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

25 August - 31 August 2015

Pasaia, Spain

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

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Executive Summary

The Working Group (WG) on Widely Distributed Stocks (WGWIDE) met at AZTI in Pasaia, Spain, from 25 to 31 August 2015. The meeting was attended by 32 delegates (two of them by WebEx) from Netherlands, Ireland, Spain, Norway, Portugal, Iceland, United Kingdom (England and Scotland, the first participating by WebEx), Faroe Islands, Denmark, Russia and Germany. Other fisheries scientists participated by correspondence. The WG reports on the status and considerations for management of northeast Atlantic mackerel, blue whiting, western and North Sea horse mackerel, northeast Atlantic boarfish, Norwegian spring spawning herring, striped red mullet (Subareas VI, VIII and Divisions VIIa-c, e-k and IXa), and red gurnard (Subareas III, IV, V, VI, VII, and VIII) stocks.

WGWIDE also worked on three special requests regarding the management strategies of Blue whiting, northeast Atlantic mackerel, and Atlantic boarfish, providing answers to the two latter.

Northeast-Atlantic (NEA) Mackerel. This species is widely distributed through the ICES area and currently supports one of the most valuable European fisheries. Mackerel is fished by a variety of fleets from many countries (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 assessment was benchmarked in 2014, and each of the three times the stock assessment has been carried out after that the perception of the stock has been revised. The assessment thus shows undesirable uncertainty. This year the assessment model was slightly modified to include a stock-recruitment relationship in order to overcome model mis-fitting.

WGWIDE provided a response to a special request regarding the long-term management strategy for NEA mackerel. The work was based on analyses carried out in WKMACLTMP 2014 and provides range for Fmsy corresponding to long term yields that differ at most 5 % from the MSY.

Blue whiting. This pelagic gadoid is widely distributed in the eastern part of the North Atlantic. The assessment this year was considered an update, although a small change was made to the parameter reflecting the timing of the spawning survey within a year. The perception of the stock changed rather substantially, the stock now being estimated at lower level than in earlier years. This is largely due to the abundance indices from the 2015 acoustic survey for the adult part of this stock being lower than expected, given the perception of the stock from last year assessment especially for the older age groups.

WGWIDE received a NEAFC request on options for a revised long-term management strategy for blue whiting. Due to the SAM model unstability that was exemplified in this year's assessment, and the fact that we are not able to fully estimate the model uncertainty, WGWIDE was not able to answer the request. Further model developments are required to address the assessment uncertainty before WGWIDE will be in a position to evaluate the management strategies requested.

Western Horse Mackerel. The WG performed an analytical assessment for western horse mackerel following the benchmark procedure. Year classes following 2001 have been weak, 2010 recruitment in particular is the lowest in the time-series. 2008 year class is estimated as higher than the recent average. Fishing mortality has been increasing since 2007 as a result of increasing catches and decreasing biomass as the 2001 year class was reduced. In the absence of any notably large recent year classes, SSB is perceived to be declining. The current outlook for the coming years suggests that this decline will continue.

North Sea horse mackerel. This year an additional survey index was available for the WG. However, the survey indices for this stock are uncertain and individual years cannot be considered to be indicative of trends. All the available data suggest that the North Sea horse mackerel stock is currently relatively stable at a low level. Recruitment has been low with some indications of increases in the last few years.

Northeast Atlantic Boarfish. This is a small, pelagic, planktivorous, shoaling species, found at depths of 0 to 600 m. The species is widely distributed from Norway to Senegal. The fishery for boarfish in the NEA is a relatively new one, and the catches of boarfish have showed first a sharp increase starting in the first part of 2000s, and later a decrease in the recent years. There is currently no accepted analytical assessment for this stock, but results from an exploratory assessment model are used as indicators for stock development. Bottom-trawl survey indices are considered indicative of trends in their respective areas. Since 2012 there has been a sharp decline in the estimated total stock biomass of boarfish in the North East Atlantic.

WGWIDE answered a special request regarding the management strategy for boarfish, and found the suggested management strategy to be precautionary.

Norwegian spring spawning herring. This is one of the largest herring stocks in the world. It is highly migratory and distributed throughout large parts of the NE Atlantic. The assessment was performed using the assessment tools software TASACS (benchmarked in 2008). This year a spawning ground in February/March along the Norwegian coast was carried out again for the first time since 2008 and was included in the assessment. The 2015 Norwegian spring spawning herring larvae survey index on the Norwegian shelf was not included in the assessment due to poor spatial coverage. Even though F has been decreasing in recent years, in the absence of any strong year classes since 2004, the stock has declined still further in 2015. SSB at the start of 2015 is estimated to be below B_{pa}. This decline is expected to continue in the near future even when fishing according to the management plan, though it is expected that following the management plan will lead to the stock stabilising above B_{lim}. Norwegian spring spawning herring assessment is scheduled for a benchmark in 2016.

Striped red mullet in North Sea, Bay of Biscay, Southern Celtic Seas, Atlantic Iberian Waters. 2015 was the first year this stock has been considered in WGWIDE. This is a category 5 stock without information on abundance or exploitation, and the evaluation is based on commercial landings. The advice for this stock is given for 2016 and 2017.

Northeast Atlantic red gurnard. 2015 was the first year this stock has been considered in WGWIDE. This is a category 6 stock for which there is no indication of where Fishing Mortality is relative to proxies and no stock indicators, and the evaluation is based on commercial landings. The advice for this stock is given for 2016 and 2017.

1 Introduction

1.1 Terms of Reference

WGWIDE – Working Group on Widely Distributed Stocks

2015/2/ACOM16 The **Working Group on Widely Distributed Stocks** (WGWIDE), chaired by Katja Enberg, Norway, will meet in AZTI-Pasaia facilities, Spain, 25–31 August, 2015 to:

a) Address generic ToRs for Regional and Species Working Groups;

b) Answer the NEAFC special request on options for a revised long-term management strategy on blue whiting;

c) Answer the EU, Faroe Island and Norwegian special request for advice concerning options for a revised management strategy for mackerel.

d) Answer the EU special request for advice concerning management strategy for boarfish.

Material and data relevant for the meeting must be available to the group no later than 27 July 2015 according to the Data call 2015, which was send out on 3 February 2015.

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

WGWIDE will report by 7 September, 2015 for the attention of ACOM.

1.2 List of participants

WGWIDE 2015 was attended by 32 delegates from the Netherlands, Ireland, Spain, Norway, Portugal, Iceland, United Kingdom (England [by WebEx] and Scotland), Faroe Islands, Denmark, Russia and Germany. Other fisheries scientists participated by correspondence. The full list of participants is in Annex 1. WGWIDE greatly missed the presence of our long term group member Manolo Meixide, who suddenly passed away this spring. It is difficult to replace such a long-standing scientist in the group, but fortunately other WGWIDE members were able to assume his earlier tasks in a satisfactory manner. However, Manolo will be dearly remembered and missed.

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 90%. In comparison to last year the proportion of the horse mackerel catch sampled decreased from 77% to 65% pointing out that there are too many countries not providing sampling data. Norwegian spring spawning herring and blue whiting sampling covers both 89% of the total catch, respectively. Following the memorandum of understanding agreement between the EU and ICES boarfish (*Capros aper*) was included into WGWIDE since 2011 and tables on the sampling level for this species are added in this section. Information on sampling data on the new into WGWIDE included species Striped red mullet (*Mullus surmuletus*) and Red Gurnard (*Chelidonichthys cuculus*) is not given in this section.

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	760000	85	920	77000	11800
1993	825000	83	890	80411	12922
1994	822000	80	807	72541	13360
1995	755000	85	1008	102383	14481
1996	563600	79	1492	171830	14130
1997	569600	83	1067	138845	16355
1998	666700	80	1252	130011	19371
1999	608928	86	1109	116978	17432
2000	667158	76	1182	122769	15923
2001	677708	83	1419	142517	19824
2002	717882	87	1450	184101	26146
2003	617330	80	1212	148501	19779
2004	611461	79	1380	177812	24173
2005	543486	83	1229	164593	20217
2006	472652	85	1604	183767	23467
2007	579379	87	1267	139789	21791
2008	611063	88	1234	141425	24350
2009	734889	87	1231	139867	28722
2010	869451	91	1241	124695	29462
2011	938819	88	923	97818	22817
2012	894684	89	1216	135610	38365
2013	933165	89	1092	115870	25178
2014	1394454	90	1506	117250	43475

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

Sampling activity in 2014 covered 90% of the working group catch, in line with previous years. The number of samples increased by approximately 50%. It should be noted that this sampling coverage 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. This is especially true when a large proportion of the total catch is taken in large, directed fisheries which are relatively straightforward to sample.

Faroe, Greenland, Iceland, Ireland, Norway, Portugal, Russia, Scotland and Spain all sampled over 95% of their catch. As in previous years, England & Wales sampled a small fraction of their total catch, corresponding to the handline fishery in area VIIe. The freezer trawler fleet operating out of the Netherlands, Germany, England and France is covered by the Dutch and German sampling programs as the fleet is principally Dutch-owned. Individual samples within this fishery consist of only 25 aged fish which can be limiting when only a single sample is available in a particular area and quarter. In particular, there is a lack of sampling activity in the fourth quarter for this fleet. The Dutch program also provided samples for English registered freezer trawlers landing into the Netherlands. Of the remaining countries with significant catches Northern Ireland and Sweden did not provide any sampling information. France conducted length-frequency sampling but no ageing was carried out.

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	56	0	0	0	0
Denmark	42222	52	10	917	917
Faroe Islands	150236	100	22	1903	1625
France	21719	0	0	0	0
Germany	28456	67	28	8378	787
Greenland	78581	100	200	6642	1
Guernsey	9	0	0	0	0
Iceland	172960	100	154	6275	3200
Ireland	103178	98	55	9544	1864
Isle of Man	3	0	0	0	0
Lithuania	9598	0	0	0	0
Netherlands	46665	62	33	2883	825
Norway	277731	99	67	1958	1958
Portugal	618	100	96	5032	594
Russia	116433	100	106	25360	1147
Spain	27296	100	282	3073	5582
Sweden	4422	0	0	0	0
UK (England & Wales)	26562	35	19	2222	531
UK (Northern Ireland)	20352	0	0	0	0
UK (Scotland)	240934	98	76	9902	2369
Total	1384998	90	1506	117250	43475

***Percentage based on Working Group catch**

The following table describes the mackerel sampling intensity levels in terms of catch in each ICES division. Only areas with relatively minor catches are insufficiently sampled.

AREA	OFF. CATCH	WG CATCH	NO SAMPLES	NO AGED	NO MEAS.	NO AGED/ kT*	NO MEAS/ kT*
IIa	433177	433177	130	2783	26028	6	60
IIb	10	10	0	0	0	0	0
IIIa	636	636	0	0	0	0	0
IIIc	1	1	0	0	0	0	0
IIId	1	1	0	0	0	0	0
Iva	380951	380951	104	4149	8859	11	23
IVb	2167	2167	2	50	169	23	78
IVc	465	465	0	0	0	0	0
Va	148495	148495	144	2979	5825	20	39
Vb	8442	8442	32	713	2026	84	240
Via	180408	180408	84	2620	16880	15	94
VIIa	7	7	0	0	0	0	0
VIIb	28914	28914	28	990	3147	34	109
VIIc	470	470	8	400	400	851	851
VIId	4903	4903	6	150	731	31	149
VIIe	754	754	0	0	0	0	0
VIIf	326	326	19	531	2222	1628	6815
VIIg	115	115	2	200	200	1739	1739
VIIh	3357	3357	4	400	400	119	119
VIIj	37714	37714	41	1316	5064	35	134
VIIIa	4802	4802	0	0	0	0	0
VIIIb	13584	13584	43	3191	2151	235	158
VIIIc	2821	2821	24	400	400	142	142
VIIIcE	25551	31396	271	4224	23495	165	919
VIIIcW	8403	11353	101	3382	1171	402	139
VIIId	164	164	0	0	0	0	0
IXa	2082	2082	161	4570	6629	2195	3183
IXaN	1886	2548	69	1681	387	891	205
IXaS	341	341	26	1691	387	4958	1134
XIVa	28	28	1	23	26	1	1
XIVb	94021	94021	206	258	6947	3	74

***Based on official catches**

Horse Mackerel

The following table shows a summary of the overall sampling intensity on horse mackerel catches in recent years in all areas 1992—2009 and in the western and North Sea areas for the following years. Since 2009 the Southern horse mackerel is dealt with by ICES WGHANSA.

Year	TOTAL CATCH (ICES estimate)	% catch covered by sampling programme*	No. samples	No. Measured	No. Aged
1992	436 500	45	1 803	158447	5797
1993	504190	75	1178	158954	7476
1994	447153	61	1453	134269	6571
1995	580000	48	2041	177803	5885
1996	460200	63	2498	208416	4719
1997	518900	75	2572	247207	6391
1998	399700	62	2539	245220	6416
1999	363033	51	2158	208387	7954
2000	272496	56	1610	186825	5874
2001	283331	64	1502	204400	8117
2002	241336	72	1768	235697	8561
2003	241830	79	1568	200563	12377
2004	216361	68	1672	213066	16218
2005	234876	78	2315	241629	15866
2006	215277	72	1623	231344	12009
2007	187995	62	1321	174897	10749
2008	198085	77	1362	186800	11915
2009	247637	87	1258	92846	13345
2010	224462	78	703	48465	13984
2011	222415	62	502	40964	7604
2012	186432	68	501	41148	8220
2013	179382	77	686	87300	9776
2014	142505	81	619	43799	7480

***Percentage related to catch acc. to ICES estimation**

The large numbers of measured fish 1992—2009 were due to intensive length measurement programs in the southern areas. In 2008, 76% of the horse mackerel measured were from Division IXa.

Countries that usually carried out sampling were Ireland, the Netherlands, Germany, Norway and Spain and they covered 56—100% of their respective catches. In 2014 Germany, Ireland, the Netherlands, Norway, UK (England) and Spain provided samples and age distributions. The lack of sampling data for relatively large portions of the horse mackerel catches continues to have a serious effect on the accuracy and reliability of the assessment and the Working Group remain concerned about the low number of fish that are aged.

The horse mackerel sampling intensity for the Western stock in 2014 was as follows:

COUNTRY	CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	5955	0	0	0	0
Faroe Islands	68	0	0	0	0
France	34283	0	0	0	0
Germany	9826	56	8	3206	277
Ireland	32396	99	33	5247	1219
Netherlands	25175	90	68	1696	1696
Norway	10265	96	18	461	245
Spain	19443	97	456	28860	3104
UK (England)	4831	78	11	1416	275
UK(Northern Ireland)	1578	0	0	0	0
UK(Scotland)	1389	92	1	63	38
Total	124916	84	595	40949	6854

***Percentage based on ICES estimate**

The horse mackerel sampling intensity for the North Sea stock in 2014 was as follows:

COUNTRY	CATCH	% CATCH SAMPLED*	NO. SAMPLES	NO. MEASURED	NO. AGED
Belgium	73	0	0	0	0
Denmark	559	0	0	0	0
France	1742	0	0	0	0
Germany	1619	0	0	0	0
Netherlands	4925	88	4	100	100
Sweden	1	0	0	0	0
UK (England)**	4200	99	15	2457	375
UK(Scotland)	262	0	0	0	0
Total	13380	63	19	2557	475

***Percentage based on ICES estimate**

****sampled by Dutch observers**

The horse mackerel sampling intensity by division was as follows:

Area	Official Catch	N samples	N measured	N aged	N measured per 1000t	N aged per 1000t
IIa	409					
IIIa	4110	5	293	151	71	37
IIIc						
IVa	10593	21	536	320	51	30
IVb	271	1	25	25	92	92
IVc	1156	4	550	100	476	86
Vb	15					
VIa	32567	40	5504	1240	169	38
VIb						
VIIa						
VIIb	26659	33	3425	1008	128	38
VIIc	2771	4	462	161	167	58
VIId	5283	14	1982	350	375	66
VIIe	6191	14	1220	348	197	56
VIIf	1					
VIIg	20					
VIIh	2509	4	98	98	39	39
VIIj	11569	18	719	450	62	39
VIIk	0					
VIIIa	2018					
VIIIb	2090	67	3249	406	1554	194
VIIIc	771					
VIIIcE	7073	280	18640	1975	2635	279
VIIIcW	19652	110	7092	844	361	43
VIIId	9					
Total	134965	687	43723	6854	324	55

Norwegian Spring Spawning Herring (NSSH)

Year	TOTAL CATCH	% catch covered by sampling programme	No. samples	No. Measured	No. Aged
2000	1207201	86	389	55956	10901
2001	766136	86	442	70005	11234
2002	807795	88	184	39332	5405
2003	789510	71	380	34711	11352
2004	794066	79	503	48784	13169
2005	1003243	86	459	49273	14112
2006	968958	93	631	94574	9862
2007	1266993	94	476	56383	14661
2008	1545656	94	722	81609	31438
2009	1686928	94	663	65536	12265
2010	1457015	91	1258	124071	12377
2011	992.997	95	766	79360	10744
2012	825.999	93	649	59327	14768
2013	684.743	91	402	33169	11431
2014	461.306	89	229	18370	5813

89% 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 48 and 100%. No sampling was carried by Germany, Greenland, Ireland and UK representing together 4% of the total catch.

COUNTRY	OFFICIAL CATCH	% catch covered by sampling programme	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	12513.32	100%	249	339	99
Faroe Islands	38529.42	99%	16	1351	1305
Germany	668.93	0			
Greenland	13107.71	0	0	0	0
Iceland	58828	100	55	2317	1241
Ireland	705.57	0	0	0	0
Netherlands	9175.12	100	7	449	175
Norway	263252.91	99	77	2444	2444
Russia	60292	48	72	11560	549
UK	4233.34	0	0	0	0
Total for Stock	461.306	89	229	18370	5813

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	No Samples	No Aged	No Measured	No Aged/ 1000 tonnes	No Measured/ 1000 tonnes
IIa	345979	130	3535	9649	10	28
IIb	16484	32	455	3985	14	227
IVa	2306	0	0	0	10	10
Va	31990	43	1043	1767	33	55
Vb	6287	7	601	620	95	98
XIVa	2171	16	74	2241	34	1032
Total	684743	229	5813	18370	12	40

Blue Whiting

Year	TOTAL CATCH	% catch covered by sampling programme	No. samples	No. Measured	No. Aged
2000	1412928	*	1136	125162	13685
2001	1780170	*	985	173553	17995
2002	1556792	*	1037	116895	19202
2003	2321406	*	1596	188770	26207
2004	2377569	*	1774	181235	27835
2005	2026953	*	1833	217937	32184
2006	1966140	*	1715	190533	27014
2007	1610090	87	1399	167652	23495
2008	1246465	90	927	113749	21844
2009	635639	88	705	79500	18142
2010	524751	87	584	82851	16323
2011	103591	85	697	84651	12614
2012	373937	80	1143	173206	15745
2013	625837	96	915	111079	14633
2014	1155279	89	912	111316	39738

*** no figures given**

89% of the total catch was covered by national sampling programmes which is the second highest coverage of the last six years. The sampling summary of the blue whiting catching countries is shown in the following table. No sampling was carried out by France, Germany, Lithuania, Sweden and the UK (England, Wales, Northern Ireland and Scotland) representing together 5.75% of the total catches.

COUNTRY	OFFICIAL CATCH	% catch covered by sampling programme	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	35256	21	6	338	338
Faroe Islands	224700	99	39	4687	3406
France	10410	0	0	0	0
Germany	24487	0	0	0	0
Iceland	182879	99	57	4907	2465
Ireland	21466	65	11	2643	968
Lithuania	4717	0	0	0	0
Netherlands	38524	65	75	9790	1874
Norway	399520	100	56	3172	1655
Portugal	2150	100	57	3102	1663
Russia	152256	100	341	69402	3944
Spain	32065	100	270	13275	23425
Sweden	2	0	0	0	0
UK (England)	11	0	0	0	0
UK(Northern Ireland)	2205	0	0	0	0
UK(Scotland)	24630	0	0	0	0
Total	**1155279**	**89**	**912**	**111316**	**39738**

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	No Samples	No Aged	No Measured	No Aged/ 1000 tonnes*	No Measured/ 1000 tonnes*
IIa	42165.855	64	12696	953	301	23
IIb	558.317	14	2141	106	3835	190
IIIa	1.942	0	0	0	0	0
IVa	28552.234	13	1040	511	36	18
IVb	41.536	0	0	0	0	0
IVc	0.041	0	0	0	0	0
IXa	5960.59469	88	3106	7515	521	1261
IXaN	3888.66385	70	4159	5852	1070	1505
V	503.926	0	0	0	0	0
Va	1947.04	0	0	0	0	0
Vb	364835.3751	161	31298	3925	86	11
VIa	274235.4172	115	14993	4215	55	15
VIb	114337.007	91	17397	1475	152	13
VIIb	3081.67158	3	555	111	180	36
VIIc	128493.4099	62	4204	1671	33	13
VIIe	10.65	0	0	0	0	0
VIIg	0.93676	2	2	2	2135	2135
VIIh	2368.80558	7	130	130	55	55
VIIIa	496.45617	0	0	0	0	0
VIIIb	20.281	0	0	0	0	0
VIIIc	23863.17024	144	9095	11704	381	490
VIIId	2537.44951	0	0	0	0	0
VIIj	1171.283	12	1360	104	1161	89
VIIk	155302.1869	61	8228	1265	53	8
XII	500	2	248	199	496	398
XIVa	394	3	664	0	1685	0
XIVb	11	0	0	0	0	0
Total	**1155279**	**912**	**111316**	**39738**	**12235**	**6259**

***Based on official catches**

Boarfish

Year	TOTAL CATCH	% catch covered by sampling programme	No. samples	No. Measured	No. Aged
2001	120	0	0	0	0
2002	91	0	0	0	0
2003	11387	0	0	0	0
2004	5151	0	0	0	0
2005	5959	0	0	0	0
2006	7137	0	0	0	0
2007	21576	NA	3	217	0
2008	34751	NA	1	152	0
2009	90370	NA	9	1 475	0
2010	144047	NA	95	10 675	403*
2011	37096	NA	27	4 066	704
2012	87355	NA	80 (68)***	9 656 (8 565)***	814**
2013	75409	NA	76	9 392	0****
2014	43418	NA	54	7 008	0****

***A common ALK was developed from fish collected from both commercial and survey samples. This comprehensive ALK was used to produce catch numbers at age data for pseudo-cohort analyses.**

****A common ALK was developed from fish collected from samples from Danish, Irish and Scottish commercial landings. This comprehensive ALK was used for all métiers to produce catch numbers-at-age data for pseudo-cohort analyses. Only aged fish measured to 0.5cm were included in the ALK.**

***** Only Irish collected samples were used for length frequency, see stock annex.**

****** 2012 ALK used.**

COUNTRY	OFFICIAL LANDINGS (excluding discards)	% landings covered by sampling programme	NO. SAMPLES	NO. MEASURED	NO. AGED
Denmark	8795	NA	11	1936	0*
Ireland	34622	NA	43	5072	0*
UK(Scotland)	38	0	0	0	0*
Total	43418	NA	54	7008	0*

*** 2012 ALK used.**

Area	Official Landings	No Samples	No Aged	No Measured	No Measured/ 1000 tonnes*
VIa	212	0	0	0	0
VIIb	3274	1	0	44	13
VIIg	135	0	0	0	0
VIIh	23196	38	0	5127	221
VIIj	16429	15	0	1837	112
VIIIa	119	0	0	0	9
VIIIk	53	0	0	0	0
Total	43418	54	0	7008	161

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.

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

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, van Helmond *et al.* 2009, 2010, 2011, van Overzee *et al.* 2013). Slipping estimates have been published for the Dutch freezer trawler fleet only, with values at around 10% by number (Borges *et al.* 2008) and around 2% in weight (van Helmond *et al.* 2009, 2010 and 2011) over the period 2003—2010. 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). Boarfish was found to account for 5% of the discards. Total amount of discards by species in this fleet were estimated by van Overzee *et al.* (2013) for the years 2003—2012. They indicate that discards in these years for blue whiting (3.5%; range 1—16%), herring (NSSH and other stocks: 3%; range 1-7%) and horse mackerel (1.4%; range 1—5%) are low, but higher for mackerel (24.2%; range 16—37%). Dutch-owned freezer-trawlers also operate in European waters under German, UK, and French flags. Unpublished data from 2013 and 2014 show for the freezer trawler fleet of the Netherlands and Germany discard rates between < 1% to 7% for mackerel, between 0 and < 1% for horse mackerel, between < 1% and 6% for blue whiting and app. 1% for herring (all stocks).

From 2015 onwards a landing obligation for European Union fisheries is in place for fisheries directed on small pelagic fish including mackerel, horse mackerel, blue whiting and herring. To date it was not analysed to which amount this has influenced the discarding behaviour of the fisheries. A general discard ban is already in place for Norwegian, Faroese and Icelandic fisheries.

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, Spain, Germany, Ireland, Denmark, Greenland and Portugal provided discard data on mackerel to the working group. Age disaggregated data was available from Spain, Portugal and Germany which indicates that the discarded catch is dominated by age 0 and 1 fish (> 85% by number). For 2014 the total mackerel discards reported were 6451 tonnes. The working group considers this to be an underestimate (see section 2.3.1) and the discard sampling to be incomplete.

Horse Mackerel

In the past discards of juvenile horse mackerel have been thought to constitute an 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. Over the years the Netherlands, Germany, Ireland and Spain have provided discard data. However, based on these data it is impossible to estimate the total discard rate in the horse mackerel fishery, since the discard rates reported are quite different. In 2014 discard data were available from Denmark, UK (England), Spain and the Netherlands. Ireland, Norway, Sweden and Germany observed zero discard during observed trips.

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 to the assessment. This is confirmed by estimates from sampling programmes carried out by some EU countries in the Data Collection Framework. Estimates on discarding in 2008 and 2009 of about 2% in weight were provided for the trawl fishery carried out by the Netherlands. In 2010 and 2012, this metier was sampled by Germany. No discarding of herring was observed (0%).

The Norwegian coast guard maintains a close presence with the pelagic fishing fleet in Norwegian waters with several vessels and a plane. IMR has a co-operation with a number of reference vessels in the pelagic fleet, primarily for the purposes of biological sampling but also recording losses through gear damage or slipping. These data indicate that the frequency of slipping and the total quantities of fish slipped are low and, although the quantity remains unknown, are too small to have a significant effect on the reliability of the assessment.

Blue Whiting

Overall discards of blue whiting are thought to be small. Estimates from the DCF discard sampling programme for 2014 were available from Denmark (0.17%), the Netherlands (0.3%), Portugal (39%), Spain (20%) and UK (England and Wales) (13%). Only the discards from Portugal and Spain were considered in the total catches used in the assessment. Most of the other blue whiting fishing countries assume their discards to be zero (Faroe, France, Russia, Norway and Iceland) due to existing discard bans in these countries and/or information from the industry.

Boarfish

Discard data were available from Ireland, Germany, the Netherlands, Portugal, Spain, and the UK. The Portuguese data relate to Division IXa and are not relevant to this stock. Discards were not obtained French freezer trawlers, though discard patterns in these fleets are likely to be similar to the Dutch fleet. It is to be expected that discarding occurred before 2003, in demersal fisheries, however it is difficult to predict what the levels may have been.

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

A small scale otolith exchange was carried out in 2013/2014 by TI-SF. Taking the results of the exchange in account the carrying out of a workshop is recommended in order to increase the agreement between the laboratories involved in stock assessment especially for older fish. This is brought forward to the Working Group on Biological Parameters (WGBIOP) which took over the responsibilities of PGCCDBS on the coordination of a practical implementation of quality assured and statistically sound development of methods, standards and guidelines for the provision of accurate biological parameters for stock assessment purposes.

Horse mackerel

Following the otolith exchange in 2011 and the workshop in 2012 an exchange was carried out in the beginning of 2015. The exchange was done with otoliths of three *Trachurus* species (*Trachurus trachurus, T. picturatus, T. mediterraneus*). The results showed for all species a very low precision with percent agreements between 47 and 56% and CVs ranging from 29 to 69%. The results will be further discussed on the forthcoming workshop in October 2015.

Norwegian Spring Spawning Herring

During the post-cruise meeting after the 2015 IESNS survey (also known as the "May survey"), age distributions of NSS herring from trawl samples from the different participating countries were compared. These age distributions were quite different, even for samples taken in the same area and time period.

As Norwegian scientists see it, the technical problems with age readings of NSS herring during the May survey can be split into two: **(1) The problem with deciding whether the herring in May has added extra growth in the otoliths or scales:** If the age readers decides there is extra growth added during the present year, they decide not to count the edge of the scales and otoliths as a winter ring. Opposite, if they do decide that there is no growth yet (during the present year), they decide to count the edge as a winter ring, thereby adding one more year. As a general rule it is very seldom that NSS herring has added growth in the otoliths in May. Norwegian age readers that follow the NSS herring with age reading all over the year, see this more clearly than readers not reading age of the herring in the months prior to the May survey. Norwegian readers therefore normally count the edge. However, non-Norwegian readers have a tendency to interpret that growth is added more often, and therefore do not count the edge. Typically this may lead to transfer of fish from a large year class like 2004 and down to a smaller year class like 2005. The problem will increase as a year class gets older, and growth ceases. The older they get, the closer is the distance between the winter rings, and the more difficult it is to decide if there is growth added to scales and otoliths already in May. **(2) The general problem with reduced quality of scales, and difficulties of aging old fish using otoliths.** Norwegian age readers claim that scales sampled in May are easier to read than otoliths for older NSS herring. However, in May it is difficult to get nice scales from herring samples, they are often 'washed off' during the trawling process. This even makes it more difficult to read the age, and decide to count the edge or not. Hence, sometimes otoliths have to be used, which are even more difficult to read than scales.

In conclusion, an age reading workshop involving technicians from the countries participating in the IESNS (May) survey should be held before the next survey in May 2016.

Blue Whiting

The last workshop (WKARBLUE) on age reading of blue whiting (*Micromesistius poutassou*) took place in 2013. WKARBLUE recommends a new workshop in 2017, and the survey group recommended that the age readers look closer into a discrepancy problem for ages 1—3 in the 2014 blue whiting age reading material. Furthermore, PGCCDBS 2014 proposed an age calibration of blue whiting otoliths in 2016.

Boarfish

This stock is not part of the EU data collection framework so no funding for age reading is available. Age length keys were produced in 2012. The age reading was conducted by DTU Aqua on samples from all three countries in the fishery: Ireland, Denmark and UK (Scotland).

1.3.5 Biological Data

No specific issues were reported regarding biological data for this section.

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 and uploaded through the InterCatch hosted application. Co-ordinators collate data using the either the *sallocl* (Patterson, 1998) application which produces a standard output file (*Sam.out*) or the InterCatch hosted application.

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

Official Catch	**Catches as reported by the official statistics to ICES**
Unallocated Catch	Adjustments (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. Sampling deficiencies are documented by the data transmission tables which were filled in by the stock coordinators. These tables can be found on the WGWIDE SharePoint.

The Working Group documents sampling coverage of the catches in two ways. National sampling effort is tabulated against official catches of the corresponding country (section 1.3.1). Furthermore, tables showing total catch in relation to numbers of aged and measured fish by area give a picture of the quality of the overall sampling programme in relation to where the fisheries are taking place. These tables are shown in section 1.3.1 as text tables under the species sections.

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

The national data on the amount and the structure of catches and effort are archived in the ICES Intercatch database. The data are provided directly by the individual countries and are highly aggregated for the use of stock assessments. In the past three years ICES maintained records of submission, use, quality and relevance of data, use of data in assessment provided by the individual countries, named as "Data Tables". The intention of this information was to fulfil ICES' obligations as a scientific organisation to make the data used in the assessment fully transparent but also to comply with ICES' obligations to the EU. These data were also used by the EC to evaluate whether EU member states have complied with EU data regulations and have submitted the data to ICES. It was decided by ICES that no data tables are supplied since 2013.

The subject of transmission of data to ICES and other end-users has been discussed by STECF in 2011 (STECF PLEN 11—02 and STECF EWG 11—08) in the context of the introduction of regional data bases (RDB) to support international co-operation in data collection by EU member states. The RDBs are now nearly implemented. STECF and ICES expects that the RDBs will develop rapidly and that in the near future it will be possible to use the RDB to aggregate data accommodating the data needs of end-users like ICES. The STECF EWG has presented a roadmap for the expected transmission routes and procedures for the submission of data by EU member states to ICES. The roadmap aims for submission of member state data to ICES through the RDB.

In recent years, ICES has implemented a Sharepoint solution for the storage and sharing of working group data and documentation. **The WG recommends all historical data and WG files are available through the appropriate Sharepoint site.**

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 an EU-study) for completing the collection of historic data, for verification and transfer into digital format.

Stock data problems relevant to data collections

A number of other stock data problems were brought forward to the contact person and are listed in table below for the information of ICES-Working Groups and RCMs as specified.

Stock	Data Problem	How to be addressed in	By who
Northeast Atlantic Mackerel	Submission of data	Data submissions must inlcude all the data outlined in the data call and be submitted by the deadline. Should the data submitter be unavailable after the data has been submitted (e.g. vacation) an alternative contact should be available who can be contacted in the event of any queries.	National laboratories
Northeast Atlantic Mackerel	Discard and slippage information	Discard and slippage information is incomplete. All fleets should be monitored and sampled for discard and slipping. Data should be supplied to the coordinator by the submission deadline, accompanied by documentation describing the sampling protocol.	National laboratories, RCMNA, RCMNS&EA
Northeast Atlantic Mackerel	Sampling deficiencies– general	All countries involved should provide sampling information. Increased cooperation between countries would help reduce redundancy and increase coverage.	National laboratories, RCMNA, RCMNS&EA

Stock	Data Problem	How to be addressed in	By who
Northeast Atlantic Mackerel	Sampling of foreign vessels	Any information available from the sampling of foreign vessels should be forwarded to the appropriate person in the national laboratory in order that they may use this information when compiling the data submission.	National laboratories; RCMNA, RCMNS&EA
Boarfish	Lack of age data.	Following the MoU between ICES and EU boarfish (*Capros aper*) was included into WGWIDE. The current surplus production model used to assess boarfish is considered an interim measure prior to the development of an aged-based assessment. Therefore boarfish should be included in the list of DCF species and be aged.	WGCATCH, WGBIOP. RCMs, EU
Boarfish	Boarfish only measured to the 1 cm on the IBTS.	Following the MoU between ICES and EU boarfish (*Capros aper*) was included into WGWIDE. Boarfish should be measured to the 0.5 cm on the IBTS due to the small length range and the relatively high ages observed.	ICES IBTSWG
Horse Mackerel – Western Stock	Uncertainties in the use of the current egg production method for the assessment	Evaluation of the assessment model based on egg production and fecundity. Precision estimates of the egg production data points to be provided in a form that can be used by the assessment model. Investigate spawning biology.	Future Benchmark
Horse Mackerel – Western Stock	Lack of fishery independent information	Exploration of additional fishery independent time-series to base an abundance index on.	Future Benchmark
Horse Mackerel – Western Stock	Assumed value of 0.15 for M.	Value of 0.15 should be investigated.	Future Benchmark

Stock	Data Problem	How to be addressed in	By who
Horse Mackerel – Western Stock	Discard Information	Discard information is incomplete. All fleets where discarding is thought to be occurring should be sampled for discard. Data should be supplied to the coordinator accompanied by documentation describing the sampling protocol.	National Institutes, RCM NA
Horse Mackerel – North Sea Stock	Low level of sampling and survey data. Currently only IBTS data are available which are not entirely suitable for pelagic species	Collection of information from other working groups. Possible implementation of an acoustic survey for horse mackerel in 3rd or 4th Quarter.	WGBIOP, WGCATCH, RCM NS&EA
Norwegian Spring Spawning Herring	Contrasting age distributions between laboratories in the May survey	It is recommended that a workshop on age reading is required for NSS herring to address discrepancies across nations, encountered during the recent May surveys.	WGBIOP
Norwegian Spring Spawning Herring	Low sampling effort on some nations (considerably lower than the 1 sample/1000 tonnes recommended for this stock by EU)	Sampling effort should be increased by nations with little or no samples.	National laboratories; RCM NS&EA
Northeast Atlantic Blue Whiting	Submission of data	Data submissions must inlcude all the data outlined in the data call and be submitted by the deadline. Should the data submitter be unavailable after the data has been submitted (e.g. vacation) an alternative contact should be available who can be contacted in the event of any queries.	National laboratories

1.4 Comment on update and benchmark assessments

For this year, ICES had scheduled update assessments for Blue Whiting, Norwegian Spring Spawning Herring, Western horse mackerel, Boarfish, and NEA Mackerel. NEA mackerel assessment was now carried out for the third time after the benchmark process in February 2014 (WKPELA 2014). The boarfish assessment, where the result from the assessment model is used as indicator of trends in the stock development was also carried out (though this stock is not yet benchmarked) and for the North Sea horse mackerel data explorations were undertake and new survey indices presented (no accepted assessment for this stock).

This year two new stock were added to the list of stock in the WGWIDE: Red gurnard (*Chelidonichthys cuculus*) in Subareas III, IV, V, VI, VII, and VIII (Northeast Atlantic) and Striped red mullet (*Mullus surmuletus*) in Subareas VI and VIII and Divisions VIIa–c, e–k and IXa (West of Scotland, Bay of Biscay, Southern Celtic Seas, Atlantic Iberian Waters). Unfortunately none of the WGWIDE members was working with or even familiar with these stocks. However, one scientist from Ireland worked out draft report and advice by correspondence. Unfortunately these were not available to the WG during the meeting.

1.4.1 Latest benchmark results

No new benchmark results since WGWIDE 2014.

1.4.2 Planning future benchmarks

Norwegian spring spawning herring is scheduled for a benchmark in 2016 and preparations are well underway. NEA mackerel benchmark should take place no later than 2017. Boarfish has not been benchmarked yet at all, and there is a need for a benchmarked assessment. It is anticipated that a benchmark could take place in 2018. For the Western and North Sea horse mackerel, a joint benchmark is needed, as it might even be discussed whether these stocks should be assessed as one or keep them as separate units. Blue whiting assessment has some issues that should be handled in an intermediate benchmark (by correspondence) already in 2016. Table 1.4.2.1 summarizes the benchmark planning for WGWIDE stocks.

Table 1.4.2.1. Benchmark planning for WGWIDE stocks.

Stock	Year benchmark planned
Norwegian spring-spawning herring	2016
NEA mackerel	2017
Boarfish	2018
Western horse mackerel	2017 (intermediate benchmark)
North Sea horse mackerel	2017
Blue whiting	2016 (intermediate)

1.5 Special Requests to ICES

1.5.1 NEAFC request to ICES on options for a revised long-term management strategy for blue whiting

ICES is requested to evaluate the following long-term management strategy for blue whiting over 5 and 10-year periods, assuming recent average levels of recruitment, where:

- *The value of F in paragraph 4 is a) F0.1=0.22 or b) F=0.25 or c) Fmsy=0.3*

- *The value for the deviation from F of X% in paragraph 6 is a) 10% or b) 15%*
- *The value for inter-annual flexibility of Y% in paragraphs 9 and 10 is a) 10% or b) 20%*

For each combination of the above mentioned values, ICES is asked to tabulate:

- *The risk of SSB falling below Blim*
- *The risk of SSB falling below Bpa*
- *The average annual yield*
- *The inter-annual TAC variability*

Proposal for a long-term management strategy for blue whiting:

1. The Parties agree to implement a long-term management strategy for the fisheries on the Blue Whiting stock, which is consistent with the precautionary approach, aiming at ensuring harvest within safe biological limits.

2. For the purpose of this long-term management strategy, 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 strategy shall ensure with high probability that the size of the stock is maintained above 1.5 million tonnes (Blim).

4. In the case that the spawning biomass is forecast to be 2.25 million tonnes (=Btrigger =Bpa) or more on 1 January of the year for which the TAC is to be set, the TAC shall be fixed corresponding to a fishing mortality of [F] on relevant age groups as defined by ICES.

5. Where the rules in paragraph 4 would lead to a TAC, which deviates by more than 20% from the TAC of the preceding year, the Parties shall fix a TAC that is no more than 20% greater or 20% less than the TAC of the preceding year.

6. Where the rule in paragraph 5 would lead to an F which deviates by more than [X%] from the F referred to in paragraph 4, the Parties shall fix a TAC corresponding to an F that is no more than [X%] greater or [X%] less than the F referred to in paragraph 4.

7. In the case that the spawning biomass (B) is forecast to be less than the precautionary biomass (Bpa) on 1 January of the year for which the TAC is to be set, the TAC shall be fixed that is consistent with a fishing mortality given by:

$$\text{Target } F = 0.05 + [(B - 1.5)*(F - 0.05) / (2.25 - 1.5)]$$

8. In the case that spawning biomass is forecast to be less than 1.5 million tonnes (Blim) 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

9. Each Party may transfer to the following year unutilised quantities of up to [Y %] of the quota allocated to it. The quantity transferred shall be in addition to the quota allocated to the Party concerned in the following year.

10.Each Party may authorise fishing by its vessels of up to [Y %] beyond the quota allocated. All quantities fished beyond the

allocated quota for one year shall be deducted from the Party's quota allocated for the following year.

11.The inter-annual quota flexibility scheme in paragraphs 9 and 10 should be suspended in the year following the TAC year, if the stock is forecast to be under the precautionary biomass level (Bpa) at the end of the TAC year.

12.The Parties, on the basis of ICES advice, shall review this long-term management strategy at intervals not exceeding five years.

WGWIDE worked quite extensively on answering this request. However, the SAM model uncertainty that was exemplified in this year's assessment and the fact that we are not able to fully estimate the model uncertainty leads to the conclusion that this request will not be answered in WGWIDE 2015. Further model developments are required to address the assessment uncertainty before we will be in the position to evaluate the management strategies requested.

1.5.2 EU request for ICES to evaluate the management strategy for boarfish (*Capros aper*) in Subareas VI–VIII (Celtic Seas and the English Channel, Bay of Biscay)

The EU has requested ICES to evaluate the following management strategy:

This management strategy aims to achieve sustainable exploitation of boarfish in line with the precautionary approach to fisheries management, FAO guidelines for new and developing fisheries, and the ICES form of advice.

1) *The TAC shall be set in accordance with the following procedure, depending on the ICES advice*
   a) *If category 1 advice (stocks with quantitative assessments) is given based on a benchmarked assessment, the TAC shall be set following that advice.*
   b) *If category 1 or 2 (qualitative assessments and forecasts) advice is given based on a non-benchmarked assessment the TAC shall be set following this advice.*
   c) *Categories 3-6 are described below as follows :*
      i) *Category 3: stocks for which survey-based assessments indicate trends. This category includes stocks with quantitative assessments and forecasts which for a variety of reasons are considered indicative of trends in fishing mortality, recruitment, and biomass.*
      ii) *Category 4: stocks for which only reliable catch data are available. This category includes stocks for which a time series of catch can be used to approximate MSY.*
      iii) *Category 5: landings only stocks. This category includes stocks for which only landings data are available.*
      iv) *Category 6: Category 6 – negligible landings stocks and stocks caught in minor amounts as bycatch*
2) *Notwithstanding paragraph 1, if, in the opinion of ICES, the stock is at risk of recruitment impairment, a TAC may be set at a lower level.*
3) *If the stock, estimated in the either of the 2 years before the TAC is to be set, is at or below Blim or any suitable proxy thereof, the TAC shall be set at 0 t.*
4) *The TAC shall not exceed 75 000 t in any year.*
5) *The TAC shall not be allowed to increase by more than 25% per year. However there shall be no limit on the decrease in TAC.*
6) *Closed seasons, closed areas, and moving on procedures shall apply to all directed boarfish fisheries as follows:*

   a) A closed season shall operate from 31 March to 31 August. This is because it is known that herring and mackerel are present in these areas and may be caught with boarfish.

   b) A closed area shall be implemented inside the Irish 12-mile limit south of 52°30 from 12 February to 31 October, in order to prevent catches of Celtic Sea herring, known to form aggregations at these times.

c) If catches of other species covered by a TAC amount to more than 5% of the total catch by day by ICES statistical rectangle, then all fishing must cease in that rectangle for 5 consecutive days.

The answer to this request was provided by working group members with support from the national institutes. This management strategy was considered to be precautionary.

1.5.3 EU, Norway, and the Faroe Islands request to ICES on the management of mackerel (*Scomber scombrus*) in the Northeast Atlantic

WKMACLTMP (2014) evaluated NEA mackerel long-term management plan and the advice was released in February 2015. WGWIDE received a follow-up request to further evaluate the long-term management strategy:

The Coastal States are preparing a new long-term management strategy for the stock of mackerel in the North East Atlantic. This strategy would include target fishing mortalities expressed as a range rather than a single reference point.

ICES is requested to provide a plausible range of values around Fmsy for the mackerel stock in the North East Atlantic, based on the stock biology (including possible density-dependent growth), fishery characteristics and environmental conditions.

ICES is also requested to update other reference points, including Btrigger, in light of the change from Fmsy as a single reference point to Fmsy as a range.

Given the uncertainty in stock level, growth patterns and recruitment, and taking into account the growing time series on tagging information (RFID), ICES is requested to perform the next (intermediate) benchmark in 2017.

The Coastal States would also like to inform ICES that they no longer consider that the existing management plan is appropriate, and that ICES should therefore give its advice based on the following objectives and timelines approach until a new management strategy is in place:

1. The Parties agree to limit their fishing on the basis of a TAC corresponding to a fishing mortality rate within the range of fishing mortalities defined by ICES as being consistent with fishing at maximum sustainable yield, provided that the SSB at the end of the TAC year is forecast to be above the value of Btrigger.

2. Where the SSB is forecast to be below Btrigger, but above Blim, the Parties agree to reduce the upper and lower bounds of the range of fishing mortality referred to in paragraph 1 by the proportion of SSB at the start of the TAC year to Btrigger.

3. Every effort shall be made to maintain a minimum level of SSB greater than Blim. Where the SSB at the start of the TAC year is estimated to be below Blim the TAC shall be set at a level corresponding to a fishing mortality rate consistent with the objective of rebuilding the SSB to above Blim the following year. The Parties may also take additional management measures that are deemed necessary in order to achieve this objective.

The request was answered based on the simulations carried out for the Workshop on the NEA Mackerel Long-term Management Plan (ICES, 2015b). We have provided a range for the F giving yield within 95% of the MSY, and a suite of alternative Btrigger values. The precautionary FMSY range for the Northeast Atlantic (NEA) mackerel is Flower = 0.15 and Fupper = 0.24. The range reflects the target F values that are expected to result in high long-term yield deviating at maximum 5% from the MSY. The range is dependent on implementing an MSY Btrigger = 3.0 Mt. Other values of Fupper dependent on the choice of MSY Btrigger are presented under Section 2.12.

1.6 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. 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 meetings 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. A close collaboration with the Working Group on Integrated Assessment on Norwegian Sea (WGINOR) will help in operationalizing ecosystem approach for the widely distributed pelagics assessed 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; 2007). 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). The 2011 winter NAO index was negative although not as low as 2010 but lower than the long-term average (1950—2010). Hence, favourable winds supporting a strong Atlantic influence in the waters west of the British Isles and other regions continued to be lower than during high NAO years. The 2015 winter NAO index was high, and simultaneously cold/fresh waters on the Canadian site of the Atlantic that winter and spring resulted in relative low temperatures in the Sub Polar Gyre

(SPG) and low temperatures at all depths in the vicinity of the Faroese in comparison to 20 years long-term mean (ICES, 2015c).

Accumulation of anthropogenic greenhouse gases in the atmosphere is currently effecting climate change (IPCC, 2001; 2007). 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 (Astthorsson *et al.,* 2012; ICES, 2013b), Norwegian spring-spawning herring and blue whiting may and have been taken advantage of warming ocean ecosystems expending possible feeding opportunities, through increasing their geographical distribution area, 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). 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 generally rising trends in the recent years. 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). This positive anomaly in the sea temperature in Northeast Atlantic continued in 2011—2015 (ICES, 2015c). 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), and also above the long-term average in 2008—2014, while around and below the average in the summer 2015 (ICES, 2015d). The largest anomalies were generally observed at high latitudes.

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 showed a reducing trend in the 2000s, whereas the North Sea showed an increased trend in phytoplankton concentrations in the late 2000s (Naustvoll *et al.*, 2010). Most likely linked to phytoplankton abundance and species compositions, a decreasing trend of silicate concentrations in early spring have been observed in Norwegian Sea and Barents Sea for recent years (Rey, 2012).

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. 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. Progressive increases in abundance of warm water/subtropical 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, according to the IESNS survey in May, showed a decreasing trend during 2002—2009, an upward trend since then up to 2014, and a slight decrease again in 2015 (ICES, 2015c). The reason for the decline in the biomass index of zooplankton during the period 2002—2009 in Nordic Seas is unknown. A number of possible reasons could explain this decline and the present low level, including reduction in phytoplankton (Naustvoll *et al.*, 2010; i.e. bottom-up), possible changes in phytoplankton community, possible changes in zooplankton community, and increased grazing pressure by pelagic fish stocks (i.e. top–down). Simultaneously to the recent (2009—2014) upward trend in the zooplankton index in May (ICES, 2015c), as well as in the IESSNS surveys in July/August (2011—2015; ICES, 2015d), the weight-at-age (this report) and length-at-age (ICES, 2013c) in the Norwegian spring-spawning herring feeding in the area are showing increasing trend. It's an indication that the Norwegian Sea is neither being overgrazed at present by the pelagic fish stocks in the area, nor that the herring stock is starving (i.e. increased natural mortality) because of relatively low zooplankton indices until 2010. Further studies on this issue will take place within the ICES working group on integrated assessment in Norwegian Sea (WGINOR; ICES, 2013c), where the zooplankton index will also be revised and produced for the different areas in the Nordic Seas.

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 extent 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 seabird 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). Comparison of population estimates of pelagic fish with those of top predators (e.g. minke whale, fin whale, killer whales) suggests 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).

In this report, different relevant aspects of interaction between the pelagic fish stocks are address. It includes spatial overlap of mackerel and NSS herring on the feeding grounds in the Nordic Seas (section 2.11), predation of mackerel on herring larvae in the Barents Sea (section 7.15), and comparison of diet composition of the pelagic fish stocks (section 7.15).

1.7 Future Research and Development Priorities

As part of the planning towards future benchmark assessments, the working group started in 2014 preparing a list of research priorities for each stock, and as a whole than can potentially improve the quality of the advice generated for each stock. This list is be updated in every WG meeting, by removing issues as they have been solved and adding new ones when they arise. We have considered scientific research, improvements to data collection and development of assessment techniques, both generally and on a stock-by-stock basis, as appropriate. The most important of these developments are described below.

1.7.1 General

Area where WGWIDE can improve considerably is work towards integrated ecosystem assessments. Some of WGWIDE members also participate in the work of the Working Group on Integrated Assessment for Norwegian Sea (WGINOR), which help in communication between these two groups. However, there are also other regional Integrated Ecosystem Assessment groups that could be relevant for WGWIDE and the stocks assessed by it. We hope to put more emphasis on this in the coming years.

1.7.2 NEA Mackerel

Following list contains issues that should be investigated before or during the next benchmark of NEA mackerel in 2017:

- Natural mortality: Current M value was estimated using both tagging-recapture information and catches from the 1970s, which are now known to be severely underestimated. The estimation of M should be revisited using most recent and accurate data.
- SAM model: Explore the effects of binding the observation variances of age groups in the catches. One option could be three groups, namely i) juveniles that are not targeted by the fishery, ii) the adults that constitute the main part of the catches and iii) the oldest age groups that are difficult to age precisely (see assessment in WGWIDE 2015).
- RFID tags:
    - Inclusion of the time series to the assessment model
    - SAM model should be adapted so that the post tagging survival is modelled as a random walk, to allow for temporal variability of this parameter.
- The triennial egg survey:
    - WGWIDE should consider the influence of the lack of egg-survey data in inter-egg-survey year assessments, and propose settings to be added to the Stock Annex for future years.
    - Examine whether the larvae data from the Continuous Plankton Recorder (CPR) can be used to supplement the egg survey.
- The IESSNS survey:
    - Explore the use of the IESSNS index as multinomial in SAM (only use the age distributions, not the density).
    - Explore adding the younger age classes.
- Additional analysis of the substantial variation in growth and maturation based on recent publications by Jansen and Burns (2015) and Olafsdottir *et al.*, (2015). Explore the possibilities for implementing this knowledge in the assessment and advice.

1.7.3 Blue Whiting

- There is a need for more information regarding population structure in these stocks. Numerous scientific studies have suggested that blue whiting in the North Atlantic consists of multiple stock units. The ICES Stock Identification Methods Working Group (SIMWG) reviewed this evidence in 2014 (ICES, SIMWG 2014) and concluded that the perception of blue whiting in the NE Atlantic as a single-stock unit is not supported by the best available science. SIMWG further recommended that blue whiting be considered as two units. However, there is currently no information available that can be used as the basis for generating advice on the status of the individual stocks. There is therefore a need to begin to collate information on these stocks in the leadup to a potential benchmark of this stock in the future. Potential data sources identified by the group include

- Otolith-shape analysis has recently been shown to be able to reliably identify the stock-origin of sampled fish Keating *et al.* (2014). Use of this method in conjunction with age-reading in both scientific surveys and catch sampling can therefore provide a valuable source of information about the individual stocks. WGWIDE therefore recommends that during the next "Age Reading Workshop for Blue Whiting", otoliths from the whole area of this stock distribution should be collected to perform shape analysis, and used to both standardize the technique and plan for its roll-out.
- The spatial and temporal coverage of the International Blue-whiting spawning stock survey (IBWSS) currently does not include the southern component, which spawns in the Porcupine Seabight in February-March (Pointin and Payne 2014). WGWIDE therefore recommends expansion of this survey to cover this component.
- This Mackerel Egg Survey (MEGS) survey has previously been shown to provide valuable information about the distribution of fish spawning, including blue whiting (Ibaibarriaga *et al.,* 2007). This survey covers the spatial and temporal distribution of spawning in both blue whiting stocks extremely well, and can therefore provide valuable information about their relative abundances. WGWIDE has been informed that presence-absence per haul of blue whiting larvae will be included during the 2016 version of this survey.

1.7.4 NSS Herring

Norwegian spring spawning herring is scheduled for a benchmark in 2016. There are several issues with the current assessment model, and work is already being undertaken in national laboratories to improve the assessment of this stock. WGWIDE has set up the following issue list for benchmark:

- incorporating uncertainty in survey and catch data into the assessment
- exploration of alternative assessment models
- investigate the bias in the assessment
- an analysis of variability or changes in the catchability of fleet 5. This is the major fleet used for tuning the assessment and seems to be causing retrospective patterns in the assessment
- the inclusion of a new tuning series (IESSNS) in the assessment
- criteria for quality check of input data to the assessment
- update maturity ogives for recent years following procedures as described by WKHERMAT.
- extend the time series used in the assessment with earlier years before 1988
- the need to continue the use of weighted average F in the assessment and advice. NSSH is one of the few stocks in which weighted F's are applied.
- the consequences for the reference points and management plans if the use of weighted F is discontinued.

1.7.5 Horse Mackerel

Generally speaking, management is most effective when its measures apply to all fisheries exploiting a stock and when catches can be identified as originating from that stock with some certainty. Considering the potential of mixing between Western and North Sea horse mackerel occurring in Division VIId/VIIe, better insight into the origin of catches from that area will be a major benefit, if not crucial, for improvement of the quality of future scientific advice and thus management of the North Sea and Western horse mackerel stocks.

- One way of possibly distinguishing between individuals of the two stocks is with the GCxGC-MS (Gas chromatography x Gas chromatography–mass spectrometry). A pilot project aimed at determining whether this technique could be used for distinguishing between Western and North Sea horse mackerel was planned at IMARES but due to funding restrictions this is unlikely to proceed further.
- Alternative methods for resolving the stock identity in the channel could be explored
- Methods for distinguishing between fish of North Sea or Western origin in the catches in this region (e.g. otolith shape analyses) should be explored

North Sea horse mackerel

To improve the knowledge base for North Sea horse mackerel, a project has been initiated in 2015 by the Pelagic Freezer-trawler Association (PFA) together with IMARES and University College Dublin. The project aims to 1) provide additional information on stock boundaries and mixing between North Sea and Western horse mackerel, and 2) explore or develop potential new abundance indices for North Sea horse mackerel.

To address stock boundaries and mixing, the project will explore the potential of utilizing skippers' catch information (with a very high spatial resolution and detailed information on size composition) to enhance the understanding on the mixing of stocks in the areas VIIe, VIId and the Southern North Sea. In addition, horse mackerel samples will be taken when the horse mackerel are separated in the summer spawning season (in the North Sea and Western waters) and when they are feeding in the winter season (in the Channel area). Genetic and chemical techniques will be used to detect the contribution of the different spawning components to the catches in winter.

To improve the abundance indicators, the project will explore additional (existing) survey data, like the CGFS that has already been used by WGWIDE 2015. The project will also explore the potential application of a commercial fishery search-time index. Horse mackerel is fished while it is very close to the bottom in relatively dispersed, small schools. The fishery is mostly executed using long hauls and there may be extensive search time involved. Handled in an appropriate statistical framework, taking into account the nature of the fishery and other factors such as seasonality and alternative fishing opportunities, the search time and catch rates could provide for an indication of changes in stock size over time. Catch rates in areas VIIe, VIId and southern North Sea will be analysed from skippers' private logbooks.

It is expected that the results of the research project can be presented to WGWIDE in 2016.

Improving the quality of age data for this species would help resolved some the lack of clear cohort signals in the catch data. Additionally, aging of horse mackerel caught in the IBTS survey (currently only length measures are taken) would improve the indices derived from this data source.

- Maintain regular age-reading workshops to ensure accuracy and consistency of age reading of this species (through ICES).
- Recommend age reading of horse mackerel caught in the IBTS and CGFS surveys.

1.7.6 Boarfish

This stock would benefit immensely if it were included in the data collection framework. The advantage would primarily come in the form of annual age reading. Support for age reading of otoliths from catch samples of boarfish would allow the compilation of annual age-length keys for the fishery. This is of great importance if the stock is to move to a more appropriate age based assessment in the future.

1.7.7 References

Astthorsson OS, Valdimarsson H, Gudmundsdottir A, Óskarsson GJ. 2012. Climate related variations in distribution and abundance of mackerel (*Scomber scombrus*) in Icelandic waters. ICES Journal of Marine Science 69: 1289–1297.

Beaugrand, G., 2005. Monitoring pelagic ecosystems from plankton indicators. ICES Journal of Marine Science 62: 333–338.

Beaugrand, G., Reid, P.C., Ibanez, F., Lindley, J.A., and Edwards, M. 2002. Reorganization of North Atlantic Marine Copepod Biodiversity and Climate. Science, 296: 1692-1694.

Borges, L., Rogan, E. and Officer, R. 2005. Discarding by the demersal fishery in the waters around Ireland. *Fisheries Research*, 76: 1–13.

Borges, L., van Keeken, O. A., van Helmond, A. T. M., Couperus, B., and Dickey-Collas, M. 2008. What do pelagic freezer-trawlers discard? ICES Journal of Marine Science, 65: 605– 611.

Dickey-Collas, M., Van Helmond, E., 2007. Discards by Dutch flagged freezer trawlers. Working Document to the Working Group Mackerel, Horse Mackerel, Sardine and Anchovy (ICES CM 2007/ACFM: 31).

Furness, R.W., 2002. Management implications of interactions between fisheries and sandeel dependent seabirds and seals in the North Sea. *Ices Journal of Marine Science* 59:261 – 269.

Harden Jones, F. R. 1968. Fish Migration. Edward Arnold, London, UK. 325 pp.

Hátún, H., A. B. Sandø, H. Drange, B. Hansen and H. Valdimarsson, 2005. Influence of the Atlantic subpolar gyre on the thermohaline circulation. *Science*, 309, 1841 – 1844.

Helmond, A.T.M. van and H.J.M. van Overzee 2009. Discard sampling of the Dutch pelagic freezer fishery in 2003-2007. CVO report 09.001

Helmond, A.T.M. van and H.J.M. van Overzee 2010. Discard sampling of the Dutch pelagic freezer fishery in 2008 and 2009. CVO report 10.008

Helmond, A.T.M. van and H.J.M. van Overzee 2011. Discard sampling of the Dutch pelagic freezer fishery in 2010. CVO report 11.0xx in press

Hofstede, R. and Dickey-Collas, M. 2006. An investigation of seasonal and annual catches and discards of the Dutch pelagic freezer-trawlers in Mauritania, Northwest Africa. *Fisheries Research*, 77: 184–191.

Ibaibarriaga, L., Irigoien, X., Santos, M., Motos, L., Fives, J., Franco, C., Reid, D. G. (2007). Egg and larval distributions of seven fish species in north-east Atlantic waters. Fisheries Oceanography, 16(3), 284–293. doi:10.1111/j.1365-2419.2006.00430.x

ICES. 2013. NEAFC request to ICES to evaluate the harvest control rule element of the long-term management plan for blue whiting. Report of the ICES Advisory Committee 2013. ICES Advice, 2013. Book 9, Section 9.3.3.1.

ICES. 2013. NEAFC request to ICES to evaluate the extra harvest control rule options for the long-term management plan for blue whiting. Report of the ICES Advisory Committee 2013. ICES Advice, 2013. Book 9, Section 9.3.3.7.

ICES. 2013b. Report of the Ad hoc Group on the Distribution and Migration of Northeast Atlantic Mackerel (AGDMM), 30-31 August 2011 and 29-31 May 2012, ICES Headquarters, Copenhagen. ICES CM 2013/ACOM:58. 211 pages.

ICES. 2013c. Interim Report of the Working Group on Integrated Ecosystem Assess-ments for the Norwegian Sea (WGINOR), 19–23 August 2013, Bergen, Norway. ICES CM 2013/SSGRSP:07. 94 pp.

ICES. 2015c. International ecosystem survey in the Nordic Sea (IESNS) in April-June 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015. 34 pp.

ICES. 2015d. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) with M/V ”Brennholm”, M/V “Eros”, M/V “Christian í Grótinum” and R/V “Árni Friðriksson”, 1 July - 10 August 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015. 47 pp

IPCC, 2001. Climate change 2001: the scientific basis. Cambridge University Press, Cambridge, 881 pp.

Jansen T. And Burns F. 2015. Density dependent growth changes through juvenile and early adult life of North East Atlantic Mackerel (*Scomber scombrus*). Fish. Res., 169:37-44.

Jones, P. D., et Moberg, A., 2003. Hemispheric and large-scale surface air temperature variations: An extensive revision and an update to 2001. Journal of Climate 16: 206 – 223.

Leggett, W. C. (1977). The ecology of fish migrations. *Annual Review of Ecology and Systematics* **8,** 285–308.

Nøttestad, L., A. Fernö, O.A. Misund, R. Vabø, 2004. Understanding herring behaviour: linking individual decisions, school patterns and population distribution. *In* The Norwegian Sea Ecosystem, 1st edn, pp. 221 – 262. Eds. H. R. Skjoldal R. Sætre, A. Fernö, O.A. Misund and I. Røttingen.Tapir Academic Press, Trondheim, Norway. 559 pp.

Nøttestad, L., and Holst J.C. 2011. Cruise report from the Norwegian mackerel / ecosystem survey with M/V ”Libas” from 18. July to 10. August 2011. Working Document (WD No. 1) to the ICES WGWIDE 2011. 16 pp.

Nøttestad, L., Utne, K.R., Oskarsson G.J., Sveinbjörnsson S., Debes, H., Jacobsen J.A. *et al*. 2012b. Cruise report from the coordinated ecosystem survey (IESSNS) with R/V “G.O. Sars”, M/V “Brennholm”, M/V “Christian í Gr´tinum” and R/V “Arni Fridriksson” in the Norwegian Sea and surrounding water, 1 July – 10 August 2012. Working document to ICES Working Group on Widely distributed Stocks (WGWIDE), Lowestoft, UK, 21–27 August 2012. 50 p.

Olafsdottir, A. H., Slotte, A., Jacobsen, J. A., Oskarsson, G. J., Utne, K. R., and Nøttestad, L. Changes in weight-at-length and size at-age of mature Northeast Atlantic mackerel (Scomber scombrus) from 1984 to 2013: effects of mackerel stock size and herring (Clupea harengus) stock size. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsv142.

Overzee, H. M. J. van; Helmond, A. T. M. van; Ulleweit, J.; Panten, K. (2013): Discard sampling of the Dutch and German pelagic freezer fishery operating in European waters in 2011 and 2012. Stichting DLO Centre for Fisheries Research (CVO), 68 pages, CVO Report 13.013

Patterson, K.R. 1998: A programme for calculating total international catch-at-age and weight at-age. WD to Herring Assessment Working Group 1998.

Pierce, G. J., J. Dyson, E. Kelly, J. D. Eggleton, P. Whomersley, I. A. G. Young, M. B. Santos, J. J. Wang and N. J. Spencer (2002). "Results of a short study on by-catches and discards in pelagic fisheries in Scotland (UK)." Aquatic Living Resources 15(6): 327-334.

Rey F (2012). Declining silicate concentrations in the Norwegian and Barents Seas. ICES Journal of Marine Science (2012), 69(2), 208–212. doi:10.1093/icesjms/ fss007.

Richardson, A.J. and Schoeman, D.S., 2004. Climate impact on plankton ecosystems in the northeast Atlantic. Science 305:1609–1612.

Rossby, T., 1999. On gyre interaction. Deep-Sea Research II, Vol. 46, No. 1 – 2, pp. 139–164.

Skjoldal, H. R., Dalpadado, P., and Dommasnes, A., 2004. Food webs and trophic interactions.*In* TheNorwegian Sea Ecosystem, 1st edn, pp. 263 – 288. Eds. H. R. Skjoldal R. Sætre, A. Fernö, O.A. Misund and I. Røttingen. Tapir Academic Press, Trondheim, Norway. 559 pp.

Sherman, K., and Skjoldal, H.R., 2002. Large Marine Ecosystems of the North Atlantic. Changing states and sustainability. Sherman, K., and Skjoldal H.R. (Eds.)). Elsevier Science B.V. The Netherlands.

Tasker, M. L. (Ed.) 2008. The effect of climate change on the distribution and abundance of marine species in the OSPAR Maritime Area. ICES Cooperative Research Report No. 293. 45 pp.

Ulleweit, J. and Panten, K., 2007. Observing the German Pelagic Freezer Trawler Fleet 2002 to 2006 – Catch and Discards of Mackerel and Horse Mackerel. Working Document to the Working Group Mackerel, Horse Mackerel, Sardine and Anchovy (ICES CM 2007/ACFM: 31).

2 Northeast Atlantic Mackerel

2.1 ICES Advice and International Management Applicable to 2015

From 2001 to 2007 the internationally agreed TACs covered most of the distribution area of the northeast Atlantic mackerel. From 2008 to 2014, no agreement has been reached among the Coastal States on the sharing of the mackerel quotas. In 2014 three of the Coastal States agreed on a TAC for 2015 and the subsequent five years, however, the total declared quotas for 2015 exceed the advised TAC. An overview of the declared quotas and transfers for 2015, as available to WGWIDE, is given in the text table below. Total removals of mackerel are expected to be approximately 1.24 Mt in 2015, exceeding the recommended upper catch limit for 2015 by about 330 kt.

Estimation of 2015 catch	Tonnes	Reference
EU quota	521 689	European Council Regulation 2015/104
Spanish payback	-9747	European Council Regulation 2011/165
Norwegian quota	242 078	Nærings- og fiskeridepartementet 23 Dec 2014 (Regjeringen.no)
Inter-annual quota transfer 2014->2015 (NO)	16 380	Directorate of Fisheries in Norway
Russian quota	114 143	Estimate from PINRO (Russia)
Discards	6451	Previous years estimate
Icelandic quota	173 000	Icelandic regulation No. 532/2015
Inter-annual quota transfer 2014->2015 (IS)	6800	Icelandic regulation No. 532/2015
Faroese quota	132 814	Faroese regulation No. 141/2014
Greenland quota	32 000	Estimate from Greenland institute of Natural Resources
Total expected catch (incl. discard) [1,2]	1 235 608	

[1] No guesstimates of banking from 2015 to 2016

[2] Quotas include amounts exchanged to other parties

The quota figures and transfers in the text table above were based on various national regulations, official press releases, and discard estimates.

Various international and national measures to protect mackerel are in operation throughout the mackerel catching countries. Refer to Table 2.2.4 for an overview.

2.2 The Fishery

2.2.1 Fleet Composition in 2014

A description of the fleets operated by the major mackerel catching nations is given in Table 2.2.1.

The total fleet can be considered to consist of the following components:

Freezer trawlers. These are commonly large vessels (up to 150 m) that usually operate a single mid-water pelagic trawl, although smaller vessels may also work as pair trawlers. These vessels are at sea for several weeks and sort and process the catch on board, storing the mackerel in frozen 20 kg blocks. The Dutch, German and the majority of the French and English fleets consist of these vessels which are owned and operated by a small number of Dutch companies. They fish in the North Sea, west of the UK and Ireland and also in the English Channel and further south along the western coast of France. The Russian summer fishery in subarea IIa is also prosecuted by freezer trawlers and partly the Icelandic fishery in Va and XIVb.

Purse Seiners. The majority of the Norwegian catch is taken by these vessels, targeting mackerel overwintering close to the Norwegian coastline. The largest vessels (> 20 m) are RSWs, storing the catch in tanks containing refrigerated seawater. Smaller purse seiners use ice to chill their catch which they take on prior to departure. A purse seine fleet is also the most important component of the Spanish fleet. They are numerous and target mackerel early in the year close to the northern Spanish coast. These are dryhold vessels, chilling the catch with ice. Denmark also has a purse seine fleet operating in the northern North Sea.

Pelagic Trawlers. These vessels vary in size from 20—100 m and operate both individually and as pairs. The largest of the pelagic trawlers use RSW tanks for storage. Iceland, Greenland, Faroes, Scotland and Ireland all fish mackerel using pelagic trawlers. Scottish and Icelandic vessels mostly operate singly whereas Ireland and Faroes vessels tend to use pair trawls. Spain also has a significant trawler fleet which target mackerel with a demersal trawl in areas VIII and IXaN.

Lines and Jigging. Norway and England have handline fleets operating inshore in the Skagerrak (Norway) and in area VIIe/f (England) around the coast of Cornwall, where other fishing methods are not permitted. Spain also has a large artisanal handline fleet as do France and Portugal. A small proportion of the total catch reported by Scotland (IVa and IVb) and Iceland (Va) is taken by a handline fleet.

Gillnets. Gillnet fleets are operated by Norway and Spain.

2.2.2 Fleet Behaviour in 2014

The most important changes in recent years are related to the geographical expansion of the northern summer fishery (areas II, V and XIV) and changes in southern waters due to stricter TAC compliance by Spanish authorities. Fishing in the North Sea and west of the British Isles followed a traditional pattern, targeting mackerel on their spawning migration from the Norwegian deep in the northern North Sea, westwards around the north coast of Scotland and down the west coast of Scotland and Ireland.

In 2010 fishing by Faroese vessels increased dramatically and has shifted exclusively to pair trawling. A small proportion of the Faroese quota is granted to smaller, traditionally demersal trawlers (using pair trawls).

The Russian freezer trawler fleet operates over a wide area in Northern waters. This fleet targets herring and blue whiting in addition to mackerel. In the third quarter the Russian vessels took the bulk of their catch from the international waters of area IIa. Smaller catches were also taken further south, between the Faroes and Iceland.

Total catches from Icelandic vessels were similar to those in recent years with the majority of the catch taken in Va in waters south and south-east of Iceland. Catches were also taken to the west of Iceland, including in area XIVb. Also targeting mackerel in area XIVb were Greenlandic vessels. This fleet has increased its catch rapidly and in 2014 caught over 87 kt of mackerel with the majority from an area 30—34 degrees west, the biggest catch by this fleet to date.

Concerning the Spanish fisheries no new regulations have been implemented since 2010 when a new control regime was enforced. Fishery has started as in previous years at the beginning of March, although the southern spawning component was already concentrated at their spawning grounds as earlier as February.

2.2.3 Recent Changes in Fishing Technology and Fishing Patterns

Northeast Atlantic mackerel, as a widely distributed species, is targeted by a number of different fishing métiers. Most of the fishing patterns of these métiers have remained unchanged during the most recent years, although the timing of the spawning migration and geographical distribution can change from year to year and this affects the fishery in various areas.

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

In 2010 the Faroese fleet switched from purse-seining in Norwegian and EU waters to pair trawling in the Faroese area. The Faroese fleet used to catch their mackerel quota in Divisions IVa and VIa during September-October with purse-seiners. However, as no agreement has been reached between the Coastal States since 2009, the mackerel quota has been taken in Faroese waters during June-October by the same fleet using pair trawls. The mackerel distribution is more scattered during summer and pair trawls seem to be effective in such circumstances. However, since the agreement between the three of the Coastal States for the fisheries in 2015, parts of the Faroese quota will now again be taken with purse-seines in Divisions IVa and VIa.

Also targeting summer feeding mackerel, Icelandic vessels have increased effort and catch dramatically in recent years from 4 kt in 2006 to on average 160 kt annually since 2011. This fishery operates over a wide area E, NE, SE, S and SW off Iceland. Since 2011 there has been less fishing activity to the north and north-east and an increase in catches taken south and west of Iceland. Greenland has reported increased catches from area XIVb since 2011.

In Spain part of the purse seiner fleet is using hand line instead of nets. Although, neither the number of vessels and its evolution nor the reason for such change were deeply analysed, it seems market reasons are driven this shift.

2.2.4 Regulations and their Effects

An overview of the major existing technical measures, TACs, effort controls and management plans are given in Table 2.2.4. Note that there may be additional existing international and national regulations that are not listed here.

Between 2010 and 2014 no overarching Coastal State Agreement/NEAFC Agreement was in place and no overall international regulation on catch limitation was in force. In 2014 an *ad hoc* agreement was reached but only involving the EU, Faroes and Norway.

Management aimed at a fishing mortality in the range of 0.15—0.20 in the period 1998—2008. The current management plan aims at a fishing mortality in the range 0.20—0.22. The fishing mortality realised during 1998—2008 was in the range of 0.27 to 0.46. Implementation of the management plan resulted in reduced fishing mortality and increased biomass. Since 2008 catches have greatly exceeded those given by the plan.

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. The traditional explanation of the decline of the North Sea spawning component has been to point to the overexploitation which has led to recruitment failure since 1969. A recent scientific paper (Jansen, 2014) has shown that this narrative may require revision, as it could be the combination of high fishing pressure, followed by decreasing temperatures that led to reduced spawning migration into the North Sea. So rather than a local stock collapse, this could also be constituted as a southwest shift in spawning distribution. For a future benchmark assessment of NEA mackerel, it would be required to provide a thorough review of all available knowledge on the North Sea spawning component and to evaluate whether the current protection measures would need to stay in place.

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 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. Recent EU TAC regulations have permitted some small quotas in IIIa and IVb,c. In the same regulation it is also stated that within the limits of the quota for the western component (VI, VII, VIIIa,b,d,e, 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 September to 31 December. Up to 2010, 30% of the Western mackerel TAC (MAC/2CX14-) could be taken in IVa, from 2010 onwards, the percentages is set at 40%.

In the southern area a Spanish national regulation affecting mackerel catches of Spanish fisheries has been implemented since 2010. In 2014 fishing opportunity was distributed by regions and gear and for the bottom trawl fleet, by individual vessel. This year Spanish mackerel fishing opportunity in VIIIc and IXa was established at 40 688 t resulting from the original quota established at 46 677 t (Commission Regulation (EU) No 432/2014 from 22 April modifying the 43/2014 one), reduced by 5989 t due to the scheduling payback quota due to overfishing of the mackerel quota allocated to Spain in 2010 (Commission Executive Regulation (EU) No 978/ 2014 modifying the Commission Regulation No 165/2011).

Within the area of the southwest Mackerel Box off Cornwall in southern England only hand liners 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.

The first phase of a landing obligation came into force in 2015 for all EU vessels in pelagic and industrial fisheries. All species that are managed through TACs and quotas must be landed under the obligation unless there is a specific exemption such as *de minimis*. There are no *de minimis* exemptions for mackerel.

2.2.5 Information from the fishing industry

A pre-meeting between ICES scientists and representatives of the EU pelagic industry was held on 19 August 2015, to discuss information from the fishing industry and any ongoing development to address data needs. Regarding mackerel, the EU fishery representatives reported that the fishermen experience a large abundance of mackerel in 2015 and very widely distributed. Mackerel is also caught in substantial amounts outside of the directed mackerel fishery and in places where it did not used to be caught in recent years (e.g. during the herring fishery in the North Sea). Mostly, the mackerel is of the smaller sizes. Denmark fishermen have reported spawning mackerel being caught during the sand eel fishery.

2.3 Catch Data

2.3.1 ICES Catch Estimates

The total ICES estimated catch for 2014 was 1 394 454 t, a significant increase of 461 289 t (49%) on the estimated catch in 2013 and the largest catch in the time series (although there is significant uncertainty regarding catches prior to 2000). Catches increased substantially from 2006—2010 and averaged 910 kt from 2011—2013. Minor revisions to 2012 and 2013 were incorporated into the time series as a result of updated estimates.

The combined 2014 TACs arising from agreements and autonomous quotas amount to 1 396 238 t. The ICES catch estimate (1 394 454 t) represents a very small undershoot. The combined fishable TAC for 2015, as best ascertained by the Working Group (see Section 2.1), amounts to 1 235 608 t.

Catches reported for 2014 and in previous Working Group reports are considered to be best estimates. In most cases, catch information comes from official logbook records. Other sources of information include catch processors. Some countries provide information on discards and slipped catch from observer programs, logbooks and compliance reports. In several countries discarding is illegal. Spanish data is based on the official data supplied by the Fisheries General Secretary (SGP) but supplemented by scientific estimates which are recorded as unallocated catch in the ICES estimates (see Section 1.3.6).

The text table below gives a brief overview of the basis for the ICES catch estimates.

Country	Official Log Book	Other Sources	Discard Information
Denmark	Y (landings)	Y (sale slips)	Y
Faroe[1]	Y (catches)	Y (coast guard)	NA
France	Y (landings)		N
Germany	Y (landings)		Y
Greenland	Y (catches)	Y (sale slips)	Y
Iceland[1]	Y (landings)		NA
Ireland	Y (landings)		Y
Netherlands	Y (landings)	Y	Y
Norway[1]	Y (catches)		NA
Portugal		Y (sale slips)	Y
Russia[1]	Y (catches)		NA
Spain	Y	Y	Y
Sweden	Y (landings)		N
UK	Y (landings)	Y	N

[1]For these nations a discarding ban is in place such that official landings are considered to be equal to catches.

The Working Group considers that the estimates of catch are likely to be an underestimate for the following reasons:

- Estimates of discarding or slipping are either not available or incomplete for most countries. Anecdotal evidence suggests that discarding and slipping can occur for a number of reasons including high-grading (larger fish attract 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 (Simmonds *et al.*, 2010) for the period studied.
- Estimates of the magnitude and precision of unaccounted mortality suggests that, on average for the period prior up to 2007, total catch related removals were equivalent to 1.7 to 3.6 times the reported 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) Nos. 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 accuracy of logbooks from countries outside the EU has not been evaluated by WGWIDE. Monitoring of logbook records is the responsibility of the national control and enforcement agencies.

The total catch as estimated by ICES is shown in Table 2.3.1.1. It is broken down by ICES area and illustrates the development of the fishery since 1969.

Discard Estimates

With a few exceptions, estimates of discards have been provided to the Working Group for the areas VI, VII/VIIIa, b, d, e and III/IV (see Table 2.3.1.1) since 1978. Historical discard estimates were revised during the data compilation exercise undertaken for the benchmark assessment (ICES CM 2014/ACOM:43). The Working Group considers the estimates for these areas are incomplete. In 2014 discard data for mackerel were provided by seven nations: The Netherlands, Germany, Ireland, Spain, Portugal, Greenland and Denmark. Total discards amounted to 6452 t from these nations (mainly Netherlands and Spain). The German program consisted of 2 mackerel-directed trips on pelagic freezer trawlers. The Danish discards apply only to observations from some demersal fisheries. The Irish pelagic discard program included 14 trips (3 mackerel directed trips).

Age-disaggregated data was limited but data from Portugal, Spain and Germany indicating that the majority of discarded fish were aged 0 to 3. In area IX, discards were almost exclusively 0-group fish,

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

2.3.2 Distribution of Catches

A significant change in the fishery took place between 2007 and 2009 with a greatly expanded northern fishery becoming established. Of the total catch in 2014, Norway accounted for the greatest proportion (20%) followed by Scotland (17%), Iceland (12%) and Faroe (11%). In the absence of an international agreement, Faroe, Greenland, Iceland and Russia declared unilateral quotas in 2014. Russia and Ireland both had catches over 100 kt and Greenland caught almost 80 kt. Germany, Netherlands, Spain, Denmark, France and England had catches of the order of 20—50 kt.

In 2014, catches in the northern areas (II, V, XIV) amounted to 684 173 t (see Table 2.3.2.1), an increase of 218 444 t on the 2013 catch and ten-fold the catch a decade earlier. Faroese, Icelandic, Norwegian and Russian catches were all over 100 kt. The large increase in Norwegian catches from those in 2013 is due to a greater proportion of the total Norwegian catch being taken in northern waters. This fishery takes place on the border of areas IIa and IVa. The wide geographical distribution of the fishery noted in previous years has continued with large catches (approx. 100 kt) now taken in area XIV by Iceland and Greenland.

The time series of catches by country from the North Sea, Skagerrak and Kattegat (Subarea IV, Division IIIa) is given in Table 2.3.2.2. Catches in 2014 amounted to 384 221 t, an increase on 2013 despite a reduced in Norwegian catches in IVa as outlined above. The overall increase is due primarily to increased catches by Faroe, Ireland and Scotland. Small catches were also reported in areas IIIb, c and d.

Catches in the western area (Subareas VI, VII and Divisions VIIIa,b,d and e) also increased to 275 519 t with most of the traditional fishing nations reporting increased catch, particularly Scotland (an increase of 43 kt). These catches are detailed in Table 2.3.2.3.

Table 2.3.2.4 details the catches in the southern areas (Division VIIIc and Subarea IXa) which are taken almost exclusively by Spain and Portugal. The reported catch of 45 570 t is an increase on 2013 which was the lowest in the time series. The catch is now closer to the long term average.

The distribution of catches by quarter (%) is described in the text table below:

Year	Q1	Q2	Q3	Q4	Year	Q1	Q2	Q3	Q4
1990	28	6	26	40	2003	36	5	22	37
1991	38	5	25	32	2004	37	6	28	29
1992	34	5	24	37	2005	46	6	25	23
1993	29	7	25	39	2006	41	5	18	36
1994	32	6	28	34	2007	34	5	21	40
1995	37	8	27	28	2008	34	4	35	27
1996	37	8	32	23	2009	38	11	31	20
1997	34	11	33	22	2010	26	5	54	15
1998	38	12	24	27	2011	22	7	54	17
1999	36	9	28	27	2012	22	6	48	24
2000	41	4	21	33	2013	19	5	52	24
2001	40	6	23	30	2014	20	4	46	30
2002	37	5	29	28					

The quarterly distribution of catch in 2014 is similar to 2010—2013 with the Northern summer fishery in Q3 accounting for the greatest proportion of the total catch.

Catches per ICES statistical rectangle are shown in Figures 2.3.2.1 to 2.3.2.4. It should be noted that these figures are a combination of official catches and ICES estimates and may not indicate the true location of the catches or represent the location of the entire stock. These data are based on catches reported by all the major catching nations and represents almost the entire ICES estimated catch.

- First quarter 2014 (280 187 t – 20%)

The distribution of catches in the first quarter is shown in Figure 2.3.2.1. The quarter 1 fishery is similar to that in previous years with the Scottish and Irish pelagic fleets targeting mackerel in VIa, VIIb and VIIj. Substantial catches are also taken by the Dutch owned freezer trawler fleet. The largest catches were taken in area VIa, as in recent years. The Spanish fisheries also take significant catches along the north coast of Spain during the first quarter.

- Second quarter 2014 (62 658 t – 4%)

The distribution of catches in the second quarter is shown in Figure 2.3.2.2. The quarter 2 fishery is traditionally the smallest and this was also the case in 2014. The most significant catches where those in VIIIc and at the start of the summer fishery in northern waters by Icelandic, Norwegian and Russian fleets.

- Third quarter 2014 (638 358 t – 46%)

Figure 2.3.2.3 shows the distribution of the quarter 3 catches. Large catches were taken throughout areas IIa (Russian, Norwegian vessels), IVa (Norwegian, Scottish vessels), Vb (Faroese vessels) and Va (Icelandic vessels). The western extent of the fishery in XIVb is similar to that reported in 2013 after several years of expansion.

- Fourth quarter 2014 (413 251 t – 30%)

The fourth quarter distribution of catches is shown in Figure 2.3.2.4. The summer fishery in northern waters has largely finished although there are large catches reported in the southern part of area IIa. Very large catches are taken by Norway, Scotland and Ireland around the Shetland Isles and along the north coast of Scotland. The pattern of catches is very similar to that reported in recent years.

2.3.3 Catch-at-Age

The 2014 catches in number-at-age by quarter and ICES area are given in Table 2.3.3.1. This catch in numbers relates to a total ICES estimated catch of 1 394 454 t. These figures have been appended to the catch-at-age assessment table (see Table 2.6.1.1).

Age distributions of commercial catch were provided by Denmark, England, Germany, Greenland, Faroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. There remain gaps in the age sampling of catches, notably for French, Swedish and Northern Irish fleets.

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 quarter and area are given in Table 2.3.3.2.

Over 75% of the catch in numbers consists of 3—7 year olds with all year classes between 2007 and 2011 contributing over 10% to the total catch by number.

