

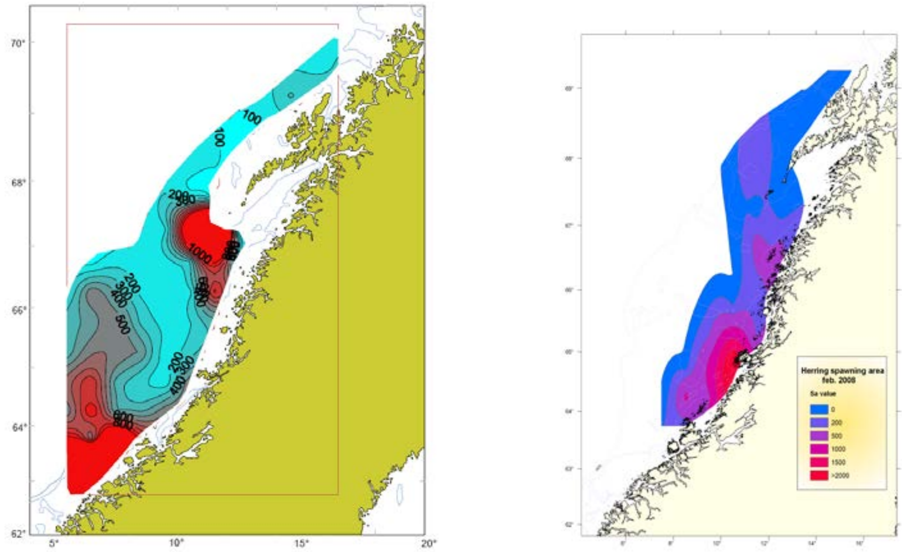

Figure B.3.1.1. NSSH Acoustic survey on spawning grounds in February March, 2007 (left) and 2008 (right).

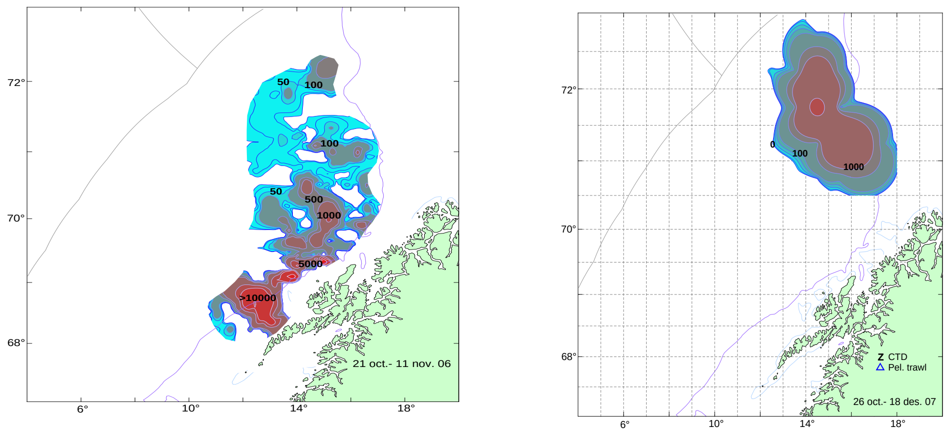

Figure B.3.2.1. NSSH Acoustic survey in November/December 2006 (left panel here) and 2007 (right panel).

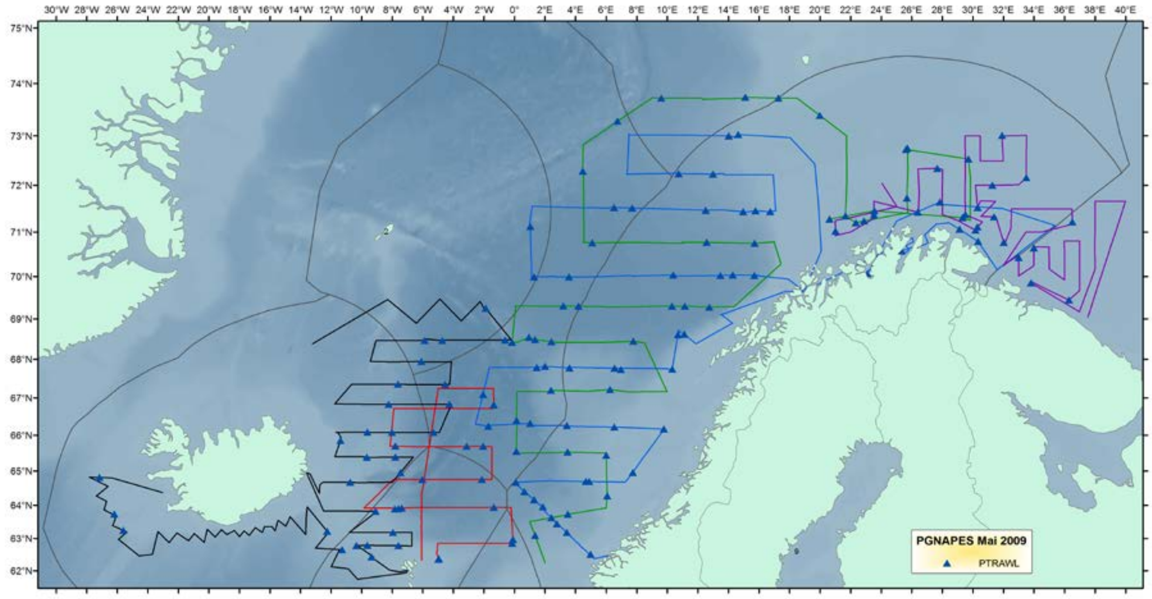

Figure B.3.4.1. Cruise tracks during the International North East Atlantic Ecosystem Survey in April-May 2009 and location of trawl stations.

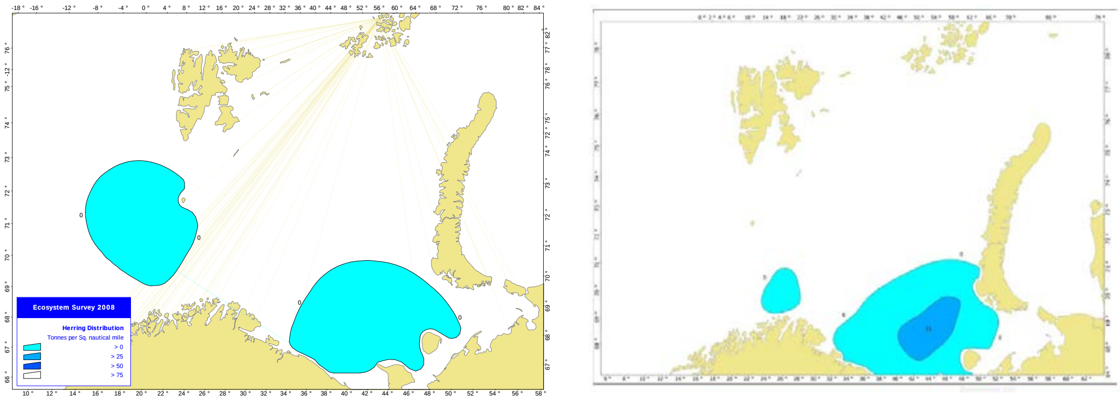

Figure B.3.5.1. Estimated total density of herring (tonnes/nautical mile²) in August-September 2008 (left panel) and 2007 (right panel).

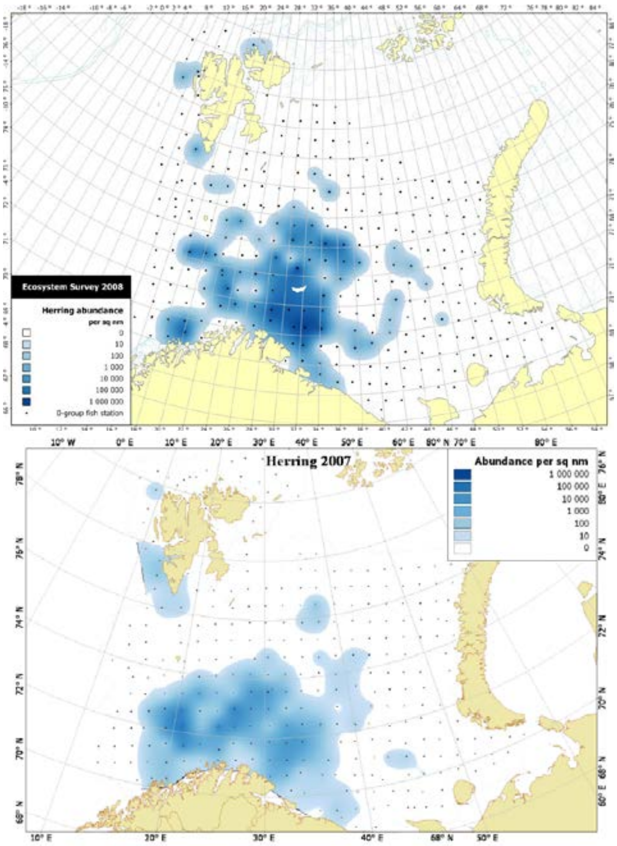

Figure B.3.5.2. NSSH O–group surveys in August/September in the Barents Sea in 2008 (left panel) and 2007 (right panel).