In subareas VIIa,d,e,f young mackerel (1—3 year olds) account for over half the catch by number although these areas are relatively lightly exploited. In subareas VIIIc and IXa the catch is also dominated by juvenile fish.

2.4 Biological Data

2.4.1 Length Composition of Catch

The mean lengths-at-age in the catch per quarter and area for 2014 are given in Table 2.4.1.1.

For the most common ages which are well sampled there is little difference to recent years. The length of juveniles is traditionally rather variable. Lengths recorded in 2014 for ages 0 and 1 are less than those recorded in 2013 which in turn was greater than 2012. The rapid growth of 0-group fish combined with variations in sampling (in recent years more juvenile fish have been sampled in northern waters whereas previously these fish were only caught in southern waters) will contribute to the observed variability in the observed size of 0-group fish. Growth is also affected by fish density as indicated by a recent study which demonstrated a link between growth of juveniles and adults (0—4 years) and the abundance of juveniles and adults (Jansen and Burns, 2015). A similar result was obtained for mature 3- to 8-year-old mackerel where a study over 1988—2014 showed declining growth rate since the mid-2000s to 2014, which was negatively related to both mackerel stock size and the stock size of Norwegian spring spawning herring (Olafsdottir *et al.*, 2015).

Length distributions of the 2014 catches were provided by England, Faeroes, Iceland, Ireland, Germany, Greenland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. The length distributions were available from most of the fishing fleets and account for over 90% of the catches. These distributions are only intended to give an indication of the size of mackerel caught by the various fleets and are used as an aid in allocating sample information to unsampled catches. Length distributions by country and fleet for 2014 catches are given in Table 2.4.1.2. They show clear differences between quarters, particularly for the Spanish, Portuguese and English fleets.

2.4.2 Weights-at-Age in the Catch and Stock

The mean weights-at-age in the catch per quarter and area for 2014 are given in Table 2.4.2.1. There is a trend towards lighter weights-at-age for the most age classes (except 0 to 2 years old) starting around 2005 is continuing until 2013 (Figure 2.4.2.1). The values for 2014 are similar to those of 2013, slightly increasing for ages 5 and above. These changes in weight-at-age are consistent with the changes noted in length in Section 2.4.1.

The Working Group used weights-at-age in the stock calculated as the average of the weights-at-age in the three spawning components, weighted by the relative size of each component (as estimated by the 2013 egg survey for the southern and western components and the 2011 egg survey for the North Sea component). Mean weights-at-age for the western component are estimated from Dutch, Irish and German commercial catch data combined with fish measured during the Norwegian tagging survey. Only samples corresponding to mature fish, coming from areas and periods corresponding to spawning, as defined at the 2014 benchmark assessment (ICES CM 2014/ACOM:43) and laid out in the stock annex, were used to compute the mean weights-at-age in the western spawning component. For the North Sea spawning component, mean weights-at-age were calculated from samples of the UK and Dutch commercial catches collected from areas IVa and IVb in the second quarter. Stock weights for the southern component, are based on samples from the Portuguese and Spanish catch taken in VIIIc and IXa in the second quarter of the year. The mean weights in the three components and in the stock in 2014 are shown in the text table below.

As for the catch weights, the decreasing trend observed since 2005 for fish of age 3 and older is continuing in 2013 (Figure 2.4.2.2). The 2014 values are comparable to those of 2013.

	North Sea Component	Western Component	Southern Component	NEA Mackerel 2013
Age				Weighted mean
0				0
1			0.081	0.104
2	0.195	0.116	0.156	0.165
3	0.242	0.166	0.185	0.199
4	0.249	0.202	0.234	0.238
5	0.296	0.238	0.279	0.291
6		0.295	0.317	0.310
7	0.323	0.320	0.339	0.341
8	0.408	0.343	0.350	0.388
9	0.383	0.399	0.384	0.416
10	0.495	0.428	0.435	0.466
11		0.475	0.389	0.458
12+		0.497	0.423	0.506
Component Weighting	2.86%	74.05%	23.09%	
Number of fish sampled	50	833	1284	

[1]In absence of data for age 1 in the western component, the mean over the last 3 years for this component was used to compute the mean weight in the stock.

2.4.3 Natural Mortality and Maturity Ogive

Natural mortality is assumed to be 0.15 for all age groups and constant over time.

The maturity ogive for 2014 was calculated as the average of the ogives of the three spawning components weighted by the relative size of each component calculated as described above for the stock weights. The ogives for the North Sea and Southern components are fixed over time. For the Western component the ogive is updated every year, using maturity data from commercial catch samples collected during the first and second quarters (ICES CM 2014/ACOM:43 and stock annex). The 2014 maturity ogives for the three components and for the mackerel stock are shown in the text table below.

A trend towards later maturation (decreasing proportion mature at age 2) has been observed from the mid-2000s to 2011, followed by quite stable values since then (Figure 2.4.3.1).

Age	North Sea Component	Western Component	Southern Component	NEA Mackerel
0	0	0	0	0
1	0	0.14	0.02	0.11
2	0.37	0.53	0.54	0.53
3	1	0.98	0.70	0.91
4	1	0.99	1	0.99
5	1	0.99	1	0.99
6	1	0.99	1	1
7	1	0.99	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	2.86%	74.05%	23.09%	

2.5 Fishery Independent Data

2.5.1 International Mackerel Egg Survey

2.5.1.1.1 Science / Industry Winter MEGS Survey 2014/15

Subsequent to discussions that commenced during WKPELA in 2014 (ICES CM 2014/ACOM:43), an industry / science collaboration was established that would attempt to address the issue of early mackerel spawning in the western area as evidenced by the results of the 2010 and 2013 MEGS surveys. This involved deployment of 4 surveys of app. 10—12 days duration undertaken on commercial vessels and covering the winter period from December through to March over a fixed area within the Celtic Sea / Biscay region. This is where the highest concentrations of spawning were observed during the 2013 MEGS survey in the western area (Figure 2.5.1.1.1).

During the first survey in December 2014 no mackerel eggs were found. No adult sampling was carried out due to equipment failure on the vessel. The second survey in January 2015 was seriously compromised by weather, and only completed one Gulf deployment which yielded no eggs. Four pelagic trawls were completed with only several juvenile mackerel caught. The third survey was carried out in February 2015 with some spawning expected to have started at this time. From the 45 plankton tows carried out, 356 mackerel eggs were identified, 276 of these were at stage 1. Low density numbers were encountered all along the survey track. The stage 1 egg densities are presented in Figure 2.5.1.1.2. No adult samples were taken. The fourth survey was carried out from the 2—11 March. 41 plankton stations were completed with 4536 mackerel eggs being recorded and of these 2875 were at stage 1. The stage 1 egg densities are presented in Figure 2.5.1.1.3. Due to the short time period available for planning the survey, no diplomatic clearance was granted to sample in French waters. This prevented any access to the Biscay region during this period. Additional sampling was undertaken on the Porcupine Bank to the north of the fixed survey area. Mackerel spawning was observed within all of the sampled area with the largest concentrations of mackerel eggs being found on the UK/French boundary at station 8 where 1050 stage 1 eggs/m^2 were recorded. Elsewhere low to moderate levels of mackerel spawning were recorded. The pelagic trawl was deployed on 2 occasions and 3 mackerel were caught.

The surveys were principally intended to demonstrate the presence/absence of spawning in each month from December 2014 onwards and its spatial scale and amplitude when observed. The first clear observation was that no mackerel eggs were found at all in December. This was expected but represents valuable confirmation. No useable egg samples were taken in the January survey, and so scale and amplitude are unknown. The major conclusions need to be drawn from the final two surveys. The nominal start date for the triennial survey in the western area is currently the 10 February (Day 42). Implicit in this start date would be that there was no spawning before that. The February 2015 survey started on day 47, just 5 days after the nominal start. Eggs were found albeit at low densities across the surveyed region. The first reasonable numbers of stage 1 eggs were taken on day 49. Taken together, this would suggest that the nominal start date only seven days earlier is probably too late in the current context.

The conclusion from the last two surveys in particular is probably that spawning was still occurring earlier in 2015 than in survey years prior to 2010, but may have been slightly later than that seen in 2013. The February survey shows low but consistent spawning underway by the middle of February, suggesting that the quite long 2013 survey period starting on day 50 was combining lower spawning activity in late February with much higher activity in the early part of March. Taking this result into account it was recommended that the first western period for the 2016 survey should start much earlier than in 2013, ideally no later than the start of February. There should also be a second survey period starting in early March. Combined with an earlier nominal start date this should provide a more robust sampling of the start of spawning and of the Total Annual Egg Production from the survey. The results together with the conclusions and subsequent implications for the MEGS survey were presented as a working document to WGWIDE.

2.5.1.2 Survey Planning for the 2016 Northeast Atlantic survey

The ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) met in Copenhagen on April 20—24, 2015, to plan the Mackerel and Horse Mackerel Egg Survey in 2016. The nations participating in the 2016 Northeast Atlantic MEGS survey will be Portugal, Spain, Scotland, Ireland, The Netherlands, Germany, Iceland and the Faroe Islands. Norway has withdrawn from the survey in 2016 although they will retain the role of coordinators of the fecundity sampling programme and will also perform the final analysis on the mackerel fecundity data.

The 2016 survey will be based on seven regular sampling periods plus an additional eighth period that will be tasked with recording any residual horse mackerel spawning activity taking place beyond the nominal end date. Norway has withdrawn their participation from first the North Sea MEGS survey and now also from the Northeast Atlantic (NEA) survey, at a time when the continued expansion of the NEA mackerel stock has resulted in a spatial and temporal broadening of the mackerel spawning area and season. Additional information collated from winter surveys undertaken in 2014/2015 (Section 2.5.1.1) point toward a continuation of the early peak spawning as observed during the 2010 and the 2013 MEGS surveys. The conclusions from this report as delivered to WGMEGS in 2015 (ICES CM 2015/SSGIEOM:09) have been acted upon with the result that surveying in the western area will commence during the first week of February 2016, which is two weeks earlier compared to 2013. The subsequent period in the western area will commence at the start of March.

Due in large part to a combination of the Norwegian withdrawal from the MEGS survey programme and the resultant earlier start to the survey schedule in the western area at the time of the WGMEGS meeting in 2015 there were 4 outstanding survey slots that remained unallocated. These have now been filled and allocated to Denmark, Scotland, Netherlands and Ireland. These additional surveys are expected to be undertaken using commercial fishing vessels supplied by the industry representing those nations. An amended version of the 2016 Northeast Atlantic survey plan is presented in Table 2.5.1.2.1. The revised survey plan will be included in the correspondence report for WGMEGS in 2016.

2.5.1.3 Update of the Mackerel SSB estimated from the Triennial Annual Egg Production method Surveys

Following the recommendation of the 2014 WKPELA benchmark workshop (ICES CM 2014/ACOM:43), WGMEGS carried out a revision of the mackerel egg survey historical database and a recalculation of the whole time series of the TAEP (Total Annual Egg Production) and SSB (Spawning Stock Biomass) in 2014. The historical time series was recalculated by applying the Mendiola mackerel egg development equation (Mendiola *et al*., 2006) instead of the Lockwood equation (Lockwood *et al*., 1977). The decision to use the Mendiola mackerel egg development equation instead of Lockwood's (traditional methodology) was taken by WGMEGS in 2012 (ICES CM 2012/SSGESST:04).

During the review, TAEP estimates of the whole time series were calculated using a new updated code in R that has been developed in recent years. Until 2007 a FORTRAN code was used to estimate TAEP for mackerel. From 2010 onwards a new code in R was used to estimate TAEP for mackerel and Western horse mackerel. This has been updated and developed further in 2015 to include checking routines which consequently detected some mistakes in the existing script and which have now been corrected. The most important mistake detected was in the interpolation algorithm which resulted in an overall underestimation of the egg production for interpolated rectangles. Consequently, the revised time-series estimates provided in Figures 2.5.1.3.1 – 2.5.1.3.3 and Tables 2.5.1.3.1 – 2.5.1.3.3 do not correspond and in fact supersede those TAEP and SSB estimates presented to WGWIDE in 2014 (ICES CM 2014/ACOM:48). The estimate of TAEP variance was also calculated over the same period and is presented using the Mendiola equation (Tables 2.5.1.3.1—2.5.1.3.3). The main results using the Mendiola mackerel egg development equation in the temporal series and the update code in R for mackerel components are presented in Tables 2.5.1.3.1—2.5.1.3.3 and Figure 2.5.1.3.4. The revised time-series of TAEP and SSB estimates shows an increase of around 25% for the TAEP and SSB compared to previously reported estimates (Figures 2.5.1.3.1—2.5.1.3.4). Differences in the TAEP and SSB in the time-series between reported values from 1992 to 2013 are shown in Figures 2.5.1.3.1—2.5.1.3.6. The results were also presented to WGMEGS in 2015 (ICES CM 2015/SSGIEOM:09) and were presented as a working document to WGWIDE.

2.5.1.4 North Sea Mackerel Egg Survey in 2015 – Preliminary Results

Between 26 May and 17tJune 2015 the Netherlands conducted a mackerel egg survey in the North Sea. The withdrawal of Norway from the North Sea survey in 2014 left the Netherlands as the sole participant. The survey was originally scheduled to be undertaken in 2014, however technical problems with the Dutch research vessel resulted in the survey being postponed until 2015.

The survey was split into 4 sampling periods whereby the entire survey area was covered 4 times. Due to the reduction in survey time and only one vessel being available these coverages were undertaken utilising an alternate transect methodology. The unsampled transects being allocated interpolated values in accordance with standard interpolation rules (ICES CM 2014/SSGESST:14). Peak spawning was observed in period 2 and was at almost the same time and magnitude as in 2011, however in contrast to

2011 an additional week was added to the survey which provided an additional early sampling point which yielded only low levels of spawning. This also provides evidence to suggest that only a small amount of spawning was missed during the 2011 survey when peak spawning was observed during the first sampling period. Spawning decreased between period 2 to period 3 and increased slightly in period 4. Two trawl hauls were carried out by R.V. Tridens to collect adult mackerel fecundity and atresia samples however due to the short time frame these have not yet been analysed. In lieu of this the previous fecundity estimate of 1401 eggs/g female was used and this provided a provisional SSB estimate of 170 456 tons.

The WG recommends that in future the survey effort should be increased to secure a proper coverage of spawning area and time and to carry out a sampling program for fecundity.

2.5.2 Demersal trawl surveys (Recruitment Index)

A recruitment index was derived from catch data from the International Bottom Trawl Surveys (IBTS) in autumn and winter. Full documentation can be found in Jansen *et al.* (2015).

The 2014 WKPELA benchmark workshop (ICES CM 2014/ACOM:43) recommended further work on extending the Q4-model with data from IBTS Q1 in the North Sea and other northern areas. Further progress of this analysis was presented at WGWIDE meeting in 2014. Most noteworthy was the inclusion of data from first quarter IBTS surveys to cover the important nursery areas in the northern North Sea. Furthermore, the index calculated by the LGC model was benchmarked against a swept-area index derived from the same data. This analysis suggested that the LGC approach was better at extracting the cohort abundance signal than the "raising" method. A WGWIDE subgroup reviewed the new results as described in Jansen *et al.* (2015). WGWIDE (ICES CM 2014/ACOM:48) regarded the LGC implementation as a valid and well documented approach. WGWIDE furthermore regarded the addition of the first quarter survey data as an improvement over the version implemented during the 2014 WKPELA benchmark workshop (ICES CM 2014/ACOM:43). However, the analysis suggested a possible difference in catchability between first and fourth quarter surveys, so an analysis of this was recommended before the new index could be implemented in the assessment. This analysis was subsequently performed, reviewed and published (Jansen *et al.*, 2015). The authors concluded that there was no significant difference in catchability between first and fourth quarter surveys. The recruitment index in WGWIDE 2015 was therefore based on data from both surveys.

A dataset was compiled incorporating observations from bottom-trawl surveys conducted between October and March during 1998—2015. Surveys conducted on the European shelf in the first and fourth quarters are collectively known as the International Bottom Trawl Survey (IBTS). All surveys sample the fish community on the continental shelf and upper shelf slope. IBTS Q4 covers the shelf from Spain to Scotland, excluding the North Sea, while IBTS Q1 covers the shelf waters from north of Ireland, around Scotland, and into the North Sea.

Trawl operations during the IBTS have largely been standardized through the relevant ICES working group (ICES, 2013a). Trawling speed was generally 3.5—4.0 knots, and trawl gear is also standardized and collectively known as the Grande Ouverture Verticale (GOV) trawl. Some countries use modified trawl gear to suit the particular conditions in the respective survey areas. In some cases, the standard GOV was modified, which was not expected to change catchability significantly. However, subsequent trawls deviated more significantly from the standard GOV type, namely the Spanish BAKA trawl, the French GOV trawl, and the Irish mini-GOV trawl. The BAKA trawl had a vertical opening of only 2.1—2.2 m and was towed at only 3 knots. This was considered substantially less suitable for catching juvenile mackerel and, therefore, was excluded from the analysis. The French GOV trawl was rigged without a kite and typically had a reduced vertical opening, which may have reduced the catchability of pelagic species like mackerel. Catchability was assumed to equal the catchability of the standard GOV trawl because testing has shown that the recruitment index was not very sensitive to this assumption (Jansen *et al*., 2015). Finally, the Irish mini-GOV trawl, used during 1998—2002, was a GOV trawl in reduced dimensions. The reduced wing-spread and trawl speed were accounted for in the model (Jansen *et al*., 2015).

Since 2011, the English survey has been discontinued and the Scottish survey has not consistently covered the area around Donegal Bay.

A geostatistical log-Gaussian Cox process model (LGC) with spatio-temporal correlations was used to estimate the catch rates of mackerel recruits through space and time. The modelled recruitment index (square root transformed catch rate) surface in autumn 2014 and winter 2015 was mapped in Figure 2.5.2.1 (right). The recruits appeared to be distributed further south than the average distribution of the time series Figure 2.5.2.1 (left).

The time series of spatially integrated recruitment index values was used in the assessment as a relative abundance index of mackerel at age 0 (recruits) – see Figure 2.5.2.2 and Table 2.6.1.9. The cohort from 2014 was estimated to be over average and the fourth largest in the time series. Recruitment of the 2013 cohort was, as indicated by WGWIDE 2014, overestimated by the old model that was based on autumn survey data only.

2.5.3 Ecosystem surveys in the Nordic Seas in July–August (IESSNS index)

During 1 July to 10 August 2015, four vessels: the chartered trawler/purse seiners M/V "Brennholm", M/V "Eros" (Norway), M/V "Christian ì Gròtinum" (Faroe Islands), and the research vessel R/V "Arni Friðriksson" (Iceland) participated in the joint ecosystem survey (IESSNS) in the Norwegian Sea and surrounding waters (ICES 2015d). Major aims of the survey were to quantify abundance, spatio-temporal distribution, aggregation and feeding ecology of Northeast Atlantic mackerel in relation to distribution of other pelagic fish species such as Norwegian spring-spawning herring, oceanographic conditions and prey communities. The pelagic trawl survey was initiated by Norway in the Norwegian Sea in the beginning of the 1990s. Faroe Islands and Iceland have then participated in the joint mackerel-ecosystem survey since 2009 and Greenland since 2012. The IESSNS provides age-disaggregated indices for age group 6+ scaled by the coverage each year (Table 2.6.1.9) for tuning in the mackerel assessment as decided at the benchmark assessment in 2014. The indices derive from swept-area estimations from predefined surface trawl stations.

Mackerel was observed in most of the surveyed area in 2015, and the zero boundaries were found in the large majority of areas (Figure 2.5.3.1). The geographical coverage and survey effort in 2015 (2.7 mill. km^2) was slightly larger than in 2014 (2.45 mill. km^2) and 2013 (2.41 mill. km^2).

The total swept area biomass index of NEA mackerel in summer 2015 was 7.7 million tonnes (Figure 2.5.3.2). This is 1.3 million tonnes lower abundance index than in 2014 when it was record high. The average density decreased also from previous two years from around 3.65 tonnes/km^2 to 2.86 tonnes/km^2. The reason for the decrease in the total biomass index of mackerel and density is not fully known, but could be a consequence of both adult and juvenile mackerel being outside of the survey area (e.g. in the North Sea and north and west of the British Isles), less fishable during surface trawling, due to different behaviour including possible higher patchiness compared to previous years, and/or that the abundance index from the IESSNS swept area survey in 2015 is simply reflecting the development of the stock size. None of these possible reasons can be excluded. However, the distribution of the mackerel and consequently also the feeding migration differed from previous years, with relatively less abundance in the northernmost and westernmost regions while much more in the area south of Iceland. Moreover, mackerel had relatively high density in the southeastern area covered (Figures 2.5.3.1 and 2.5.3.2), which all together could imply that higher proportion of the stock might have been missed in this year's survey because of a more pronounced southerly distribution. This emphasizes the necessity of covering the potential distribution areas further south (in the North Sea and west of the British Isles) as a part of IESSNS and recommended by the survey group (Nøttestad *et al.*, 2015).

The 2011-year class of mackerel contributed with 28% of numbers followed by the 2010-year class with 22%. The 2012 year class had 12% in number. (Figure 2.5.3.3). Altogether 71% of the estimated number of mackerel was less than 6 years old. The internal consistency plot for age-disaggregated year classes has improved since the benchmark in 2014 by the inclusion of two more survey years (2014 and 2015; Figure 2.5.3.4). This is especially apparent for younger ages. There is now good internal consistency for 1-10 years old mackerel, except between age 5 and 6. The reason for the low consistency around age 5 is unknown, but could partly be due to similar abundance estimates of these two consecutive cohorts aged 5 and 6. The improved consistency for young NEA mackerel in the IESSNS survey should be taken into consideration in the planned interim benchmark assessment for mackerel (possibly in 2017), specifically by including estimates of younger mackerel 1-5 years of age, and not only age 6+ mackerel. This is also important considering that altogether 71% of the estimated number of mackerel was less than 6 years old and are therefore not used for tuning in the current analytical assessment.

The spatial overlap between mackerel and NSS herring was highest in the south-western part of the Norwegian Sea (Faroe and east Icelandic area) according to the catch compositions in the survey (Figure 2.5.3.5), which is similar to 2014.

The mackerel had a more patchy distribution in July-August 2015 based on the trawl catches compared to previous years. The mackerel were also present in smaller quantities in the northernmost and westernmost regions of the surveyed area compared to the last few years (Figure 2.5.3.2). The 2015 survey did neither cover North Sea (south of 60°N) nor west of the British Isles. This may have influenced the abundance estimation of the NEA mackerel. The reasons for the apparent changes in the mackerel distribution from previous years are uncertain, but are considered to be related to environmental factors. Relatively cold surface waters southeast of Iceland, around the Faroese and in the southern part of the Norwegian Sea in the spring 2015, as presented by the May survey results (Nøttestad *et al.*, 2015), might for example had contributed to these changes. This needs however, further examination later including a broader scientific approach.

2.5.4 Tag Recapture data

The Institute of Marine Research in Bergen has conducted tagging experiments on mackerel since 1968, both in the North Sea and to the west of Ireland during the spawning season May–June. However, only the information from mackerel tagged west of Ireland is used in the mackerel assessment, and only information on recaptures of mackerel tagged with steel-tags until 2006 (releases from 1977 to 2004). See the 2014 WKPELA benchmark workshop (ICES CM 2014/ACOM:43) for a thorough description on how the tag-recapture information is used in the assessment.

Steel-tags

These tags have been recovered at metal detector/deflector gate systems installed at plants processing mackerel for human consumption. This system demanded a lot of manual work, paying for external personnel to stay at the plants during processing. Among the typical 50 fish deflected, the hired personal must find the tagged fish with a hand-hold detector and send the fish to IMR for analysis. This has been time consuming and expensive. Besides being used in present mackerel assessment model, the tagging data have also been used in estimates of mortality, and recently in estimation of spawning stock biomass, and further has the tagging data been valuable for understanding the migration of the mackerel (Tenningen *et al.*, 2011).

RFID tags

New and promising radio-frequency identification (RFID) tagging project on NEA mackerel was in 2011 initiated at the Institute of Marine Research, Bergen (IMR) in Norway. RFID is a technology that uses radio waves to transfer data from an electronic tag, called an RFID tag, through a reader for the purpose of identifying and tracking the object. The new RFID tagging project has moved away from manual and expensive to an automatic and cost-effective scanning system.

During the period 2011—2015 as many as 203,936 mackerel has been tagged with the new tags and 765 of these tags have recaptured (Table 2.5.4.1). A recent small test experiment in Iceland is not included in these numbers, data are not in the data base yet.

The RFID-tagged mackerel are currently recaptured at 15 European factories processing mackerel for human consumption (Table 2.5.4.2). The project started with RFID antenna reader systems connected to conveyor belt systems at 8 Norwegian factories in 2012. Now there are 4 operational systems in at 3 factories in UK (Denholm has 2 RFID systems), 3 Iceland, and 1 at the Faroes. In addition, more systems are also bought by UK (2), Denmark (1) and Ireland (3), which up to now has been non-operational. The factories having operational systems are online on internet or GPRS and RFID tagged mackerel recaptured by the systems are automatically updated in the central database in Bergen with date, time, and factory of location.

There is a web-based software solution that is used to track the different systems, import data on catch information, and biological sampling data of released fish and screened catches. Based on this information the system can estimate numbers released and screened by year class in a known biomass landed, which is used to estimate abundance by year class and totally.

Hence, the usefulness of the data is dependent on the work from each country's research institutes, fisheries authorities or the industry to provide additional data about catches screened through the RFID systems, such as total catch weight, position of catch (ICES rectangle), mean weight in catch etc. Regular biological sampling of the catches landed at these factories is also needed. Altogether, these data are essential for the estimation of numbers screened per year class, which is needed as input to the tag data-table currently used in the SAM-assessment for steel tags.

The major aim for the RFID program is to expand the tagging time series by including these data in the assessment model for NEA mackerel, at latest during the next benchmark, possibly in 2017. The tag data format will be the same as the one already included in the 2014 benchmark with steel tags, but treated as a different time series. The time series will by 2017 include data from experiments 2011-2016, a time series of 6 years. Preliminary explorations of the data indicate that it is possible to trace the development of year class abundance in the data, indicating the potential for use in the assessment (Figure 2.5.4.1).

2.5.5 Other surveys

2.5.5.1 International Ecosystem survey in the Norwegian Sea (IESNS)

In recent years an increasing amount of mackerel has been observed in the Norwegian Sea during the combined survey in May targeting herring and blue whiting. The edge of the distribution has also been found progressively further north and west. However, the mackerel was mainly found in the eastern part of the survey area up to 67°N in May 2015, with few exceptions at western stations further south (Rybakov *et al*., 2015). It should be noted, however, that the sampling may not provide a representative picture of mackerel distribution because of its vertical distribution and relatively low trawling speed.

2.5.5.2 Acoustic estimates of mackerel in the Iberian Peninsula and Bay of Biscay (PELACUS)

PELACUS 0315 was carried out on board R/V Miguel Oliver from 13th March to 16th April. The methodology was similar to that of the previous surveys (Carrera and Riveiro, 2015) (Figure 2.5.5.2.1).

A total of 66 fishing station were performed. Mackerel was the most abundant fish species, both in number and weight (34% and 71% respectively) and was also present in the 91% of the fishing hauls. Contrary to the normal occurrence, an important part of the adult fish was located in IXaN. This would be a consequence of the upwelled colder waters off NW Spanish corner (ICES VIIIcWest Subdivision), avoided by this fish species, due to the strength of NE winds. (Figure 2.5.5.2.2).

Total mackerel biomass estimate was 483,371 tonnes, corresponding to 1,574 million fish (Table 2.5.5.2.1 and 2.5.5.2.2), a remarkable decrease from 2014 when almost 800 thousand tonnes were estimated (Figure 2.5.5.2.3). Adult fish mainly belonged to age groups 4 to 6, with a mode at 36 cm, a similar stock structure as observed in the previous year assessment. Two factors would be affected the results achieved. The strength of the NE wind could disturbed the normal mackerel behaviour with rather thick shoals occurring close to the surface, as this year this layer-like was scarce and the density lower than that of the previous year; on the other hand the change of the steaming way (normally against the expected main mackerel westward movement) done in NW Spanish corner and in the inner part of the Bay of Biscay due the windy conditions, might be resulted in an underestimation of the total biomass.

2.6 Stock Assessment

2.6.1 Update assessment

NEA Mackerel was classed as an update assessment this year. The update assessment was carried out by fitting the state-space assessment model SAM (Nielsen and Berg, 2014) using the web interface on www.stockassessment.org (assessment name: NEA_Mac_WGWIDE2015_V1 (ICES CM 2014/ACOM: 43) and described in the Stock Annex. The assessment model is fitted to catch-at-age data for ages 0 to 12 (plus group) for the period 1980 to 2014 (with a strong down-weighting of the catches for the period 1980-1999) and three surveys: 1) the SSB estimates from the triennial Mackerel Egg survey (every three years in the period 1992-2013), 2) the recruitment index from the western Europe bottom trawl IBTS Q1 and Q4 surveys (1998-2014) and 3) the abundance estimates for ages 6 to 11 from the IESSNS survey (2007 and 2010-2015). The model also incorporates tagging-recapture data from the Norwegian tagging program (for fish recaptured between 1980 and 2005).

Fishing mortality-at-age and recruitment in the model are modelled as random walks, and there is a process error term on ages 1-11.

The new data used in this assessment compared to the previous assessment (ICES CM 2014/ACOM: 15) were:

- Revision of the entire egg survey SSB time series (see Section 2.5.1.3).
- Revision of the entire IBTS recruitment index (see Section 2.5.2).
- Addition of the 2015 survey data in the IESSNS indices.
- Addition of the 2014 catch-at-age, weights-at-age in the catch and in the stock and maturity ogive, proportions of natural and fishing mortality occurring before spawning.

Input parameters and configurations are summarized in Table 2.6.1.1. The input data are given in Tables 2.6.1.2 to 2.6.1.9. Given the size of the data base (1,700 lines) the tagging data are not presented in this report, but are available on www.stockassessment.org in the data section.

Model parameters for the 2015 update assessment were examined and found to be very different from the 2014 update assessment (Table 2.6.1.10). Revision of the parameters was to be expected since two of the time series were revised. The scale of both the IBTS recruit index and the egg survey SSB index is different from the previous assessment (smaller and larger, respectively), which explains the revision in the catchability estimate for these two surveys (downwards and upwards, respectively). In addition, given that the time series for IESSNS survey is still short the observed revision of the estimated catchability in SAM for this survey was also to be expected. However, it is difficult to interpret the large revision of the observation variances and random walk variances. The random walk variance for the fishing mortality has decreased substantially, while the observation variance for the catches has doubled. This means that the 2015 update has very smooth temporal variations in the fishing mortality, and, consequently, is not able to produce a good fit to the catch data. The decrease in the random walk variance on age 0 corresponds to a very smooth recruitment time series. The observation variances in the 2015 update assessment indicate that the model now gives much less weight to the catch data and to the IESSNS survey and a higher weight to the egg survey and the IBTS recruitment index. The fit to the IBTS survey is unrealistically good (observation variance of 0.03 meaning that the assessment agrees with the recruits' survey with maximum deviation in the range of ±5%). Although the Working Group acknowledges that the inclusion of the Q1 resulted in an improvement of the IBST index, such a perfect fit with a survey time series in a model is unrealistic and is symptomatic of model mis-fitting.

For this reason, the Working Group rejected the update assessment, and decided to conduct a series of exploratory runs to investigate the cause of this model mis-fitting.

2.6.2 Exploratory assessment runs

2.6.2.1 Influence of survey additional years and index revision

The influence on model fit of the changes in the survey indices (revision or/and addition of one extra year of data) was investigated by comparing the 2015 update assessment and the 2014 WGWIDE assessment with assessments run with:

- The previous IBTS recruitment time series (1998-2013) to test influence of the revision of the index
- The new IBTS index, excluding the 2014 data point, for comparison with the run above.
- The IESSNS excluding the 2015 data point, to test the effect of this additional data point.

- The previous egg survey index (used in the 2014 assessment).

The estimated model parameters are given in Table 2.6.1.10 and the corresponding stock trajectories are shown in Figure 2.6.2.1.

Inspection of the model parameter values shows that the models can be classified into two groups:

- The run excluding the 2015 IESSNS data point and the run using the old egg survey data have similar parameters as the 2015 update assessment. The main differences are that the exclusion of the 2015 IESSNS data point results in a better fit (lower observation variance) to this survey and a small revision of the catchabilities of all surveys. Using the old egg survey mostly results in a revision of the catchability of this survey. In the three cases, the fit to the IBTS index remain unrealistically good.
- The run with the old IBTS index, and the run with the new IBTS index excluding the year 2014 have similar parameters as the 2014 WGWIDE assessment. The main differences are the higher catchability for the egg survey compared to the 2014 WGWIDE assessment, explained by the upwards revision of this index.

The 2015 update results in a large revision of the perception of the stock for the last 5 years compared to the 2014 WGWIDE assessment. The SSB is estimated to be between 6% and 16% lower in the update assessment, whereas the fishing mortality $F_{bar4\text{-}8}$ is estimated to be between 10% and 37% higher than in the previous accepted assessment. The recruitment time series from the 2015 update assessment is identical to the IBTS index (small observation variance), and is much less variable than the recruitment from the 2014 WGWIDE assessment (differences in the random walk variance on age 0). The run in which the 2015 IESSNS point was removed is the most similar to last year's assessment regarding the recent values of SSB and of $F_{bar4\text{-}8}$, but has similar recruitment estimates as the 2015 update assessment. The run with the old IBTS index and with the new IBTS index excluding the 2014 point both produces SSB trajectories intermediate between the 2015 update and the 2014 WGWIDE assessments. Fishing mortality for these two runs is, however, almost identical to the 2015 update, while the recruitment is similar to the 2014 WGWIDE assessment. The run using the old egg survey index is almost identical to the 2015 update assessment.

The Working Group also decided to conduct an exploratory assessment run including ages 2-5 (density index) from the IESSNS, instead of only including ages 6-11 from this time series. A general weakness with the present mackerel assessment is a lack of annual fishery independent data for the younger age groups. This was especially apparent after the first assessment run, where the model results strongly depended on the recruitment index from IBTS. A longer time series (7 years), with a strong internal consistency between consecutive ages of the same cohort in the time series, supports the inclusion of younger age groups from the IESSNS in this explanatory run as input data to the assessment. The run resulted in a SSB that is between 7% lower to 58% higher (SSB = 3.38–5.72 million tonnes), and an $F_{bar4\text{-}8}$ that is 0-38% (F=0.21-0.34) lower than that from the update assessment. Both the negative log likelihood for the model and the observation variance for IESSNS (Table 2.6.2.1) for this run are higher than for the updated assessment. This indicates that the model fit is not improved by adding the younger age groups (2-5 years old) from the IESSNS. The estimated model parameters are given in Table 2.6.2.1 and the corresponding stock trajectories are shown in Figure 2.6.2.2.

2.6.2.2 Changes in model configuration

Different changes in model configuration were investigated to try to avoid the model mis-fitting described above:

- narrower constraints were used for observation variance values. In the model developed at the 2014 benchmark assessment (ICES CM 2014/ACOM:43), the lower bound for observation variances was set to exp(-5) = 0.007. In this run it was raised to exp(-2)= 0.14 to artificially avoid the very low estimate for the IBTS index.
- to give the model more freedom, a model with an increased number of parameters was run. 4 observation variances on different age groups were estimated instead of 1 for the catches, and 2 instead of 1 for the IESSNS survey. Two catchability parameters were estimated for 2 different age groups for the IESSNS survey instead of 1.
- to relax the random walk constraint on recruitment and give more flexibility to the model, the random walk parameterisation was replaced by a stock recruitment function.

The estimated parameters are given in Table 2.6.2.2 and the estimated stock trajectories are show in Figure 2.6.2.3.

For the run using a narrower range of possible values for the observation variances, the observation variance for the IBTS index was estimated at 0.14, which is the value of the lower bound for this parameter. This indicates model mis-fitting. Similarly, for the model with an increased number of parameters, the observation variance for the IBTS index was estimated to be 0.007, the lower bound in the benchmark assessment model. There was no overfitting to the IBTS index for the model with the Ricker stock recruitment relationship, and the weights of the different data sources were more balanced. The catchabilities for the surveys were very similar to the values of the model with a random walk recruitment.

SSB trajectories were very similar for all models, except for the last 2 years for the model with more parameters. The $F_{bar4\text{-}8}$ trajectories were also very close, except for the model with more parameters for which variation in the earlier part of the times series was smoother that the other models. Recruitment variation was similar for all models, except the one with the Ricker stock recruitment relationship, for which recruitment was much more variable.

2.6.2.3 Conclusions

From this investigation it appears that the model is very sensitive to each single data source, and often even single data points:

- The new 2015 IESSNS data point allows for a better estimation of the catchability of this survey, which causes a revision of the perception of the SSB in the recent years. As the IESSNS time series becomes longer, the influence of the first data point (2007, 3 years before the start of the continuous time series) on the estimated catchability decreases, and this data point appears now as being an outliers (see residual plots in Figure 2.6.3.5.). The next benchmark should consider removing it from the time series.

- The inclusion of the 2014 IBTS data point causes model fitting problems, of which the perfect fit to the IBTS index is an indication. The model changes from a state with relatively parsimonious influence of the different data sources and relatively weak temporal autocorrelation in the fishing mortality and recruitment, to a state where the IBTS index receives the highest weight in combination with highly autocorrelated fishing mortality and recruitment. The Working Group was unable to provide any explanation for this behaviour.

Incorporating a stock recruitment model in the assessment seems to give more flexibility to the model and results in a more realistic fit to the data. The resulting stock-recruitment pairs and underlying stock recruitment model are shown in Figure 2.6.2.4. The historical range of estimated SSB corresponds to the flat part of the Ricker curve, which reflects the weakness of the stock recruitment relationship for NEA mackerel. This implies that the modelled recruitment is very weakly influenced by SSB in the assessment model, and could be almost considered as a random process.

Decision on the final assessment

The Working Group considered that the model with the Ricker stock recruitment function can be accepted and used to provide a catch advice for 2016.

Whilst allowing for a more realistic fit to the observations and to a more variable recruitment than the update, the implementation of the stock recruitment model did not alter substantially the historical SSB and F_{bar4-8} development. The modelled recruitment was not really constrained by the Ricker curve (practically a random process), which means that the choice of implementing a Ricker model does not have a large influence on the perceived dynamics of the stock at its current and historical levels.

There was furthermore no rationale for rejecting any of the data points in the indices time series.

2.6.3 Final assessment

The final assessment is publicly available from www.stockassessment.org, under the name NEA-Mac-WGWIDE2015-V1_ricker.

2.6.3.1 Model diagnostics

The estimated parameters for the final model have been presented and discussed in Section 2.6.2.

There are few strong correlations between the fitted parameters (Figure 2.6.3.1). The only exception is the negative correlation between the random walk variance for the fishing mortalities and the observation variance of the catches (i.e. stable F with large residuals to the catches vs. variable F with good fit to the catches). The post tagging survival was also positively correlated to the catchability of the egg survey. The shape parameters of the Ricker model were also highly confounded. Otherwise, the majority of the other parameters appear independent of each other.

Residuals for the catches did not show any temporal pattern (Figure 2.6.3.2) except for the last three years for which they were mainly positive for 2014 and negative for 2012 and 2013. This may result from the rather strong random walk constraint (low variance) imposed to the variation on fishing mortality, which prevents the model from increasing the fishing mortality suddenly (which probably happened given the sharp increase in the catches in 2014). Residuals for ages 0 and 1 are larger than for subsequent ages 2 to 6. Residuals for ages 7 to 12 are also larger than for ages 2 to 6. This suggest that decoupling the observation variance of the catches (for example by grouping age 0 and 1, ages 2 to 6 and ages 7 and older) could have been more appropriate. This should be investigated during the next benchmark assessment. Residuals for the surveys are given in Figures 2.6.3.3 to 2.6.3.5. Residuals for the egg survey show a slight temporal pattern with positive residuals in the period 1995-2001 and negative residuals since 2010. The model estimates a steeper increase in the SSB in the recent years than what is indicated by the egg survey. Residuals to the recruitment index show no particular pattern. Residuals for the IESSNS indices were in general small, except for the year 2007 where large negative residuals were observed for most ages. The spatial coverage of the IESSNS in 2007 was quite small compared to the subsequent years, which might explain this year effect.

Residuals for the tag recaptures do not show any temporal or age pattern (Figure 2.6.3.6).

2.6.3.2 State of the Stock

The stock summary is presented in Figure 2.6.3.7 and Table 2.6.3.1. The stock numbers-at-age and fishing mortality-at-age are presented in Tables 2.6.3.2-3. The spawning stock biomass is estimated to have increase almost continuously from just below 2 million tonnes in the late 1990s and early 2000s to 4.2 million tonnes in 2014. The estimate for 2015 (supported only by the IESSNS data) suggests a slight decline from 2014 to 2015. The fishing mortality has been declining since the mid-2000s and was stable in the early 2010s at around 0.30 and increased to 0.34 in 2014. The recruitment time series from the assessment shows a clear increasing trend since the late 1990s in which two very large year classes (2 to 3 times the average) are apparent (2002 and 2006). The 2011 year class appears to be large (third in magnitude since 1990). The model indicates an above average recruitment for 2012, but a very low recruitment for 2013, which would be the lowest since 2003. There is insufficient information to estimate accurately the size of the 2014 year class.

There is some indication of changes in the selectivity of the fishery over the last 20 years (Figure 2.6.3.8.). In the year 1990, the fishery seems to have exerted a high fishing mortality on the fish 7 years and older. This changed gradually until 2000, when the fishing mortality on younger ages (3- to 6-years) increased compared to the older fish. In the following years, the selectivity pattern changed again towards a lower fishing mortality on the age-classes younger than 7 years until 2008. Finally, in the recent years, the fishing mortality on younger ages (4 to 7) increased again compared to the older ages.

2.6.3.3 Quality of the assessment

Large confidence intervals are associated with the SSB in the years before 1992. This results from the absence of information from the egg survey index, the downgrading of the information from the catches and the assessment being only driven by the tagging data and natural mortality in the early period. The confidence intervals become narrower from the early 1990s to the mid-2000s, corresponding to the period where information is available from the egg survey index, the tagging data and (partially) catches. The uncertainty increases again in the recent years, for the period when the IESSNS indices are introduced, and where no tagging data are available and where catches are not providing sufficient information of the most recent year classes. The SSB estimate for 2014 is estimated with a precision of +/- 30% (Figure 2.6.3.7). There is generally also a corresponding large uncertainty on the fishing mortality, especially before 1995. The estimate of F_{bar4-8} in 2014 has a precision of +/- 23%. The uncertainty on the recruitment is high for the years before 1998 (precision of on average +/- 55%). The precision improves slightly for the years for which the recruitment index is available (+/- 40%) except for the last estimated recruitment (+/- 53%).

The retrospective analysis was carried out for 4 retro years, by fitting the assessment using the 2015 data, removing successively 1 year of data (Figure 2.6.3.9). A strong retrospective pattern is observed in the SSB for the first retrospective year, when the 2014 data is removed (2015 data removed for the IESSNS survey). Removing additional years of data does not further modify the SSB. A consistent retrospective pattern is however observed for the fishing mortality. The value of F_{bar4-8} is systematically revised upward for the inclusion of each additional year of data. The magnitude of this revision is usually small, except for the first retrospective year, for which a strong upwards revision is observed. Recruitment appears to be quite consistently estimated.

Removing 3 or 4 years of data leaves only 4 and 3 data points to estimate the catchability of the IESSNS, respectively, which considerably increases the uncertainty on this parameter. At each new assessment, the addition of an additional year of data for IESSNS time series results in an improved estimation of its catchability. The short length of the IESSNS time series is, therefore, a source of instability in the assessment. However, this is not the most likely explanation for the retrospective pattern observed in the fishing mortality. This pattern was already observed in the past (see e.g. ICES CM 2012/ACOM:15) when the assessment was run with ICA and included only the egg survey as a tuning index.

2.7 Short term forecast

The short-term forecast provides estimates of SSB and catch in 2016 and 2017, given assumption of the current year's (also called intermediate year) catch and a range of management options for the catch in 2016.

All procedures used this year follow those used in the benchmark of 2014 as described in the Stock Annex.

2.7.1 Intermediate year catch estimation

Estimation of catch in the intermediate year (2015) is based on declared quotas and interannual transfers as shown in the text table in Section 2.1. Modifications of the total of the declared quotas in 2015 come from: inter-annual transfer of quotas not fished in 2014, discards and quota payback.

2.7.2 Initial abundances at age

The recruitment estimate at age 0 from the assessment in the terminal assessment year (2014) was considered too uncertain to be used, because this year class has not yet fully recruited into the fishery. The last recruitment estimate was therefore replaced by predictions from the RCT3 software (Shepherd, 1997). The RCT3 software evaluates the historical performance of the IBTS recruitment index, by performing a linear regression between the index and the SAM estimates over the period 1998 to 2013. The 2014 RCT3 recruitment is then calculated as a weighted mean of the prediction from this linear regression based on the 2014 IBTS index value, and a time tapered geometric mean of the SAM estimates from 1990 to 2013. Note that the 2014 WKPELA benchmark workshop (ICES CM 2014/ACOM:43) used another year range of SAM estimates (1998 to present), however, WGWIDE included the entire time series from 1990. WKPELA's argument for truncating the time series of recruit estimates was that the productivity of the stock may be different in recent years than in the early 1990s. However, this is already accounted for by using a time tapered geometric mean where the latest years are given more weight. The difference between these two approaches is minor (0.5 %).

The log(index) from IBTS in 2014 was 15.88, substantially higher than the time tapered geometric mean (15.30) from 1990—2013. RCT3 calculated the weighted mean to be 15.44 (5 081 mill). The weighting factors were 0.24 for the IBTS index and 0.76 for the time tapered geometric mean, given the historical performance of the IBTS index. RCT 3 output is given in Table 2.7.2.1.

2.7.3 Short term forecast

A deterministic short-term forecast was calculated using FLR. Table 2.7.3.1 lists the input data and Tables 2.7.3.2 and 2.7.3.3 provide projections for various fishing mortality multipliers and catch constraints in 2016.

Assuming catches for 2015 of 1,236 kt, F was estimated at 0.37 and SSB at 3.59 Mt in 2015. If catches in 2016 equal the catch in 2015, F is expected to increase to 0.45 in 2016 with a corresponding reduction in SSB to 2.33 Mt in spring 2017, assuming an F of 0.45 again in 2017.

Exploitation in 2016 at FMSY (0.22) will yield catches of 667 kt and a reduction in SSB to 3.13 Mt in spring 2016 (-13% change), still above MSY Btrigger (3.00 Mt) therefore it is not necessary to reduce fishing mortality. Maintaining same F levels for 2017 would result in 646 kt catch and SSB up at 3.04 Mt in 2017 (3% reduction relative to the previous year).

2.8 Biological Reference Points

A long term management plan evaluation was conducted in 2014 (ICES CM 2014/ACOM:63) which resulted in the adoption of new reference points for NEA mackerel stock by ICES.

2.8.1 Precautionary reference points

B_{lim} - There is no evidence of significant reduction in recruitment at low SSB within the time series hence the previous basis for B_{lim} was retained. B_{lim} is taken as B_{loss}, the lowest estimate of spawning stock biomass from the revised assessment. This was estimated to have occurred in 2002; B_{loss} = 1,840,000 t.

F_{lim} - F_{lim} is derived from B_{lim} and is determined from the long term equilibrium simulations as the F that on average would bring the stock to B_{lim}; F_{lim} = 0.36.

B_{pa} - The ICES basis for advice requires that a precautionary safety margin incorporating the uncertainty in actual stock estimates leads to a precautionary reference point B_{pa}, which is a biomass reference point with a high probability of being above B_{lim}. B_{pa} was calculated as $B_{lim} * \exp(1.645\sigma)$ where $\sigma = 0.30$ (the estimate of uncertainty associated with the spawning biomass as estimated in the 2014 management plan evaluation in the most recent year (2013); B_{pa} = 3,000,000 t.

F_{pa} - F_{pa} is derived from B_{pa} and is determined from the long term equilibrium simulations as the F that on average would bring the stock to B_{pa}; F_{pa} = 0.25.

2.8.2 MSY reference points

The ICES MSY framework specifies a target fishing mortality, F_{MSY}, which, over the long term, maximises yield, and also a spawning biomass, MSY $B_{trigger}$, below which target fishing mortality is reduced linearly relative to the SSB $B_{trigger}$ ratio.

Following the ICES guidelines (ICES CM 2013/ACOM:37), long term equilibrium simulations indicated that F=0.22 would be an appropriate F_{MSY} target as on average it resulted in the highest mean yields in the long term, with a low probability (less than 5%) of reducing the spawning biomass below B_{lim}.

The ICES basis for advice notes that, in general, F_{MSY} should be lower than F_{pa}, and MSY $B_{trigger}$ should be equal to or higher than B_{pa}. Simulations indicated that potential values for MSY Btrigger were below Bpa. Following the ICES procedure MSY $B_{trigger}$ was set equal to B_{pa}, 3,000,000 t.

Updated ICES reference points for NEA mackerel

Type		Value	Technical basis
MSY approach	MSY $B_{trigger}$	3.0 million tonnes	B_{pa} [1]
	F_{MSY}	0.22	Stochastic simulations [1]
Precautionary approach	B_{lim}	1.84 million tonnes	B_{loss} in 2002 [2]
	B_{pa}	3.0 million tonnes	$B_{lim} \times \exp(1.654 \times \sigma)$, $\sigma = 0.3$ [1]
	F_{lim}	0.36	F that on average leads to B_{lim} [1]
	F_{pa}	0.25	F that on average leads to B_{pa} [1]

[1] 2014 management plan evaluation (ICES CM 2014/ACOM:63)

[2] 2014 benchmark assessment (ICES CM 2014/ACOM:43)

2.9 Comparison with previous assessment and forecast

The last available assessment was carried out in 2014 at WGWIDE (ICES CM 2014/ACOM:15). The new 2015 WGWIDE assessment gives a revised perception of the stock (text table below and Figure 2.9.1). The differences in the 2013 TSB and SSB estimates between the previous and the present assessments are moderate, of – 16%. The upward revision of the 2013 fishing mortality estimate is, however, much larger, of +39%. The changes in the estimated model parameters have been discussed in the section 2.6.

This revision of the perception of the stock is explained by a combination of different factors:

- The increasing length of the IESSNS resulted in a re-estimation of the catchability of this survey (section 2.6). This change in catchability causes a rescaling of the assessment for the period covered by the IESSNS data.
- The change from a random walk recruitment to a Ricker model, albeit it effect seems to be minimal on the 2015 assessment.

The fitted model has a low random walk variance for the fishing mortality which makes sudden increases in fishing mortality. The steep increase in the fishing mortality in 2014 (suggested by the increase of the catches by 50%) cannot be made in one step by the model, which has to increase the fishing mortality on the recent years in order to accommodate for the observed catches (see Section 2.6).

	TSB 2013	SSB 2013	F4-8 2013
2014 WGWIDE assessment	5,610 kt	4 299 kt	0.217
2015 WGWIDE assessment	4,714 kt	3 624 kt	0.302
% difference	- 16%	- 16%	39%

The uncertainty on the SSB and $F_{bar4\text{-}8}$ for the last year in the assessment is very similar to the previous assessment.

The prediction of mackerel catch for 2014 used for the short-term forecast in the 2015 advice was very close to the actual 2014 catch reported in 2015 and used in the present assessment (text table below). The new assessment produced an estimate of the SSB in 2014 of 4.16 Mt, which is 10% lower than the forecast estimate. The fishing mortality $F_{bar4\text{-}8}$ for 2014 estimated this year is 5% higher than the value estimated by the short term forecast in the previous assessment. Most of these discrepancies can be explained by the revision of the perception of the stock described above.

	Catch (2014)	SSB (2014)	F_{4-8}(2014)
2014 WGWIDE assessment	1,396 kt	4.605 Mt	0.324
2015 WGWIDE assessment	1,394 kt	4.160 Mt	0.339
% difference	-0%	-10%	+5%

2.10 Management Considerations

A long term management plan evaluation was carried out in 2014 (ICES, 2014b), which led to the revision of the reference point for the stock (see Section 2.8). A range of management strategies were also evaluated and a series of management options leading to maximum long–term yields combined to low probability for the stock to fall under B_{lim} were identified. These options range from low Ftarget (0.21) combined to low Btrigger (2.0 Mt) to higher Ftarget (0.25) combined with higher Btrigger (3.2 Mt). These values are based on simulations were the present low weight-at-age is assumed to continue for the simulated period. If weight-at-age returns to long term average, a slightly higher F_{target} can be applied. This is most likely also the case if there is density dependent factors regulation individual growth, as indicated by two recent papers (Jansen and Burns, 2015; Olafsdottir *et al.*, 2015). Simulations incorporating density dependent growth has not been included when evaluating the management plan. During an adhoc workshop on density dependent growth, 13-14 August 2015 (Pastoors *et al.*, 2015), the potential effects of density dependent growth were estimated in the order of 10%. A similar potential effect was observed by changing the stock-recruitment assumption. WGWIDE received a special request regarding long term management plan also in 2015, and this is considered under 2.13.

Management options with a higher Ftarget allowed for higher yields in the short term, but lead in the long-term to a smaller stock, and resulted in higher interannual variation in TAC. These results have been considered during the latest coastal states negotiations, but no new long-term management plan has been agreed upon yet. The coastal states have sent a request to ICES in which they stipulate that the current management plan is no longer considered appropriate. Using the stock-recruitment relationship from the current assessment, would change the estimate of Fmsy substantially, indicating that Fmsy is rather sensitive to the stock-recruitment data used. However, the calculations also show that a Ftarget above 0.22 will only give a small increase in long term yield but the risk of falling below Blim increase rapidly with higher Ftarget. Hence, until a new management strategy is in place, ICES should give advice based on the MSY approach.

The instability of the assessment is a source of considerable concern, as it does not provide a consistent basis for formulating an advice. Last year's assessment gave the perception of a stock well above B_{pa} and exploited with a fishing mortality close to F_{MSY}. The new assessment still estimates the stock to be above B_{pa}, but the fishing mortality is now estimated to have been consistently above F_{pa} and close to F_{lim} in 2014. A consequence of this revision in the perception of the stock is large variation in the catch advice resulting of the implementation of the MSY approach. In a management strategy such as the previous long term management plan, maximum TAC interannual variation constrains can be applied. The benefit from such a constraint is that, by limiting the interannual variation in the TAC, it minimises the effect of the instability of the assessment and results in a more stable and predictable management.

Since 2008, unilateral quotas have been set, which together are higher than the advised TAC. The total catch for 2014 was the highest on record, of 1.39 Mt, an excess of 40% compared to the scientific advice. It is estimated to have resulted in a fishing mortality of 0.34. Similarly, the WG estimated the sum of the declared quotas for 2015 to be 1.24 Mt (36% higher than the scientific advice), which would represent a fishing mortality of 0.37 for 2015.

The recommended management measures for the mackerel spawning component in the North Sea have been the same for many years. A recent scientific paper (Jansen, 2014) has shown that the narrative of overexploitation leading to recruitment failure may require revision, as it could be the combination of high fishing pressure, followed by decreasing temperatures that led to reduced spawning migration into the North Sea. So rather than a local stock collapse, this could also be constituted as a southwest shift in spawning distribution. For a future benchmark assessment of NEA mackerel, it would be required to provide a thorough review of all available knowledge on the North Sea spawning component and to evaluate whether the current protection measures would need to stay in place.

The minimum landing size for mackerel in the North Sea has been set at 30cm for a very long time already, whereas the minimum landing size in the western waters is 20cm. A recent historical overview of the basis for the minimum landing sizes for mackerel, has shown that there is relatively little biological basis for the determination of the minimum landing size. Because a substantial portion of the TAC of western mackerel can be taken in subarea IVa (from 1 September – 15 February), it is important to review the basis for the minimum landing size and to determine a minimum landing size that is relevant for the optimal use of the mackerel caught, while preventing exploitation of juvenile fish.

2.11 Ecosystem considerations

An overview of the main ecosystem drivers possibly affecting the different life-stages of Northeast Atlantic mackerel and relevant observations are given in the Stock Annex. The discussion here is limited to recent features of relevance.

Measuring overlap between pelagic fish species, actual feeding of mackerel and available planktonic food are important for improved understanding of the link between mackerel and other parts of the ecosystem. Lower overall plankton concentrations were measured both in May-June and July-August 2015, which may have influenced the feeding conditions on herring and mackerel in a negative way (Nøttestad *et al*., 2015; Rybakov *et al*., 2015).

There are strong indications for interspecific competition for food between NSS-herring, blue whiting and mackerel (Huse *et al*., 2012). According to Langøy *et al.* (2012), Debes *et al.* (2012), and Oskarsson *et al.* (2015) the herring may suffer from this competition, as mackerel had higher stomach fullness index than herring and the herring stomach composition is different from previous periods. Langøy *et al* (2012) and Debes *et al*. (2012) also found that mackerel target a higher variability of prey species than herring. Mackerel may thus be thrive better in periods with low zooplankton abundances. The feeding and diet composition of the NEA mackerel, NSS herring and blue whiting in the Norwegian Sea both during spring and summer have been addressed by Bachiller (submitted). Results show that blue whiting generally had low diet overlap with mackerel and herring, broader diet composition and a dominance of larger prey like euphausiids and amphipods. Mackerel were not caught in spring samples, but had high feeding overlap with herring in the summer and similar diet width mainly consisting of calanoid copepods, especially *C. finmarchicus*. Stomach filling degree in herring decreased from spring to summer and feeding incidence was lower than that of mackerel in summer. However, stomach filling degree was not different between the two species, indicating that herring maintain equally effective feeding as mackerel in summer. Feeding incidence increased with decreasing temperature for all species, and for mackerel also stomach filling degree, indicating that feeding activity is highest in areas associated with colder water masses. Results from IESSNS in July showed that the overlap between mackerel and NSS herring was highest in the south-western part of the Norwegian Sea (Faroe and east Icelandic area).

There is a growing concern that recruitment success of NSS herring is affected by predation from mackerel on herring larvae. Skaret *et al*. (2015) evaluated mackerel predation in an area of overlap between adult mackerel and herring larvae in the Norwegian coastal shelf, with particular focus on predation on herring larvae. 45% of the mackerel guts contained herring larvae, with a maximum of 225 larvae counted in a single gut. Both the frequency of guts containing herring larvae and the average amount of herring larvae increased in line with increasing abundance of larvae. On the other hand, no spatial correlation between mackerel abundance and herring larvae abundance was found at the station level. The results suggest that mackerel fed opportunistically on herring larvae, and that predation pressure therefore largely depends on the degree of overlap in time and space (Skaret *et al*., 2015).

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 2.11.1), if this reflect an increase in abundance, increased interspecific competition with mackerel is possible.

Last year, the time series (1999-2014) of mackerel stomach contents obtained in spring time in the Bay of Biscay from PELACUS were presented at the WG. The ratio of non-empty stomachs ranged from 55 to 92%, although samples were only obtained during day time. Accordingly, mackerel is still actively feeding at the spawning time. The diet composition largely changed along this time series. From 2000 to 2004, their own eggs have represented up to a 20 % of the total diet in volume, and salps got a contribution of 50% either. From 2004 to 2012 copepods were relevant, with more than the 20% of the total diet in volume. Since 2012 euphausids and mysids have increased their presence in the diet achieving more than a 25% of the total diet in volume.

2.12 Special request: EU, Norway, and the Faroe Islands request to ICES on the management of mackerel (Scomber scombrus) in the Northeast Atlantic

The Request:

The Coastal States are preparing a new long-term management strategy for the stock of mackerel in the North East Atlantic. This strategy would include target fishing mortalities expressed as a range rather than a single reference point.

ICES is requested to provide a plausible range of values around Fmsy for the mackerel stock in the North East Atlantic, based on the stock biology (including possible density-dependent growth), fishery characteristics and environmental conditions.

ICES is also requested to update other reference points, including Btrigger, in light of the change from Fmsy as a single reference point to Fmsy as a range.

Given the uncertainty in stock level, growth patterns and recruitment, and taking into account the growing time series on tagging information (RFID), ICES is requested to perform the next (intermediate) benchmark in 2017.

The Coastal States would also like to inform ICES that they no longer consider that the existing management plan is appropriate, and that ICES should therefore give its advice based on the following objectives and timelines approach until a new management strategy is in place:

1. The Parties agree to limit their fishing on the basis of a TAC corresponding to a fishing mortality rate within the range of fishing mortalities defined by ICES as being consistent with fishing at maximum sustainable yield, provided that the SSB at the end of the TAC year is forecast to be above the value of Btrigger.

2. Where the SSB is forecast to be below Btrigger, but above Blim, the Parties agree to reduce the upper and lower bounds of the range of fishing mortality referred to in paragraph 1 by the proportion of SSB at the start of the TAC year to Btrigger.

3. Every effort shall be made to maintain a minimum level of SSB greater than Blim. Where the SSB at the start of the TAC year is estimated to be below Blim the TAC shall be set at a level corresponding to a fishing mortality rate consistent with the objective of rebuilding the SSB to above Blim the following year. The Parties may also take additional management measures that are deemed necessary in order to achieve this objective.

2.12.1 Methods

The work to answer this request is based on the simulations carried out for the Workshop on the NEA Mackerel Long-term Management Plan (ICES, 2015b). ICES has used the stochastic simulation model developed for the long term managment plan evaluation in WKMACLTMP (ICES, 2015b) to estimate FMSY and appropriate ranges. This tool was designed to offer a realistic representation of the dynamics of the NEA mackerel stock and of its exploitation, and to mimic as closely as possible the stock assessment and management procedures to be evaluated. The simulation tool was parameterized to give a correct representation of the natural sources of variability in the stock (e.g. recruitment and growth variability) and of the uncertainty in the system. This was done by incorporating stochasticity in the starting conditions, in the future biology of the stock (recruitment, weights, maturity, proportion of mortality before spawning time) and of the fishery characteristics (selection pattern), and in the observation and stock assessment parts of the model. Parameterization of the simulation was based on the 2014 NEA mackerel assessment (ICES, 2014e).

Simulations were run in parallel for 1000 iterations (replicates of the stock), each having their own equally likely starting conditions and individual biological and exploitation parameters.

Recruitment was generated using stock–recruitment functions with a log-normal error distribution. The historical stock–recruit pairs (covering the years 1990—2012) did not give clear support for any particular stock–recruitment model formulation. Therefore, the approach developed for the previous management plan evaluation (Simmonds et al., 2011) was adopted here. The method consisted in estimating a probability for a selection of model formulations (Beverton and Holt, Ricker, and segmented regression), to assign randomly one model formulation to each of the 1000 iterations according to these probabilities, and to estimate the shape, auto-correlation, and variance parameters individually for each iteration.

Changes were observed in the mackerel biology in the last decade, characterized by trends towards low weights-at-age, earlier spawning, and later maturation (ICES, 2014a). In the simulations, assumptions on the future biology were based on the average of the last three years (2011—2013) with additional auto-correlated random variations parameterized on the full time-series.

The future age selectivity of the fishery was simulated using resampling of the historical period (2000—2013) by blocks of years.

The stock assessment process was mimicked to estimate the state of the stock in the simulations, providing a basis to give advice according to the management strategies investigated. Stock assessment error matrices were applied to the "true" abundance and fishing mortality-at-age and resulted in temporally auto-correlated errors on SSB and Fbar.

A series of test runs was conducted to validate the model and investigate the effect of the main assumptions.

The ICES guidelines to estimate ranges of values of FMSY were established at ICES WKMSYREF3 (ICES, 2014g). For stocks where ICES advice is given based on the MSY approach ICES has developed an advice rule (AR) based on the FMSY fishing mortality reference point, that provides the exploitation rate to give catch advice, and a biomass reference point MSY Btrigger which is used to linearly reduce F if the biomass in the TAC year is predicted to be lower than this reference value (ICES, 2014g). The ICES MSY AR is evaluated to check that the FMSY and MSY Btrigger combination results in maximum long-term yield subject to precautionary considerations, i.e. in the long term there should be an annual probability < 5% that SSB < Blim.

To develop suitable FMSY ranges ICES has used the following criteria:

1) MSY is interpreted as maximum long-term average yield from a sustainable stock. This implies variable catch from year to year from a stock above precautionary limits.
2) F refers to total F for catch (landings plus discards) for all stocks where catch advice based on F is given. For stocks for which catch cannot be estimated and discards are not included in the F, F refers to landings only.
3) F_{MSY} and the ranges F_{upper} and F_{lower} are calculated based on maximizing long-term average yield, where yield is taken to be the catch of fish at lengths above the Minimum Conservation or Catch Size (MCS). Where selection at MCS is not known, yield is taken to be the landings, reflecting discard practices in recent years.
4) The F_{MSY} ranges are derived based on yields within 95% of yields at F_{MSY}. The choice of 95% of yield is somewhat arbitrary, but is in line with a "pretty good" yield concept (e.g. Hilborn, 2010) and delivers less than 5% reduction in long-term yield compared with MSY.
5) The values around F_{MSY} are based on recent stock biology, fishery characteristics, and environmental conditions. ICES has applied current growth, maturation, and natural mortality typically based on values from the last ten years used in the stock assessments. Where recent trends have been observed, the ten-year period is reduced to reflect recent conditions (the last 3 years were used for the mackerel). For simulated recruitment the earliest part of the time-series was not used because of the high uncertainty in the assessment for the period before 1990.
6) The ICES catch advice at F_{MSY} and at F_{upper} and F_{lower} will follow an advice rule based on F reduction when SSB in the TAC year is predicted to be below MSY $B_{trigger}$. This advice rule conforms to the current ICES MSY approach. ICES considers that to be in accordance with the precautionary approach there is a need for overarching precautionary considerations, and does not consider that F should be maintained at F_{MSY} when stock biomasses are below MSY $B_{trigger}$.
7) In order to be consistent with the ICES approach for estimating F_{MSY}, and taking into account advice error as well as biological and fishery variability, the values of F_{upper} and F_{MSY} are capped if they are not precautionary so that the

probability of SSB < B_{lim} is no more than 5%. If the stock has no available precautionary criteria, the F_{MSY} range is constrained to a maximum of F_{MSY} and a minimum of F_{lower}.

The range was thus defined as follows (where $F_{P.05}$ is the value of F that corresponds to 5% probability of SSB < B_{lim}), with the case corresponding to the mackerel highlighted in bold:

Case	Final F_{MSY}	F_{MSY} range
F_{upper}< $F_{P.05}$	F_{MSY}	F_{lower}–F_{upper}
F_{MSY}< $F_{P.05}$ < F_{upper}	**F_{MSY}**	**F_{lower}–$F_{P.05}$**
$F_{P.05}$ < F_{MSY}< F_{upper}	$F_{P.05}$	F_{lower}–$F_{P.05}$
$F_{P.05}$ cannot be defined	F_{MSY}	F_{lower}–F_{MSY}

In order to answer the request the following assumptions regarding the approach detailed in the request were made:

- In paragraph 1 SSB and Btrigger are specified in the proposal as being at the end of a TAC year. These parameters are normally specified by ICES to be at spawning time. ICES assumes that the intention of the strategy is that ICES should have a greater or equal to 50% probability to classify SSB > Btrigger at the end of the fishery year. Currently for NEA mackerel ICES carries out this classification based on SSB in May in the TAC year, ICES will continue to use this basis unless ICES is advised that this not what is intended.
- In paragraph 3 the strategy defines a requirement to bring SSB above Blim both at the start and the end of the TAC year. Similar to item 1 above ICES assumed the purpose of this paragraph is to test the SSB at the beginning of the year and have a greater than 50% probability of SSB > Blim by the end of the fishery year. Currently for NEA mackerel ICES carries out this classification based on SSB in May in the year, ICES will continue to use this basis unless ICES is advised that this not what is intended.
- ICES notes that the strategy specifies a Btrigger. The current plan has a Btrigger of 2.2 Mt, the MSY Btrigger is currently accepted by ICES is 3.0 Mt ICES is unsure whether it is intended that this Btrigger should be maintained at 3.0 Mt or if the evaluation should consider other options. ICES has tested other candidates of MSY Btrigger, consistent with the ICES MSY approach

2.12.2 Results

ICES performed long term stochastic simulations showing that a maximum long term yield of on average 676 kt is obtained for a fishing mortality $F_{bar4\text{-}8}$ of 0.22 (Figure 9.2.3.3.1). The actual value of yield that are expected to occur will depend on the realised recruitment and the values given in this document are only provided for comparison and should not be taken as expected values. The range of $F_{bar4.8}$ values between 0.15 and 0.29 are expected to deliver less than 5% reduction in long-term yield compared with MSY.

The implementation of the ICES MSY advice rule is explicitly stated in the request (bullet point 2); the F_{upper} value is therefore capped at the F that results in a 5% probability of SSB less than Blim ($F_{P.05}$).

The FMSY ranges [Flower, Fupper] are derived under three conditions: (1) to deliver no more than 5% reduction in long-term yield compared with MSY; (2) to be consistent with the ICES precautionary approach Fupper is capped, so that the probability of SSB < Blim is no more than 5%; and, as requested (3) the ICES MSY advice rule (AR) is applied throughout this evaluation, implying a linear reduction in F towards zero when SSB is below MSY Btrigger.

The resulting range estimated for the NEA mackerel, based on current biological characteristics and following the parameterization used in the ICES advice of February 2015 (ICES 2015a), is given in Table 9.2.3.3.1.

ICES provides MSY estimates, taking into account selectivity, recruitment, growth, and natural mortality under recent ecosystem conditions (ICES, 2014f — Section 1.2). Consequently, the advice is based on the recent stock dynamics. Other scenarios are documented in ICES (2015b). Because the long-term dynamics of the stocks are not clear, ICES advises that the FMSY values and ranges provided should be considered applicable for at least the next five years.

The Northeast Atlantic (NEA) mackerel stock is currently characterized by low weight-at-age, late maturity, and early spawning compared to the historical mean. There is no firm scientific basis yet to indicate whether this situation should be considered permanent or transient (either returning to the previous state or continuing to change in the same direction). However, recent scientific publications have indicated that the growth of mackerel could be dependent on a number of factors, including the size of the mackerel stock and the size of the Norwegian spring-spawning herring stock (Jansen and Burns, 2015; Olafsdottir et al., 2015).

Reflecting the uncertainty in the temporal dynamics of the biological characteristics of the NEA mackerel stock, ICES has also evaluated a scenario where the biological characteristics gradually return to the historical mean (ICES, 2015). It is worth noting that even though the parameterization of this scenario does not assume any relationship between stock size and growth, the consequences in the short term are assumed to be similar to those resulting from density-dependent growth, as in the short term, the stock size decreases and the growth rate increases. This scenario allows for higher level of fishing mortality, and consequently, short term differences in terms of higher yield, but the difference in expected long term yield is small (+3% with Btrigger = 3.0 Mt). In order to cover a more complete range of potential biological scenarios, an alternative one with a continuing trend in the biological characteristics should also be investigated. Such scenario could be envisioned if the changes are due to some external driver with a continuous trend. ICES acknowledges that simulations with inclusion of such scenario would help in mapping the uncertainty related to changes in biological characteristics.

Explicitly assigning the return to faster growth just to the stock size and managing on the expectation that this response will occur is a more demanding assumption than present management. Preliminary simulations of taking density-dependent growth into account in a management rule, indicates that fishing mortality could be slightly higher with density-dependence (in the order of 10%) (ICES, 2015c).

2.12.2.1 Sensitivity to the assumption on recruitment model

A preliminary comparison of evaluations using 2014 and 2015 assessments shows sensitivity to the assumption on the recruitment model (Figures 2.12.2.1 and 2.12.2.2). This did not alter precautionary considerations (the probability of SSB < Blim). This comparison showed an effect on MSY ranges of least a similar magnitude to the growth changes. A full evaluation of the current stock recruit relationship has not been done.

2.12.2.2 Range of alternative Btrigger values

As requested ICES has provided results for a range of alternative Btriggers and corresponding Fupper values (Table 2.12.2.2.1). These Fupper values are limited by precautionary considerations, and higher fishing mortalities will increase the probability of SSB < Blim to levels > 5%. Increasing Btrigger will allow for higher Fupper, but at the same time, will lead to higher variability in yield (ICES 2015a) as the SSB will be below Btrigger in more years, (ie. high Btriggers react to increased stock size and deplete these more quickly taking potential catch earlier at the expense of lower catch later). If SSB is less than Btrigger then the advised F in that year is reduced, this results in the realized long term mean F's being being very similar regardless of Btrigger and Fupper (Table 2.12.2.1). Fuppers between 0.24 and 0.30 corresponding to Btriggers between 3.0 and 5.0 Mt all results in long term realized F of 0.23—0.24.

The differences in the long term average yield are small (2—3%, Table 2.12.2.1), and the gains are only attainable in the short term.

2.12.2.3 Density dependent growth and environmental effects

The request specifically asked that the advice should be based on the stock biology (including possible density-dependent growth), fishery characteristics and environmental conditions. The numerical part of this evaluation is based on current biological conditions of the stock, with slow growth and late maturation. Other biological scenarios are discussed, but full numerical evaluations have not been carried out.

Recent scientific work has provided some support for density dependent growth in NEA mackerel. Jansen and Burns (2015) have found a negative relation between juvenile size and both the biomass of the adults and the abundance of juveniles. Olafsdottir et al., 2015 investigated mackerel growth between age 3 and age 8 and described a marked reduction in growth, which was found to be concomitant with trends in the size of both the NEA mackerel and the Norwegian spring spawning herring stocks. The authors also included temperature as an explanatory factor for the changes in growth and concluded that its effect was not significant.

However, this converging evidence for a density dependence effect should be supported by studies aiming at identifying the actual mechanisms (e.g. reduction of the food available per capita due to the increased number of conspecific individuals, increase feeding migration distances due to the increase competition for space). Studies based on actual field observations (fish distribution, stomach contents, plankton abundances, physical factors) combined with experimental work and bio-energetic modelling will help to better understand these mechanisms.

The influence of other factors may have acted in combination with the increasing stock size on mackerel growth. The carrying capacity of the ecosystem may also have varied due to the effect of environmental changes (changes in prey abundance, in competing species abundance, changes in the geographical extension of the suitable habitat for mackerel). In addition, growth, as all physiological processes, is directly influenced by the local physical conditions (e.g. temperature) experienced by the fish. Furthermore, many of the potential drivers are correlated with each other, which makes the interpretation of causal links challenging (see Pastoors et al., 2015 for further discussion).

Until we have a good understanding of the density dependent and density independent (i.e. environmental) factors that govern the changes in mackerel biology and population dynamics (growth, but also recruitment regime, migration time, etc.), it seems difficult to incorporate adequately any of those factors in the simulations carried out to give advice on the appropriate levels of exploitation. In absence of clear indication of reversibility of the recent changes, ICES currently uses simulations conditioned based on the recent biological conditions.

During the long term management plan evaluation (ICES, 2015c) an alternative scenario for the future biology of the stock was presented. In this scenario, all biological characteristics were modelled so that their baseline level (i.e. when not considering the stochastic yearly variations) would return progressively from the current level to the long term historical average. If, indeed the recent changes in growth are due to the large size of the stock, a recovery of the mean weights-at-age might be expected if the stock size decreases from the current high level.

Simulations using the return to faster growth and earlier maturation indicate that a FMSY=0.24 would maximise the long term yields, and the F values between Flower=0.17 and Fupper=0.28 would result in less that 5% reduction in long-term yield compared with MSY and still be precautionary. These changes would be expected whatever the reason for return to the historical biological conditions.

The effect of density on fish growth can also be directly incorporated in the population model used in a management strategy evaluation. The framework used by ICES (2015b) does not have this possibility at the moment, but ICES (2015c) investigated the magnitudinal effect of density-dependent growth using another modelling framework parameterized for NEA mackerel stock, allowing fish size-at-age to be directly dependent on the stock size at any given time. The HCS software (Skagen, 2015) was used for a brief exploratory study of the relative effect size of density dependence on reference points like FMSY (Pastoors et al. 2015). It was loosely conditioned as a stock with mackerel-like properties.

HCS runs an age-structured population forwards with removals according to a harvest rule. Stochastic elements include recruitment, weight and maturities at age, initial numbers, errors in the perceived stock abundance used to decide on TACs and in implementing TACs.

Initial numbers, standard weights at age, selection at age in the fishery and natural mortality were taken from the input to the short term prediction by WGWIDE 2014.

Recruitment was modelled using two different methods:

1. Recruitment assumed to be log-normally distributed around the long term geometric mean of 4272 million and a CV of 39%. The stock recruit function was a hockey stick with breakpoint at Blim = 1.84 million tons. The CV is that of the historic series of recruitments.

2. Recruitment replicates (1000 iterations) taken from WKMACLTMP. These were derived by estimating the stock–recruitment function probabilities according to Simmonds et al. (2011). For the three selected stock–recruitment functions (segmented regression, Ricker and Beverton and Holt), a Bayesian estimation of the model parameters was performed assuming lognormal distributed errors, based on the point estimates from the 2014 SAM assessment corresponding to the period 1990 to 2012. For each stock–recruitment function, a set of 1000 models were kept. The probabilities of the three model forms were calculated based on the likelihoods of the three sets of 1000 model fits.

Stochastic initial numbers were obtained using the observation model noise as described below, assuming that the present and future stock numbers will have similar uncertainties.

The observation model, that imitates future assessment, has a noise component that is a product of a year effect and an age effect redrawn each year. The resulting CV on the estimate of the current SSB was 33%.

Implementation of the decided TACs was assume to be bias-free, with a small (CV = 10%) error on the numbers caught at each age.

Altogether, this conditioning was intended to create a mackerel-like stock, which should be sufficient for comparing the outcome of fishing at a range of levels of fishing mortality with and without density dependence, even though the exact values of the results should not be regarded as a second opinion of the performance of candidate harvest rules (next to the results obtained in WKMACLTMP, ICES 2015b).

Density dependence

The density dependence is modelled as a multiplier to the standard weight. Following Kovalev and Bogstad (2005), this multiplier is a truncated linear function of the total biomass, here the biomass of age 1 and older:

TSB_factor = 1+α_{TSB}*(B0-TSB)/B0

The factor was truncated at 0.5 and 2.5. The slope α_{TSB} is defined for each age separately, but applies in all years. The slopes used presently were obtained by doing a linear regression of the historical stock weights at age on the SSB. Although the way the slopes were derived (using SSB in the actual year rather than the TSB the year before) does not correspond exactly to the way they are used, the order of magnitude should be representative of the strength of the density dependence that would be needed if all variations in weights at age should be caused by that.

The model conditioning is documented by including the conditioning files opt.inn and bio.inn for the run as annex to Pastoors et al. 2015b.

The HCS conditioned as described was used to explore the effect of a range of constant fishing mortalities on long term equilibrium yield and SSB, in order to outline the impact of a plausible density dependence on candidate MSY reference points. The model was run for 98 years with constant fishing mortalities without biomass triggers, and the results for year 98 were taken as a long term equilibrium. The time course of the results indicated that equilibrium would be reached after some 20 years.

Results are summarized in figures 2.12.2.3.1-2.12.2.3.3 for simulations with and without density dependent growth and with two different stock-recruitment relationships; simple with lognormal variance around the long term mean and a complex including three different stock-recruitment relationships as used in WKMACLTMP. Results are summarized for catch (figure 2.12.2.3.1), SSB (figure 2.12.2.3.2) and risk (type 3) to Blim (figure 2.12.2.3.3).

As expected, the inclusion of density dependence led to higher yield and SSB compared with no density dependence at similar fishing mortalities. This effect was most prominent at high fishing mortalities, i.e. with low stock abundance. The deterministic F0.1 was 0.215 with density dependence and 0.183 without density dependence. The risk to Blim started to increase at about F = 0.2 without density dependence and about F= 0.24 with density dependence.

The influence of the stock-recruitment relationship used was also noticeable. Using a hockey-stick model gave more flat-topped yield curves estimates with higher Fmsy compared to the more complex recruitment model used by WKMACLTMP.

As noted above, the effects shown here should only be used to indicate the relative effect of density dependence on growth, and not as alternative estimates of these reference points. The preliminary results indicate that in the range of potential Fmsy, the effect of density dependence in growth appears to be between 5% and 10% in yield.

2.13 References

Bachiller E., Skaret G., Nøttestad L., Slotte A. 2015 (submitted). Feeding ecology of Northeast Atlantic mackerel, Norwegian spring-spawning herring and blue whiting in the Norwegian Sea. PlosONE.

Carrera, P. and Riveiro, I. 2015. Multidisciplinary acoustic survey PELACUS0315: preliminary results on fish abundance estimates and distribution. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Pasaia, Spain, 25 – 31 August 2015.

Debes, H., Homrum, E., Jacobsen, J.A., Hátún, H., Danielsen, J. 2012. The feeding ecology of pelagic fish in the southwestern Norwegian Sea –Inter species food competition between Herring (Clupea harengus) and mackerel (Scomber scombrus). ICES CM 2012/M:07. 19 pp.

Huse G., Holst J.C, Utne K.R., Nøttestad L., Melle W., Slotte A., Ottersen G., Fenchel T. and Uiblein F. (2012): Effects of interactions between fish populations on ecosystem dynamics in the Norwegian Sea – results of the INFERNO project, Marine Biology Research, 8:5-6, 415-419

ICES. 2012a. Report of Working Group of Mackerel and Horse mackerel Egg surveys (WGMEGS). 18-21 April 2012. Galway, Ireland. ICES CM 2012/SSGESST:04.

ICES. 2012b. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 21-27 August 2012, Lowestoft, UK. ICES CM 2012/ACOM:15. 940 pp.

ICES. 2013a. Manual for the International Bottom Trawl Surveys. Series of ICES Survey Protocols. SISP 1-IBTS IX. 83 pp.

ICES. 2013b. Report of the Workshop to consider reference points for all stocks (WKMSYREF). 23 - 25 January 2013. Copenhagen, Denmark. ICES CM 2013/ACOM:37. 17 pp.

ICES. 2014a. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA). 17–21 February 2014. Copenhagen, Denmark. ICES CM 2014/ACOM:43. 344 pp.

ICES. 2014b. Report of the EU Workshop on the NEA Mackerel Long-term Management Plan (WKMACLTMP). ICES CM 2014/ACOM:63. 118 pp.

ICES. 2014c. Report of the WGWIDE subgroup for updated Mackerel advice for 2014. ICES CM 2014/ACOM:48. 44 pp.

ICES. 2014d. Report of Working Group of Mackerel and Horse mackerel Egg surveys (WGMEGS). 7-11 April 2014. Reykjavik, Iceland. ICES CM 2014/SSGESST:14.

ICES. 2014e. Report of the Working Group on Widely Distributed Stocks (WGWIDE). 26 August - 1 September 2014. ICES Headquarters, Copenhagen, Denmark. ICES CM 2014/ACOM:15. 945 pp.

ICES. 2014f. Report of the ICES Advisory Committee, 2014. ICES Advice 2014, Book 1.

ICES. 2014g. Report of the Joint ICES–MYFISH Workshop to consider the basis for FMSY ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

ICES. 2015a. EU, Norway, and the Faroe Islands request to ICES to evaluate a multi-annual management strategy for mackerel (Scomber scombrus) in the Northeast Atlantic. In Report of the ICES Advisory Committee, 2015. ICES Advice 2015, Book 9, Section 9.2.3.1.

ICES. 2015b. Report of the EU Workshop on the NEA Mackerel Long-term Management Plan (WKMACLTMP), 24–27 June and 17–19 November 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:63.

ICES. 2015c. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 25–31 August, 2015, Pasaia, Spain. ICES CM 2015/ACOM:15.

ICES. 2015. First Interim Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). 20–24 April 2015 ICES Headquarters, Copenhagen. ICES CM 2015/SSGIEOM:09.

Jansen, T. 2014. Pseudocollapse and rebuilding of North Sea mackerel (*Scomber scombrus*). ICES Journal of Marine Science, 71: 299-307.

Jansen T. and Burns F. 2015. Density dependent growth changes through juvenile and early adult life of North East Atlantic Mackerel (*Scomber scombrus*). Fish. Res., 169:37-44.

Jansen, T., Kristensen, K., van der Kooij, J., Post, S., Campbell, A., Utne, K. R., Carrera, P., Jacobsen, J. A., Gudmundsdottir, A., Roel, B. A., & Hatfield, E. M. C. 2015. Nursery areas and recruitment variation of North East Atlantic mackerel (*Scomber scombrus*). ICES J.Mar.Sci., 72(6), 1779-1789.

Jansen, T. 2014. Pseudocollapse and rebuilding of North Sea mackerel (*Scomber scombrus*). – ICES J.Mar.Sci., 71: 299–307.

Kovalev, Y. and Bogstad, B. 2005. Evaluation of maximum long-term yield for North-East Arctic cod. Proceedings of the 11th Russian-Norwegian Symposium, Murmansk, 15-17 August 2005, PINRO Press. Murmansk 2005.

Langøy, H., Nøttestad, L., Skaret, G., Broms, C., & Fernö, A. 2012. Overlap in distribution and diets of Atlantic mackerel (Scomber scombrus), Norwegian spring- spawning herring (Clupea harengus) and blue whiting (Micromesistius poutassou) in the Norwegian Sea during late summer. Marine biology research, 8(5-6), 442-460.

Lockwood, S.J., Nichols, J.H. and S.H. Coombs. 1977. The development rates of mackerel (*Scomber scombrus* L.) eggs over a range of temperatures. ICES CM 1977/J:13. 5 pp.

Mendiola, D., Alvarez, P., Cotano, U., Etxebeste, E. and A. Martínez de Murguia. 2006. Effects of temperature on development and mortality of Atlantic mackerel fish eggs. Fish. Res., 80: 158–168.