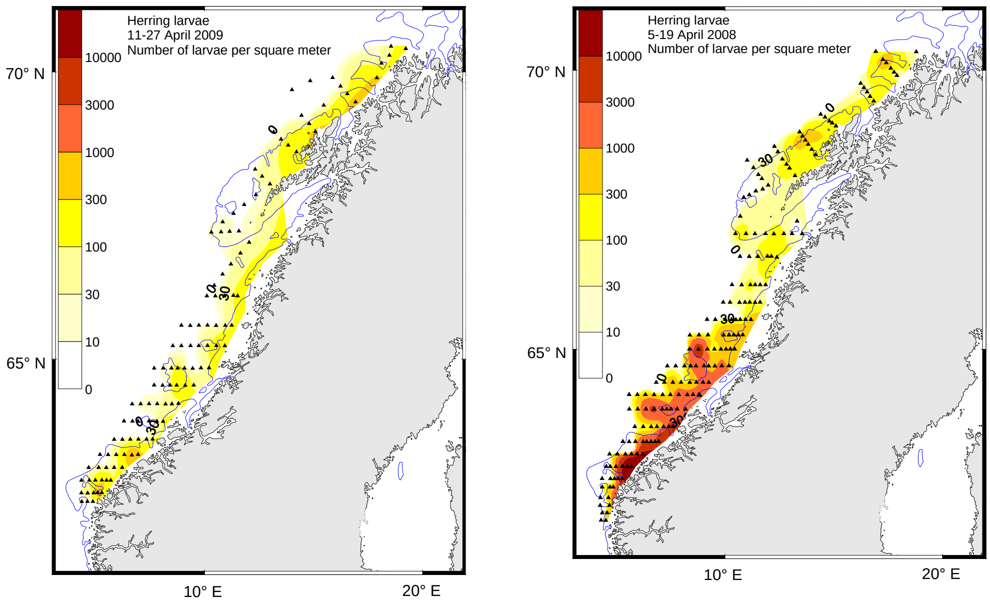

Figure B.3.6.1. NSSH. Distribution of herring larvae on the Norwegian shelf in 2009 (left panel) and 2008 (right panel). The 200 m depth line is also shown.

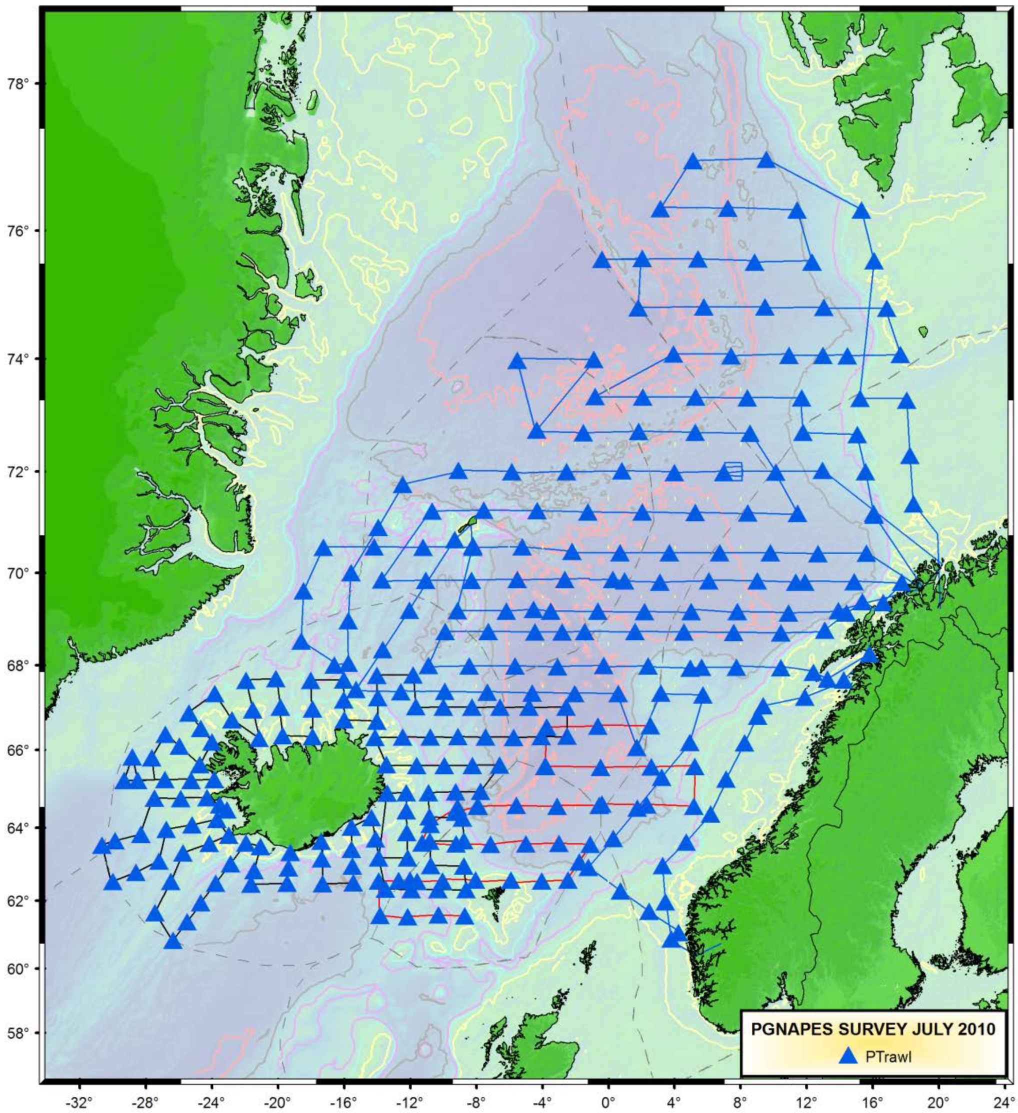

Figure B.3.7.1. Cruise tracks during the coordinated ecosystem survey in Norwegian Sea and adjoining waters in July-August 2010 and location of trawl stations.

Table 9.4.5.3 Herring in the Northeast Atlantic (Norwegian spring-spawning herring). Summary of the stock assessment. Data prior to 1988 are from the 2006 assessment year.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	F weighted Ages 5-14
1950	751000000	14200000	826000	0.0584
1951	146000000	12500000	1280000	0.0697
1952	96600000	10900000	1250000	0.0728
1953	86100000	9350000	1070000	0.0663
1954	42100000	8660000	1640000	0.1130
1955	25000000	9270000	1360000	0.0783
1956	29900000	10900000	1660000	0.1100
1957	25400000	9650000	1320000	0.1030
1958	23100000	8690000	986000	0.0787
1959	412000000	7180000	1110000	0.1130
1960	198000000	5850000	1100000	0.1360
1961	76100000	4390000	830000	0.1040
1962	19000000	3440000	849000	0.1460
1963	169000000	2670000	985000	0.2530
1964	93900000	2530000	1280000	0.2260
1965	8490000	3060000	1550000	0.2780
1966	51400000	2800000	1960000	0.6960
1967	3950000	1470000	1680000	1.5200
1968	5190000	344000	712000	3.4900
1969	9780000	145000	67800	0.5900
1970	661000	71000	62300	1.3200
1971	236000	32000	21100	1.5300
1972	957000	16000	13200	1.5000
1973	12900000	85000	7020	1.1700
1974	8630000	91000	7620	0.1140
1975	2970000	79000	13700	0.1900
1976	10100000	138000	10400	0.1060
1977	5100000	286000	22700	0.1110
1978	6200000	358000	19800	0.0434
1979	12500000	388000	12900	0.0238
1980	1470000	471000	18600	0.0341
1981	1100000	504000	13700	0.0215
1982	2340000	503000	16700	0.0200
1983	343000000	575000	23100	0.0291
1984	11500000	602000	53500	0.0903
1985	36600000	515000	170000	0.3790
1986	6040000	437000	225000	1.0700
1987	9090000	926000	127000	0.4040
1988	25724000	2768000	135301	0.045
1989	73988400	3409000	103830	0.029
1990	109705800	3702000	86411	0.022

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	F weighted Ages 5-14
1991	320875600	3877000	84683	0.023
1992	383921700	3767000	104448	0.027
1993	121890400	3641000	232457	0.064
1994	42242100	4122000	479228	0.129
1995	18643900	4976000	905501	0.229
1996	57789400	6545000	1220283	0.192
1997	50575900	7887000	1426507	0.180
1998	282407700	7290000	1223131	0.153
1999	227356600	6852000	1235433	0.186
2000	54030800	5837000	1207201	0.213
2001	35695300	4794000	766136	0.180
2002	568142000	4928000	807795	0.184
2003	185261300	6298000	789510	0.114
2004	344513300	7149000	794066	0.094
2005	53536700	7715000	1003243	0.128
2006*	90770000	11580000	968958	0.131
2007*	30990000	11836000	1266993	0.098
2008**	103000000	12437000	1545656	0.125
2009**	103000000	13300000		
Average	100457748	4646433	690524	0.3220

*** Recruitment value has been replaced in the forecast by RCT estimate.**

**** GM mean 1989-2005**

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:	Updated in September 2010.
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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 the 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 differences 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 by 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% of the total in the mid-1990s 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 blue whiting spawning areas 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 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 RMC/06, 2009). The overlapping distribution of feeding mackerel within 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^{o}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 to 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.

Recruitment

A workshop was held in 2009 that examined blue whiting recruitment. The group reviewed and updated existing work on both the oceanography in the region and the distribution dynamics of blue whiting, particularly focusing on the most recent observations. A broad selection of hypothesizes were examined that may explain the recruitment dynamics of this stock. The group focused on two potential mechanisms that may account for the hypothesized links between the oceanographic climate and the recruitment dynamics.

1. The predation hypothesis

This hypothesis examines the role of mackerel predation and changes in the spawning distribution of blue whiting. Changes in the spawning distribution lead to changes in the mackerel-blue whiting larvae overlap, and therefore the degree of predation.

2. The food hypothesis

This hypothesis is based on the amount and availability of food to the larvae and juveniles. Changes in the oceanographic conditions may change the food availability and ultimately impact larval/juvenile growth, survival and recruitment. More research if required to examine these topics (ICES, 2009 c, RMC:09)

Finally, the workshop examined potential schemes that could be used for generating recruitment forecasts. A high-degree of autocorrelation is present in the time-series, and indeed the assumption that recruitment in the following year is the same as the recruitment in the previous year was found to give relatively good predictions (r2=0.57). However, in the absence of a detailed process understanding, it was not possible to move beyond such basic schemes towards making genuine, knowledge-based, forecasts. Further research is required.

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 produced the standard outputs on sampling status and biological parameters. It also clearly documented any decisions made by the stock co-ordinators for filling in missing data and raising the catch information of one nation/quarter/area with information from another data set.