Nielsen, A. and C.W. Berg. 2014. Estimation of time-varying selectivity in stock assessment using state–space models, Fish. Res., 158:96-101

Nøttestad, L., Anthonypillai, V., Tangen, Ø., Utne, K.R., Óskarsson, G.J., Jónsson S., Homrum, E., Smith, L., Jacobsen, J.A. and Jansen, T. 2015. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) with M/V ”Brennholm”, M/V “Eros”, M/V “Christian í Grótinum” and R/V “Árni Friðriksson”, 1 July - 10 August 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015. 47 pp.

Olafsdottir, A. H., Slotte, A., Jacobsen, J. A., Oskarsson, G. J., Utne, K. R., and Nøttestad, L. 2015. Changes in weight-at-length and sizeat-age of mature Northeast Atlantic mackerel (*Scomber scombrus*) from 1984 to 2013: effects of mackerel stock size and herring (*Clupea harengus*) stock size. ICES Journal of Marine Science, doi: 10.1093/icesjms/fsv142.

Óskarsson, G.J., Guðmundsdóttir, A., Sveinbjörnsson, S. and Sigurðsson, Th. 2015. Feeding ecology of mackerel and dietary overlap with herring in Icelandic waters Ecological impacts of recent extension of feeding migration of NE-Atlantic mackerel into the ecosystem around Iceland. Marine Biology Research, (in press).

Pastoors, M., Brunel, T., Skagen, D., Utne, K.R., Enberg, K and Sparrevohn, C.R. 2015. Mackerel growth, the density dependent hypothesis and implications for the configuration of MSE simulations: Results of an ad-hoc workshop in Bergen, 13-14 August 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Pasaia, Spain, 25 – 31 August 2015. 20 pp.

Rybakov, M, Sergeeva, T., Goncharova O., Tangen, Ø., Anthonypillai, V., Salthaug, A., Høines, Å., Mork, K.A., Melle, W., Stæhr, K., Couperus, B., Kloppmann, M., Óskarsson, G.J., Sveinbjörnsson, S., Valdimarsson, H., Gíslason, Á., Homrum, E., Mortensen, E., Vestergaard, P., Thomassen, J.A. and Smith, L. 2015. International ecosystem survey in the Nordic Sea (IESNS) in April-June 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015. 34 pp.

Skaret G., Bachiller E., Langøy H., Stenevik, E.K. 2015. Mackerel predation on herring larvae during summer feeding in the Norwegian Sea. ICES JMS, doi:10.1093/icesjms/fsv087

Simmonds, E. J., Portilla, E., Skagen, D., Beare, D., and Reid, D. G. 2010. Investigating agreement between different data sources using Bayesian state-space models: an application to estimating NE Atlantic mackerel catch and stock abundance. – ICES Journal of Marine Science, 67: 1138–1153.

Simmonds, E. J., Campbell, A., Skagen, D., Roel, B. A., and Kelly, C. 2011. Development of a stock–recruit model for simulating stock dynamics for uncertain situations: the example of Northeast Atlantic mackerel (Scomber scombrus). ICES Journal of Marine Science, 68: 848–859.

Shepherd, J.G. 1997. Prediction of year-class strength by calibration regression analysis of multiple recruit index series. ICES J. mar. Sci., 54: 741–752.

Tenningen, M., A. Slotte and D. Skagen. 2011. Abundance estimation of Northeast Atlantic mackerel based on tag–recapture data – A useful tool for stock assessment? Fish. Res., 107:68–74.

Table 2.2.1. 2014 Mackerel fleet composition of major mackerel catching nations.

Country	Len (m)	Engine power (hp)	Gear	Storage	No vessels
Denmark	57-86	4077-8158	Trawl	Tank	7
	70-76	4077-6118	Purse Seine	Tank	3
Faroe Islands	49-69	2400-4000kw	Purse Seine/Trawl	RSW	4
	70-79	3900-8000kw	Purse Seine/Trawl	RSW	5
	68-90	3200-6000kw	Trawl	Freezer	2
	<50		Trawl		30
France	<24		Trawl		1230
	>24		Trawl		36
Germany	90-140	3800-12000	Single Midwater Trawl	Freezer	4
Greenland	90-140	4350-8049	Trawl	Freezer	7
	40-90	1353-9073	Trawl	Freezer/RSW	22
Iceland	51-60	2502-4079	Single Midwater Trawl	RSW, Freezer	6
	61-70	2000-7507	Single Midwater Trawl	RSW, Freezer	17
	71-80	3200-11257	Single Midwater Trawl	RSW, Freezer	12
	>80	8051	Single Midwater Trawl	Freezer	1
Ireland	27-65	522-3840	Pair Midwater Trawl	RSW	16
	8-37	22-1119	Pair Midwater Trawl	Dryhold	26
	50-71	1007-3460	Midwater Trawl	RSW	7
	11-16	33-171	Midwater Trawl	Dryhold	2
Netherlands	55	2125	Pair Midwater Trawl	Freezer	1
	88-145	4400-10455	Single Midwater Trawl	Freezer	9
Norway	>27		Purse Seine		80
	21-27		Purse Seine		17
	<21		Purse Seine		164
			Trawler		21
			Handline/Gillnet		155
Portugal	10-20		Trawl	Freezer	2
	20-30		Trawl	Freezer	7
	30-40		Trawl	Freezer	5
	0-10		Trawl	Other	259
	10-20		Trawl	Other	68
	20-30		Trawl	Other	60
	30-40		Trawl	Other	29
	0-10		Purse Seine	Other	79
	10-20		Purse Seine	Other	103
	20-30		Purse Seine	Other	79
Spain	18-24	96-294	Trawl	Dryhold	7
	24-40	162-862	Trawl	Dryhold	127
	40-	353-876	Trawl	Dryhold	3
	0-10	33	Purse Seine	Dryhold	1

	10-12	21-107	Purse Seine	Dryhold	10
	12-18	21-306	Purse Seine	Dryhold	114
	18-24	70-397	Purse Seine	Dryhold	128
	24-40	140-809	Purse Seine	Dryhold	104
	0-10	2-74	Artisanal	Dryhold	291
	10-12	12-118	Artisanal	Dryhold	190
	12-18	18-239	Artisanal	Dryhold	226
	18-24	81-368	Artisanal	Dryhold	41
	24-40	129-368	Artisanal	Dryhold	11

Table 2.2.4. Overview of major existing regulations on mackerel catches.

Technical measure	National/International level	Specification	Note
Catch limitation	Coastal States/NEAFC	2010-2015: not agreed	
Management plan	European (EU, NO)	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, NO, FO)	30cm in the North Sea	
Minimum size (all areas except North Sea)	European (EU, FO)	20cm in all areas except North Sea	10% undersized allowed
Minimum size	National (NO)	30cm in all areas	
Catch limitation	European (EU, NO, FO)	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
Area limitations	National (IS)	Pelagic trawl fishery only allowed outside of 200m depth contours around Iceland and/or 12 nm from the coast.	
Quota adaptation	European (EU)	Reducing of Spanish mackerel quota with a scheduled payback until 2015 following the exceeding of fishing opportunities in 2010	

Technical measure	National/International level	Specification	Note
National catch limitations by gear, semester and area	National (ES)	30.5% of the Spanish national quota is assigned for the trawl fishery, 27.7% for purse seiners and 34.6% for the artisanal fishery	90,6 % of the Spanish national quota should be caught in ICES Div, IXa N and VIIIc. Besides, a 30.5% is assigned to the trawler fleet (8 tm as maximum daily catch per vessel), 27.7% to purse seiner (8 tm as maximum daily catch per vessel) and 34.6% to the artisanal fleet (2.3 tm as maximum daily catch per vessel); for all of them, a 7% of the catches should be kept for the second half of the year.
High-grading ban	European (EU)	High-grading (discarding fish of lower commercial value due to limited space on board) is banned in European water	
Discard prohibition	National (NO, IS, FO)	All discarding is prohibited for Norwegian, Icelandic and Faroese vessels	
Landings Obligation	European	From 2015 onwards a landing obligation for European Union fisheries is in place for small pelagics including mackerel, horse mackerel, blue whiting and herring.	

Table 2.3.1.1. NE Atlantic Mackerel. ICES estimated catches by area (t). Discards not estimated prior to 1978 (data submitted by Working Group members).

Year	Subarea VI			Subarea VII and Divisions VIIIabde			Subareas III and IV			Subareas I,II,V and XIV			Divisions VIIIc and IXa			Total		
	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch
1969	4,800		4,800	47,404		47,404	739,175		739,175	7		7	42,526		42,526	833,912		833,912
1970	3,900		3,900	72,822		72,822	322,451		322,451	163		163	70,172		70,172	469,508		469,508
1971	10,200		10,200	89,745		89,745	243,673		243,673	358		358	32,942		32,942	376,918		376,918
1972	13,000		13,000	130,280		130,280	188,599		188,599	88		88	29,262		29,262	361,229		361,229
1973	52,200		52,200	144,807		144,807	326,519		326,519	21,600		21,600	25,967		25,967	571,093		571,093
1974	64,100		64,100	207,665		207,665	298,391		298,391	6,800		6,800	30,630		30,630	607,586		607,586
1975	64,800		64,800	395,995		395,995	263,062		263,062	34,700		34,700	25,457		25,457	784,014		784,014
1976	67,800		67,800	420,920		420,920	305,709		305,709	10,500		10,500	23,306		23,306	828,235		828,235
1977	74,800		74,800	259,100		259,100	259,531		259,531	1,400		1,400	25,416		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		4,200	25,909		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		7,000	21,932		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		8,300	12,280		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		18,700	16,688		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		37,600	21,076		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		49,000	14,853		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		98,222	20,208		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		78,000	18,111		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		101,000	24,789		24,789	594,697	7,431	602,128

Year	Subarea VI			Subarea VII and Divisions VIIIabde			Subareas III and IV			Subareas I,II,V and XIV			Divisions VIIIc and IXa			Total		
	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch
1987	183,700		183,700	100,300		100,300	290,829	10,789	301,618	47,000		47,000	22,187		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		120,404	24,772		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		90,488	18,321		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		118,700	21,311		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		97,800	20,683		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		139,062	18,046		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		165,973	19,720		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		72,309	25,043		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		135,496	27,600		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		103,376	34,123		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		103,598	40,708		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		134,219	44,164		44,164	658,652	8,012	666,664
1999	116,362		116,362	94,290		94,290	313,014		313,014	72,848		72,848	43,796		43,796	640,311		640,311
2000	187,595	1	187,595	115,566	1,918	117,484	285,567	165	304,898	92,557		92,557	36,074		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		67,097	43,198		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		73,929	49,576		49,576	749,131	23,774	772,905
2003	135,690	1,399	137,089	90,356	5,712	96,068	354,109	11,785	365,894	53,883		53,883	25,823	531	26,354	659,831	19,427	679,288
2004	134,033	1,705	134,738	103,703	5,991	109,694	306,040	11,329	317,369	62,913	9	62,922	34,840	928	35,769	640,529	19,962	660,491
2005	79,960	8,201	88,162	90,278	12,158	102,436	249,741	4,633	254,374	54,129		54,129	49,618	796	50,414	523,726	25,788	549,514

Year	Subarea VI			Subarea VII and Divisions VIIIabde			Subareas III and IV			Subareas I,II,V and XIV			Divisions VIIIc and IXa			Total		
	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch
2006	88,077	6,081	94,158	66,209	8,642	74,851	200,929	8,263	209,192	46,716		46,716	52,751	3,607	56,358	454,587	26,594	481,181
2007	110,788	2,450	113,238	71,235	7,727	78,962	253,013	4,195	257,208	72,891		72,891	62,834	1,072	63,906	570,762	15,444	586,206
2008	76,358	21,889	98,247	73,954	5,462	79,416	227,252	8,862	236,113	148,669	112	148,781	59,859	750	60,609	586,090	37,075	623,165
2009	135,468	3,927	139,395	88,287	2,921	91,208	226,928	8,120	235,049	163,604		163,604	107,747	966	108,713	722,035	15,934	737,969
2010	106,732	2,904	109,636	104,128	4,614	108,741	246,818	883	247,700	355,725	5	355,729	49,068	4,640	53,708	862,470	13,045	875,515
2011	160,756	1,836	162,592	51,098	5,317	56,415	301,746	1,906	303,652	398,132	28	398,160	24,036	1,807	25,843	935,767	10,894	946,661
2012	121,115	952	122,067	65,728	9,701	75,429	218,400	1,089	219,489	449,325	1	449,326	24,941	3,431	28,372	879,510	15,174	894,684
2013	132,062	273	132,335	49,871	1,652	51,523	260,921	337	261,258	465,714	15	465,729	19,733	2,455	22,188	928,433	4,732	933,165
2014	180,068	340	180,408	93,709	1,402	95,111	383,887	334	384,221	684,082	91	684,173	46,257	4,284	50,541	1,388,003	6,451	1,394,454

Table 2.3.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in the Norwegian Sea (IIa) and Area V 1984–2014 (Data submitted by Working Group members).

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Denmark	11,787	7,610	1,653	3,133	4,265	6,433	6,800	1,098	251	
Estonia									216	
Faroe Islands	137				22	1,247	3,100	5,793	3,347	1,167
France		16				11		23	6	6
Germany, Fed. Rep.			99		380					
Germany, Dem. Rep.			16	292		2,409				
Iceland										
Ireland										
Latvia									100	4,700
Lithuania										
Netherlands										
Norway	82,005	61,065	85,400	25,000	86,400	68,300	77,200	76,760	91,900	100,500
Poland										
Sweden										
United Kingdom			2,131	157	1,413		400	514	802	
USSR/Russia	4,293	9,405	11,813	18,604	27,924	12,088	28,900	13,361	42,440	49,600
Misreported (IVa)										
Misreported (VIa)										
Misreported (Ukn)										
Unallocated										
Discards										
Total	98,222	78,096	101,112	47,186	120,404	90,488	118,700	97,819	139,062	165,973

Table 2.3.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in the Norwegian Sea (IIa) and Area V 1984–2014. Continued.

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Denmark		4,746	3,198	37	2,090	106	1,375	7	1	
Estonia	3,302	1,925	3,741	4,422	7,356	3,595	2,673	219		
Faroe Islands	6,258	9,032	2,965	5,777	2,716	3,011	5,546	3,272	4,730	
France	5	5		270						
Germany										
Greenland			1							
Iceland			92	925	357				53	122
Ireland						100				495
Latvia	1,508	389	233							
Lithuania							2,085			
Netherlands			561			661			569	44
Norway	141,114	93,315	47,992	41,000	54,477	53,821	31,778	21,971	22,670	12,548[1]
Poland				22						
Sweden								8		
United Kingdom	1,706	194	48	938	199	662		54	665	692
Russia	28,041	44,537	44,545	50,207	67,201	51,003	49,100[1]	41,566	45,811	40,026
Misreported (IVa)	-109,625	-18,647			-177	-40,011				
Misreported (VIa)						-100				
Misreported (Ukn)									-570	
Unallocated										-44
Discards										
Total	72,309	135,496	103,376	103,598	134,219	72,848	92,557	67,097	73,929	53,883

Table 2.3.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in the Norwegian Sea (IIa) and Area V 1984–2014. Continued.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Denmark							4,845	269		391	2,345
Estonia										1,367[1]	
Faroe Islands	650	30		278	123	2,992	66,312	121,499	107,198	142,976	103,896
France	2	1						2		197	8
Germany				7					107	74	
Greenland								62[1]	7,402[1]	54,148[1]	87,581[1]
Iceland		363	4,222	36,706	112,286	116,160[1]	121,008[1]	159,263[1]	149,282[1]	151,103[1]	172,960[1]
Ireland	471							90			1,725
Latvia											
Lithuania											1,082
Netherlands	34	2,393		10	72		90	178	5	1	5,887
Norway	10,295	13,244	8,914	493	3,474	3,038	104,858	43,168	110,741	33,817	192,322
Poland											
Sweden									4	825	3,310
United Kingdom	2,493				4					2	5,534
Russia	49,489	40,491	33,580	35,408	32,728	41,414[1]	58,613	73,601	74,587	80,812	116,433[1]
Misreported (IVa)											
Misreported (VIa)											
Misreported (Ukn)	-553										
Unallocated	32	-2,393		-10	-18						
Discards	9				112		5	28	1	15[1]	91[1]
Total	62,922	54,129	46,716	72,891	148,781	163,604	355,729	398,160	449,326	465,729	684,173

[1]Includes catches in I, XII and XIVb

Table 2.3.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Sub-area IV and IIIa) 1988-2014 (Data submitted by Working Group members).

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Belgium	20	37		125	102	191	351	106	62	114
Denmark	32,588	26,831	29,000	38,834	41,719	42,502	47,852	30,891	24,057	21,934
Estonia					400					
Faroe Islands		2,685	5,900	5,338		11,408	11,027	17,883	13,886	3,288[2]
France	1,806	2,200	1,600	2,362	956	1,480	1,570	1,599	1,316	1,532
Germany, Fed. Rep.	177	6,312	3,500	4,173	4,610	4,940	1,497	712	542	213
Iceland										
Ireland		8,880	12,800	13,000	13,136	13,206	9,032	5,607	5,280	280
Latvia					211					
Lithuania										
Netherlands	2,564	7,343	13,700	4,591	6,547	7,770	3,637	1,275	1,996	951
Norway	59,750	81,400	74,500	102,350	115,700	112,700	114,428	108,890	88,444	96,300
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
United Kingdom	1,002	38,660	30,800	36,917	35,137	41,010	27,479	21,609	18,545	19,204
USSR (Russia from 1990)										3,525
Misreported (IIa)							109,625	18,647		
Misreported (VIa)	180,000	92,000	126,000	130,000	127,000	146,697	134,765	106,987	51,781	73,523
Misreported (Unknown)										
Unallocated	29,630	6,461	-3,400	16,758	13,566			983	236	1,102
Discards	29,776	2,190	4,300	7,200	2,980	2,720	1,150	730	1,387	2,807
Total	338,316	281,600	305,100	365,875	367,164	390,558	472,397	322,204	212,839	229,487

Table 2.3.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Sub-area IV and IIIa) 1988-2014. Continued.

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[1]
Belgium	125	177	146	97	22	2	4	1	3	1
Denmark	25,326	29,353	27,720	21,680	34,375[1]	27,508[1]	25,665	23,212[1]	24,219[1]	25,217[1]
Estonia										
Faroe Islands	4,832	4,370	10,614	18,751	12,548	11,754	11,705	9,739	12,008	11,818
France	1,908	2,056	1,588	1,981	2,152	1,467	1,538	1,004	285	7,549
Germany	423	473	78	4,514	3,902	4,859	4,515	4,442	2,389	5,383
Iceland		357								
Ireland	145	11,293	9,956	10,284	20,715	17,145	18,901	15,605	4,125	13,337
Latvia										
Lithuania										
Netherlands	1,373	2,819	2,262	2,441	11,044	6,784	6,366	3,915	4,093	5,973
Norway	103,700	106,917	142,320	158,401	161,621	150,858	147,068	106,434	113,079	131,191
Poland								109		
Romania										
Sweden	5,146	5,233	4,994[1]	5,090	5,232[1]	4,450	4,437	3,204	3,209	3,858[1]
United Kingdom	19,755	32,396	58,282	52,988	61,781	67,083	62,932	37,118	28,628	46,264
Russia	635	345	1,672	1				4		
Misreported (IIa)		40,000								
Misreported (VIa)	98,432	59,882	8,591	39,024	49,918	62,928	23,692	37,911	8,719	
Misreported (Ukn)										
Unallocated	3,147	17,344	34,761	24,873	22,985	-730	-783	7,043	171	2,421
Discards	4,753		1,912	24	8,583	11,785	11,329	4,633	8,263	4,195
Total	269,700	313,015	304,896	339,970	394,878	365,894	317,369	254,374	209,192	257,208

Table 2.3.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Subarea IV and IIIa) 1988-2014. Continued.

Country	2008[1]	2009[1]	2010[1]	2011[1]	2012[1]	2013[1]	2014[1]
Belgium	2	3	27	21	39	62	56
Denmark	26,716	23,491	36,552	32,800	36,492	31,924	21,340
Estonia							
Faroe Islands	7,627	6,648	4,639	543	432	25	42,919
France	490	1,493	686	1,416	5,736	1,788	4,912
Germany	4,668	5,158	2,562[1]	5,291[1]	4,560	5,755	4,979
Iceland							
Ireland	11,628	12,901	14,639	15,810	20,422	13,523	45,167
Latvia							
Lithuania							8,340
Netherlands	1,980	2,039	1,300	9,881	6,018	4,863	24,536
Norway	114,102	118,070	129,064	162,878	64,181	130,056	85,409
Poland							
Romania							
Sweden	3,664[1]	7,303[1]	3,429[1]	3,248[1]	4,560	2,081	1,112
United Kingdom	37,055	47,863	52,563	69,858	75,959	70,840	145,119
Russia			696			4	
Misreported (IIa)							
Misreported (VIa)	17,280	1,959					
Misreported (Ukn)							
Unallocated	2,039	-629	660				
Discards	8,862	8,120	883	1,906	1,089	337	334
Total	236,111	235,049	247,700	303,652	219,489	261,258	384,221

[1]-includes small catches in IIIb,c,d

Table 2.3.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e) 1985–2014 (Data submitted by Working Group members).

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Belgium										
Denmark	400	300	100		1,000		1,573	194		2,239
Estonia										
Faroe Islands	9,900	1,400	7,100	2,600	1,100	1,000				4,283
France	7,400	11,200	11,100	8,900	12,700	17,400	4,095		2,350	9,998
Germany	11,800	7,700	13,300	15,900	16,200	18,100	10,364	9,109	8,296	25,011
Guernsey										
Ireland	91,400	74,500	89,500	85,800	61,100	61,500	17,138	21,952	23,776	79,996
Isle of Man										
Jersey										
Lithuania										
Netherlands	37,000	58,900	31,700	26,100	24,000	24,500	64,827	76,313	81,773	40,698
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
United Kingdom	205,900	156,300	200,700	208,400	149,100	162,700	162,588	196,890	215,265	208,656
Misreported (Area IVa)		-148,000	-117,000	-180,000	-92,000	-126,000	-130,000	-127,000	-146,697	-134,765
Misreported (Unknown)										
Unallocated	75,100	49,299	26,000	4,700	18,900	11,500	-3,802	1,472		4,632
Discards	4,500			5,800	4,900	11,300	23,550	22,020	15,660	4,220
Total	467,700	232,599	284,100	197,000	199,100	182,400	183,509	236,079	248,785	251,646

Table 2.3.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e) 1985–2014. Continued.

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Belgium										1
Denmark	1,143	1,271			552	82	835		113	
Estonia	361									
Faroe Islands	4,284		2,448[1]	3,681	4,239	4,863	2,161	2,490	2,260	674
France	10,178	14,347	19,114	15,927	14,311	17,857	18,975	19,726	21,213	18,549
Germany	23,703	15,685	15,161	20,989	19,476	22,901	20,793	22,630	19,200	18,730
Guernsey										
Ireland	72,927	49,033	52,849	66,505	48,282	61,277	60,168	51,457	49,715	41,730
Isle of Man										
Jersey										
Lithuania										
Netherlands	34,514	34,203	22,749	28,790	25,141	30,123	33,654	21,831	23,640	21,132
Norway			223							
Poland										
Spain	4,509	2,271	7,842	3,340	4,120	4,500	4,063	3,483		
United Kingdom	190,344	127,612	128,836	165,994	127,094	126,620	139,589	131,599	167,246	149,346
Misreported (Area IVa)	-106,987	-51,781	-73,523	-98,255	-59,982	-3,775	-39,024	-43,339	-62,928	-23,139
Misreported (Unknown)										
Unallocated	28,245	10,603	4,577	8,351	21,652	31,564	37,952	27,558	5,587	9,714
Discards	6,991	10,028	16,057	3,277		1,920	1,164	15,191	7,111	7,696
Total	270,212	213,272	196,110	218,599	204,885	297,932	280,553	252,620	233,157	244,432

Table 2.3.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas VI and VII and Divisions VIIIa,b,d,e) 1985–2014. Continued.

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium					1	2				
Denmark			6	10		48	2,889	8	903	18,538
Estonia										
Faroe Islands		59	1,333	3,539	4,421	36	8			3,421
France	15,182	14,625	12,434	14,944	16,464	10,301	11,304	14,448	12,438	16,627
Germany	14,598	14,219	12,831	10,834	17,545	16,493	18,792	14,277	15,102	23,478
Guernsey		10					10	5	9	9
Ireland	30,082	36,539	35,923	33,132	48,155	43,355	45,696	42,627	42,988	56,286
Isle of Man						14	11	11	8	3
Jersey	9	8	6	7	8	6	7	8	8	7
Lithuania		95	7				23			176
Netherlands	18,819	20,064	18,261	17,920	20,900	21,699	18,336	19,794	16,295	16,242
Norway			7	3,948	121	30	2,019	1,101	734	
Poland	461	1,368	978							
Russia						1				
Spain	4,795	4,048	2,772	7,327	8,462	6,532	1,257	773	635	1,796
United Kingdom	115,586	67,187	87,424	76,882[1]	109,147	107,840	111,103	93,775	92,957	137,195
Misreported (Area IVa)	-37,911	-8,719		-17,280	-1,959					
Misreported (Unknown)										
Unallocated	13,412	4,783	10,042	-952	490	4,503	399	16	-144	
Discards	20,359	14,723	10,177	27,351	6,848	7,518	7,153	10,654	2,105	1,742
Total	190,597	169,009	192,201	177,662	230,603	218,377	219,007	197,496	183,857	275,519

Table 2.3.2.4. NE Atlantic Mackerel. ICES estimated catch (t) in Divisions VIIIc and IXa, 1977–2014 (Data submitted by Working Group members).

Country	Div	1977	1978	1979	1980	1981	1982	1983	1984	1985
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
Spain	VIIIc	19,852	18,543	15,013	11,316	12,834	15,621	10,390	13,852	11,810
Spain	IXa	2,935	6,221	6,280	2,719	2,111	2,437	2,224	4,206	2,123
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
Total		27,417	26,508	22,475	15,964	18,053	21,076	14,853	20,308	18,111

Country	Div	1986	1987	1988	1989	1990	1991	1992	1993	1994
France	VIIIc									
Poland	IXa									
Portugal	IXa	6,419	5,714	4,388	3,112	3,819	2,789	3,576	2,015	2,158
Spain	VIIIc	16,533	15,982	16,844	13,446	16,086	16,940	12,043	16,675	21,246
Spain	IXa	1,837	491	3,540	1,763	1,406	1,051	2,427	1,027	1,741
USSR	IXa									
Total	IXa	8,256	6,205	7,928	4,875	5,225	3,840	6,003	3,042	3,899
Total		24,789	22,187	24,772	18,321	21,311	20,780	18,046	19,719	25,045

Country	Div	1995	1996	1997	1998	1999	2000	2001	2002	2003
France	VIIIc									226
Poland	IXa									
Portugal	IXa	2,893	3,023	2,080	2,897	2,002	2,253	3,119	2,934	2,749
Spain	VIIIc	23,631	28,386	35,015	36,174	37,631	30,061	38,205	38,703	17,384
Spain	IXa	1,025	2,714	3,613	5,093	4,164	3,760	1,874	7,938	5,464
Discards	VIIIc									531
Discards	IXa	3,918	5,737	5,693	7,990	6,165	6,013			
Total	IXa	27,549	34,123	40,708	44,164	43,796	36,074	4,993	10,873	8,213
Total								43,198	49,575	26,354

Table 2.3.2.4. NE Atlantic Mackerel. ICES estimated catch (t) in Divisions VIIIc and IXa, 1977–2014 (Data submitted by Working Group members). Continued.

Country	Div	2004	2005	2006	2007	2008	2009	2010	2011	2012
France	VIIIc	177	151	43	55	168	383	392	44	283
Poland	IXa									
Portugal	IXa	2,289	1,509	2,620	2,605	2,381	1,753	2,363	962	824
Spain	VIIIc			43,063	53,401	50,455	91,043	38,858	14,709	17,768
Spain	IXa			7,025	6,773	6,855	14,569	7,347	2,759	845
Discards	VIIIc	928	391	3,606	156	73	725	4,408	563	2,187
Discards	IXa		405	1	916	677	241	232	1,245	1,244
Unallocated	VIIIc	28,429	42,851						4,691	4,144
Unallocated	IXa	3,946	5,107					108	871	1,076
Total	IXa	6,234	7,021	9,646	10,293	9,913	16,562	10,049	5,836	3,989
Total		35,768	50,414	56,358	63,906	60,609	108,713	53,708	25,843	28,372

Country	Div	2013	2014
France	VIIIc	220	171
Poland	IXa		
Portugal	IXa	254	618
Spain	VIIIc	14,617	33,783
Spain	IXa	1,162	2,227
Discards	VIIIc	1,428	2,821
Discards	IXa	1,027	1,463
Unallocated	VIIIc	-573	8,795
Unallocated	IXa	4,053	662
Total	IXa	6,497	4,308
Total		22,188	45,570

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014.

Quarters 1-4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	0.06				1533.43	1.59	27.12	537.37
1	0.16		0.01		4298.41	4.99	271.26	5431.37
2	94.58		0.2	0.12	57026.67	298.33	121.5	5212.05
3	244.24		1.04	0.3	252041.8	1967.08	424.05	6078.78
4	383.49	0.01	0.49	0.42	214346.6	2601.54	437.87	1516.16
5	475.67	0.01	0.22	0.58	122370.6	1228.49	217.96	1208.69
6	188.69		0.11	0.23	136035.4	250.34	12.79	116.91
7	88.21		0.09	0.09	131011.4	343.48	38.33	59.27
8	163.92		0.02	0.19	75885.64	423.91	82.51	596.65
9	14.11		0.03	0.02	30937.96	165.03	31.74	59.27
10	85.28			0.1	10534.06	138.74	45.12	596.65
11	2.02				3985.91	6.57	0.08	59.27
12	10.12			0.01	2128.77	9.71	0.33	59.27
13					141.23	0.13		
14								
15+					10	0.06	0.03	29.64
SOP	636.8194	0.00658	0.671345	0.721308	381253.8	2196.244	472.1608	4893.96
Cth	636.41	0.01	0.67	0.72	380951.4	2167.37	464.81	4903.37
SOP%	100%	152%	100%	100%	100%	99%	98%	100%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	0.1	257.62	314.34	18.72	1.44		19.46	965.73
1	2.86	2579.32	1464.26	442.09	187.03	10.49	127.89	476.61
2	6.83	21946.63	704.51	1279.81	582.9	24.93	403.98	2490.89
3	6.08	31736.16	593.61	1061.13	420.85	38.74	567.17	7294.25
4	3.49	10170.59	83.6	326.22	162.9	50.66	1336.02	15081.61
5	2.12	10952.72	51.39	130.48	55.15	42.93	1352.67	12697.39
6	1.85	13029.7	29.65	73.41	38.1	64.28	2134.9	20066.31
7	2.32	12284.26	55.85	56.64	31.14	51.73	1706.1	18360.91
8	1.06	8438.38	33.34	59.73	16.71	51.38	1752.76	20003.26
9	0.45	4533.75	42.29	25.13	8.3	16.49	530.3	7047
10	0.14	1290.8	17.31	33.04	2.54	8.71	268.85	6240.99
11	0.06	858.31	6.44	9.84	0.26	2.33	75.3	1494.54
12	0.02	151.05	1.66	7.79	1.1	0.78	26.7	177.75
13	0.04	150.67	1.71	5.63	3.78	0.44	8.7	308.29
14								
15+				3.23				
SOP	7.375649	29649.89	485.5511	752.6657	326.3141	114.9209	3356.801	37315.43
Cth	7.37	28913.91	470.47	753.72	326.33	115.18	3357.45	37713.93
SOP%	100%	98%	97%	100%	100%	100%	100%	101%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarters 1-4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			31892.48	0.03	1113.48		21549.07	2919.29	
1	578.26	1362.49	9068.89	54.77	4644.04	0.05	3981.55	4468.52	1195.49
2	433.48	1135.91	1293.55	662.71	2669.86	0.16	708.77	610.23	220.92
3	2100.62	4487.6	1607.14	4697.3	4448.32	3.81	815.24	1467.8	384.83
4	2657.91	4073.91	684.02	12029.59	5848.16	7.39	265.8	703.99	122.45
5	1195.42	5312.25	500.08	20709.44	5681.86	43.54	163.92	667.26	34.26
6	1688.04	7031.22	341.4	25054.47	4946.89	100.71	157.53	711.82	6.46
7	1482.99	8258.39	202.54	20389.49	3990.61	85.67	177.12	593.25	2.67
8	2171.42	5521.96	83.67	10589.2	2754.09	53.19	130.96	441.03	1.09
9	1376.86	2259.54	24.27	4133.38	1665.8	68.76	94.82	251.92	0.09
10	1156	1228.13	2.2	592.08	496.16	52.14	66.93	72.53	
11	496.62	609.01	2.01	514.2	391.54	16.77	4.86	63.14	
12	21.2	25.3	1.06	335.42	314.11	6.01	8.81	51.84	
13	86.62	45.57	0.87	215.31	270.28	3.1	6.49	44.93	
14							2.27		
15+		0.82		15.97	1676.53		0.1		
SOP	4799.296	13586.74	2783.579	31251.91	11204.88	163.2689	2113.651	2524.587	345.4452
Cth	4801.78	13583.6	2821.06	31395.95	11353.05	164.13	2081.53	2548.1	341.11
SOP%	100%	100%	101%	100%	101%	101%	98%	101%	99%

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	Total
0	946.24			0.05		0.03	2.44	62100.11
1	118.71		98.03	6.66	2284.04	0.02	15.21	43173.46
2	13507.26	0.24	10194.55	187.21	3083.02	1.44	12885.2	137788.5
3	191209.9	5.49	60792.48	4895.14	42186.18	9.83	48361.67	669948.7
4	322600.6	7.71	105008	6583.91	72899.96	19.36	49384.69	829399.1
5	197421	2.62	75004.15	1602.57	69102.31	16.3	36263.42	564507.5
6	132755.7	2.68	67670.57	2974.17	95735.57	12.07	38752.82	549984.8
7	130472.5	3.77	40924.36	2808.67	95793.58	7.83	34016.66	503299.8
8	98378.95	2.9	16825.28	1911.96	79056.23	3.85	14102.39	339537.6
9	50449.57	1.05	5298.36	1491.25	30213.11	1.82	601.72	141344.2
10	20789.73	0.27	1334.08	507.51	16170.36	0.93	1882.78	63614.15
11	7473.78	0.15	799.87	118.58	3773.62	0.54	528.63	21294.25
12	1844.45	0.01	180.9	2.58	2475.82	0.22	34.38	7877.2
13	291.13			1.3	843.81	0.11	8.76	2438.94
14	456.32			0.6	241.03	0.06	4.83	705.11
15+	100.59			0.52	274.01	0.04	3.35	2114.9
SOP	433259.3	10.34835	148496.5	8442.193	180333.9	28.26898	97550.83	1398256
Cth	433176.8	10.35	148495	8441.83	180407.9	27.93	94021.42	1394455
SOP%	100%	100%	100%	100%	100%	99%	96%	100%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 1

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1							0.06	15.14
2	0.01				58.12		3.64	946.96
3	0.12			0.01	465.01		3.48	891.88
4	0.24			0.03	959.09	0.01	0.5	115.99
5	0.17			0.03	697.55	0.01	0.17	35.22
6	0.06			0.04	261.66		0.13	30.76
7	0.01			0.04	29.17		0.06	15.62
8				0.03	0.08		0.06	15.62
9				0.01	0.03		0.06	15.62
10				0.01	0.01		0.06	15.62
11							0.06	15.62
12							0.06	15.62
13								
14								
15+							0.03	7.81
SOP	0.23			0.07	912.05	0.01	1.48	371.62
Cth	0.23			0.08	911.26	0.01	1.47	374.01
SOP%	102%			111%	100%	130%	100%	101%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0				0.03	0.01			
1	0.03	1580.29	965.7	9.81	2.62	10.32	79.81	412.86
2	0.12	17723.59	304.49	174.16	9.33	23.89	365.64	2483.34
3	0.11	26421.11	373.37	174.5	8.64	37.29	545.85	7259.91
4	0.05	8894.11	45.54	48.6	4.43	46.39	1331.89	15010.45
5	0.02	10477.89	29.1	17.39	1.69	38.28	1348.2	12327
6	0.01	12595.04	22.39	17.6	1.27	56.78	2128.86	19170.03
7	0.01	11552.74	40.99	13.92	1.15	45.72	1700.2	17573.76
8	0.01	7901.76	31.58	18.48	0.75	45.33	1749.79	19528.41
9		4085.62	31.34	11.69	0.45	14.61	525.73	6473.03
10		1141.94	11.83	9.7	0.15	7.73	265.67	5832.76
11		731.8	6.44	5.6	0.04	2.07	74.45	1351.38
12		131.34	1.66	2.56	0.06	0.68	26.39	129.55
13		131.4	1.71	0.93	0.14	0.41	8.54	277.84
14								
15+				1.2				
SOP	0.07	26667.47	203.35	103.57	6.48	103.48	3321.42	35868.76
Cth	0.08	26067.28	189.04	103.95	6.48	103.74	3322.15	36268.98
SOP%	110%	98%	93%	100%	100%	100%	100%	101%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 1

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							1866.62		
1		55.39	8642.08	1.08	2740.29		2929.46	114.22	3.06
2	165.58	814.94	1233.36	475.54	2153.1	0.12	439.7	38.61	8.5
3	995.45	3553.84	1507.84	3062.36	3101.88	0.75	326.3	110.26	17.62
4	1403.7	3180.97	628.71	6075.16	4040.55	1.08	92.73	148.7	6.37
5	553.68	3834.31	447.45	9517	3244.89	0.82	54.02	99.66	1.77
6	716.49	5003.82	295.12	10952.91	2286.56	1.5	46.64	42.85	0.29
7	637.83	5496.31	165.14	8516.31	1877.6	1.29	45.71	31.8	0.11
8	1080.81	3917.68	60.34	4273.67	1301.78	1.3	34.63	20.19	0.03
9	620.25	1401.16	18.65	1601.04	867.31	1.12	28.37	11.68	0.01
10	531.54	807.47	1.44	218.13	277.65	0.89	9.26	2.24	
11	239.22	354.98	1.33	185	216.73	0.34	4.67	1.91	
12		1.14	0.63	117.92	177.78	0.06	2.35	1.24	
13	41.39	45.57	0.5	72.28	156.49	0.06	0.06	0.8	
14							2.27		
15+					1091.62				
SOP	2172.35	9135.26	1392.90	13631.93	6247.43	3.18	542.39	130.63	6.07
Cth	2172.42	9131.85	1419.59	13696.72	6334.7	3.16	519.72	131.53	6.71
SOP%	100%	100%	102%	100%	101%	99%	96%	101%	110%

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	Total
0								1866.66
1					2150.03			19712.25
2	211.16				2524.43			30158.36
3	1689.31				40230.6			90777.48
4	3484.21				70768.22			116287.7
5	2533.97				67439.07			112699.4
6	950.24				94197.27			148778.3
7	105.58				93596.52			141447.6
8					78121.88			118104.2
9					29854.17			45561.94
10					16024.89			25159
11					3716.1			6907.76
12					2472.78			3081.81
13					843.79			1581.92
14					241.03			243.29
15+					274.01			1374.67
SOP	3312.79				176045.83			280169.51
Cth	3310				176112.2			280187.3
SOP%	100%				100%			100%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 2

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1					0.69			42.49
2	35.61				58.12	169.59	23.21	2652.96
3	96.87		0.01	0.02	856.4	1456.75	191.82	2500.04
4	157.11		0.01	0.03	1119.36	2224.35	260.78	325.42
5	188.95			0.01	371.04	947.92	108.61	98.73
6	75.67				386.11	91.33	8.46	86.14
7	38.38				534.2	234.85	25.21	43.65
8	68.11			0.01	409.87	338.15	34.8	43.65
9	6.41				144.31	136.78	21.17	43.65
10	34.24				37.32	108.35	10.58	43.65
11	0.92				20.16	4.47	0.02	43.65
12	4.03				2.52	6.06	0.01	43.65
13								
14								
15+						0.06	0.01	21.83
SOP	257.56		0.01	0.02	1508.75	1610.85	197.46	1040.51
Cth	257.44		0.01	0.03	1507.97	1584.44	192.52	1047.72
SOP%	100%		200%	148%	100%	98%	97%	101%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0				0.15	0.15			
1	0.55	113.43		39.44	33.99	0.03		0.06
2	1.97	3489.85	0.04	372.95	120.71	0.18	0.06	0.55
3	1.92	4899.16	0.06	347.57	109.78	0.26	0.24	31.28
4	1.1	1172.38	0.03	87.38	54.32	0.75	0.44	65
5	0.57	398.75	0.01	31.33	21.23	0.82	1.93	363.89
6	0.6	369.98	0.03	24.57	16.06	1.32	4.39	885.73
7	0.57	659.02		19.48	14.53	1.06	3.66	778.68
8	0.37	492.77		12.45	7.84	1.06	2.3	466.4
9	0.14	415.96		9.58	5.26	0.34	2.87	571.21
10	0.04	133.09		5.31	1.4	0.18	2.16	406.75
11	0.01	124.89		4.23	0.2	0.05	0.69	142.76
12	0.02	19.14		4.9	0.82	0.02	0.25	48.03
13	0.03	19.14		1.82	1.72	0.01	0.13	30.41
14								
15+				2.03				
SOP	1.87	2392.58	0.04	181.50	81.00	2.03	7.03	1402.60
Cth	1.87	2259.45	0.04	182.18	81.01	2.03	7.06	1402.66
SOP%	100%	94%	91%	100%	100%	100%	100%	100%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers (‘000s) -at-age by area for 2014 (cont.).

Quarter 2

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							2891.92		
1			206.41	19.22	389.41		282.06	98.83	51.37
2	137.63	20.19	15.75	167.67	327.63		98.51	74.04	142.91
3	827.43	292.52	15.41	1575.19	991.41	3.03	269.03	469.77	296.22
4	1166.77	744.4	10.99	5917.54	1742.56	6.29	120.78	404.88	107.16
5	460.22	1412.22	23.47	11156.27	2405.94	42.63	72.75	503.35	29.78
6	595.55	1976.66	28.39	14075.84	2633.52	99.01	92.76	616.42	4.9
7	530.17	2730.51	20.91	11854.05	2094.77	84.2	108.76	527.02	1.76
8	898.38	1588.12	11.67	6300.32	1432.43	51.79	87.14	385.68	0.54
9	515.56	858.38	5.62	2532.34	797.57	67.51	65.38	239.4	0.09
10	441.83	420.66	0.76	373.95	216.66	51.14	57.52	68.58	
11	198.84	254.03	0.68	329.2	174.81	16.4	0.19	61.23	
12		24.16	0.44	217.51	136.34	5.94	6.47	50.6	
13	34.41		0.37	143.03	113.79	3.03	6.43	44.13	
14									
15+		0.78		15.26	584.91				
SOP	1805.68	3871.15	57.48	17538.08	4444.50	159.73	529.52	1059.36	102.10
Cth	1805.74	3873.35	58.56	17616.52	4499.41	160.61	521.09	1067.71	112.85
SOP%	100%	100%	102%	100%	101%	101%	98%	101%	111%

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	Total
0								2892.22
1							0.18	1278.18
2	1690		1558.04	44.97	0.08		451.01	11654.24
3	697.45		5800.5	184.7	101.26		1601.73	23617.81
4	1471.01		9035.19	289.34	110.95		1470.61	28066.92
5	1083.33		4445.1	143.7	11.24		1073.4	25397.21
6	3707.64		2799.77	94.09	19.03		1199.27	29893.25
7	4154.64		1704.97	64.49	30.55		1122.07	27382.17
8	5178.8		520.2	27.04	22.16		463.22	18845.28
9	3909.83		408.73	22.51	9.88		0.39	10790.85
10	2718.71		210.46	12.62	0.56		64.25	5420.79
11	1371.56			4.59	8.2		15.53	2777.32
12	474.27			2.01	0.08		0.01	1047.27
13				1.28	0.02			399.75
14				0.58	0.01			0.59
15+	20			0.52	0.01			645.4
SOP	12661.86		8434.21	286.12	79.74		3106.22	62820.99
Cth	12646.14		8433	286.08	79.75		2971	62658.25
SOP%	100%		100%	100%	100%		96%	100%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 3

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0							21.06	348.83
1	0.04		0.01		6.21	1.55	210.65	3488.32
2	55.17		0.2	0.12	901.65	84.35	75.89	1046.5
3	131.14		1.03	0.26	8319.33	331.85	197.19	1744.16
4	212.88		0.48	0.36	11016.1	243.12	163.51	697.66
5	279.14	0.01	0.22	0.53	5010.93	201.26	96.24	697.66
6	105.91		0.11	0.18	4033.99	74.79	3.81	
7	44.62		0.09	0.05	4905.53	36.97	12.96	
8	92.2		0.01	0.15	4133.15	45.01	41.55	348.83
9	6.06		0.03		1266.93	10.34	10.49	
10	50.62			0.1	645.91	24.44	28.43	348.83
11	0.87				180	0.06		
12	6			0.01	61.51	2.72	0.25	
13								
14								
15+								
SOP	357.20	0.00	0.66	0.62	15380.61	346.28	232.43	2260.11
Cth	357.04	0.01	0.66	0.61	15373.13	344.5	230	2260.09
SOP%	100%	278%	100%	98%	100%	99%	99%	100%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	0.1	1.91	3.48	12.17	0.98		0.52	10.61
1	2.15	6.94	11.72	228.98	115.41	0.05	1.76	35.86
2	4.36	3.27	1.01	386.59	347.45	0.34	0.15	3.53
3	3.68	3.74	0.07	291.65	232.04	0.47	0.04	0.88
4	2.08	10.89		103.53	79.9	1.39	0.06	1.95
5	1.35	11.65		47.44	24.73	1.5	0.4	2.21
6	1.09	18.58		16.15	15.95	2.4	0.94	3.63
7	1.53	14.86		12.02	11.87	1.92	0.8	2.92
8	0.59	15.19		17.48	6.24	1.95	0.49	2.87
9	0.27	4.41		1.99	2	0.58	0.64	1.01
10	0.09	2.19		11.91	0.76	0.29	0.48	0.56
11	0.04	0.56			0.01	0.08	0.16	0.16
12		0.23		0.17	0.17	0.03	0.06	0.06
13	0.01	0.06		1.49	1.47	0.01	0.03	0.02
14								
15+								
SOP	4.88	29.66	2.40	258.50	183.29	3.66	1.82	11.80
Cth	4.89	29.67	2.43	258.52	183.27	3.65	1.83	11.86
SOP%	100%	100%	101%	100%	100%	100%	100%	100%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 3

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			437.22	0.02	244.17		4346.12	623.78	
1		109.69	126.76	8.38	361.13		437.91	1234.86	772.07
2		30.63	34.59	5.66	47.78		106.95	127.97	45.78
3	10.82	87.18	68.52	16.77	77.2	0.01	195.29	161.44	49.68
4	22.47	12.78	35.46	11.3	27.42	0.01	37.83	54.7	7.57
5	152.21	3.73	22.71	11.4	24.91	0.09	31.01	51.63	2.71
6	353.55	3.34	12.42	8.37	23.2	0.2	13.39	46.32	1.27
7	300.67	1.23	11.75	6.13	16.64	0.17	17.12	32.68	0.8
8	184.93	0.47	7.05	5.12	18.31	0.11	6.15	34.19	0.51
9	241.05				0.84	0.14	0.02	0.84	
10	182.63				1.69	0.11	0.04	1.67	
11	58.56					0.03			
12	21.2					0.01			
13	10.82					0.01			
14									
15+				0.26			0.08		
SOP	570.36	58.20	93.49	25.24	153.68	0.33	430.05	399.18	162.26
Cth	573.51	58.12	95.31	25	155.4	0.33	428.05	403.93	151.52
SOP%	101%	100%	102%	99%	101%	100%	100%	101%	93%

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	Total
0	921.45			0.05		0.03	2.44	6974.96
1	81.73		98.03		0.1	0.02	15.03	7355.35
2	7941.62	0.24	8636.51	82.88	4.6	1.44	12434.19	32411.43
3	164373.96	5.43	54991.98	3230.1	10.05	9.83	46759.94	281305.74
4	295130.46	7.44	95972.84	4385.26	14.63	19.36	47914.08	456187.55
5	182166.99	2.29	70559.05	988.21	21.37	16.3	35190.02	295619.88
6	113945	2.58	64870.8	1995.3	7.95	12.07	37553.56	223126.85
7	115995.51	3.69	39219.39	1914.18	3.41	7.83	32894.59	195471.89
8	85999.69	2.83	16305.09	1292.37	6.28	3.85	13639.17	122211.84
9	42593.71	0.99	4889.63	1112.75	0.32	1.82	601.34	50748.19
10	17348.85	0.24	1123.62	409.83	3.79	0.93	1818.53	22006.53
11	5702.56	0.14	799.87	75.2	0.04	0.54	513.1	7331.97
12	1192.72	0.01	180.9	0.05	0.44	0.22	34.37	1501.15
13	289.13			0.02		0.11	8.76	311.93
14	456.32			0.03		0.06	4.83	461.23
15+	80.59					0.04	3.35	84.33
SOP	380517.65	10.00	140060.49	5738.58	26.04	28.27	94441.96	641811.07
Cth	380489.68	10	140062	5738.63	26.02	27.93	91050.42	638353.01
SOP%	100%	100%	100%	100%	100%	99%	96%	99%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	0.06				1533.43	1.59	6.05	188.54
1	0.12				4291.51	3.44	60.55	1885.41
2	3.79				56008.77	44.4	18.75	565.62
3	16.11				242401.1	178.47	31.56	942.71
4	13.26				201252	134.07	13.09	377.08
5	7.41				116291.1	79.3	12.94	377.08
6	7.05				131353.6	84.22	0.39	
7	5.21				125542.5	71.66	0.11	
8	3.6				71342.54	40.76	6.1	188.54
9	1.64				29526.68	17.92	0.01	
10	0.42				9850.82	5.96	6.05	188.54
11	0.23				3785.75	2.04		
12	0.09				2064.74	0.93		
13					141.23	0.13		
14								
15+					10			
SOP	21.83				363449.65	238.98	40.83	1221.57
Cth	21.71				363159	238.4	40.82	1221.56
SOP%	99%				100%	100%	100%	100%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0		255.71	310.86	6.36	0.3		18.94	955.12
1	0.12	878.66	486.84	163.87	35.01	0.08	46.32	27.84
2	0.38	729.92	398.98	346.1	105.41	0.52	38.12	3.46
3	0.38	412.16	220.12	247.41	70.39	0.72	21.04	2.18
4	0.26	93.21	38.03	86.7	24.24	2.13	3.64	4.21
5	0.18	64.44	22.28	34.31	7.49	2.34	2.14	4.29
6	0.15	46.1	7.23	15.09	4.82	3.78	0.71	6.92
7	0.21	57.64	14.85	11.23	3.59	3.03	1.44	5.55
8	0.08	28.65	1.76	11.32	1.88	3.04	0.18	5.58
9	0.03	27.77	10.94	1.86	0.6	0.97	1.06	1.75
10	0.01	13.58	5.47	6.12	0.22	0.51	0.53	0.91
11	0.01	1.06				0.14		0.24
12		0.33		0.16	0.05	0.05		0.1
13		0.08		1.39	0.45	0.02		0.03
14								
15+								
SOP	0.55	558.69	279.80	209.06	55.58	5.77	26.46	32.70
Cth	0.55	557.53	278.95	209.06	55.57	5.77	26.39	30.44
SOP%	100%	100%	100%	100%	100%	100%	100%	93%

Table 2.3.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2014 (cont.).

Quarter 4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			31455.26		869.31		12444.42	2295.51	
1	578.26	1197.41	93.65	26.08	1153.2	0.05	332.13	3020.61	368.99
2	130.27	270.15	9.85	13.83	141.35	0.04	63.61	369.62	23.73
3	266.93	554.06	15.38	42.98	277.83	0.02	24.63	726.33	21.31
4	64.97	135.76	8.86	25.59	37.62		14.46	95.71	1.34
5	29.31	61.98	6.44	24.78	6.12		6.14	12.62	
6	22.45	47.4	5.47	17.35	3.61		4.74	6.22	
7	14.33	30.35	4.73	13.01	1.6		5.53	1.75	
8	7.3	15.68	4.61	10.09	1.56		3.03	0.96	
9					0.07		1.05	0.01	
10					0.15		0.11	0.02	
11									
12									
13									
14									
15+		0.04		0.45			0.02		
SOP	250.53	521.22	1239.91	58.01	359.89	0.02	611.31	935.70	75.07
Cth	250.11	520.29	1247.61	57.72	363.54	0.03	612.67	944.92	70.03
SOP%	100%	100%	101%	99%	101%	128%	100%	101%	93%

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	Total
0	24.79							50366.27
1	36.98			6.65	133.91			14827.69
2	3664.48			59.36	553.91			63564.43
3	24449.18	0.06		1480.34	1844.27			274247.7
4	22514.89	0.27		1909.31	2006.16			228856.8
5	11636.73	0.34		470.67	1630.65			130791.1
6	14152.82	0.1		884.79	1511.32			148186.4
7	10216.72	0.08		830	2163.11			138998.2
8	7200.46	0.07		592.55	905.91			80376.27
9	3946.04	0.06		355.98	348.73			34243.19
10	722.17	0.04		85.07	141.12			11027.82
11	399.65	0.01		38.79	49.28			4277.2
12	177.47			0.52	2.52			2246.96
13	2.01							145.34
14								0
15+								10.51
SOP	36736.27	0.35		2417.21	4189.83			413551.86
Cth	36730.98	0.35		2417.12	4190.03			413251.2
SOP%	100%	99%		100%	100%			100%

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5%.

Quarters 1-4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	0%				0%	0%	2%	2%
1	0%		0%		0%	0%	16%	25%
2	5%		9%	6%	5%	4%	7%	24%
3	14%		47%	15%	24%	26%	25%	28%
4	22%	50%	22%	20%	21%	35%	26%	7%
5	27%	50%	10%	28%	12%	17%	13%	6%
6	11%		5%	11%	13%	3%	1%	1%
7	5%		4%	4%	13%	5%	2%	0%
8	9%		1%	9%	7%	6%	5%	3%
9	1%		1%	1%	3%	2%	2%	0%
10	5%			5%	1%	2%	3%	3%
11	0%				0%	0%	0%	0%
12	1%			0%	0%	0%	0%	0%
13					0%	0%		
14								
15+					0%	0%	0%	0%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	0%	0%	9%	1%	0%		0%	1%
1	10%	2%	43%	13%	12%	3%	1%	0%
2	25%	19%	21%	36%	39%	7%	4%	2%
3	22%	27%	17%	30%	28%	11%	6%	6%
4	13%	9%	2%	9%	11%	14%	13%	13%
5	8%	9%	2%	4%	4%	12%	13%	11%
6	7%	11%	1%	2%	3%	18%	21%	18%
7	8%	10%	2%	2%	2%	14%	17%	16%
8	4%	7%	1%	2%	1%	14%	17%	18%
9	2%	4%	1%	1%	1%	5%	5%	6%
10	1%	1%	1%	1%	0%	2%	3%	6%
11	0%	1%	0%	0%	0%	1%	1%	1%
12	0%	0%	0%	0%	0%	0%	0%	0%
13	0%	0%	0%	0%	0%	0%	0%	0%
14								
15+				0%				

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarters 1-4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			70%	0%	3%		77%	22%	
1	4%	3%	20%	0%	11%	0%	14%	34%	61%
2	3%	3%	3%	1%	7%	0%	3%	5%	11%
3	14%	11%	4%	5%	11%	1%	3%	11%	20%
4	17%	10%	1%	12%	14%	2%	1%	5%	6%
5	8%	13%	1%	21%	14%	10%	1%	5%	2%
6	11%	17%	1%	25%	12%	23%	1%	5%	0%
7	10%	20%	0%	20%	10%	19%	1%	5%	0%
8	14%	13%	0%	11%	7%	12%	0%	3%	0%
9	9%	5%	0%	4%	4%	16%	0%	2%	0%
10	7%	3%	0%	1%	1%	12%	0%	1%	
11	3%	1%	0%	1%	1%	4%	0%	0%	
12	0%	0%	0%	0%	1%	1%	0%	0%	
13	1%	0%	0%	0%	1%	1%	0%	0%	
14							0%		
15+		0%		0%	4%		0%		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	0%			0%		0%	0%	2%
1	0%		0%	0%	0%	0%	0%	1%
2	1%	1%	3%	1%	1%	2%	5%	3%
3	16%	20%	16%	21%	8%	13%	20%	17%
4	28%	29%	27%	29%	14%	26%	21%	21%
5	17%	10%	20%	7%	13%	22%	15%	14%
6	11%	10%	18%	13%	19%	16%	16%	14%
7	11%	14%	11%	12%	19%	11%	14%	13%
8	8%	11%	4%	8%	15%	5%	6%	9%
9	4%	4%	1%	6%	6%	2%	0%	4%
10	2%	1%	0%	2%	3%	1%	1%	2%
11	1%	1%	0%	1%	1%	1%	0%	1%
12	0%	0%	0%	0%	0%	0%	0%	0%
13	0%			0%	0%	0%	0%	0%
14	0%			0%	0%	0%	0%	0%
15+	0%			0%	0%	0%	0%	0%

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 1

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1							1%	1%
2	2%				2%		43%	44%
3	20%			5%	19%		42%	42%
4	39%			15%	39%	50%	6%	5%
5	28%			15%	28%	50%	2%	2%
6	10%			20%	11%		2%	1%
7	2%			20%	1%		1%	1%
8				15%	0%		1%	1%
9				5%	0%		1%	1%
10				5%	0%		1%	1%
11							1%	1%
12							1%	1%
13								
14								
15+							0%	0%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0				0%	0%			
1	8%	2%	52%	2%	9%	3%	1%	0%
2	33%	17%	16%	34%	30%	7%	4%	2%
3	31%	26%	20%	34%	28%	11%	5%	7%
4	14%	9%	2%	10%	14%	14%	13%	14%
5	6%	10%	2%	3%	5%	12%	13%	11%
6	3%	12%	1%	3%	4%	17%	21%	18%
7	3%	11%	2%	3%	4%	14%	17%	16%
8	3%	8%	2%	4%	2%	14%	17%	18%
9		4%	2%	2%	1%	4%	5%	6%
10		1%	1%	2%	0%	2%	3%	5%
11		1%	0%	1%	0%	1%	1%	1%
12		0%	0%	1%	0%	0%	0%	0%
13		0%	0%	0%	0%	0%	0%	0%
14								
15+				0%				

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 1

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXaCN	IXaN	IXaS
0							32%		
1		0%	66%	0%	12%		50%	18%	8%
2	2%	3%	9%	1%	9%	1%	7%	6%	23%
3	14%	12%	12%	7%	13%	8%	6%	18%	47%
4	20%	11%	5%	13%	17%	12%	2%	24%	17%
5	8%	13%	3%	21%	14%	9%	1%	16%	5%
6	10%	18%	2%	24%	10%	16%	1%	7%	1%
7	9%	19%	1%	19%	8%	14%	1%	5%	0%
8	15%	14%	0%	9%	6%	14%	1%	3%	0%
9	9%	5%	0%	4%	4%	12%	0%	2%	
10	8%	3%	0%	0%	1%	10%	0%	0%	
11	3%	1%	0%	0%	1%	4%	0%	0%	
12		0%	0%	0%	1%	1%	0%	0%	
13	1%	0%	0%	0%	1%	1%	0%	0%	
14							0%		
15+					5%				

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0								0%
1					0%			2%
2	2%				1%			3%
3	19%				8%			11%
4	39%				14%			13%
5	28%				13%			13%
6	11%				19%			17%
7	1%				19%			16%
8					16%			14%
9					6%			5%
10					3%			3%
11					1%			1%
12					0%			0%
13					0%			0%
14					0%			0%
15+					0%			0%

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 2

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1					0%			1%
2	5%				1%	3%	3%	44%
3	14%		50%	29%	22%	25%	28%	42%
4	22%		50%	43%	28%	39%	38%	5%
5	27%			14%	9%	17%	16%	2%
6	11%				10%	2%	1%	1%
7	5%				14%	4%	4%	1%
8	10%			14%	10%	6%	5%	1%
9	1%				4%	2%	3%	1%
10	5%				1%	2%	2%	1%
11	0%				1%	0%	0%	1%
12	1%				0%	0%	0%	1%
13								
14								
15+						0%	0%	0%

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0				0%	0%			
1	7%	1%		4%	9%	0%		0%
2	25%	28%	24%	39%	31%	3%	0%	0%
3	24%	40%	35%	36%	28%	4%	1%	1%
4	14%	10%	18%	9%	14%	12%	2%	2%
5	7%	3%	6%	3%	5%	13%	10%	10%
6	8%	3%	18%	3%	4%	22%	23%	23%
7	7%	5%		2%	4%	17%	19%	21%
8	5%	4%		1%	2%	17%	12%	12%
9	2%	3%		1%	1%	6%	15%	15%
10	1%	1%		1%	0%	3%	11%	11%
11	0%	1%		0%	0%	1%	4%	4%
12	0%	0%		1%	0%	0%	1%	1%
13	0%	0%		0%	0%	0%	1%	1%
14								
15+				0%				

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 2

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							70%		
1			61%	0%	3%		7%	3%	8%
2	2%	0%	5%	0%	2%		2%	2%	23%
3	14%	3%	5%	3%	7%	1%	6%	13%	47%
4	20%	7%	3%	11%	12%	1%	3%	11%	17%
5	8%	14%	7%	20%	17%	10%	2%	14%	5%
6	10%	19%	8%	26%	19%	23%	2%	17%	1%
7	9%	26%	6%	22%	15%	20%	3%	15%	0%
8	15%	15%	3%	12%	10%	12%	2%	11%	0%
9	9%	8%	2%	5%	6%	16%	2%	7%	0%
10	8%	4%	0%	1%	2%	12%	1%	2%	
11	3%	2%	0%	1%	1%	4%	0%	2%	
12		0%	0%	0%	1%	1%	0%	1%	
13	1%		0%	0%	1%	1%	0%	1%	
14									
15+		0%		0%	4%				

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0								2%
1							0%	1%
2	6%		6%	5%	0%		6%	6%
3	3%		22%	21%	32%		21%	12%
4	6%		34%	32%	35%		20%	15%
5	4%		17%	16%	4%		14%	13%
6	14%		11%	11%	6%		16%	16%
7	16%		6%	7%	10%		15%	14%
8	20%		2%	3%	7%		6%	10%
9	15%		2%	3%	3%		0%	6%
10	10%		1%	1%	0%		1%	3%
11	5%			1%	3%		0%	1%
12	2%			0%	0%		0%	1%
13				0%	0%			0%
14				0%	0%			0%
15+	0%			0%	0%			0%

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 3

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0							2%	4%
1	0%		0%	0%	0%	0%	24%	40%
2	6%		9%	7%	2%	8%	9%	12%
3	13%		47%	15%	21%	31%	23%	20%
4	22%		22%	20%	27%	23%	19%	8%
5	28%	100%	10%	30%	12%	19%	11%	8%
6	11%		5%	10%	10%	7%	0%	
7	5%		4%	3%	12%	3%	2%	
8	9%		0%	9%	10%	4%	5%	4%
9	1%		1%		3%	1%	1%	
10	5%			6%	2%	2%	3%	4%
11	0%				0%	0%		
12	1%			1%	0%	0%	0%	
13								
14								
15+								

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	1%	2%	21%	1%	0%		8%	16%
1	12%	7%	72%	20%	14%	0%	27%	54%
2	25%	3%	6%	34%	41%	3%	2%	5%
3	21%	4%	0%	26%	28%	4%	1%	1%
4	12%	12%		9%	10%	13%	1%	3%
5	8%	12%		4%	3%	14%	6%	3%
6	6%	20%		1%	2%	22%	14%	5%
7	9%	16%		1%	1%	17%	12%	4%
8	3%	16%		2%	1%	18%	8%	4%
9	2%	5%		0%	0%	5%	10%	2%
10	1%	2%		1%	0%	3%	7%	1%
11	0%	1%			0%	1%	2%	0%
12		0%		0%	0%	0%	1%	0%
13	0%	0%		0%	0%	0%	0%	0%
14								
15+								

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 3

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			58%	0%	29%		84%	26%	
1		44%	17%	11%	43%		8%	52%	88%
2		12%	5%	8%	6%		2%	5%	5%
3	1%	35%	9%	23%	9%	1%	4%	7%	6%
4	1%	5%	5%	15%	3%	1%	1%	2%	1%
5	10%	1%	3%	16%	3%	10%	1%	2%	0%
6	23%	1%	2%	11%	3%	22%	0%	2%	0%
7	20%	0%	2%	8%	2%	19%	0%	1%	0%
8	12%	0%	1%	7%	2%	12%	0%	1%	0%
9	16%				0%	16%	0%	0%	
10	12%				0%	12%	0%	0%	
11	4%					3%			
12	1%					1%			
13	1%					1%			
14									
15+				0%			0%		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	0%			0%		0%	0%	0%
1	0%		0%		0%	0%	0%	0%
2	1%	1%	2%	1%	6%	2%	5%	2%
3	16%	21%	15%	21%	14%	13%	20%	17%
4	29%	29%	27%	28%	20%	26%	21%	27%
5	18%	9%	20%	6%	29%	22%	15%	17%
6	11%	10%	18%	13%	11%	16%	16%	13%
7	11%	14%	11%	12%	5%	11%	14%	11%
8	8%	11%	5%	8%	9%	5%	6%	7%
9	4%	4%	1%	7%	0%	2%	0%	3%
10	2%	1%	0%	3%	5%	1%	1%	1%
11	1%	1%	0%	0%	0%	1%	0%	0%
12	0%	0%	0%	0%	1%	0%	0%	0%
13	0%			0%		0%	0%	0%
14	0%			0%		0%	0%	0%
15+	0%					0%	0%	0%

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	0%				0%	0%	4%	4%
1	0%				0%	1%	39%	40%
2	6%				6%	7%	12%	12%
3	27%				24%	27%	20%	20%
4	22%				20%	20%	8%	8%
5	13%				12%	12%	8%	8%
6	12%				13%	13%	0%	
7	9%				13%	11%	0%	
8	6%				7%	6%	4%	4%
9	3%				3%	3%	0%	
10	1%				1%	1%	4%	4%
11	0%				0%	0%		
12	0%				0%	0%		
13					0%	0%		
14								
15+					0%			

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0		10%	20%	1%	0%		14%	94%
1	7%	34%	32%	18%	14%	0%	35%	3%
2	21%	28%	26%	37%	41%	3%	28%	0%
3	21%	16%	15%	27%	28%	4%	16%	0%
4	14%	4%	3%	9%	10%	12%	3%	0%
5	10%	2%	1%	4%	3%	14%	2%	0%
6	8%	2%	0%	2%	2%	22%	1%	1%
7	12%	2%	1%	1%	1%	17%	1%	1%
8	4%	1%	0%	1%	1%	18%	0%	1%
9	2%	1%	1%	0%	0%	6%	1%	0%
10	1%	1%	0%	1%	0%	3%	0%	0%
11	1%	0%				1%		0%
12		0%		0%	0%	0%		0%
13		0%		0%	0%	0%		0%
14								
15+								

Table 2.3.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2014. Zeros represent values <0.5% (cont.).

Quarter 4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			100%		35%		96%	35%	
1	52%	52%	0%	15%	46%	45%	3%	46%	89%
2	12%	12%	0%	8%	6%	36%	0%	6%	6%
3	24%	24%	0%	25%	11%	18%	0%	11%	5%
4	6%	6%	0%	15%	2%		0%	1%	0%
5	3%	3%	0%	14%	0%		0%	0%	
6	2%	2%	0%	10%	0%		0%	0%	
7	1%	1%	0%	7%	0%		0%	0%	
8	1%	1%	0%	6%	0%		0%	0%	
9					0%		0%	0%	
10					0%		0%	0%	
11									
12									
13									
14									
15+		0%		0%			0%		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	0%							4%
1	0%			0%	1%			1%
2	4%			1%	5%			5%
3	25%	6%		22%	16%			23%
4	23%	26%		28%	18%			19%
5	12%	33%		7%	14%			11%
6	14%	10%		13%	13%			13%
7	10%	8%		12%	19%			12%
8	7%	7%		9%	8%			7%
9	4%	6%		5%	3%			3%
10	1%	4%		1%	1%			1%
11	0%	1%		1%	0%			0%
12	0%			0%	0%			0%
13	0%							0%
14								
15+								0%

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014.

Quarters 1-4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	197				196	197	245	245
1	297		267		296	287	288	287
2	324		302	321	317	301	305	288
3	316		313	313	323	309	311	305
4	328	325	325	326	336	323	325	316
5	345	344	339	344	352	343	352	370
6	359		362	359	361	363	374	345
7	369		357	369	368	361	352	405
8	369		367	370	373	380	380	376
9	377		367	378	379	376	375	380
10	368			369	388	392	383	368
11	389				396	397	408	415
12	405			405	404	404	405	405
13					405	405		
14								
15+					415	442	465	465

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	194	163	157	243	225		161	152
1	277	231	222	274	267	194	236	212
2	285	262	286	280	280	266	258	263
3	302	286	297	297	295	303	302	303
4	323	323	325	313	313	322	323	328
5	337	352	348	337	321	346	345	347
6	350	356	341	337	333	357	357	356
7	363	367	365	355	345	364	364	364
8	367	378	380	366	346	370	370	371
9	375	387	379	373	364	382	382	382
10	382	398	387	376	361	390	389	377
11	414	367	354	410	406	398	403	402
12	386	415	415	402	385	402	401	397
13	334	415	415	342	335	406	405	405
14								
15+				465				

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarters 1-4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			187	245	186		235	186	
1	301	300	212	290	264	294	226	284	285
2	297	293	276	301	280	294	289	305	283
3	303	306	293	317	303	313	316	313	296
4	326	335	325	336	325	334	344	326	311
5	356	356	340	351	342	352	364	349	326
6	357	362	352	361	361	362	385	363	344
7	368	370	357	369	372	366	386	373	346
8	380	374	366	375	379	375	391	381	355
9	383	389	376	386	396	388	401	397	352
10	390	396	396	398	415	399	412	414	
11	402	410	394	395	413	406	420	413	
12	385	435	403	402	419	385	408	418	
13	405	405	408	413	425	405	409	424	
14							423		
15+		446		454	483		443		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	217			217		217	217	204
1	256		280	303	195	275	245	253
2	307	301	316	296	290	317	293	300
3	317	318	318	306	303	317	327	317
4	325	331	331	321	327	328	345	330
5	330	340	353	337	347	344	358	344
6	348	352	361	346	355	358	368	357
7	357	361	368	353	363	364	377	365
8	366	369	376	358	370	370	389	371
9	370	375	384	373	379	372	382	377
10	373	381	387	370	383	370	410	382
11	386	388	390	361	395	380	401	392
12	395	397	430	383	394	390	410	400
13	405			387	409	401	401	410
14	396			380	420	392	392	404
15+	427			400	422	413	413	471

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 1

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1							215	215
2	315				315	315	276	276
3	324			309	324		295	295
4	354			330	354	354	312	308
5	363			348	362	363	335	329
6	381			355	381		348	345
7	400			364	400		405	405
8				372	372		385	385
9				381	381		380	380
10				388	388		400	400
11							415	415
12							405	405
13								
14								
15+							465	465

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0				225	225			
1	268	197	185	256	268	194	202	202
2	283	260	260	277	283	267	253	263
3	299	285	289	296	299	303	302	303
4	319	323	314	317	320	322	323	328
5	323	352	342	339	325	346	345	347
6	332	357	335	349	335	357	357	355
7	349	367	367	371	351	364	364	364
8	345	378	380	378	354	370	370	371
9	365	388	386	380	369	382	382	382
10		398	397	390	372	390	389	376
11		365	354	407	401	398	403	401
12		415	415	404	385	402	401	401
13		415	415	377	338	406	405	405
14								
15+				465				

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 1

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							288		
1		264	210	255	254		212	250	256
2	289	284	274	295	277	289	277	281	279
3	299	301	290	310	300	306	300	300	293
4	326	333	323	334	323	329	334	323	310
5	356	355	338	350	339	354	367	334	324
6	356	361	351	360	360	359	381	355	342
7	368	368	355	368	372	367	384	371	341
8	380	373	363	373	380	378	387	380	351
9	382	383	370	384	398	385	401	392	352
10	388	391	392	397	416	394	408	399	
11	401	404	390	393	415	404	421	398	
12		435	402	399	420	385	413	402	
13	405	405	408	411	426	405	408	412	
14							423		
15+					483				

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0								288
1					189			212
2	315				285			267
3	324				302			298
4	354				327			328
5	363				347			348
6	381				355			356
7	400				363			364
8					370			371
9					379			381
10					383			383
11					395			394
12					394			397
13					409			410
14					420			420
15+					422			470

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 2

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1					265			215
2	324				302	292	283	276
3	316		307	308	318	306	308	295
4	328		323	323	332	322	326	308
5	344			342	344	341	346	328
6	358				354	361	381	345
7	367				361	357	352	405
8	369			379	369	382	383	385
9	376				376	376	375	380
10	368				383	396	415	400
11	389				389	397	385	415
12	405				393	404	411	405
13								
14								
15+						442	465	465

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	225			225	225			
1	268	220		263	268	210	210	210
2	283	260	285	278	283	250	304	278
3	299	290	309	296	299	303	320	315
4	320	316	332	315	319	324	333	335
5	335	341	336	325	324	345	352	351
6	348	340	335	338	334	357	361	362
7	361	365		362	351	364	366	367
8	367	378		360	347	370	375	373
9	375	383		373	368	382	388	388
10	376	397		391	370	390	399	400
11	396	379		414	406	404	406	406
12	386	415		402	385	398	385	387
13	334	415		337	336	405	405	405
14								
15+				465				

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 2

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							288		
1			223	257	253		226	249	256
2	289	319	269	316	283		298	292	279
3	299	330	299	328	306	315	317	302	293
4	326	346	338	338	329	335	344	324	310
5	356	358	353	352	347	352	360	349	324
6	356	365	359	361	361	362	391	363	342
7	368	375	368	370	371	366	387	373	341
8	380	376	375	376	377	375	391	380	351
9	382	397	393	387	393	388	401	397	352
10	388	407	402	400	413	400	413	414	
11	401	418	401	397	411	406	391	413	
12		435	404	403	417	385	406	418	
13	405		408	413	424	405	409	424	
14									
15+		446		455	482				

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0								288
1					280	280	170	239
2	307		308	308	284	318	291	283
3	313		308	308	299	319	328	305
4	320		320	320	317	332	348	327
5	329		346	343	338	354	359	349
6	361		353	351	349	361	369	361
7	372		368	363	359	368	379	370
8	380		358	357	371	376	391	377
9	388		370	368	363	385	385	388
10	394		390	378	388	386	413	397
11	402			378	416	390	405	403
12	408			375	398	430	430	408
13				387	413			415
14				380	421			380
15+	442			400	432			480

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 3

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0							245	245
1	305		265	265	276	270	288	288
2	324		302	322	313	310	310	315
3	316		313	314	318	314	312	317
4	327		325	325	332	327	322	320
5	344	344	339	344	344	345	356	375
6	359	360	362	360	355	362	360	
7	369	378	357	375	362	364	352	
8	369	369	365	369	369	370	378	375
9	376		366		376	369	375	
10	368	367		367	375	371	374	365
11	389				389	389		
12	405	405		405	400	405	405	
13								
14								
15+								

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	193	195	195	243	225		195	195
1	280	274	278	277	267	210	278	277
2	287	255	281	282	279	248	281	277
3	303	302	296	298	294	302	310	301
4	324	324		311	309	324	335	324
5	338	345		345	319	345	352	345
6	351	357		331	331	357	362	358
7	364	364		340	340	364	366	364
8	368	369		363	343	370	375	370
9	375	382		353	353	382	388	383
10	384	388		364	347	389	400	392
11	420	403			406	403	406	404
12	385	401		385	385	400	385	396
13	335	405		335	335	405	405	405
14								
15+								

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 3

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			167	245	190		255	190	
1		311	298	308	286		285	283	287
2		321	320	336	305		324	297	295
3	315	327	333	339	321	315	338	318	313
4	335	330	351	358	357	335	363	356	333
5	352	346	360	365	374	352	365	373	355
6	362	344	359	367	377	362	361	376	355
7	366	356	359	368	379	366	378	379	360
8	375	370	368	377	389	375	394	387	359
9	388				415	388	415	415	
10	400				415	400	415	415	
11	406					406			
12	385					385			
13	405					405			
14									
15+				435			448		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	217			217		217	217	236
1	242		280		283	275	246	286
2	303	301	318	290	322	317	293	303
3	316	318	319	306	315	317	327	318
4	324	332	332	321	326	328	345	328
5	328	343	354	336	344	344	358	338
6	346	353	361	346	359	358	367	354
7	356	361	368	353	371	364	377	362
8	365	369	376	359	369	370	389	369
9	368	376	385	373	377	372	382	371
10	369	383	386	370	368	370	410	374
11	382	389	390	360	420	380	401	384
12	390	400	430	386	405	390	410	395
13	405			405		401	401	404
14	396			396		392	392	396
15+	423	429		417		413	413	422

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	197				196	197	245	245
1	294				296	294	288	288
2	319				317	318	315	315
3	324				323	325	317	317
4	340				336	338	323	320
5	357				352	355	375	375
6	362				361	364	376	
7	370				369	371	390	
8	374				373	376	375	375
9	382				379	383	415	
10	387				388	398	365	365
11	391				396	399		
12	395				404	402		
13	405				405	405		
14								
15+	415				415	415		

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0		163	157	242	225		160	152
1	269	294	293	274	267	210	293	274
2	283	306	306	280	279	248	306	278
3	304	311	311	297	294	302	311	303
4	324	335	339	310	309	324	338	323
5	339	351	355	337	319	345	355	345
6	352	358	361	331	331	357	361	357
7	364	361	357	340	340	364	357	364
8	369	370	375	358	343	370	375	370
9	377	366	360	353	353	382	361	382
10	387	371	365	363	345	390	366	390
11	420	407			406	404	406	404
12	385	401		385	385	398	385	399
13	335	405		335	335	405	405	405
14								
15+								

Table 2.4.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2014 (cont.).

Quarter 4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			188	245	184	189	209	184	
1	301	301	276	310	286	294	264	286	287
2	316	316	310	330	313	306	302	313	290
3	328	329	331	336	320	311	335	320	304
4	338	338	360	358	325		356	323	305
5	354	355	372	365	343		382	334	
6	353	354	374	367	354		391	341	
7	357	358	378	369	370		409	354	
8	363	364	389	376	391		415	391	
9					415		413	415	
10					415		415	415	
11									
12									
13									
14									
15+		435		435			425		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	197				197			192
1	285			303	290			291
2	315			295	313			317
3	323	303		307	318			323
4	333	311		321	331			336
5	352	319		336	342			352
6	355	334		346	356			360
7	364	347		353	367			368
8	368	358		358	372			373
9	373	362		373	379			378
10	379	366		368	394			387
11	388	376		360	420			396
12	397			415	415			403
13	405				405			404
14								396
15+								416

Table 2.4.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet, 2014. Zeros represent values <0.5%. ***Handline Fleets/ Purse Seiners***

	UKE lines							NO PS						DK PS	
	VIIe				VIIf			IIa			IVa			IIa/IVa	
	Q1	Q2	Q3	Q4	Q2	Q3	Q4	Q2	Q3	Q4	Q2	Q3	Q4	Q1	Q4
15															
16															
17															
18															
19															
20							0%								
21				0%	0%	0%	0%								
22				0%	0%	0%	0%								
23				0%	0%	0%	0%								
24		0%	1%	1%	1%	0%									
25	2%	1%	9%	5%	3%	7%	0%								
26	7%	2%	22%	21%	7%	18%	2%								
27	10%	9%	28%	22%	13%	12%	6%								
28	14%	12%	17%	21%	12%	16%	10%			0%			0%		
29	8%	28%	10%	14%	17%	20%	19%	0%	0%	0%	0%	0%	0%	1%	
30	10%	14%	6%	5%	14%	10%	21%	5%	1%	0%	5%	1%	1%	5%	1%
31	6%	11%	4%	2%	10%	6%	14%	2%	19%	19%	2%	19%	19%	1%	9%
32	11%	8%	1%	1%	7%	3%	8%	1%	9%	11%	1%	9%	11%	4%	13%
33	5%	5%		2%	5%	3%	7%	1%	23%	21%	1%	23%	21%	9%	14%
34	9%	3%		2%	5%	2%	5%	2%	9%	9%	2%	9%	9%	9%	10%
35	5%	2%		2%	3%	1%	3%	5%	13%	16%	5%	13%	16%	16%	11%
36	7%	2%	1%	1%	1%	0%	1%	15%	18%	15%	15%	18%	15%	21%	16%
37	3%	1%		1%	1%	0%	1%	22%	7%	6%	22%	7%	6%	22%	14%
38		0%		0%	0%	0%	0%	23%	1%	2%	23%	1%	2%	5%	7%
39	1%	0%		0%	0%		0%	16%	0%	0%	16%	0%	0%	4%	3%
40	1%	0%			0%	0%	0%	6%			6%		0%	1%	1%
41		0%			0%			1%			1%		0%	1%	1%
42					0%				0%						0%
43	1%								0%						0%
44								0%							0%
45															
46															
47															

Table 2.4.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet, 2014. Zeros represent values <0.5% (cont.). ***Southern Fleets***

	ES Purse Seine				ES Trawl				ES Artisanal				PT All			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
15				1%												
16				4%												
17			2%	10%												
18			9%	8%												
19			6%	3%												
20			2%	2%												
21			0%	2%	0%											
22		0%	0%	1%	0%											
23	0%	0%	0%	0%	0%									1%		
24	0%	1%	1%	0%	0%		1%									
25	1%	1%	2%	0%	0%		8%						0%			
26	0%	1%	8%	3%	2%	1%	19%	1%					2%			
27	0%	1%	13%	18%	4%	0%	15%	6%		0%			5%		1%	13%
28	0%	3%	14%	16%	4%	2%	16%	12%	0%	0%	1%		9%	1%	10%	15%
29	0%	3%	17%	4%	2%	2%	10%	10%	0%	0%	4%		9%	2%	10%	15%
30	2%	3%	12%	8%	4%	4%	6%	13%	1%	1%	13%	13%	9%	8%	10%	12%
31	4%	4%	5%	10%	7%	3%	4%	11%	4%	1%	11%	11%	8%	8%	10%	10%
32	9%	6%	2%	6%	12%	8%	3%	13%	4%	3%	23%	23%	5%	8%	10%	9%
33	10%	9%	1%	2%	10%	11%	3%	12%	8%	6%	21%	21%	2%	8%	10%	7%
34	18%	14%	0%	0%	8%	10%	2%	3%	15%	13%	15%	15%	3%	5%	10%	3%
35	23%	20%	1%	0%	12%	8%	2%	0%	20%	20%	9%	9%	4%	5%	10%	1%
36	17%	19%	1%	0%	11%	17%	4%	9%	18%	20%	2%		7%	7%	4%	3%
37	9%	10%	2%	0%	10%	10%	4%	3%	13%	14%			9%	8%	6%	1%
38	5%	5%	2%	0%	3%	8%	2%	5%	8%	10%			8%	8%	7%	
39	2%	1%	1%	0%	2%	3%	1%	1%	5%	6%			7%	9%		2%
40	0%	1%	0%	0%	2%	3%	1%		2%	4%			4%	14%	1%	2%
41	0%	0%	0%		2%	3%	0%		1%	2%			5%	8%		3%
42	0%	0%			1%	2%			0%	1%			2%	2%		1%
43					1%	2%			0%	0%			1%	1%		1%
44		0%			0%	0%								1%		1%
45					1%	1%				0%						
46					0%	0%										
47					1%	1%										

49		
50	1%	1%
52	0%	0%

Table 2.4.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet, 2014. Zeros represent values <0.5% (cont.). ***Pelagic Trawl Fleets***

	FO		IS			GL	IE		UKS				
						XIVb			VIa	VIIb	IVa		VIIj
	Q3	Q4	Q2	Q3	Q4	Q3	Q1	Q4	Q1	Q1	Q3	Q4	Q1
15													
16													
17						0%							
18							0%						
19							0%	0%					
20							0%	0%					
21	0%						0%						
22							0%						
23							0%						
24							0%		0%				
25						0%	0%		0%				
26						0%	0%		0%			0%	
27		0%				0%	0%	0%	0%			0%	
28			1%	0%		0%	1%	0%	1%			0%	
29	1%	0%	3%	1%		1%	2%		2%	0%		1%	
30	6%	3%	12%	4%	9%	2%	3%	1%	3%	2%	1%	4%	
31	14%	9%	18%	9%	12%	5%	4%	8%	4%	3%	16%	12%	1%
32	19%	19%	19%	13%	30%	9%	4%	16%	5%	5%	19%	16%	3%
33	18%	11%	10%	12%	12%	10%	6%	17%	9%	8%	12%	13%	10%
34	9%	11%	7%	10%	6%	9%	10%	11%	16%	20%	10%	10%	18%
35	13%	11%	11%	13%	15%	9%	18%	10%	21%	20%	17%	12%	26%
36	10%	16%	8%	16%	9%	11%	20%	14%	18%	20%	16%	14%	21%
37	5%	11%	6%	12%	6%	14%	15%	13%	10%	12%	6%	9%	11%
38	4%	4%	3%	6%		12%	8%	7%	6%	7%	2%	4%	8%
39	1%	2%	1%	3%		8%	4%	3%	3%	1%		2%	2%
40	1%	0%	0%	1%		4%	2%	1%	1%	1%	1%	1%	1%
41		1%	0%	0%		3%	1%	0%	1%	1%		0%	0%
42		0%		0%		2%	1%		0%			0%	0%
43				0%		1%	0%	0%	0%				
44				0%		0%	0%					0%	
45													
46													
47													

Table 2.4.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet, 2014. Zeros represent values <0.5% (cont.). ***Freezer Trawlers***

	DE				NL				UKE				RU	
	IVa	VIa	VIIb										IIa	
	Q4	Q1	Q1	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q2	Q3
15														
16														
17				0%										
18				2%										
19				1%										
20			0%	0%										0%
21			0%	0%	0%									0%
22			1%											0%
23			4%		0%									0%
24		0%	11%		0%				3%			2%		0%
25		0%	17%	1%	0%				9%					
26		1%	34%	4%	1%		1%		32%	1%	2%			
27		2%	12%	5%	2%	0%			77%			6%	0%	0%
28	0%	5%	12%	12%	5%	7%	1%		53%		8%	3%	1%	0%
29	2%	7%	3%	24%	5%	4%	5%		35%	3%	25%	3%	5%	3%
30	17%	8%	1%	25%	6%	7%	11%	2%	20%	4%	17%	6%	17%	10%
31	18%	7%	1%	11%	6%	33%	22%	2%	7%	6%	10%	7%	22%	18%
32	18%	6%	1%	4%	8%	13%	27%	15%	6%	6%	7%	9%	18%	19%
33	10%	7%	1%	3%	6%	10%	15%	17%	9%	2%	5%	4%	12%	14%
34	6%	12%	0%	3%	7%	2%	5%	3%	7%	7%	1%	5%	6%	8%
35	6%	15%		3%	10%	5%	5%	14%	5%	3%	1%	2%	6%	9%
36	6%	14%		1%	15%	5%	4%	24%	4%	11%	0%	7%	6%	9%
37	5%	7%		1%	14%	2%	3%	14%	1%	7%		6%	4%	6%
38	5%	4%			8%	2%	1%	6%	4%	4%		1%	1%	3%
39	2%	2%			4%	6%		2%	4%	2%		1%	0%	1%
40	3%	1%			2%	2%		1%	2%	2%		3%	0%	0%
41		0%			1%	1%			1%	2%		1%	0%	0%
42	1%	0%			1%	1%	1%		1%	0%			0%	0%
43	0%	0%			0%	0%							0%	0%
44		0%							1%					0%
45													0%	0%
46									1%					
47														

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014.