InterCatch

InterCatch which is a web-based system for handling fish stock assessment data was first used in 2009. Blue Whiting data are submitted using the ‘Data Submission Workbook’ spreadsheet and converted into the InterCatch format by the program “InterCatchFilemaker”, developed by Andrew Campbell from Marine Institute, Galway, Ireland. The total International Catch-at-Age was obtained through the InterCatch web program in 2009 and 2010. The allocations for those countries reporting 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).

An otolith exchange is being carried out in 2009/2010 with a workshop planned for 2011.

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 1981–2009 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 assessment model.

Discards

Discards of blue whiting are thought to be small. Most of the blue whiting caught in directed fisheries are used for reduction to fish meal and fish oil. However, some discarding occurs in the fisheries for human consumption and as bycatch in fisheries directed towards 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 (IBWSS)

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 WGNAPES. 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 and the time series is now 7 years with ages 3-8 used.

2. International ecosystem survey in the Nordic Seas (IESNS)

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 WGNAPES. Ages 1-2 from this survey are used to tune the assessment.

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 declining 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.

<u>Models used for exploratory assessments</u>

1. TISVPA

Since 2006 a "triple-separable" version of the ISVPA model (TISVPA) was used for exploratory blue whiting assessment runs (Vasilyev, 2006). 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 reason. 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 model settings 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 IBWSS (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 to the catch-at-age data. The results are presented in annual working group reports.

TISVPA was used again in 2010 with the following settings:

- the "mixed" version (residuals in catch-at-age are attributed both to violations of selection pattern stability and to errors in catch-at-age data) with the condition of unbiased separable representation of fishing mortalities (more correctly - of exploitation rates)
- window for estimation of cohort-factors from age 1 to age 8
- the measure of closeness of fit for catch-at-age was the absolute median deviations (AMD) in residuals in logarithmic catch-at-age. For survey 2 the AMDs in residuals between logarithmic abundance-at-age from the survey and their model-derived values were minimized, for surveys 1 and 3 the measure of closeness of fit was sum of squared residuals in abundance-at-age. Catchability coefficients were estimated for all surveys. The overall objective function was the weighted sum of the above mentioned components.

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 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:

Table of final assessment settings from 2007-2010

Settings/options for the final assessment	**2007**	**2008**	**2009**	**2010**
Software	SMS	SMS	SMS	SMS
Age range for the analysis	1–10+	1–10+	1-10+	1-10+
Last age a plus-group?	Yes	Yes	Yes	Yes
Catch data				
Constant selection pattern for the catch	2 periods: 1981–1992,1993–2006	2 periods: 1981–1999,1999–2007	2 periods: 1981–1999,1999–2008	2 periods: 1981–1999,1999–2009
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**	1993–2003	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**	2000–2007	2000–2008	2000-2009	2000-2010
First age with age independent catchability	2	2	2	2
Age groups with the same variance	1, 2	1, 2	1,2	1,2
International blue whiting spawning stock ground survey , ages 3–8	2004–2007	2004–2008	2004-2009	2004-2010
First age with age independent catchability	5	5	5	5
Age groups with the same variance	3–8, min std 0.4	3–8, min std 0.4	3–8, min std 0.4	3–8, min std 0.4

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1981 – 2009	1-10	Yes
Canum	Catch at age in numbers	1981 - 2009	1-10	Yes
Weca	Weight at age in the commercial catch	1981 – 2009	1-10	Yes
West	Weight at age of the spawning stock at spawning time.	1981 – 2009	1-10	Yes
Mprop	Proportion of natural mortality before spawning	1981 – 2009	1-10	No
Fprop	Proportion of fishing mortality before spawning	1981 - 2009	1-10	No
Matprop	Proportion mature at age	1981 - 2009	1-10	No
Natmor	Natural mortality	1981 - 2009	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 - 2010	1-2
Tuning fleet 3	International Spawning Stock Survey	2004 - 2010	3-8

D. Short-Term Projection

Software used: MFDP (Multi Fleet Deterministic Projections)

Initial stock size: Stock numbers from the assessment

Recruitment: At the 2007 working group recruitment estimates for input to the short term forecast were based on a mean of two surveys. The surveys used were the International ecosystem survey in the Nordic Seas with full coverage and one from the Barents Sea winter survey. The reason for not using the final assessment estimate of recruitment at age 1 in 2006 is that this is unrealistically low and appeared as an extreme outlier (ICES 2007a).

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.

In 2010 the surveys provided very low indices of recruitment which may not be realistic. It was therefore decided to use the lowest observed recruitment estimate produced by the assessment in the forecasts.

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 1st 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 in 2007 (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 advised 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.

In 2009 ICES advised that based on the most recent estimates of SSB (in 2009) and, fishing mortality (in 2008), ICES classifies the stock as having full reproductive capacity and being harvested sustainably (F=0.29). Year classes 2005-2008 are among the lowest observed. Due to recent low recruitment, SSB has declined from its historical peak in 2003-2004 of more than 7 million tonnes to 3.6 million tonnes at the beginning of 2009, and the decline is expected to continue in the short-term.

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, the TAC is 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.

<u>Text for the 2005 management plan for Blue Whiting</u>

7) *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.*

8) *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.*

9) *For 2006, the Parties agree to limit their fisheries of blue whiting to a total allowable catch of no more than 2 million tonnes.*

10) *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.

11) *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.*

12) *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.*

13) *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 2008 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 (B_{lim}).

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 and 6, the Parties agree to establish the TAC consistent with reductions in fishing mortality of 35% each year until the fishing mortality established in paragraph 4 and 6 has been reached. This paragraph shall apply only during 2009 and 2010.

6) 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.

7) 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:

   a. • In the case that the spawning biomass is forecast to reach or exceed 2.25 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.

b. • In the case that the spawning biomass is forecast to be less than 2.25 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:

$$F = 0.05 + [(B - 1.5)(0.18 - 0.05) / (2.25 - 1.5)]$$

c. • 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.

8) 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 2.25 million tonnes, the Parties agree to discuss the appropriateness of adopting constraints on TAC changes within the plan.

9) 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

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
2010	3.19	0.10

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

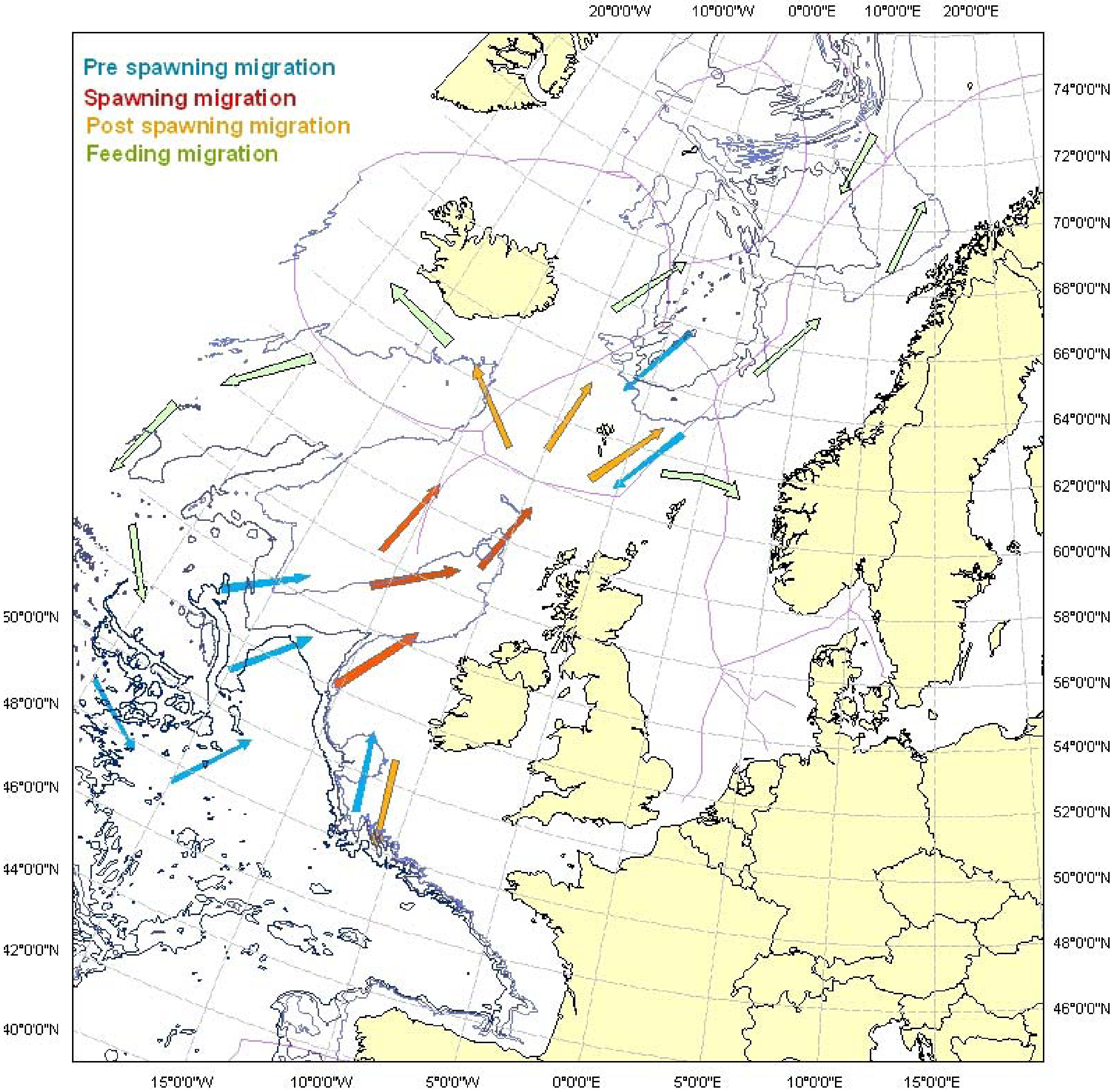

Figure E1. Migration routes for the blue whiting in the Northern Atlantic. Tangen and Sveinbjörnsson (Source: Worsoe Clausen, *et al* 2005)