Quarters 1-4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0				54	55	114		114
1		145		216	188	186		184
2		250	287	269	241	233		169
3		278	265	291	241	243		206
4	298	303	295	333	265	277	298	270
5	360	345	357	382	321	360	360	458
6		429	405	414	423	453		323
7		420	432	442	379	334		541
8		415	445	462	437	446		495
9		438	438	490	411	383		409
10			448	526	480	439		414
11				563	580	591		635
12			609	597	613	608		591
13				585	585	463		
14								
15+				653	809	939		939

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	52	29	25	113	100		25	19
1	175	98	90	173	167	50	105	64
2	195	118	177	176	190	146	122	123
3	230	161	189	204	221	225	201	197
4	285	245	262	255	260	260	249	257
5	329	331	328	331	276	319	307	313
6	368	347	304	312	304	350	343	340
7	419	373	359	366	338	372	365	368
8	430	410	401	406	337	392	385	387
9	460	432	408	393	378	442	426	418
10	493	457	436	416	366	479	450	395
11	651	365	316	566	500	514	501	461
12	438	497	499	566	443	512	500	490
13	298	463	470	334	310	589	518	516
14								
15+				939				

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarters 1-4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			38	107	44		47	44	
1	193	192	60	185	127	194	78	171	175
2	175	176	144	188	144	171	182	213	155
3	190	203	177	216	182	214	248	223	174
4	238	267	253	255	224	280	323	236	198
5	326	325	297	291	263	305	385	285	231
6	328	344	334	317	309	336	447	322	279
7	355	370	351	340	340	345	450	349	292
8	382	377	383	357	360	378	464	373	324
9	400	428	418	393	413	413	499	415	287
10	396	441	498	432	479	433	526	476	
11	445	493	490	422	472	512	636	470	
12	449	613	531	443	493	449	523	489	
13	507	516	553	481	515	446	506	510	
14							654		
15+		603		639	765		736		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	88			89		89	89	43
1	149		215	226	51	202	223	127
2	266	260	299	243	188	305	279	232
3	304	306	305	277	213	305	327	282
4	328	346	342	318	275	332	379	324
5	349	376	409	368	331	379	424	362
6	402	416	434	404	354	425	460	395
7	436	449	459	430	383	446	488	422
8	468	479	487	452	409	468	549	444
9	485	505	516	519	444	468	510	468
10	497	526	524	501	463	463	637	482
11	550	558	541	454	507	499	629	523
12	570	569	708	435	508	527	617	549
13	639			410	567	590	590	545
14	570			423	642	537	537	595
15+	747			517	639	669	669	749

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 1

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1							56	56
2	245				245		133	133
3	275			227	275		165	164
4	365			281	365	365	217	203
5	402			333	402	402	285	257
6	471			355	471		335	323
7	543			383	542		541	541
8				413	413		436	436
9				448	448		409	409
10				476	476		500	500
11							635	635
12							591	591
13								
14								
15+							939	939

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0				85	85			
1	145	47	36	124	145	50	52	51
2	170	115	115	139	170	148	112	123
3	199	159	161	170	199	225	200	197
4	246	248	216	226	245	260	249	257
5	252	333	292	286	256	321	307	313
6	273	349	275	315	278	351	343	340
7	321	375	351	382	325	373	365	369
8	305	412	398	383	325	393	385	388
9		435	413	397	370	444	426	419
10		459	447	415	357	483	451	392
11		358	316	521	436	514	501	456
12		497	499	580	424	515	501	501
13		463	470	420	291	596	519	524
14								
15+				939				

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 1

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							57		
1		127	57	113	103		59	99	107
2	153	156	141	176	136	153	148	142	138
3	180	190	172	203	173	195	199	175	162
4	236	260	247	249	220	255	294	218	192
5	329	324	290	287	254	317	402	242	221
6	326	340	329	313	307	331	457	294	261
7	358	364	344	336	341	352	469	338	259
8	383	374	369	353	365	380	481	365	285
9	398	409	397	388	420	405	542	400	287
10	390	410	483	429	483	411	576	424	
11	436	457	474	418	478	475	642	418	
12		614	527	439	498	449	600	432	
13	516	516	553	480	517	487	553	468	
14							654		
15+					766				

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0								57
1					41			60
2	245				170			127
3	275				210			192
4	365				274			269
5	402				331			324
6	471				353			348
7	543				381			375
8					408			401
9					443			435
10					462			442
11					505			472
12					508			505
13					567			539
14					642			642
15+					639			742

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 2

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0								
1					140			56
2	294				256	222	199	133
3	280		234	237	304	228	238	164
4	313		265	269	346	256	277	203
5	362			323	382	307	322	256
6	417				419	423	471	322
7	464				450	349	332	541
8	460			427	478	432	416	436
9	508				506	398	383	409
10	450				527	483	495	500
11	560				560	589	448	635
12	615				583	615	534	591
13								
14								
15+						811	939	939

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	85			85	85			
1	145	65		136	145	59		59
2	170	114	186	145	170	108	217	164
3	199	164	236	176	199	206	237	219
4	248	218	315	231	246	251	277	284
5	285	287	323	254	253	306	305	304
6	322	281	326	292	278	343	335	335
7	361	344		369	323	364	346	352
8	379	384		353	311	384	378	376
9	405	406		386	370	426	413	412
10	414	443		465	363	451	434	434
11	483	404		626	513	512	513	510
12	430	497		562	426	491	450	460
13	278	463		283	281	495	445	445
14								
15+				939				

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 2

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0							57		
1			70	116	102		73	98	107
2	153	223	131	211	145		203	159	138
3	180	252	190	238	184	218	248	178	162
4	236	296	290	261	233	284	313	221	192
5	329	328	338	295	274	305	355	279	221
6	326	352	357	319	310	336	447	315	261
7	358	382	387	342	338	345	434	344	259
8	383	385	413	360	354	378	447	365	285
9	398	461	486	395	405	413	478	415	287
10	390	499	528	434	472	433	518	475	
11	436	543	520	425	464	513	478	472	
12		613	536	445	487	449	495	491	
13	516		553	482	513	445	505	511	
14									
15+		599		637	765				

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0								57
1							246	88
2	272		265	264	175		277	177
3	296		265	266	192		329	224
4	308		293	292	224		389	279
5	340		357	346	281		429	316
6	442		378	376	307		466	350
7	481		419	407	330		492	382
8	517		391	392	352		558	418
9	547		425	426	380		523	461
10	577		485	442	476		666	518
11	608			383	537		659	541
12	635			382	521		708	553
13				407	598			491
14				417	635			419
15+	811			517	677			769

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 3

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0							114	114
1	227		140		164	151	186	186
2	295		250	290	277	266	244	250
3	277		278	269	302	274	248	258
4	311		304	299	342	307	275	298
5	362	360	345	360	376	360	387	483
6	417		429	417	419	427	416	
7	470		421	480	451	438	335	
8	458		412	453	476	448	463	502
9	509		438		507	441	383	
10	449			446	487	450	425	405
11	560				560	560		
12	615			616	604	616	616	
13								
14								
15+								114

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0	50	51	51	113	102		44	44
1	183	166	173	179	172	59	147	147
2	207	120	181	201	196	105	154	147
3	245	204	214	235	230	204	208	198
4	303	251		274	268	251	284	251
5	347	306		382	293	306	305	306
6	391	344		326	326	344	336	343
7	439	365		353	353	365	345	363
8	458	384		452	363	384	378	384
9	485	427		396	396	427	413	424
10	520	454		403	371	453	433	448
11	704	511			513	511	513	512
12		500		512	511	498	449	483
13	338	517		338	338	511	445	480
14				113	102		44	44
15+	50	51	51	179	172	59	147	147

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 3

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			26	107	47		50	48	
1		213	188	223	178		172	171	178
2		235	240	294	218		280	199	196
3	218	249	276	302	255	218	322	249	237
4	284	258	330	364	361	284	399	357	288
5	305	299	360	387	421	305	407	418	356
6	336	295	355	394	430	336	390	429	355
7	345	327	358	397	440	345	456	437	370
8	378	371	388	430	475	378	517	468	369
9	413				587	413	587	587	
10	433				587	433	587	587	
11	513					513			
12	449					449			
13	445					445			
14									
15+				684			761		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	89			89		89	89	57
1	130		215		191	202	223	181
2	266	260	305	236	290	305	279	279
3	304	307	309	278	269	305	326	308
4	327	347	346	319	301	332	379	337
5	345	384	412	370	360	379	424	371
6	399	418	437	406	414	425	460	420
7	434	450	461	433	466	446	488	449
8	466	479	490	457	454	468	548	478
9	480	508	523	526	491	468	510	486
10	484	534	531	507	448	463	636	498
11	537	560	541	458	704	499	629	543
12	544	578	708	531	616	527	617	567
13	639			639		590	590	628
14	570			570		537	537	570
15+	731					669	669	729

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 4

Age	IIIa	IIIb	IIIc	IIId	IVa	IVb	IVc	VIId
0	55				54	55	114	114
1	204				216	204	186	186
2	278				269	268	251	250
3	298				290	288	260	258
4	350				332	329	305	298
5	403				383	387	480	483
6	428				414	419	482	
7	455				442	446	534	
8	473				461	465	502	502
9	508				489	493	668	
10	525				528	557	405	405
11	542				563	561		
12	564				597	588		
13					585	585		
14								
15+					653			

Age	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj
0		29	25	112	102	0	24	18
1	174	194	193	177	172	59	194	141
2	205	225	225	198	196	105	225	151
3	250	236	236	233	230	204	236	204
4	305	307	318	272	268	251	318	248
5	348	355	375	353	293	306	375	306
6	394	366	393	326	326	343	391	343
7	442	385	379	353	353	364	379	364
8	461	402	450	430	363	384	446	384
9	495	407	393	396	396	426	393	426
10	539	426	411	401	368	451	411	451
11	704	556			513	512		512
12		500		512	512	491		492
13		517		338	338	494		497
14								
15+								

Table 2.4.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2014 (cont.).

Quarter 4

Age	VIIIa	VIIIb	VIIIc	VIIIcE	VIIIcW	VIIId	IXa	IXaN	IXaS
0			38	107	43		43	43	
1	193	193	145	227	177	194	128	177	178
2	227	227	216	278	237	225	222	237	186
3	253	253	270	296	254	236	307	254	215
4	278	279	359	364	266		385	262	217
5	322	323	403	387	319		474	292	
6	319	321	409	393	352		516	313	
7	330	332	424	400	406		602	353	
8	347	350	471	425	486		635	485	
9					587		630	587	
10					587		587	587	
11									
12									
13									
14									
15+		684		684			637		

Age	IIa	IIb	Va	Vb	VIa	XIVa	XIVb	All
0	55							40
1	189			226	204			192
2	262			238	265			267
3	303	274		276	278			291
4	335	293		318	319			332
5	403	318		370	356			384
6	411	359		403	403			413
7	439	404		425	445			441
8	453	445		445	465			460
9	475	457		502	500			488
10	502	472		480	557			524
11	535	517		454	704			561
12	571			634	634			595
13	585							582
14								570
15+								655

Table 2.5.1.2.1. Updated Schedule displaying periods and area assignments for vessels by week for the 2016 MEGS survey. Area assignments and dates are provisional.

		Area							
week	Starts	Portugal, Cadiz & Galicia	Cantabrian Sea	Biscay	Celtic Sea	North west Ireland	West of Scotland	Northern Area	Period
1	18-Jan-16	PO1(DEPM)							1
2	25-Jan-16	PO1(DEPM)							1
3	1-Feb-16	PO1(DEPM)		IRL1	IRL1				2
4	8-Feb-16	PO1(DEPM)		IRL1	IRL1				2
5	15-Feb-16	PO1(DEPM)		IRL1	IRL1				2
6	22-Feb-16	PO1(DEPM)		IRL1	IRL1	SCO1	SCO1		2
7	29-Feb -16					SCO1	SCO1		2
8	7-Mar-16		IEO1	IEO1					3
9	14-Mar-16		IEO1	IEO1/ AZTI1					3
10	21-Mar-16		IEO1	IEO1/ AZTI1	AZTI1/ GER	GER	DEN		3
11	28-Mar-16		IEO1	AZTI1	AZTI1/ GER	GER	DEN		3
12	4-Apr-16			AZTI1	GER	GER			3
16	11-Apr-16		IEO2		GER	GER			4
14	18-Apr-16		IEO2	IEO2/ NED1	NED1/ GER	GER	SCO2		4
15	25-Apr-16		IEO2	IEO2/NED1	NED1/GER	GER	SCO2		4
16	2-May-16		IEO2/AZTI2(DEPM)	NED1	NED1				4
17	9-May-16			AZTI2(DEPM)	NED2	SCO3	SCO3	FAR	5
18	16-May-16			AZTI2(DEPM)	NED2	SCO3	SCO3	FAR	5
19	23-May-16		AZTI2(DEPM)	AZTI2(DEPM)	NED2	SCO3	SCO3	FAR	5
20	30-May -16			NED3	NED3	IRL2	IRL2		6
21	6-Jun-16			NED3	NED3	IRL2	IRL2	ICE	6
22	16-Jun-16			NED3	NED3	IRL2	IRL2	ICE	6
23	20-Jun-16					IRL2	IRL2		6
24	27-Jun -16								7
25	4-Jul-16				SCO4	SCO4	SCO4		7
26	11-Jul-16				SCO4	SCO4	SCO4		7
27	18-Jul-16				SCO4	SCO4	SCO4		7
28	25-Jul-16								7
29	1-Aug-16								8
30	8-Aug-16					IRE3	IRE3		8
31	15-Aug-16					IRE3	IRE3		8
32	22-Aug-16								8

Table 2.5.1.3.1. Revised MEGS mackerel TAEP and SSB index for the southern area.

Component	Year	TAEP	CV TAEP (var. Trad.)	CV TAEP (var. GAM)	SSB	CV SSB	CV SSB (GAM)
southern	1992	4.45*e14	3%	3%	672.4	NA	
southern	1995	3.02*e14	81%	20%	601.3	81%	
southern	1998	6.43*e14	244%	99%	1185.7	244%	
southern	2001	3.66*e14	52%	32%	479.4	52%	
southern	2004	1.65*e14	41%	18%	370.0	41%	
southern	2007	4.42*e14	60%	32%	945.3	NA	
southern	2010	5.72*e14	67%	36%	1154.9	NA	
southern	2013	7.79*e14	113%	45%	1391.0	NA	

Table 2.5.1.3.2. Revised MEGS mackerel TAEP and SSB index for the western area.

Component	Year	TAEP	CV TAEP (var. Trad.)	CV TAEP (var. GAM)	SSB	CV SSB	CV SSB (GAM)
western	1992	2.82*e15	7%	6%	4263.6	NA	
western	1995	2.35*e15	26%	27%	3904.6	26%	
western	1998	1.65*e15	16%	14%	3558.6	16%	
western	2001	1.48*e15	23%	17%	3105.0	23%	
western	2004	1.51*e15	21%	12%	3109.5	27%	
western	2007	1.63*e15	17%	11%	3483.2	NA	
western	2010	2.12*e15	16%	13%	4285.8	NA	
western	2013	2.37*e15	77%	23%	4241.9	NA	

Table 2.5.1.3.3. Revised MEGS mackerel TAEP and SSB index for the combined area.

	Year	TAEP	CV TAEP (var. Trad.)	CV TAEP (var. GAM)	SSB	CV SSB	CV SSB (GAM)
NE Atlantic Mackerel	1992	3.27*e15	6%	5%	4936.0		
NE Atlantic Mackerel	1995	2.66*e15	25%	24%	4506.0	25%	
NE Atlantic Mackerel	1998	2.29*e15	69%	10%	4744.4		
NE Atlantic Mackerel	2001	1.85*e15	21%	15%	3584.5	21%	
NE Atlantic Mackerel	2004	1.68*e15	19%	11%	3479.4	24%	
NE Atlantic Mackerel	2007	2.07*e15	19%	11%	4428.5		
NE Atlantic Mackerel	2010	2.70*e15	19%	13%	5440.7		
NE Atlantic Mackerel	2013	3.15*e15	64%	21%	5632.9		

Table 2.5.4.1. Numbers of RFID tagged and recaptured mackerel by tagging experiment.

Year	Period	Area	N-Released	N-Recaptured
2011	May-June	Ireland-Hebrides	18645	92
2011	Sep	Norwegian west coast	31257	82
2012	May-June	Ireland-Hebrides	32139	172
2013	May-June	Ireland-Hebrides	22794	168
2014	May-June	Ireland-Hebrides	55187	240
2015	May-June	Ireland-Hebrides	43914	11
Total			203936	765

Table 2.5.4.2. Numbers of recaptured mackerel with RFID tags by factory and recapture year.

	Recapture year				
Recapture Factory	**2012**	**2013**	**2014**	**2015**	**Total**
Brødrene Sperre	7	18	21	6	52
Pelagia Austevoll	1	1	7	0	9
Pelagia Egersund	12	25	19	7	63
Pelagia Florø	6	19	33	2	60
Pelagia Liavågen	10	13	34	3	60
Pelagia Måløy	6	18	21	12	57
Pelagia Selje	19	35	38	13	105
Skude Fryseri	9	10	22	9	50
IS01 Vopnafjörð	0	0	25	52	77
IS02 STH Höfn	0	0	0	1	1
IS03 SVN Neskaupstad	0	0	0	19	19
FO01 Vardin Pelagic	0	0	15	3	18
GB01 Denholm	0	0	26	47	73
GB02 Lunar Freezing	0	0	34	15	49
GB04 Shetland Catch	0	0	25	47	72
Total	70	139	320	236	765

Table 2.5.5.2.1. Biomass, abundance, mean length and mean weight at age of mackerel from the Spanish spring acoustics surveys (PELACUS 04) from 2001 to 2014.

	2001				2002				2003			
AGE	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)	Number (millions)	L (cm)	W (g)	Biomass t ('000)
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**			
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**			
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
	2010				**2011**				**2012**			
1	431.8	23.6	89.2	38.6	1936.9	22.5	77.4	149.3	698.05	22.07	74.36	51.83
2	72.7	30.6	194.8	14.2	29.7	30.5	201.3	6.0	16.7	27.71	150.62	2.5
3	189.6	31.5	214.9	40.9	63.1	32.3	239.2	15.1	11.18	33.27	265.58	2.98
4	662.7	33.6	262.3	174.1	90.6	33.7	273.6	24.7	32.34	34.63	299.04	9.69
5	873.3	35.0	296.3	258.8	154.8	35.0	308.5	47.6	60.04	35.62	325.28	19.53
6	306.6	36.8	346.3	106.1	144.1	36.1	340.6	49.0	147.09	36.58	353.17	51.84
7	388.9	38.1	385.6	149.8	57.7	38.2	406.2	23.4	121.31	37.66	386.73	46.77
8	239.2	38.2	388.3	92.8	54.2	39.5	446.9	24.1	61.9	39.43	445.95	27.53
9	113.9	39.5	427.5	48.6	31.2	39.6	451.5	14.0	32.39	40.12	470.22	15.19
10	26.4	40.8	470.2	12.4	10.3	41.0	503.5	5.2	19.11	40.54	485.42	9.26
11	16.5	40.9	475.8	7.8	4.7	41.0	503.1	2.4	8.07	40.66	489.56	3.94
12	10.3	41.4	492.4	5.0	3.1	41.8	533.3	1.6	2.78	41.94	538.24	1.49
13	7.5	41.9	509.7	3.8	2.4	41.6	527.1	1.2	1.36	42.38	555.37	0.75
14	5.3	42.4	530.5	2.8	0.0	0.0	0.0	0.0	1.36	42.38	555.37	0.75
15+	3.0	43.1	557.7	1.7	0.0	0.0	0.0	0.0	1.19	44.53	649.03	0.78
TOTAL	3347.8	34.0	286.0	957.5	2582.9	25.8	141.2	363.7	1214.88	28.46	201.91	244.81
	2013				**2014**				**2015**			
1	99	24.5	93.0	9	68.1	22.5	71.5	5.1	101.38	22.34	69.55	7.50
2	653	26.5	119.1	81	42.8	32.0	217.4	9.1	11.91	31.88	214.66	2.60
3	123	28.6	152.4	20	157.4	32.3	223.7	34.6	43.16	32.69	232.42	10.20
4	114	34.2	267.6	31	340.4	33.3	245.5	81.9	112.36	34.05	264.52	29.81
5	228	35.3	296.0	68	675.8	34.5	275.3	181.7	299.50	35.09	290.94	86.92
6	235	36.2	322.3	76	581.1	36.1	318.0	179.5	348.66	36.40	326.84	112.95
7	178	36.7	335.3	60	502.4	36.6	333.9	163.0	344.06	37.03	345.17	117.63
8	64	37.6	361.4	23	246.9	36.7	335.2	80.4	164.59	37.02	344.84	56.24

9	11	38.1	378.2	4	84.5	38.2	381.8	31.3	71.17	38.37	386.31	27.15
10	8	40.0	439.4	4	33.1	39.2	414.3	13.3	29.50	39.17	412.51	12.00
11	3	40.8	470.1	1	34.7	39.4	420.9	14.2	29.95	39.24	414.69	12.25
12	2	41.2	490.3	1	34.7	39.4	420.9	14.2	29.95	39.24	414.69	12.25
13												0
14												0
15+												0
TOTAL	1718	31.2	200.2	379	2802.0	35.1	291.0	808.4	1586.20	35.40	299.24	487.49

Table 2.5.5.2.2. Mackerel Abundance and Biomass by ICES sub-divisions from Spanish spring acoustic surveys (PELACUS04) from 2001 to 2014.

	ICES IXA-N		ICES VIIIC-W		VIIIC-EW		VIIIC-EE		TOTAL	
	Abund. (109)	Biomass (kt)	Abund. (109)	Biomass (kt)	Abund. (109)	Biomass (kt)	Abund. (109)	Biomass (kt)	Abund. (109)	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
2011	1.42	109.2	0.51	39.4	0.65	212.4	0.01	2.7	2.58	363.7
2012	0.61	45.03	0.02	1.3	0.57	190.7	0.02	7.8	1.21	244.8
2013	0.00	00.00	0.46	58.0	1.06	270.9	0.19	49.7	1.72	378.6
2014 [1]	0.02	2.4	0.03	3.0			2.75	803	2.80	808.4
2015	.21	73.6	0.3	7.4			1.36	410	1.57	483.3

(1) Without split VIIIcEW and VIIIcEE

Table 2.6.1.1. NE Atlantic mackerel. Input data and parameters and the model configurations for the assessment.

Input data types and characteristics:

Name	Year range	Age range	Variable from year to year
Catch in tonnes	1980 – 2014		Yes
Catch-at-age in numbers	1980 – 2014	0-12+	Yes
Weight-at-age in the commercial catch	1980 – 2014	0-12+	Yes
Weight-at-age of the spawning stock at spawning time.	1980 – 2014	0-12+	Yes
Proportion of natural mortality before spawning	1980 -2014	0-12+	Yes
Proportion of fishing mortality before spawning	1980 -2014	0-12+	Yes
Proportion mature-at-age	1980 -2014	0-12+	Yes
Natural mortality	1980 -2014	0-12+	No, fixed at 0.15

Tuning data:

Type	Name	Year range	Age range
Survey (SSB)	ICES Triennial Mackerel and Horse Mackerel Egg Survey	1992, 1995, 1998, 2001, 2004, 2007, 2010, 2013.	Not applicable (gives SSB)
Survey (abundance index)	IBTS Recruitment index	1998-2014	Age 0
Survey (abundance index)	International Ecosystem Summer Survey in the Nordic Seas (IESSNS)	2007, 2010-2015	Ages 6-11
Tagging/recapture	Norwegian tagging program	1980-2005 (recapture years)	Ages 2 and older

Table 2.6.1.1. NE Atlantic mackerel. Input data and parameters and the model configurations for the assessment (Continued).

SAM parameter configuration :

SETTING	VALUE	DESCRIPTION
Coupling of fishing mortality states	1/2/3/4/5/6/7/8/8/8/8/8/8	Different F states for ages 0 to 6, one same F state for ages 7 and older
Correlated random walks for the fishing mortalities	0	F random walk of different ages are independent
Coupling of catchability parameters	0/0/0/0/0/0/0/0/0/0/0/0/0	No catchability parameter for the catches
	0/0/0/0/0/0/0/0/0/0/0/0/0	One catchability parameter estimated for the egg
	1/0/0/0/0/0/0/0/0/0/0/0/0	One catchability parameter estimated for the recruitment index
	0/0/0/0/0/0/2/2/2/2/2/2/0	One catchability parameter estimated for the IESSNS (same for age 6 to11)
Power law model	0	No power law model used for any of the surveys
Coupling of fishing mortality random walk variances	1/1/1/1/1/1/1/1/1/1/1/1/1	Same variance used for the F random walk of all ages
Coupling of log abundance random walk variances	1/2/2/2/2/2/2/2/2/2/2/2/2	Same variance used for the log abundance random walk of all ages except for the recruits (age 0)
Coupling of the observation variances	1/1/1/1/1/1/1/1/1/1/1/1/1	Same observation variance for all ages in the catches
	0/0/0/0/0/0/0/0/0/0/0/0/0	One observation variance for the egg survey
	2/0/0/0/0/0/0/0/0/0/0/0/0	One observation variance for the recruitment index
	0/0/0/0/0/0/3/3/3/3/3/3/0	One observation variance for the IESSNS (all ages)
Stock recruitment model	0	No stock-recruiment model

Table 2.6.1.2. NE Atlantic Mackerel. CATCH IN NUMBER

Units : thousands

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	33101	56682	11180	7333	287287	81799	49983	7403	57644	65400	24246	10007
1	411327	276229	213936	47914	31901	268960	58126	40126	152656	64263	140534	58459
2	393025	502365	432867	668909	86064	20893	424563	156670	137635	312739	209848	212521
3	64549	231814	472457	433744	682491	58346	38387	663378	190403	207689	410751	206421
4	328206	32814	184581	373262	387582	445357	76545	56680	538394	167588	208146	375451
5	254172	184867	26544	126533	251503	252217	364119	89003	72914	362469	156742	188623
6	142978	173349	138970	20175	98063	165219	208021	244570	87323	48696	254015	129145
7	145385	116328	112476	90151	22086	62363	126174	150588	201021	58116	42549	197888
8	54778	125548	89672	72031	61813	19562	42569	85863	122496	111251	49698	51077
9	130771	41186	88726	48668	47925	47560	13533	34795	55913	68240	85447	43415
10	39920	146186	27552	49252	37482	37607	32786	19658	20710	32228	33041	70839
11	56210	31639	91743	19745	30105	26965	22971	25747	13178	13904	16587	29743
12	104927	199615	156121	132040	69183	97652	81153	63146	57494	35814	27905	52986

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	43447	19354	25368	14759	37956	36012	61127	67003	36345	26034	70409	14744
1	83583	128144	147315	81529	119852	144390	99352	73597	102407	40315	222577	187997
2	156292	210319	221489	340898	168882	186481	229767	132994	142898	158943	70041	275661
3	356209	266677	306979	340215	333365	238426	264566	223639	275376	234186	367902	91075
4	266591	398240	267420	275031	279182	378881	323186	261778	390858	297206	350163	295777
5	306143	244285	301346	186855	177667	246781	361945	281041	295516	309937	262716	235052
6	156070	255472	184925	197856	96303	135059	207619	244212	241550	231804	237066	183036
7	113899	149932	189847	142342	119831	84378	118388	159019	175608	195250	151320	133595
8	138458	97746	106108	113413	55812	66504	72745	86739	106291	120241	118870	94168
9	51208	121400	80054	69191	59801	39450	47353	50613	52394	72205	79945	75701
10	36612	38794	57622	42441	25803	26735	24386	30363	31280	42529	43789	45951
11	40956	29067	20407	37960	18353	13950	16551	17048	18918	20546	21611	25797
12	68205	68217	57551	39753	30648	24974	22932	32446	34202	40706	40280	30890

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	11553	12426	75651	19302	25886	17615	23453	30429	23872	11325	62100
1	31421	46840	149425	88439	59899	36514	78605	62708	66196	47020	43173
2	453133	135648	173646	190857	167748	113574	137101	115346	200167	235411	137788
3	529753	668588	159455	220575	399086	455113	303928	322725	214043	399751	669949
4	147973	293579	470063	215655	284660	616963	739221	469953	415884	370551	829399
5	258177	120538	195594	455131	260314	319465	611729	654395	456404	442597	564508
6	145899	121477	97061	203492	255675	224848	284788	488713	511270	429324	549985
7	89856	63612	73510	77859	124382	194326	143039	244210	323835	336701	503300
8	65669	38763	33399	59652	57297	73171	102072	113012	142948	188910	339538
9	40443	23947	18961	30494	32343	29738	45841	53363	69551	112765	141344
10	35654	18612	13987	16039	19482	14989	21222	25046	30619	45938	63614
11	16430	7955	8334	11416	6798	7470	6255	12311	11603	18928	21294
12	19509	10669	10186	12801	9581	5003	8523	10775	11678	17857	13136

Table 2.6.1.3. NE Atlantic Mackerel. WEIGHTS AT AGE IN THE CATCH

Units : Kg

year

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.057	0.060	0.053	0.050	0.031	0.055	0.039	0.076	0.055	0.049	0.085	0.068	0.051	0.061
1	0.131	0.132	0.131	0.168	0.102	0.144	0.146	0.179	0.133	0.136	0.156	0.156	0.167	0.134
2	0.249	0.248	0.249	0.219	0.184	0.262	0.245	0.223	0.259	0.237	0.233	0.253	0.239	0.240
3	0.285	0.287	0.285	0.276	0.295	0.357	0.335	0.318	0.323	0.320	0.336	0.327	0.333	0.317
4	0.345	0.344	0.345	0.310	0.326	0.418	0.423	0.399	0.388	0.377	0.379	0.394	0.397	0.376
5	0.378	0.377	0.378	0.386	0.344	0.417	0.471	0.474	0.456	0.433	0.423	0.423	0.460	0.436
6	0.454	0.454	0.454	0.425	0.431	0.436	0.444	0.512	0.524	0.456	0.467	0.469	0.495	0.483
7	0.498	0.499	0.496	0.435	0.542	0.521	0.457	0.493	0.555	0.543	0.528	0.506	0.532	0.527
8	0.520	0.513	0.513	0.498	0.480	0.555	0.543	0.498	0.555	0.592	0.552	0.554	0.555	0.548
9	0.542	0.543	0.541	0.545	0.569	0.564	0.591	0.580	0.562	0.578	0.606	0.609	0.597	0.583
10	0.574	0.573	0.574	0.606	0.628	0.629	0.552	0.634	0.613	0.581	0.606	0.630	0.651	0.595
11	0.590	0.576	0.574	0.608	0.636	0.679	0.694	0.635	0.624	0.648	0.591	0.649	0.663	0.647
12	0.580	0.584	0.582	0.614	0.663	0.710	0.688	0.718	0.697	0.739	0.713	0.708	0.669	0.679

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.046	0.072	0.058	0.076	0.065	0.062	0.063	0.069	0.052	0.081	0.067	0.048	0.038	0.089
1	0.136	0.143	0.143	0.143	0.157	0.176	0.135	0.172	0.160	0.170	0.156	0.151	0.071	0.120
2	0.255	0.234	0.226	0.230	0.227	0.235	0.227	0.224	0.256	0.267	0.263	0.268	0.197	0.215
3	0.339	0.333	0.313	0.295	0.310	0.306	0.306	0.305	0.307	0.336	0.323	0.306	0.307	0.292
4	0.390	0.390	0.377	0.359	0.354	0.361	0.363	0.376	0.368	0.385	0.400	0.366	0.357	0.372
5	0.448	0.452	0.425	0.415	0.408	0.404	0.427	0.424	0.424	0.438	0.419	0.434	0.428	0.408
6	0.512	0.501	0.484	0.453	0.452	0.452	0.463	0.474	0.461	0.477	0.485	0.440	0.479	0.456
7	0.543	0.539	0.518	0.481	0.462	0.500	0.501	0.496	0.512	0.522	0.519	0.496	0.494	0.512
8	0.590	0.577	0.551	0.524	0.518	0.536	0.534	0.540	0.536	0.572	0.554	0.539	0.543	0.534
9	0.583	0.594	0.576	0.553	0.550	0.569	0.567	0.577	0.580	0.612	0.573	0.556	0.584	0.573
10	0.627	0.606	0.596	0.577	0.573	0.586	0.586	0.603	0.600	0.631	0.595	0.583	0.625	0.571
11	0.678	0.631	0.603	0.591	0.591	0.607	0.594	0.611	0.629	0.648	0.630	0.632	0.636	0.585
12	0.713	0.672	0.670	0.636	0.631	0.687	0.644	0.666	0.665	0.715	0.684	0.655	0.689	0.666

year

age	2008	2009	2010	2011	2012	2013	2014
0	0.051	0.104	0.048	0.029	0.089	0.091	0.043
1	0.105	0.153	0.118	0.113	0.123	0.173	0.127
2	0.222	0.213	0.221	0.231	0.187	0.234	0.232
3	0.292	0.283	0.291	0.282	0.285	0.277	0.282
4	0.370	0.331	0.331	0.334	0.340	0.336	0.324
5	0.418	0.389	0.365	0.368	0.375	0.360	0.362
6	0.444	0.424	0.418	0.411	0.401	0.386	0.395
7	0.497	0.450	0.471	0.451	0.431	0.406	0.422
8	0.551	0.497	0.487	0.494	0.469	0.431	0.444
9	0.571	0.538	0.515	0.540	0.503	0.454	0.468
10	0.620	0.586	0.573	0.580	0.537	0.472	0.482
11	0.595	0.599	0.604	0.611	0.538	0.493	0.523
12	0.662	0.630	0.630	0.664	0.585	0.554	0.583

Table 2.6.1.4. NE Atlantic Mackerel. WEIGHTS AT AGE IN THE STOCK

Units : Kg

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.063	0.063	0.063	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.120	0.118	0.118	0.117	0.114	0.118	0.111	0.076	0.106	0.109	0.096	0.174	0.112	0.111
2	0.205	0.179	0.159	0.179	0.204	0.244	0.184	0.157	0.181	0.162	0.166	0.184	0.201	0.190
3	0.287	0.258	0.217	0.233	0.251	0.281	0.269	0.234	0.238	0.230	0.247	0.243	0.260	0.266
4	0.322	0.312	0.300	0.282	0.293	0.308	0.301	0.318	0.298	0.272	0.290	0.303	0.308	0.323
5	0.356	0.335	0.368	0.341	0.326	0.336	0.350	0.368	0.348	0.338	0.332	0.347	0.360	0.359
6	0.377	0.376	0.362	0.416	0.395	0.356	0.350	0.414	0.392	0.392	0.383	0.392	0.397	0.410
7	0.402	0.415	0.411	0.404	0.430	0.407	0.374	0.415	0.445	0.388	0.435	0.423	0.419	0.432
8	0.434	0.431	0.456	0.438	0.455	0.455	0.434	0.431	0.442	0.449	0.447	0.492	0.458	0.459
9	0.438	0.454	0.455	0.475	0.489	0.447	0.428	0.483	0.466	0.432	0.494	0.500	0.487	0.480
10	0.484	0.450	0.473	0.467	0.507	0.519	0.467	0.507	0.506	0.429	0.473	0.546	0.513	0.515
11	0.520	0.524	0.536	0.544	0.513	0.538	0.506	0.492	0.567	0.482	0.495	0.526	0.543	0.547
12	0.534	0.531	0.544	0.528	0.567	0.591	0.542	0.581	0.594	0.556	0.536	0.615	0.568	0.577

age	1994	1995	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	0.000	0.000
1	0.114	0.114	0.109	0.108	0.083	0.112	0.108	0.112	0.109	0.112	0.111	0.116	0.107	0.083
2	0.163	0.201	0.185	0.196	0.172	0.210	0.194	0.190	0.206	0.181	0.158	0.140	0.165	0.149
3	0.240	0.278	0.250	0.257	0.248	0.260	0.253	0.246	0.245	0.251	0.258	0.221	0.238	0.206
4	0.306	0.327	0.322	0.310	0.299	0.317	0.301	0.303	0.288	0.277	0.318	0.328	0.293	0.288
5	0.368	0.385	0.372	0.356	0.348	0.356	0.357	0.342	0.333	0.341	0.355	0.378	0.334	0.330
6	0.418	0.432	0.425	0.401	0.383	0.392	0.394	0.398	0.360	0.401	0.406	0.403	0.402	0.362
7	0.459	0.458	0.446	0.460	0.409	0.424	0.416	0.417	0.418	0.407	0.449	0.464	0.411	0.448
8	0.480	0.491	0.471	0.473	0.455	0.456	0.438	0.451	0.429	0.489	0.482	0.481	0.436	0.452
9	0.496	0.511	0.513	0.505	0.475	0.489	0.464	0.484	0.458	0.490	0.507	0.548	0.456	0.509
10	0.550	0.517	0.508	0.511	0.530	0.508	0.489	0.521	0.511	0.488	0.517	0.536	0.467	0.525
11	0.592	0.560	0.538	0.546	0.500	0.545	0.514	0.535	0.523	0.521	0.577	0.507	0.528	0.530
12	0.604	0.602	0.573	0.585	0.547	0.576	0.551	0.574	0.557	0.540	0.591	0.605	0.570	0.590

age	2008	2009	2010	2011	2012	2013	2014
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.135	0.110	0.111	0.112	0.108	0.108	0.104
2	0.160	0.162	0.163	0.181	0.153	0.146	0.165
3	0.207	0.214	0.206	0.219	0.209	0.180	0.199
4	0.260	0.268	0.253	0.269	0.250	0.247	0.238
5	0.349	0.295	0.297	0.329	0.284	0.282	0.291
6	0.354	0.354	0.346	0.366	0.309	0.320	0.310
7	0.397	0.389	0.380	0.378	0.353	0.342	0.341
8	0.450	0.437	0.407	0.417	0.376	0.372	0.388
9	0.453	0.464	0.430	0.443	0.443	0.412	0.416
10	0.476	0.522	0.486	0.479	0.494	0.442	0.466
11	0.484	0.550	0.535	0.518	0.502	0.499	0.458
12	0.515	0.563	0.573	0.527	0.561	0.526	0.506

Table 2.6.1.5. NE Atlantic Mackerel. NATURAL MORTALITY

Units : NA

age \ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
1	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
3	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
4	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
5	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
6	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
7	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
8	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
9	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
12	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

age \ year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
1	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
3	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
4	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
5	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
6	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
7	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
8	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
9	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
10	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
11	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
12	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

age \ year	2014
0	0.15
1	0.15
2	0.15
3	0.15
4	0.15
5	0.15
6	0.15
7	0.15
8	0.15
9	0.15
10	0.15
11	0.15
12	0.15

Table 2.6.1.6. NE Atlantic Mackerel. PROPORTION MATURE

Units : NA

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.105	0.109	0.110	0.111	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116	0.116
2	0.487	0.503	0.511	0.532	0.486	0.487	0.497	0.412	0.404	0.419	0.406	0.466	0.523	0.558
3	0.840	0.817	0.877	0.880	0.871	0.888	0.923	0.924	0.917	0.916	0.913	0.920	0.930	0.936
4	0.933	0.919	0.934	0.970	0.968	0.967	0.989	0.990	0.990	0.993	0.994	0.993	0.995	0.996
5	0.963	0.971	0.970	0.991	0.988	0.988	0.990	0.996	0.994	0.999	0.999	0.998	0.998	0.999
6	0.980	0.978	0.980	0.995	0.996	0.994	0.997	0.997	0.997	0.998	1.000	0.998	0.996	0.996
7	0.983	0.980	0.979	0.994	0.994	0.996	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999
8	1.000	0.999	0.999	0.998	0.998	0.997	0.997	0.997	0.997	0.997	0.998	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

year

age	1994	1995	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	0.000	0.000
1	0.116	0.116	0.116	0.109	0.109	0.109	0.118	0.118	0.118	0.120	0.120	0.120	0.107	0.107
2	0.607	0.573	0.588	0.608	0.626	0.606	0.637	0.632	0.696	0.705	0.719	0.704	0.680	0.610
3	0.941	0.922	0.916	0.859	0.873	0.874	0.906	0.909	0.944	0.939	0.940	0.941	0.913	0.905
4	0.997	0.996	0.997	0.987	0.988	0.988	0.987	0.984	0.994	0.990	0.990	0.991	0.994	0.994
5	0.999	0.999	1.000	0.997	0.997	0.997	0.997	0.996	0.999	0.999	0.998	0.998	0.999	0.999
6	0.996	0.996	0.998	0.998	0.998	0.999	0.998	0.998	0.999	0.999	0.999	0.999	1.000	1.000
7	0.999	0.999	0.999	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.999	0.999	1.000	1.000
8	1.000	1.000	1.000	0.998	0.998	0.998	0.998	0.999	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

year

age	2008	2009	2010	2011	2012	2013	2014
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.107	0.108	0.108	0.108	0.105	0.105	0.105
2	0.588	0.584	0.545	0.544	0.528	0.544	0.526
3	0.910	0.912	0.909	0.913	0.909	0.913	0.915
4	0.996	0.997	0.997	0.997	0.997	0.999	0.999
5	0.998	1.000	0.999	0.999	0.999	0.999	0.998
6	1.000	1.000	0.999	0.999	1.000	0.999	0.999
7	1.000	1.000	1.000	1.000	0.999	0.999	0.998
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 2.6.1.7. NE Atlantic Mackerel. FRACTION OF HARVEST BEFORE SPAWNING

Units : NA

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.177	0.179	0.181	0.216
2	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.177	0.179	0.181	0.216
3	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.254	0.285	0.316	0.318
4	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.223	0.254	0.285	0.316	0.318
5	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
6	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
7	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
8	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
9	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
10	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
11	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436
12	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.383	0.392	0.402	0.411	0.436

year

age	1994	1995	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	0.000	0.000
1	0.252	0.287	0.250	0.212	0.175	0.179	0.183	0.187	0.202	0.217	0.231	0.230	0.230	0.229
2	0.252	0.287	0.250	0.212	0.175	0.179	0.183	0.187	0.202	0.217	0.231	0.230	0.230	0.229
3	0.321	0.323	0.329	0.335	0.340	0.364	0.389	0.413	0.406	0.399	0.393	0.375	0.358	0.341
4	0.321	0.323	0.329	0.335	0.340	0.364	0.389	0.413	0.406	0.399	0.393	0.375	0.358	0.341
5	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
6	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
7	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
8	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
9	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
10	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
11	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339
12	0.461	0.486	0.491	0.496	0.500	0.464	0.426	0.389	0.404	0.419	0.433	0.402	0.370	0.339

year

age	2008	2009	2010	2011	2012	2013	2014
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.198	0.165	0.134	0.174	0.213	0.112	0.112
2	0.198	0.165	0.134	0.174	0.213	0.112	0.112
3	0.307	0.272	0.239	0.226	0.212	0.076	0.076
4	0.307	0.272	0.239	0.226	0.212	0.076	0.076
5	0.309	0.277	0.247	0.217	0.188	0.222	0.222
6	0.309	0.277	0.247	0.217	0.188	0.222	0.222
7	0.309	0.277	0.247	0.217	0.188	0.222	0.222
8	0.309	0.277	0.247	0.217	0.188	0.222	0.222
9	0.309	0.277	0.247	0.217	0.188	0.222	0.222
10	0.309	0.277	0.247	0.217	0.188	0.222	0.222
11	0.309	0.277	0.247	0.217	0.188	0.222	0.222
12	0.309	0.277	0.247	0.217	0.188	0.222	0.222

Table 2.6.1.8. NE Atlantic Mackerel. FRACTION OF NATURAL MORTALITY BEFORE SPAWNING

Units : NA

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
1	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
2	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
3	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
4	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
5	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
6	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
7	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
8	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
9	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
10	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
11	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341
12	0.397	0.396	0.394	0.392	0.394	0.396	0.397	0.388	0.378	0.369	0.357	0.345	0.333	0.341

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
1	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
2	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
3	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
4	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
5	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
6	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
7	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
8	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
9	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
10	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
11	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339
12	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355	0.350	0.346	0.342	0.339

year

age	2008	2009	2010	2011	2012	2013	2014
0	0.311	0.283	0.255	0.252	0.249	0.246	0.246
1	0.311	0.283	0.255	0.252	0.249	0.246	0.246
2	0.311	0.283	0.255	0.252	0.249	0.246	0.246

3	0.311	0.283	0.255	0.252	0.249	0.246	0.246
4	0.311	0.283	0.255	0.252	0.249	0.246	0.246
5	0.311	0.283	0.255	0.252	0.249	0.246	0.246
6	0.311	0.283	0.255	0.252	0.249	0.246	0.246
7	0.311	0.283	0.255	0.252	0.249	0.246	0.246
8	0.311	0.283	0.255	0.252	0.249	0.246	0.246
9	0.311	0.283	0.255	0.252	0.249	0.246	0.246
10	0.311	0.283	0.255	0.252	0.249	0.246	0.246
11	0.311	0.283	0.255	0.252	0.249	0.246	0.246
12	0.311	0.283	0.255	0.252	0.249	0.246	0.246

Table 2.6.1.9. NE Atlantic Mackerel. SURVEY INDICES

```
Some random text
103
SSB-egg-based-survey
1992    2015
1       1       0       0
99      99
1       4936042
1       -1
1       -1
1       4505959
1       -1
1       -1
1       4744355
1       -1
1       -1
1       3584476
1       -1
1       -1
1       3479420
1       -1
1       -1
1       4428506
1       -1
1       -1
1       5440700
1       -1
1       -1
1       5632910
1       -1
1       -1
R-idx(sqrt transf)
1998    2014
1       1       0       0
0       0
1       0.066974794
1       0.070762502
1       0.060229695
1       0.080503501
1       0.080147024
1       0.0601185
1       0.083588153
1       0.098808751
1       0.094132945
1       0.075337645
1       0.071033429
1       0.065389631
1       0.089285081
1       0.103440179
1       0.084659561
1       0.081859108
1       0.095786088
```

```
Swept-idx
2007    2015
1       1       0.58    0.75
6       11
1       0.192833347     0.066149865     0.047027669     0.035354394     0.012980085
        0.010398726
1       -1      -1      -1      -1      -1      -1
1       -1      -1      -1      -1      -1      -1
1       0.62958251      0.273344863     0.18997 0.116164047     0.030974702
        0.020263107
1       0.995318947     0.463782442     0.226442003     0.099828111     0.051338264
        0.046593113
1       1.310799591     0.890325315     0.353939232     0.185671543     0.064728514
        0.032820661
1       1.300869937     1.202164384     0.572929131     0.195023604     0.078744988
        0.068672101
1       1.071   1.0911  0.6883  0.3018  0.1469  0.035
1       0.732424 0.691463 0.383553 0.228849 0.115505 0.02632
```

Table 2.6.1.10. NE Atlantic Mackerel. Comparison of the SAM parameters for the update assessment and the last accepted assessment (WGWIDE, 2014), and with 4 exploratory runs in which part of the survey data was modified.

	2015 update	WGWIDE 2014	excluding 2015 IESSNS	old IBTS index (1998-2013)	new IBTS index excl. 2014	old egg survey index
random walk						
F	0.18	0.26	0.19	0.21	0.19	0.18
N@age0	0.18	0.42	0.18	0.50	0.43	0.18
process error						
N@age1 to 12+	0.20	0.18	0.21	0.19	0.20	0.20
observation variance						
catches	0.24	0.12	0.23	0.15	0.17	0.24
egg survey	0.14	0.19	0.17	0.16	0.16	0.16
Recruit index	0.03	0.29	0.04	0.32	0.24	0.04
IESSNS	0.31	0.26	0.24	0.31	0.31	0.31
tag recaptures overdispersion	1.20	1.21	1.20	1.20	1.20	1.20
catchabilities						
R index	1.7E-08	1.5E-07	1.6E-08	1.5E-07	1.6E-08	1.6E-08
IESSNS	8.0E-07	6.1E-07	6.7E-07	7.9E-07	7.9E-07	7.9E-07
egg survey	1.74	1.46	1.67	1.72	1.73	1.54
post tagging survival	0.39	0.38	0.40	0.39	0.39	0.39

Table 2.6.2.1. NE Atlantic Mackerel. Comparison of the SAM parameters for the update assessment and an exploratory run where age groups 2-5 from the IESSNS were included in the model.

	2015 update + Ricker	2015 update + Ricker + extended IESSNS
random walk		
F	0,18	0,17
N@age0		
Ricker SR model	3,76	3,65
	3,20E-07	3,00E-07
	0,35	0,35
process error		
N@age1 to 12+	0,2	0,21
observation variance		
catches	0,17	0,17
egg survey	0,14	0,16
Recruit index	0,28	0,29
IESSNS	0,31	0,54
		0,28
tag recaptures overdispersion	1,2	1,2
catchabilities		
R index	1,80E-08	1,70E-08
IESSNS	8,10E-07	3,10E-07
		4,70E-07
		7,10E-07
egg survey	1,74	1,68
post tagging survival	0,39	0,4

Table 2.6.2.2. NE Atlantic Mackerel. Comparison of the SAM parameters for the update assessment and the last accepted assessment (WGWIDE 2014), and with 3 exploratory runs in which model configuration was modified.

	2015 update	WGWIDE 2014	constraint on ovservation variances	2015 update + Ricker
random walk				
F	0.18	0.26	0.18	0.18
N@age0	0.18	0.42	0.234	
Ricker SR model		a		3.76
		b		3.2E-07
		sigma		0.35
process error				
N@age1 to 12+	0.20	0.18	0.20	0.20
observation variance				
catches	0.24	0.12	0.22	0.17
egg survey	0.14	0.19	0.15	0.14
Recruit index	0.03	0.29	0.14	0.28
IESSNS	0.31	0.26	0.31	0.31
tag recaptures overdispersior	1.20	1.21	1.20	1.20
catchabilities				
R index	1.7E-08	1.5E-07	1.6E-08	1.8E-08
IESSNS	8.0E-07	6.1E-07	8.0E-07	8.1E-07
egg survey	1.74	1.46	1.74	1.74
post tagging survival	0.39	0.38	0.39	0.39

random walk	**increased numb. Parameters**
F	0.14
N@age0	0.18
process error	
N@age1 to 12+	0.21
observation variance	
catches0-1	0.51
catches2-3	0.07
catches4-10	0.01
catches11-12	0.14
egg survey	0.15
Recruit index	0.01
IESSNS6-8	0.31
IESSNS9-11	0.34
tag recaptures overdispersion	1.21
catchabilities	
R index	1.6E-08
IESSNS6-8	7.8E-07
IESSNS9-11	7.7E-07
egg survey	1.72
post tagging survival	0.40

Table 2.6.3.1. NE Atlantic Mackerel. STOCK SUMMARY. Low = lower limit and High = higher limit of 95% confidence interval.

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F48	Low	High
1980	8293644	3104242	22158240	5950584	3139644	11278175	4000780	1837139	8712593	0.196	0.11	0.348
1981	5416714	2981032	9842497	5688744	3338793	9692665	3620056	1830244	7160139	0.196	0.114	0.338
1982	2972756	1563035	5653922	5411300	3440612	8510745	3645485	2063884	6439104	0.197	0.118	0.33
1983	2733245	1368629	5458475	5432989	3756507	7857665	4004783	2595942	6178215	0.198	0.122	0.323
1984	5683058	3110581	10382996	5341409	3844215	7421710	4260939	2973826	6105130	0.2	0.127	0.317
1985	3925483	2233008	6900745	5520616	4191126	7271841	4155736	3044600	5672384	0.205	0.133	0.316
1986	3898101	2272066	6687830	5025322	3895918	6482132	3711698	2799748	4920693	0.212	0.141	0.317
1987	5101270	3025177	8602127	4785016	3703615	6182171	3730303	2815302	4942689	0.22	0.151	0.32
1988	3671093	2197168	6133769	4891453	3892492	6146787	3634565	2814345	4693833	0.229	0.161	0.325
1989	4036950	2423250	6725252	4565324	3687281	5652452	3382075	2670617	4283067	0.243	0.176	0.336
1990	3298571	1909248	5698879	4488369	3677729	5477690	3402429	2744145	4218626	0.261	0.194	0.353
1991	3798056	2287523	6306050	4470452	3716549	5377284	3265750	2682592	3975679	0.284	0.214	0.379
1992	4295163	2592362	7116453	3945160	3326083	4679463	2931427	2454334	3501262	0.308	0.233	0.408
1993	3506048	2102841	5845601	3649132	3075321	4330008	2602544	2180080	3106875	0.328	0.248	0.433
1994	3495545	2103514	5808773	3194688	2698963	3781465	2280716	1917456	2712795	0.337	0.257	0.442
1995	3051061	1808232	5148109	3175577	2694928	3741952	2264807	1917126	2675541	0.326	0.255	0.417
1996	3992787	2287797	6968426	2931427	2487259	3454914	2145751	1815817	2535633	0.304	0.242	0.383
1997	3207492	1861960	5525366	3002633	2558439	3523946	2124400	1819700	2480121	0.29	0.23	0.365
1998	3645485	2431892	5464701	2910979	2469771	3431006	2143606	1822748	2520944	0.295	0.236	0.369
1999	3984809	2710870	5857421	3236490	2772228	3778501	2305942	1966064	2704577	0.314	0.257	0.384
2000	3150274	2214683	4481104	3134562	2751624	3570792	2213311	1926636	2542641	0.338	0.29	0.392
2001	4601993	3254080	6508242	2853338	2524425	3225105	2074021	1822019	2360878	0.378	0.325	0.44
2002	7579820	4943084	11623041	2993638	2608062	3436218	1955194	1698887	2250169	0.415	0.355	0.486
2003	2813669	1995250	3967791	3275562	2803452	3827177	1945442	1671520	2264254	0.445	0.375	0.528
2004	3269017	2243797	4762675	3204286	2746451	3738444	2315185	1964417	2728586	0.42	0.355	0.498
2005	4338330	2978588	6318801	2928497	2481560	3455929	2180359	1817855	2615150	0.345	0.292	0.407
2006	8186524	5226226	12823628	3066355	2597417	3619954	2071948	1733020	2477162	0.327	0.276	0.388
2007	3949107	2786453	5596881	3246214	2757475	3821578	2191288	1858819	2583222	0.373	0.316	0.441
2008	4282297	3014969	6082340	3756507	3146030	4485444	2605148	2178358	3115555	0.348	0.294	0.412
2009	4061244	2861395	5764218	4061244	3415328	4829319	3109586	2594909	3726343	0.311	0.261	0.371
2010	5015281	3523411	7138834	4368805	3720639	5129886	3328392	2814592	3935986	0.3	0.251	0.359
2011	5909076	4119655	8475753	4891453	4149888	5765532	3749001	3154530	4455501	0.298	0.246	0.36
2012	4569891	3201276	6523620	4648244	3924596	5505323	3446949	2897984	4099904	0.285	0.232	0.349
2013	3084808	2055932	4628577	4713777	3962446	5607570	3623678	3037380	4323146	0.302	0.244	0.373
2014	7519423	4518723	12512766	5137104	4159228	6344888	4159893	3324135	5205779	0.339	0.269	0.427
2015							3620056	2688462	4874461			

Table 2.6.3.2. NE Atlantic Mackerel. ESTIMATED POPULATION ABUNDANCE

Units : Thousands

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0	8293644	5416714	2972756	2733245	5683058	3925483	3898101	5101270	3671093	4036950
1	4809001	7095703	5035382	2242272	2006696	5336070	3282120	3246214	4657549	2966816
2	2228858	3976848	5903170	4556202	1651179	1439779	4876801	2681803	2647165	4143287
3	897169	1799465	3318422	5121716	4439268	1183516	1043405	4528947	2141463	2312871
4	1531870	696623	1364093	2780107	4368805	4069375	905280	735275	3972873	1671112
5	3265750	1149687	506865	946002	2128653	3409240	3143980	725778	478782	3094076
6	2612975	2371421	846614	381551	664639	1613635	2463269	2176002	574353	323191
7	824886	1828488	1649528	590072	275681	474018	1102400	1669442	1431166	455887
8	308970	576079	1276969	1143953	406362	199586	320296	779182	1128049	1050734
9	851709	215561	401114	888242	793334	284077	141634	215130	545796	766048
10	235155	595407	150242	278730	618468	549080	199985	97441	143200	368796
11	342833	164062	414986	104506	193687	428909	377000	136762	66304	92503
12	680784	716404	613540	712119	565802	525970	654744	698018	559053	413743

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	3298571	3798056	4295163	3506048	3495545	3051061	3992787	3207492	3645485	3984809
1	3365207	2563797	3112697	3649132	2788460	2782889	2347825	3358483	2518062	2928497
2	2340792	2727784	1947389	2490515	3023725	2156506	2156506	1760309	2757955	1918396
3	3980826	2092772	2535750	1612022	1992698	2458348	2171655	1955194	1236753	2543369
4	1823011	3044965	1492555	2012725	1082734	1432598	1810294	1772675	1666106	1195410
5	1077334	1240469	1891726	968981	1366824	674010	963184	1201402	1531870	1273144
6	2065742	788589	953600	1158921	588305	978719	490411	722881	865446	904376
7	209400	1288514	491393	590662	665304	353982	580706	323515	482145	615383
8	342491	132720	738961	309279	335709	280127	212564	344208	265136	311141
9	696623	237994	83117	396726	174556	170076	133119	149792	213203	182956
10	486018	452707	147709	47240	196418	99211	86942	84204	103466	133920
11	242074	295670	266999	85562	24909	111190	54612	46120	53316	65973
12	328733	358613	388481	362943	250948	151903	146972	117712	107045	107796

age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	3150274	4601993	7579820	2813669	3269017	4338330	8186524	3949107	4282297	4061244
1	3358483	1703167	5751665	7202941	2045187	2839107	5587262	5926830	3737771	3288690
2	2301335	2602544	1114593	4852478	6168708	1988716	2847637	4785016	4950504	3308482
3	1692979	1723728	2371421	795718	3630932	4862192	1629852	2371421	4248175	4685579
4	1859838	1211052	1436902	1510574	689692	1850562	3066355	1426879	1905014	3641841
5	923568	1256700	914379	849158	924492	496332	1008526	1990706	1155449	1507555
6	859409	590072	807744	530195	432787	455431	334703	626560	1069819	829850
7	617849	579546	364033	377755	249447	215561	252458	212777	381933	637303
8	372503	416649	330380	215993	171271	120331	120692	148598	149941	238232
9	190042	238709	219916	176310	104925	79778	64473	79937	86077	97929
10	115382	119970	123130	107689	80178	54122	45707	37309	48874	47287
11	72620	69703	60355	60536	43217	29792	28226	26716	18579	26030
12	117360	119253	103466	75282	51948	37835	34718	33996	27310	19902

age	2010	2011	2012	2013	2014
0	5015281	5909076	4569891	3084808	7519423
1	4164055	4704359	5427559	3707988	2873381
2	3388846	3166065	4629688	5443866	3185118

3	3140837	3204286	2561235	4143287	5298848
4	4073446	2810857	2652465	2249008	3809468
5	2735979	3044965	2278436	2141463	1968928
6	1124670	1880409	2113805	1837653	1797667
7	534988	824061	1233048	1401425	1458618
8	350109	382697	542531	738222	982642
9	155749	192914	251954	353982	451351
10	68050	87816	114119	145947	196614
11	25952	46120	48194	68941	73424
12	29290	35668	45798	56727	53210

Table 2.6.3.3. NE Atlantic Mackerel. ESTIMATED FISHING MORTALITY

Units : f

age	1980	1981	1982	1983	1984	1985	1986	1987
0	0.0094589	0.0094835	0.0095092	0.0095530	0.0096230	0.0096461	0.0096403	0.0096211
1	0.0359617	0.0358433	0.0357109	0.0356324	0.0354831	0.0352673	0.0350949	0.0349758
2	0.0583498	0.0581052	0.0577749	0.0575616	0.0576422	0.0573834	0.0570573	0.0569888
3	0.1025095	0.1025813	0.1023354	0.1025813	0.1036640	0.1060547	0.1086091	0.1106481
4	0.1681834	0.1686887	0.1697888	0.1698567	0.1711697	0.1745228	0.1798198	0.1885674
5	0.1750997	0.1755028	0.1763649	0.1789051	0.1809020	0.1845195	0.1889260	0.1927618
6	0.2129495	0.2138458	0.2154126	0.2172297	0.2215294	0.2274102	0.2337507	0.2405806
7	0.2106621	0.2111471	0.2117392	0.2126729	0.2142525	0.2196763	0.2277288	0.2382821
8	0.2106621	0.2111471	0.2117392	0.2126729	0.2142525	0.2196763	0.2277288	0.2382821
9	0.2106621	0.2111471	0.2117392	0.2126729	0.2142525	0.2196763	0.2277288	0.2382821
10	0.2106621	0.2111471	0.2117392	0.2126729	0.2142525	0.2196763	0.2277288	0.2382821
11	0.2106621	0.2111471	0.2117392	0.2126729	0.2142525	0.2196763	0.2277288	0.2382821
12	0.2106621	0.2111471	0.2117392	0.2126729	0.2142525	0.2196763	0.2277288	0.2382821

age	1988	1989	1990	1991	1992	1993	1994	1995
0	0.0096645	0.0096867	0.0096877	0.0096877	0.0097246	0.0097567	0.0097997	0.0098459
1	0.0349443	0.0349758	0.0350038	0.0349723	0.0348919	0.0347944	0.0346832	0.0344447
2	0.0568465	0.0568977	0.0573146	0.0578906	0.0587714	0.0596358	0.0603859	0.0610965
3	0.1139039	0.1174902	0.1215779	0.1258581	0.1295226	0.1338146	0.1363814	0.1381936
4	0.1954795	0.2058516	0.2141454	0.2223061	0.2267516	0.2288245	0.2304780	0.2279110
5	0.2002277	0.2066146	0.2117815	0.2190840	0.2310549	0.2385682	0.2409177	0.2458337
6	0.2466956	0.2617148	0.2765953	0.2899346	0.3017972	0.3122347	0.3155936	0.3152782
7	0.2511512	0.2706307	0.3018878	0.3455562	0.3905732	0.4304216	0.4484805	0.4204289
8	0.2511512	0.2706307	0.3018878	0.3455562	0.3905732	0.4304216	0.4484805	0.4204289
9	0.2511512	0.2706307	0.3018878	0.3455562	0.3905732	0.4304216	0.4484805	0.4204289
10	0.2511512	0.2706307	0.3018878	0.3455562	0.3905732	0.4304216	0.4484805	0.4204289
11	0.2511512	0.2706307	0.3018878	0.3455562	0.3905732	0.4304216	0.4484805	0.4204289
12	0.2511512	0.2706307	0.3018878	0.3455562	0.3905732	0.4304216	0.4484805	0.4204289

age	1996	1997	1998	1999	2000	2001	2002	2003
0	0.0099042	0.0099598	0.0100037	0.0100217	0.0100207	0.0077033	0.0077956	0.0058548
1	0.0341463	0.0337019	0.0332135	0.0326275	0.0320198	0.0298909	0.0328468	0.0268658
2	0.0622996	0.0638257	0.0647903	0.0661983	0.0679421	0.0681326	0.0690241	0.0683509
3	0.1400438	0.1432162	0.1487185	0.1595656	0.1713409	0.1639490	0.1658784	0.1498081
4	0.2252375	0.2212195	0.2260950	0.2371885	0.2549469	0.2741993	0.2766229	0.2512517
5	0.2552530	0.2715796	0.2950236	0.3181603	0.3499028	0.3364183	0.3539145	0.3559731
6	0.3122347	0.3129537	0.3185423	0.3379018	0.3690216	0.4285191	0.4299484	0.4478038
7	0.3643283	0.3220334	0.3184149	0.3380708	0.3568999	0.4261346	0.5083526	0.5854234
8	0.3643283	0.3220334	0.3184149	0.3380708	0.3568999	0.4261346	0.5083526	0.5854234
9	0.3643283	0.3220334	0.3184149	0.3380708	0.3568999	0.4261346	0.5083526	0.5854234
10	0.3643283	0.3220334	0.3184149	0.3380708	0.3568999	0.4261346	0.5083526	0.5854234
11	0.3643283	0.3220334	0.3184149	0.3380708	0.3568999	0.4261346	0.5083526	0.5854234
12	0.3643283	0.3220334	0.3184149	0.3380708	0.3568999	0.4261346	0.5083526	0.5854234

age	2004	2005	2006	2007	2008	2009	2010	2011
0	0.0045711	0.0044192	0.0065284	0.0058326	0.0058647	0.0051953	0.0052036	0.0054062
1	0.0205273	0.0200185	0.0222681	0.0181026	0.0167493	0.0148256	0.0167929	0.0150361
2	0.0737260	0.0702707	0.0613046	0.0478110	0.0412296	0.0401955	0.0424045	0.0425064

```
  3  0.1578990 0.1460655 0.1209957 0.1110694 0.1084246 0.1088483 0.1088701 0.1091535
  4  0.2372834 0.2065113 0.1901010 0.1820088 0.1827018 0.1941741 0.2013924 0.1960864
  5  0.3440047 0.3031280 0.2722594 0.2778983 0.2701440 0.2618719 0.2639224 0.2584637
  6  0.4305852 0.3846121 0.3765027 0.3804959 0.3369570 0.3303839 0.3171121 0.3155620
  7  0.5445530 0.4155094 0.3978899 0.5132152 0.4749005 0.3845352 0.3592991 0.3593710
  8  0.5445530 0.4155094 0.3978899 0.5132152 0.4749005 0.3845352 0.3592991 0.3593710
  9  0.5445530 0.4155094 0.3978899 0.5132152 0.4749005 0.3845352 0.3592991 0.3593710
  10 0.5445530 0.4155094 0.3978899 0.5132152 0.4749005 0.3845352 0.3592991 0.3593710
  11 0.5445530 0.4155094 0.3978899 0.5132152 0.4749005 0.3845352 0.3592991 0.3593710
  12 0.5445530 0.4155094 0.3978899 0.5132152 0.4749005 0.3845352 0.3592991 0.3593710
    year
age  2012      2013      2014
  0  0.0054350 0.0052292 0.0069842
  1  0.0141237 0.0143644 0.0153767
  2  0.0456341 0.0467893 0.0472596
  3  0.1045385 0.1131433 0.1288508
  4  0.1933023 0.2035182 0.2316564
  5  0.2520318 0.2650863 0.3080479
  6  0.3057768 0.3050438 0.3411613
  7  0.3359812 0.3671077 0.4066632
  8  0.3359812 0.3671077 0.4066632
  9  0.3359812 0.3671077 0.4066632
  10 0.3359812 0.3671077 0.4066632
  11 0.3359812 0.3671077 0.4066632
  12 0.3359812 0.3671077 0.4066632
```

Table 2.7.2.1. RCT3 output.

```
Analysis by RCT3_R ver3.1 of data from file :

RCT3/RCT3init.txt

RCT3 for NEA Mackerel

Data for 1 surveys over 25 years :  1990 - 2014

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 0.000
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.


yearclass = 2014

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 IBTS.index  39.97  12.05   0.45  0.336     16   0.10   15.88    0.539    0.243

                                        VPA Mean =   15.30    0.305    0.757




 Year     Weighted      Log     Int     Ext     Var     VPA      Log
 Class     Average      WAP     Std     Std    Ratio             VPA
          Prediction           Error   Error

 2014     5080975     15.44    0.27    0.25     0.86
```

Table 2.7.3.1. NE Atlantic Mackerel. Short-term prediction: INPUT DATA

	Stock Numbers	M	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploitation pattern	Weights in the catch
2015								
0	4052792	0.15	0.000	0.000	0.247	0.000	0.006	0.074
1	4342799	0.15	0.105	0.146	0.247	0.107	0.015	0.141
2	2436322	0.15	0.533	0.146	0.247	0.155	0.047	0.218
3	2615589	0.15	0.912	0.121	0.247	0.196	0.115	0.281
4	4012801	0.15	0.998	0.121	0.247	0.245	0.209	0.333
5	2599943	0.15	0.999	0.211	0.247	0.286	0.275	0.366
6	1249183	0.15	0.999	0.211	0.247	0.313	0.318	0.394
7	1149687	0.15	0.999	0.211	0.247	0.345	0.370	0.420
8	795718	0.15	1.000	0.211	0.247	0.379	0.370	0.448
9	517104	0.15	1.000	0.211	0.247	0.424	0.370	0.475
10	244507	0.15	1.000	0.211	0.247	0.467	0.370	0.497
11	87904	0.15	1.000	0.211	0.247	0.486	0.370	0.518
12+	72548	0.15	1.000	0.211	0.247	0.531	0.370	0.574
2016								
0	4052792	0.15	0.000	0.000	0.247	0.000	0.006	0.074
1	-	0.15	0.105	0.146	0.247	0.107	0.015	0.141
2	-	0.15	0.533	0.146	0.247	0.155	0.047	0.218

	Stock Numbers	M	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploitation pattern	Weights in the catch
3	-	0.15	0.912	0.121	0.247	0.196	0.115	0.281
4	-	0.15	0.998	0.121	0.247	0.245	0.209	0.333
5	-	0.15	0.999	0.211	0.247	0.286	0.275	0.366
6	-	0.15	0.999	0.211	0.247	0.313	0.318	0.394
7	-	0.15	0.999	0.211	0.247	0.345	0.370	0.420
8	-	0.15	1.000	0.211	0.247	0.379	0.370	0.448
9	-	0.15	1.000	0.211	0.247	0.424	0.370	0.475
10	-	0.15	1.000	0.211	0.247	0.467	0.370	0.497
11	-	0.15	1.000	0.211	0.247	0.486	0.370	0.518
12+	-	0.15	1.000	0.211	0.247	0.531	0.370	0.574
2017								
0	4052792	0.15	0.000	0.000	0.247	0.000	0.006	0.074
1	-	0.15	0.105	0.146	0.247	0.107	0.015	0.141
2	-	0.15	0.533	0.146	0.247	0.155	0.047	0.218
3	-	0.15	0.912	0.121	0.247	0.196	0.115	0.281
4	-	0.15	0.998	0.121	0.247	0.245	0.209	0.333
5	-	0.15	0.999	0.211	0.247	0.286	0.275	0.366
6	-	0.15	0.999	0.211	0.247	0.313	0.318	0.394
7	-	0.15	0.999	0.211	0.247	0.345	0.370	0.420
8	-	0.15	1.000	0.211	0.247	0.379	0.370	0.448

	Stock Numbers	M	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploitation pattern	Weights in the catch
9	-	0.15	1.000	0.211	0.247	0.424	0.370	0.475
10	-	0.15	1.000	0.211	0.247	0.467	0.370	0.497
11	-	0.15	1.000	0.211	0.247	0.486	0.370	0.518
12+	-	0.15	1.000	0.211	0.247	0.531	0.370	0.574

Table 2.7.3.2. NE Atlantic Mackerel. Short-term prediction: Multi-option table for 1,236 kt catch in 2015 and a range of F-values in 2016.

2015			
TSB	SSB	Fbar	Landings
4 582 509	3 588 927	0.371	1 235 608

2016				2017		
TSB	SSB	Fbar	Landings	TSB	SSB	Implied change in the landings
4000435	3245272	0	0	4420986	3676929	-100%
-	3239987	0.01	33313	4393275	3644256	-97%
-	3234713	0.02	66324	4365823	3611961	-95%
-	3229449	0.03	99035	4338628	3580039	-92%
-	3224197	0.04	131448	4311688	3548486	-89%
-	3218955	0.05	163568	4285000	3517297	-87%
-	3213725	0.06	195397	4258562	3486469	-84%
-	3208505	0.07	226938	4232371	3455995	-82%
-	3203296	0.08	258194	4206424	3425872	-79%
-	3198097	0.09	289168	4180718	3396096	-77%
-	3192910	0.10	319862	4155253	3366661	-74%
-	3187733	0.11	350279	4130024	3337565	-72%
-	3182567	0.12	380423	4105030	3308802	-69%
-	3177412	0.13	410296	4080268	3280368	-67%
-	3172267	0.14	439900	4055735	3252260	-64%
-	3167133	0.15	469238	4031431	3224473	-62%
-	3162009	0.16	498313	4007351	3197004	-60%
-	3156896	0.17	527128	3983494	3169848	-57%
-	3151794	0.18	555685	3959858	3143001	-55%
-	3146702	0.19	583987	3936440	3116460	-53%
-	3141621	0.20	612036	3913238	3090221	-50%
-	3136550	0.21	639834	3890250	3064280	-48%
-	3131490	0.22	667385	3867474	3038633	-46%
-	3126440	0.23	694691	3844908	3013277	-44%
-	3121400	0.24	721754	3822548	2988209	-42%
-	3116371	0.25	748576	3800395	2963423	-39%
-	3111353	0.26	775160	3778444	2938918	-37%
-	3106344	0.27	801509	3756695	2914690	-35%
-	3101346	0.28	827624	3735145	2890735	-33%
-	3096358	0.29	853509	3713791	2867050	-31%
-	3091381	0.30	879164	3692634	2843631	-29%
-	3086414	0.31	904593	3671669	2820475	-27%

-	3081457	0.32	929798	3650895	2797579	-25%
-	3076510	0.33	954781	3630311	2774941	-23%
-	3071574	0.34	979544	3609914	2752555	-21%
-	3066647	0.35	1004089	3589703	2730421	-19%
-	3061731	0.36	1028419	3569675	2708533	-17%
-	3056825	0.37	1052536	3549829	2686890	-15%
-	3051929	0.38	1076441	3530163	2665488	-13%
-	3047043	0.39	1100137	3510675	2644325	-11%
-	3042167	0.40	1123626	3491363	2623397	-9%

Table 2.7.3.3. NE Atlantic Mackerel. Short-term prediction: Management option table for 1 236 kt catch in 2015 and a range of catch options for 2016.

Options	Fbar (2016)	Catch (2016)	SSB (2016)	TSB (2016)	SSB (2017)	TSB (2017)	% change TAC 2015–2016	% change SSB 2016->2017
Catch(2016) = Zero	0.00	0	3245272	4000435	3676929	4420986	-100%	13%
Catch(2016) = 2015 catch[1]	0.45	1235608	3018461	4000435	2325691	3399379	0%	-23%
Fbar(2016) = 0.25 (Fpa)	0.25	748576	3116371	4000435	2963423	3800395	-39%	-5%
Fbar(2016) = 0.22 (Fmsy)	0.22	667385	3131490	4000435	3038633	3867474	-46%	-3%

[1] excl. interannual transfer and discard

Table 2.11.1. Catches in tonnes of *Scomber colias* in Divisions VIIIb, VIIIc and IXa in the period 1982 – 2014.

Subdivisions		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
VIIIb	Spain	0	0	0	0	0	0	0	0	0	487	7	4	427	247	778
VIIIc	Spain	322	254	656	513	750	1150	1214	3091	1923	1502	859	1892	1903	2558	2679
IXa N & S	Spain	0	0	0	0	0	0	0	0	0	0	895	3357	8573	5068	5437
IXa-CN, CS & S	Portugal	2458	1364	8059	9118	8184	8876	3816	6447	8568	10142	8981	7341	4430	3884	4759
Sub-Divisions		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
VIIIb	Spain	362	1218	632	344	426	99	157	40	222	262	744	42	122	520	384
VIIIc	Spain	5026	1765	418	1905	1496	1509	2525	2741	3150	4260	7153	5203	3930	8939	17694
IXa N & S	Spain	2340	1381	983	1001	553	1566	981	888	812	2984	8239	8544	11860	12218	9152
IXa-CN, CS & S	Portugal	5408	6690	13877	10520	4228	5301	8030	14714	14905	13031	20222	23286	14428	22283	30635
Subdivisions		2012	2013	2014												
VIIIb	Spain	2089	4688	817												
VIIIc	Spain	12068	5356	13682												
IXa N & S	Spain	13499	8597	22137												
IXa-CN, CS & S	Portugal	37191	39250													
Unallocated			1070													

Table 2.12.2.1 Estimates of F_{MSY}, F at 95% of MSY above and below FMSY, long term realized F_{bar}, and percentage difference in long-term mean yield compared to MSY. All options are considered based on an upper bound on 95% MSY. Source: WKMACLTMP (ICES, 2015b).

Stock	Precautionary F, F_{MSY}, and F intervals				Long-term realized F_{bar}	% difference in long term mean yield compared with MSY
	Btrigger	F_{MSY}	F_{lower}	F_{upper}		
NEA mackerel	3.0mt	0.22	0.15	0.24	0.23	3%
	3.2mt			0.25	0.23	2%
	3.5mt			0.26	0.24	2%
	4.0mt			0.28	0.24	2%
	5.0mt			0.30	0.23	2%

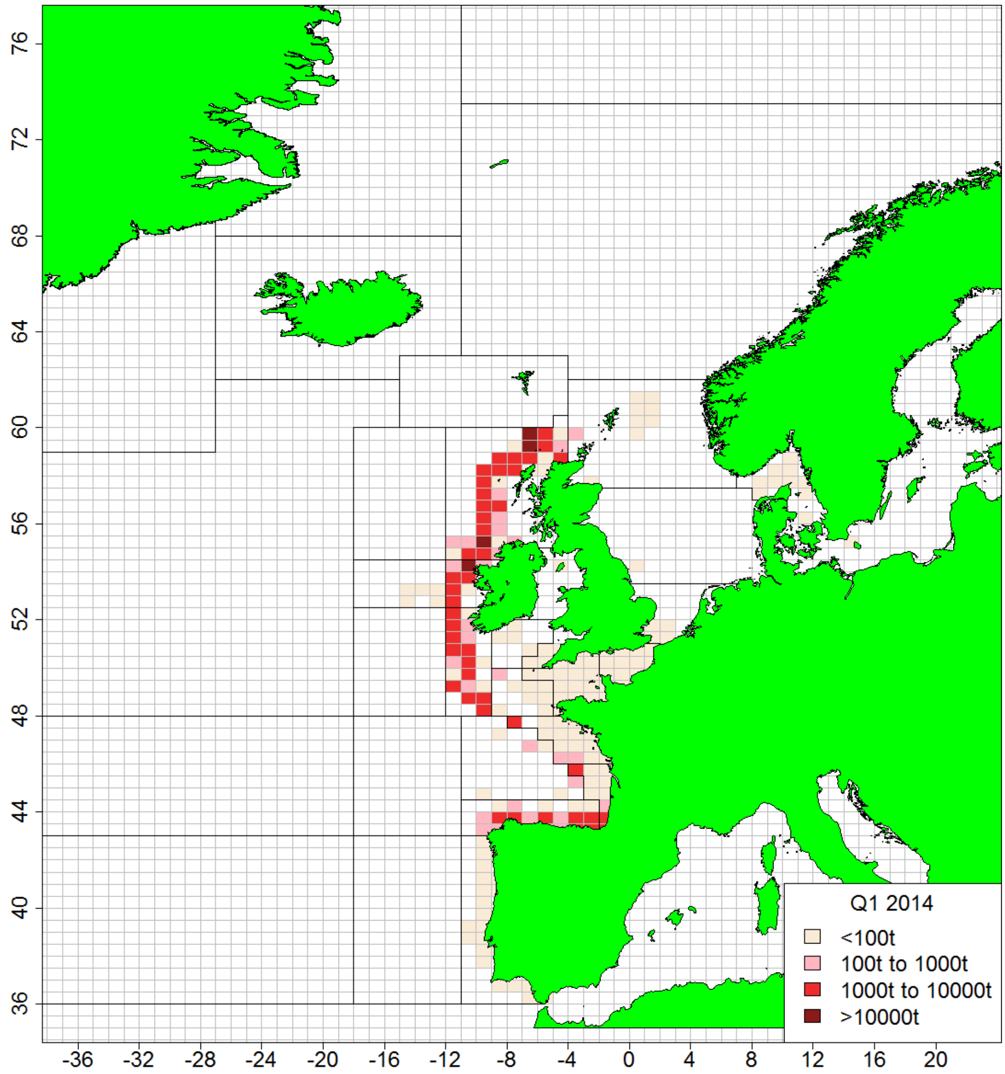


Figure 2.3.2.1. NE Atlantic Mackerel. Commercial catches in 2014, quarter 1.

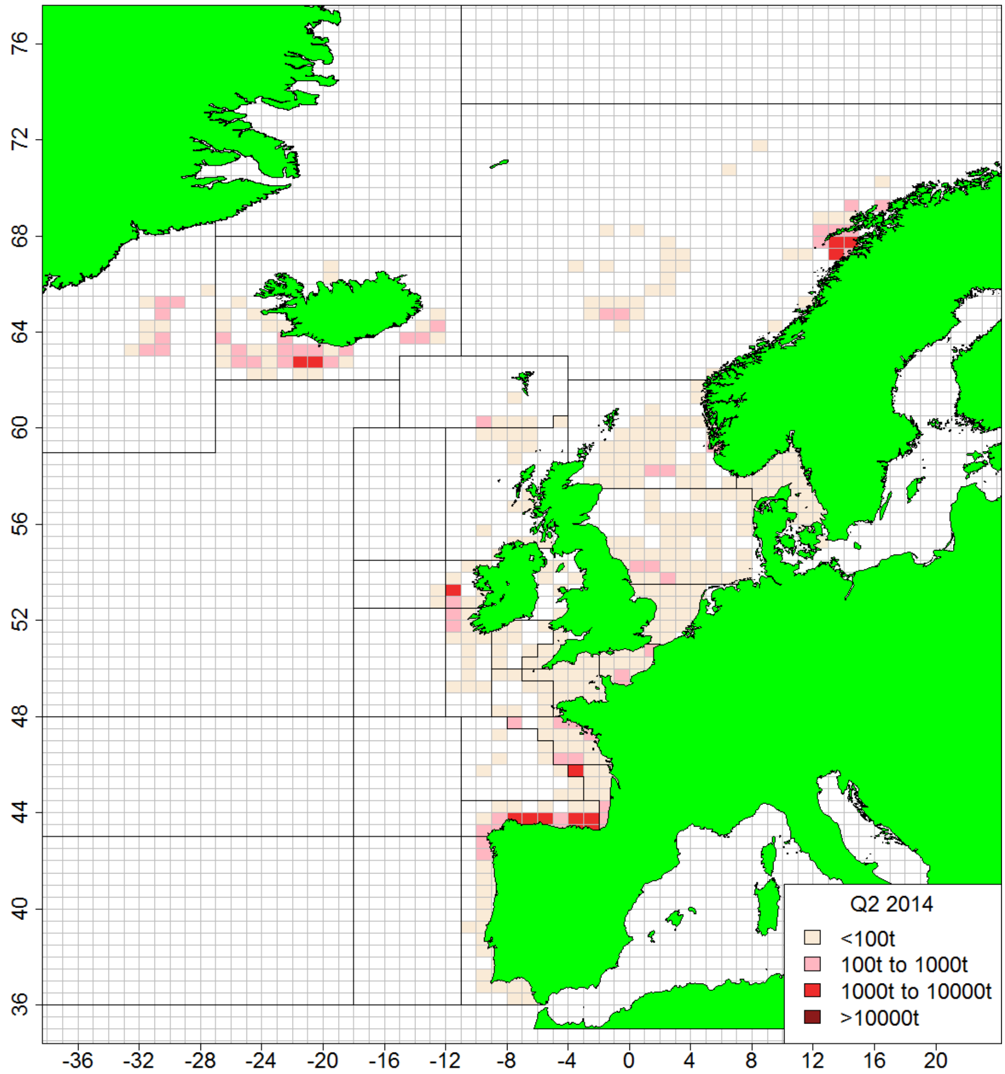


Figure 2.3.2.2. NE Atlantic Mackerel. Commercial catches in 2014, quarter 2.