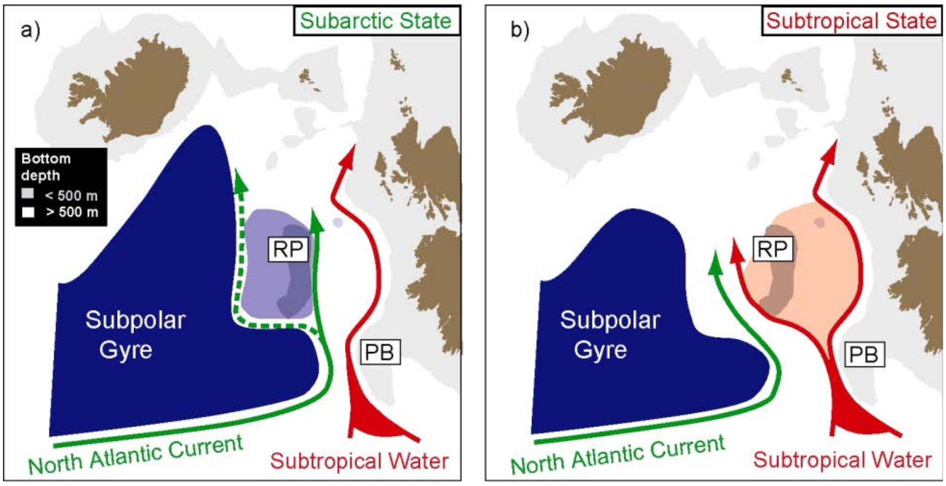

Figure E2 Outline of the source flows to the blue whiting spawning grounds in the Rockall Region. (a) A strong subpolar gyre (SPG) results in strong influence of cold subarctic water near the Rockall Plateau. (b) A weak gyre results in warm subtropical dominance near the plateau (based on Hátún *et al.,* 2005). Abbreviations - RP: Rockall Plateau and PB: Porcupine Bank. (Source: Hatun *et al* 2009a)

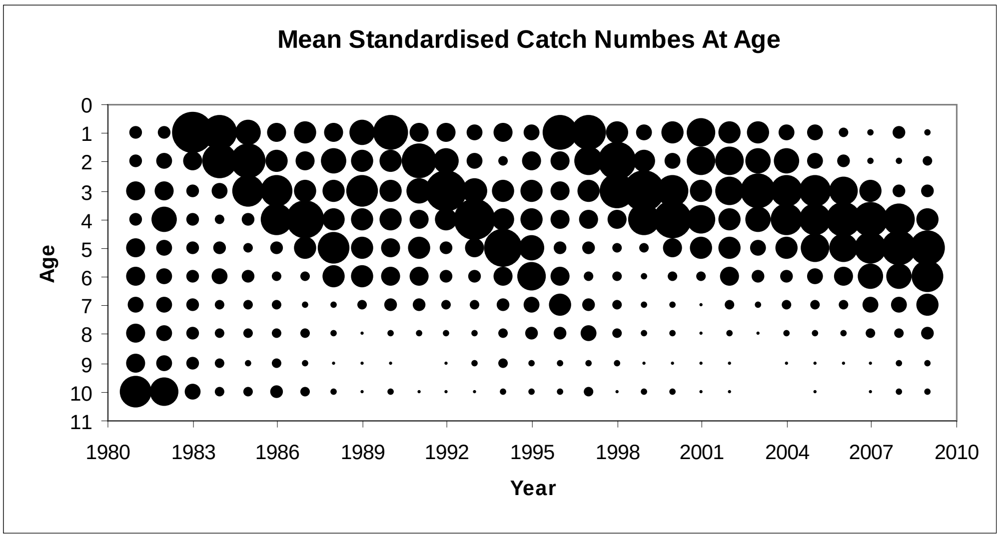

Figure E3: Catch numbers at age mean standardised by year 1981 - 2009

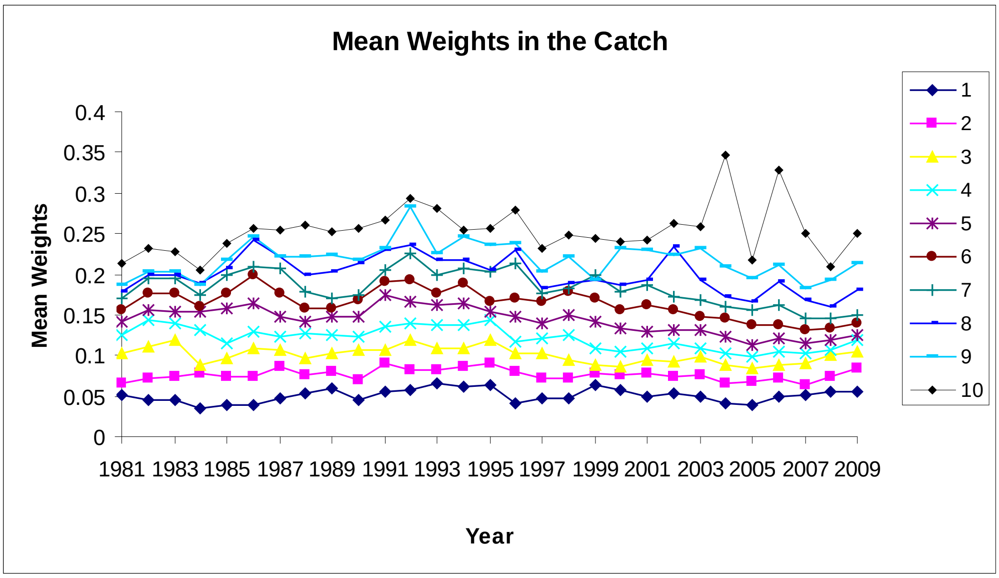

Figure E4: Mean weight in the catch 1981-2009

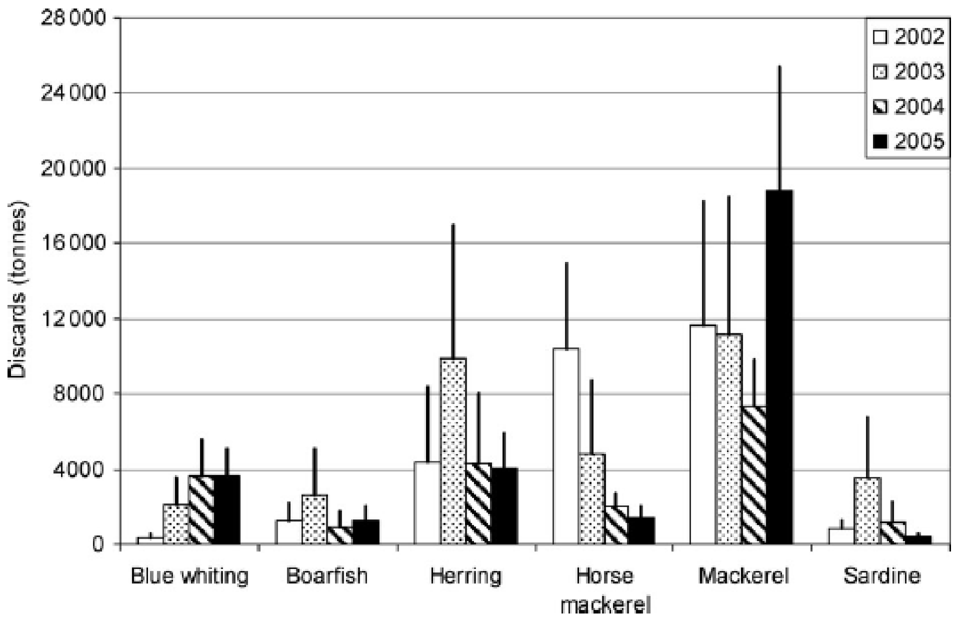

Figure E5: Biomass discarded by the Dutch freezer trawler fleet annually (raised using total number of trips) for the six most discarded species. The vertical lines represent the standard error on the estimates. (From Borges *et al* 2008)

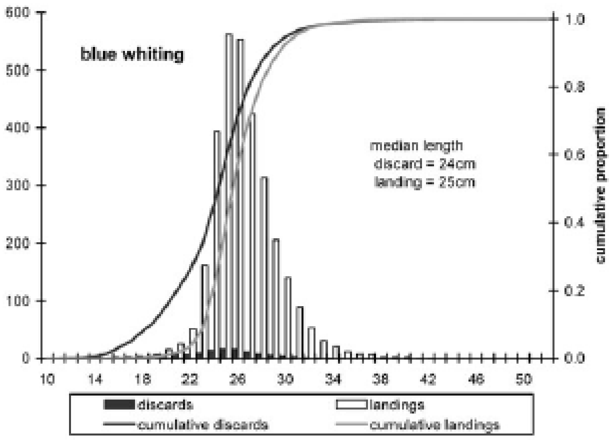

Figure E6: Length frequencies of discarded (filled histograms) and landed blue whiting (white histograms) by the Dutch fleet between 2002 and 2005. (From Borges, *et al* 2008)

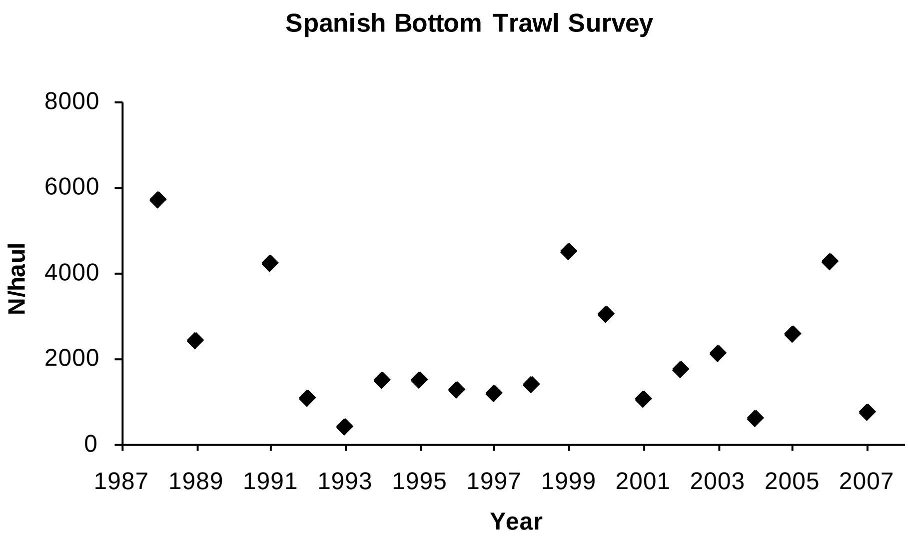

Figure E7. Mean catch rates (Kg/haul and Number/haul) of blue whiting in Spanish bottom trawl survey.