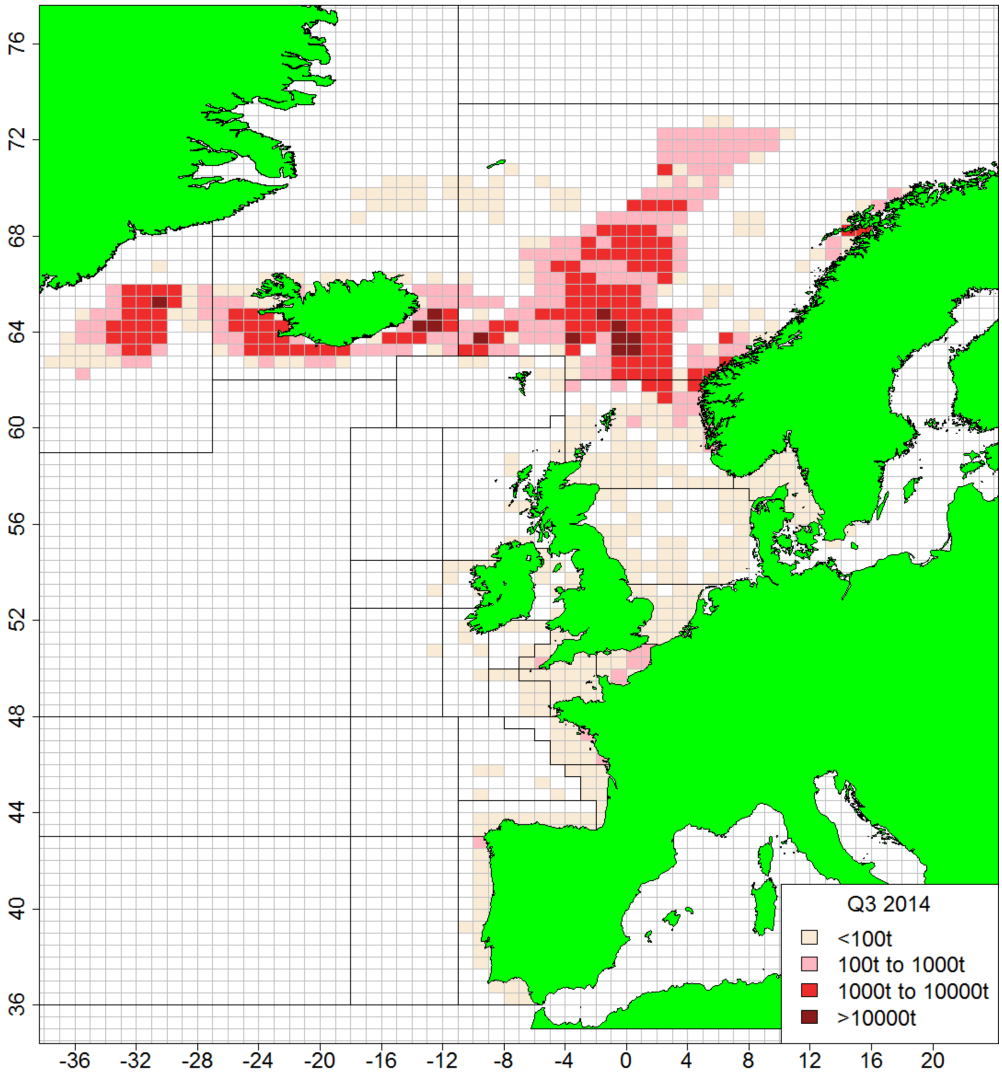


Figure 2.3.2.3. NE Atlantic Mackerel. Commercial catches in 2014, quarter 3.

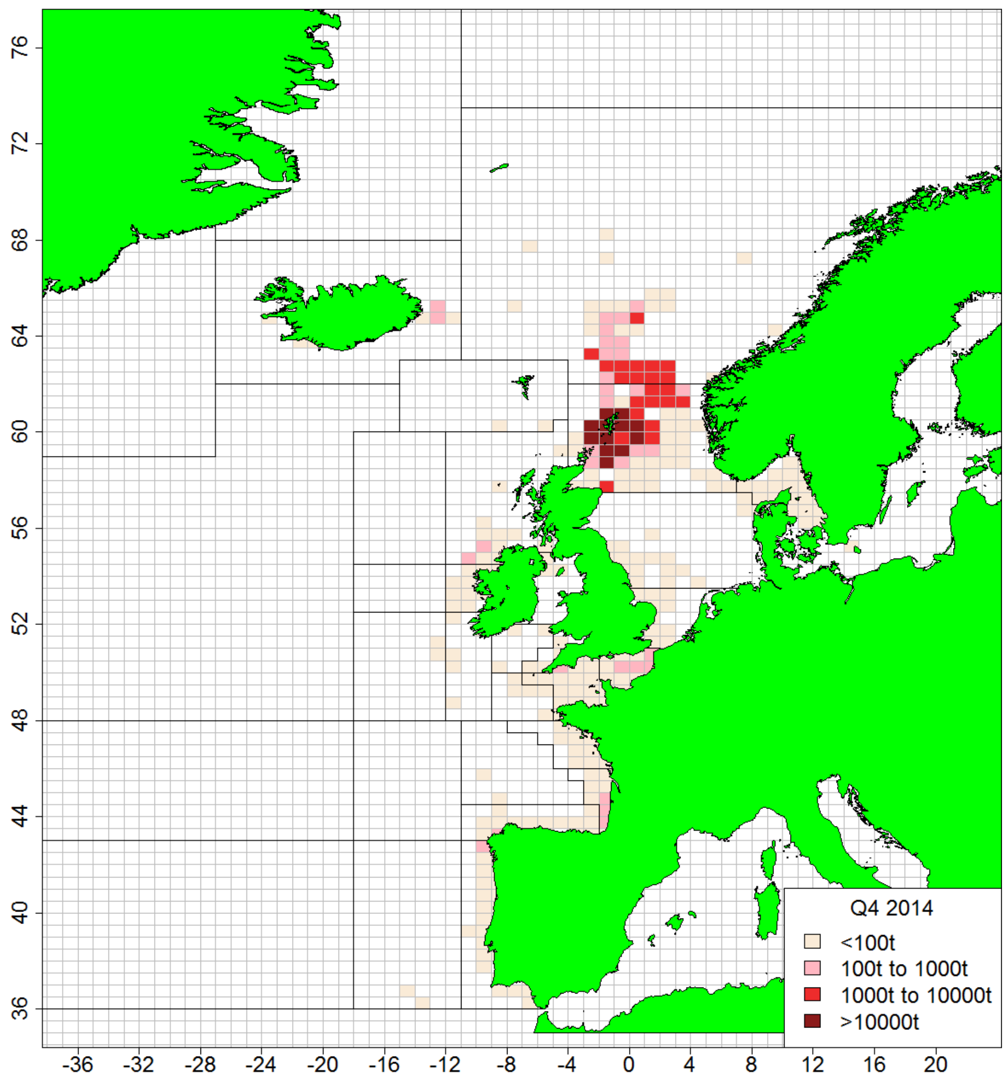


Figure 2.3.2.4. NE Atlantic Mackerel. Commercial catches in 2014, quarter 4.

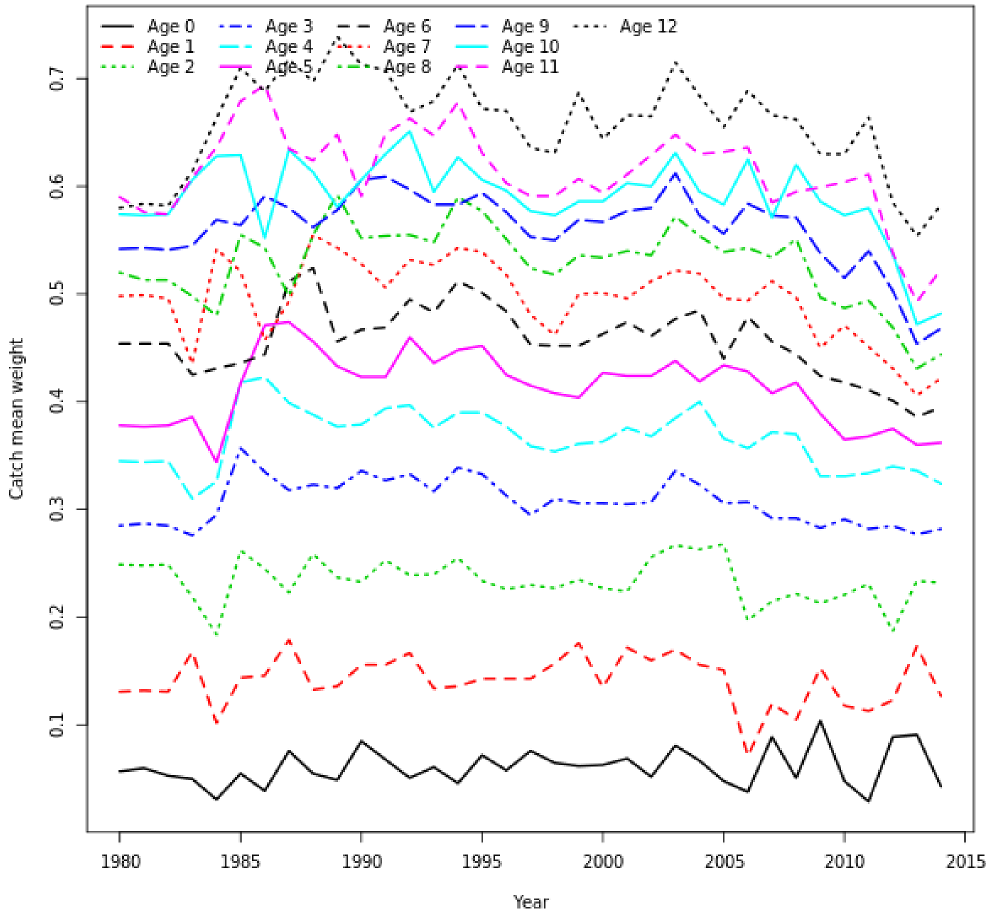


Figure 2.4.2.1. NE Atlantic mackerel. Weights-at-age in the catch.

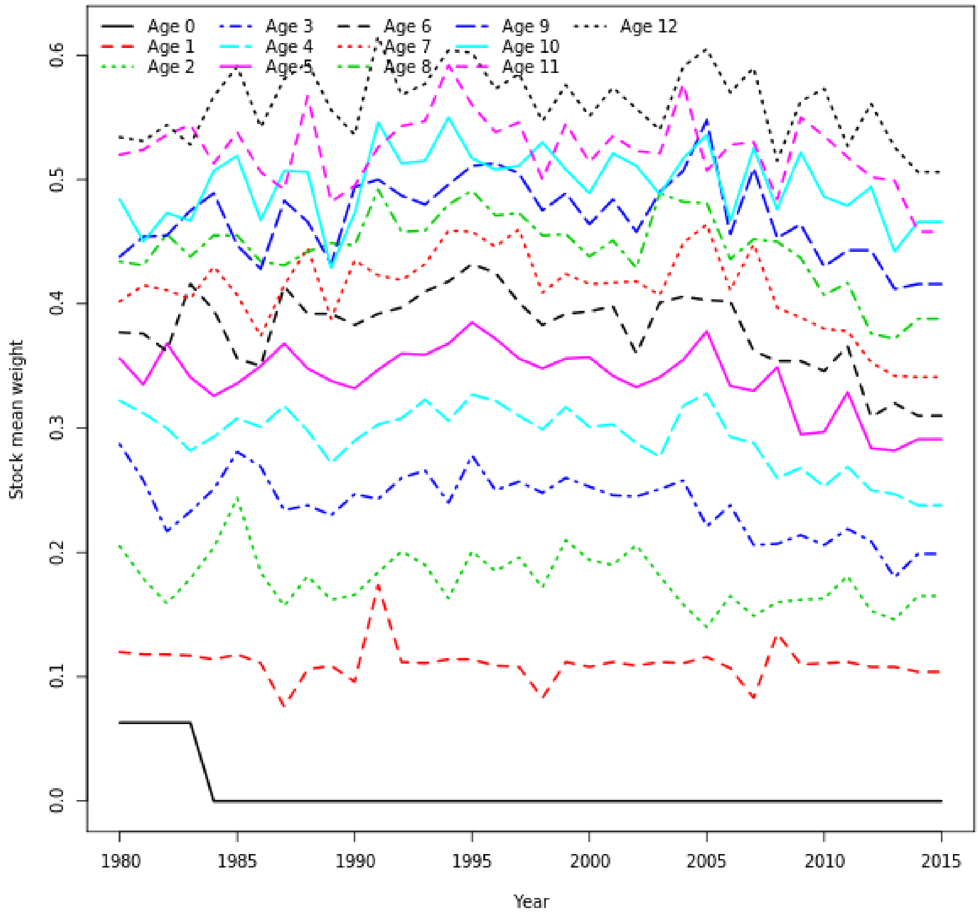


Figure 2.4.2.2. NE Atlantic mackerel. Weights-at-age in the stock.

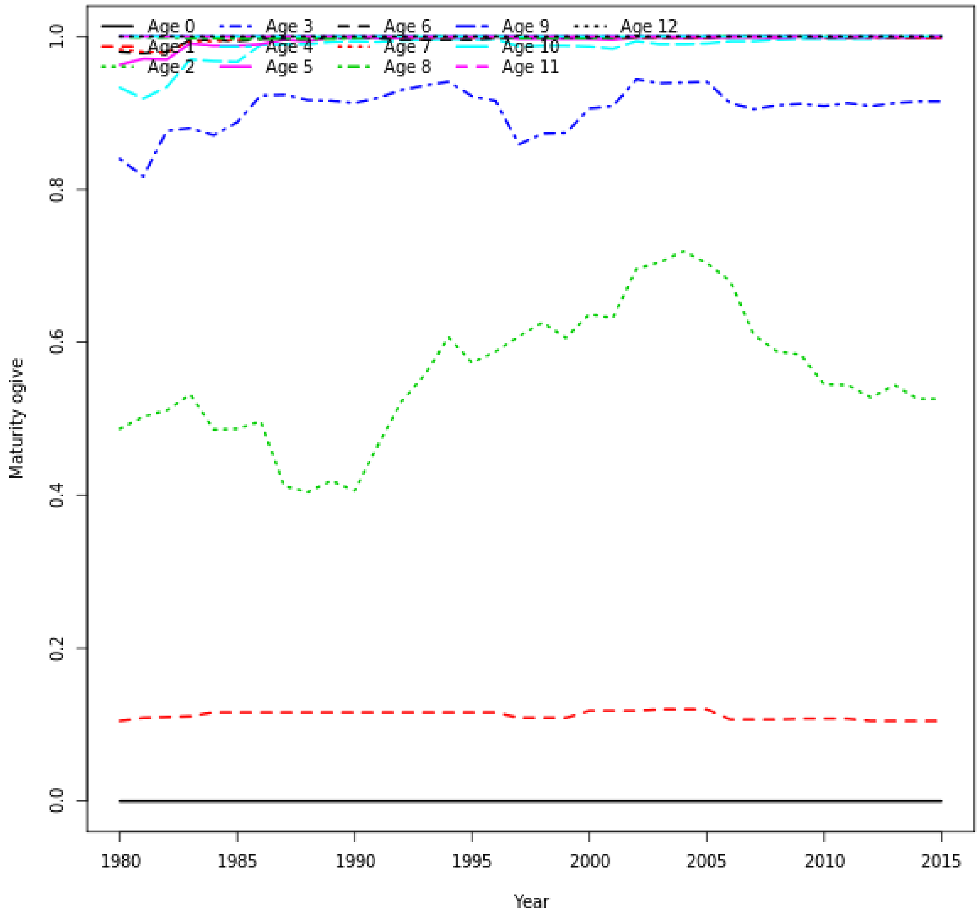


Figure 2.4.3.1. NE Atlantic mackerel. Proportion of mature fish at age.

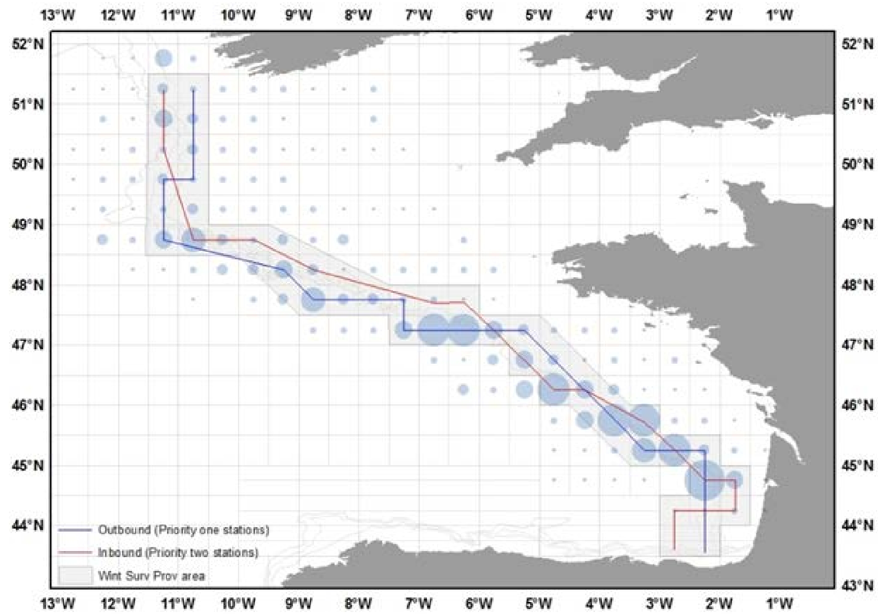


Figure 2.5.1.1.1. Winter Survey Area.

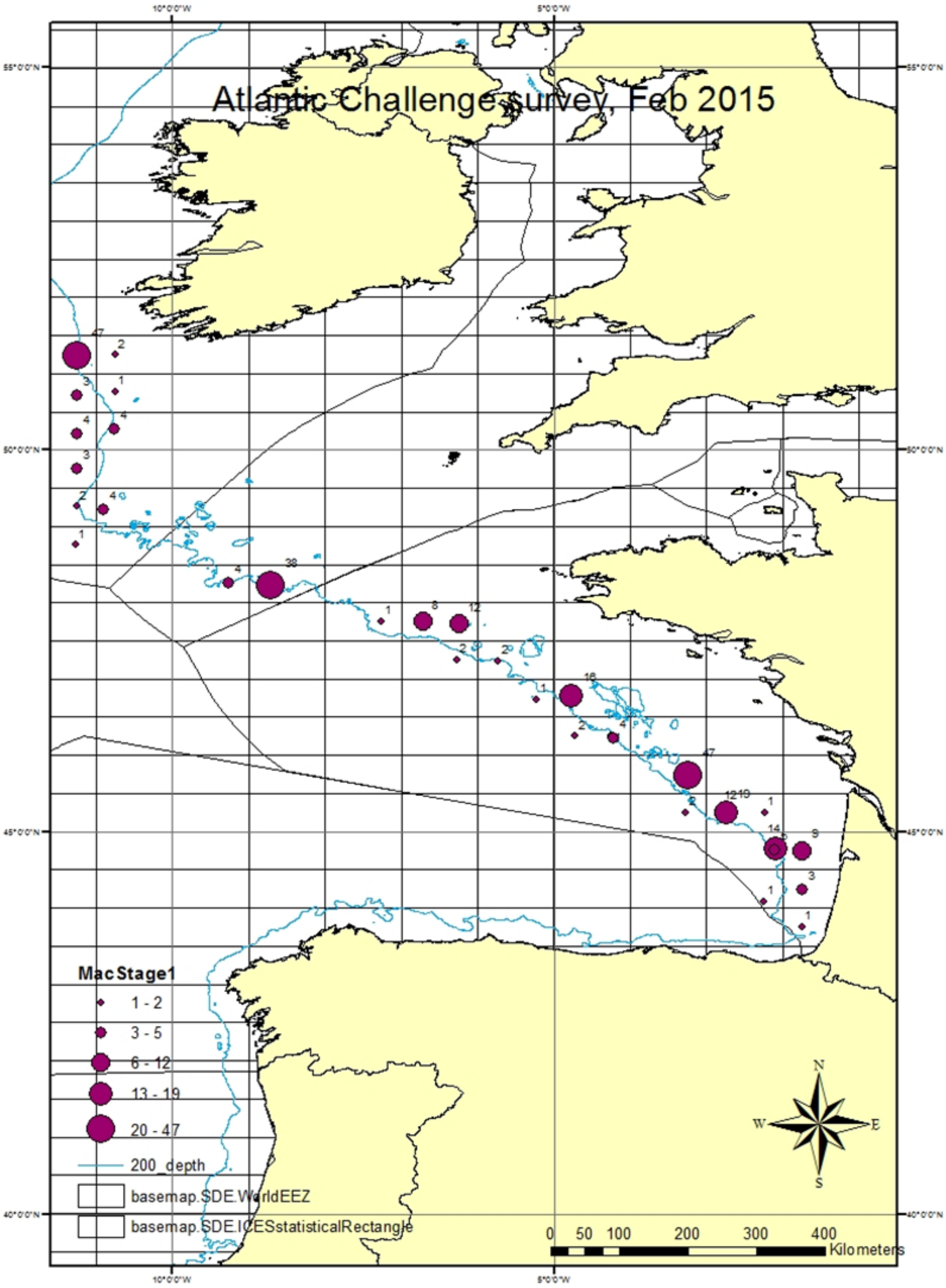


Figure 2.5.1.1.2. Mackerel Stage 1 eggs per station for period 3.

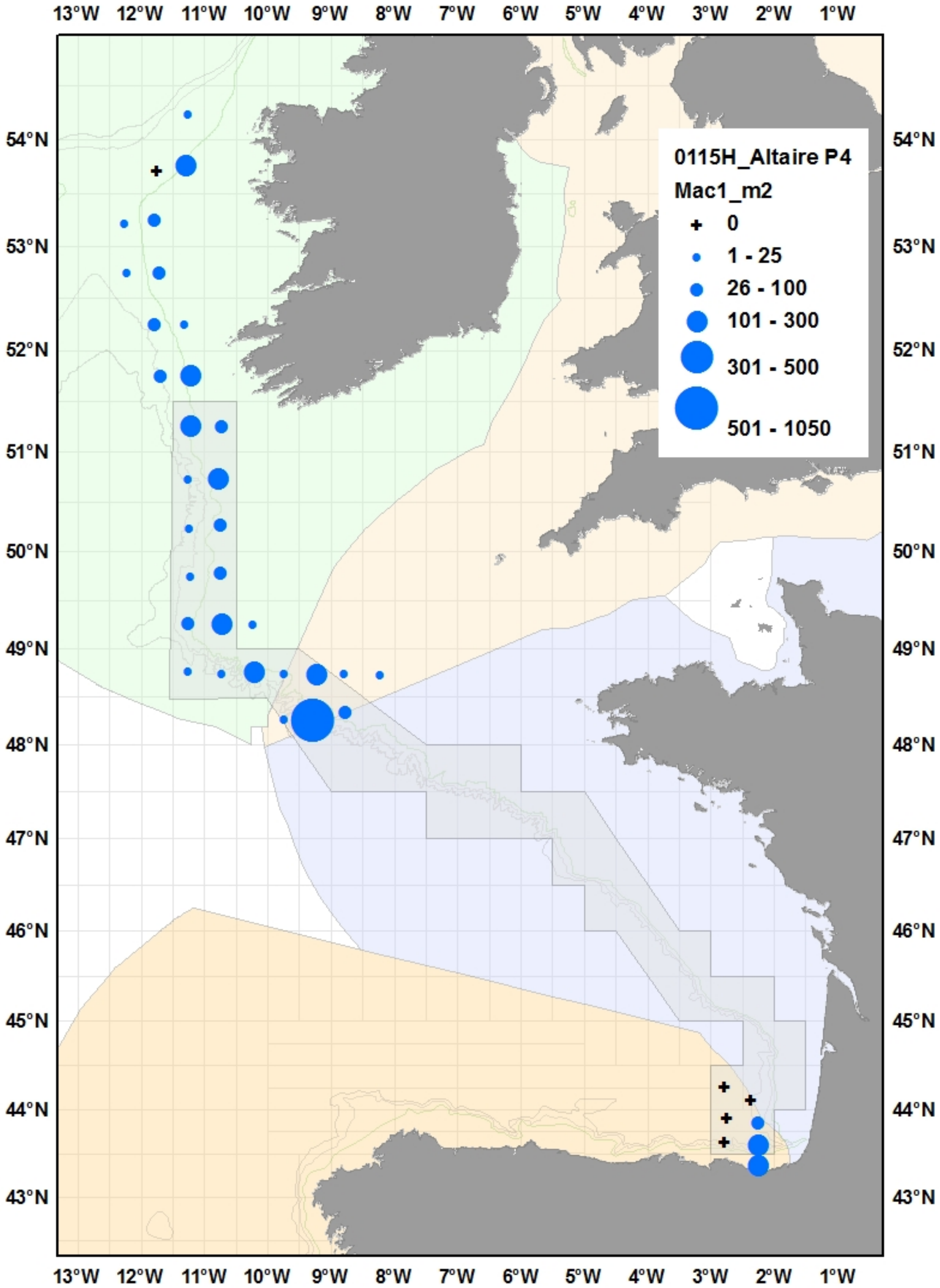


Figure 2.5.1.1.3. Mackerel Stage 1 eggs per m2 for period 4.

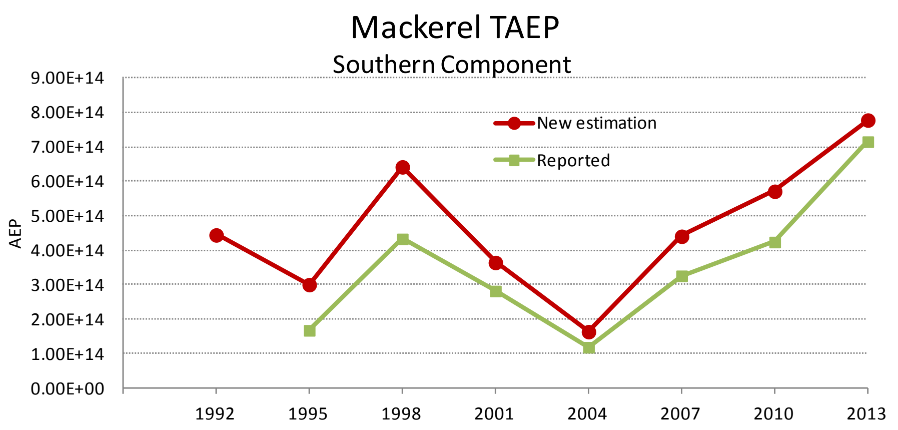


Figure 2.5.1.3.1. Comparison between reported and revised estimation of the Total Annual Egg Production (1992—2013) for mackerel (Southern component).

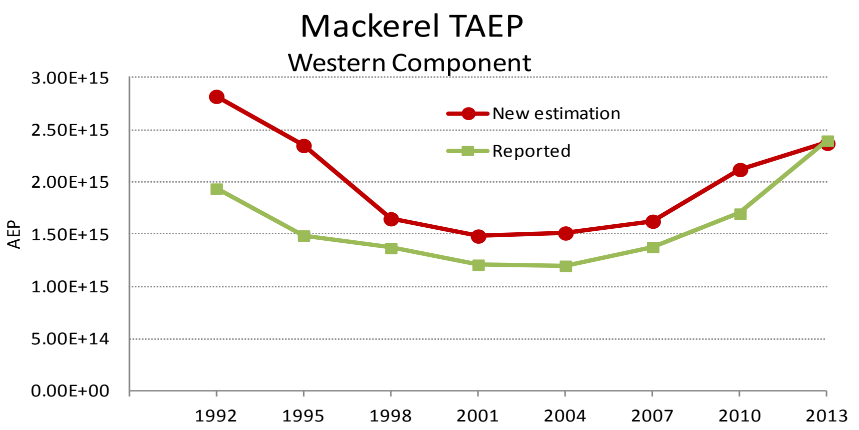


Figure 2.5.1.3.2. Comparison between reported and revised estimation of the Total Annual Egg Production (1992 – 2013) for mackerel (Western component).

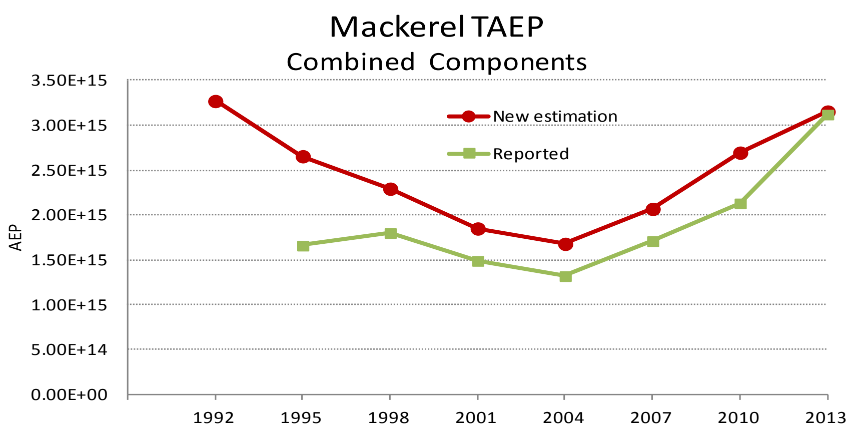


Figure 2.5.1.3.3. Comparison between reported and revised estimation of the Total Annual Egg Production (1992 – 2013) for mackerel (Both components combined).

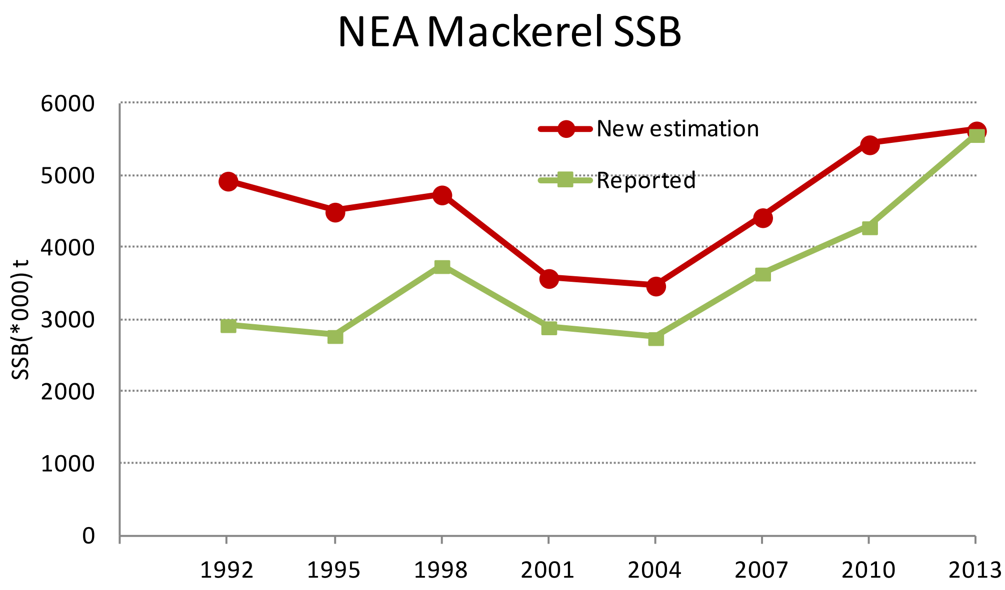


Figure 2.5.1.3.4. Comparison between reported and revised estimation of the Spawning Stock Biomass (1992 – 2013) for NEA mackerel (Both components combined).

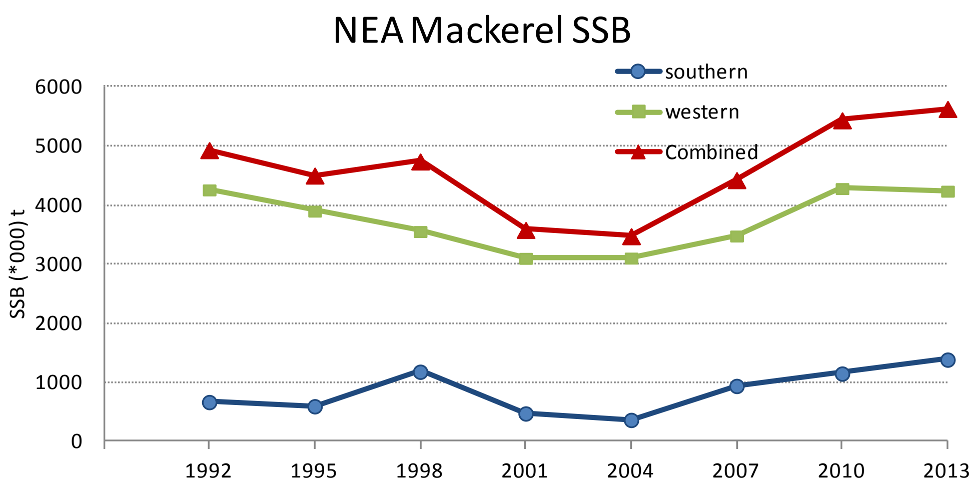


Figure 2.5.1.3.5. Revised estimation of the Spawning Stock Biomass (1992 – 2013) for NEA mackerel (Displayed separately and also with southern and western components combined).

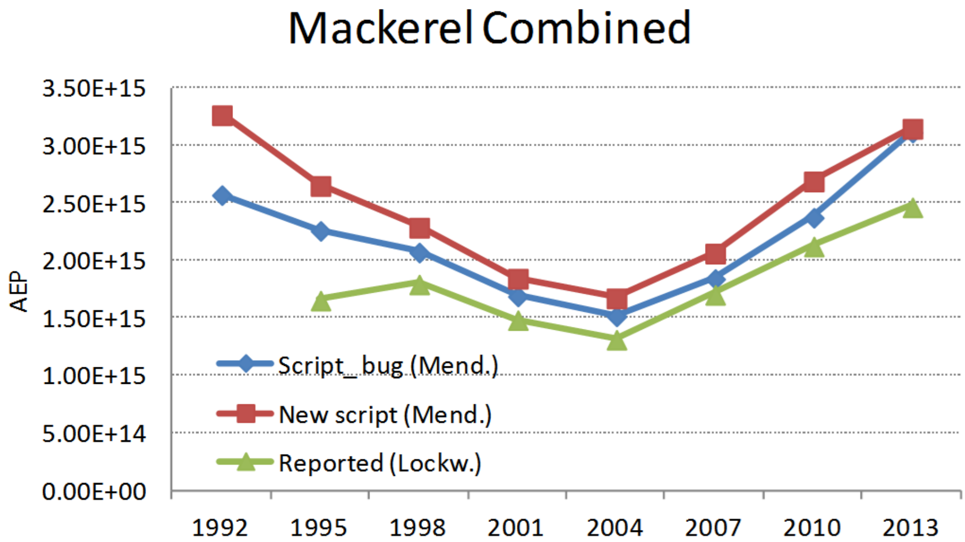


Figure 2.5.1.3.6 Comparison between reported (Lockwood) Total Annual Egg Production (TAEP) estimates, the previous revised estimate calculated using the script with the bug and finally the newly revised estimation of the Total Annual Egg Production for mackerel calculated using the corrected scripts (Both components combined).

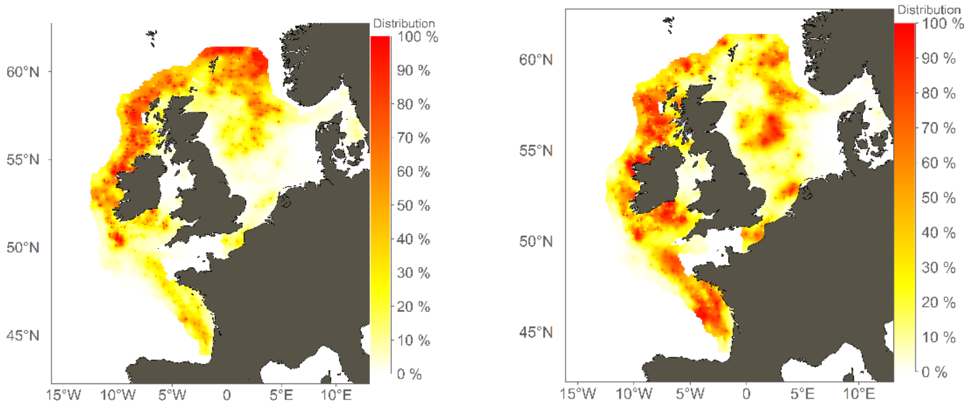


Figure 2.5.2.1. Distributions of modelled squared catch rates of mackerel at approximately 3-9 months of age in first and fourth quarter demersal trawl surveys. Left) average rates for cohorts from 1998-2014, and Right) 2014. See Jansen *et al.* (2015) for details.

Figure 2.5.2.2. IBTS recruitment index derived from square root transformed CPUE. See Jansen *et al.*(2015) for details.

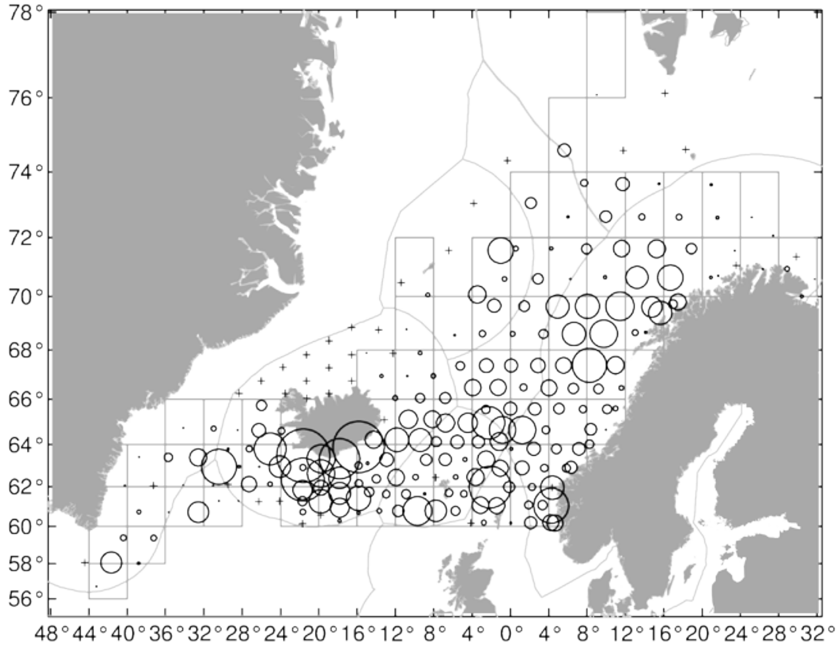


Figure 2.5.3.1. Stations and catches of mackerel in the IESSNS survey in July/August 2015 where the circles size is proportional to square root of catch (kg/km²) and stations with zero catches are denoted with +. Rectangle grid (2° by 4°) used for averaging overlaid.

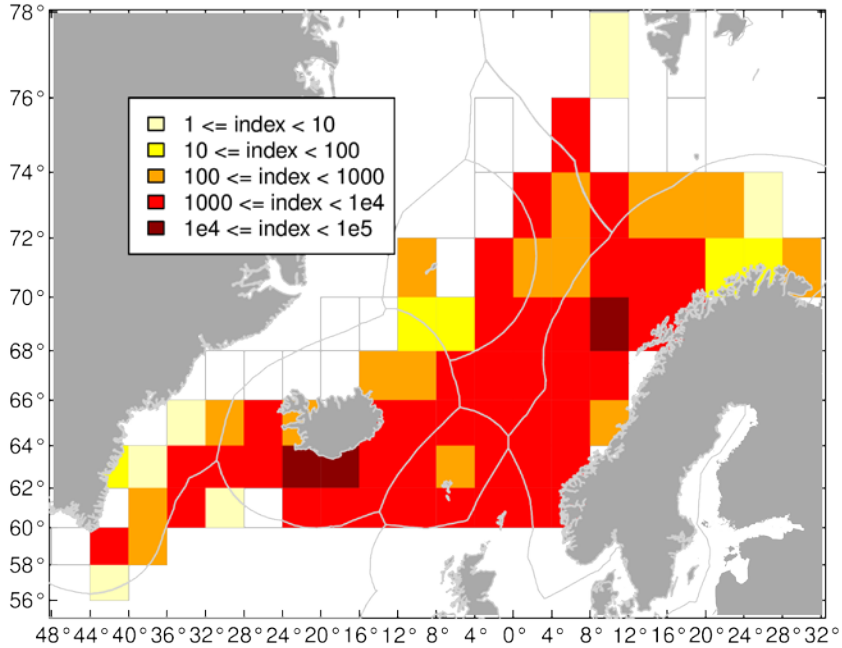


Figure 2.5.3.2. Standardized mackerel catch rates (kg/km2) for mackerel in the IESSNS survey in July/August 2015 represented graphically. Empty rectangles shown in the map indicate that trawling has been done, but where no mackerel was caught.

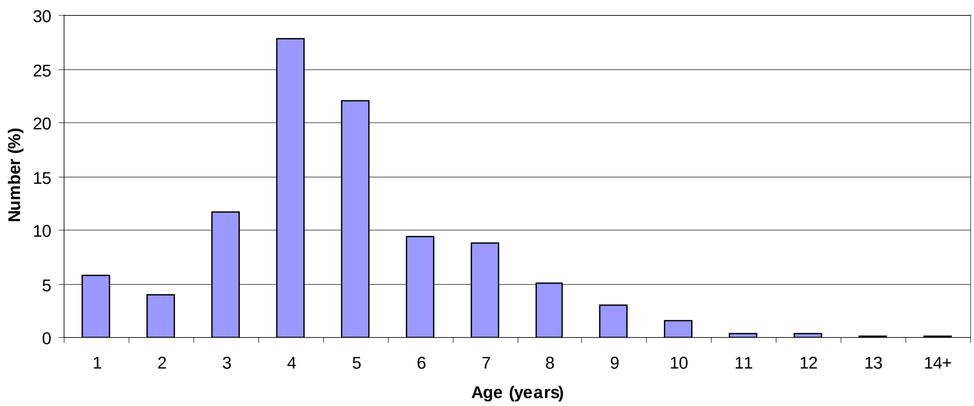


Figure 2.5.3.3. Age distribution in percent (%) of Atlantic mackerel, in the Nordic Seas according to IESSNS in July/August 2015.

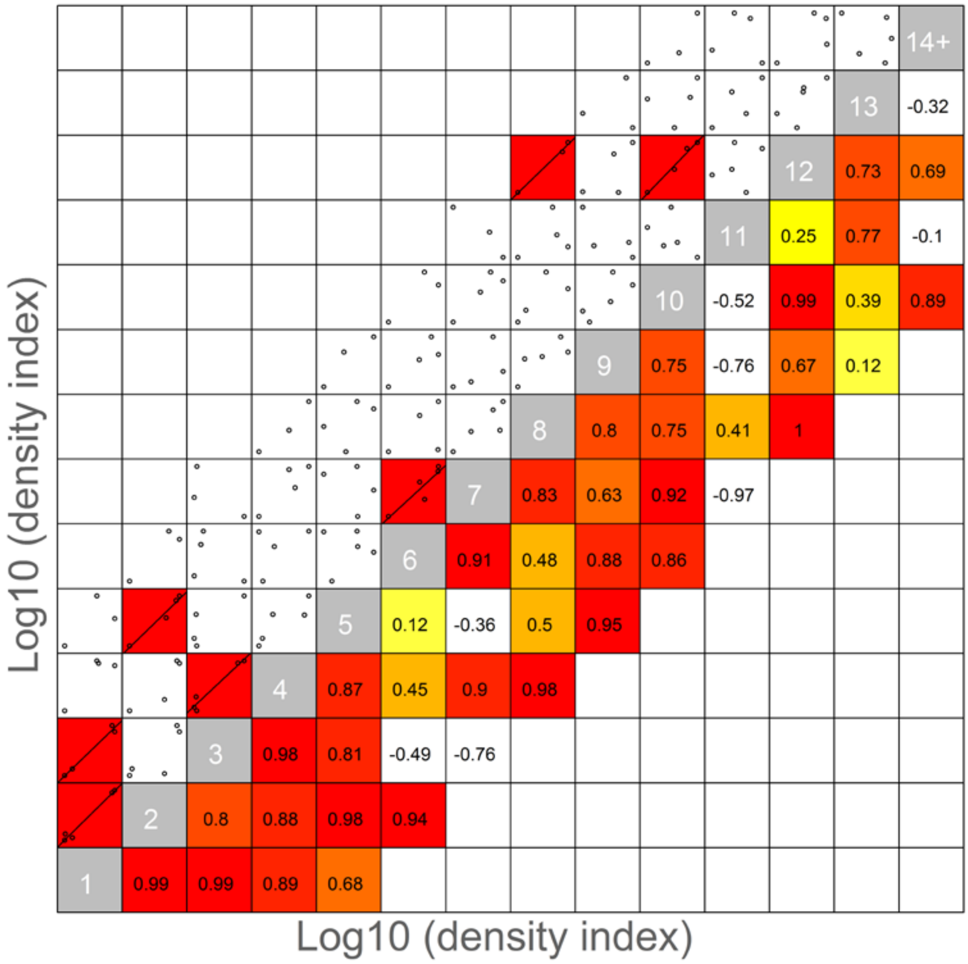


Figure 2.5.3.4. Internal consistency of mackerel density index in the IESSNS surveys from 2007-2015. Ages indicated by white numbers in grey diagonal cells. Statistically significant positive correlations (*p<0.05*) are indicated by regression lines and red cells in upper left half. Correlation coefficients (r) are given in the lower right half.

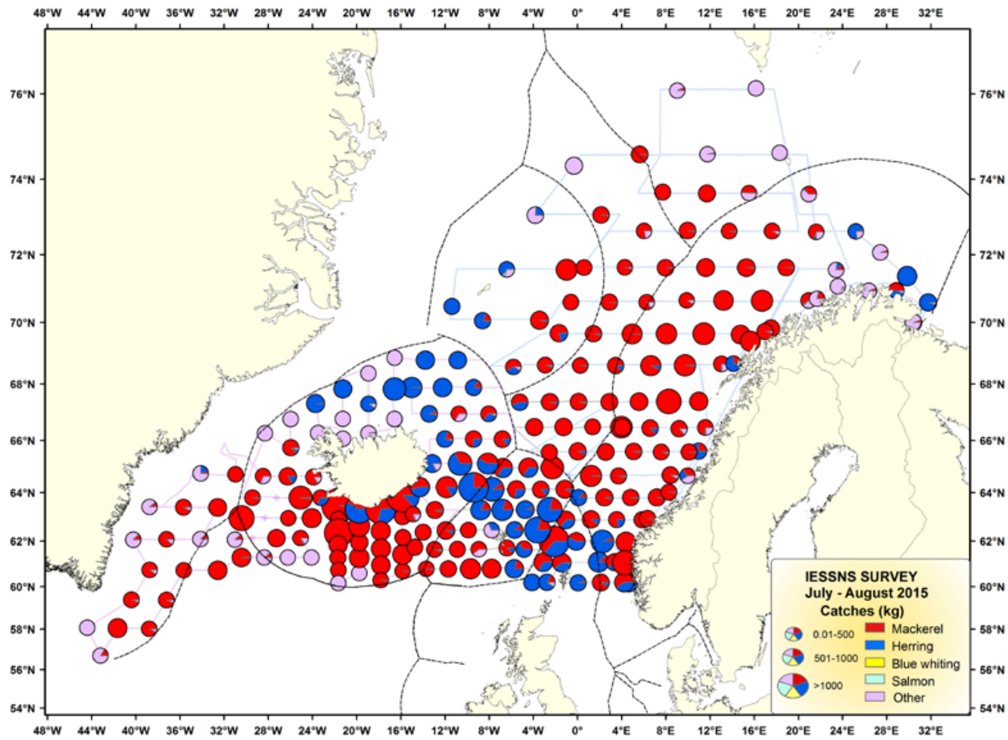


Figure 2.5.3.5. Distribution and spatial overlap between mackerel (red), herring (blue), blue whiting (yellow) and salmon (turquoise) from the IESSNS joint ecosystem survey conducted onboard M/V "Brennholm" and M/V "Eros" (Norway), M/V "Christian í Grótinum" (Faroe Islands) and R/V "Árni Friðriksson" (Iceland) in the Norwegian Sea and surrounding waters between 1st of July to 10th of August 2015. Vessel tracks are shown as continuous lines.

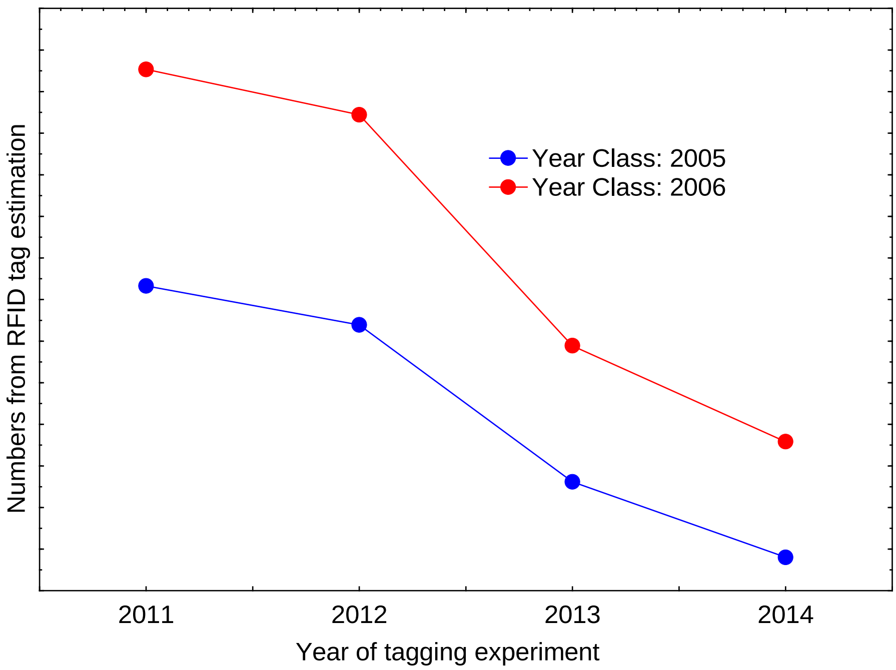


Figure 2.5.4.1. Example of yearly estimates of mackerel abundance of year classes 2005-2006 based on RFID tag-recapture data (preliminary exploration).

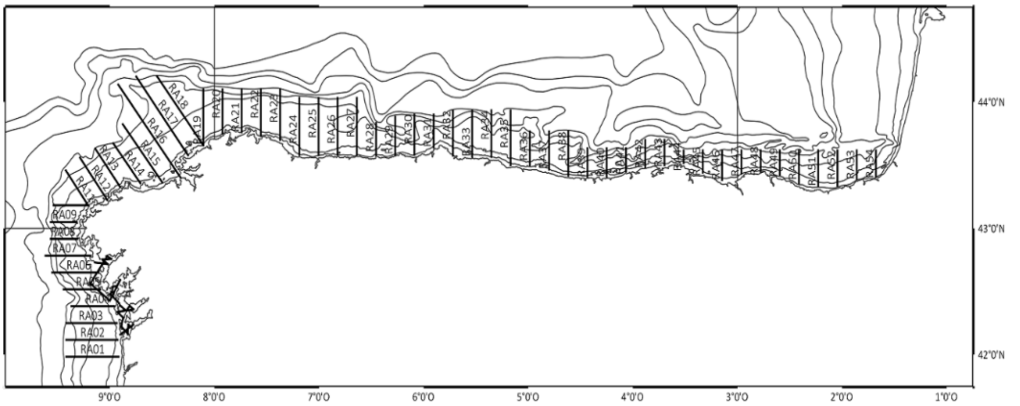


Figure 2.5.5.2.1: Survey track for PELACUS 0315.

Figure 2.5.5.2.2: Sea Surface Temperature from continuous record during PELACUS 0315.

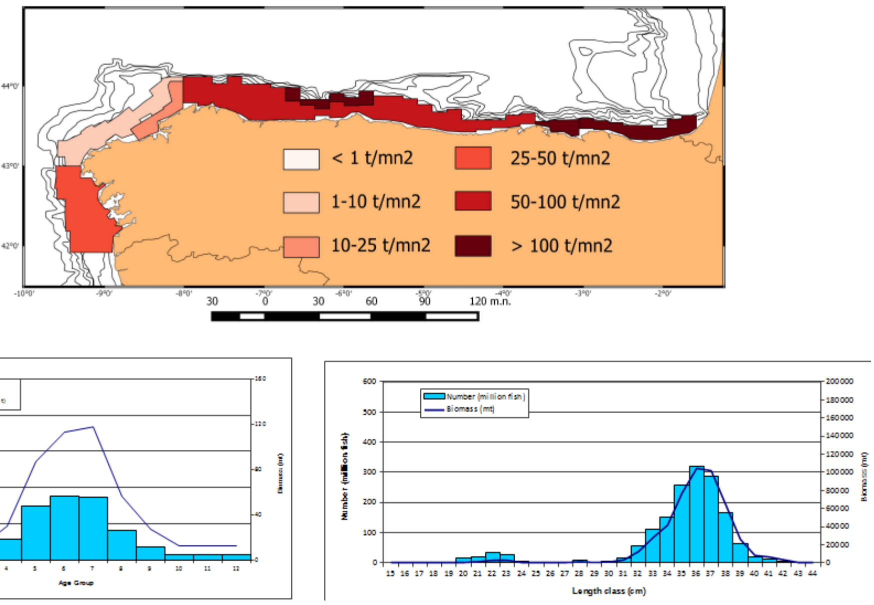


Figure 2.5.5.2.3: Mackerel distribution density and assessment by age group (bottom left) and by length class (bottom right).

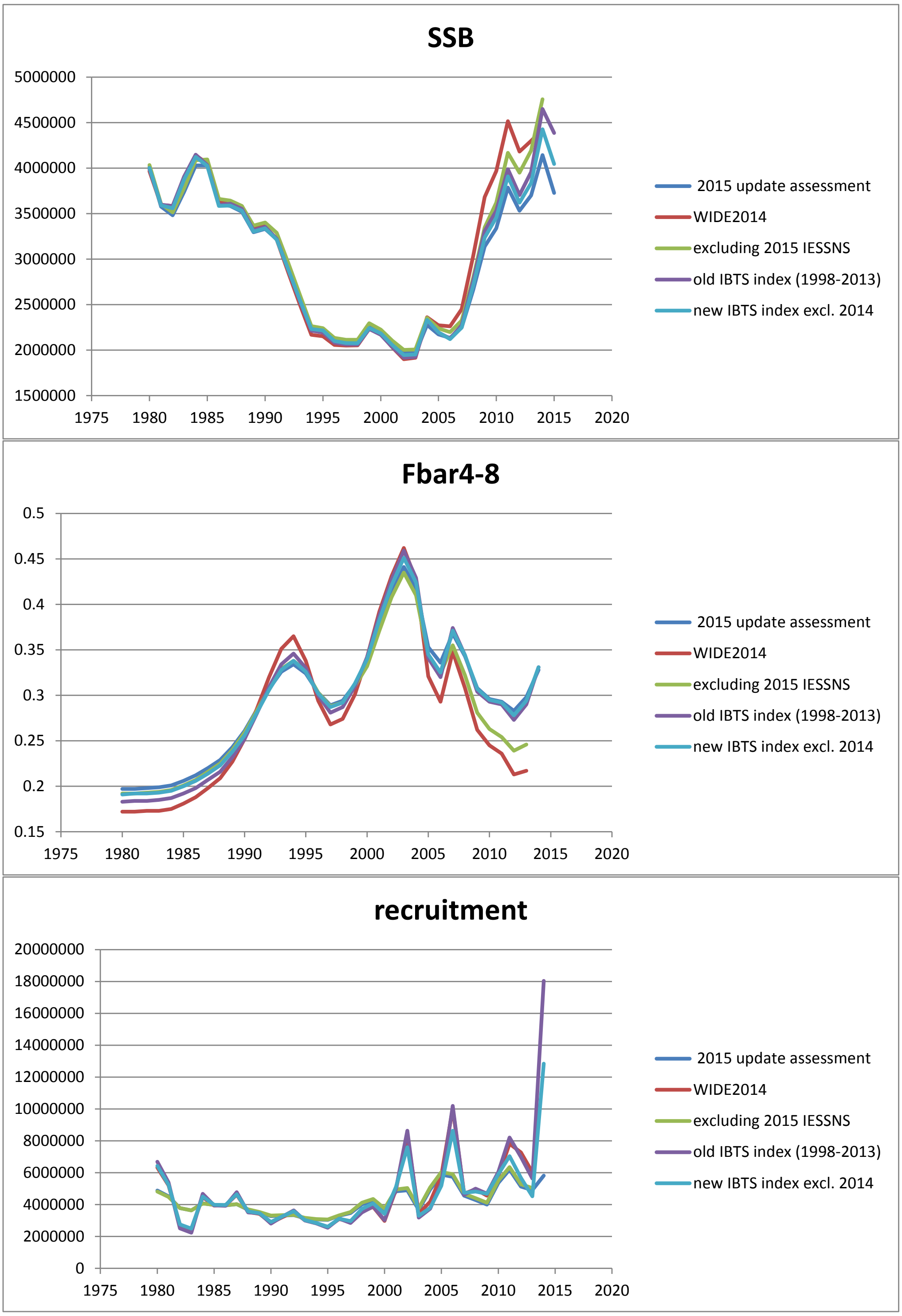


Figure 2.6.2.1. NE Atlantic mackerel. Comparison of stock trajectories from the 2015 update assessment, the 2014 WGWIDE assessment and 4 different assessment *in which part of the survey data was modified.*

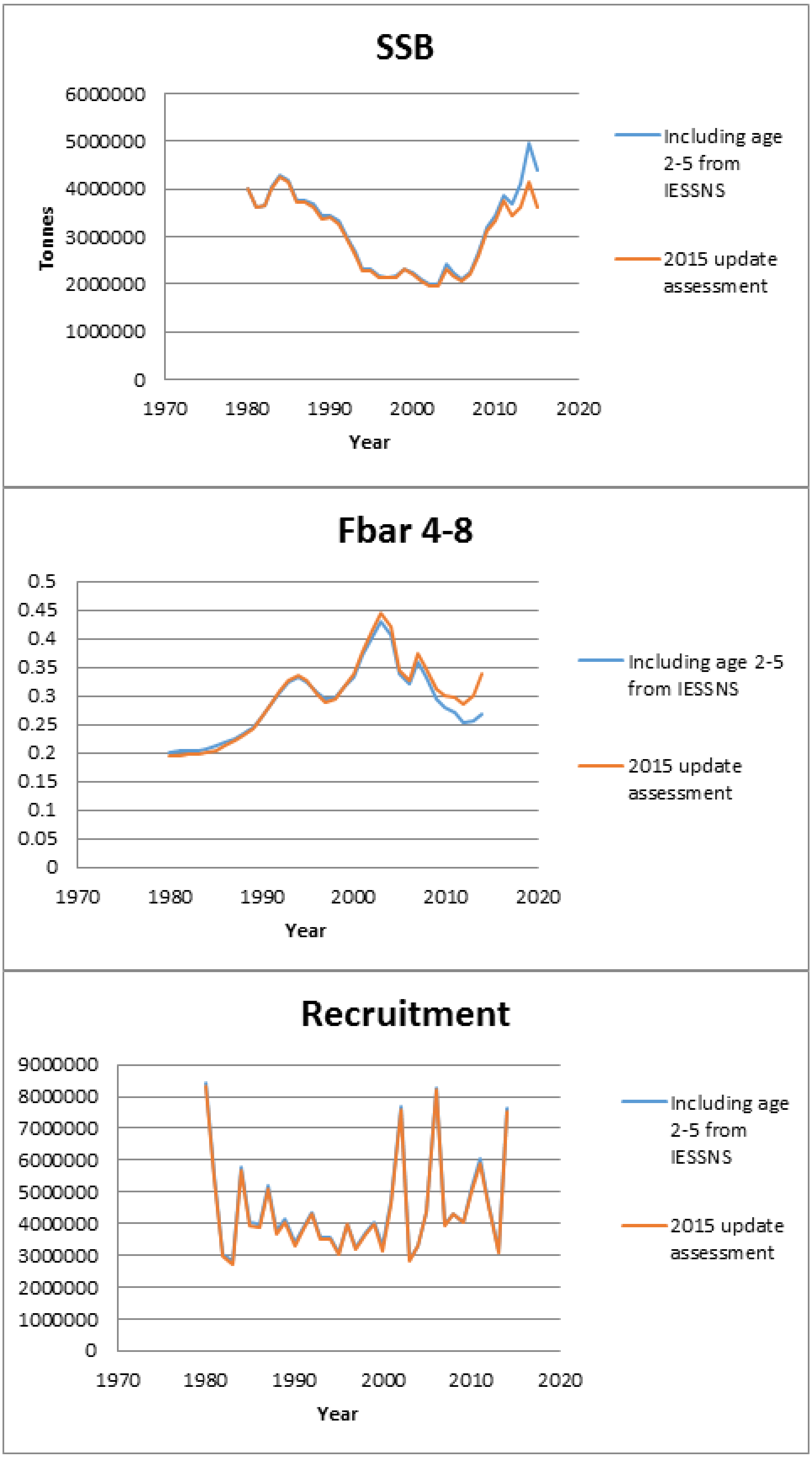


Figure 2.6.2.2. NE Atlantic mackerel. Comparison of stock trajectories from the 2015 update assessment and the assessment including age 2-5 from IESSNS.

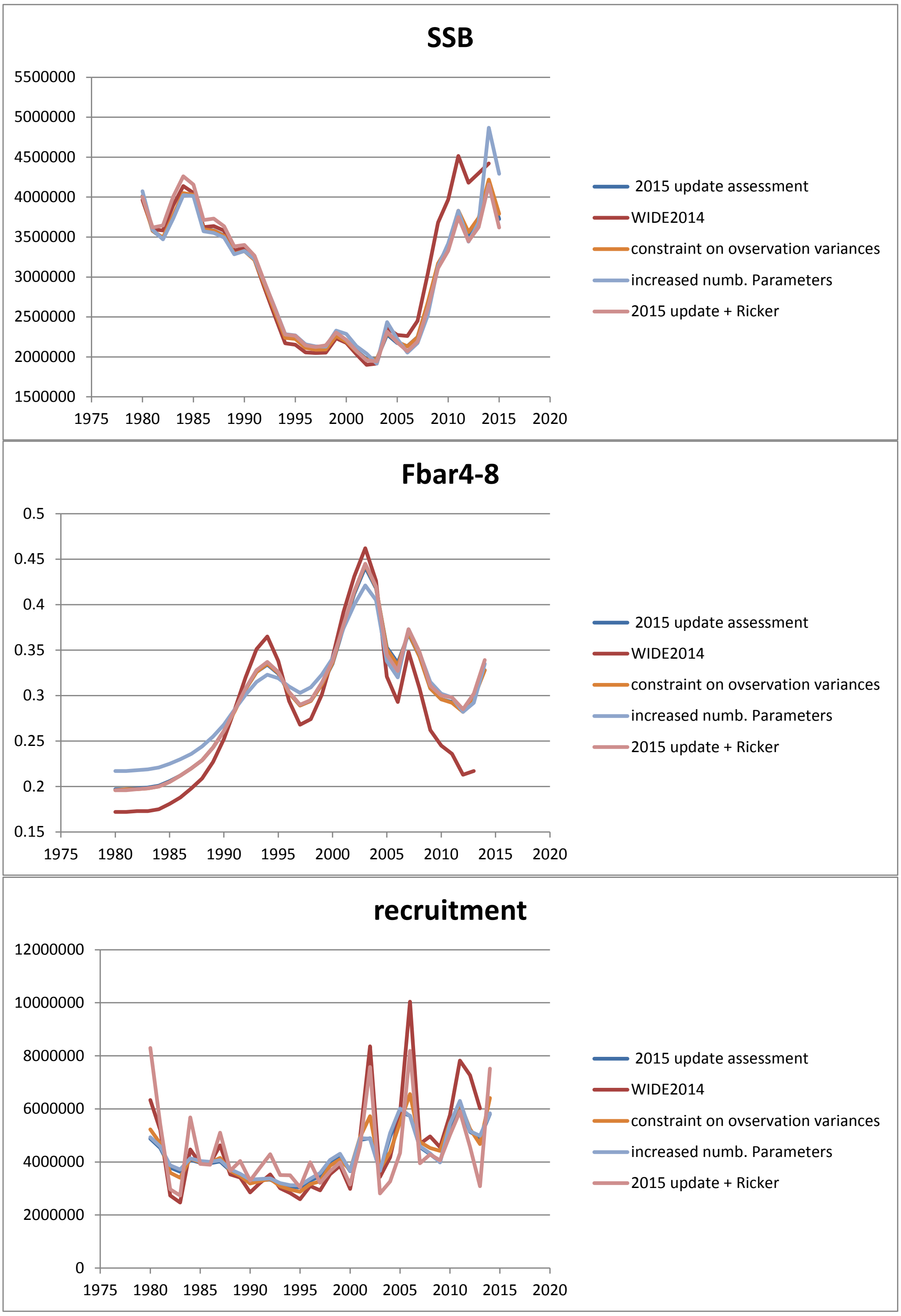


Figure 2.6.2.3. NE Atlantic mackerel. Comparison of stock trajectories from the 2015 update assessment, the 2014 WGWIDE assessment and 4 different assessment *with 3 exploratory runs in which model configuration was modified.*

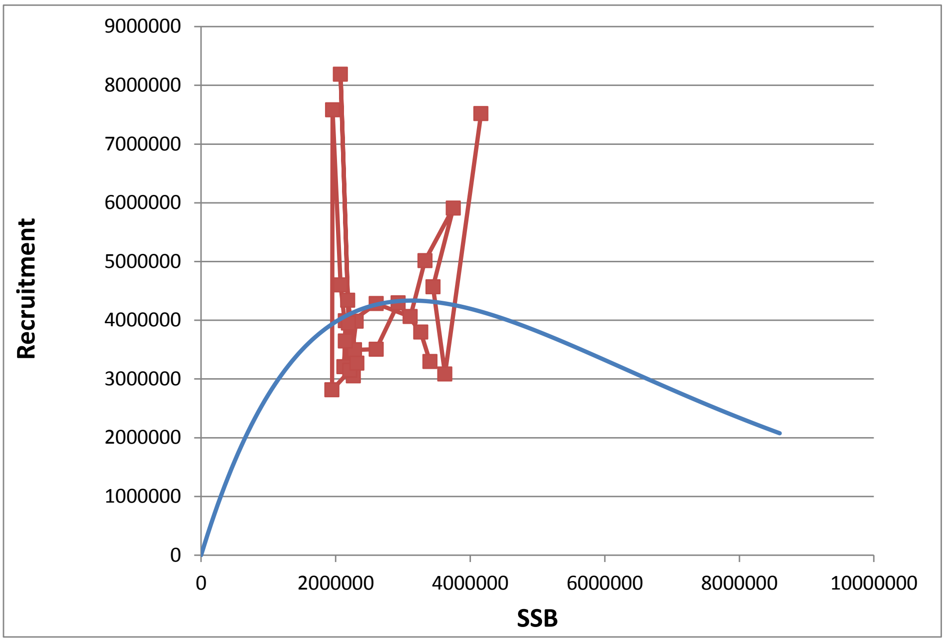


Figure 2.6.2.4. NE Atlantic mackerel. Stock recruitment estimates and underlying Ricker model for the 2015 assessment model in which the random walk on recruitment has been replaced by a Ricker stock recruitment relationship.

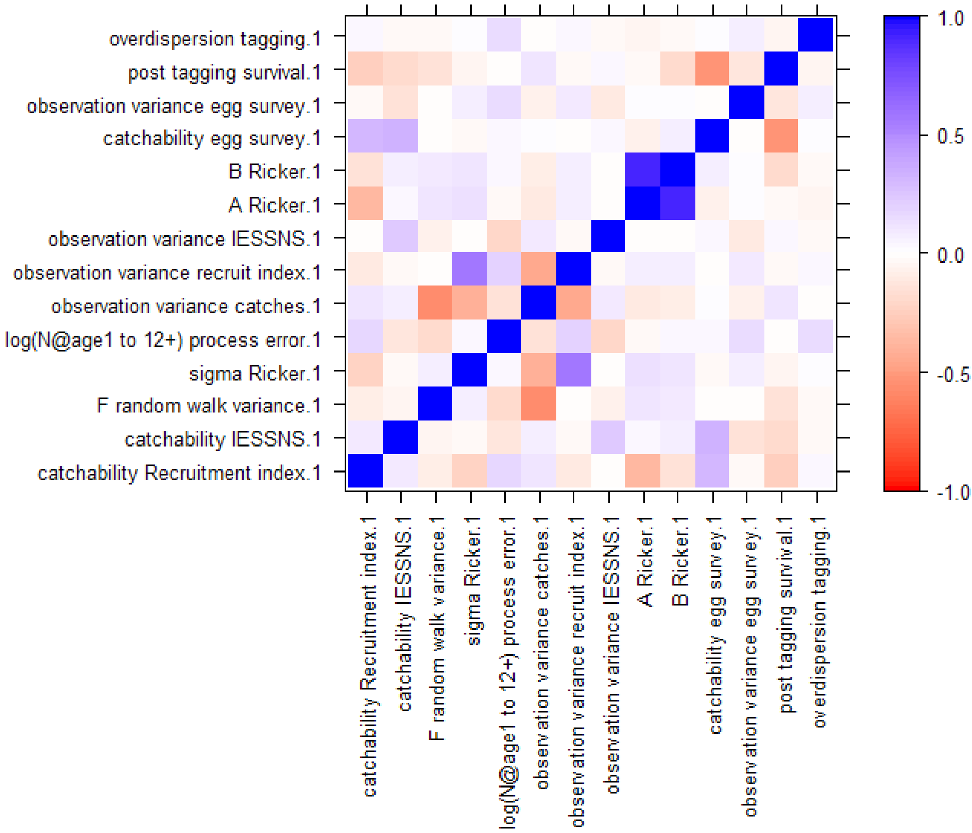


Figure 2.6.3.1. NE Atlantic mackerel. Parameter correlations for the final model. The horizontal and vertical axes show the parameters estimated by the model. The colouring indicates the (Pearson) correlation between the two parameters.

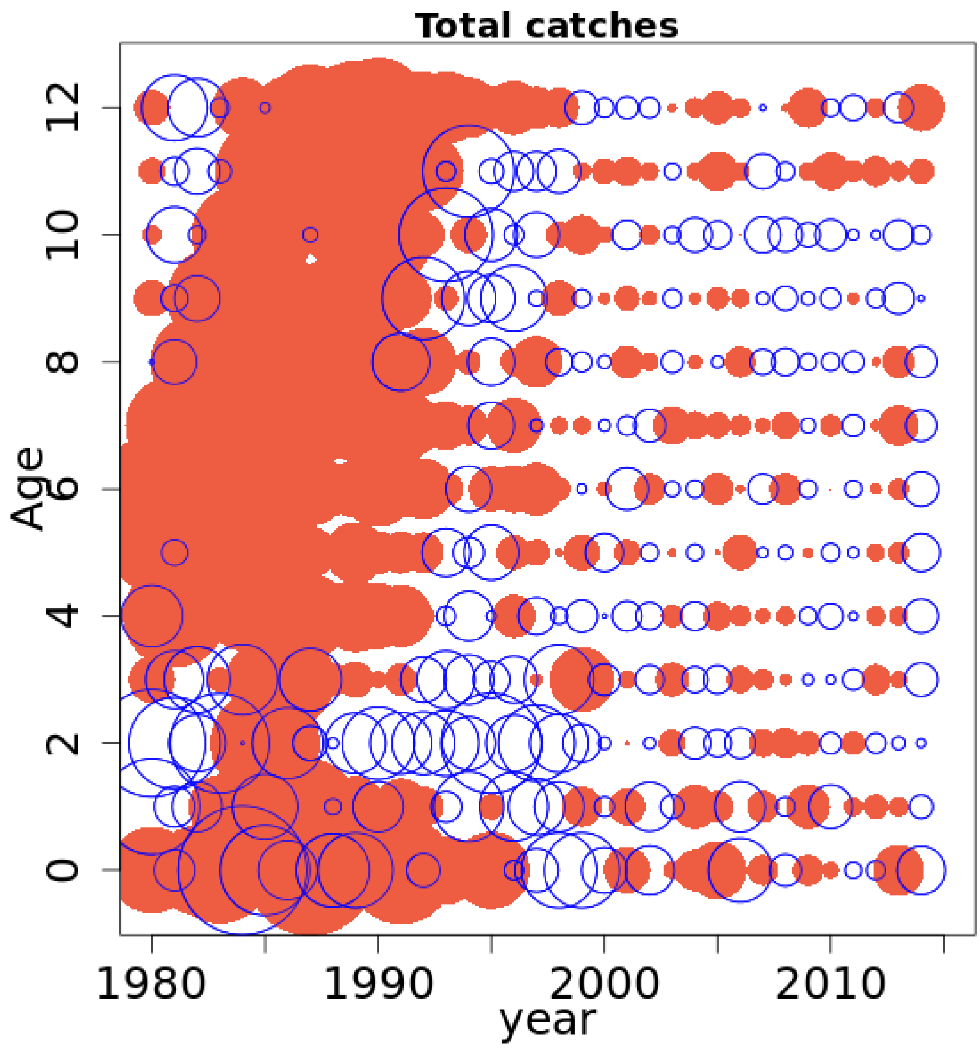


Figure 2.6.3.2. NE Atlantic mackerel. Normalized residuals for the fit to the catch data (catch data prior to 2000 were not used to fit the model). Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

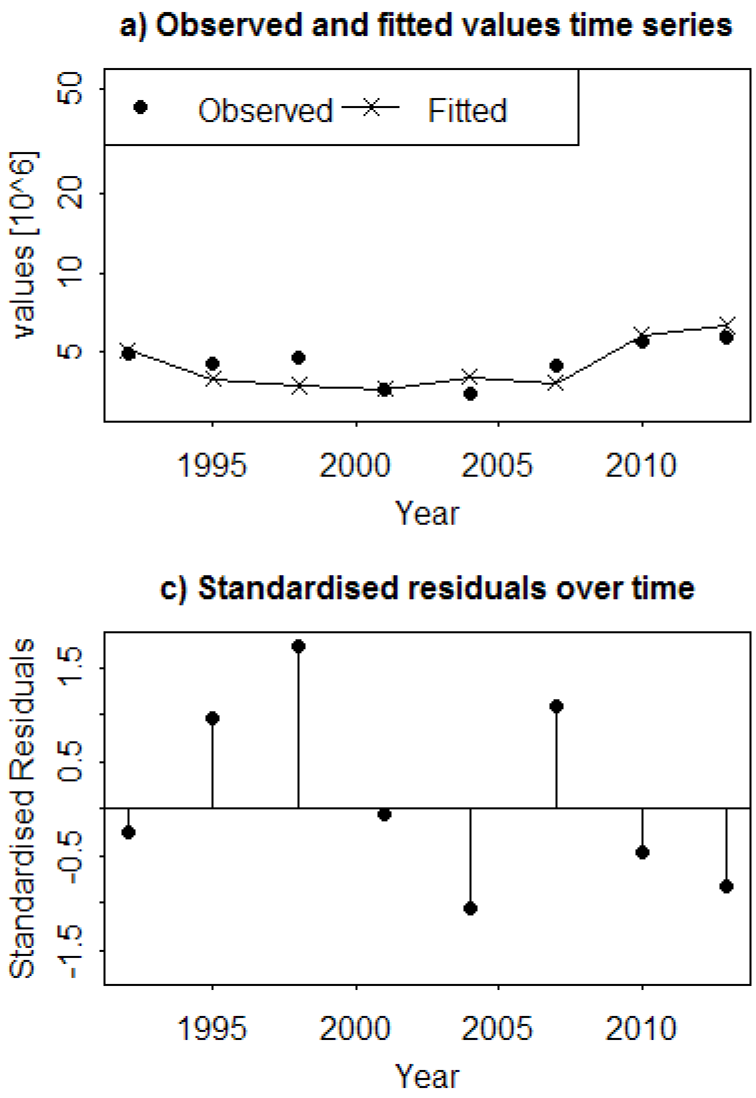
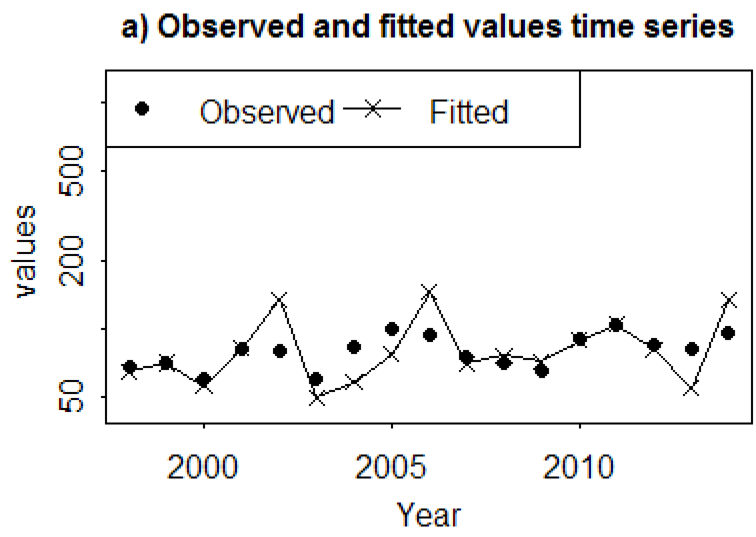


Figure 2.6.3.3. NE Atlantic mackerel. Model diagnostics for the fit to the egg survey index time-series.



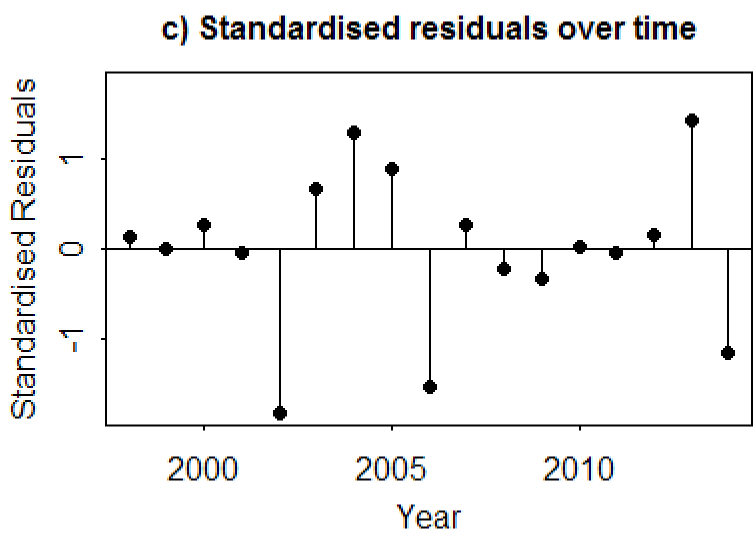


Figure 2.6.3.4. NE Atlantic mackerel. Model diagnostics for the fit to the recruitment index time-series.

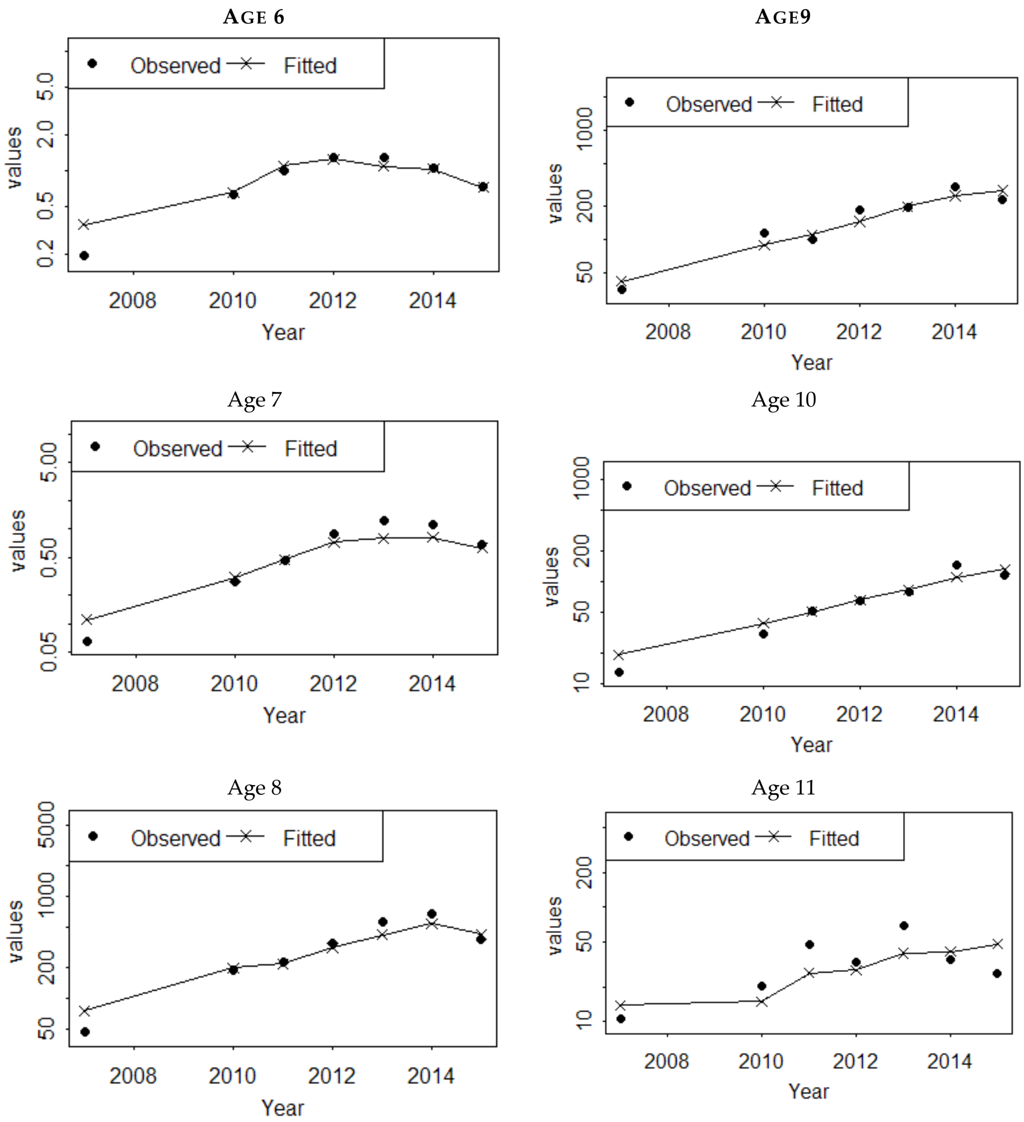


Figure2.6.3.5. NE Atlantic mackerel. Fit of the final assessment to the IESSNS indices for ages 6 to 11 (observed vs. fitted).

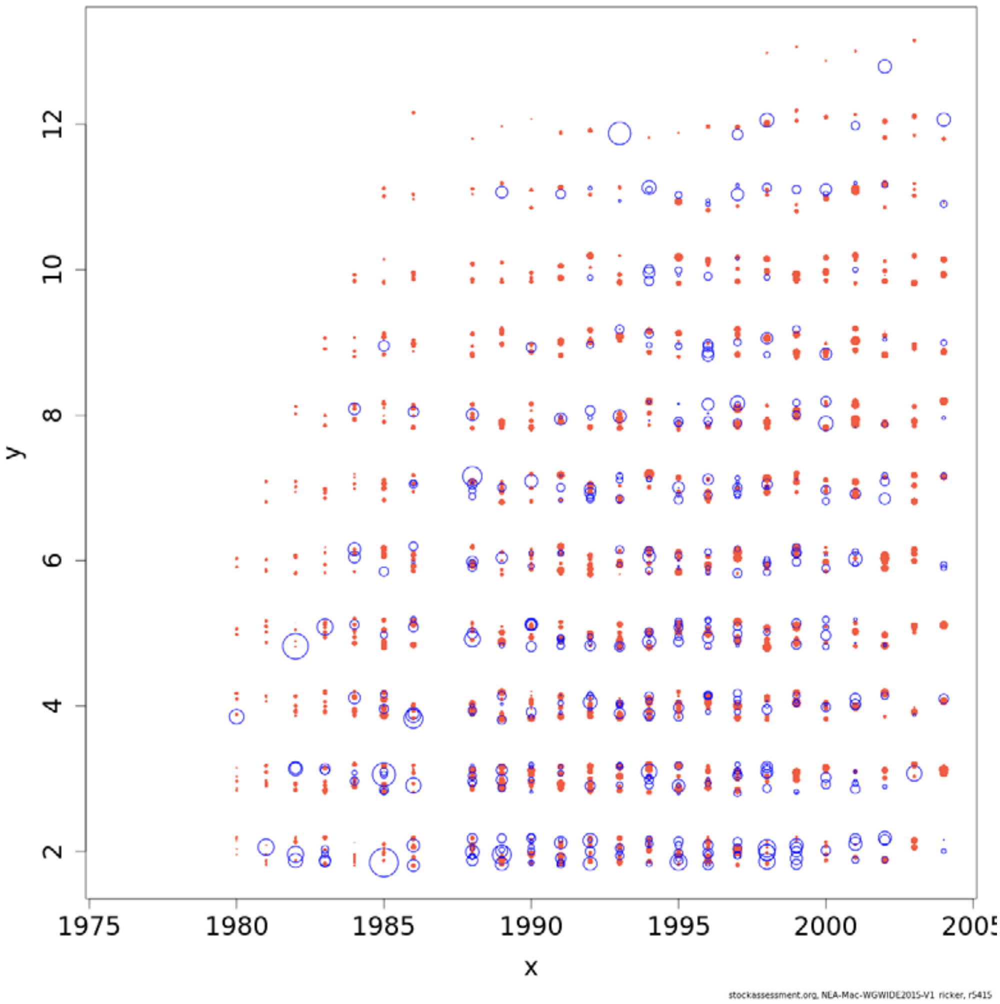


Figure2.6.3.6. NE Atlantic mackerel. Normalized residuals for the fit to the recaptures of tags in the final assessment. The x-axis represents the release year, and the y-axis is the age of the fish at release. The different circles for a same x-y point represent the successive recaptures. Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

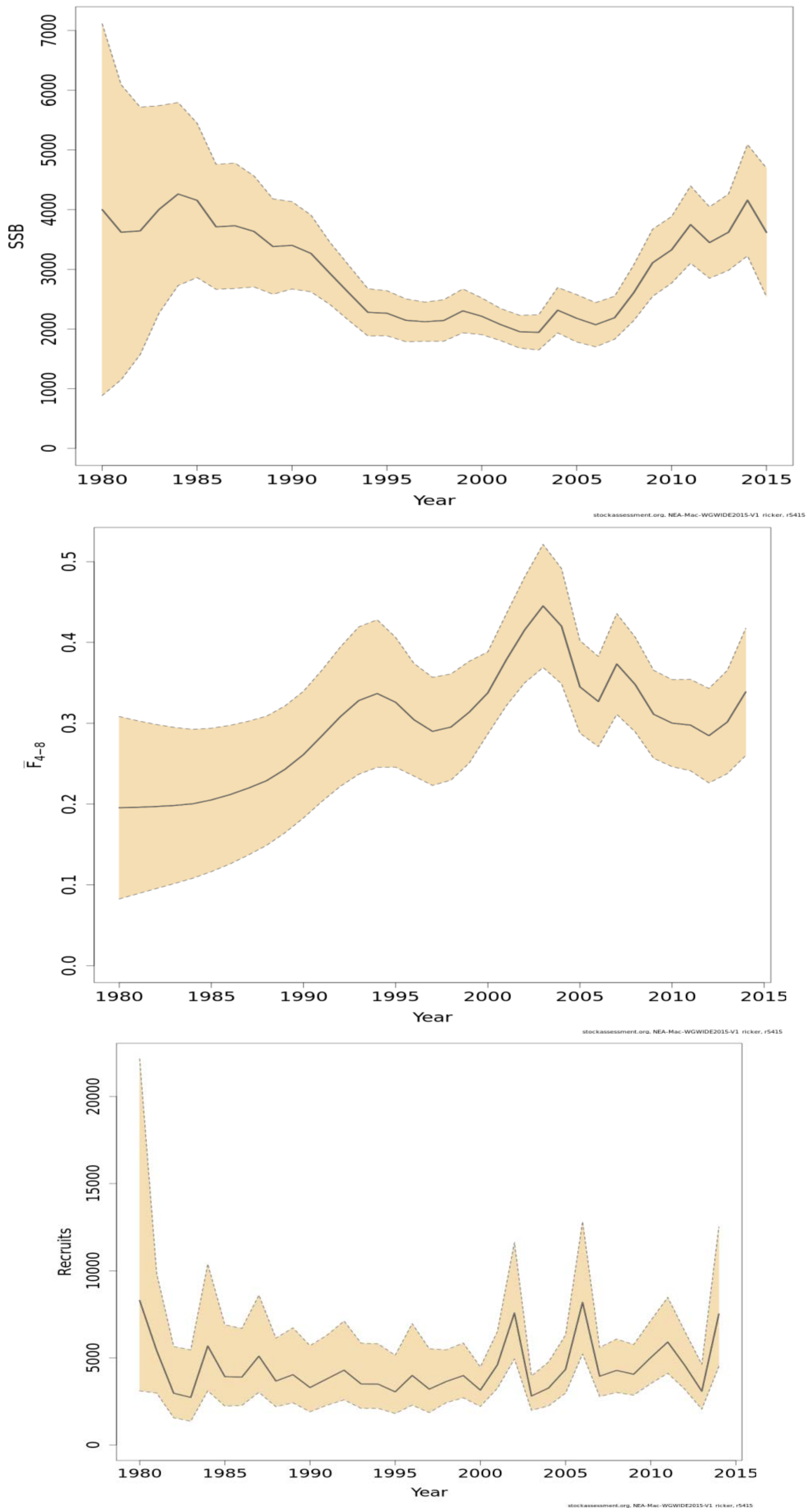


Figure2.6.3.7. NE Atlantic mackerel. Perception of the NEA mackerel stock, showing the SSB, Fbar4-8 and recruitment (with 95% confidence intervals) from the SAM assessment.

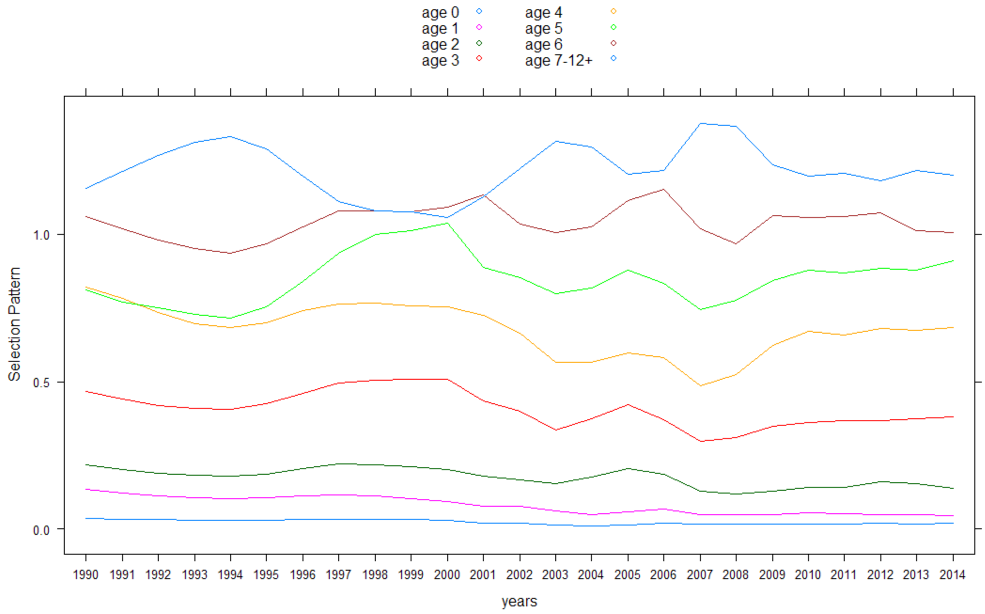


Figure 2.6.3.8. NE Atlantic mackerel. Estimated selectivity for the period 1990 to 2014, calculated as the ratio of the estimated fishing mortality-at-age and the Fbar4-8 value in the corresponding year.

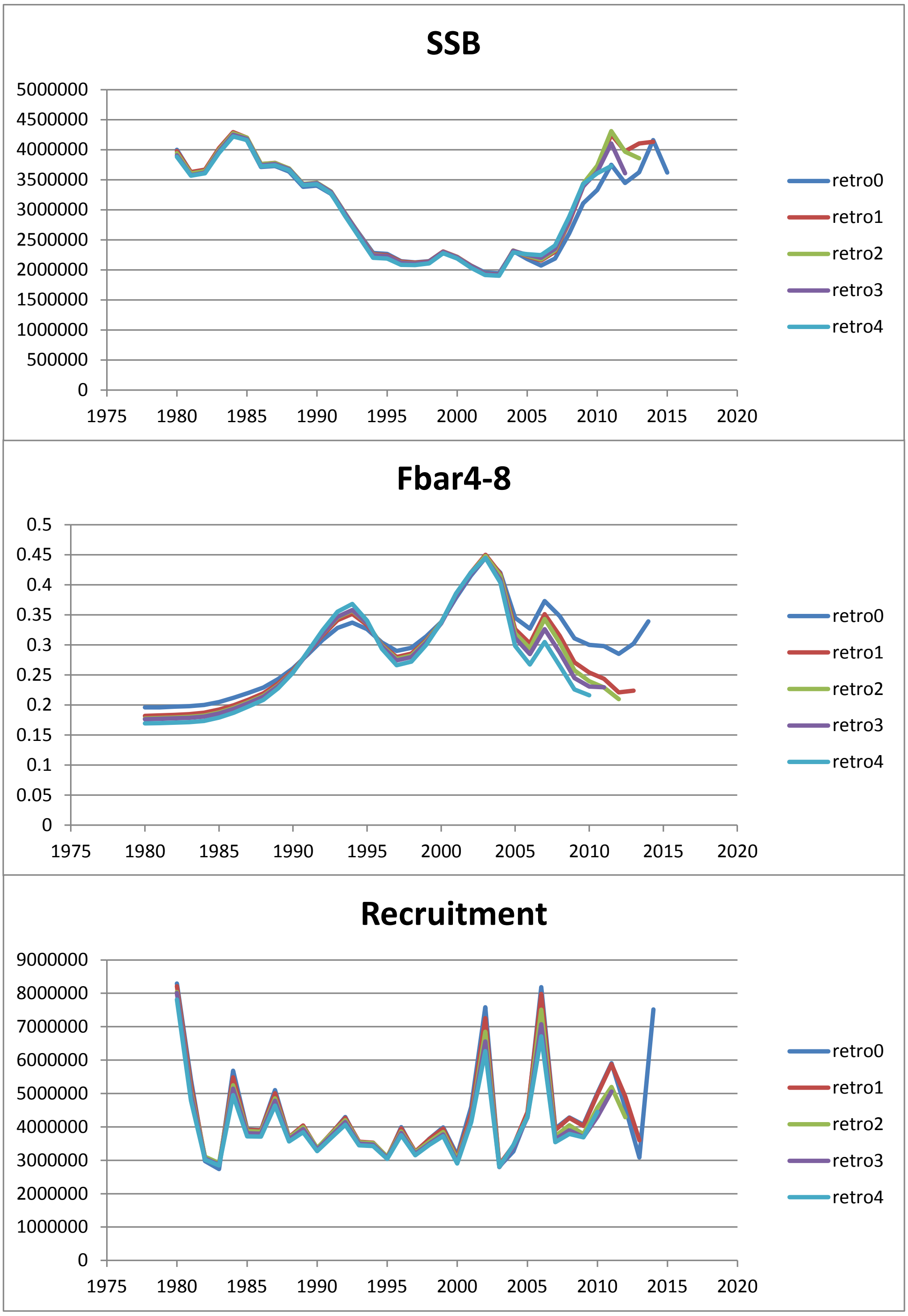


Figure 2.6.3.9. NE Atlantic mackerel. Analytical retrospective patterns (2014 to 2011) of SSB, Fbar4-8 and recruitment from the benchmarked SAM assessment.

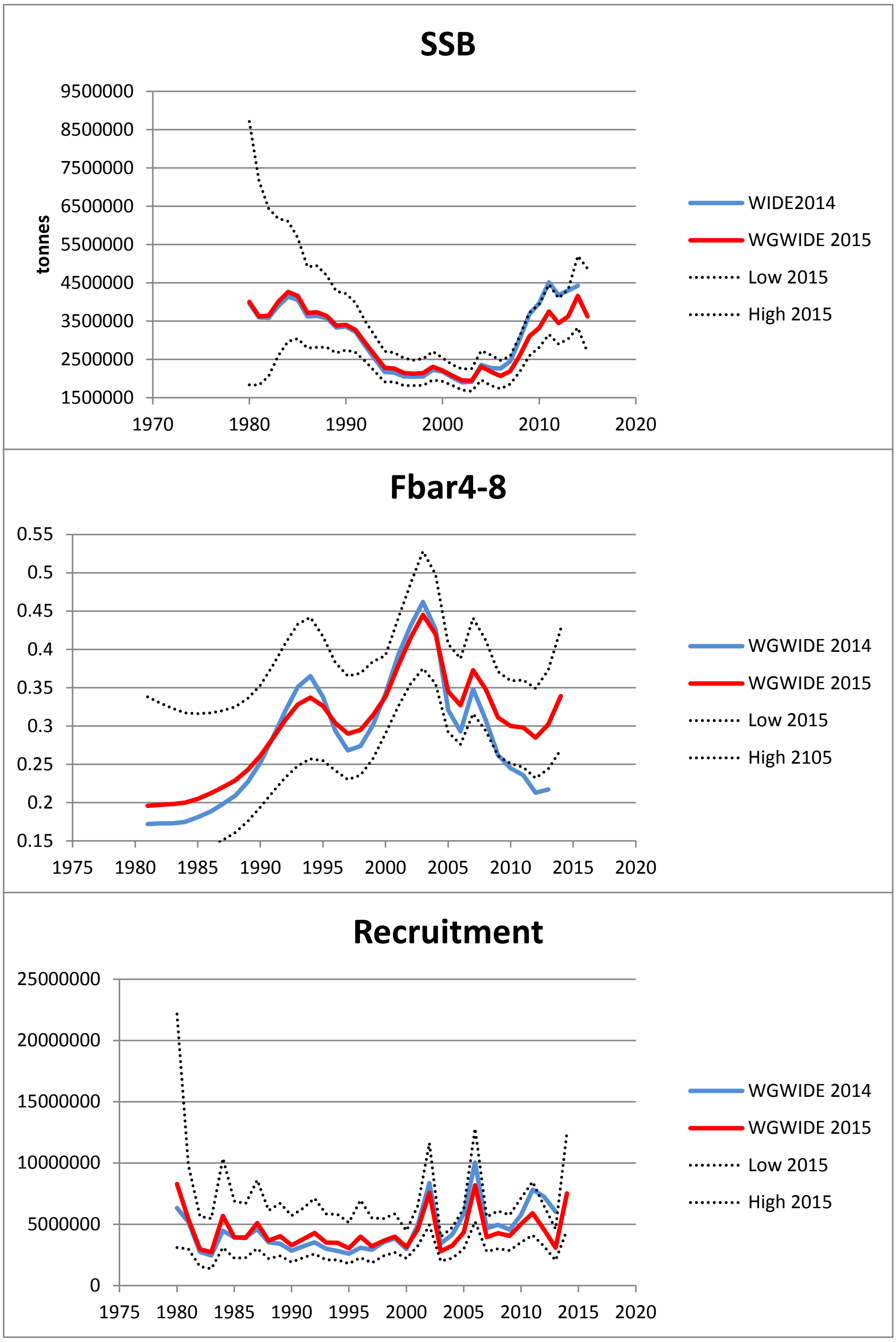


Figure 2.9.1. NE Atlantic mackerel. Comparison of the stock trajectories between the 2015 WGWIDE assessment and the 2014 WGWIDE assessment.

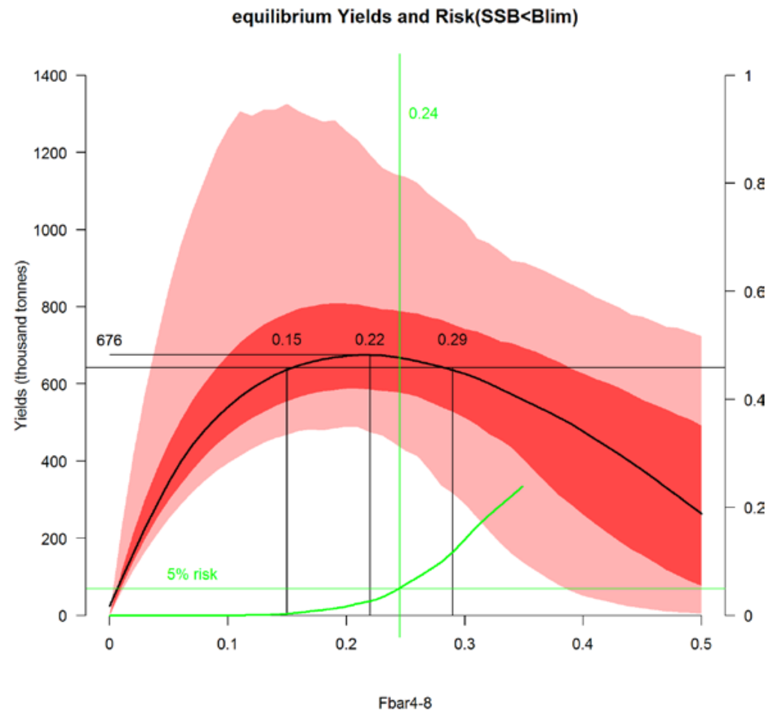


Figure 2.12.2.1 Equilibrium yields as a function of $F_{bar,4\text{–}8}$ (black line: median over the 1000 replicates, dark and light red area: 50% and 90% of the distribution among the 1000 replicates). The green line represent the probability of SSB< B_{lim}, calculated with implementing the ICES MSY advice rule with a MSY $B_{trigger}$ of 3.0 Mt in the simulations.

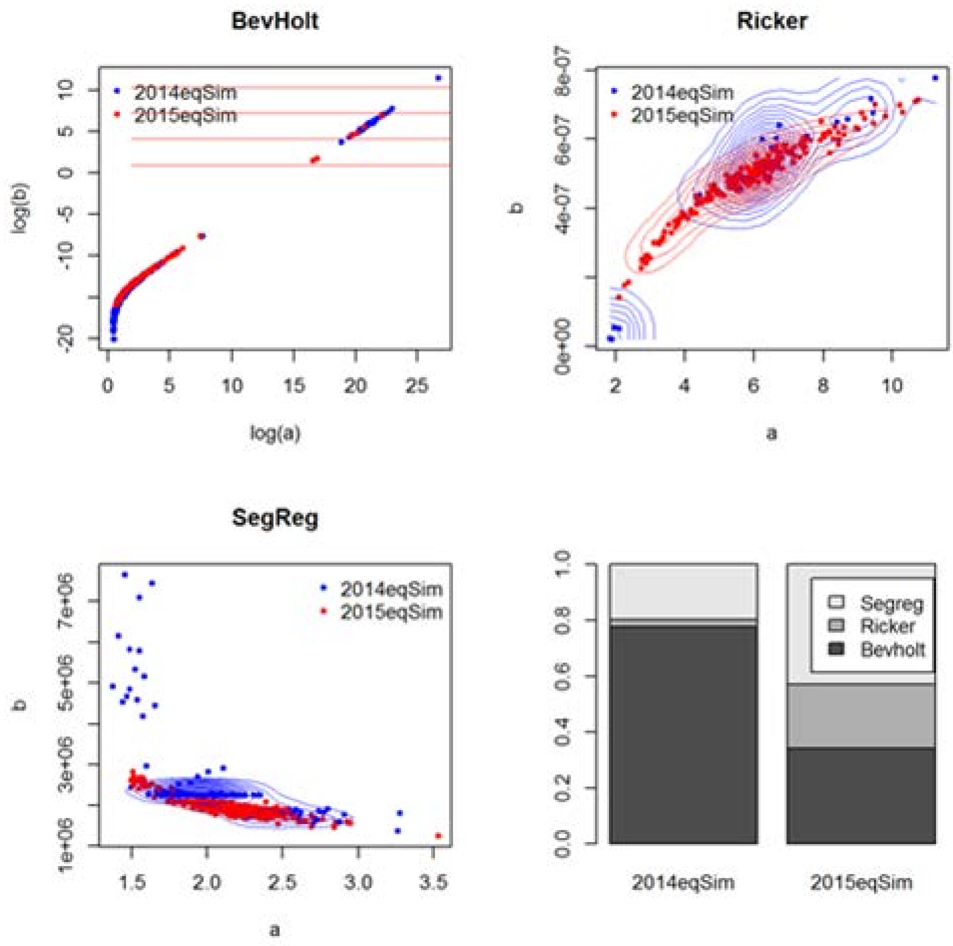


Figure 2.12.2.2 Comparison of the stock-recruitment model parameters using EqSim model between stock assessment of 2014 (2014eqSim) and 2015 (2015eqSim).

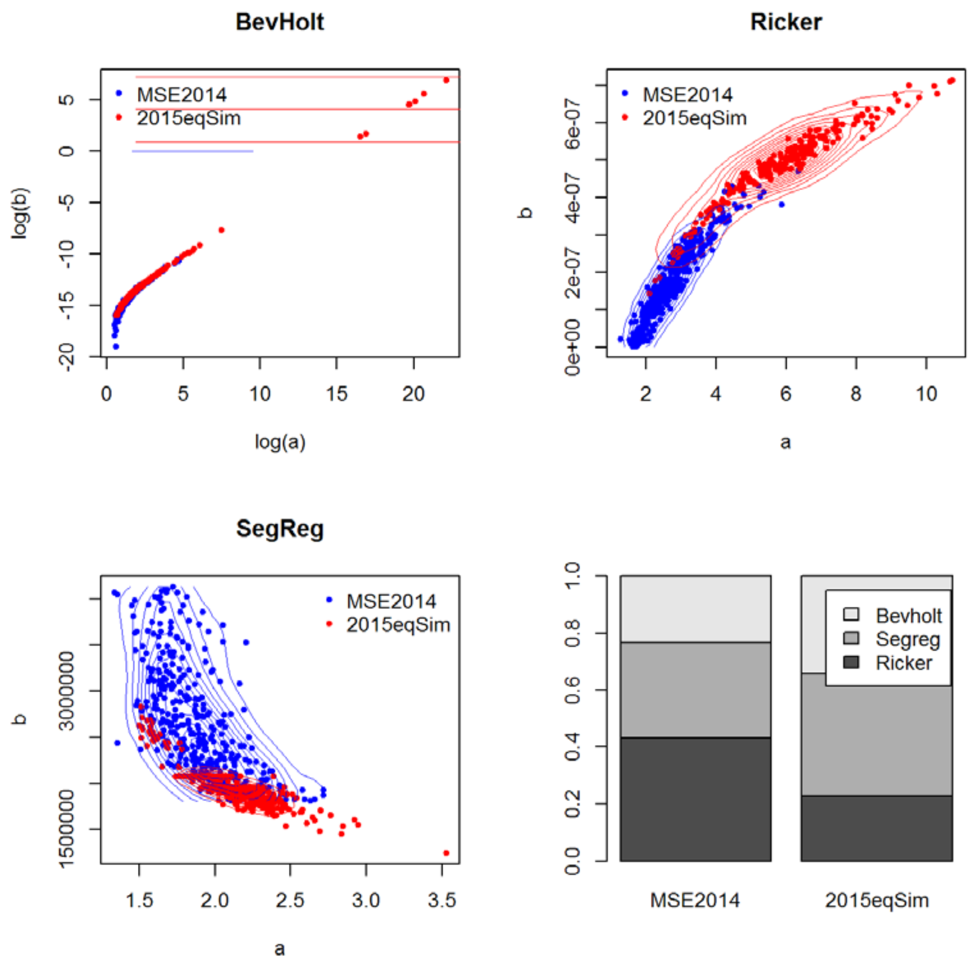


Figure 2.12.2.3 Comparison of the stock-recruitment model parameters between the recruitment pairs used in the MSE done in WKMACLTMP (ICES 2015b; 2014MSE) and EqSim model using the 2015 assessment (2015eqSim).

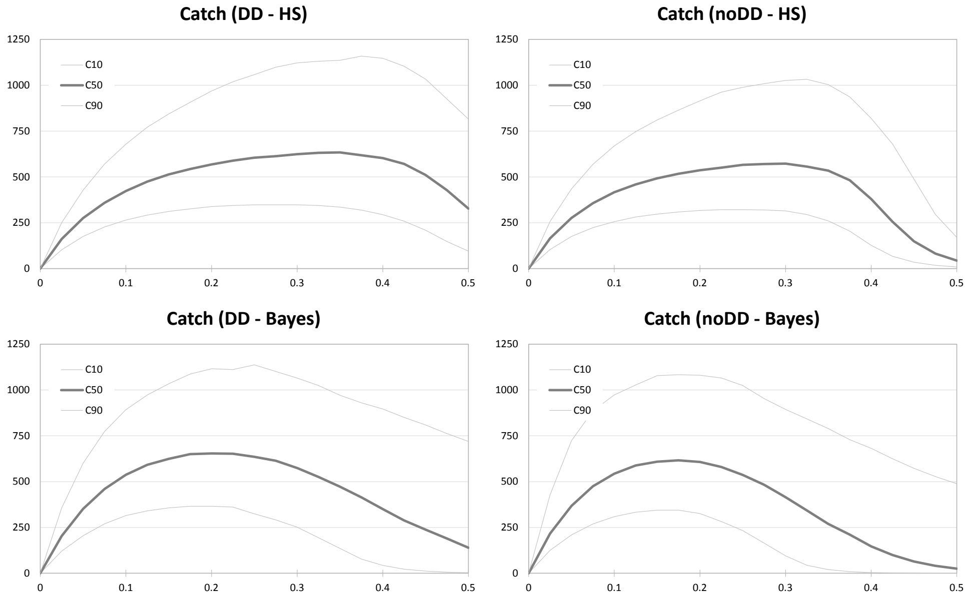


Figure 2.12.2.3.1 catch in equilibrium against different values of F for simulations with density dependence (left) and without density dependence (right), and for simple hockey-stick stock recruitment (HS, top) and complex stock-recruitment (Bayes, bottom). C10, C50 and C90 refer to the 10th, 50th and 90th percentiles of the distribution.

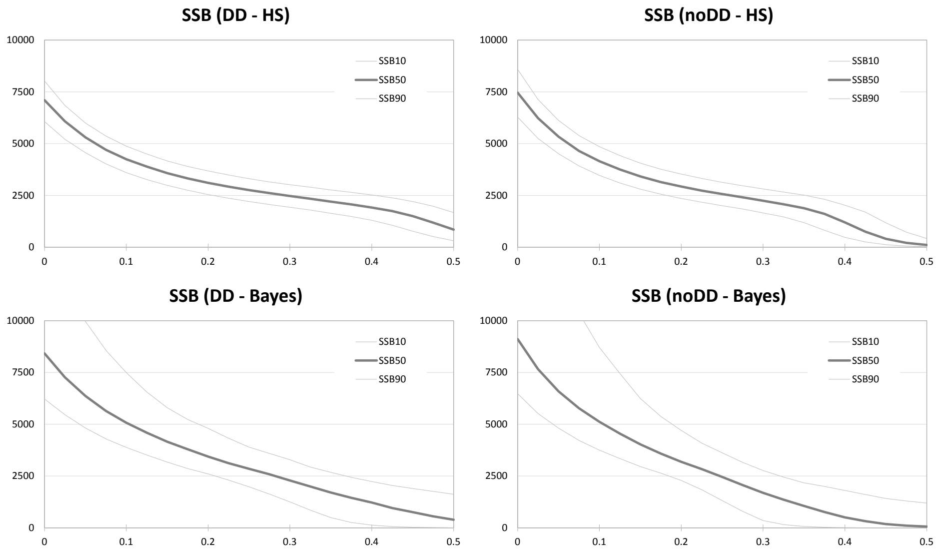


Figure 2.12.2.3.2 SSB in equilibrium against different values of F for simulations with density dependence (left) and without density dependence (right), and for simple hockey-stick stock recruitment (HS, top) and complex stock-recruitment (Bayes, bottom). SSB10, SSB50 and SSB90 refer to the 10th, 50th and 90th percentiles of the distribution of SSB.

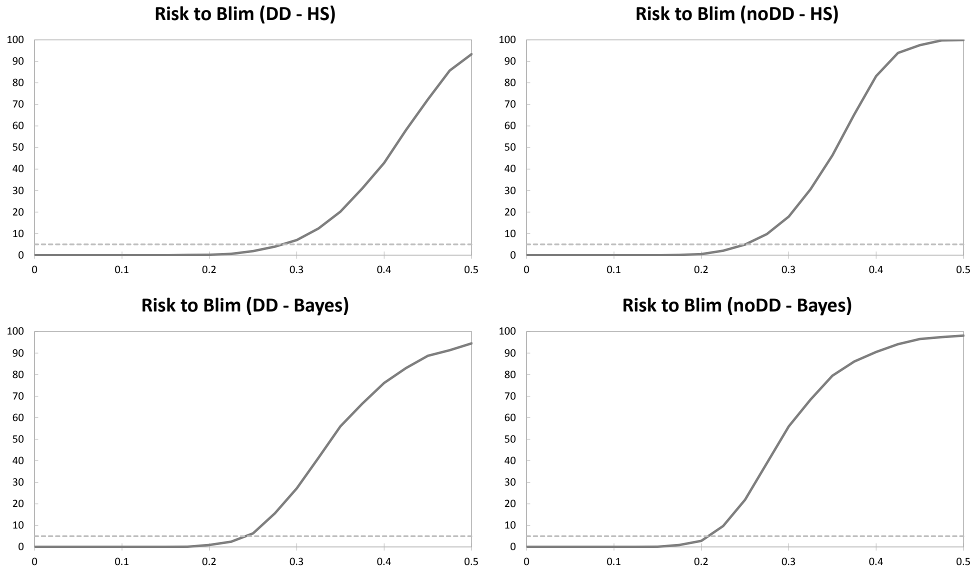


Figure 2.12.2.3.3 Risk to Blim in equilibrium against different values of F for simulations with density dependence (left) and without density dependence (right), and for simple hockey-stick stock recruitment (HS, top) and complex stock-recruitment (Bayes, bottom).

3 Horse Mackerel

3.1 Fisheries in 2014

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 southern horse mackerel stock is currently assessed by ICES WGHANSA). The total catch from all areas in 2014 for the Western and North Sea stock was 142,405 tons which is 41,377 tons less than in 2013 (23% lower than in 2012 and 27% lower than 2012). Ireland, Denmark, Scotland, France, Germany and the Netherlands have a directed trawl fishery and Norway a directed purse seine fishery for horse mackerel. Spain has 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 North Sea and western horse mackerel by Division and Sub-division in 2014 are given in Table 3.1.2 and the distribution of the fisheries are given in Figure 3.1.1.a–d. The maps are based on data provided by Germany, Ireland, Netherlands, Norway, Northern Ireland, Scotland, Sweden, England + Wales and Spain representing 90% of the total catches. The distribution of the fishery is similar to the later years.

The Dutch and German fleets operated mainly west of the Channel, in the Channel area, north and west of Ireland and in the southern North Sea. Ireland fished mainly north and west of Ireland and Norway in the north eastern part of the North Sea. The Spanish fleet operated mainly in their respective waters.

First quarter: Catches were 53,607 tons. As usual the fishery was mainly carried out west of Scotland and west and south of Ireland, in the Channel and along the Spanish coast (Figure 3.1.1.a).

Second quarter: 14,576 tons. As usual, catches were significantly lower than in the first quarter as the second quarter is the main spawning period. Most of the catches were taken south of Ireland, along the Spanish coast and in the Channel (Figure 3.1.1.b).

Third quarter: 11,215 tons. Most of the catches were taken in Spanish waters and Norwegian coast. Also some smaller catches were reported in the Channel, south of Ireland and southern part the North Sea (Figure 3.1.1.c).

Fourth quarter: This is the fishing season with most of the catches 63,008 tons. The catches were distributed in four main areas (Figure 3.1.1.d):

- Spanish waters,
- Northern Irish waters and West of Scotland
- northern-central part of the North Sea
- the Channel

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 2013 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. This stock is now dealt with by another working group (ICES WGHANSA).

The catches by stock are given in Table 3.1.1 and Figure 3.3.1. The catches by stock and countries for the period 1997-2013 are given in Table 3.3.2-3.3.4.

In 2013 some small catches were reported from Divisions VIb (31 tons) and IIIc (183 tons) which were no allocated in any stock.

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. For 2014 most of countries provided such data (the Netherlands, Germany, Ireland, Spain Denmark, Norway and UK (Engl. + Wales)). Their catches represented about 95% of the total catch of western horse mackerel. The provided discard rates were around 1.3% in weight. Discards rate in North Sea stock were to be bellow of 0.1% and in Western stock were to be below 1.5% in 2014..

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 fishery takes mainly place in the eastern part of ICES Division VIIIc. There is not a clear trend in *T. mediterraneus* catches in this area but in the last years show a low level (Table 3.5.1). Information of *T. picturatus* fishery is available in the WGHANSA Report (Working Group on Horse Mackerel, Anchovy and Sardine).

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, Scotland and Spain provided length distribution for their catches in 2014. The length distributions given by Ireland, Germany, the Netherlands, Norway and Spain covered app. 86% of the total landings of the Western and North Sea horse mackerel catches and are shown in Table 3.6.1.

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

Subarea	1979	1980	1981	1982	1983	1984	1985	1986
II	2	-	+	-	412	23	79	214
IV + IIIa	1,412	2,151	7,245	2,788	4,420	25,987	24,238	20,746
VI	7,791	8,724	11,134	6,283	24,881	31,716	33,025	20,455
VII	43,525	45,697	34,749	33,478	40,526	42,952	39,034	77,628
VIII	47,155	37,495	40,073	22,683	28,223	25,629	27,740	43,405
IX	37,619	36,903	35,873	39,726	48,733	23,178	20,237	31,159
Total	137,504	130,970	129,074	104,958	147,195	149,485	144,353	193,607
Subarea	1987	1988	1989	1990	1991	1992	1993	1994
II	3,311	6,818	4,809	11,414	4,487	13,457	3,168	759
IV + IIIa	20,895	62,892	112,047	145,062	77,994	113,141	140,383	112,580
VI	35,157	45,842	34,870	20,904	34,455	40,921	53,822	69,616
VII	100,734	90,253	138,890	192,196	201,326	188,135	221,120	200,256
VIII	37,703	34,177	38,686	46,302	49,426	54,186	53,753	35,500
IX	24,540	29,763	29,231	24,023	34,992	27,858	31,521	28,442
	222,340	269,745	358,533	439,901	402,680	437,698	503,767	447,153
Subarea	1995	1996	1997	1998	1999	2000	2001	2002
II	13,133	3,366	2,617	2,538	2,557	1,169	60	1,324
IV + IIIa	98,745	27,782	81,198	31,295	58,746	31,583	19,839	49,691
VI	83,595	81,259	40,145	35,073	40,381	20,657	24,636	14,190
VII	330,705	279,109	326,415	250,656	186,604	137,716	138,790	97,906
VIII	28,709	48,269	40,806	38,562	47,012	54,211	75,120	54,560
IX	25,147	20,400	29,491	41,574	27,733	26,160	24,912	23,665
Total	580,034	460,185	520,672	399,698	363,033	272,496	283,357	241,335
Subarea	2003	2004	2005	2006	2007	2008	2009	2010
II	24	47	176	30	366	572	1,847	1,656
IV + IIIa	34,226	30,540	40,564	38,911	16,407	15,377	78,591	13,670
VI	23,254	21,929	22,055	15,751	26,279	25,902	17,776	22,612
VII	123,046	116,139	107,475	101,912	93,132	98,746	89,563	145,320
VIII	41,711	24,125	41,495	34,122	28,387	33,892	33,355	43,227
IX	19,570	23,581	23,111	24,557	23,423	23,596	26,496	27,217
Total	241,831	216,361	234,876	215,283	187,994	198,085	247,628	253,702

Subarea	2011	2012	2013	2014[1]
II	648	66	30	409
IV + IIIa	25,183	5,265	6,722	14,699
VI	39,528	44,975	43,266	32,459
VII	127,903	123,579	83,684	49,720
VIII	35,675	17,402	26,983	31,614
IX	22575	25316	29382	29205
Total	251512	216603	190068	158107

[1]Preliminary. * Southern Horse Mackerel (ICES Division IX) is assessed by ICES WGHANSA since 2011

Table 3.1.2 HORSE MACKEREL Western and North Sea Stock combined. Quarterly catches (1000 t) by Division and Subdivision in 2014.

Division	1Q	2Q	3Q	4Q	TOTAL
IIa+Vb	0	41	46	337	424
III	1	+	4	4,105	4,110
IVa	1	1	334	10,257	10,593
IVbc	532	362	116	1,594	2,604
VIId	1,649	426	548	8,149	10,772
VIa,b	21,891	8	0	10,668	32,567
VIIa–c,e–k	25,757	6,369	328	17,267	49,720
VIIIa,b,d,e	1,178	1,293	924	723	4,118
VIIIc	2,596	6,075	8,917	9,908	27,496
Sum	53,607	14,576	11,215	63,008	142,405

+ less than 50 tonnes

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**	**Western + NS Stock**	**Southern Stock (IXa)[x]**	All stocks
1982	2.788[1]		-		1.247	4.035	-		-	6.283	32.231	3.073	19.610	-	61.197	65.232	39.726	104.958
1983	4.420[1]		-		3.600	8.020	412		-	24.881	36.926	2.643	25.580	-	90.442	98.462	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	126.222	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	130.593	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	170.647	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	198.972	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	238.400	29.763	268.163
1989	436		25.830		6.522	33.265	4.809		85304[2]	34.870	131.218	11.516	27.170	1.150	296.037	329.302	29.231	358.533
1990	2.261		17.437		1.325	18.762	11.414	14.878	112753[2]	20.794	182.580	21.120	25.182	9.930	398.645	417.407	24.023	441.430
1991	913		11.400		600	12.000	4.487	2.725	63869[2]	34.415	196.926	25.693	23.733	5.440	357.288	369.288	34.992	404.280
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	409.836	27.858	437.694
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	472.245	31.521	503.766
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	418.711	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	554.887	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	439.785	20.400	460.185
1997			14.078	10	5.452	19.540	2.617	2.037	65073[3]	40.145	318.101	11.677	29.129	2.921	471.700	491.240	29.491	520.731
1998	3.693		10.530	83	16.194	30.500	2540[4]		17.011	35.043	232.451	15.662	22.906	830	326.443	356.943	41.574	398.517
1999			9.335		27.889	37.224	2557[5]	2.095	47.316	40.381	158.715	22.824	24.188		298.076	335.300	27.733	363.033
2000			25.954		22.471	48.425	1169[6]	1.105	4.524	20.657	115.245	32.227	21.984		196.911	245.336	26.160	271.496
2001	85	69	8.157		38.114	46.356	60	72	11.456	24.636	100.676	54.293	20.828		212.090	258.446	24.912	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	217.671	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	222.261	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	192.781	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	211.705	23.111	234.816
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	190.720	24.557	215.277

2007	63	2.056	9.118	139	29.788	41.164	366	110	4.940	26.279	63.223	14.428	13.960	102	123.408	164.572	23.423	187.994
2008	27	1.003	2.330		31.389	34.749	572[7]	3	12.014	25.902	67.325	14.537	19.345	43	139.741	174.490	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	221.141	26.496	247.637
2010	+	100	1.965	2	20.188	22.255	1.627	88	11.516	22.641	114.483	2.042	37.505	15.366	205.268	227.004	27.217	254.221
2011	0.2		10.458		18.886	29.344	648	1	14.724	39.298	103.156	2.303	32.943	6.522	199.593	228.937	22.575	251.512
2012	0.2	355	1.588		19.480	21.423	66	9	3.312	44.975	104.098	5051	12351	3.280	173.142	194.565	25316	219881
2013	0	17	1.478		17.202	18.697	30	19	6.703	43.264	83.683	9212	17773	4.401	165.085	183782	29382	213.164
2014	1	2	2.597	7	10.772	13.380	424	4.096	10.573	32.444	48.747	4.118	26.727	1.896	129.025	142.405	29205	171.610

[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.

[6]Includes 250 t from Vb. [7] all fom Vb

[5]Includes 132 t from Vb

[X] Southern Horse Mackerel is assessed by ICES WGHANSA since 2011

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	10751	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 (N. 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	15,256	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	158328	181,994

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014[1]
Belgium	-	-	-	-	19	2	0.2	14	-
Denmark	8,353	7,617	5,261	6,009	5,941	6,109	4,002	6,829	5,945
Estonia	-	-	-	-	-	-			-
Faroe Islands	1,205	478	841	-	374	349	-		68
France	11,034	12,748	12,626	-	260	8,271	1,795	3,593	3,428
Germany, Fed.Rep.	10,863	5,784	11,708	15,121	17,688	21,114	17,063	24,835	9,826
Ireland	26,779	30,091	35,612	40,754	44,488	38,464	45,242	35,791	32,667
Lithuania	6,829	5,467	5,548	-	-	-	-		-
Netherlands	37,130	29,083	43,648	39,451	61,504	55,692	66,396	53,697	25,053
Norway	27,114	4,182	1,223	59,764	11,978	13,755	3,251	6,596	14,353
Russia	-	-	-	-	-	-			
Spain	13,878	14,257	19,851	21,077	38,744	34,581	13,560	22,541	19,442
Sweden	-	76	9	258	2	90	-	1	0
UK (Engl. + Wales)	3,583	5,482	3,365	6,482	12,714	11,716	12,122	3,959	4,832
UK (N. Ireland)	224	-	-	-	-	-	-	2,325	1,579
UK (Scotland)	469	778	1,077	1,413	2,348	2,928	1,335	504	1,389
Unallocated	7,534	7,263	2,294	-7,010	7,237	-	5,095	--	8,545
Discard	99	102	43	81	14,846	6,522	3,280	4,401	1,896
Total	155,094	123,408	143,106	183,400	218,143	199,593	173,141	165,087	129,025

[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	2010	2011	2012	2013[1]	2014[1]
Belgium	4	6	3	5	17	26	46	51	74
Denmark	1,341	255	57	89	15	142	1514	1,020	552
Faroe Islands	-	-	-	-	-	-	0		
France	4,380	5,349	2,246	-	813	273	1,047	1,010	1,742
Germany, Fed.Rep.	1,691	87	1,176	1,299	3,794	3,642	5,356	2,941	1,619
Ireland	2,077	1	897	-	-	-	0		0
Lithuania	2,377	296	-	-	-	-	0		0
Netherlands	27,284	31,154	19,439	22,546	17,094	16,289	12,157	8,725	4,925
Norway	113	1,243	21	12,855	526	7,359	129	377	0
Sweden	491	53	35	402	-	-	0		1
UK (Engl. + Wales)	596	-	1,060	1,235	1,809	1,699	935	4,401	4,198
UK (Scotland)	300	625	6	4	111	93	240	172	262
Unallocated	-5,106	1,956	10,869	5,988	-116	0	0	0	
Discard	78	139	-	1,036	2	0	0	0	7
Total	35,626	41,164	35,809	45,659	24,146	29523	21424	18,696	13,380

[1]Preliminary

Table 3.5.1. Catches (t) of *Trachurus mediterraneus* in Divisions VIIIab, VIIIc and Sub-Area VII

	VII	VIIIab	VIIIc East	VIIIc West	TOTAL
1989	0	23	3903		3926
1990	0	298	2943		3241
1991	0	2122	5020		7142
1992	0	1123	4804		5927
1993	0	649	5576		6225
1994	0	1573	3344		4917
1995	0	2271	4585		6856
1996	0	1175	3443		4618
1997	0	557	3264		3821
1998	0	740	3755		4495
1999	0	1100	1592		2692
2000	59	988	808		1854
2001	1	525	1293		1820
2002	1	525	1198		1724
2003	0	340	1699		2039
2004	0	53	841		894
2005	1	155	1005		1162
2006	1	168	794		963
2007	0	126	326		452
2008	0	82	405		487
2009	0	42	1082		1124
2010	0	97	370		467
2011	0	119	1096		1225
2012	0	186	667	116	969
2013	0	52	238	0	290
2014	0	130	1160	0	1290

Table 3.6.1 Horse mackerel general. Length distributions (%) Catches by fleet and country in 2014. (0.0= <0.05%)

	Netherlands	Ireland	Norway	Scotland	Germany			Spain		
	Pel. Trawl	All_fleet	P.seine	All_fleet	All_fleet	All_fleet	All_fleet	P.seine	Trawl	Artisanal
cm	All	All	All	VIa	VIa	VIIb	VIIc	VIIIbc	VIIIc	VIIIc
5										
6										
7										
8										
9										
10										0.0%
11										0.0%
12	0.0%									0.3%
13										1.3%
14										6.5%
15	0.4%									15.4%
16	4.6%									17.3%
17	4.1%									13.0%
18	4.9%			4.7%				0.5%		8.9%
19	3.5%			3.4%				4.0%		4.9%
20	1.8%	0.0%		2.5%				7.1%		5.2%
21	1.7%	0.1%		2.5%				14.3%	0.0%	5.3%
22	3.4%	0.3%		5.2%				17.4%	0.1%	3.2%
23	3.6%	0.9%		9.2%	0.0%			8.9%	0.5%	3.6%
24	3.7%	2.0%	0.1%	10.9%	0.2%	0.5%		7.1%	2.4%	2.5%
25	8.8%	3.7%	0.1%	15.8%	1.0%	3.0%		5.8%	7.3%	1.1%
26	14.5%	6.6%	0.8%	23.2%	5.4%	9.4%		9.4%	12.9%	0.7%
27	13.6%	11.6%	2.7%	17.3%	12.9%	15.6%	1.3%	7.1%	13.7%	0.5%
28	8.6%	13.4%	8.3%	4.6%	17.6%	12.5%	0.4%	9.8%	10.4%	0.6%
29	4.3%	11.7%	13.9%	0.8%	11.6%	10.9%	1.7%	3.1%	9.6%	0.8%
30	3.2%	9.0%	12.0%		8.4%	11.7%	8.1%	4.5%	14.6%	1.1%
31	3.2%	10.7%	15.5%		8.1%	10.0%	19.6%	0.9%	12.4%	1.2%
32	3.1%	8.8%	13.5%	0.2%	6.0%	7.6%	24.3%		8.3%	1.4%
33	2.7%	5.7%	13.6%		4.6%	5.6%	14.0%		3.9%	1.3%
34	1.8%	3.9%	9.7%		4.6%	4.3%	14.5%		1.8%	1.2%
35	1.5%	3.4%	4.1%		4.4%	3.7%	4.3%		0.8%	1.0%
36	1.0%	2.3%	2.6%		4.4%	2.6%	5.5%		0.6%	0.8%
37	1.1%	2.2%	1.3%		4.8%	1.6%	2.1%		0.4%	0.5%
38	0.6%	1.7%	1.0%		3.0%	0.6%	1.7%		0.2%	0.3%
39		1.3%	1.0%		1.6%	0.3%	1.3%		0.1%	0.2%

Continues on next page

Continued from previous page

40		0.4%			0.8%	0.2%	1.3%		0.0%	0.1%
41	0.5%	0.2%			0.4%	0.1%			0.0%	0.0%
42+		0.0%			0.2%				0.0%	0.0%

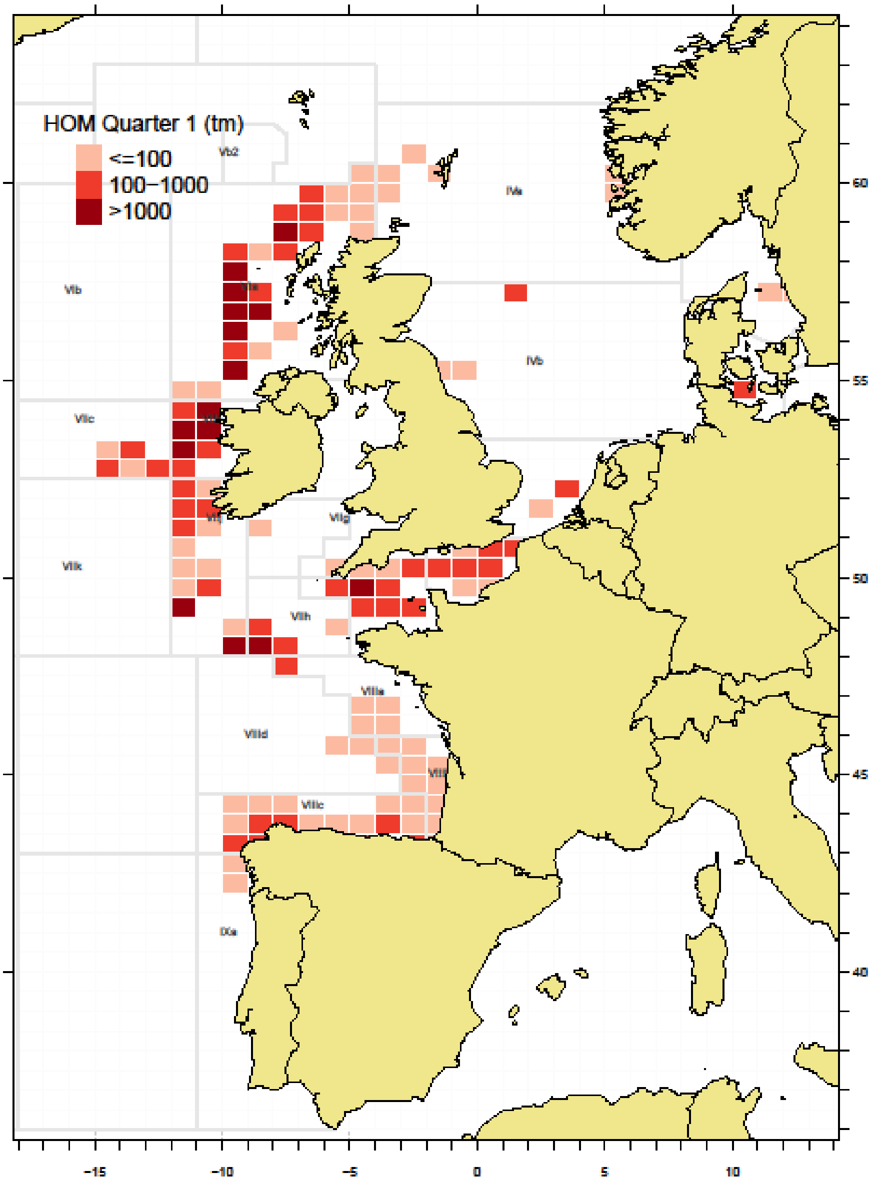


Figure 3.1.1a. Horse mackerel catches 1st quarter 2014

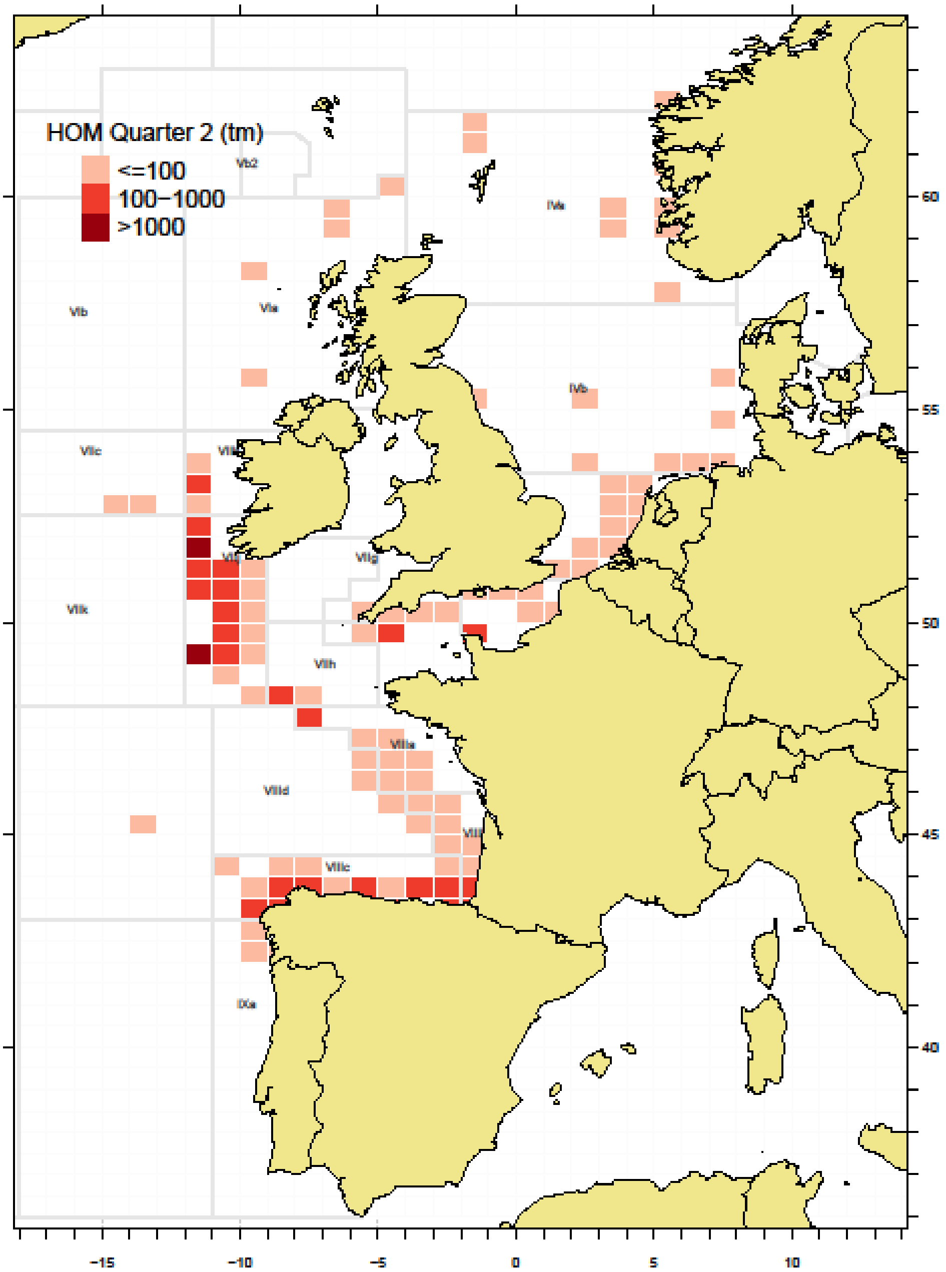
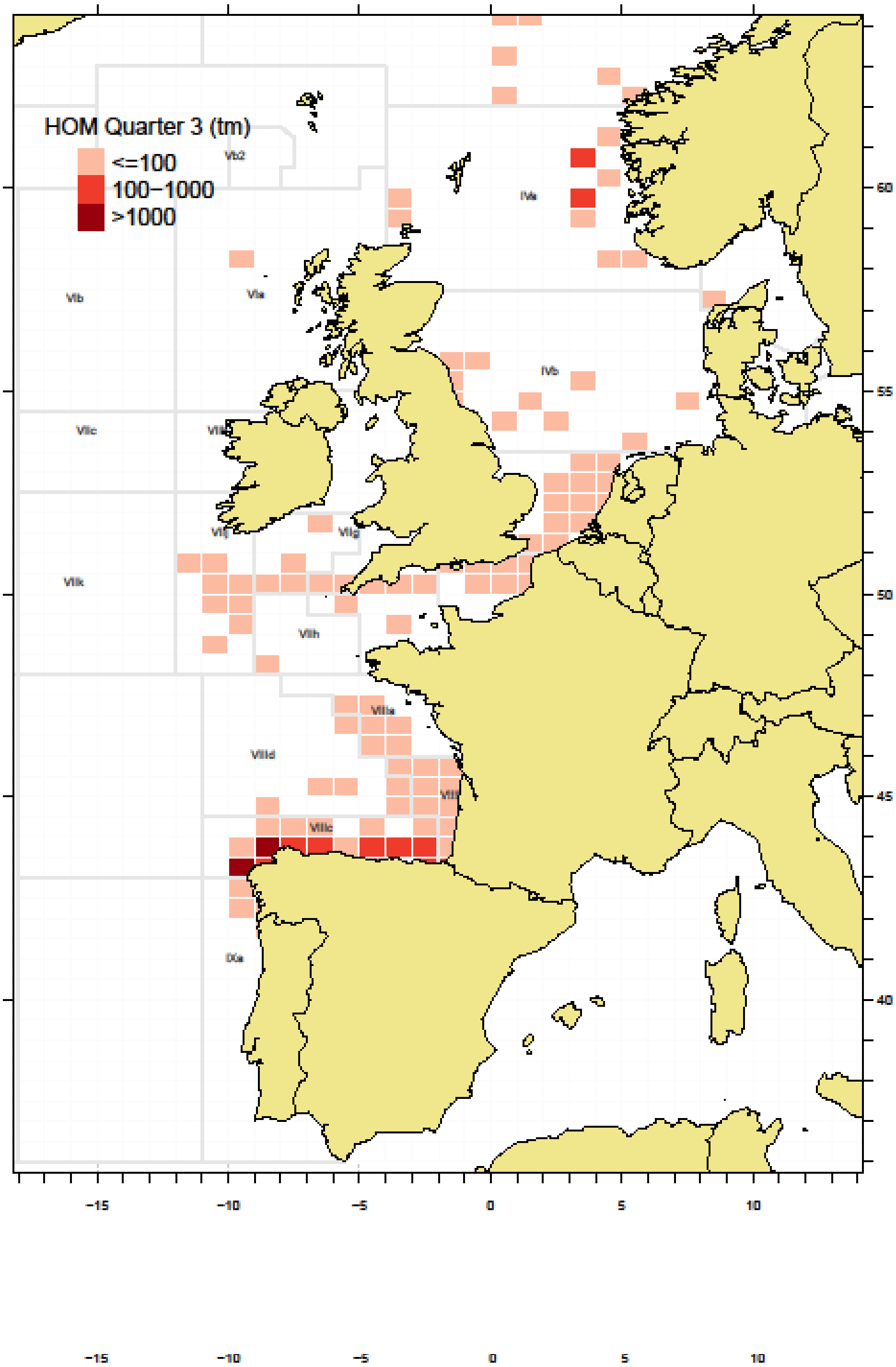


Figure 3.1.1b. Horse mackerel catches 2nd quarter 2014


HOM Quarter 3 (tm)
<=100
100−1000
>1000
Vb2
IVa
VIa
VIb
IVb
VIIc
VIIb
VIIj
VIIg
VIIk
VIIh
VIIIa
VIIId
VIIIc
IXa
60
55
50
45
40
−15
−10
−5
0
5
10

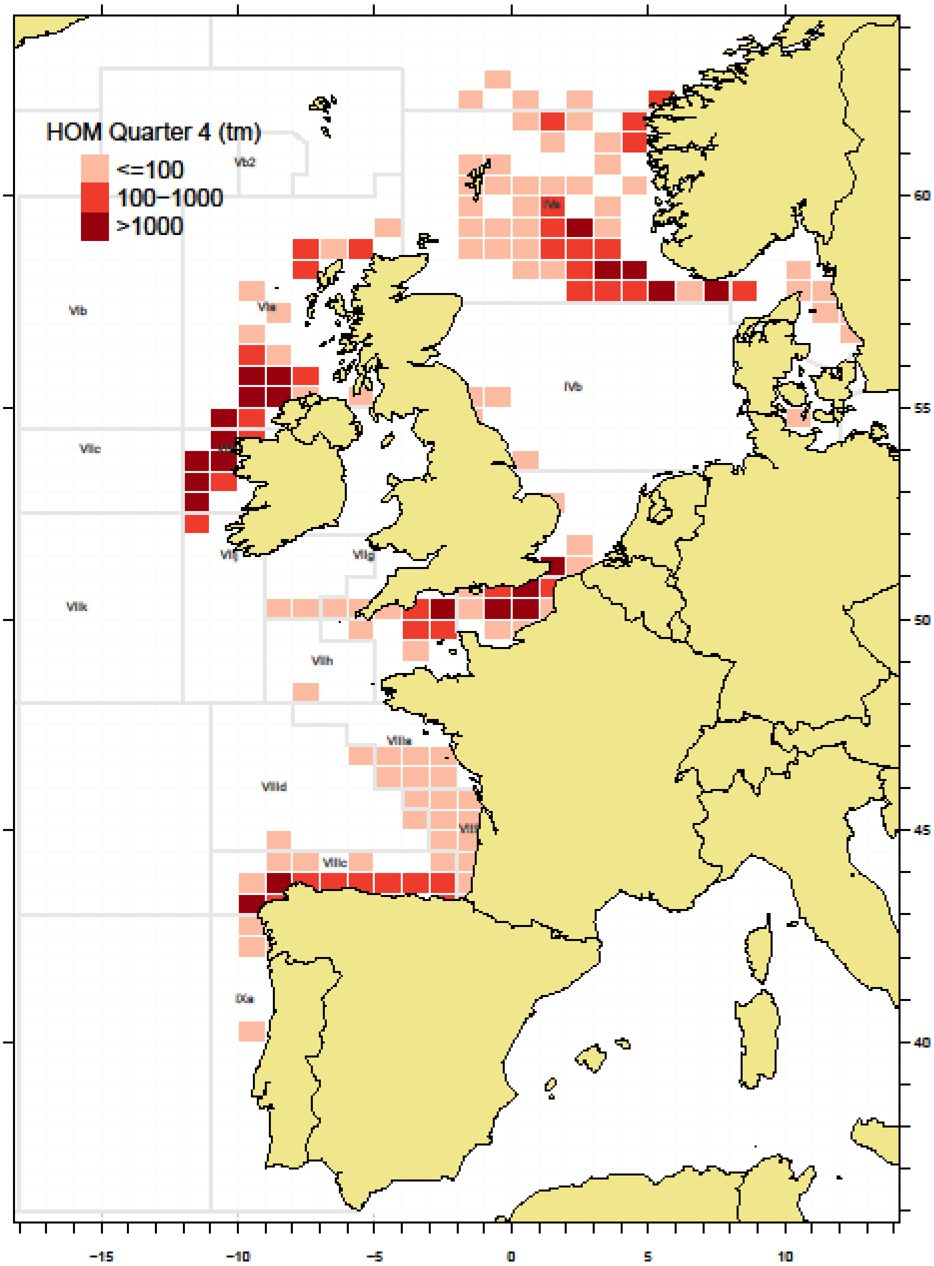


Figure 3.1.1d. Horse mackerel catches 4th quarter 2014

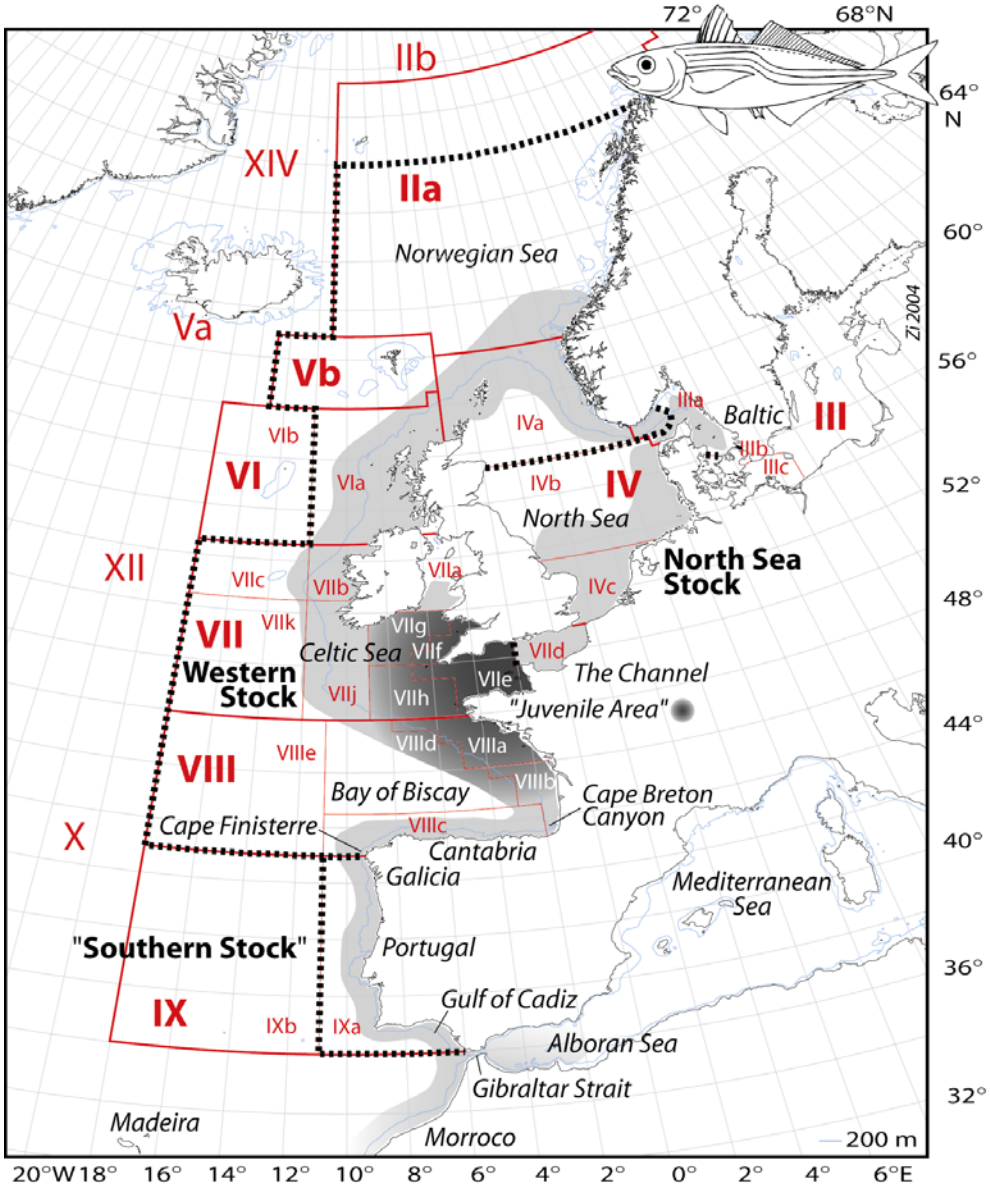


Figure 3.2.1: Distribution of Horse Mackerel in the Northeast-Atlantic: Stock definitions as used by the 2004 WG MHSA. Note that the "Juvenile Area" is currently only defined for the Western Stock distribution area – juveniles do also occur in other areas (like in Div. VIId). Map source: GEBCO, polar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

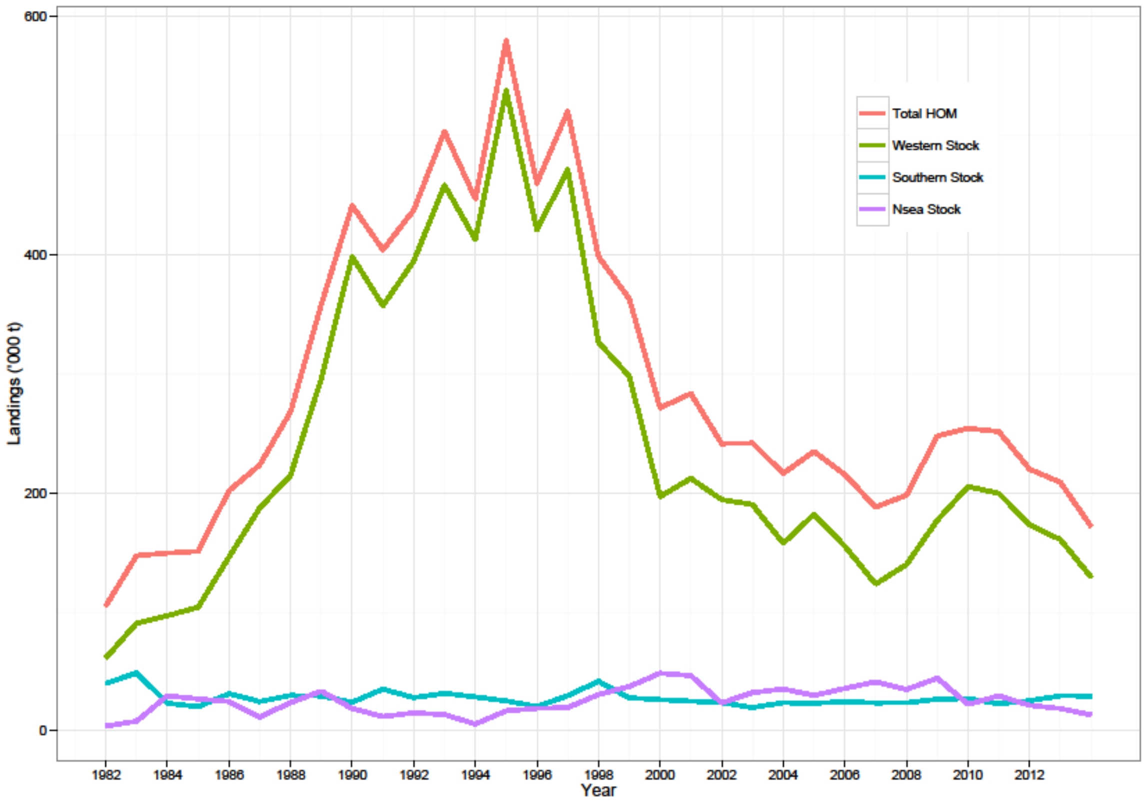


Figure 3.3.1 Horse mackerel general. Total catches in the northeast Atlantic during the period 1982—2014. The catches taken from the southern, western and North Sea horse mackerel stocks are shown in relation to the total catches in the northeast Atlantic. Caches from Div. VIIIc are transferred from southern stock to western stock from 1982 onwards. Southern horse mackerel is assessed by ICES WGHANSA since 2011.

4 North Sea Horse Mackerel: Divisions IVa (Q1 and Q2), IIIa (excluding Western Skagerrak Q3 and Q4), IVb, IVc and VIId

4.1 ICES Advice Applicable to 2015

In 2012, based on ICES approach to data-limited stocks (category 5), ICES advised for 2013 that catches of horse mackerel in Divisions IIIa and IVa first and second quarter, IVb,c, and VIId (North Sea stock) should be no more than 25 500 tonnes, which represented a 20% precautionary reduction to then recent catch levels. In 2013, new data on survey indices available for this stock were considered to not change the perception of the stock and therefore the advice for the fishery in 2014 was the same as the advice for 2013: no more than 25 500 tonnes. Exploratory assessments and improve index analyses in 2014, though not conclusive, showed the stock to be in a poor condition. A considerable reduction in catches was felt necessary to reduce pressure on the stock. Hence the advise for 2015 was set less than 15 200 tonnes, almost half that of 2014. Discards are known to take place but cannot be quantified; therefore total catches could not be calculated.

The TAC for IVbc and VIId in 2015 was 15 200 tonnes.

4.2 The Fishery in 2014 on the North Sea horse mackerel stock

Based on historical catches taken by the Danish industrial fleet for reduction into fishmeal and fish oil 1970s and 1980s approximately 48% of the EU North Sea horse mackerel TAC is Danish. Catches were taken in the fourth quarter mainly in Divisions IVb and VIId. The 1990s saw a drop in the value of industrial fish, limited fishing opportunities and steep increases in fuel costs, both with influenced the Danish quota uptake.

In 2001, individual quota scheme for a number of species, but not North Sea horse mackerel, was introduced in Denmark. This lead to a rapid restructuring and lower capacity of the Danish fleet, and this combined with decreasing prises of industrial fish led to that the Danish North Sea horse mackerel catches have diminished. Since the 1990's, a larger portion of catches has been taken in a directed horse mackerel fishery for human consumption by the Dutch freezer-trawler fleet. This is possible because Denmark has traded parts of its quota with the Netherlands for fishing opportunities for other species, however due to the structure of the Danish quota management set-up only a limited amount of quota can be made available for swaps with other countries. These practical implications of the management scheme largely explain the consistent underutilisation of the TAC (approximately 50% in 2010—2013) in recent years. However, following the sharp reduction in TAC in 2014, uptake has increased significantly to above 80% (see Figure 4.2.1).

Catches taken in Divisions IVa and IIIa during the two first quarters and all year in Divisions IVb, IVc and VIId are regarded North Sea horse mackerel (Section 3, Table 3.3.1). In Section 3, Table 3.3.3 shows the reported national catches of this stock from 1997—2014. The catches were relatively low during the period 1982—1997 (not shown) with an average of 18 000 tonnes. The catches increased between 1998 (30 500 tonnes) and 2000 (48 425 tonnes). Between 2000 and 2010, the catches varied between 23 379 and 48 425 tonnes. In 2014 the catch was 13 388 tonnes, with a total of 80% being caught in VIId. Catches by ICES Division are illustrated in Figure 4.2.2 for the period 1982—2014.

4.3 Biological Data

4.3.1 Catch in Numbers at Age

In 2014, 63% of the landings were sampled. These samples were taken by Netherlands and Dutch observers on UK (England) vessels in all quarters except Q2 (only 8% of the landings occur in this quarter). A total of 19 samples were collected (Section 1.3.1). Sampling coverage in 2014 has decreased compared to 2013. The catch at age data remains questionable and, if an analytical assessment is to be carried out in the future, methods for distinguishing landings from the Western stock and the North Sea horse mackerel stock need to be developed.

Table 4.3.1 shows catch numbers by quarter (and annual totals) by area in 2014. Annual catch numbers at age for the whole stock for 1995—2014 are given in Table 4.3.2. Age compositions for the period 1987—1995 are also available and are plotted together with the estimates from 1995—2014 in Figure 4.3.1. However, these are based on samples taken from low numbers of Dutch commercial catches and catches from research vessels. These samples cover only a small proportion of the total catch and therefore only give a rough indication of the age composition of the stock. After 1998 catch at age data by area are available (Figure 4.3.3). Since the mid-2000s the majority of the catch has come from VIId.

Cohort structure is generally not clearly detectible in the data. This may partly be due to the shifts in distribution of the fishery. In addition, it may partly be due to age reading difficulties, which are a known to be encountered (e.g. Bolle *et al.*, 2011). Most clearly detectable is the relatively large 2001 year class, although it is not clearly present in the catch in all years. There are indications that environmental circumstance may be an important factor (possibly stronger than stock size) contributing to spawning success in horse mackerel. This is for example illustrated by the largest year classes (1982 and 2001) observed in the Western stock which incidentally were produced at the lowest observed stock sizes. Since 2001 is considered to have been a relatively strong year class in the Western stock as well, it is plausible that circumstances in the North Sea were similar to those in Western areas and also allowed for relatively high spawning success in the North Sea.

Lastly, potential mixing of fish from the Western and North Sea stock in area VIId and VIIe in winter may also confuse the cohort signals. For example, the large recruitment in the Western stock may have led to more of these fish being located in the North Sea stock area as age 1 fish in 2002. In 2015, a research project has been started by IMARES and the Pelagic Freezer-trawler Association (PFA) that aims to clarify the mixing of horse mackerel of the Western and North Sea stocks in the Channel area.

4.3.2 Mean weight at age and mean length at age

Tables 4.3.3 and 4.3.4 show mean weight and length at age by quarter and by area in 2014. The annual average values are also shown in those same tables.

4.3.3 Maturity at age

There is no information available about the maturity at age of the North Sea Horse mackerel stock. Peak spawning in the North Sea falls in May and June (Macer, 1974), and spawning occurs in the coastal regions of the southern North Sea along the coasts of Belgium, the Netherlands, Germany, and Denmark.

4.3.4 Natural mortality

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

4.4 Data Exploration

4.4.1 Catch curves

The log-catch numbers were plotted by cohort to estimate the negative gradient of the slope and get an estimate of total mortality (Z). Fully selected ages 3—11 from the 1997—2014 period (when catch at age estimates are considered more representative of the whole fishery) provide complete data for the 1994 to 2003 cohorts (Figure 4.4.1). The estimated negative gradients by cohort (Figure 4.4.2) indicate a high mortality, declining towards 2000, before increasing to the previous high level. Recruiting year classes around the turn of the century are thought to be strong, which may explain this reduction in F over those cohorts. However the poor quality of the cohort signals in the data likely make these Z estimates highly uncertain.

4.4.2 Alternative methods to estimate the biomass

In 2002, Ruckert *et al.* estimated the North Sea horse mackerel biomass based on a ratio estimate that related CPUE data from the IBTS to CPUE data of whiting (Merlangius merlangus). The applied method assumes that length specific catchability of whiting and horse mackerel are the same for the IBTS gear. Subsequently, they use the total biomass of whiting derived from an analytical stock assessment (MSVPA) to estimate the relationship between CPUE and biomass.

Other methods to use information from data-rich stocks to assess the biomass of data poor stocks have recently been suggested by Punt *et al.* (2011). WGWIDE suggests that these methods should be further investigated to enable stock estimates of the North Sea horse mackerel.

4.4.3 Survey Data

4.4.3.1 IBTS Survey in area IV

Many pelagic species are frequently found close to the bottom during daytime (which is when the IBTS survey operates) and migrate upwards predominantly during the night they are susceptible to semi-pelagic fishing gear and to bottom trawls (Barange *et al.*, 1998). Eaton *et al.* (1983) argued that horse mackerel of 2 years and older are predominantly demersal in habit. Therefore, in the absence of a targeted survey for this stock, the IBTS is considered a reasonable alternative. IBTS data are also used in the assessment of the southern horse mackerel stock.

IBTS data from quarter 3 were obtained from DATRAS and analysed. Based on a comparison of IBTS data from 4 quarters in the period 1991—1996, Ruckert *et al.* (2002) showed that horse mackerel catches in the IBTS were most abundant in the third quarter of the year. In contrast to previous years, when during WGWIDE meetings, three indices were derived: (a) for fish < 14 cm, (b) for fish >= 14 cm and < 23 cm and (c) for fish >= 23 cm, the working group in 2013 considered that using an ‘exploitable biomass index’ is most appropriate for the purpose of interpreting trend in the stock.

Commercial catch data show that 2-year old fish and older make up 96% of the landings, which roughly coincides with fish of >= 20 cm (see Figure 4.4.3 in WGWIDE, 2014). Index including fish of 20 cm and larger (roughly corresponding to age 2 and older) were therefore derived for the interpretation of stock trend.

To create indices, a subset of ICES rectangles was selected. Rectangles that were not covered by the survey more than once during the period 1991—2012 were excluded from the index area. In 2012, WGWIDE expressed concern that the previously selected index area did not sufficiently cover the distribution area of the stock, especially in years that the stock would be relatively more abundant and spread out more. Ruckert *et al.* (2002) also identified a larger distribution area of the North Sea stock. Based on the above, 61 rectangles were identified to be included in the index area as shown in Figure 4.4.4 (in WGWIDE, 2014).

In 2015, using the same methods, an index of the < 20 cm fish in the IBTS survey area was calculated.

All IBTS data were downloaded from DATRAS in July 2015[1].

4.4.3.2 The French Channel Groundfish Survey (CGFS) in Q4

In order to improve data basis for the North Sea horse mackerel assessment, alternative survey indices have been explored. Previous indices used had only cover the North Sea distribution of the stock, while the majority of catches in recent years have come from the eastern English Channel (VIId). We evaluated the potential contribution of the French Channel Groundfish Survey in VIId (CGFS) in Quarter 4. The CGFS is carried out since 1990 and has frequent captures of horse mackerel. Though this survey is conducted in a different quarter to the North Sea IBTS, the observed seasonal migration patterns of horse mackerel indicate that fish move into the channel following quarter 3, so the timing is considered appropriate.

The survey data was downloaded from the IFREMER website[2] on 28 August 2015 after contacting the relevant survey coordinator (Franck Coppin). We selected only the horse mackerel data and used the catches by length per half hour tow. We also computed the number of hauls where no horse mackerel was caught.

4.4.3.3 UK Beamtrawl Survey in VIIe (WBEAM) in Q1

The UK Beamtrawl survey in VIIe is carried out in the first quarter. The start of the time series is 2006. It is aimed primarily at flatfish, but catches also some horse mackerel. However, the catches of horse mackerel are low and infrequent. Overall, only 10% of the hauls had horse mackerel in them. We found that the survey indices for horse mackerel were very different from the trends observed in the IBTS and CGFS. Although this could be due to the WBEAM survey being held in VIIe (and hence purported to be part of the Western Stock), we believe that the low number of positive hauls also makes this survey less useable as an index of abundance for horse mackerel. This survey has therefore not been included in the analyses below.

4.4.4 Survey analyses: General Linear Modelling approach

Even though survey trawl hauls in the IBTS are supposed to be directly comparable, there still may exist differences in catchability between vessels, especially with species for which the survey was not designed. If the proportion or the geographical distribution of the data collected by the different vessels varies among years, then the vessel effect needs to be accounted for in the computation of the abundance index.

A generalized linear model (GLM) approach accounts for the above mentioned issue in establishing the index. Catches from the survey can be modelled as a linear function of explanatory variables, which may be continuous (depth) or factors (year, vessel, gear

[1] http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx

[2]http://www.ifremer.fr/SIH-indices-campagnes/source/source.action?facade=mancheorientale&zone=ciem7d

type) and offer the possibility to specify a distribution different from the normal distribution. The abundance index (corrected for the other potential effects such as vessel effects) can then be obtained from the estimated year effects. Sensitivity tests suggested that the index is robust to the inclusion of new years of data.

In zero inflated GLMs, the zeros (absence of the species) are assumed to result of two different causes: i) the false zeros, corresponding to sampling errors (such as sampling in wrong areas, i.e. outside the distribution area of the species, or using an inadequate technique) and ii) the real zeros, corresponding to sampling in low abundance areas. The zero inflated GLM is then a combination of two models: a model for the probability of occurrence of a false zero multiplied by a model of the count data conditional to not having a false zero.

Where $E(Y_i)$ is the expected catch for the trawl haul *i*, and $var(Y_i)$ is the associated variance, π_i is the probability of having a false zero, μ_i is the expected catch, conditional to not having a false zero, and *k* is the dispersion parameter from the negative binomial distribution.

The probability of having a false zero is modelled by a logistic regression, where

$$logit(\pi_i) = I_{zero} + Depth\ Cathegory_{i,zero} + Vessel_{i,zero} + Year_{i,zero}$$

The expected number of fish, conditional to not having a false zero is modelled as negative binomial regression :

$$log(\mu_i) = I_{count} + Depth\ Cathegory_{i,count} + Vessel_{i,count} + Year_{i,count} + offset\ (\log(haul\ duration))$$

Using $\log(haul\ duration)$ as an offset is a common way of standardizing samples taken by trawl haul of different length and it comes down to modelling the CPUE of the horse mackerel in fish per hour.

Due to changes in vessels conducting the the IBTS, the GLM analysis is only conducted using data since 1998. The year effect from this model fit then represents an index of the relative changes in stock abundance in the index area over time. The GLM analysis was only applied to the 20+ fish in the IBTS survey, and has not yet been applied to the CGFS data. The 20+ cm IBTS GLM index is shown in Table 4.4.1 and Figure 4.4.3.

4.4.5 Survey Analyses: Delta Log-Normal computation of index

As an alternative simple approach to deal with the skewed nature of the data together with its relatively large number of zeros, the mean annual cpue was computed assuming a lognormal distribution for the positive values only, together with an additional probability mass at zero. This type of distribution is commonly referred to as the delta-lognormal distribution, and was first discussed by Aitchison (1957). It has been used in various applications since then, and is commonly used in fisheries research (e.g. Pennington, 1996; Fletcher, 2008).

The expected annual index values are computed as the product of the proportion of positive (non-zero) hauls and the mean and variance of the cpue of the positive hauls:

$$\mu_Y = \pi \exp(\mu_X + \frac{\sigma_X^2}{2})$$

Where: π = the proportion of positive hauls in each year

μ , σ = the mean and variance of the cpue from the positive hauls each year

The proportion of positive hauls, the cpue in the positive hauls and the resultant index values are shown in Table 4.4.1 and the standardised index values for 0—19cm and > 20 cm fish (compared to the mean from 2006—2014) are shown for the IBTS in Figure 4.4.4 and the CGFS in Figure 4.4.4. IBTS values are used from 1992 onwards (following improved standardisation of gears used in the survey) and from 1990 onwards for the CGFS.

4.4.6 Summary of index trends

20+ cm indices

IBTS GLM Index for 20+ horse mackerel decreased steadily over the 2000s. Since 2010 there are some signs of a slight increase in abundance/biomass, however the relative increase in the index is small in comparison to the uncertainty range and the most recent value (2014) is among the lowest of the time series.

The IBTS DLN index for 20+ cm fish in the North Sea shows a roughly similar pattern as the GLM index. In the DLN index the reduction is mainly due to the proportion of hauls in which horse mackerel are found decreasing steadily over time, from 74% in 1998 to the lowest observed value of 28% in 2013. 2014 saw a slight increase in non-zero hauls, but the low cpue of non-zero values keeps the index low. From 2008—2013, cpue in the positive hauls increased, but 2014 was the low.

The CGFS DLN index for 20+ cm horse mackerel in the eastern channel shows a strong decline from the early 1990s to the mid-2000s. Since then the index has fluctuated at a relatively low level. In contrast to the IBTS, the 2014 index value shows an increase, and is the highest value since 2006. The proportion of non-zero hauls from this survey is generally very high, though the last four years have been at a slightly lower level than previous years.

0—19cm indices

The IBTS DLN index for 0—19 cm fish indicates high numbers in 2002 and 2003 and more or less fluctuating numbers for the other years. The 2013 and 2014 values are slightly higher indicating a potential increase in recruits in this area.

The CGFS DLN index for 0—19 cm fish does not show the high index values from the early 2000s as observed in the IBTS index in the North Sea. Following higher values in the early 1990s, index values have been fluctuating at a lower level. The last two values are amongst the highest in the last ten years.

Conclusions on survey indices

Although the IBTS and CGFS survey indices for horse mackerel, roughly indicate a similar trend (higher values at the beginning of the time series, lower value towards the end of the time series), there are noticeable differences in the timing and the scale of the decline.

Preliminary examinations of how the juvenile (0—19cm) indices relate to subsequent exploitable abundance (20+ cm) do not indicate strong linkages. The very high juvenile indices in the early 2000s in the IBTS were not subsequently picked up in the exploitable component. Hence while increases in the juvenile indices are encouraging, whether these lead to increases in the exploitable component of the stock need to be confirmed in the future with observations in the 20+ cm indices.

Further work is needed to better explore the consistency of the surveys in dealing with recommendations for horse mackerel catches.

4.4.7 Ongoing work

To improve the knowledge base for North Sea horse mackerel, a project has been initiated in 2015 by the Pelagic Freezer-trawler Association (PFA) together with IMARES and University College Dublin. The project aims to 1) provide additional information on stock boundaries and mixing between North Sea and Western horse mackerel, and 2) explore or develop potential new abundance indices for North Sea horse mackerel.

To address stock boundaries and mixing, the project will explore the potential of utilizing skippers' catch information (with a very high spatial resolution and detailed information on size composition) to enhance the understanding on the mixing of stocks in the areas VIIe, VIId and the Southern North Sea. In addition, horse mackerel samples will be taken when the horse mackerel are separated in the summer spawning season (in the North Sea and Western waters) and when they are feeding in the winter season (in the Channel area). Genetic and chemical techniques will be used to detect the contribution of the different spawning components to the catches in winter.