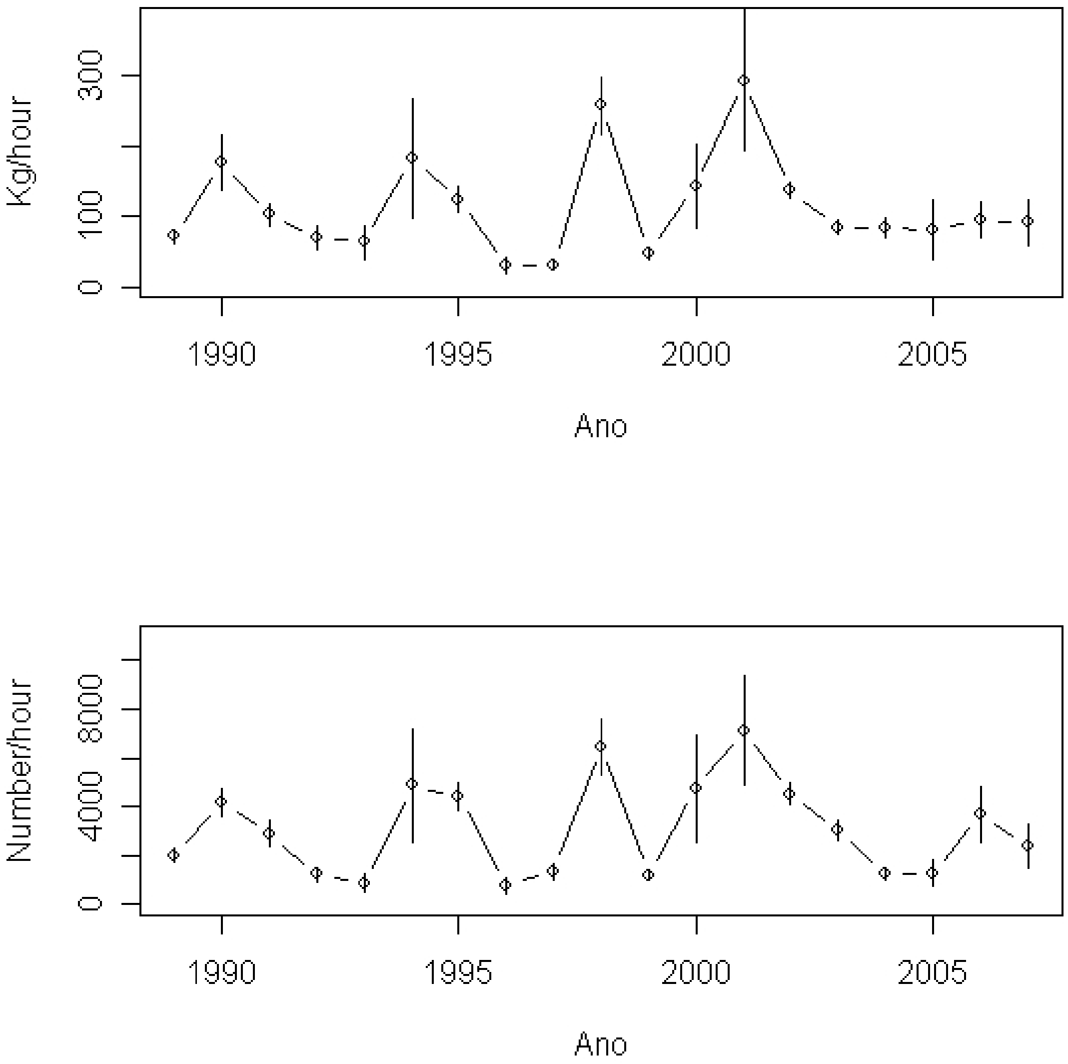

Figure E8: Stratified mean catch (Kg/haul and Number/haul) and standard error of blue whiting in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September –October

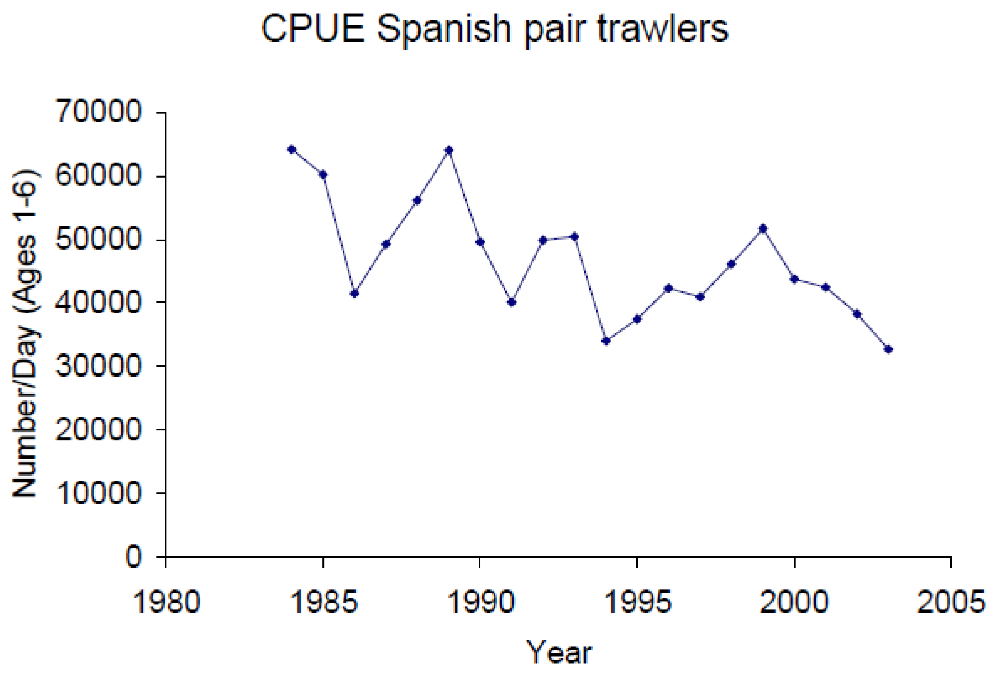

Figure E9: Blue Whiting CPUE from Spanish Pair Trawlers in ICES Div VIIIc and IXa (North)

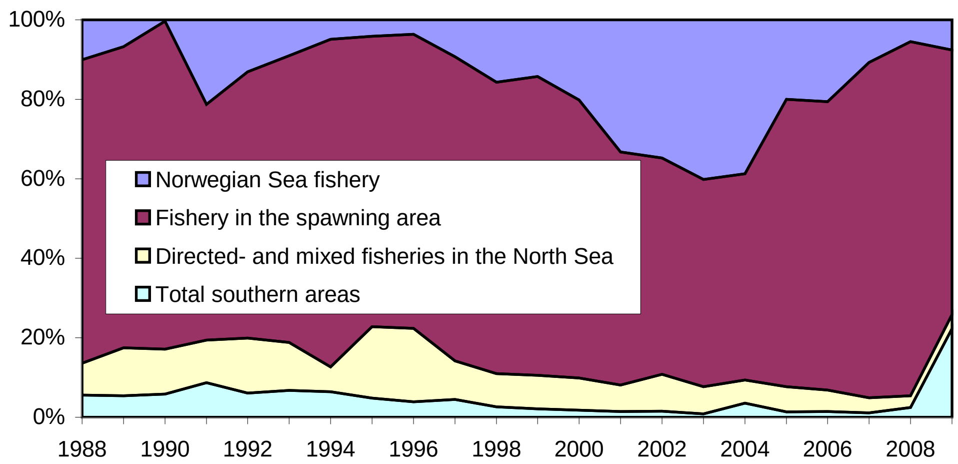

Figure E10: Development of Blue Whiting fisheries in different areas

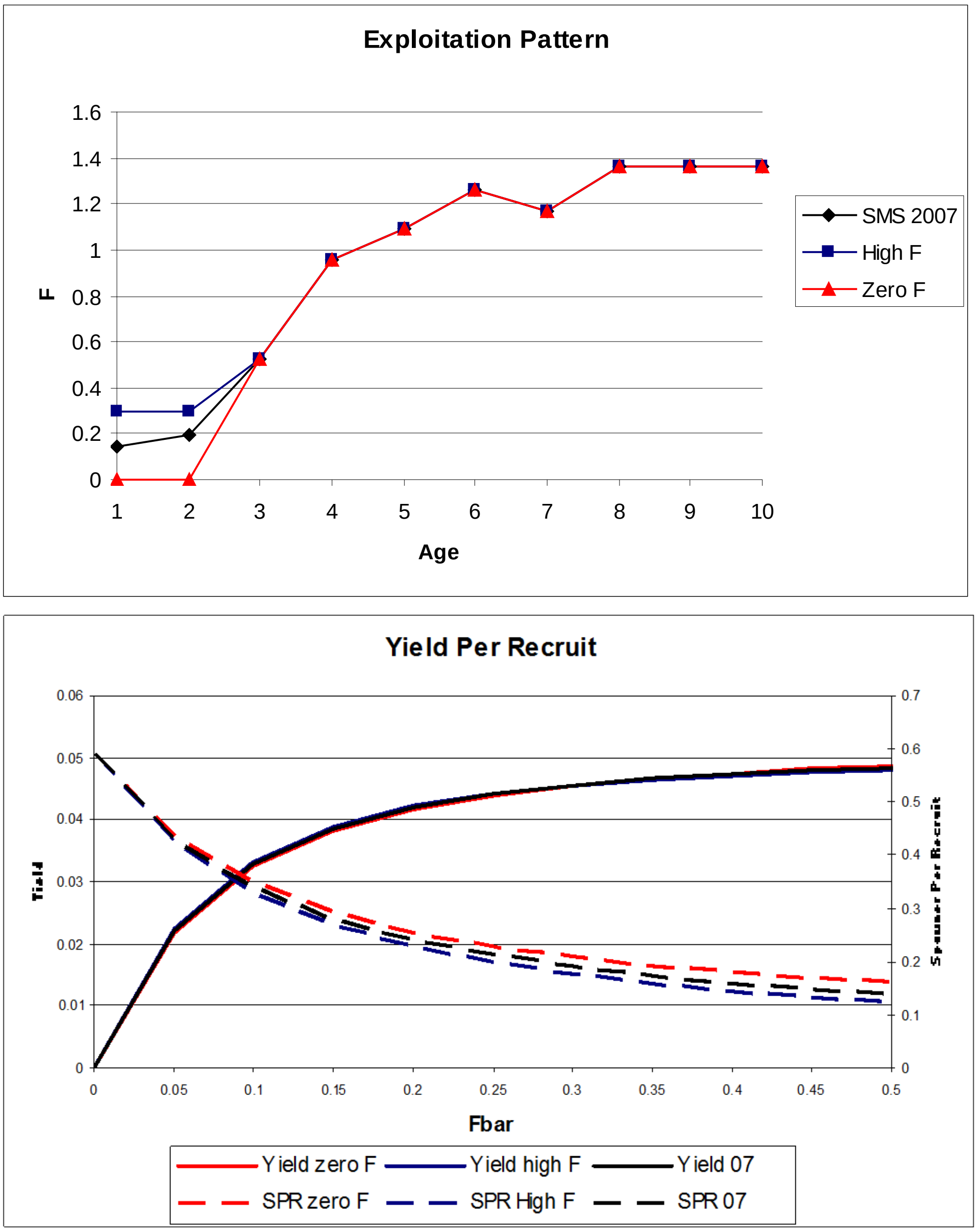

Figure E11: Blue Whiting exploitation pattern (upper) and yield per recruit curves (lower)

Annex 03 Review group Technical Minutes

Review Group Widely Distributed Stocks

Review of ICES Working Group of Widely Distributed Stocks - Report 2010 7 -14 September, 2010

Reviewers:	Ari Leskelä (chair)
	Antonio Avila de Melo
	Höskuldur Bjornsson
	Max Cardinale
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 draft report was delivered to RG in time. However, for some of the stocks Working Group report was scattered in separate files in separate folders. This was by no doubt caused by the time limits and work load of the Working Group, but nonetheless it made the Review Group work more difficult.

The Review Group considered the following stocks:

- **Herring in the Northeast Atlantic (Norwegian spring-spawning herring**)
  Update assessment
- **Horse mackerel (*Trachurus trachurus*) in Division IIIa, Division IVb,c and VIId (North Sea stock)**
  Same advice as last year
- **Horse mackerel (*Trachurus trachurus*) in Division IXa (Southern stock)**
  Same advice as last year
- **Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)**
  Update assessment
- **Mackerel in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)**
  Update assessment
- **Blue whiting in Subareas I-IX, XII and XIV (Combined stock)**
  Update assessment

Review group worked by correspondence and two webex meetings. As the time available for review was very short, the working group had to focus more on the update stocks than on the SALY stocks, and tried to pick up the most important issues to be discussed. Other commitments and workload put the RG members under a considerable pressure. Having some more time to do the review and finished reports to work with would have made the review process more convenient.

Herring in the Northeast Atlantic (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**: A new maturity ogive was used in the assessment according to recommendations by WKHERMAT. The results from this year's assessment deviate from the results from previous years. This is partly because of a change in maturity oogive but mainly because of a low value of survey index in survey 5.
6) **Stock status**: SSB at B_{pa} and MSY $B_{trigger}$,F above F_{pa} and Fmsy. No strong year classes after 2004.
7) **Man. Plan.**: Agreed in 1996. ICES considers that the management plan is consistent with precautionary approach

General comments

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 2009. Sampled catches accounted for 94 % of the total catches. Working group has no comprehensive estimates on discards. However, discarding is considered to be very low, as confirmed by recent estimates from sampling programmes carried out by some EU countries in the DCR framework. New data was available for surveys 4, 5, 6, 7 and 8.

Catch in numbers by age and weight at age were calculated with SALLOC program as described in the stock annex.

Mackerel by-catch problems reported in Faroes and Iceland catches in recent year were less in 2009 due to differences in the distribution area of herring and mackerel.

The 2010 assessment shows considerable downward revision from last year, mostly driven by the International ecosystem survey in the Nordic Seas in May (survey 5) 2010 that measured 45% less biomass than the same survey one year earlier.

Technical comments

The "final formatted" received by review group was not complete, e.g. the output tables were missing. Those could be found in the WG sharepoint draft folder, but searching pieces of advice from different folders and downloading them took some time.

The assessment was carried out as described in the stock annex except for the change in the maturity ogive.

As recommended by WG in previous years, a workshop on estimation of maturity ogive in Norwegian spring spawning herring (WKHERMAT) was arranged. Working group considered the results of WKHERMAT and adopted the maturity ogives derived from back calculation of scales for the historical time period (years 1950-2007) in the assessment. For the years after 2007 for which no data are available from this method (including the years considered in the forecast) default maturity ogives were assumed, one for average and weak year classes and one for strong year classes.

The new maturity at age is much lower for ages 4 and 5 than earlier one in the case f strong year classes (table 7.8.2), and the strong year classes are those that count.

Review group agrees on the choice of maturity ogive made by working group. Review group also notes that introducing new maturity ogive now does not affect the advice in the short term.

More details on how much of the change in SSB is caused by reduced stock numbers and how much by reduced stock weights. Stock assessment models do only to limited degree take account of new survey numbers that do not fit with older numbers. Changes in mean weight at age, on the other hand, are taken at face value. For herring there is up to 10% reduction in mean weight at age between 2009 and 2010, that does directly lead to 10% (or more if no growth continues)change in TAC for next year. How much of the 25% reduction in advice is caused by changed mean weight at age?

Residual plot (figure 7.7.3.4) was somewhat less than perfect, practically useless. Residuals for survey 5 in 2010 look relatively small except for ages 11 and 12 and possibly 7. There is a huge drop in biomass in the survey that the model does not pick up so either we must have large negative residuals in the terminal year or positive in the years before that.

The most important thing to be presented in the assessment would be residuals from survey 5, both log-residuals and observed vs. modelled biomass. As fishing mortality is low old data depreciate slowly and the model does probably only pick up small part of the 45% drop in survey biomass. This is OK and to some extent accounted for in the Harvest control rule. Still some comments on this would be appreciated. Can the biomass of approximately 10 million tonnes in the summer survey be put in context with the development of the stock?

According to this year's assessment, year classes 2005 and later are all very small. Historically this stock has shown large variations and dependency on the occurrence of irregular strong year classes. Consecutive years with poor recruitment are natural for the stock and one of the reasons for the relatively conservative management plan.

Conclusions

The Review Group agrees with the WG on this stock.

The model is a VPA type model tuned with a number of acoustic surveys some of which have been discontinued. The main surveys are 2 recruitment surveys in the Barents sea and the survey in the Norwegian sea in May. The use of other surveys than those 3 should be questioned in the next benchmark workshop. Data are screened and spurious data points are not used. Survey data for small year classes are ignored as they contain much noise. Equivalent approach would be to use multinomial or log(I+R) where R is a resolution parameter.

There arises a question if biomass reference/trigger points should be re-evaluated in the next benchmark assessment due to change in maturity ogives.

Mackerel in the Northeast Atlantic (combined Southern, Western and North Sea spawning components) (report section 2))

1) **Assessment type: update**
2) **Assessment**: analytical
3) **Forecast**: Short term forecast presented in the assessment.
4) **Assessment model**: An integrated catch analysis (ICA) was used and calibrated with a triennial egg survey providing an SSB estimate.
5) **Consistency**: ICA settings have not changed since previous assessments. Catch data were updated and results of the 2010 egg survey for the western and southern components were included. The addition of new data changed perception of stock status. It resulted in an upward revision of SSB and TSB while F remained at the same level as in previous assessment
6) **Stock status**: SSB above Fpa and MSY B trigger. F at Fpa, above FMSY. Recruitment estimates uncertain.
7) **Man.** Plan.: Agreed in 2008. ICES considers the agreed management plan to be consistent with the precautionary approach.

General comments

Report received from WG was still in bits and pieces so it was difficult to read.

There is a lot of speculation about discard and misreporting in the assessment. Based on egg surveys and the tagging experiments it has been estimated that the actual catches might be 1.7 - 3.6 times the reported catches (Simmonds *et al*., 2010). Landings by area are described in the report, but landings probably are not informative due to discard and unreported landings.

The length composition of the stock has remained "similar to recent years except for ages 0 and 1 fish for which the mean length has increased by 4cm and 2cm respectively. This increase has been reported by several national sampling programmes." Could this be caused by earlier spawning?

Technical comments

The assessment was done according to the stock annex.

The recent egg survey has most effects on the assessment and changes the perception of the stock status. A few things about the egg survey could have affected the results

1) Area coverage of the survey was expanded to the north in periods 4 and 5.
2) Extremely high production in the first measurement (fig 2.1 in WGMEGS preliminary report). Perhaps some spawning was missed. According to WG spawning may have started before the nominal starting date. The high mean length of age groups 0 and 1 in 2009 (mentioned in report) could indicate that spawning has been started earlier.
3) Low fecundity was measured and preliminary reported. However, it was later discovered that laboratory effect may have biased fecundity estimate downwards. The estimated low fecundity was not used but replaced with an average fecundity estimate of the last three survey years (2001, 2004 and 2007).

The first of these points should lead to relatively higher estimated spawning stock biomass but the other ones to lower. Review group agrees with the decisions made in WG, but the many changes connected to egg survey data make the survey data series less reliable.