To improve the abundance indicators, the project will explore additional (existing) survey data, like the CGFS that has been reported to WGWIDE in the section above. We also want to explore the potential application of a commercial fishery search-time index. Horse mackerel is fished while it is very close to the bottom in relatively dispersed, small schools. The fishery is mostly executed using long hauls and there may be extensive search time involved. Handled in an appropriate statistical framework, taking into account the nature of the fishery and other factors such as seasonality and alternative fishing opportunities, the search time and catch rates could provide for an indication of changes in stock size over time. Catch rates in areas VIIe, VIId and southern North Sea will be analysed from skippers' private logbooks.

It is expected that the results of the research project can be presented to WGWIDE in 2016.

4.5 Basis for 2015 Advice

The new index data for the IBTS and the additional indices from the CGFS do not change the perception that the adult North Sea horse mackerel stock remains at a low level. There are some potential signs of improved recruitment, but additional years of data are necessary to confirm that these will lead to an increased exploitable biomass in future.

There was a large reduction in advised catches in 2014, and ICES considered that this advice should remain valid for at least 2 years since any potential changes in stock status are highly uncertain. As a result no change in advice is proposed for 2015: catches should not exceed 15 200 tonnes.

4.6 Management considerations

In the past, Division VIId was included in the management area for Western horse mackerel together with Divisions IIa, VIIa–c, VIIe–k, VIIIa, VIIIb, VIIId, VIIIe, Subarea VI, EU and international waters of Division Vb, and international waters of Subareas XII and XIV. ICES considers Division VIId to be part of the North Sea horse mackerel distribution area. Since 2010, the EU TAC for the North Sea area has included Divisions IVb,c and VIId. Considering that a majority of the catches are taken in Division VIId, the total of North Sea horse mackerel catches are effectively constrained by the TAC since the realignment of the management areas in 2010.

Catches in Divisions IIIa (Western Skagerrak) and IVa in quarters 3 and 4 are considered to be from the Western horse mackerel stock, while catches in quarters 1 and 2 are considered to be from the North Sea horse mackerel stock. Catches in area IVa and IIIa are variable. In recent years only Norway has had significant catches in this area, but these are only taken in some years (see Figure 4.2.1).

4.7 References

Aitchison, J. 1955. On the distribution of a positive random variable having a discrete probability mass at the origin. J Am Sta Assoc 50:901–908.

Barange, M., Pillar, S. C., and Hampton, I. 1998. Distribution patterns, stock size and life-history strategies of Cape horse mackerel Trachurus trachurus capensis, based on bottom trawl and acoustic surveys. South African Journal of Marine Science, 19: 433–447.

Bolle, L.J., Abaunza, P., Albrecht, C., Dijkman-Dulkes, A., Dueñas, C., Gentschouw, G., Gill, H., Holst, G., Moreira, A., Mullins, E., Rico, I., Rijs, S., Smith, T., Thaarup, A., Ulleweit, J. 2011 . Report of the Horse Mackerel Exchange and Workshop 2006. CVO report: 11.007.Eaton, D. R. 1983. Scad in the North-East Atlantic. Laboratory Leaflet, Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research, Lowestoft, 56: 20 pp.

Eaton, D. R. 1983. Scad in the North-East Atlantic. Lab. Leafl., MAFF Direct. Fish. Res., Lowestoft (56): 20pp.

Fletcher, D., 2008. Confidence intervals for the mean of the delta-lognormal distribution. Environ Ecol Stat (2008) 15:175–189.

Macer, C.T. 1974. The reproductive biology of the horse mackerel Trachurus trachurus (L.) in the North Sea and English Channel. J. Fish Biol., 6(4): 415-438.

Pennington, M., 1996. Estimating the mean and variance from highly skewed marine data. Fishery Bulletin 94:498-505.

Punt, A. E., Smith, D. C., and Smith, A. D. M. 2011. Among-stock comparisons for improving stock assessments of data-poor stocks: the “Robin Hood” approach. – ICES Journal of Marine Science, 68: 972–981.

Rückert, C., Floeter, J., A. Temming. 2002: An estimate of horse mackerel biomass in the North Sea, 1991-1997. - ICES Journal of Marine Science, 59: 120-130.

Table 4.3.1. North Sea Horse Mackerel stock. Catch in numbers (1000) by quarter and area in 2014.

1Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.00	0.00	0.00	0.00	1262.54	1262.54
2	0.19	0.17	36.68	37.82	682.71	757.57
3	1.52	1.35	286.87	295.80	1443.56	2029.11
4	2.10	1.86	395.60	407.91	2485.20	3292.66
5	1.54	1.37	290.80	299.85	1333.90	1927.47
6	1.90	1.69	358.92	370.09	1340.34	2072.94
7	0.38	0.33	70.74	72.94	712.63	857.01
8	0.76	0.68	144.09	148.58	605.53	899.64
9	0.19	0.17	36.68	37.82	221.00	295.87
10	0.58	0.51	108.72	112.11	507.95	729.87
11	0.38	0.34	72.05	74.29	424.20	571.25
12	0.00	0.00	0.00	0.00	157.82	157.82
13	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	122.42	122.42
15+	0.00	0.00	0.00	0.00	59.23	59.23
Sum	9.55	8.46	1801.15	1857.20	11359.04	15035.40
2Q Ages	**IIIa**	**IVa**	**IVb**	**IVc**	**VIId**	**Total**
0						
1	0.0	0.0	0.0	0.0	332.3	332.3
2	0.0	0.0	0.0	48.9	188.4	237.3
3	0.0	0.0	0.0	382.3	375.1	757.5
4	0.0	0.2	2.2	527.3	641.1	1170.8
5	0.2	0.8	11.0	387.6	342.2	741.8
6	0.3	1.1	15.4	478.4	343.8	839.1
7	0.1	0.5	6.6	94.3	182.8	284.3
8	0.2	0.6	8.8	192.0	155.3	357.0
9	0.0	0.0	0.0	48.9	56.7	105.6
10	0.0	0.2	2.2	144.9	130.3	277.6
11	0.0	0.2	2.2	96.0	108.8	207.3
12	0.0	0.2	2.2	0.0	40.5	42.9
13	0.1	0.3	4.4	0.0	0.0	4.8
14	0.0	0.0	0.0	0.0	31.4	31.4
15+	0.0	0.0	0.0	0.0	15.2	15.2
Sum	1.2	4.0	55.2	2400.6	2944.0	5404.9

3Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1			0.0	101.2	1480.5	1581.7
2			0.0	159.0	2326.5	2485.5
3			0.0	57.8	846.0	903.8
4			3.5	53.2	634.5	691.1
5			17.4	49.0	0.0	66.4
6			24.3	68.6	0.0	92.9
7			10.4	29.4	0.0	39.8
8			13.9	39.2	0.0	53.1
9			0.0	0.0	0.0	0.0
10			3.5	9.8	0.0	13.3
11			3.5	9.8	0.0	13.3
12			3.5	9.8	0.0	13.3
13			6.9	19.6	0.0	26.5
14			0.0	0.0	0.0	0.0
15+			0.0	0.0	0.0	0.0
Sum			86.8	606.3	5287.6	5980.7

4Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1			8.1	2110.0	10144.8	12263.0
2			6.5	1688.0	10084.8	11779.3
3			0.3	90.1	4943.1	5033.6
4			14.0	3646.3	21413.0	25073.3
5			10.9	2830.7	8222.7	11064.3
6			6.4	1654.8	2407.4	4068.5
7			0.7	180.2	1367.5	1548.4
8			1.6	422.0	1655.4	2079.1
9			0.7	180.2	357.5	538.4
10			0.0	0.0	0.0	0.0
11			0.0	0.0	537.0	537.0
12			0.0	0.0	195.2	195.2
13			0.0	0.0	0.0	0.0
14			0.0	0.0	0.0	0.0
15+			0.0	0.0	0.0	0.0
Sum			49.1	12802.3	61328.5	74180.0

1-4Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.0	0.0	8.1	2211.2	13220.2	15439.5
2	0.2	0.2	43.2	1933.7	13282.5	15259.7
3	1.5	1.3	287.2	826.0	7607.8	8724.0
4	2.1	2.0	415.3	4634.6	25173.9	30227.9
5	1.8	2.2	330.1	3567.2	9898.7	13799.9
6	2.2	2.8	405.0	2571.9	4091.5	7073.5
7	0.5	0.8	88.5	376.8	2262.9	2729.5
8	1.0	1.3	168.4	801.8	2416.3	3388.8
9	0.2	0.2	37.4	266.9	635.2	939.9
10	0.6	0.7	114.4	266.8	638.3	1020.8
11	0.4	0.5	77.7	180.1	1070.0	1328.8
12	0.0	0.2	5.7	9.8	393.5	409.1
13	0.1	0.3	11.4	19.6	0.0	31.4
14	0.0	0.0	0.0	0.0	153.8	153.8
15+	0.0	0.0	0.0	0.0	74.4	74.4
Sum	10.8	12.4	1992.2	17666.4	80919.1	100601.0

Table 4.3.2. Catch in numbers at age (millions), weight at age (kg) and length at age (cm) for the North Sea horse mackerel 1995-2014.

millions	Catch number																			
Age	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1	1.8	4.6	12.6	2.3	12.4	70.2	12.8	60.4	13.8	15.7	52.4	5.0	3.4	1.7	34.1	3.3	8.1	9.5	7.6	15.4
2	3.1	13.8	27.2	22.1	31.5	78.0	36.4	16.8	56.2	17.5	29.8	23.7	15.5	8.8	13.9	22.5	23.3	24.3	10.0	15.3
3	7.2	11.0	14.1	36.7	23.1	28.4	174.3	19.3	23.4	34.4	27.8	61.5	22.8	36.1	28.4	10.7	76.5	20.4	21.3	8.7
4	10.3	11.9	14.9	38.8	17.6	21.4	87.8	11.9	33.2	14.5	12.6	40.9	82.6	16.7	22.1	15.7	37.3	40.2	22.2	30.2
5	12.1	9.6	14.6	20.8	23.1	31.3	18.5	5.6	26.9	27.8	16.7	73.0	71.2	36.4	17.3	23.7	14.6	25.8	27.1	13.8
6	13.2	12.5	12.4	12.1	26.2	19.6	11.5	5.8	10.6	20.2	5.2	23.4	30.5	36.1	16.3	15.9	9.9	20.8	6.0	7.1
7	11.4	8.0	10.1	14.0	20.6	19.5	18.3	5.5	6.3	10.6	2.9	13.7	23.9	27.3	21.5	27.6	5.8	3.1	7.2	2.7
8	12.6	6.6	8.6	10.8	21.8	9.0	14.7	10.5	9.6	3.8	2.4	5.9	17.3	21.9	47.1	5.6	6.0	5.0	4.3	3.4
9	7.3	1.5	2.5	8.3	12.9	11.5	10.2	6.3	10.9	5.4	3.8	1.6	7.9	10.2	11.2	6.3	3.4	4.6	4.0	0.9
10	5.9	5.3	0.8	4.0	8.2	9.0	10.0	6.8	1.5	11.0	5.8	1.4	1.7	7.5	9.3	8.3	10.1	1.5	5.4	1.0
11	0.0	0.3	0.3	2.7	2.1	7.0	9.6	5.1	3.4	6.2	2.3	0.2	0.6	1.9	7.2	2.9	6.9	0.5	3.7	1.3
12	8.8	1.3	0.3	0.7	0.4	3.1	5.4	3.0	3.3	4.5	4.1	1.7	0.2	2.1	3.7	0.3	3.6	0.1	1.0	0.4
13	0.2	8.9		1.8	1.4	1.6	3.7	2.2	2.3	6.2	2.5	0.6	0.7	0.4	0.3	0.3	0.8		0.6	0.0
14	4.4	8.0	1.4	0.3	3.8		2.0	1.3	3.4	2.3	9.9	1.0	0.7	2.4	0.9	0.2	0.3	0.2	0.0	0.2
15+				5.1	4.0	12.2	5.8	2.7	4.7	8.5	9.6	0.8		1.0	6.1	1.1	0.5		0.1	0.1

kg weight

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
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	0.077	0.06	0.069	0.08	0.078
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	0.101	0.092	0.09	0.1	0.110
3	0.125	0.143	0.126	0.126	0.126	0.136	0.071	0.129	0.123	0.12	0.103	0.116	0.105	0.109	0.109	0.115	0.098	0.118	0.11	0.113
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	0.138	0.116	0.142	0.14	0.135
5	0.146	0.177	0.16	0.16	0.16	0.166	0.12	0.172	0.166	0.174	0.158	0.141	0.13	0.145	0.145	0.154	0.146	0.152	0.17	0.144
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	0.18	0.167	0.172	0.18	0.177
7	0.161	0.203	0.199	0.199	0.199	0.198	0.197	0.216	0.195	0.225	0.251	0.21	0.191	0.194	0.194	0.207	0.188	0.183	0.2	0.184
8	0.178	0.195	0.231	0.231	0.231	0.213	0.201	0.227	0.212	0.229	0.27	0.244	0.197	0.221	0.221	0.195	0.206	0.188	0.22	0.201
9	0.165	0.218	0.25	0.25	0.25	0.247	0.235	0.228	0.238	0.256	0.28	0.231	0.256	0.286	0.286	0.241	0.3	0.212	0.22	0.222
10	0.173	0.241	0.259	0.259	0.259	0.28	0.246	0.251	0.259	0.291	0.291	0.284	0.258	0.296	0.296	0.225	0.324	0.204	0.23	0.220
11	0.317	0.307	0.3	0.3	0.3	0.279	0.26	0.302	0.245	0.301	0.344	0.237	0.517	0.273	0.273	0.286	0.341	0.274	0.24	0.264
12	0.233	0.211	0.329	0.329	0.329	0.342	0.286	0.292	0.295	0.3	0.361	0.257	0.279	0.309	0.309	0.227	0.402	0.195	0.26	0.287
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	0.288	0.405		0.26	0.252
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	0.315	0.415	0.187	0.56	0.408
15+	0.348	0.277	0.36	0.36	0.36	0.332	0.336	0.39	0.38	0.401	0.367	0.402		0.389	0.389	0.358	0.473		0.34	0.273

cm	length																			
Age	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
1	19.2	19.2	19.2	19.2	19.2	19.0	18.7	17.1	20.2	19.8	20.5	19.9	20.1	20.0	20.0	20.8	19.2	19.9	20.9	20.4
2	22.0	22.0	22.0	22.0	22.0	21.5	20.4	21.4	22.4	22.2	21.5	21.9	20.8	21.6	21.6	22.6	21.7	21.7	22.4	22.9
3	23.5	23.5	23.5	23.5	23.5	23.9	20.6	22.9	23.8	23.6	23.0	23.4	22.6	23.2	23.2	23.8	23.1	23.5	23.5	23.5
4	24.8	24.8	24.8	24.8	24.8	24.9	21.3	24.9	24.6	25.2	24.7	24.1	23.6	24.1	24.1	25.0	24.5	25.0	25.3	24.8
5	25.5	25.5	25.5	25.5	25.5	26.0	25.0	26.2	26.2	26.6	25.5	25.4	24.4	25.6	25.6	25.7	25.9	25.7	27.0	25.4
6	26.4	26.4	26.4	26.4	26.4	27.8	27.4	26.6	27.3	27.5	27.8	27.0	26.6	26.3	26.3	27.0	27.5	27.0	27.1	27.3
7	27.2	27.2	27.2	27.2	27.2	28.3	28.0	27.4	28.2	28.9	30.4	28.5	27.8	28.1	28.1	28.2	28.0	27.1	28.3	27.5
8	29.2	29.2	29.2	29.2	29.2	28.6	28.4	28.2	29.0	29.2	31.2	29.8	28.1	28.8	28.8	28.2	27.7	27.1	28.9	28.0
9	29.5	29.5	29.5	29.5	29.5	30.0	29.7	29.2	29.9	30.5	31.8	30.6	30.1	31.2	31.2	30.2	31.9	28.6	29.2	28.8
10	29.5	29.5	29.5	29.5	29.5	31.3	30.2	30.8	30.8	31.5	32.3	31.6	31.2	31.8	31.8	29.9	32.5	28.0	29.5	29.2
11	30.6	30.6	30.6	30.6	30.6	31.4	30.7	32.5	30.8	32.0	34.4	31.2	39.5	31.6	31.6	32.1	33.3	30.1	30.0	30.7
12	32.1	32.1	32.1	32.1	32.1	33.7	32.0	33.8	31.9	31.8	36.2	30.8	31.5	32.2	32.2	29.6	34.5	27.5	30.4	30.6
13	33.3	33.3	33.3	33.3	33.3	33.5	31.7	33.8	32.9	32.0	34.2	32.1	33.4	33.9	33.9	31.8	35.2		32.1	30.0
14	31.1	31.1	31.1	31.1	31.1	33.4	32.1	32.4	32.7	33.0	34.9	32.2	34.5	32.3	32.3	33.0	36.0	27.5	38.5	36.0
15+	32.5	32.5	32.5	32.5	32.5	33.4	33.4	34.4	34.6	34.8	35.4	35.4		35.1	35.1	34.7	37.0		34.2	32.5

Table 4.3.3. North Sea Horse Mackerel stock. Mean weight at age (kg) in the catch by quarter and area in 2014.

1Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.000	0.000	0.000	0.000	0.094	0.094
2	0.053	0.053	0.053	0.053	0.077	0.074
3	0.094	0.094	0.094	0.094	0.096	0.095
4	0.106	0.106	0.106	0.106	0.117	0.114
5	0.140	0.140	0.140	0.140	0.145	0.143
6	0.166	0.166	0.166	0.166	0.162	0.163
7	0.148	0.148	0.148	0.148	0.164	0.161
8	0.215	0.215	0.215	0.215	0.211	0.212
9	0.186	0.186	0.186	0.186	0.208	0.203
10	0.201	0.201	0.201	0.201	0.230	0.221
11	0.287	0.287	0.287	0.287	0.300	0.296
12	0.000	0.000	0.000	0.000	0.246	0.246
13	0.000	0.000	0.000	0.000	0.000	-
14	0.000	0.000	0.000	0.000	0.408	0.408
15+	0.000	0.000	0.000	0.000	0.273	0.273

2Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.000	0.000	0.000	0.000	0.093	0.093
2	0.000	0.000	0.000	0.053	0.079	0.074
3	0.000	0.000	0.000	0.094	0.097	0.095
4	0.177	0.177	0.177	0.106	0.117	0.112
5	0.197	0.197	0.197	0.140	0.145	0.143
6	0.222	0.222	0.222	0.166	0.162	0.165
7	0.230	0.230	0.230	0.148	0.164	0.160
8	0.262	0.262	0.262	0.215	0.211	0.214
9	0.000	0.000	0.000	0.186	0.208	0.198
10	0.285	0.285	0.285	0.201	0.230	0.215
11	0.282	0.282	0.282	0.287	0.300	0.294
12	0.391	0.391	0.391	0.000	0.246	0.254
13	0.252	0.252	0.252	0.000	0.000	0.252
14	0.000	0.000	0.000	0.000	0.408	0.408
15+	0.000	0.000	0.000	0.000	0.273	0.273

3Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1			0.000	0.063	0.063	0.063
2			0.000	0.113	0.113	0.113
3			0.000	0.124	0.124	0.124
4			0.177	0.146	0.139	0.140
5			0.197	0.197	0.000	0.197
6			0.222	0.222	0.000	0.222
7			0.230	0.230	0.000	0.230
8			0.262	0.262	0.000	0.262
9			0.000	0.000	0.000	
10			0.285	0.285	0.000	0.285
11			0.282	0.282	0.000	0.282
12			0.391	0.391	0.000	0.391
13			0.252	0.252	0.000	0.252
14			0.000	0.000	0.000	
15+			0.000	0.000	0.000	

4Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0			0.062	0.062	0.082	0.078
1			0.102	0.102	0.114	0.112
2			0.141	0.141	0.120	0.121
3			0.127	0.127	0.141	0.139
4			0.135	0.135	0.147	0.144
5			0.170	0.170	0.195	0.185
6			0.215	0.215	0.199	0.200
7			0.166	0.166	0.199	0.192
8			0.209	0.209	0.252	0.238
9			0.000	0.000	0.000	
10			0.000	0.000	0.218	0.218
11			0.000	0.000	0.321	0.321
12			0.000	0.000	0.000	
13			0.000	0.000	0.000	
14			0.000	0.000	0.000	
15+			0.062	0.062	0.082	0.078
			0.101	0.082	0.175	0.174

1-4Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.000	0.000	0.062	0.062	0.081	0.078
2	0.053	0.053	0.060	0.101	0.112	0.110
3	0.094	0.094	0.094	0.101	0.115	0.113
4	0.108	0.112	0.108	0.123	0.138	0.135
5	0.148	0.161	0.145	0.137	0.147	0.144
6	0.175	0.188	0.172	0.170	0.181	0.177
7	0.171	0.196	0.164	0.186	0.185	0.184
8	0.225	0.238	0.221	0.192	0.203	0.201
9	0.186	0.186	0.186	0.202	0.233	0.222
10	0.208	0.221	0.205	0.204	0.230	0.220
11	0.287	0.286	0.287	0.287	0.259	0.264
12	0.391	0.391	0.391	0.391	0.283	0.287
13	0.252	0.252	0.252	0.252	0.000	0.252
14	0.000	0.000	0.000	0.000	0.408	0.408
15+	0.000	0.000	0.000	0.000	0.273	0.273

Table 4.3.4. North Sea Horse Mackerel stock. Mean length (cm) at age in the catch by quarter and area in 2014.

1Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.0	0.0	0.0	0.0	22.1	22.1
2	19.5	19.5	19.5	19.5	21.3	21.1
3	22.9	22.9	22.9	22.9	22.7	22.8
4	23.5	23.5	23.5	23.5	24.1	23.9
5	25.5	25.5	25.5	25.5	25.9	25.8
6	26.8	26.8	26.8	26.8	26.6	26.6
7	26.5	26.5	26.5	26.5	26.8	26.8
8	29.0	29.0	29.0	29.0	28.7	28.8
9	27.5	27.5	27.5	27.5	27.9	27.8
10	28.8	28.8	28.8	28.8	29.4	29.2
11	32.0	32.0	32.0	32.0	31.9	31.9
12	0.0	0.0	0.0	0.0	29.5	29.5
13	0.0	0.0	0.0	0.0	0.0	NA
14	0.0	0.0	0.0	0.0	36.0	36.0
15+	0.0	0.0	0.0	0.0	32.5	32.5
Mean						
2Q Ages	**IIIa**	**IVa**	**IVb**	**IVc**	**VIId**	**Total**
0						
1	0.0	0.0	0.0	0.0	22.0	22.0
2	0.0	0.0	0.0	19.5	21.4	21.0
3	0.0	0.0	0.0	22.9	22.7	22.8
4	26.5	26.5	26.5	23.5	24.1	23.8
5	26.7	26.7	26.7	25.5	25.9	25.7
6	28.1	28.1	28.1	26.8	26.6	26.7
7	27.8	27.8	27.8	26.5	26.8	26.8
8	29.5	29.5	29.5	29.0	28.7	28.9
9	0.0	0.0	0.0	27.5	27.9	27.7
10	29.5	29.5	29.5	28.8	29.4	29.1
11	28.5	28.5	28.5	32.0	31.9	31.9
12	33.5	33.5	33.5	0.0	29.5	29.7
13	30.0	30.0	30.0	0.0	0.0	30.0
14	0.0	0.0	0.0	0.0	36.0	36.0
15+	0.0	0.0	0.0	0.0	32.5	32.5

3Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1			0.0	18.9	18.9	18.9
2			0.0	22.4	22.4	22.4
3			0.0	23.8	23.8	23.8
4			26.5	24.6	24.2	24.2
5			26.7	26.7	0.0	26.7
6			28.1	28.1	0.0	28.1
7			27.8	27.8	0.0	27.8
8			29.5	29.5	0.0	29.5
9			0.0	0.0	0.0	NA
10			29.5	29.5	0.0	29.5
11			28.5	28.5	0.0	28.5
12			33.5	33.5	0.0	33.5
13			30.0	30.0	0.0	30.0
14			0.0	0.0	0.0	NA
15+			0.0	0.0	0.0	NA

4Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1			19.9	19.9	20.5	20.4
2			23.3	23.3	23.2	23.2
3			25.5	25.5	23.9	23.9
4			24.5	24.5	25.1	25.0
5			25.3	25.3	25.3	25.3
6			27.2	27.2	28.0	27.7
7			28.0	28.0	28.1	28.1
8			27.5	27.5	27.5	27.5
9			28.5	28.5	30.1	29.5
10			0.0	0.0	0.0	NA
11			0.0	0.0	29.1	29.1
12			0.0	0.0	31.5	31.5
13			0.0	0.0	0.0	NA
14			0.0	0.0	0.0	NA
15+			0.0	0.0	0.0	NA
Mean			17.67	13.07	24.85	26.26

1-4Q Ages	IIIa	IVa	IVb	IVc	VIId	Total
0						
1	0.0	0.0	19.9	19.9	20.5	20.4
2	19.5	19.5	20.1	23.0	22.9	22.9
3	22.9	22.9	22.9	23.2	23.6	23.5
4	23.6	23.7	23.6	24.3	24.9	24.8
5	25.7	26.0	25.6	25.4	25.4	25.4
6	27.0	27.3	26.9	27.1	27.4	27.3
7	26.9	27.3	26.8	27.3	27.6	27.5
8	29.1	29.3	29.1	28.2	27.9	28.0
9	27.5	27.5	27.5	28.2	29.1	28.8
10	28.9	29.0	28.9	28.8	29.4	29.2
11	31.6	30.9	31.8	31.8	30.5	30.7
12	33.5	33.5	33.5	33.5	30.5	30.6
13	30.0	30.0	30.0	30.0	0.0	30.0
14	0.0	0.0	0.0	0.0	36.0	36.0
15+	0.0	0.0	0.0	0.0	32.5	32.5

Table 4.4.1. North Sea horse mackerel. Relative indices of abundance derived from the IBTS Q3 data (North Sea only, no VIId included) and the French Channel Groundfish Survey in Q4 (CGFS, VIId). The GLM index uses a zero inflated negative binomial model to predict the trend in abundance of exploitable (≥ 20 cm) horse mackerel in the North Sea. The DLN indices is derived as the product of the CPUE in the positive (non-zero) hauls and the proportion of positive hauls.

	IBTS Q3 IV						CGFS Q4 VIId		
Year	GLM 20+ cm	GLM 5%	GLM 95%	DLN 0—19 cm	DLN 20+ cm	Proportion non-Zero	DLN 0—19 cm	DLN 20+ cm	Proportion non-Zero
1990							6.17	1.28	0.91
1991							3.39	5.03	1.00
1992				478	68823	0.78	12.88	3.53	0.98
1993				279	58569	0.77	4.71	0.98	0.98
1994				554	51375	0.76	5.20	3.66	0.98
1995				104	54688	0.65	8.64	2.07	0.94
1996				208	98715	0.73	2.85	1.87	0.94
1997				1184	28743	0.70	2.33	1.54	0.97
1998	1.89	0.94	3.83	245	24014	0.74	1.88	1.39	0.98
1999	3.99	1.85	8.62	774	8005	0.68	3.27	1.10	0.95
2000	9.15	3.99	20.99	241	38015	0.64	3.71	0.41	0.94
2001	1.51	0.69	3.32	420	31967	0.60	2.81	1.21	0.95
2002	3.47	1.61	7.48	2073	16119	0.64	2.63	0.46	0.96
2003	2.70	1.25	5.83	2396	6363	0.67	4.31	0.42	0.98
2004	1.68	0.78	3.66	283	5083	0.66	3.08	0.52	0.96
2005	2.70	1.17	6.21	450	7417	0.53	2.09	0.73	0.92
2006	2.15	0.97	4.77	288	10923	0.53	1.60	0.98	0.92
2007	0.38	0.17	0.88	193	2044	0.51	1.56	0.53	0.88
2008	1.22	0.50	2.99	257	789	0.51	0.72	0.24	0.86
2009	0.92	0.39	2.17	234	1500	0.50	1.86	0.20	0.92

2010	0.43	0.18	1.02	213	2361	0.49	4.43	0.23	0.90
2011	0.94	0.39	2.24	103	1554	0.39	0.79	0.32	0.80
2012	1.01	0.40	2.54	108	5562	0.32	0.79	0.14	0.87
2013	1.61	0.61	4.21	313	6301	0.28	3.48	0.28	0.86
2014	0.34	0.14	0.83	303	366	0.46	4.86	0.61	0.89

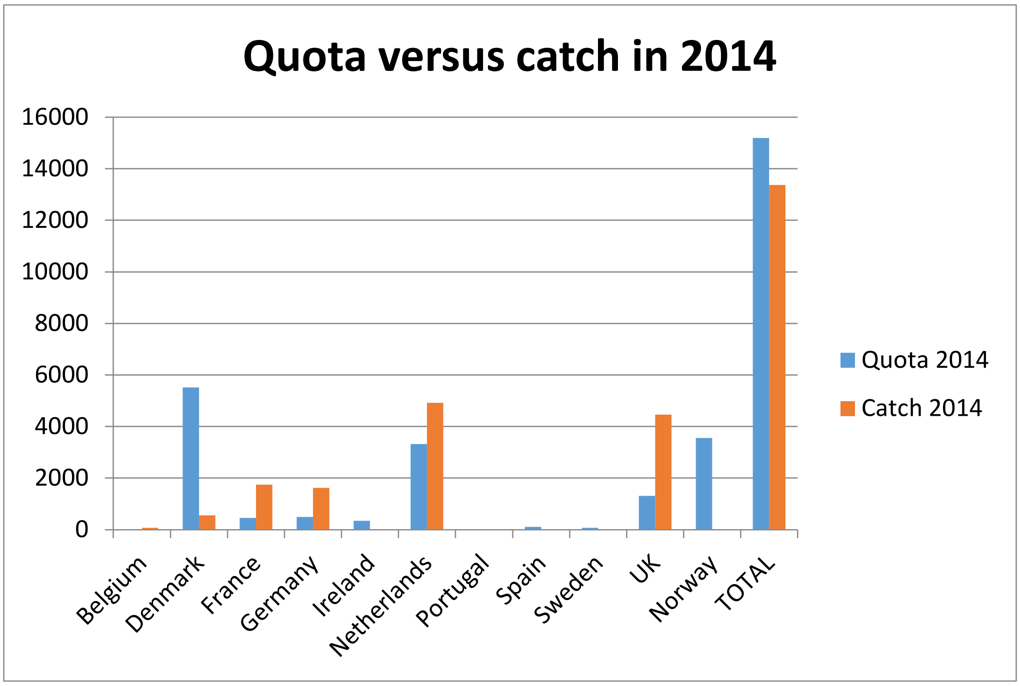


Figure 4.2.1. North Sea horse mackerel. Utilisation of quota by country.

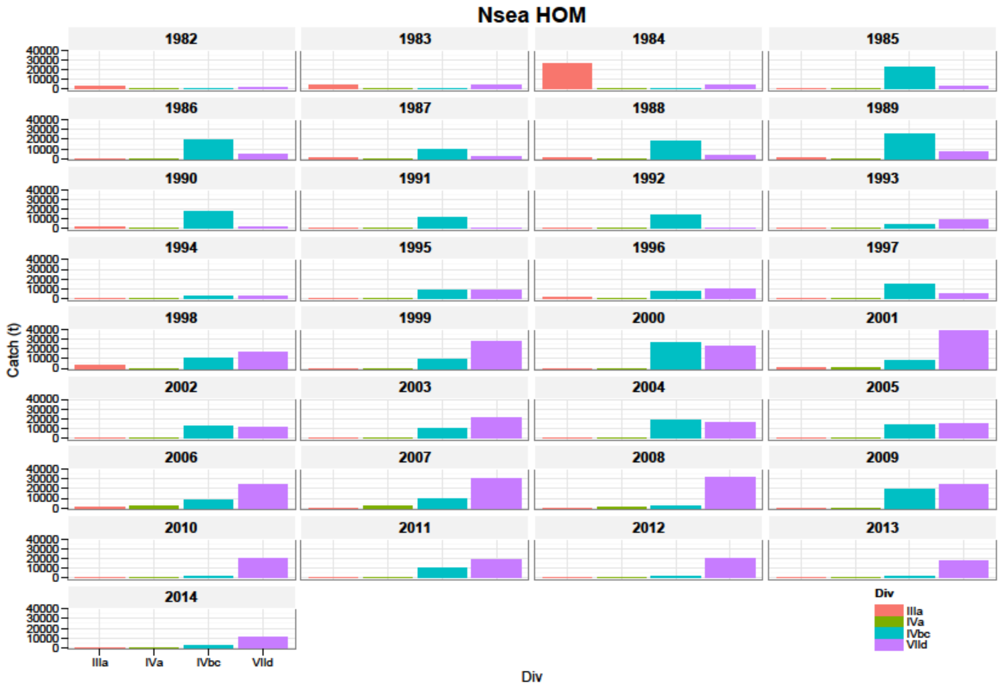
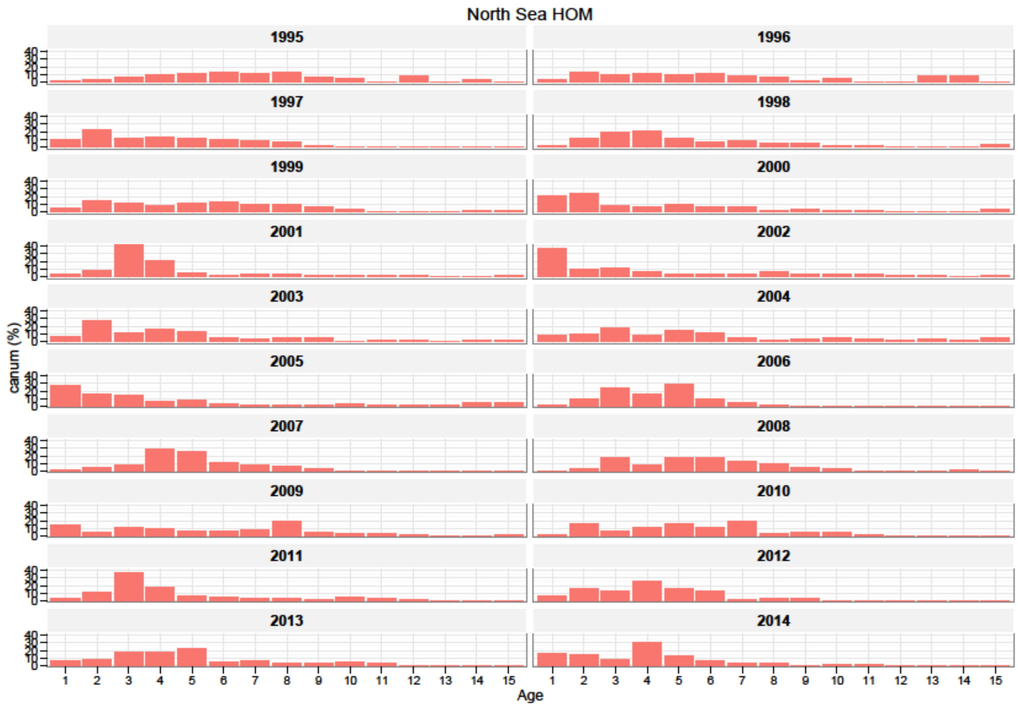


Figure 4.2.2 North Sea horse mackerel. Catch by ICES Division for 1982—2014.

A



B

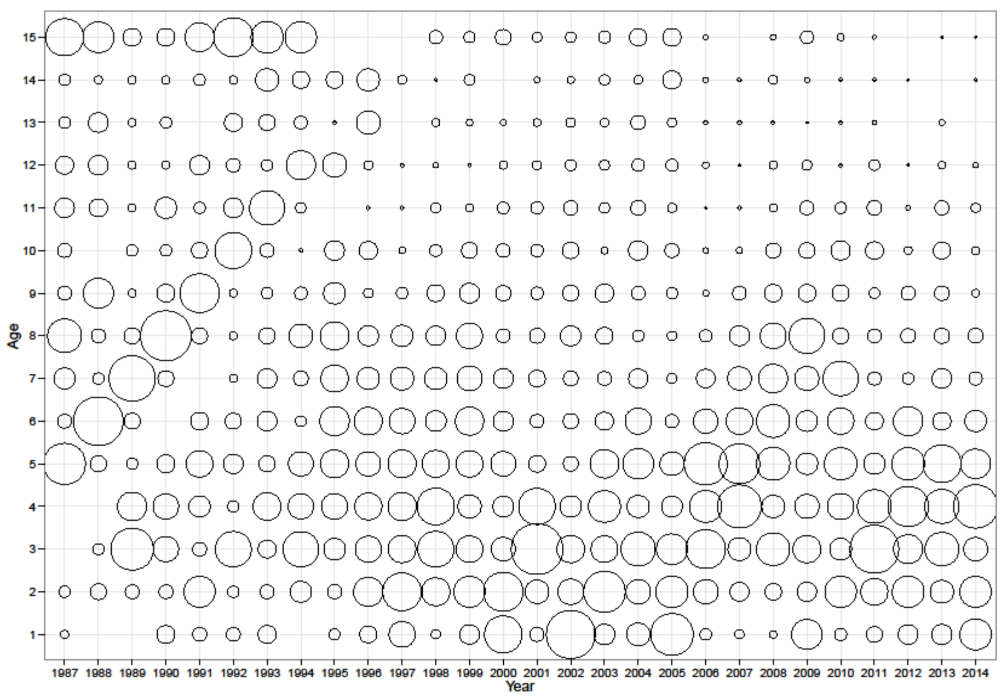


Figure 4.3.1 North Sea horse mackerel. A- Age distribution in the catch for 1995—2014. B- Bubbleplot of age distribution in the catch in all areas for 1987—2014. Area of bubbles is proportional to the catch number. Note that age 15 is a plus group.

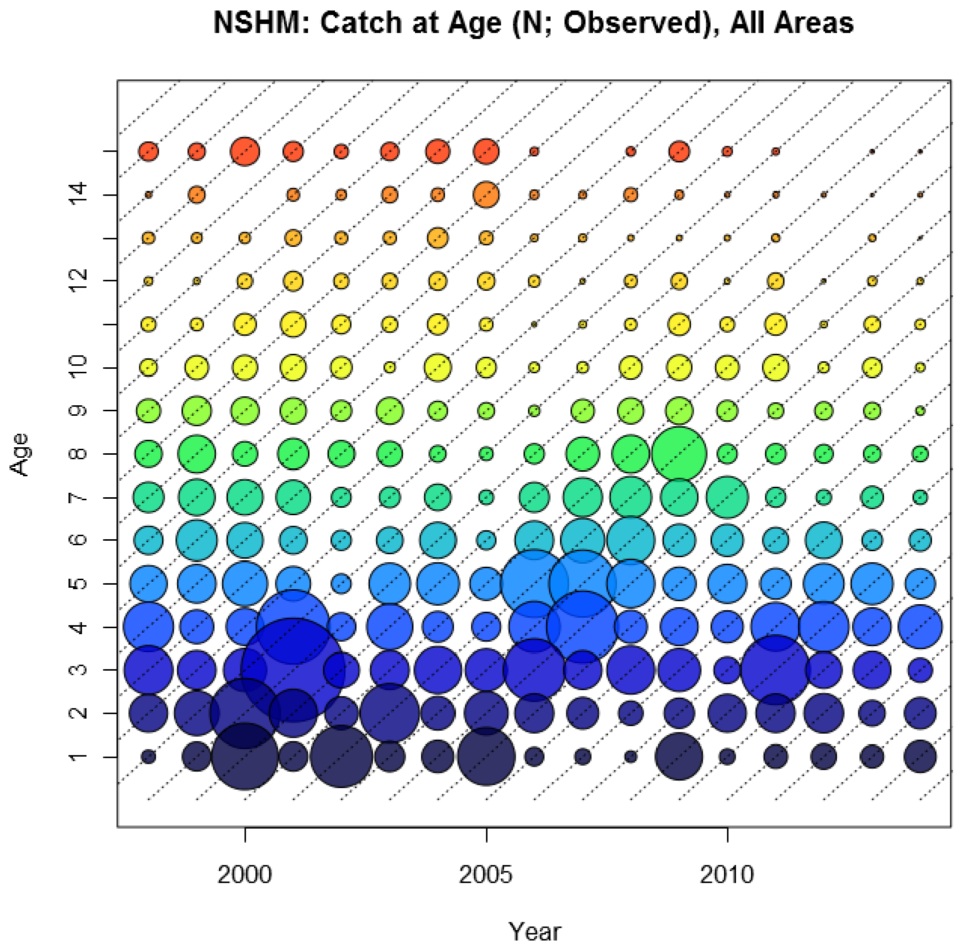
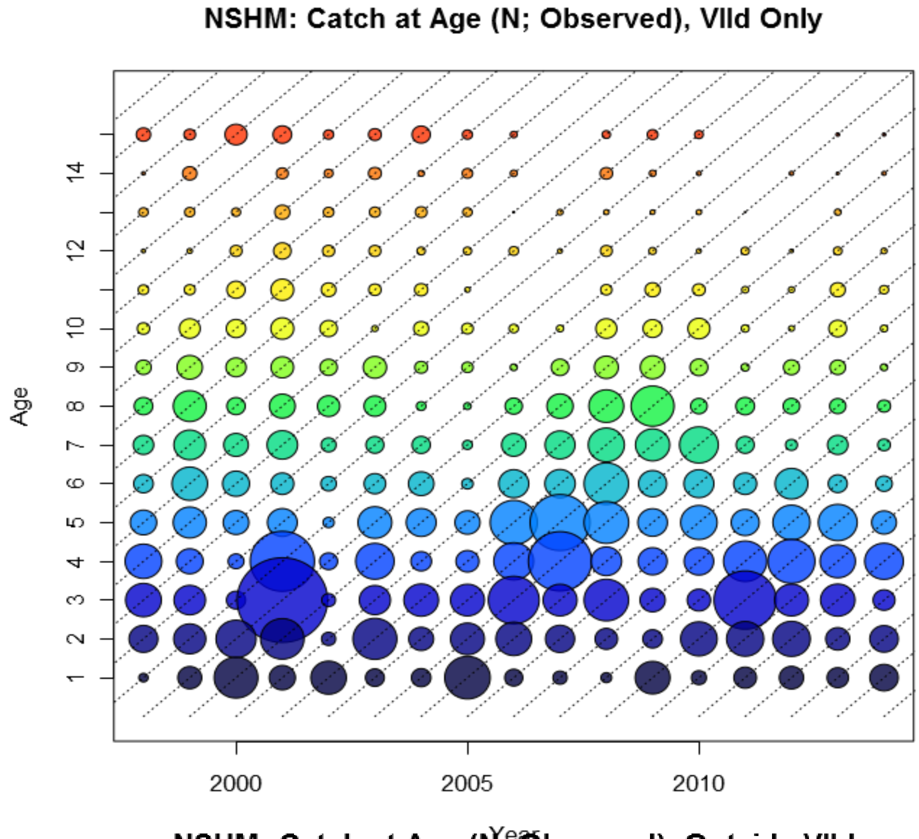


Figure 4.3.2. North Sea horse mackerel. Bubbleplot of age distribution in the catch in all areas for 1987—2014. The area of bubbles is proportional to the catch number. Note that age 15 is a plus group.


NSHM: Catch at Age (N; Observed), VIId Only
Age
1
2
3
4
5
6
7
8
9
10
12
14
2000
2005
2010
Year

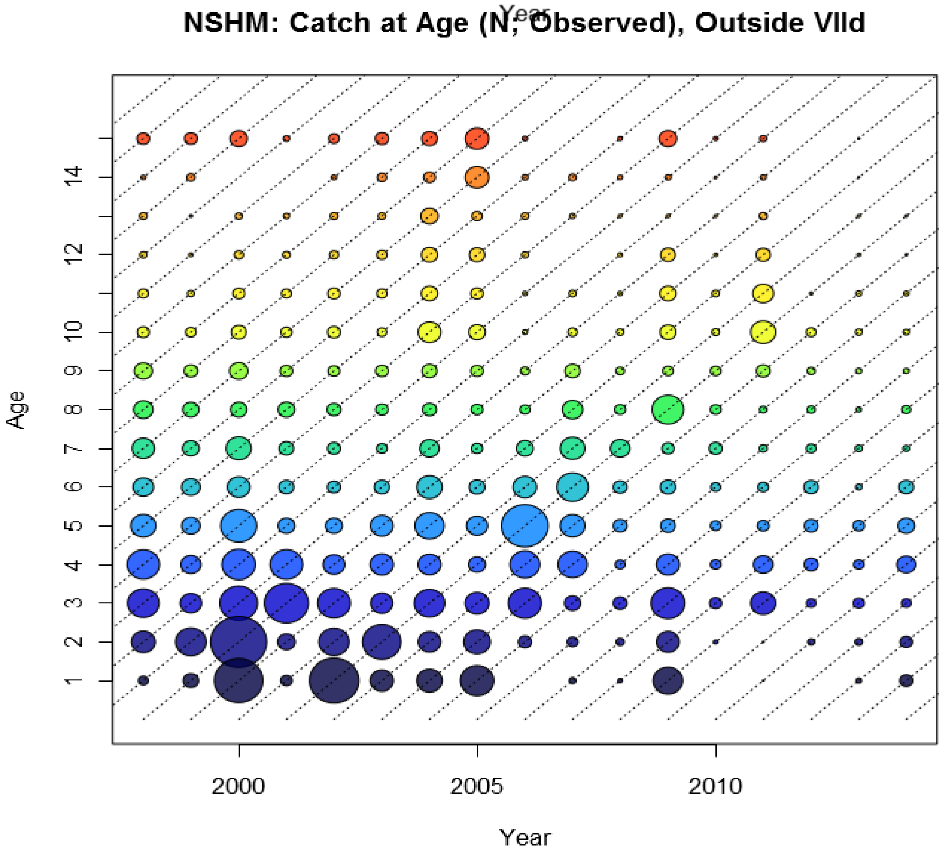

NSHM: Catch at Age (N; Observed), Outside VIId
Age
1
2
3
4
5
6
7
8
9
10
12
14
2000
2005
2010
Year

Figure 4.3.3. North Sea horse mackerel. Bubbleplots of age distribution in the catch by area for 1998—2014. The area of bubbles is proportional to the catch number. Note that age 15 is a plus group.

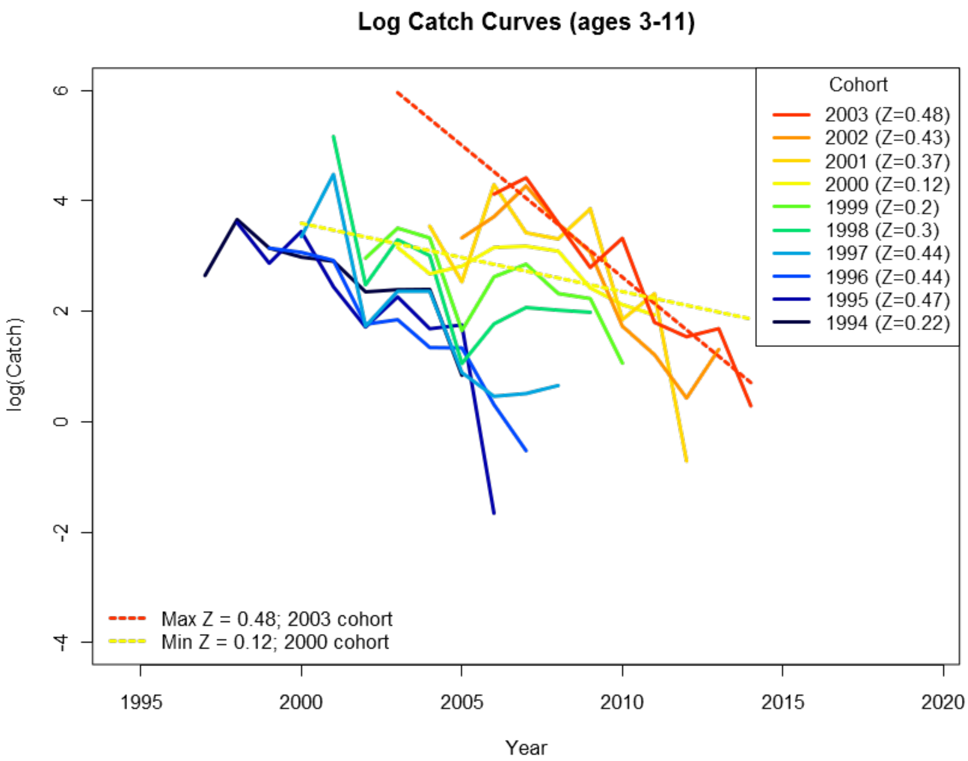


Figure 4.4.1. North Sea Horse Mackerel. Catch curves for the 1994 to 2003 cohorts, ages from 3 to 11. Values plotted are the log(catch) values for each cohort in each year. The negative slope of these curves estimates total mortality (Z) in the cohort.

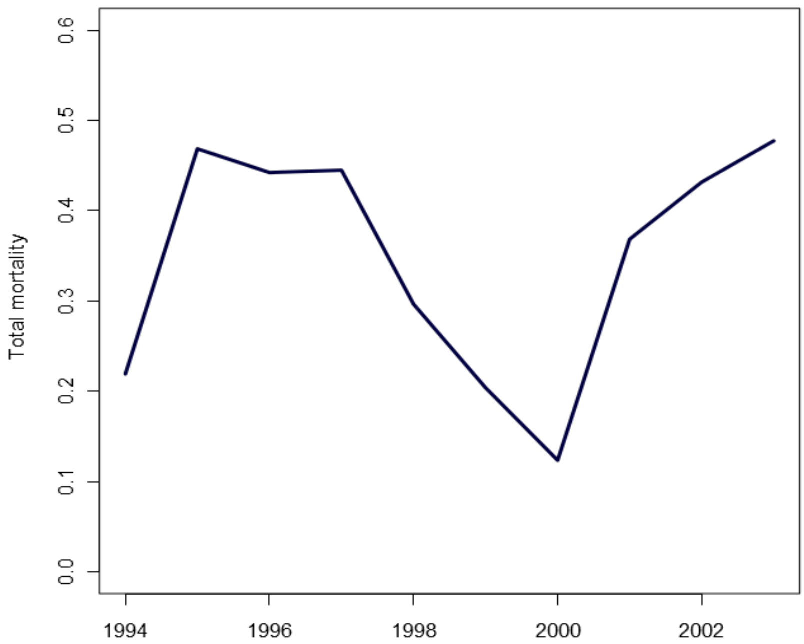
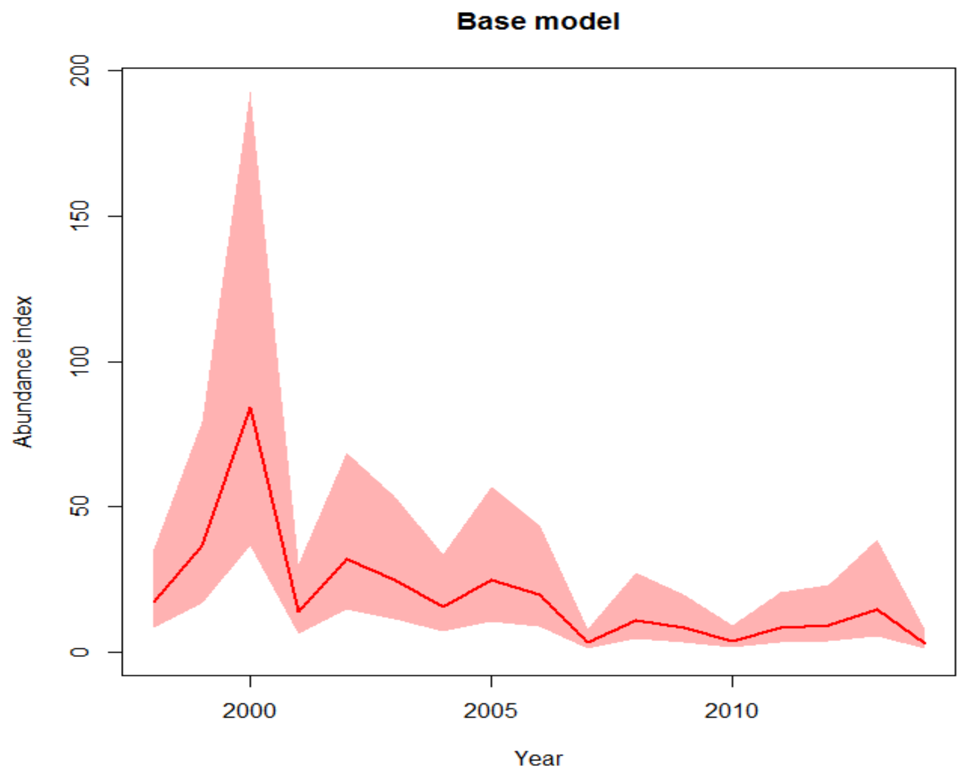


Figure 4.4.2. North Sea Horse Mackerel. Cohort total mortality (Z), negative gradients of the 1994—2003 cohort catch curves.



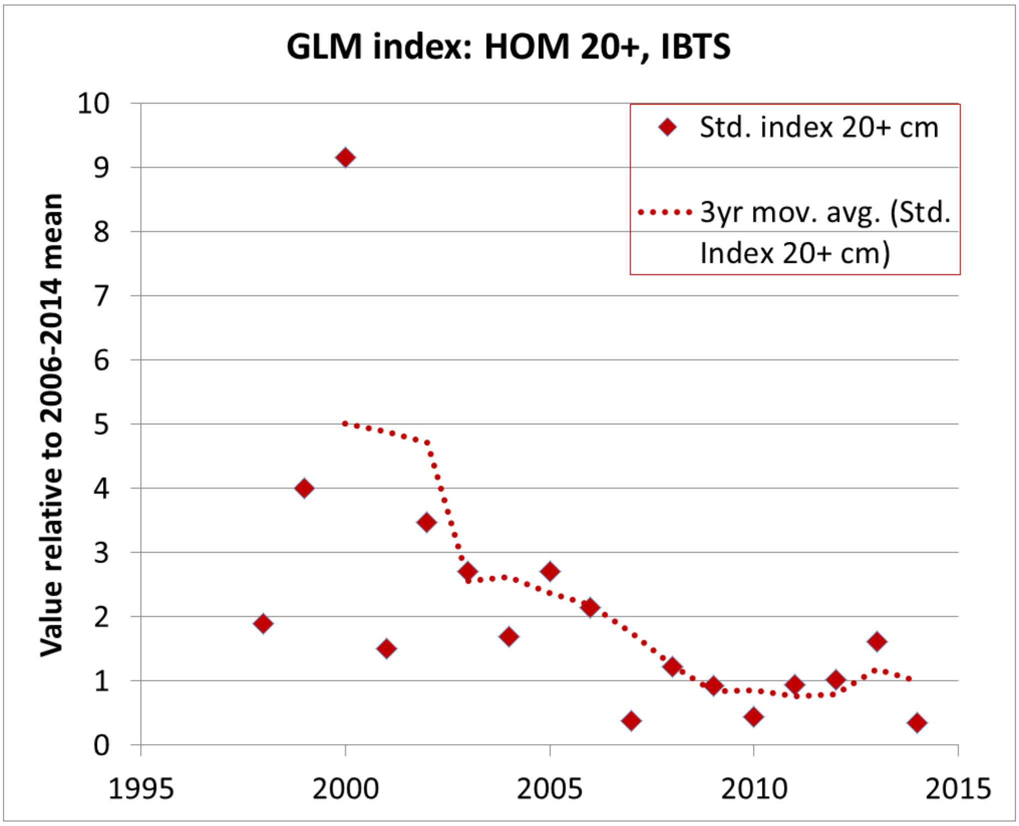


Figure 4.4.3. North Sea horse mackerel. GLM abundance indices. Top: Abundance index, the shaded area indicates the 95% confidence intervals for the estimated index values. Bottom: The abundance index standardised to the 2006—2014 mean, with 3yr running mean trendline.

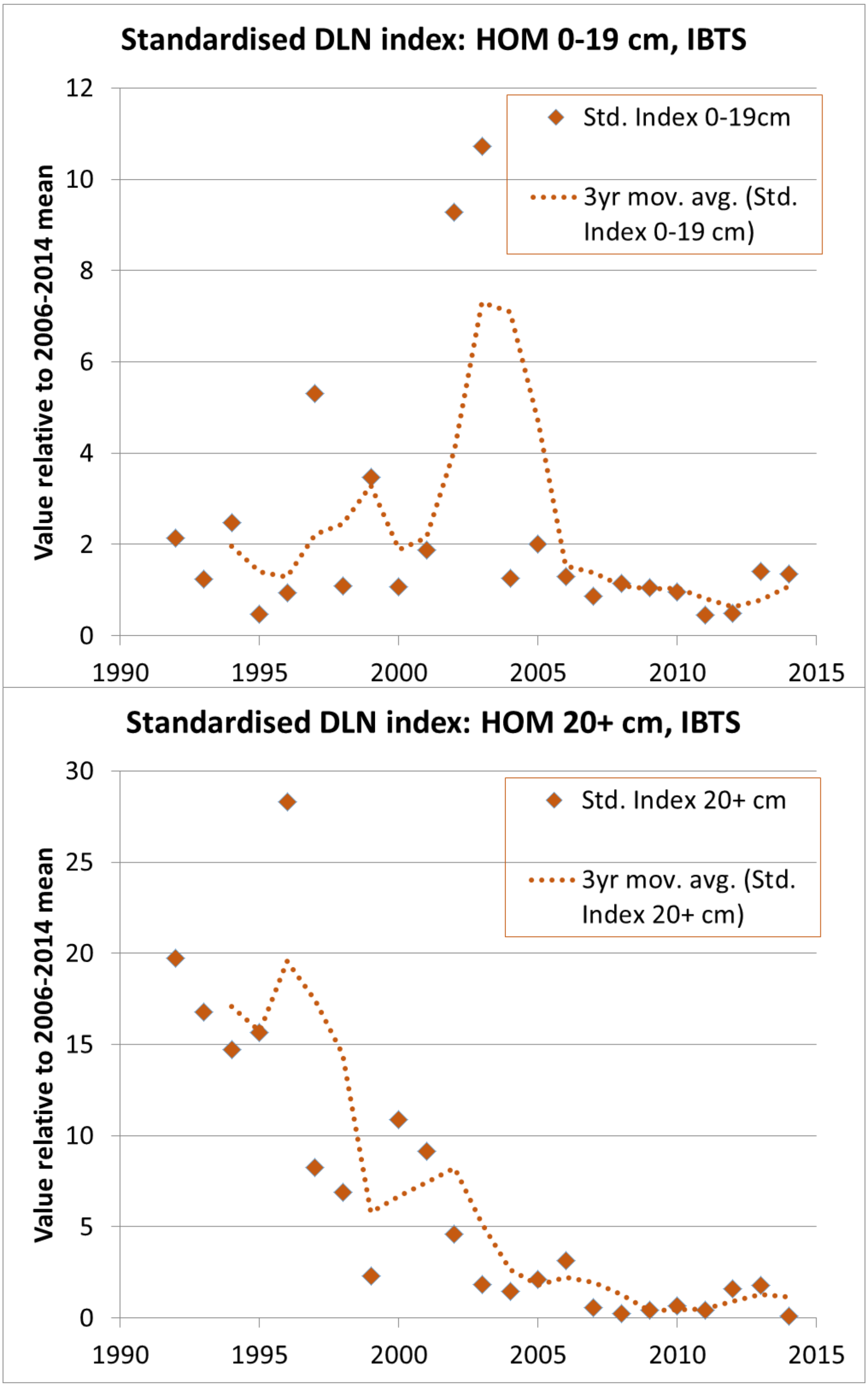


Figure 4.4.4. Delta-lornormal indices derived from the IBTS survey in the North Sea (IVbc). Top: Young fish (~ages 0 and 1); Bottom: older fish (~age 2+). The abundance index values are standardised to 2006—2014 mean, with 3yr running mean trendline.

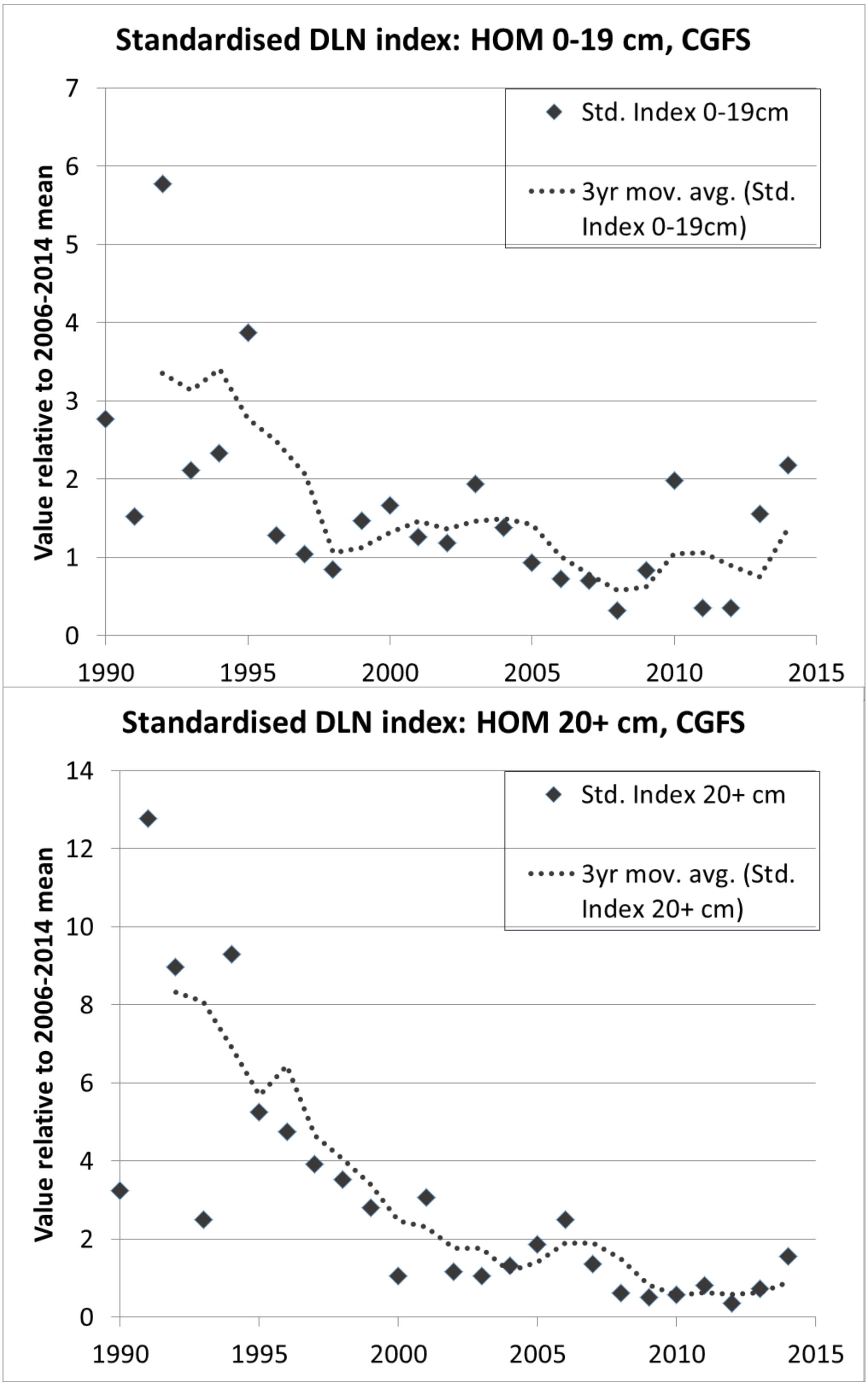


Figure 4.4.5. Delta-lognormal indices derived from the CGFS survey in the eastern English Channel (VIId). Top: Young fish (~ages 0 and 1); Bottom: older fish (~age 2+). The abundance index values are standardised to the 2006-2014 mean, with 3yr running mean trendline.

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 2014 and 2015

Since 2011, the TACs cover areas in line with the distribution areas of the stocks.

For 2014 the TAC set in EU waters (EU 43/2014) was the following:

Areas in EU waters	TAC 2014	Stocks fished in this area
IIa, IVa, Vb, Subareas VI,VIIa-c, VIIe-k, VIIIabde, Vb, XII, XIV	115 212 t	Western stock & North Sea stock in IVa 1-2 quarters
IVb,c, VIId	28 170 t	North Sea stocks
Division VIIIc	18 508 t	Western stock

For 2015 the TAC set in EU waters (EU 2015/104) was the following:

Areas in EU waters	TAC 2015	Stocks fished in this area
IIa, IVa, Vb, Subareas VI,VIIa-c, VIIe-k, VIIIabde, Vb, XII, XIV	84 032 t	Western stock & North Sea stock in IVa 1-2 quarters
IVb,c, VIId	11 650 t	North Sea stocks
Division VIIIc	13 572 t	Western stock

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

In 2014 ICES advised on the basis of MSY approach that Western horse mackerel catches in 2015 should be no more than 99 304 tonnes. The Western horse mackerel TAC for 2015 is 99 304 tonnes, the TAC for EU waters only is 97 604. The TAC should apply to the total distribution area of this stock. The EU horse mackerel catches in Division IIIa are taken outside the horse mackerel TACs.

5.1.1 The fishery in 2014

Information on the development of the fisheries by quarter and division is shown in Table 3.1.1 and 3.1.2 and in Figures 3.1.1.a–d. The total catch allocated to western horse mackerel in 2014 was 129 025 t which is 31 661 t less than in 2013 and 18479 t more than advised by ICES. The catches of horse mackerel by country and area are shown in Tables 5.1.1.1-5.

5.1.2 Estimates of discards

Over the years, few countries have provided data on discards, so that the estimated amount of discards are not representative for the total fishery. Based on the limited data available it has been impossible to estimate the amount of discard in the horse mackerel fisheries until now.

However, in 2015 most countries have presented discard data. Horse mackerel discards were presented by Spain, Germany, United Kingdom (England + Wales), Norway, Denmark, Sweden, Netherlands and Ireland. Discard rate for western Horse mackerel was estimated to be below 1.5 % in weight.

Discard data for 2014 was used in the assessment.

5.1.3 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 the 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 following the yearly distribution described in Section 3.3 (Figure 5.1.3.1). The western stock is considered a management unit and advised accordingly. At present there are no international agreed management measures. EU regulates the fishery by TAC. This TAC is now set in accordance with the distribution of the stock although catches in IIIa are taken outside the TAC.

5.2 Scientific data

5.2.1 Egg survey estimates

In 2013 an egg survey was carried out in the western and southern spawning areas and a working document with preliminary results of the survey was distributed to WGWIDE members (Burns *et al.* 2013).

As a consequence of the revision of the mackerel and horse mackerel historical egg survey database (1992 to 2013) carried out by WGMEGS in 2014 (ICES. 2014b). An initial attempt to recalculate the TAEP (Total Annual Egg Production) of the whole time series for Western horse mackerel using this reviewed historical database was performed in 2015 (WD Costas et al., 2015). In addition, the provisional horse mackerel TAEP estimates for the whole time series were calculated using a new updated code in R that has been developed in recent years. The results of the updated horse mackerel egg production estimates will be reported by WGMEGS in the 2016 WG report..

The updated time-series is reported in table 5.2.1.1 In 1992, 1995 and 1998 the provisional revised estimates represented a significant increase on the original reported estimates (21%, 9% and 10%, respectively) Figure 5.2.1.1. The causes for these bigger divergences were explained as:

1) The reported 1992 estimate had not included the TAEP from the southern part of the stock (Div. VIIIc) so it was corrected to include those data. In addition, the 1992 survey just covered a denoted “standard area” that was defined in previous reports (ICES, 1993).
2) In the original calculation of the 1995 reported estimate only the data from the “standard area” corresponding to that used in 1992 (ICES, 1996) were used. The revised estimate in 2015 includes all the data collected from the entire surveyed area, thus providing more complete coverage of the spawning distribution in the western area.

This preliminary revised index corresponds to the years from 1992 onwards. It should be noted that in the original reported estimates for years prior to 1992 the southern part of this stock (division VIIIc) had not been included in the estimation and so consequently, the western horse mackerel TAEP estimates during these early years would have been underestimated.

The time series of TAEP estimates used in assessment is shown in Table 5.2.1.2.

5.2.2 Other surveys for western horse mackerel

Bottom trawl surveys

New information on combined fisheries independent bottom trawl surveys was presented, but not used in the assessment. These surveys could be considered in future to provide indices of recruitment or abundance for western horse mackerel.

Anecdotal information from Spanish fisheries independent surveys confirms the good incoming recruitment.

Further information can be found in the stock annex, and in ICES (2008/ACOM:13) and ICES (2009/RMC:04).

Acoustic surveys

Nevertheless, in the Bay of Biscay two coordinated acoustic surveys are taking place at the spring time, PELGAS (Ifremer-France) and PELACUS (IEO-Spain)

PELACUS 0315 was carried out on board R/V Miguel Oliver from 13th March to 16th April. The methodology was similar to that of the previous surveys (see Carrera and Riveiro, WD for further details). The assessment done on the horse mackerel population resulted in a remarkable increase from 31 thousand tonnes estimated in 2013 up to 62 thousand tonnes estimated this year (Figure 5.2.2.1) The most noticeable fact from this assessment is the strong recruitment signal occurred in 2014. Moreover, although not available yet, results from PELGAS survey seems to confirm this perception.

On the other hand, within the frame of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VII, VIII and IX, WGACEGG, it could be feasible to provide a combined survey index from PELGAS and PELACUS surveys. For this purpose, the time series will be analysed during the next WG meeting to be held at Lowestoft next November

5.2.3 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.

5.2.4 Catch in numbers

In 2014, the Netherlands (IVa,VIa,VIIb,c,e,h,j, VIIIb), Norway (IIIa,IVa), Ireland (VIa and VIIb), Germany (VIa VIIb,c), Spain (VIIIb,c) and UK(England) (VIIe,j) provided catch in numbers at age. The catch sampled for age readings in 2014 covered 84%, in 2013 covered 71%, in 2012 covered 71% and in 2011 covered 62%.

The total annual and quarterly catches in numbers for western horse mackerel in 2014 are shown in Table 5.2.4.1. The sampling intensity is discussed in Section 1.3.

Catch data was amended during the working group which accounted for an additional 5% of total catch (7335 tonnes in division VIIb). This was not used in the assessment due to time limitations.

The catch at age matrix, as used in the assessment, is given in Table 5.2.4.2, and illustrated in Figure 5.2.4.1. 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 which has now entered the plus group in 2012, has been caught in considerable numbers. The 2008 year class can be followed in the catch data suggesting it was stronger than other year classes subsequent to the 2001.

5.2.5 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 area, and by quarter in 2014 are shown in Tables 5.2.5.1 and 5.2.5.2. Weight at age time-series is shown in Figure 5.2.5.1.

Mean weight at age in the stock

Mean weights-at-age in the stock, as used in the assessment, are presented in Table 5.2.5.3. Weights for age two in 2012, 2013 and 2014 were assigned as 0.085kg, according to the stock annex as there were no weight samples available for this age group. Weight samples for age 3 in 2013 were available only for area VIIj period 1, where the mean weight of 0.160 kg is much higher than seen before in the time series. Weight for age three in 2013 was therefore taken as the mean of 1995—2012. Weight at age 3 for 2014 were assigned the same value as in 2013 as there were no weight samples available. Weight at age time-series is shown in Figure 5.2.5.2. Further information can be found in the stock annex.

5.2.6 Maturity ogive

Maturity-at-age, as used in the assessment, is presented in Table 5.2.6.1. Further information can be found in the stock annex.

5.2.7 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.

5.2.8 Fecundity data

The potential fecundity data used in the assessment is listed in Table 5.2.8.1. The basis for specifying the realised fecundity 'prior', as used in the assessment (mean=1847 eggs per gram spawning female, CV=0.287), is given in the stock annex.

5.2.9 Information from the fishing industry

A pre-meeting between ICES scientists and representatives of the EU pelagic industry was held on 19 August 2015, to discuss information from the fishing industry and any ongoing development to address data needs. The EU industry industry acknowledges that the stock is in a relatively low state. However, Horse mackerel has been relatively easy to catch during the beginning of 2015. So far 40% of the TAC has been caught, while the main fishery still has to take place. Several fisheries have reported unexpected large horse mackerel in areas VIa and IVa in winter. The Danish industry reported a substantial influx of horse mackerel in the Skagerrak. The Irish industry reported substantial quantities of small horse mackerel south west of Ireland.

5.2.10 Data exploration

Within-cohort consistency of the catch-at-age matrix is investigated in Figure 5.2.10.1, which shows 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 5.2.10.2, 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 were not fully selected until they 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 5.2.10.2) 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, diagnostics

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 separable window as in recent assessments.

Fits to the available data are given in Figure 5.2.11.1, and model estimates with associated precision in Figures 5.2.11.2—3. Model estimates and residual patterns are similar to those presented in 2013 and 2014 (ICES 2013/ACOM:15 & ICES 2014/ACOM:15). A deterioration of the model fit to the early data is apparent and could be related to the model assumption of constant fecundity. The model estimate of egg production is higher than the survey estimate; this is consistent with the observation that spawning may have continued beyond the survey period. A comparison with the 2014 assessment is discussed in Section 5.6.

Retrospective plots are shown for two cases. In the first case, 4-year retrospective plots were constructed for SSB, recruitment and F trajectories, and for selectivity-at-age, where the length of the separable window is fixed at six years (Figure 5.2.11.4.) Information on the distribution of the Dutch fleet presented to WGHMMP 2014 suggested that constant selection should not be assumed beyond 2006 therefore, only a four-year retrospective assessment is presented. The exclusion of the egg production data as the retrospective analysis is carried out has an effect back in the time-series estimates (not only for this set of retrospective plots, but for the one discussed below).

For the second case, 3-year retrospective plots were constructed as before, but this time the starting year of the separable window (2009) 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 3 years in length results in a large deterioration in the precision of model estimates. Results for the second set of retrospective plots are shown in Figure 5.2.11.5. The selectivity-at-age retrospective in Figure 5.2.11.5d suggests larger instability of selection as the separable window is shortened, causing greater uncertainty and deterioration in the precision of the model estimates, particularly in the younger age groups.

5.3 State of the Stock

5.3.1 Stock assessment

The SAD model with a separable window of 2009—2014 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. Subsequently SSB peaked following the moderate year classes in the early- to mid-90s and the moderate-to-strong year class of 2001 (a third of the size of the 1982 year class). Year classes following 2001 have been weak, 2013 recruitment in particular has been estimated as the lowest in the time-series closely followed by recruitment in 2010. 2008 and 2012 year classes are estimated be higher than the recent average. Fishing mortality has been increasing since 2007 as a result of increasing catches and decreasing biomass as the 2001 year-class was reduced. SSB in 2014 is estimated as the forth lowest in the time-series.

5.4 Short-term forecast

A deterministic 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 average of the 2012 to 2014. Selection (exploitation pattern) is based on F in 2013 from the most recent assessment and is the average of ages 1 to 10, which assumes a fixed selection in the period 2009—2014. 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.

As with last year the expected landings for the intermediate year were set to the level that corresponds to the 2015 TAC in EU waters, 97 604 t which is considered an appropriate estimate for the forecast.

Output

Detailed age disaggregated tables for an F status quo projection ($F = F_{2014}$) are shown in Table 5.4.2 and a range of predicted catch and SSB options from the short term forecast are presented in Table 5.4.3. The % TAC change in Table 5.4.3 corresponds to the total Western horse mackerel TAC of 99 304 t.

The management plan proposed by the Pelagic RAC in 2007 was recently evaluated (ICES 2013/ACOM:59) and, ICES considered that the HCR and reference points were not consistent with the precautionary approach.

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 is used for scaling, and the inclusion of any additional information on realised fecundity would help to 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 on 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 51—81% for the most recent 5 years. This result is expected given the negligible input the first three age classes make to SSB and the limited catch data for recruits. This uncertainty increases as the assessment is updated without additional egg production survey data. The estimate for the 2001 year class at age 0 is the largest since 1982, with a CV of 21%.

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 of the update assessment with the 2013 assessment is shown in Figure 5.6.1. SSB, recruitment show a similar patterns, were F trajectories appear to have stabilised. The decrease in selectivity for younger age groups, particularly for the 1 and 2 year olds (see Figure 5.6.1), is largely due to the lack of information on these age groups which causes instability in the estimated selection pattern.

5.7 Management Options

5.7.1 MSY approach

In 2010 deterministic and stochastic equilibrium analyses were carried out using the 'plotMSY' software (WKFRAME 2010) to provide an estimate for F_{MSY} which was subsequently re-evaluated in 2013. Both results suggested that the F_{MSY} proxy of 0.13 was most appropriate. See WGWIDE 2011 for details, or refer to the stock annex.

During WKMSYREF3 (ICES 2015/ACOM:64) further investigations were carried out making use of the guidelines set out and implemented in the plotMSY software (ICES 2013/ACOM:39). The method used took into account a weighting of three stock recruit curves in the order of 46% for Beverton-Holt, 32% for Ricker and 22% for smooth Hockey-stick, resulting in a revised value for F_{MSY} of 0.06.

A continuation of this work was carried out to take into account recruitment serial correlation and alternative stock-recruit scenarios. Due to the high CV's of the stock-recruit parameters, the spread of SSB and recruitment values and the association with low Fcrash values it was decided to investigate two scenarios: artificially reducing the uncertainty in the simulation associated with the assessment and fitting only the Hockey stick stock-recruit relationship, this resulted in revised F_{MSY} values of 0.055 and 0.095 respectively. The F_{MSY} of 0.095 is calculated without taking into account the precautionary considerations. If the precautionary approach was also taken into account, this translated into a constrained F_{MSY} of 0.09 which is put forward as a replacement to the F=0.13 value that had been suggested in the previous advice.

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 was 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

A request from EU was posed to ICES at the end of 2012 to:

A request from EU was posed to ICES at the end of 2012 to:

3) Fully evaluate the plan, and ascertain whether it is precautionary in the long term as well as in the short term.

4) Should the plan be found not to be precautionary in the long term, ICES is requested to identify reinforcements in the harvesting rules that would resolve the plan's shortcomings in that respect.

5) ICES is furthermore requested to identify what TAC should apply in 2013 in accordance with a revised harvesting rule under point 2 above.

Upon evaluation in 2013, ICES considered the plan not to be precautionary. However, the request was not fully addressed therefore, in December 2013 EU reiterated the need that ICES fully addressed the initial request (above). ICES convened a group Chaired by Ciaran Kelly (Ireland) and participants from the Marine Institute (Ireland), Cefas (UK England) and IMARES (the Netherlands) in response.

Considerable progress has been made so far. Results are summarized in WD x (Pastoors et al) that contains the simulation reults, the review process and the subsequent simulations.

Simulations were developed on two platforms:1) Full feedback (FLR , ADMB), and 2) FPRESS Stochastic simulation (R)

Conditioning was derived from the 2013 assessment (WGWIDE 2013/ACOM:15) including updated catch information and the finalised 2013 egg survey result. The variance-covariance matrix from the assessment was used to generate 1000 populations, each with their own set of parameters.

Considerable attention was paid to the modelling of the stock and recruitment relationship. The plotMSY software (ICES 2013/ACOM:39) was used to derive the relative weights given to three stock recruit forms (49% to Beverton-Holt, 28% to Ricker and 23% to Hockeystick), which were then fitted in these proportions to "historic" stock-recruit pairs from 1000 populations; in this way, the stock-recruit parameters (which included recruitment variability and serial correlation) were entirely consistent with the associated population. In this process, the 1982 and 2001 year-classes were considered outliers (to be treated separately when modelling recruitment spikes) and not included in the stock-recruit fits.

In a second step, a spike year was modelled using a boxcar distribution (Skagen 2012) with a mean interval between spikes of 19 years (perios between the historic two high recruitment events). In the event of a spike there is a 50/50 chance of a 1982 or 2001 residual draw. The appropriate residual is added to the stock recruitment form for the current population (model iteration).

Initial simulations were carried out according to the following specifications:

- Long term (200 years), statistics from final 50 years
- Range of fishing mortalities from 0 to 0.2, no HCR
- Excluding/ including spikes
- Including serial correlation
- 100 iterations for full feedback model, 1000 for FPRESS model

Results from both platforms were in good agreement. Predicted yields, SSB and associated risks from population projections are presented in Figure 5.7.2.1 for illustration. The curves correspond to median and confidence intervals of mean values computed over the final 50 years in 200 years population projections. The plots are based on 100 iterations.

The results of the simulations were reviewed by an independent scientist in May 2015. On the basis of the review, additional simulations were carried out using a constrained hockey-stick recruitment model, because the combined Bayesian recruitment model was found to give regularly spurious result (i.e. very badly fitting recruitment curves) which was suspected to have lead to the very low F_{MSY} derived from the original fit (0.06). An important result from the additional work has been to estimate F_{MSY} based on the hockey-stick recruitment model. This led to an F_{MSY} of 0.095 without taking into account the precautionary considerations. If the precautionary approach was also taken into account, this translated into a constrained F_{MSY} of 0.09.

Several different potential management strategies were explored (no catch scenario, egg-survey based rules, SSB based rules), with different remedial actions in case of low stock size (Figure 5.7.3). Median results generally indicate a decline in catches in the very short term and a rebuilding of stock and increase in catches in the medium term. However, due to the uncertainty in the recruitment and the assessment, the 5^{th} percentile of the SSB is only very slow to increase. This leads to a perception where in all scenario's, the risk to Blim remains above 5% for at around 30 years. This happens, even though the expected fishing mortality is very low (below half of Fmsy). Given these results, it has not been possible yet, to select a viable strategy for management for the coming years.

5.8 Management considerations

The 2001 year class has now entered the plus group and there are no detectable strong year classes entering the fishery. With the inclusion of the 2013 egg survey estimate the perception of the stock changed. However the declining trend in SSB remains the same and upward trajectory of $F_{1\text{-}10}$ has plateaued.

SSB in 2015 was estimated by the assessment at 723 560 tonnes, this is below the 1982 SSB previously estimated at 1.4Mt which was previously 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. There are currently no accepted biomass reference points for this stock following the revision of the assessment methodology and acceptance of the assessment in 2011.

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 subareas VIIe,h and VIId (the latter then belonging to the North Sea stock management area) is effectively hindered. The mismatch between TAC and fishing areas and the fact that the TAC is only applied to EU waters has resulted in the catch prior to 2007 exceeding those advised by ICES.

The management plan proposed by the Pelagic RAC in 2007 was evaluated by ICES and considered to be precautionary in the short term. 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 finalised egg survey time-series the catch advice for 2014-2016 is 137 534 t. 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. Following a evaluation in 2013, ICES considered this management plan is not precautionary.

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 now belongs to the western stock. Landings from VIId are now allocated to the North Sea horse mackerel. A research project is currently underway in the Netherlands and Ireland, to review the stock separation between the Western stock and the North Sea stock in the Channel area (see North Sea horse mackerel section in the report). The project is using genetic and chemical techniques to separate the different components. Results are expected to be presented to WGWIDE 2016.

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 large 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.

5.13 References

Abaunza, P., Gordo, L., Karlou-Riga, C., Murta, A., Eltink, A. T. G. W., García Santamaría, M. T., Zimmermann, C., Hammer, C., Lucio, P., Iversen, S. A., Molloy J., and Gallo, E. 2003. Growth and reproduction of horse mackerel, *Trachurus trachurus* (carangidae). Reviews in Fish Biology and Fisheries, 13: 27–61.

Burns, F., van Damme, C., Ulleweit, J. Fonn, M., Thorsen, A. and Franco, C. 2013. 2013 Mackerel and Horse Mackerel Egg Survey. Preliminary Results. WD presented to WGWIDE, 2013.

Costas, G., Burns, F., van Damme, C. 2015. Revised egg production time series for western horse mackerel stock. WD presented to WGWIDE, 2015.

ICES. 2006. Report of the Working Group on Acoustic and Egg Surveys for Sardine and Anchovy in ICES Areas VIII and IX (WGACEGG). 27 November-1 December 2006, Lisbon, Portugal. ICES CM 2006/LRC:18: 169 pp.

ICES. 2007. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA). 4-13 September 2007, ICES Headquarters. ICES CM 2007/ACFM:31: 712 pp.

ICES. 2008. Report of the Working Group on Widely Distributed Stocks (WGWIDE). 2-11 September 2008, ICES Headquarters Copenhagen. ICES CM 2008/ACOM:13: 691pp.

ICES. 2009. Report of the International Bottom Trawl Survey Working Group (IBTSWG). 30 March-3 April 2009, Bergen, Norway. ICES CM 2009/RMC:04: 241 pp.

ICES. 2013. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 27 August - 2 September 2013, ICES Headquarters, Copenhagen, Denmark. ICES CM 2013/ACOM:15. 944 pp.

ICES. 2013. Report of the Workshop to evaluate the EU management plan for Western horse mackerel (WKWHMAC), 18–19 June 2013, ICES Headquarters, Copenhagen. ICES CM 2013/ACOM:59.

ICES. 2013. Report of the Workshop on Guidelines for Management Strategy Evaluations (WKGMSE), 21–23 January 2013, ICES Headquarters, Copenhagen, Denmark. ICES CM 2013/ACOM:39. 121 pp.

ICES. 2015. Report of the Joint ICES-MYFISH Workshop to consider the basis for F_{MSY} ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 156 pp.

Iversen, S., A., Skogen, M., D., and Svendsen, E. 2002. Availability of horse mackerel (Trachurus trachurus) in the north-eastern North Sea, predicted by the transport of Atlantic water. Fish. Oceanogr., 11(4): 245-250.

Skagen, D.W. 2012. Harvest control rules for blue whiting. Report for the Pelagic RAC. [Accessed online 30/03/2015: http://www.pelagic-ac.org/media/pdf/Final%20report%20Dankert%20Skagen.pdf.]

Table 5.1.1.1. Western horse mackerel. 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	2010[1]
Faroe Islands	-	-	3	-	-	-	2923[3]
Denmark	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-
Germany	-	-	-	-	-	-	-
Ireland	-	-	-	366[4]	-	-	-
Norway	42	176	27	-	572	1,847	1,364
Russia	-	-	-	-	-	-	-

UK (England + Wales)	-	-	-	-	-	-	-
Estonia	-	-	-	-	-	-	-
Total	42	176	30	366	572	1,847	1,656

[1]Preliminary.