Conclusions

Review group agrees with working group on this assessment.

Ideas for the next benchmark

No information is available on the age composition of the stock except from the landings. This is not good in a stock where discard is a large problem. Is it possible to use the pelagic survey results in the Norwegian sea in July? There is a need to standardize the results before using them.

Egg surveys are the only fisheries independent data in the assessment. The importance of egg surveys obvious since there is high unaccounted mortality in the fishery. Annual egg surveys would be a better alternative than triannual, especially since spawning time and area seems to be changing.

Should the assessment be done by fixing q in the egg survey to 1, estimating M ? Could be reasonable in a stock where there is so high unreported mortality.

As each cohort lasts in the catch for some time catch curve analysis would be useful to check if Z is roughly in line with model estimates.

WGWIDE recommendation: (see section 2.3.7.) WGWIDE recommends applying mackerel tagging data time series as additional fishery independent information for tuning the NEA mackerel stock assessment. Due to the considerable changes in migration pattern of NEA mackerel observed in later years and to improve the time series WGWIDE further recommends that tagging/screening has to be continued on an international basis. Review group has a positive attitude for this approach, especially if it would be possible to increase the portion of the catch which is checked with detectors. However, since there was no information on recapture rates in the wg report, it is difficult to estimate the potential of tagging results as a fisheries independent tuning data.

Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock) (report section 5)

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: A short-term forecast is not conducted for western horse mackerel because a management plan is in place.
4) **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. SAD also uses egg production estimates (sampled every three years) and catch at age data.
5) **Consistency**: consistent in all methodological aspects and data input with the 2009 assessment.

   However, the update assessment presents a more pessimistic perception of the stock compared to 2009 assessment both in terms of SSB and F. There is also an increase in the selectivity-at-age for 1 to 6 year old individuals, probably related also to the 30% egg reduction between the 2007 and 2010 egg surveys, rather than exclusively to a sudden shift of selectivity towards younger ages between the last couple of years.
6) **Stock status**: SSB in 2009 (2.27 mt) is above both Btrigger (1.80 mt) and Bpa (1.80 mt). F (0.087) is below F_{msy} (0.13, F_{01}). There is a large historical retrospective pattern with a clear tendency to underestimate F and overestimate SSB that mostly depends on the egg estimates and the length of the separable period. Reference points are unchanged compared to the 2009 assessment.
7) **Man. Plan**: Management plan was evaluated by ICES and it provides a constant TAC set for 3 years. The triennial TAC was set in 2007, based on an egg production estimate derived from triennial egg survey results. This TAC (181 211t) has been updated using the provisional 2010 egg survey estimate. This value will remain unchanged for 2012 and 2013, subject to review in 2014. However, 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. Thus, the TAC is not set by EU in accordance with the distribution of the stock.

General comments

Discard information is not available and discard is not considered in the assessment and not even mentioned in the report.

Taking into account the apparent chronically low to very low fishing mortalities, this stock should present a clear increase of SSB regardless its generally low recruitment regime (occasionally interrupted by the income of a good year class). However, this is not apparent in the present update assessment.

The SSB plot with associated error bars given by the update assessment suggests no significant changes of spawning biomass since 1995. Similar apparent stability is suggested by the plot of fishing mortality year effects between 2004 and 2009.

Technical comments

5.1.1

The TAC set by EU is not in accordance with the distribution of the stock.

5.2.5

The RG does not understand what the WG means by a sampling intensity of 84% for catch at age data. This was already pointed out by the RG in 2009 but no action has been taken by the EG to clarify this issue.

5.2.11

The assessment is an update of the 2009 assessment, where the separable window has been kept at 6 years. The key parameters in terms of model settings and data input are: i) length of the separable period and ii) total egg production from the triennial egg survey.

Selection has shifted towards younger fish over the past decade. This likely affects the length of the separable period and it might violate the assumption of constant selectivity in the separable period.

The lack of fisheries independent information for the age classes included in the catch at age matrix is a matter of concern and it has been pointed out before by previous RG and EG. This might possibly cause the assessment to shift in level of SSB and F between years and generate large retrospective bias especially when new egg information is made available every three years. However, it is not easy to separate the effect of the changes in selectivity in the separable period and the inclusion of the egg productivity data on the retrospective bias of the assessment.

French and Spanish bottom trawl and acoustic surveys are carried out in a systematic and standardized way, covering different areas of the western horse mackerel distribution. Thus, efforts should be made in order to use the age disaggregated abundance indices estimated from those surveys in the assessment of western horse mackerel.

The existing egg surveys are not able to fully cover the horse mackerel spawning season, despite their good geographical and temporal coverage. Furthermore, since horse mackerel is an indeterminate spawner, egg production conversion to SSB is weak.

No age disaggregated tuning data is included in the assessment framework. Only one parameter (SSB) is calibrated with fishery-independent data, with a high associated uncertainty. An SSB observation is derived from an egg production point given by a sequence of egg surveys carried out every three years, some of them with a considerable amount of interpolated egg production values. From the sensitivity analysis regarding the length of the separable window, the retrospective analysis with fixed and variable length of the separable window, and the comparison of the last consecutive assessments, it seems that the assessment results are greatly dependent on these egg production estimates, namely the most recent one from which is derived the observed SSB on the terminal year. Furthermore a realized fecundity parameter, needed to convert egg production into SSB, is derived from potential fecundity vs. fish weight data, with the underlying assumption that these fecundity data are from determinate spawners. But the spawning biology considers at present that horse mackerels of this stock are indeterminate spawners. Finally even if this realized fecundity is adequate to the stock biology, there is a possibility of presenting a trend over time instead of being kept constant, and, if so, inducing a systematic bias on SSB estimates.

The reliability of the results is heavily dependent on the reliability of the realized fecundity parameter and its stability over time. 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 need to be addressed in the future if a systematic estimation of likely error in the SAD model is to be evaluated. The inclusion of independent estimates of the uncertainty of the egg production would improve the reliability of the SAD assessment. Selectivity for the younger ages (1-6) is very sensitive to the length of SAD separable window.

Although egg production estimates are very similar to 2007, changes in realised fecundity might have a large impact on egg production estimates and thus on the assessment. Priority should be given to gather more information of the variability of this parameter.

5.6

Figure 5.2.8.2a should be Figure 5.2.9.2.

5.12

Ecological factors or environmental conditions possibly impacting the dynamic of the stock have not been accounted for in the assessment but they have been briefly discussed in the report.

A short-term forecast is not conducted for western horse mackerel because a management plan is in place. A deterministic and stochastic equilibrium analyses, carried out using the 'plot-MSY' software (WKFRAME 2010) was carried out to determine candidate Fmsy for the western horse mackerel stock. These analyses were dependent on results given by the last SAD assessment, such as stock-recruit pairs from the period 1982-2009 and 5-year averages of selectivity. Taking into account the uncertainty associated with the assessment, F_{msy} estimation, this value might be need to be revised in the future when more knowledge will be available.

Conclusions:

The assessment has been performed correctly and in accordance with the stock Annex, thus the review group agrees with the WG on this assessment.

All results and implications are well presented and explained, possible sources of uncertainties are also well presented.

As pointed out by previous RG, the main areas for potential improvement in the assessment have been mentioned in the report and those are: i) the incorporation of survey indices for the age classes included in the catch at age matrix, ii) further information on realised fecundity and thus total egg production, iii) selectivity assumption in the separable model and length of the separable period iv) explore the performance of age structured models that are not dependent on fecundity data and allowing for flexibility on catchability and selectivity at age.

Blue whiting in Subareas I-IX, XII and XIV (Combined stock) (report section 8)

1) **Assessment type:** update but no benchmark has ever been conducted (benchmark scheduled for 2011).
2) **Assessment**: analytical
3) **Forecast**: presented with the assessment (MFDP)
4) **Assessment model**: SMS – tuned by 3 surveys (1 historical survey and 2 on-going surveys)
5) **Consistency**: Consistent in all methodological aspects and data input with 2009 assessment, including short term forecast except for the RCT3 estimates of recruitment that were not used this year and were substituted by the lowest observed value. Current assessment indicates much worse state of the stock than previous assessments.
6) **Stock status**: SSB in 2010 (1.3 mt) is below Blim(1.5mt) and is predicted to decrease to 0.8mt in 2011 with landings of 548kt in 2008.). F2009 (0.399) is both above Fpa (0.32) and F_{msy} (0.18, $F_{0.1}$). F2010 is predicted to be around 0.5. Reference points are unchanged compared to last year.
7) **Man. Plan.**: ICES has evaluated the management plan and considers it precautionary providing "that to be consistent with the precautionary approach it is necessary to reduce F according to the HCR in one year. The management plan stipulated a maximum reduction of 35% in fishing mortality in the first two years (2009 and 2010) of the plan and a trigger biomass set at 2.25 million tonnes. ICES also considered that the harvest control rules contained in the agreed management plan are consistent with the precautionary approach in the long-term (the risk of falling below Blim in the long term 10-20 years is less than 5 %)". This is written in 2009 but now the situation is such that according to current stock assessment the stock will most likely be below Blim for at least next 5 years, even with no fishing.

General comments

The assessment is conducted according to the Stock Annex. However, no benchmark has ever been performed. General, it is apparent that assessment results are largely dependent on the input data (i.e. selection of the surveys used for tuning purposes) and, in negligible extent if any, to the type of model used. SSB has largely declined, F is still high and R is very low although the assessment might have underestimated SSB and possibly R due to issue related to the survey data (See 8.3.5).

Technical comments

8.3

There has been a slight shift of the catches towards the southern part of the range distribution of the stock and to the first part of the year compared to previous years. As the stock is widely distributed and productivity is largely dependent and linked to large scale oceanographic features, such changes might be related to a real changes in the stock distribution. Such phenomenon can affect the survey estimates in case they do not cover the entire area of the stock (see section 8.3.5).

8.3.1.1

Discard seems to be negligible except in the human consumption fisheries (13%). It is not clear to which part of the human consumption fleet or fisheries corresponds in tables 8.3.1.3.1-3.

8.3.5

The blue whiting assessment is tuned with 3 surveys, 1 "historical survey" on the spawning grounds conducted by Norway in 1990-2003 (NBWSSS), international survey in the same area 2004-2010 with somewhat different coverage (IBWSSS) and ecosystem survey in the Norwegian sea in May 2000-2010. The first 2 surveys are used for tuning age groups 3-9 but the May survey for age groups 1-2. Selection of the surveys is the key parameter affecting the estimate of F and SSB of the blue whiting stock and treatment of survey indices both regarding preparation of data and how they are treated in the model may be questioned.

The largest problem in the current assessment is the IBWSSS in 2010 where Russian data were discarded due to time mismatch (2 weeks) with other vessels. The other vessels did not manage to cover the area properly due to combination of limited time, bad weather and no work on weekends for some vessel. An area where heavy fishing was taking place was not surveyed and as blue whiting presents generally a highly patchy distribution high proportion of the stock could have been in this area . PGNAPES interpolates over those areas using data from neighbourhood areas (with low abundance) and recommends using that index.

"*Total stock abundance was revised during the WGNAPES meeting by interpolating surrounding mean acoustic values into un-surveyed rectangles. The exercised revised the total stock biomass upwards by 19% (580,000t) and stock abundance by 15% (2.8x109 individuals). The revised estimate is considered robust by the group and it is recommended that this estimate is accepted by WGWIDE. The international survey in the Nordic seas in May also observed the strong decrease in the stock found during the spawning stock survey.* "

The Russian data seem to cover the main part of the stock distribution area better and a sensitivity analysis of the assessment tuned with the IBWSSS survey index estimated also using the Russian observation should have been conducted. But there is of course no good way to handle this problem and 2 weeks is a substantial time delay in this area.

The IBWSSS series is rather short (since 2004). The inclusion of the new low survey point increases estimated catchability which would not be possible in a longer series based on more years where the stock-assessment has converged. In last years report catchability by age is shown both for the IBWSSS and NBWSSS showing some alarming difference between those two. Nothing comparable is provided this year. The question is really if those two surveys can not be merged to one series.

Residuals from the IBWSSS show very strong yearblocks that should be modelled seperately either by modelling correlation between adjacent age groups in the same year or year factor. Tuning where the total biomass is used in tuning as lognormal and proportion at age as multinomial could be a solution.

In the Ecosystem survey in the Norwegian sea in May the very low indices of age 1 and 2 seen in recent years are not treated properly. The survey indices indicate that the most recent yearclasses are very small even zero. There is no doubt that these yearclasses are small, landings by number confirm that but not as small as the survey indicates. This is known problem with many recruitment indices and one possible solution

to this is to tune with $\log\left(\frac{I+R}{\hat{I}+R}\right)$ where R is a low number (not very low) corresponding to the intercept in I vs N plot or looked at as a sampling error something that would correspond to 5 otholits in catch in numbers calculations. It is the point where the error starts to become multinomial rather than lognormal. Same problem has been observed in NSSH due to largest in yearclass size. There the solution has been kind of ignoring the survey indices of the small yearclasses that are very noisy.

Dankert Skagen discusses this problem in his working paper and shows that if selection on the youngest fish is allowed to change it increases in recent years if the survey indices for age 1 and 2 are used. According to development of the fisheries the opposite should have happened as the fisheries in the Norwegian Sea in the latter part of the year have more or less stopped and most of the young fish were caught there.

This problem does propably not have major effect on the biomass estimates as most of these yearclasses are very small and even though the estimate is doubled or tripled it does not have major effect on stock biomass.

The survey names are inconsistent through the entire report.

8.10

Ecological factors and environmental conditions possibly impacting the dynamic of the stock have not been accounted for in the assessment but they have been well discussed and presented.

8.4

The settings of the assessment run made by the SMS final model are the same as in the 2009 assessment. However, the range of the years of the Norwegian spawning ground survey (1991-2003) used in the assessment does not correspond to what stated in the stock Annex (1993-2003).

8.7.1

RCT3 estimates were discarded because considered too low. However, the same survey data have been used as input to tune the final assessment. Thus, there is an inconsistency here as the same data are sometime considered valid (i.e. assessment) and sometime discarded (i.e. recruitment prediction).

Conclusions:

The assessment has been performed correctly and in accordance with the stock Annex, thus the review group agrees with the WG on this assessment. However, this assessment is an example of a situation where rigid following of stock annex might be questioned.

The problem is though not easy and "the solution" does not exist. Rather a number of sensitivity analysis should have been conducted like including the Russian observations for the IBWSSS, combining NBWSSS and IBWSSS, improve treatment of the recruitment indices etc. The main results of the assessment that the stock is rapidly decreasing are probably robust, the question is really how small it is today. Year classes 2005 and later are all small, most very small (Table 8.7.2.2). If the recruitment estimates are correct incoming year classes will be considerably smaller than those observed before the high recruitment period from 1996 – 2003 and SSB will be below Blim for at least 5 years, even if no fishing takes place. This is very different from what was shown in the report last year.

The report should contain more information about the assessment. Tables of catchability in the survey is an example of things that are missing. The report should also contain more detailed comparison with last years assessment and more sensitivity analysis using the SMS model but different treatment of the data. Some of those details were in last years report and the reason for them not being here is probably that the report which the working group got was not finished.

Horse mackerel (Trachurus trachurus) in Division IIIa, Division IVb,c and VIId (North Sea stock) (report section 4)

1) **Assessment type:** no assessment conducted, landings only
2) **Assessment**: not conducted
3) **Forecast**: not conducted
4) **Assessment model**: none
5) **Consistency**: not relevant
6) **Stock status**: unknown
7) **Man. Plan.**: none

General comments

No assessment has ever been conducted for this stock.

The data available for this stock do not give reason to change the advice from 2007

Specific section comment

The RG does not understand what the WG means by a sampling intensity of 92% for catch at age data. This was already pointed out by the RG in 2009 but no action has been taken by the EG to clarify this issue.

Conclusions

RG agrees with WG on this stock

Horse mackerel (Trachurus trachurus) in Division IXa (Southern stock) (report section 6)

Assessment type: SALY

Assessment: Several age based assessments using different models/frameworks were carried out as part of the preparatory work for the forthcoming benchmark assessment.

Forecast: No forecast was presented.

Assessment model: Age Structured Assessment Program (ASAP), two alternate runs

Extended Survivors Analysis (XSA)

Integrated Catch-at-age Analysis (ICA), two alternate runs

Consistency: Last years ASAP assessment was not accepted.

The last ASAP assessment has been updated with 2009 catch and survey data, using last year settings. The assessment diagnostics were very similar to the previous ones, with the model generally overestimating catches up to 8 years old and underestimating catches of older ages for the Spanish bottom-trawl fleet. The model also continues to present high residuals in the fitting of the catch at age from the combined survey.

The XSA trials presented the same type of poor diagnostics (convergence dependent of a heavy F shrinkage, year effects on survey catchabilty residuals) as on earlier XSA's for this stock, regardless the longer times series now available. The two ICA trials, both with separability through the whole assessment period but one using survey catch at age assembled into survey biomass and the other using the survey catch at age matrix, have also shown catch-at-age and survey data residuals of high magnitude associated with clear patterns.

One alternate ASAP trial was made with catch-at-age data not disaggregated by fleet and with separable survey catchability at age (considered as a combination of a year effect with an age effect). Annual catch was the only source contributing to the objective function with a (100 times) higher weight, in order to compensate for the much higher number of data points on the catch proportions at age and on the age-structured survey data.

This last ASAP assessment provided better diagnostics than the rest of the exploratory assessments: good fitting to the total catch and generally low residuals with no clear patterns on survey indices, either for annual abundance or relative abundance at age.

Stock status: Reference points have not been defined for this stock. This stock has supported a stable exploitation level for a long time period. The SSB estimates from the bottom-trawl survey are highly variable but show no trends. The SSB estimates based on triannula egg surveys have increased from 2002-2007.

Man. Plan: No management plan. However, fishing mortality is increasingly driven by the catches from Spanish bottom trawl fleet. Catches from this fleet are mainly composed of larger fish. Such shift on the overall exploitation pattern towards the adult component lead to recent decline on SSB and can impact the reproductive potential of the stock.

General comments:

Catch from the Galician coasts were distributed between the Subdivisions VIIIc and Subdivision IXa North for the period 1992 – 2009. Catch during the assessment period declined from a 1998 peak until a 2003 minimum. Catch increased in 2004 and remained at stable until 2008. A marginal increase is recorded on 2009. Catch from Portugal decrease in recent years (2006-2009) while catch from Spain is increasing.

Survey catch at age matrices are available from the fall bottom trawl surveys of Portugal and Spain. Portuguese and Spanish bottom trawl surveys have a similar catchability for horse mackerel despite their different design and so are able to provide combined tuning indices, with the weight given to each data set proportional to the respective area covered. Cohorts can be tracked through the combined survey data set. Horse mackerel is a peculiar pelagic with a closer association to the sea floor than most pelagic species, which makes the Portugal-Spain bottom trawl survey combo a valid source of fishery independent indices covering the whole distribution of southern horse mackerel.

Technical comments:

From the exploratory analyses carried out so far, this last alternate ASAP assessment gave the better fitting of a model to the available data. Taking into account that most of the horse mackerel catches in Iberian waters are from bottom-trawl, lumping together the several catches at age by fleet in a single matrix makes sense and helps the model to get rid of a bunch of selectivity parameters.

As regards relative abundance at age from the alternate ASAP assessment, more positive residuals than negative occur. The size of some cohorts may be underestimated and its impact on assessment results should be further investigated. The apparent contradiction between recent trends on SSB given by the model and the survey can be related with this unbalance.

Comparative assessment involving different age structured models should not be restricted to diagnostics but should also focus on comparison of results, namely as regards SSB and fishing mortality trends. Regardless better or worse diagnostics different models should tell basically the same story.

Retrospective analysis is missing from the exploratory assessments presented.

Things that need update before ADG:

Conclusions: RG considers this update/exploratory assessment an important work in preparation of the next benchmark assessment.