[2]Included in Subarea IV.

[3]Includes catches in Div. Vb.

[4]Taken in Div. Vb

Table 5.1.1.1 cont. Western horse mackerel. Catches (t) in Subarea II. (Data as submitted by Working Group members).

	2011	2012	2013	2014[1]
Faroe Islands	349[4]	-	-	-
Denmark	-	-	-	-
France	-	+	-	-
Germany	-	-	-	-
Ireland	-	-	-	-
Netherlands	1	-		107
Norway	298	66	30	302
Russia	-	-		-
UK (England + Wales)	-	-		-
Estonia	-	-		-
Total	648	66	30	409

[1]Preliminary

[2]Included in IV.

[3]Includes catches in Div. Vb.

[4]Taken in Div. Vb.

Table 5.1.1.2. Western horse mackerel. 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 5.1.1.2 cont. Western horse mackerel. 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	2010	2011	2012	2013	2014[1]
Belgium	5	2	4	12	-	-	0	-
Denmark	329	59	279	75	20	9	9	8
Faroe Islands	3	55	-	81	-	-	-	-
France	457	943	-	173	268[2]	-	-	0
Germany, Fed.Rep.	93	1,167	1,299	242	-	--	20	-
Ireland	652	1,186	342	12	755	25	7	-
Netherlands	20,027	9,400	10,077	1,342	81	92	0	-
Lithuania	98	-	-	-	-	-	-	-
Norway	5.423	11652	70,745	11,082	13,409	3,183	6,566	4,088
Sweden	130	45	660	2	90	-	0	-
UK (Engl. + Wales)	2,966	-	-	-	-	-	16	-
UK (Scotland)	626	20	51	646	101	12	102	-
Unallocated +discards	14,403	-9,151	-5,898	0	-	-	-	12
Total	16,407	15,377	78,595	13,667	14,725	3,321	6,721	4,109

[1]-Preliminary.

[2]French catches landed in the Netherlands

Table 5.1.1.3 Western horse mackerel. 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

Table 5.1.1.3. cont. Western horse mackerel. Catches (t) in Subarea VI by country. (Data submitted by Working Group members).

Country	2007	2008	2009	2010	2011	2012	2013	2014[1]
Denmark	-	-	-	-	58	1131	433	856
Faroe Islands	-	573	-	1	-	-	-	
France	-	74	-	-	246[5]	-	-	195
Germany	1,835	5,097	635	773	6,508	672	8,616	4194
Ireland	20,341	18,786	16,565	19,985	23,556	29,283	19,979	15745
Lithuania	80	641	-	-	-	-	-	
Netherlands	2,177	3,904	2,332	1,685	6,353	12,653	11,078	8580
Norway	2	20	27	18	48	2	-	
Russia	-	-	-	-	-	-	-	
Spain	-	-	-	-	-	-	-	
UK (Engl. + Wales)	232	-	-	-	-	-	451	18
UK (Scotland)	38	588	243	89	2,528	1,232	2,325	1579
UK (N.Ireland)	-	-	-	-	-	-	-	1277
Unallocated+disc.	1,474	-3,781	-2,057	62	230	2	0	123
Total	26,279	25,902	17,776	22,613	39,528	44,975	43,266	32,567

[1]Preliminary. [2]Included in Subarea VII. [3]Includes Divisions IIIa, IVa,b and VIb.

[4]Includes a negative unallocated catch of -7000 t. [5]French catches landed in the Netherlands

Table 5.1.1.4. Western horse mackerel. 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	4,010[3]	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

Table 5.1.1.4. cont. Western horse mackerel. Catches (t) in Subarea VII by country. (Data submitted by the Working Group members).

Country	2007	2008	2009	2010	2011	2012	2013	2014[1]
Faroe Islands	475	212	-	-	-	-	-	-
Belgium	+	+	1	24	2	+	14	-
Denmark	4,806	1,970	2,710	5,247	5,831	2,281	6,373	5,066
France	6,844	11,008	-	899	7431[2]	579	744	940
Germany	3.943	5,700	14,204	20,404	14,545	16,391	15,781	5,613
Ireland	8,039	16,293	23,841	24,490	14,154	15,893	15,805	16,922
Lithuania	5,585	4,907	-	-	-	-	-	-
Netherlands	38,034	43,514	47,741	75,475	49,207	53,644	41,562	15,529
Norway	-	-	-	40	-	-	-	-
Spain	-	11	6	6	-	58	-	-
Sweden	55	-	-	-	-	-	-	-
UK (Engl. + Wales)	9,105	-	-	-	11,688	12,122	3,388	4,576
UK (Scotland)	738	476	1,123	1,723	299	91	17	101
Unallocated+discards	15,460	14,656	-61	17,534	-	3039	4,401	974
Total	93,084	98,746	89,565	145,839	103,156	104,098	88,085	49720

[1]Preliminary. [2]French catches landed in the Netherlands

Table 5.1.1.5. Western horse mackerel. 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	2010	2011	2012	2013	2014[1]
Denmark	2,687	3,289	3,109	632	200	581	14	
France	10,741	2,848	-	-	326[3]	1216	2,849	2,277
Germany	-	918	281	64	61	-	417	19
Ireland	694	246	-	-	-	39	-	
Lithuania	-	-	-	-	-	-	-	
Netherland	-	6,269	1,849	97	49		1,057	526
Russia	-	-	-	-	-	7	-	
Spain	13,853	19,840	21,071	38,740	34,581	13,502-	22,541	19,442
UK (Engl. + Wales)	-	-	-	-	28		104	
UK (Scotland)	-	-	-	-	-	-	-	35
Unallocated+discards	412	482	7,045	3,694		2057	0	9,315
Total	28,387	33,892	33,355	43,227	35,245	17,402	26,983	31614

[1]Preliminary, [2]Included in Subarea VII, [3]French catches landed in the Netherlands

Table 5.2.1.1. Western horse mackerel. Comparison between the provisional estimates and reported estimates of Western horse mackerel Total Annual Egg Production (TAEP).

year	1983	1989	1992	1995	1998	2001	2004	2007	2010	2013
Provis. TAEP	-	-	2.16*e15	1.39*e15	1.26*e15	8.49*e14	9.32*e14	1.69*e15	1.06*e15	4.06*e14
se	-	-	2.20*e14	6.16*e14	1.02*e16	1.64*e14	1.48*e14	6.83*e14	1.80*e14	7.91*e13
cv	-	-	10%	44%	14%	19%	16%	40%	17%	19%
Reported TAEP	5.13*e14	1.762*e15	1.712*e15	1.265*e15	1.136*e15	8.21*e14	8.89*e14	1.64*e15	1.093*e15	3.97*e14

Table 5.2.1.2. Western horse mackerel. The time series of Total Annual Egg Production (TAEP) estimates (10^{12} eggs).

YEAR	TAEP
1983	513
1989	1762
1992	1712
1995	1265
1998	1136
2001	821
2004	889
2007	1640
2010	1093
2013	397

Table 5.2.4.1. Western Horse Mackerel stock. Catch in numbers (thousands) at age by quarter and area in 2014

1Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Total
0																					0
1														48	262	0		0	80	316	706
2					123			1784	0					541	965	1		3	2884	8095	14396
3					249	73		2373	0					506	114	0		0	316	1466	5097
4					274	375		5199	0		419	252		1132	143	0		0	389	2029	10212
5					1376	3395		3416	0		3371	2641		1111	316	0		0	462	853	16942
6					4450	7133	303	3916	0		5539	10509		1445	337	0		0	359	318	34310
7					2644	1953	379	407	0		700	1955		166	52	0		0	260	94	8610
8					1158	594	287	541	0		400	238		162	52	0		0	248	42	3722
9					830	543	424	182	0		232	1199		72	56	0		0	212	46	3795
10					1621	766	437	901	0		146	709		219	109	0		0	234	66	5209
11					2498	699	1359	500	0		254	1467		138	50	0		0	130	23	7117
12					3447	1634	1138	80	0			1690		25	46	0		0	130	34	8224
13					10982	3135	1991	249	0		632	2469		136	100	0		0	73	16	19783
14					5062	522	1506	82	0			506		21	26	0		0	91	24	7841
15+					3848	352	1102	18	0		645	787		79	43	0		0	288	92	7254
Sum					38560	21175	8927	19647	1		12339	24422		5802	2668	3		6	6154	13513	153218

2Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Total
0																					0
1														55	670	5		0	736	398	1863
2								339	0	0	11			453	5561	39		0	1539	9889	17833
3								378	0	0	12			14	174	1		0	101	2661	3342
4						2	1	577	0	0	23	107		11	132	1		0	216	2640	3711
5						24	19	349	0	0	66	1372		13	165	1		0	457	2200	4668
6				1	0	119	92	235	0	0	278	6748		16	197	1		0	584	2082	10354
7				1	0	25	19				57	1412		20	250	2		0	701	1106	3593
8				1	0	7	5	36	0	0	17	388		30	366	3		0	997	614	2463
9				4	2	7	6				16	408		31	385	3		0	1015	556	2434
10				2	1	24	19	42	0	0	57	1374		42	517	4		0	1446	732	4260
11				1	0	36	28				82	2035		23	285	2		0	769	242	3504
12				3	1	26	20				58	1452		20	249	2		0	724	307	2861
13				23	13	80	62				182	4533		11	130	1		0	344	171	5549
14						7	5				16	400		11	136	1		0	366	200	1143
15+				8	4	12	9				27	677		31	379	3		0	1146	557	2854
Sum				43	23	368	286	1957	1	2	902	20906		783	9597	68		1	11142	24353	70432

Table 5.2.4.1 cont. Western Horse Mackerel stock. Catch in numbers (thousands) at age by quarter and area in 2014

3Q **Ages**	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Total
0														4259	2234	0		0	2157	161	8812
1								1986	4	5	1	2		651	75	0		0	1814	3158	7697
2		0				0		851	2	2	1	1		929	373	0		0	1780	15588	19528
3	1	0	4			0		567	1	1	0	1		794	340	0		0	622	5513	7844
4						0		142	0	0	0	0		370	175	0		0	276	1867	2829
5	1	0	6			0								357	187	0		0	410	3775	4736
6	10	1	74			0								220	115	0		0	509	2881	3810
7	24	2	174			0								148	78	0		0	445	1734	2605
8	15	1	105			0								53	28	0		0	296	1389	1887
9	4	0	30			0								38	20	0		0	378	1114	1585
10	2	0	16			0								39	20	0		0	798	1696	2571
11	9	1	61			0								15	8	0		0	472	906	1471
12	9	1	66			0								8	4	0		0	539	560	1187
13	17	1	125			0								1	0	0		0	449	389	982
14	32	2	230			0								2	1	0		0	274	432	974
15+	11	1	82			0								14	7	0		0	1434	1640	3189
Sum	136	11	972			0		3546	6	8	2	4		7898	3667	2		1	12653	42803	71707

4Q																					
Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Total
0								2074						3916	2555	0	0	0	1754	105	10403
1								9377	2					1129	736	0	0	0	702	3362	15309
2	1	40			461	117	1	4480	1	0		1		1196	781	0	0	0	1315	18447	26841
3	6	207	116		709	255	2	2857	1	0		2		312	203	0	0	0	705	8654	14031
4					731	1096	4	1111	0	0	0	5	0	174	113	0	0	0	296	3452	6983
5	7	155	171		3676	3167	10	1110		0	1	14	0	41	27	0	0	0	291	7063	15735
6	74	852	2294		10069	14048	41	4166		1	4	54	0	25	17	0	0	0	194	3921	35760
7	195	3223	5403		2413	2011	6	668		0	1	9	0	29	19	0	0	0	174	2007	16158
8	109	1367	3271		1123	714	1	136		0	0	2	0	37	24	0	0	0	223	1542	8547
9	27	132	933		399	101	1	89		0		1		30	19	0	0	0	326	2139	4197
10	24	697	486		740	784	2	191		0	0	2	0	46	30	0	0	0	684	2786	6472
11	55	307	1904		672	179	1	139		0		2		18	12	0	0	0	385	1045	4719
12	65	686	2038		777	184	1	140		0		2		14	9	0	0	0	397	594	4906
13	117	882	3877		1584	897	2	250		0	0	3	0	3	2	0	0	0	267	105	7991
14	228	2392	7152		64	24	0	19		0		0		3	2	0	0	0	180	96	10159
15+	88	1260	2543		307	746	1	148		0	0	2	0	16	11	0	0	0	843	675	6640
Sum	996	12200	30188		23725	24323	74	26955	4	1	7	99	0	6988	4559	0	0	0	8736	55994	194850

Table 5.2.4.1 cont. Western Horse Mackerel stock. Catch in numbers (thousands) at age by quarter and area in 2014

1-4Q **Ages**	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Total
0	0	0	0	0	0	0	0	2074	0	0	0	0	0	8175	4789	0	0	0	3911	266	19215
1	0	0	0	0	0	0	0	11363	6	5	1	2	0	1883	1744	5	0	0	3332	7234	25575
2	1	40	0	0	584	117	1	7455	3	2	11	2	0	3120	7680	41	0	3	7518	52019	78597
3	7	207	120	0	958	328	2	6176	2	2	13	3	0	1625	831	1	0	0	1744	18294	30314
4	0	0	0	0	1005	1473	5	7030	1	1	442	365	0	1686	563	1	0	0	1177	9987	23736
5	8	155	177	0	5052	6586	29	4875	0	0	3438	4028	0	1523	695	1	0	1	1620	13892	42080
6	85	853	2368	1	14520	21300	436	8317	0	1	5822	17310	0	1706	666	2	0	0	1646	9202	84234
7	220	3225	5577	1	5057	3989	404	1075	0	0	757	3376	0	363	398	2	0	0	1579	4941	30965
8	123	1368	3376	1	2281	1314	294	713	0	0	417	627	0	282	470	3	0	0	1763	3587	16620
9	31	132	964	4	1231	652	430	270	0	0	249	1609	0	171	480	3	0	0	1931	3854	12012
10	26	697	502	2	2362	1574	458	1134	0	0	203	2086	0	346	676	4	0	0	3162	5280	18512
11	64	308	1965	1	3170	914	1388	638	0	0	336	3504	0	194	355	2	0	0	1756	2216	16811
12	74	686	2103	3	4225	1844	1159	220	0	0	58	3143	0	67	308	2	0	0	1790	1494	17178
13	134	883	4002	23	12579	4112	2056	499	0	0	815	7005	0	151	232	1	0	0	1133	681	34305
14	260	2394	7382	0	5126	553	1512	100	0	0	16	906	0	37	165	1	0	0	912	752	20117
15+	99	1261	2624	8	4159	1110	1112	166	0	0	672	1465	0	141	440	3	0	1	3711	2963	19936
Sum	1132	12211	31160	43	62309	45866	9286	52105	13	11	13251	45431	0	21469	20492	72	0	8	38685	136662	490207

Table 5.2.4.2. Western horse mackerel. Catch-at-age (thousands).

	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
2010	6806	82287	159023	93764	32789	31381	52379	104625	72210	269930	68571	129653
2011	1094	18864	59027	93167	46347	41372	35607	60798	63676	78422	246442	177090
2012	5350	48100	42654	64222	171285	56012	37914	28132	25608	45590	41255	278872
2013	93473	137210	34571	34042	74935	239987	64187	24328	17881	20190	30125	183268
2014	19215	26052	82238	34309	27375	57791	143016	50190	20048	15454	23200	146614

Table 5.2.5.1. Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2014

1Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0					0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0		0.0	0.0	0.0	NA
1					0.0	0.0	0.0	0.0	0.0	0.0	0.0			31.2	31.2	32.3		40.3	35.4	61.1	44.3
2					60.8	0.0	0.0	82.3	82.3	82.3	0.0			70.4	45.8	69.0		60.5	75.4	85.0	78.1
3					97.1	121.0	0.0	100.9	100.9	101.5	0.0			100.8	98.7	100.6		104.6	101.2	113.9	104.6
4					154.2	134.0	0.0	115.1	115.7	117.6	129.8			115.8	119.8	120.6		129.8	120.9	129.4	122.6
5					158.4	160.5	0.0	137.3	141.8	148.6	150.6			142.2	150.3	144.2		139.1	140.7	137.2	152.7
6					189.4	178.5	213.5	170.2	168.0	172.6	165.1			167.9	164.6	167.5		165.1	169.8	163.2	178.6
7					209.3	203.9	217.2	159.8	176.7	198.9	195.8			179.8	231.0	208.5		209.5	204.7	182.0	205.0
8					244.2	239.8	255.0	214.4	209.0	219.2	195.0			210.3	229.9	240.5		258.2	242.4	224.0	236.5
9					255.5	239.4	271.0	239.2	236.5	237.5	232.4			241.9	274.2	277.3		286.7	278.0	239.9	250.8
10					293.8	258.2	264.9	236.9	234.1	242.0	201.0			235.9	254.4	277.5		294.4	286.4	265.9	267.9
11					308.6	287.6	293.9	246.6	248.8	274.2	257.0			251.0	282.3	308.1		320.6	316.3	299.0	289.3
12					319.7	271.5	276.2	249.4	249.4	292.1	0.0			272.5	317.5	321.1		362.6	322.2	328.6	298.8
13					312.1	272.7	291.3	250.1	242.3	283.8	236.4			244.1	255.8	298.8		382.1	347.8	381.4	299.2
14					349.1	282.0	317.6	216.0	216.0	260.4	0.0			235.0	301.2	356.0		403.2	369.0	411.6	327.7
15+					377.1	321.7	337.2	496.0	298.7	342.8	287.9			304.4	356.4	399.5		399.6	404.8	451.8	366.4

2Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	NA
1				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		34.3	34.3	34.3		45.6	30.0	58.5	37.8
2				0.0	67.5	0.0	0.0	67.5	67.5	67.5	67.5	0.0		56.2	56.2	56.2		87.2	55.7	89.8	75.5
3				0.0	94.6	0.0	0.0	94.6	94.6	94.6	94.6	0.0		89.3	89.3	89.3		104.3	104.4	113.0	108.9
4				0.0	118.7	157.5	157.5	109.7	109.7	113.9	118.7	157.5		116.8	116.8	116.8		118.2	134.6	128.1	125.6
5				0.0	178.4	177.3	177.3	147.4	147.4	167.5	172.2	177.3		152.3	152.3	152.3		135.3	158.6	146.5	157.8
6				214.0	207.8	189.4	189.4	167.4	167.4	188.1	188.8	189.4		184.7	184.7	184.7		174.6	185.7	169.0	184.6
7				255.0	250.4	236.4	236.4	0.0	0.0	236.4	236.4	236.4		217.9	217.9	217.9		188.2	220.3	190.0	218.1
8				311.0	309.1	258.2	258.2	184.0	184.0	247.0	253.1	258.2		245.1	245.1	245.1		292.0	249.7	220.7	242.4
9				312.5	312.0	276.6	276.6	0.0	0.0	276.5	276.5	276.5		264.2	264.2	264.2		306.8	271.6	238.6	264.3
10				294.6	291.2	263.8	263.8	200.0	200.0	260.2	262.2	263.8		275.0	275.0	275.0		295.2	278.8	265.9	270.0
11				305.0	304.2	287.3	287.3	0.0	0.0	287.3	287.3	287.3		302.8	302.8	302.8		313.5	307.1	301.1	293.8
12				321.5	320.8	294.3	294.3	0.0	0.0	294.3	294.3	294.3		300.8	300.8	300.8		363.6	307.4	324.7	301.6
13				338.8	338.5	322.1	322.1	0.0	0.0	322.1	322.1	322.1		328.1	328.1	328.1		380.1	328.0	373.3	324.4
14				0.0	407.5	387.7	387.7	0.0	0.0	387.7	387.7	387.7		331.3	331.3	331.3		412.9	347.4	378.9	367.1
15+				448.6	447.7	343.0	343.0	0.0	0.0	342.5	342.5	342.5		322.7	322.7	322.7		396.1	337.4	366.7	343.9

Table 5.2.5.1 cont. Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2014

3Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0		32.7	32.7	32.6		32.5	32.5	43.5	32.8
1	0.0	0.0	0.0			0.0	0.0	46.4	46.4	46.4	46.4	46.4		49.8	61.6	45.0		86.2	42.3	76.8	58.1
2	0.0	180.0	0.0			147.0	147.0	69.0	69.0	69.0	69.0	73.4		105.8	117.0	82.4		118.2	73.7	90.6	89.3
3	199.0	222.3	199.0			145.0	145.0	106.5	106.5	106.5	106.5	112.8		134.4	140.6	122.6		129.6	117.0	115.3	117.9
4	0.0	0.0	0.0			183.4	176.1	153.0	153.0	153.0	153.0	171.9		151.1	150.9	147.8		140.5	149.1	136.6	141.7
5	255.7	271.7	255.7			199.6	198.3	0.0	0.0	0.0	0.0	196.7		182.3	182.3	169.0		155.2	167.4	159.9	163.5
6	278.2	281.3	278.2			211.0	208.8	0.0	0.0	0.0	0.0	207.7		209.7	209.7	189.8		183.0	187.9	181.9	188.2
7	290.5	293.7	290.5			231.5	223.0	0.0	0.0	0.0	0.0	235.0		220.3	220.3	198.3		191.9	195.3	197.5	206.5
8	308.8	307.5	308.8			255.1	267.0	0.0	0.0	0.0	0.0	257.6		262.9	262.9	225.8		226.8	223.4	223.4	230.7
9	347.7	355.1	347.7			261.0	267.7	0.0	0.0	0.0	0.0	261.0		283.1	283.1	248.9		248.5	247.8	244.8	249.2
10	338.6	337.9	338.6			273.0	254.1	0.0	0.0	0.0	0.0	276.1		295.6	295.6	268.4		267.7	268.1	264.9	267.1
11	338.0	346.4	338.0			237.0	266.4	0.0	0.0	0.0	0.0	260.3		306.1	306.1	294.9		295.4	295.7	281.9	289.3
12	360.8	352.6	360.8			254.0	279.3	0.0	0.0	0.0	0.0	261.8		332.2	332.2	329.5		338.7	330.0	317.1	325.9
13	355.6	350.8	355.6			272.3	307.5	0.0	0.0	0.0	0.0	295.6		348.4	348.4	376.7		380.0	377.1	367.0	368.9
14	364.4	361.1	364.4			297.0	366.1	0.0	0.0	0.0	0.0	338.0		275.3	275.3	376.2		396.4	376.6	376.2	373.6
15+	435.3	455.9	435.3			232.0	291.9	0.0	0.0	0.0	0.0	256.8		287.0	287.0	403.0		431.6	402.5	424.3	414.4

4Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0	0.0	0.0		0.0	0.0	0.0	38.5	0.0	0.0	0.0	0.0	0.0	38.5	38.5	38.5	42.8	27.5	27.5	42.8	36.7
1	0.0	0.0	0.0		0.0	0.0	0.0	47.3	46.4	0.0	0.0	0.0	0.0	60.2	60.2	60.2	77.1	96.0	42.9	77.1	55.1
2	180.0	180.0	0.0		141.8	147.0	147.0	72.3	69.0	147.0	147.0	147.0	0.0	82.3	82.3	82.3	92.4	111.8	82.9	92.4	92.0
3	217.9	235.0	199.0		146.4	145.0	145.0	108.8	106.5	145.0	145.0	145.0	0.0	104.6	104.6	104.6	117.3	125.5	113.2	117.3	124.4
4	0.0	0.0	0.0		165.8	183.4	183.7	159.2	153.0	183.4	191.8	183.4	210.0	99.3	99.3	99.3	138.2	136.2	133.5	138.2	158.4
5	266.6	286.0	255.7		200.2	199.6	199.6	199.0	0.0	199.6	200.3	199.6	201.7	173.6	173.6	173.6	157.5	156.9	152.4	157.5	188.6
6	279.8	287.0	278.2		214.2	211.0	211.0	211.0	0.0	211.0	212.0	211.0	213.5	227.6	227.6	227.6	179.8	181.4	180.5	179.8	213.4
7	292.5	298.0	290.5		225.8	231.5	231.8	231.7	0.0	231.5	239.2	231.5	253.0	241.4	241.4	241.4	196.3	203.9	197.0	196.3	251.4
8	307.8	304.0	308.8		229.3	255.2	254.7	256.9	0.0	255.2	248.4	255.2	244.0	266.8	266.8	266.8	225.7	223.5	226.0	225.7	272.7
9	350.4	381.0	347.7		272.0	261.0	261.0	266.1	0.0	261.0	261.0	261.0	0.0	289.7	289.7	289.7	245.3	247.7	249.7	245.3	274.9
10	337.4	336.0	338.6		271.6	272.9	273.3	277.5	0.0	272.9	279.2	272.9	285.0	308.8	308.8	308.8	262.6	269.3	269.2	262.6	279.2
11	342.7	389.0	338.0		267.6	237.0	237.0	242.9	0.0	237.0	237.0	237.0	0.0	321.6	321.6	321.6	275.7	285.7	291.4	275.7	292.6
12	354.9	327.0	360.8		266.8	254.0	254.0	259.0	0.0	254.0	254.0	254.0	0.0	348.3	348.3	348.3	297.4	318.3	322.4	297.4	310.9
13	352.4	330.0	355.6		270.0	272.3	272.3	273.2	0.0	272.3	272.6	272.3	273.0	402.2	402.2	402.2	340.3	368.8	370.7	340.3	310.7
14	361.9	350.0	364.4		271.9	297.0	297.0	298.4	0.0	297.0	297.0	297.0	0.0	315.1	315.1	315.1	271.8	379.6	368.4	271.8	357.3
15+	447.9	489.0	435.3		301.0	232.1	231.6	238.2	0.0	232.1	223.6	232.1	217.0	336.3	336.3	336.3	298.6	418.1	392.9	298.6	379.8

Table 5.2.5.1 cont. Western horse mackerel stock. Mean weight (kg) in catch at age by quarter and area in 2014

1-4Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.5	0.0	0.0	0.0	0.0	0.0	35.5	35.8	34.0	42.8	31.5	30.3	43.3	34.9
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.1	46.4	46.4	46.4	46.4	0.0	55.1	45.9	34.8	77.1	43.9	39.5	75.2	54.4
2	180.0	180.0	0.0	0.0	134.8	147.0	147.0	74.0	69.1	75.2	68.7	89.7	0.0	83.4	60.5	56.8	92.4	75.9	72.3	90.2	85.0
3	216.5	235.0	199.0	0.0	141.6	144.0	145.0	104.6	104.8	102.5	100.5	127.4	0.0	117.8	115.3	92.7	117.3	121.4	111.9	115.8	118.3
4	0.0	0.0	0.0	0.0	162.2	177.1	179.0	122.3	129.6	119.2	129.4	159.5	210.0	121.9	124.6	118.5	138.2	132.3	133.2	133.5	138.1
5	265.5	286.0	255.7	0.0	190.6	183.2	191.0	152.0	145.2	150.9	151.2	168.0	201.7	152.5	160.3	151.6	157.5	150.3	154.6	155.2	170.5
6	278.5	287.0	278.2	214.0	205.4	199.2	207.7	190.5	167.8	176.0	166.6	183.3	213.5	174.3	179.9	182.6	179.8	179.0	182.3	177.5	196.7
7	292.0	298.0	290.5	255.0	215.1	214.7	219.0	204.5	176.7	207.0	199.7	218.1	253.0	203.3	221.2	216.9	196.3	200.0	208.1	195.1	226.6
8	308.0	304.0	308.8	311.0	239.6	245.7	255.1	220.7	196.1	223.4	198.0	249.8	244.0	231.3	245.6	244.7	225.7	230.1	241.3	224.0	253.2
9	342.6	380.9	347.7	312.5	259.9	245.8	271.0	248.0	236.5	243.2	236.1	256.9	0.0	263.5	267.1	264.4	245.3	258.1	264.0	244.1	260.8
10	333.1	336.0	338.6	294.6	288.4	263.8	264.9	242.1	217.3	247.2	221.4	256.2	285.0	257.0	273.8	274.9	262.6	273.4	274.6	263.8	271.9
11	341.2	388.9	338.0	305.0	300.1	268.7	293.6	245.8	248.8	278.7	265.8	271.1	0.0	267.9	300.6	302.8	275.7	292.9	301.3	281.3	291.0
12	353.7	327.0	360.8	321.5	313.2	267.2	276.5	255.5	249.4	292.5	294.2	290.9	0.0	304.0	305.1	302.2	297.4	332.0	318.6	311.1	303.8
13	349.6	330.0	355.6	338.8	307.0	273.0	292.5	261.7	242.3	297.1	259.4	314.4	273.0	254.1	297.7	328.5	340.3	375.5	358.8	364.8	305.6
14	362.2	350.0	364.4	0.0	346.9	283.8	317.9	231.4	216.0	288.9	387.6	291.0	0.0	271.6	326.0	333.4	271.8	393.2	362.5	364.8	344.7
15+	446.7	489.0	435.3	448.6	370.1	274.1	336.9	266.3	298.7	341.6	290.7	389.1	217.0	310.4	325.7	329.4	298.6	419.4	380.4	385.7	374.7

Table 5.2.5.2. Western horse mackerel stock. Mean length (cm) in catch at age by quarter and area in 2014

1Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	NA
1					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		16.2	16.2	16.3		16.7	16.5	19.4	17.5
2					19.6	0.0	0.0	21.9	21.9	21.9	0.0	0.0		20.7	18.3	20.4		19.2	21.0	21.7	21.2
3					22.4	24.5	0.0	23.3	23.3	23.4	0.0	0.0		23.4	23.6	23.5		23.3	23.4	24.1	23.5
4					26.4	25.9	0.0	24.3	24.4	24.5	25.2	28.5		24.4	24.8	24.9		25.2	24.9	25.2	24.8
5					26.9	27.6	0.0	26.0	26.4	26.9	27.1	27.8		26.4	27.1	26.5		25.8	26.2	25.7	27.0
6					29.0	28.5	30.1	27.4	27.8	28.4	28.2	28.9		27.8	27.6	27.8		27.3	27.9	27.3	28.6
7					30.0	29.7	30.3	27.3	28.6	29.7	30.0	29.9		28.7	30.6	29.8		29.7	29.6	28.4	29.8
8					31.3	31.4	32.0	29.2	29.1	30.2	28.9	32.5		29.2	30.6	31.2		31.9	31.3	30.6	31.0
9					31.9	31.5	32.6	30.2	30.8	31.8	31.8	32.7		31.0	32.1	32.7		33.1	32.8	31.3	32.0
10					32.9	32.2	32.5	30.0	29.9	31.1	29.5	31.8		30.1	31.8	32.9		33.5	33.3	32.4	32.1
11					33.7	33.2	33.5	30.2	30.6	32.5	32.0	32.6		30.7	32.4	33.9		34.6	34.4	33.8	33.2
12					34.0	32.4	32.9	31.1	31.1	33.2	0.0	33.6		32.2	34.3	34.5		36.0	34.6	34.8	33.4
13					34.0	32.6	33.5	30.5	31.4	33.1	32.1	33.6		31.5	32.2	33.8		36.7	35.5	36.8	33.6
14					35.2	32.9	34.5	29.5	29.5	32.2	0.0	31.1		30.3	33.2	35.7		37.4	36.3	37.7	34.5
15+					36.2	34.4	35.1	37.5	33.5	33.8	33.3	33.8		33.8	36.2	37.2		37.3	37.3	38.7	35.5

2Q																					
Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	NA
1	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		16.3	16.3	16.3		17.5	15.5	19.1	16.6
2	0.0			0.0	20.6	0.0	0.0	20.6	20.6	20.6	20.6	0.0		19.0	19.0	19.0		21.9	19.0	22.1	20.8
3	0.0			0.0	22.9	0.0	0.0	22.9	22.9	22.9	22.9	0.0		22.4	22.4	22.4		23.4	23.7	24.0	23.8
4	0.0			0.0	24.5	27.5	27.5	23.8	23.8	24.1	24.5	27.5		24.7	24.7	24.7		24.4	25.7	25.1	25.0
5	0.0			0.0	28.4	28.4	28.4	26.3	26.3	27.7	28.1	28.4		27.1	27.1	27.1		25.5	27.2	26.3	27.1
6	30.5			30.5	30.2	29.4	29.4	27.1	27.1	29.3	29.3	29.4		28.9	28.9	28.9		27.9	28.7	27.7	29.0
7	32.5			32.5	32.3	31.2	31.2	0.0	0.0	31.2	31.2	31.2		30.4	30.4	30.4		28.7	30.3	28.8	30.3
8	35.5			35.5	35.4	31.7	31.7	26.5	26.5	30.9	31.3	31.7		31.7	31.7	31.7		33.2	31.7	30.4	31.3
9	34.1			34.1	34.1	32.9	32.9	0.0	0.0	32.9	32.9	32.9		32.5	32.5	32.5		33.9	32.6	31.2	32.3
10	34.5			34.5	34.3	32.3	32.3	28.5	28.5	32.0	32.2	32.3		33.0	33.0	33.0		33.6	33.0	32.4	32.6
11	32.5			32.5	32.7	33.5	33.5	0.0	0.0	33.5	33.5	33.5		34.1	34.1	34.1		34.3	34.1	33.8	33.7
12	34.8			34.8	34.7	33.3	33.3	0.0	0.0	33.3	33.3	33.3		34.0	34.0	34.0		36.0	34.1	34.7	33.7
13	35.1			35.1	35.1	34.4	34.4	0.0	0.0	34.4	34.4	34.4		35.0	35.0	35.0		36.7	34.9	36.5	34.5
14	0.0			0.0	36.7	35.9	35.9	0.0	0.0	35.9	35.9	35.9		35.1	35.1	35.1		37.8	35.6	36.6	35.8
15+	38.5			38.5	38.5	34.7	34.7	0.0	0.0	34.7	34.7	34.7		34.7	34.7	34.7		37.1	35.1	36.0	35.2

Table 5.2.5.2 cont. Western horse mackerel stock. Mean length (cm) in catch at age by quarter and area in 2014

3Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0		15.9	15.9	16.0		16.1	16.1	17.2	16.0
1	0.0	0.0	0.0			0.0	0.0	17.4	17.4	17.4	17.4	17.4		18.0	19.9	17.8		21.8	17.5	20.9	18.9
2	0.0	25.0	0.0			26.2	26.2	19.5	19.5	19.5	19.5	19.9		23.6	24.9	21.7		24.4	21.0	22.2	22.1
3	27.0	28.8	27.0			26.1	26.1	22.5	22.5	22.5	22.5	23.1		25.7	26.4	24.8		25.2	24.4	24.1	24.3
4	0.0	0.0	0.0			28.6	28.1	25.5	25.5	25.5	25.5	27.4		26.8	27.0	26.5		25.9	26.5	25.7	26.0
5	29.1	30.3	29.1			29.3	29.4	0.0	0.0	0.0	0.0	29.2		28.8	28.8	27.8		26.8	27.6	27.1	27.4
6	30.9	31.0	30.9			30.1	30.0	0.0	0.0	0.0	0.0	30.0		30.2	30.2	28.9		28.5	28.8	28.4	28.7
7	31.4	31.5	31.4			31.1	30.7	0.0	0.0	0.0	0.0	31.2		30.6	30.6	29.3		28.9	29.1	29.2	29.5
8	31.8	31.8	31.8			32.8	32.7	0.0	0.0	0.0	0.0	32.5		32.5	32.5	30.7		30.7	30.6	30.5	30.7
9	33.2	33.3	33.2			32.6	32.7	0.0	0.0	0.0	0.0	32.6		33.3	33.3	31.7		31.7	31.7	31.5	31.7
10	32.7	32.6	32.7			33.5	32.2	0.0	0.0	0.0	0.0	33.2		33.8	33.8	32.6		32.5	32.6	32.4	32.5
11	33.1	33.3	33.1			31.4	32.5	0.0	0.0	0.0	0.0	32.5		34.2	34.2	33.6		33.6	33.6	33.1	33.3
12	33.7	33.5	33.7			32.2	32.9	0.0	0.0	0.0	0.0	32.4		35.1	35.1	34.9		35.3	35.0	34.4	34.6
13	33.6	33.4	33.6			33.2	34.0	0.0	0.0	0.0	0.0	33.7		35.7	35.7	36.6		36.7	36.6	36.3	36.0
14	33.9	33.7	33.9			34.2	35.8	0.0	0.0	0.0	0.0	34.7		33.0	33.0	36.6		37.3	36.6	36.5	35.9
15+	35.6	35.8	35.6			31.2	33.5	0.0	0.0	0.0	0.0	31.8		33.4	33.4	37.4		38.3	37.3	37.8	37.5

4Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0	0.0	0.0		0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	16.7	16.7	16.7	17.1	15.5	15.5	17.1	16.5
1	0.0	0.0	0.0		0.0	0.0	0.0	17.6	17.4	0.0	0.0	0.0	0.0	19.6	19.6	19.6	20.9	22.7	17.7	20.9	18.5
2	25.0	25.0	0.0		25.9	26.2	26.2	20.0	19.5	26.2	26.2	26.2	0.0	21.9	21.9	21.9	22.3	23.9	21.7	22.3	22.2
3	28.4	29.7	27.0		26.1	26.1	26.1	22.8	22.5	26.1	26.1	26.1	0.0	23.8	23.8	23.8	24.3	24.9	24.3	24.3	24.6
4	0.0	0.0	0.0		27.3	28.6	28.6	26.4	25.5	28.6	29.2	28.6	30.5	23.2	23.2	23.2	25.8	25.7	25.9	25.8	26.9
5	30.0	31.5	29.1		29.3	29.3	29.3	29.3	0.0	29.3	29.3	29.3	29.2	28.2	28.2	28.2	27.0	26.9	27.1	27.0	28.7
6	30.9	31.2	30.9		30.0	30.1	30.1	30.1	0.0	30.1	30.2	30.1	30.4	30.8	30.8	30.8	28.3	28.4	28.5	28.3	30.0
7	31.5	31.7	31.4		30.6	31.1	31.1	31.1	0.0	31.1	31.4	31.1	32.0	31.5	31.5	31.5	29.2	29.5	29.3	29.2	30.9
8	31.8	31.8	31.8		31.0	32.8	32.8	32.7	0.0	32.8	32.6	32.8	32.5	32.6	32.6	32.6	30.6	30.5	30.7	30.6	31.6
9	33.3	34.0	33.2		32.9	32.6	32.6	32.7	0.0	32.6	32.6	32.6	0.0	33.5	33.5	33.5	31.5	31.6	31.8	31.5	32.3
10	32.6	32.5	32.7		32.8	33.5	33.5	33.6	0.0	33.5	34.0	33.5	34.5	34.2	34.2	34.2	32.3	32.6	32.6	32.3	32.7
11	33.2	34.6	33.1		32.6	31.4	31.4	31.6	0.0	31.4	31.4	31.4	0.0	34.7	34.7	34.7	32.8	33.2	33.5	32.8	32.7
12	33.6	32.8	33.7		32.9	32.2	32.2	32.4	0.0	32.2	32.2	32.2	0.0	35.7	35.7	35.7	33.7	34.5	34.7	33.7	33.3
13	33.5	32.9	33.6		32.8	33.2	33.2	33.3	0.0	33.2	33.3	33.2	33.5	37.5	37.5	37.5	35.4	36.3	36.4	35.4	33.3
14	33.8	33.3	33.9		32.7	34.2	34.2	34.2	0.0	34.2	34.2	34.2	0.0	34.4	34.4	34.4	32.5	36.6	36.3	32.5	33.8
15+	35.7	36.3	35.6		34.1	31.2	31.2	31.4	0.0	31.2	30.8	31.2	30.5	35.1	35.1	35.1	33.4	37.8	37.0	33.4	34.8

Table 5.2.5.2 cont. Western horse mackerel stock. Mean length (cm) in catch at age by quarter and area in 2014

1-4Q Ages	IIa	IIIa	IVa	Vb	VIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIId	VIIIe	VIIIc	VIIIc east	VIIIc west	Mean
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	16.3	16.3	16.2	17.1	16.0	15.8	17.2	16.3
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5	17.4	17.4	17.4	17.4	0.0	18.9	17.9	16.4	20.9	17.1	17.1	20.7	18.5
2	25.0	25.0	0.0	0.0	25.3	26.2	26.2	20.4	19.6	20.7	20.0	21.3	0.0	21.8	19.5	19.0	22.3	20.7	20.7	22.2	21.6
3	28.3	29.7	27.0	0.0	25.7	26.0	26.1	23.0	22.6	23.1	22.8	24.5	0.0	24.6	24.5	22.7	24.3	24.6	24.1	24.2	24.3
4	0.0	0.0	0.0	0.0	27.0	28.2	28.4	24.6	24.6	24.6	25.1	28.2	30.5	24.8	25.1	24.8	25.8	25.4	25.7	25.5	25.7
5	29.9	31.5	29.1	0.0	28.7	28.6	29.0	26.8	26.3	27.0	27.2	28.1	29.2	27.0	27.6	27.0	27.0	26.5	27.0	26.8	27.8
6	30.9	31.2	30.9	30.5	29.6	29.5	30.0	28.8	27.5	28.6	28.3	29.1	30.4	28.1	28.5	28.7	28.3	28.2	28.5	28.1	29.3
7	31.5	31.7	31.4	32.5	30.2	30.2	30.4	29.6	28.6	30.0	30.1	30.4	32.0	29.8	30.5	30.3	29.2	29.3	29.8	29.1	30.3
8	31.9	31.8	31.8	35.5	31.2	31.9	32.0	29.7	27.7	30.3	29.0	32.0	32.5	30.5	31.6	31.6	30.6	30.8	31.3	30.6	31.3
9	33.4	34.0	33.2	34.1	32.2	31.8	32.6	31.0	30.8	32.0	31.9	32.8	0.0	32.2	32.5	32.5	31.5	32.0	32.3	31.5	32.1
10	32.8	32.5	32.7	34.5	32.9	32.7	32.5	30.5	29.2	31.3	30.4	32.1	34.5	31.4	32.9	32.9	32.3	32.7	32.8	32.3	32.5
11	33.2	34.6	33.1	32.5	33.4	32.5	33.5	30.5	30.6	32.9	32.4	33.1	0.0	31.7	33.8	34.0	32.8	33.5	33.9	33.1	33.1
12	33.7	32.8	33.7	34.8	33.9	32.4	32.9	31.9	31.1	33.3	33.3	33.5	0.0	33.8	34.1	34.0	33.7	35.0	34.5	34.2	33.5
13	33.9	32.9	33.6	35.1	33.9	32.8	33.6	31.9	31.4	33.5	32.7	34.1	33.5	31.9	33.8	35.0	35.4	36.6	36.0	36.2	33.7
14	33.8	33.3	33.9	0.0	35.1	33.0	34.5	30.4	29.5	33.0	35.9	33.2	0.0	32.2	34.8	35.1	32.5	37.1	36.1	36.1	34.3
15+	36.0	36.3	35.6	38.5	36.0	32.7	35.1	32.1	33.5	34.0	33.4	34.2	30.5	34.1	34.8	34.9	33.4	37.9	36.6	36.5	35.5

Table 5.2.5.3. 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	0.150	0.177	0.168	0.169	0.205	0.223	0.217	0.316
2010	0.000	0.050	0.070	0.084	0.114	0.149	0.171	0.182	0.187	0.206	0.221	0.268
2011	0.000	0.070	0.075	0.086	0.119	0.151	0.171	0.190	0.203	0.220	0.238	0.278
2012	0.000	0.000	0.085	0.077	0.093	0.138	0.165	0.185	0.207	0.236	0.231	0.274
2013	0.000	0.000	0.085	0.094	0.135	0.147	0.163	0.218	0.240	0.231	0.249	0.248
2014	0.000	0.000	0.085	0.094	0.156	0.169	0.182	0.218	0.250	0.257	0.256	0.306

Weight at age 3 in 2013 and 2014 is the average of the time series 1995-2012.

Table 5.2.6.1. 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
2010	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2011	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2012	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1
2013	0	0	0.05	0.25	0.7	0.95	1	1	1	1	1	1
2014	0	0	0.05	0.25	0.70	0.95	1	1	1	1	1	1

Table 5.2.8.1. 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	68032700	815494	2047230	3887200	572217	512892	420803	334410	52712.2	59387.6	68104.9	3357190
1983	526707	58556300	698457	1742520	3220730	481829	429207	351296	279621	43838.1	50731.3	2871240
1984	1551200	453341	50392500	599063	1469270	2722470	400478	328101	253496	224044	34678.6	2221530
1985	2788350	1335130	390194	43149300	511500	1230940	2204280	323959	246919	186624	179147	1695060
1986	3911490	2399950	1147640	331296	36579500	436111	1020680	1804120	267104	197521	154877	1523760
1987	5209280	3366650	2065660	987787	283713	30857000	367268	818071	1451000	206044	150360	1291620
1988	1998970	4483670	2897610	1777470	850196	241457	25731600	314198	665560	1164640	166452	1156320
1989	2110830	1719720	3833740	2488330	1527940	727687	190227	21273700	259194	535823	939446	1066840
1990	1836840	1816810	1480170	3299730	2122460	1298150	621401	150277	17126000	211914	406119	1562490
1991	3344910	1580980	1544810	1232210	2711210	1769810	1086430	525058	110227	13455700	148060	1378410
1992	6129400	2859850	1329630	1246400	1039210	2140820	1390560	866699	428386	71137.8	10449900	1085170
1993	7231120	5261810	2248390	1110720	998054	842245	1605040	1079000	700496	351039	39474.2	8801020
1994	7532210	6223840	4427620	1847540	940473	800850	637060	1087070	794539	537316	271811	6609890
1995	4375160	6479610	5300540	2965050	1482820	760180	647835	512355	729715	585051	424621	4932720
1996	2362390	3763230	5423620	4125720	2158160	1076380	599524	473328	407910	400561	393048	3451790
1997	2008420	2023380	3220690	4057030	2752260	1684700	847117	468361	356159	301569	291763	2793910
1998	3226040	1724150	1639350	2340350	2809170	1987920	1223360	618662	284688	181779	157547	1592540
1999	3960480	2775990	1399100	1239890	1561010	2083780	1507240	906932	418762	169423	93126.8	988515
2000	4183550	3395060	2298810	1126550	903044	1096960	1557400	1100400	606884	223749	73746.7	549853
2001	16427100	3600220	2849000	1856960	920723	710665	804192	1182390	781994	398691	135454	396115
2002	3815000	14084500	3034320	2223440	1457560	701133	517654	583674	799828	483975	246704	326855
2003	2788650	3270880	11694900	2500240	1760680	1137330	543679	380766	414767	567547	337402	395252
2004	1547820	2398500	2533500	9522500	1998280	1374310	896391	414655	285427	311092	402437	529177
2005	1013890	1312510	1934300	2078030	7756240	1649390	1087280	706721	316075	216319	222105	681472
2006	991274	871494	1069260	1510160	1500530	6180070	1355990	866816	551085	231726	165501	675607
2007	1631090	851434	704275	883732	1261230	1222990	4854280	1113950	709500	433811	183539	666191
2008	3853390	1399640	698317	569304	717757	1026790	955188	3865820	914193	585032	354686	693628
2009	1666080	3288900	1133810	581971	445396	569572	809540	775086	3051360	738923	469247	831144
2010	697595	1391180	2720670	933252	473159	358908	450275	630261	596674	2385300	572845	1008180
2011	856096	594111	1126700	2186640	736015	368096	271140	332270	457114	443059	1748750	1159200
2012	2330290	735833	484190	911959	1740120	578582	281844	203280	245276	344633	330236	2167630
2013	651330	2000730	595804	389050	718985	1353210	436879	207859	147339	182028	252509	1830320
2014	2449397[1]	473886	1617240	477817	305977	557547	1018070	320814	149939	108895	132773	1519380
2015		2020375	383749	1299630	376771	237990	421098	751041	232602	111305	79809.7	1210990

1. Age 0 in 2014 is the geometric mean of the time-series 1983 to 2013

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	0.011	0.038	0.022	0.028	0.031	0.029	0.034	0.008	0.026	0.026
1983	0.000	0.000	0.004	0.021	0.018	0.035	0.119	0.176	0.072	0.084	0.124	0.124
1984	0.000	0.000	0.005	0.008	0.027	0.061	0.062	0.134	0.156	0.074	0.136	0.136
1985	0.000	0.001	0.014	0.015	0.009	0.037	0.050	0.043	0.073	0.036	0.057	0.057
1986	0.000	0.000	0.000	0.005	0.020	0.022	0.071	0.068	0.110	0.123	0.112	0.112
1987	0.000	0.000	0.000	0.000	0.011	0.032	0.006	0.056	0.070	0.063	0.071	0.071
1988	0.000	0.007	0.002	0.001	0.006	0.088	0.040	0.042	0.067	0.065	0.065	0.065
1989	0.000	0.000	0.000	0.009	0.013	0.008	0.086	0.067	0.051	0.127	0.100	0.100
1990	0.000	0.012	0.033	0.046	0.032	0.028	0.018	0.160	0.091	0.209	0.206	0.206
1991	0.007	0.023	0.065	0.020	0.086	0.091	0.076	0.053	0.288	0.103	0.191	0.191
1992	0.003	0.091	0.030	0.072	0.060	0.138	0.104	0.063	0.049	0.439	0.121	0.121
1993	0.000	0.023	0.046	0.016	0.070	0.129	0.240	0.156	0.115	0.106	0.141	0.141
1994	0.001	0.011	0.251	0.070	0.063	0.062	0.068	0.249	0.156	0.085	0.183	0.183
1995	0.001	0.028	0.101	0.168	0.170	0.087	0.164	0.078	0.450	0.248	0.290	0.290
1996	0.005	0.006	0.140	0.255	0.098	0.090	0.097	0.134	0.152	0.167	0.169	0.169
1997	0.003	0.060	0.169	0.218	0.175	0.170	0.164	0.348	0.523	0.499	0.511	0.511
1998	0.000	0.059	0.129	0.255	0.149	0.127	0.149	0.240	0.369	0.519	0.421	0.421
1999	0.004	0.039	0.067	0.167	0.203	0.141	0.165	0.252	0.477	0.682	0.527	0.527
2000	0.000	0.025	0.063	0.052	0.090	0.160	0.125	0.192	0.270	0.352	0.304	0.304
2001	0.004	0.021	0.098	0.092	0.122	0.167	0.170	0.241	0.330	0.330	0.336	0.336
2002	0.004	0.036	0.044	0.083	0.098	0.104	0.157	0.192	0.193	0.211	0.222	0.222
2003	0.001	0.105	0.055	0.074	0.098	0.088	0.121	0.138	0.138	0.194	0.175	0.175
2004	0.015	0.065	0.048	0.055	0.042	0.084	0.088	0.121	0.127	0.187	0.163	0.163
2005	0.001	0.055	0.098	0.176	0.077	0.046	0.077	0.099	0.160	0.118	0.141	0.141
2006	0.002	0.063	0.041	0.030	0.055	0.091	0.047	0.050	0.089	0.083	0.083	0.083
2007	0.003	0.048	0.063	0.058	0.056	0.097	0.078	0.048	0.043	0.051	0.053	0.053
2008	0.008	0.061	0.032	0.095	0.081	0.088	0.059	0.087	0.063	0.071	0.082	0.082
2009	0.030	0.040	0.045	0.057	0.066	0.085	0.100	0.112	0.096	0.105	0.105	0.105
2010	0.011	0.061	0.069	0.087	0.101	0.130	0.154	0.171	0.148	0.160	0.160	0.160
2011	0.001	0.055	0.061	0.078	0.091	0.117	0.138	0.154	0.132	0.144	0.144	0.144
2012	0.002	0.061	0.069	0.088	0.101	0.131	0.154	0.172	0.148	0.161	0.161	0.161
2013	0.168	0.063	0.071	0.090	0.104	0.135	0.159	0.177	0.152	0.166	0.165	0.165
2014	0.000	0.061	0.069	0.088	0.101	0.131	0.154	0.172	0.148	0.161	0.161	0.161

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	68032700	1822660	2097975	61197	0.034	0.018	0.029	0.023
1983	526707	1777640	2040600	90442	0.051	0.008	0.084	0.065
1984	1551200	1599340	4089199	96744	0.060	0.004	0.088	0.066
1985	2788350	2581900	4941143	103843	0.040	0.010	0.043	0.034
1986	3911490	3281450	5191489	145999	0.044	0.002	0.058	0.053
1987	5209280	3843960	5115406	187338	0.049	0.000	0.035	0.031
1988	1998970	4361100	5017377	214729	0.049	0.003	0.049	0.038
1989	2110830	3989020	4774216	296037	0.074	0.003	0.045	0.046
1990	1836840	3396650	4156095	398645	0.117	0.031	0.066	0.084
1991	3344910	3220720	3929771	357288	0.111	0.036	0.119	0.100
1992	6129400	2637580	3192412	394793	0.150	0.064	0.083	0.117
1993	7231120	2458820	3030160	458628	0.187	0.028	0.142	0.104
1994	7532210	2078060	2746582	413022	0.199	0.110	0.119	0.120
1995	4375160	1600240	2365943	538131	0.336	0.099	0.190	0.178
1996	2362390	1451670	2276455	420942	0.290	0.134	0.114	0.131
1997	2008420	1240440	2067004	471700	0.380	0.149	0.276	0.284
1998	3226040	1026430	1569803	326443	0.318	0.148	0.207	0.242
1999	3960480	963625	1406467	298076	0.309	0.091	0.247	0.272
2000	4183550	885165	1252197	196911	0.222	0.047	0.167	0.163
2001	16427100	606007	1042332	212090	0.350	0.070	0.206	0.191
2002	3815000	720761	1212952	194292	0.270	0.054	0.149	0.134
2003	2788650	783084	1730547	190183	0.243	0.078	0.117	0.119
2004	1547820	945880	1995686	157627	0.167	0.056	0.093	0.098
2005	1013890	1341390	2066867	181994	0.136	0.109	0.092	0.105
2006	991274	1348350	1767190	155094	0.115	0.045	0.066	0.063
2007	1631090	1241670	1534173	123408	0.099	0.056	0.064	0.059
2008	3853390	1347480	1631200	143106	0.106	0.063	0.075	0.072
2009	1666080	1419420	1759164	183400	0.129	0.047	0.092	0.081
2010	697595	1141150	1637262	218143	0.191	0.072	0.141	0.124
2011	856096	1058020	1495420	199593	0.189	0.065	0.126	0.111
2012	2330290	956537	1239484	173141	0.181	0.073	0.141	0.125
2013	651330	854205	1093927	160686	0.188	0.075	0.145	0.128
2014	2449397[1]	838100	1143955	129025	0.154	0.072	0.141	0.124
2015		723560						

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

1. R(age 0) in 2014 is the geometric mean of the time series 1983 to 2013

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

2015	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	2449397	0.15	0	0.45	0.45	0.000	0	0.044
1	2020372	0.15	0	0.45	0.45	0.000	0.061	0.057
2	383749	0.15	0.05	0.45	0.45	0.085	0.069	0.086
3	1299630	0.15	0.25	0.45	0.45	0.088	0.088	0.116
4	376771	0.15	0.7	0.45	0.45	0.128	0.101	0.143
5	237990	0.15	0.95	0.45	0.45	0.151	0.131	0.167
6	421098	0.15	1	0.45	0.45	0.170	0.154	0.19
7	751041	0.15	1	0.45	0.45	0.207	0.172	0.22
8	232602	0.15	1	0.45	0.45	0.232	0.148	0.239
9	111305	0.15	1	0.45	0.45	0.241	0.161	0.252
10	79809.7	0.15	1	0.45	0.45	0.245	0.161	0.262
11	1210990	0.15	1	0.45	0.45	0.276	0.161	0.309

2016	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	2449397	0.15	0	0.45	0.45	0.000	0	0.044
1	.	0.15	0	0.45	0.45	0.000	0.061	0.057
2	.	0.15	0.05	0.45	0.45	0.085	0.069	0.086
3	.	0.15	0.25	0.45	0.45	0.088	0.088	0.116
4	.	0.15	0.7	0.45	0.45	0.128	0.101	0.143
5	.	0.15	0.95	0.45	0.45	0.151	0.131	0.167
6	.	0.15	1	0.45	0.45	0.170	0.154	0.19
7	.	0.15	1	0.45	0.45	0.207	0.172	0.22
8	.	0.15	1	0.45	0.45	0.232	0.148	0.239
9	.	0.15	1	0.45	0.45	0.241	0.161	0.252
10	.	0.15	1	0.45	0.45	0.245	0.161	0.262
11	.	0.15	1	0.45	0.45	0.276	0.161	0.309

2017	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	2449397	0.15	0	0.45	0.45	0.000	0	0.044
1	.	0.15	0	0.45	0.45	0.000	0.061	0.057
2	.	0.15	0.05	0.45	0.45	0.085	0.069	0.086
3	.	0.15	0.25	0.45	0.45	0.088	0.088	0.116
4	.	0.15	0.7	0.45	0.45	0.128	0.101	0.143
5	.	0.15	0.95	0.45	0.45	0.151	0.131	0.167
6	.	0.15	1	0.45	0.45	0.170	0.154	0.19
7	.	0.15	1	0.45	0.45	0.207	0.172	0.22
8	.	0.15	1	0.45	0.45	0.232	0.148	0.239
9	.	0.15	1	0.45	0.45	0.241	0.161	0.252
10	.	0.15	1	0.45	0.45	0.245	0.161	0.262
11	.	0.15	1	0.45	0.45	0.276	0.161	0.309

Table 5.4.2. Western Horse Mackerel Short term prediction single option table. Catch constraint of 97 604 t in 2015 and F for 2016 and 2017 = F2014

Year:	2015	F multiplier	0.7365	Fbar:	0.0918				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	2449397	0	0	0	0	0
1	0.0449	82468	4701	2020372	0	0	0	0	0
2	0.0508	17668	1519	383749	32619	19187	1631	17530	1490
3	0.0648	75798	8793	1299630	114367	324908	28592	294971	25957
4	0.0744	25104	3590	376771	48227	263740	33759	238409	30516
5	0.0965	20350	3399	237990	35936	226091	34140	202354	30555
6	0.1134	41988	7978	421098	71587	421098	71587	374027	63585
7	0.1267	83112	18285	751041	155465	751041	155465	663120	137266
8	0.109	22336	5338	232602	53964	232602	53964	207012	48027
9	0.1186	11574	2917	111305	26825	111305	26825	98634	23771
10	0.1186	8299	2174	79810	19553	79810	19553	70724	17327
11	0.1186	125926	38911	1210990	334233	1210990	334233	1073130	296184
Total		514624	97604	9574755	892776	3640771	759748	3239911	674679

Year:	2016	F multiplier	1	Fbar:	0.1246				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	2449397	0	0	0	0	0
1	0.061	115940	6609	2108216	0	0	0	0	0
2	0.069	103024	8860	1662556	141317	83128	7066	75326	6403
3	0.088	24584	2852	313930	27626	78483	6906	70512	6205
4	0.101	93645	13391	1048404	134196	733883	93937	655500	83904
5	0.131	34380	5742	301043	45457	285991	43185	252020	38055
6	0.154	24700	4693	186000	31620	186000	31620	162219	27577
7	0.172	47584	10469	323580	66981	323580	66981	279932	57946
8	0.148	72889	17420	569515	132127	569515	132127	498042	115546
9	0.161	24841	6260	179528	43266	179528	43266	156082	37616
10	0.161	11774	3085	85089	20847	85089	20847	73977	18124
11	0.161	136540	42191	986776	272350	986776	272350	857904	236782
Total		689902	121571	10214032	915788	3511971	718285	3081514	628157

Year:	2017	F multiplier	1	Fbar:	0.1246				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
0	0	0	0	2449397	0	0	0	0	0
1	0.061	115940	6609	2108216	0	0	0	0	0
2	0.069	105789	9098	1707178	145110	85359	7256	77348	6575
3	0.088	104590	12132	1335567	117530	333892	29382	299980	26398
4	0.101	22102	3161	247441	31672	173209	22171	154709	19803
5	0.131	93154	15557	815682	123168	774897	117010	682854	103111
6	0.154	30184	5735	227296	38640	227296	38640	198235	33700
7	0.172	20182	4440	137242	28409	137242	28409	118730	24577
8	0.148	30012	7173	234498	54404	234498	54404	205069	47576
9	0.161	58496	14741	422751	101883	422751	101883	367541	88577
10	0.161	18202	4769	131542	32228	131542	32228	114363	28019
11	0.161	108672	33580	785370	216762	785370	216762	682802	188453
Total		707322	116993	10602180	889806	3306057	648144	2901631	566789

Table 5.4.3. Western Horse Mackerel. Short term prediction; single area management option table. OPTION: Catch constraint 97 604 t in 2015 (EU TAC). The % TAC change corresponds to the total Western horse mackerel TAC of 99 304 t.

2015				
Biomass	SSB	FMult	FBar	Landings
892776	674679	0.7365	0.0918	97604

2016					2017			
TSB	SSB	FMult	FBar	Landings	Biomass	SSB	SSB	TAC
915788	671401	0	0	0	1003428	696624	4%	-100%
.	666943	0.1	0.0125	12906	991364	682355	2%	-87%
.	662515	0.2	0.0249	25639	979461	668389	1%	-74%
.	658117	0.3	0.0374	38202	967719	654718	-1%	-62%
.	653749	0.4	0.0498	50597	956134	641337	-2%	-49%
.	650276	0.48	0.0598	60394	946977	630837	-3%	-39%
.	649411	0.5	0.0623	62826	944704	628239	-3%	-37%
.	645102	0.6	0.0748	74892	933427	615419	-5%	-25%
.	643386	0.64	0.0797	79674	928959	610367	-5%	-20%
.	641676	0.68	0.0847	84429	924514	605358	-6%	-15%
.	640822	0.7	0.0872	86797	922301	602869	-6%	-13%
.	638268	0.76	0.0947	93864	915697	595467	-7%	-5%
.	636572	0.8	0.0997	98544	911324	590585	-8%	-1%
.	636148	0.81	0.1009	99710	910234	589371	-8%	0%
.	632350	0.9	0.1121	110134	900493	578560	-9%	11%
.	630879	0.935	0.1165	114155	896736	574412	-10%	15%
.	628994	0.98	0.1221	119296	891932	569123	-11%	20%
.	628157	1	0.1246	121571	889806	566789	-11%	22%
.	626488	1.04	0.1296	126103	885572	562151	-11%	27%
.	623993	1.1	0.1371	132855	879262	555267	-12%	34%
.	619857	1.2	0.1495	143990	868859	543987	-14%	45%
.	615749	1.3	0.162	154978	858593	532945	-16%	56%
.	611669	1.4	0.1744	165820	848464	522136	-17%	67%
.	607616	1.5	0.1869	176518	838469	511554	-19%	78%
.	603592	1.6	0.1994	187076	828607	501195	-20%	88%
.	599594	1.7	0.2118	197494	818875	491054	-22%	99%
.	595624	1.8	0.2243	207775	809272	481126	-24%	109%
.	591680	1.9	0.2367	217921	799795	471407	-26%	119%
.	587764	2	0.2492	227933	790444	461892	-27%	130%

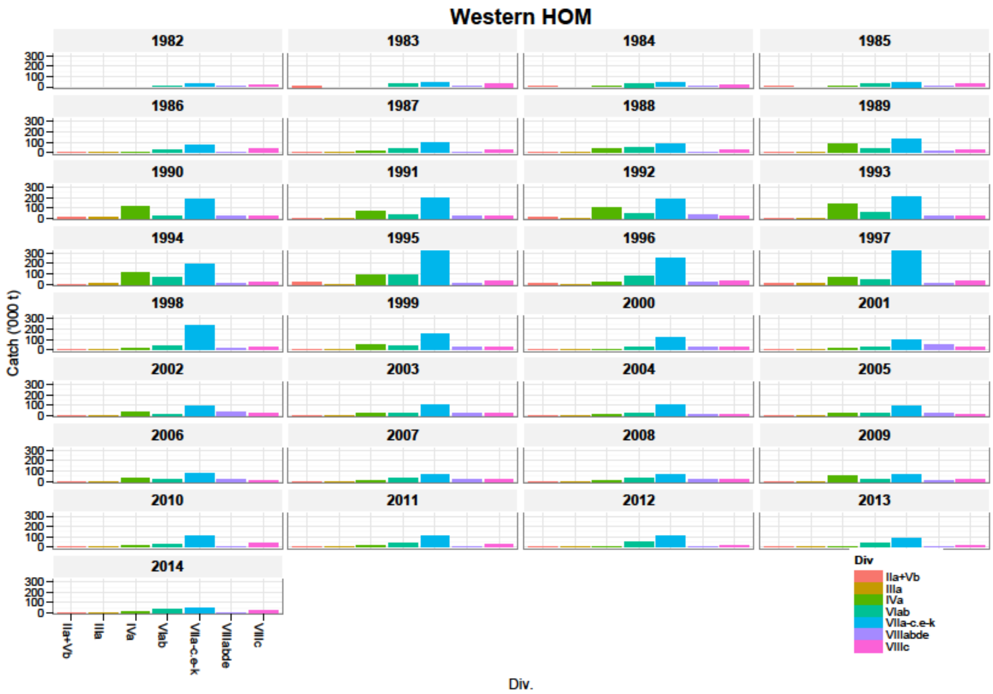


Figure 5.1.3.1. Western horse mackerel. Catch by ICES Division for 1982-2014

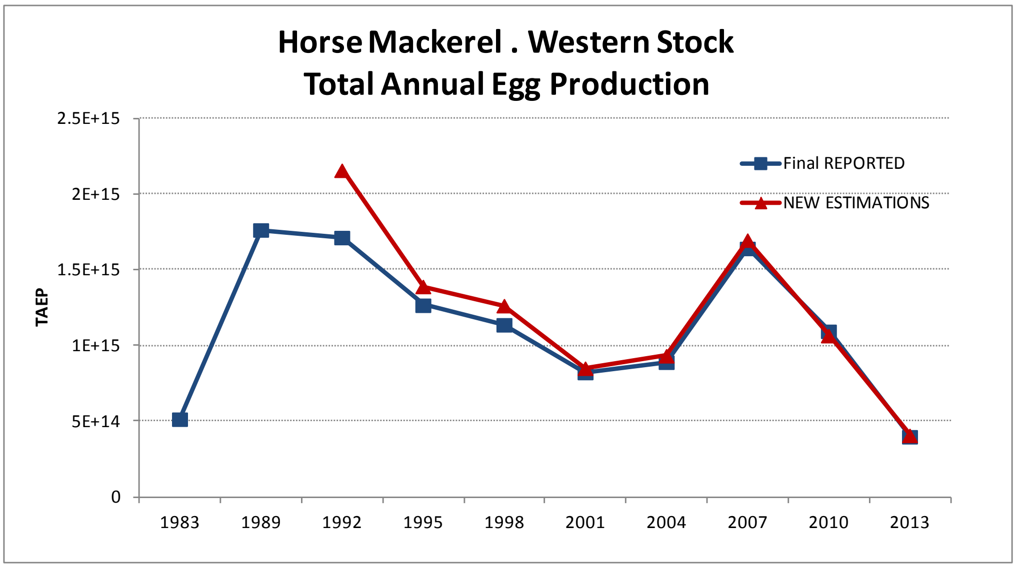


Figure 5.2.1: Western horse mackerel. Comparison between revised and reported Total Annual Egg Production estimates (1983 – 2013) for western horse mackerel.

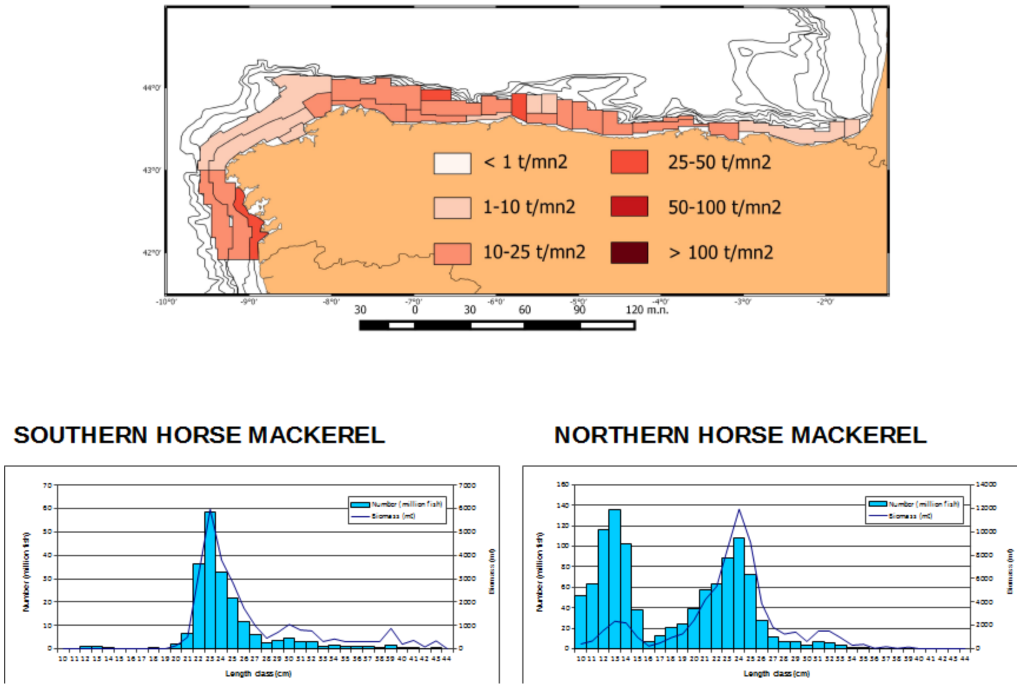


Figure 5.2.2.1: Horse mackerel assessment from PELACUS 0315., including fish density distribution. Note that the scales for the length distribution are different.

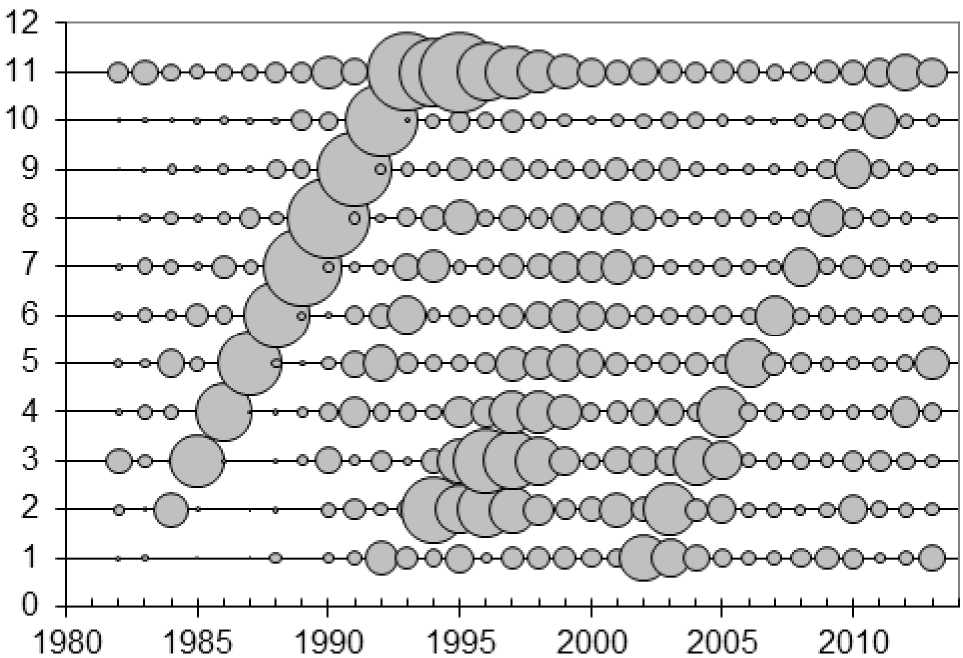


Figure 5.2.4.1: Western horse mackerel. Catch-at-age matrix, expressed as numbers (thousands). The area of bubbles is proportional to the catch number. Note that age 11 is a plus group.

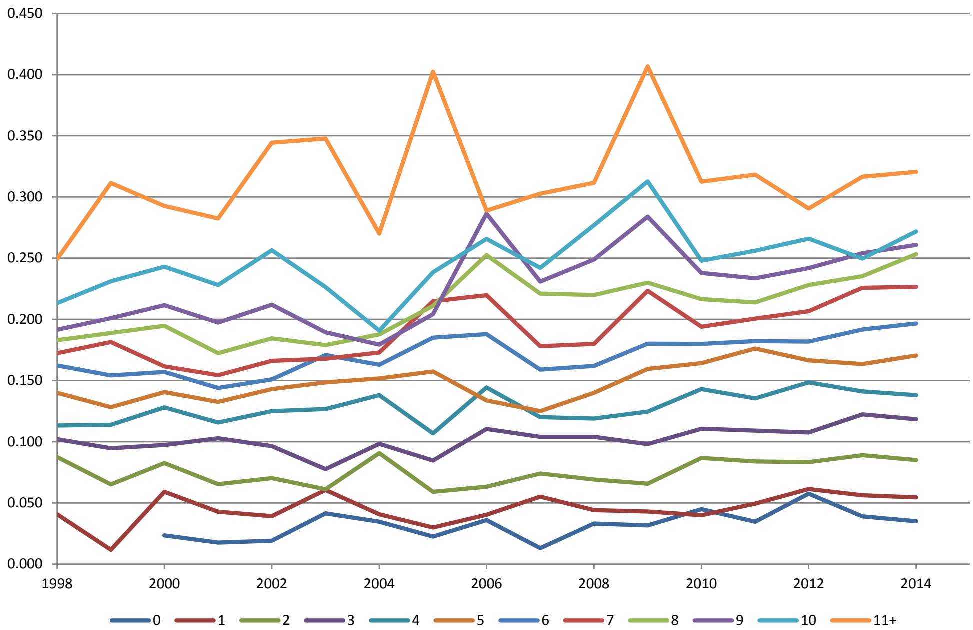


Figure 5.2.5.1: Western horse mackerel. Weight in the catch (kg) by year.

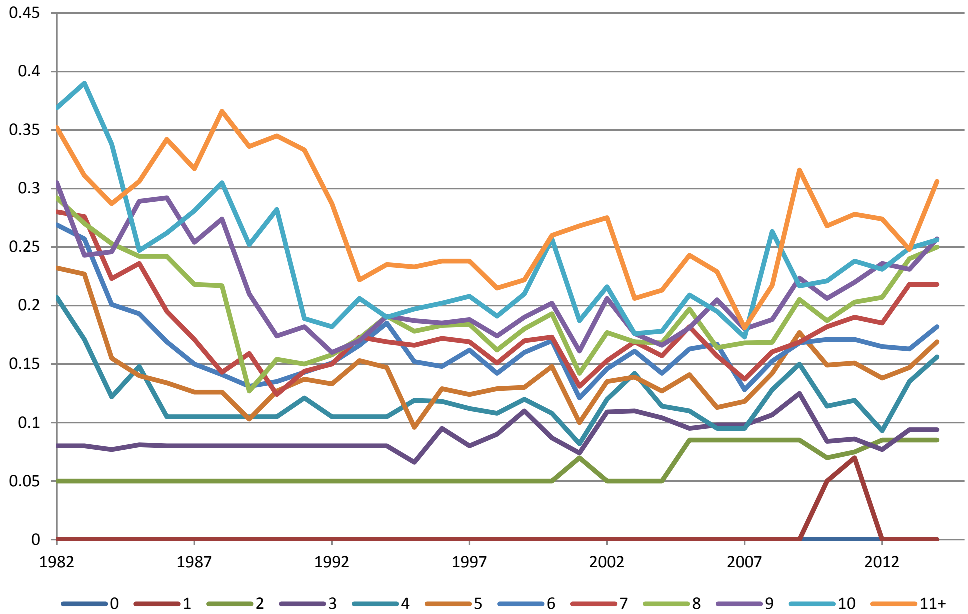


Figure 5.2.5.2: Western horse mackerel. Weight in the stock (kg) by year.

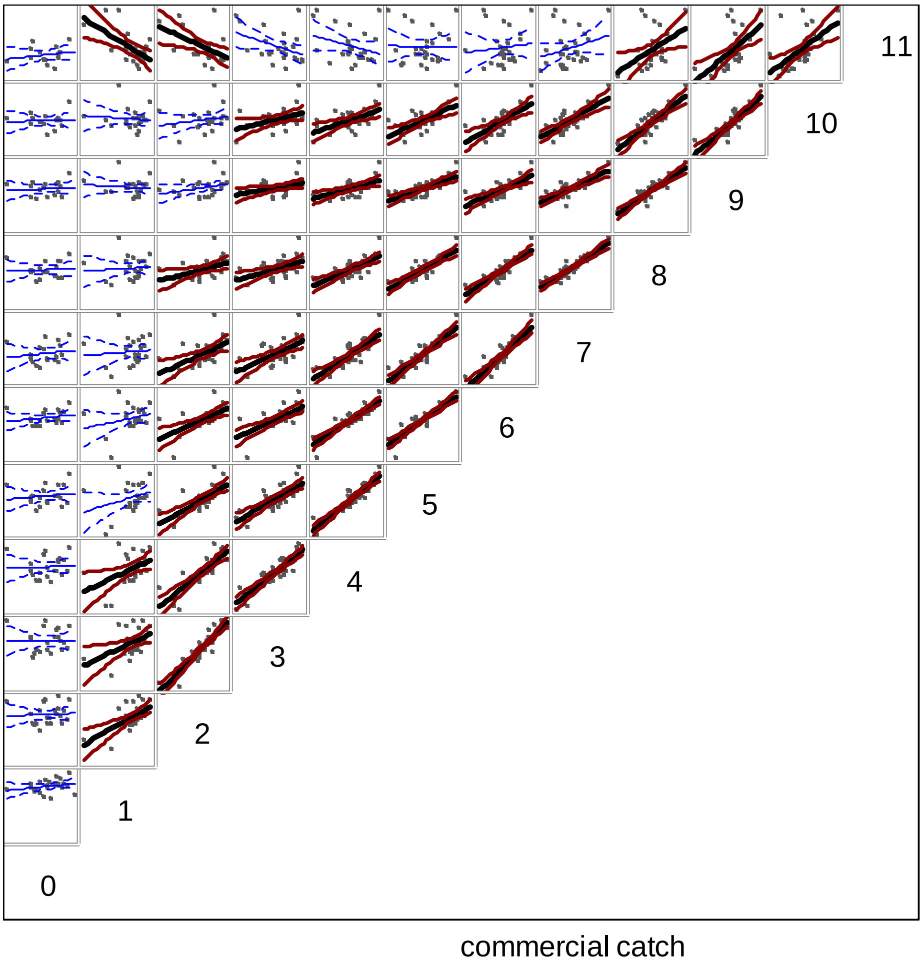


Figure 5.2.10.1: Western horse mackerel. Data exploration. Within-cohort consistency in the catch-at-age matrix, shown by plotting the log-catch of a cohort at a particular age against the log-catch of the same cohort at subsequent ages. Thick lines represent a significant (p<0.05) regression and the curved lines are approximate 95% confidence intervals.

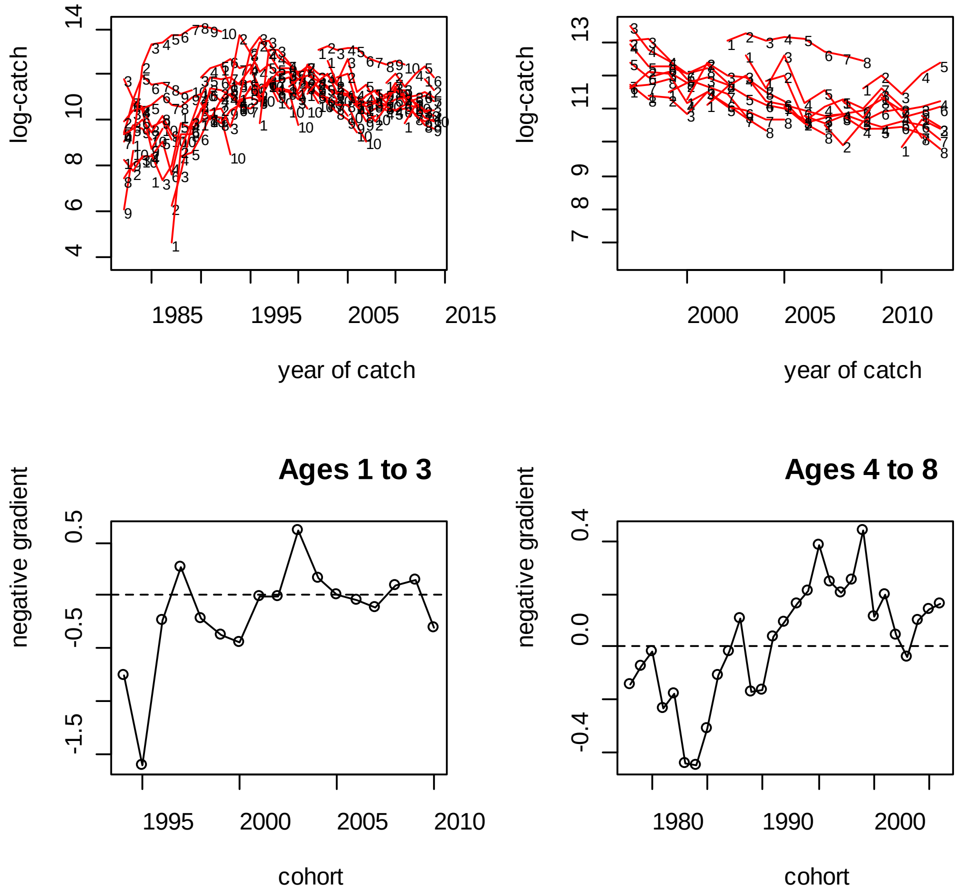


Figure 5.2.10.2: Western horse mackerel. Data exploration. Log-catch cohort curves (top row shows the full time series on the left, and the most recent period for ages 1-8 on the right) and the associated negative gradients for each cohort across the reference fishing mortality of ages 1-3 (bottom left) and 4-8 (bottom right).

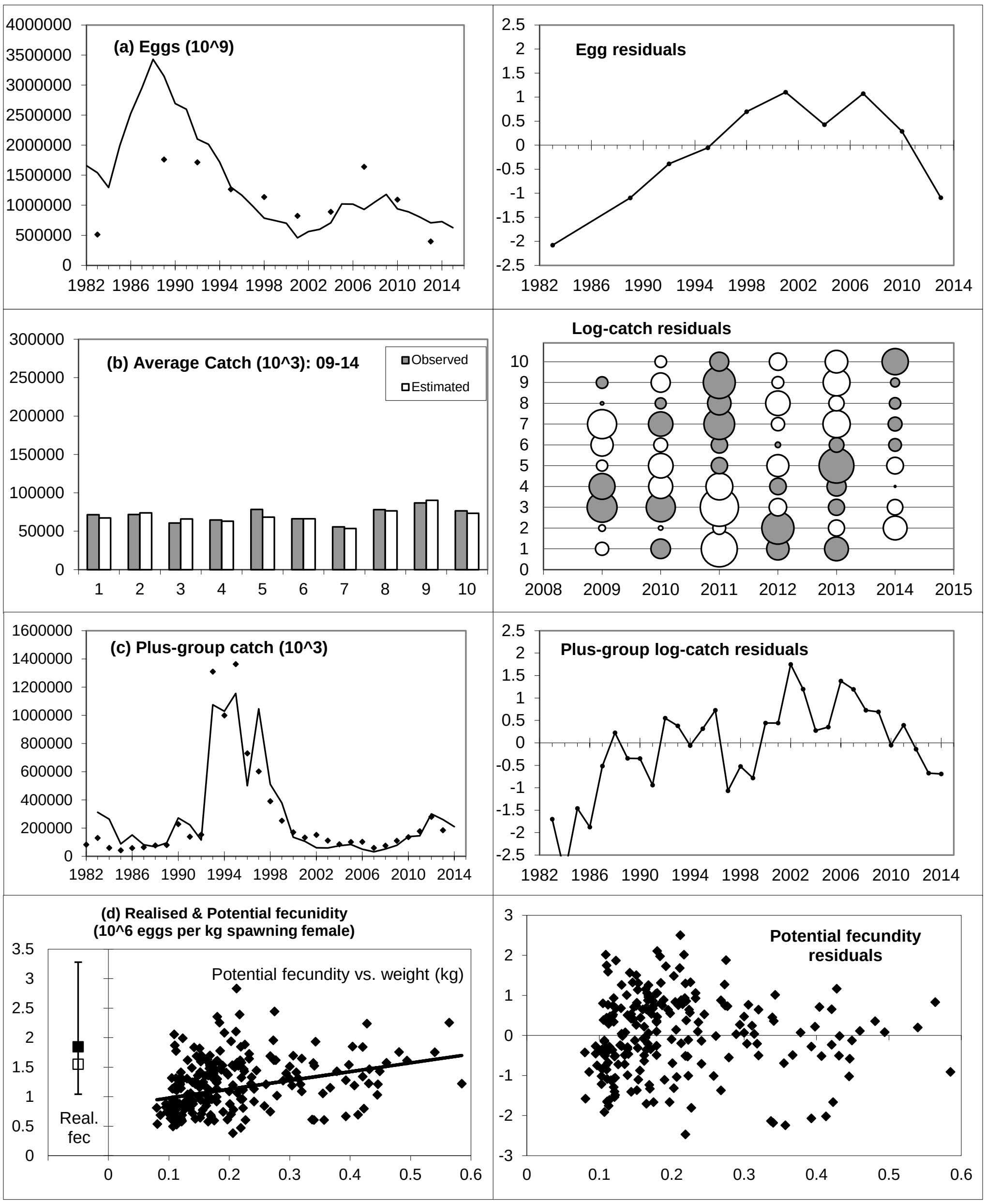


Figure 5.2.11.1: Western horse mackerel. SAD model with 2009-2014 separable window. Model fits to data for the five components of the likelihood, corresponding to (a) the egg estimates, (b) the catches in the separable period, (c) to the catches in the plus-group, and (d) population-mean realised fecundity (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.

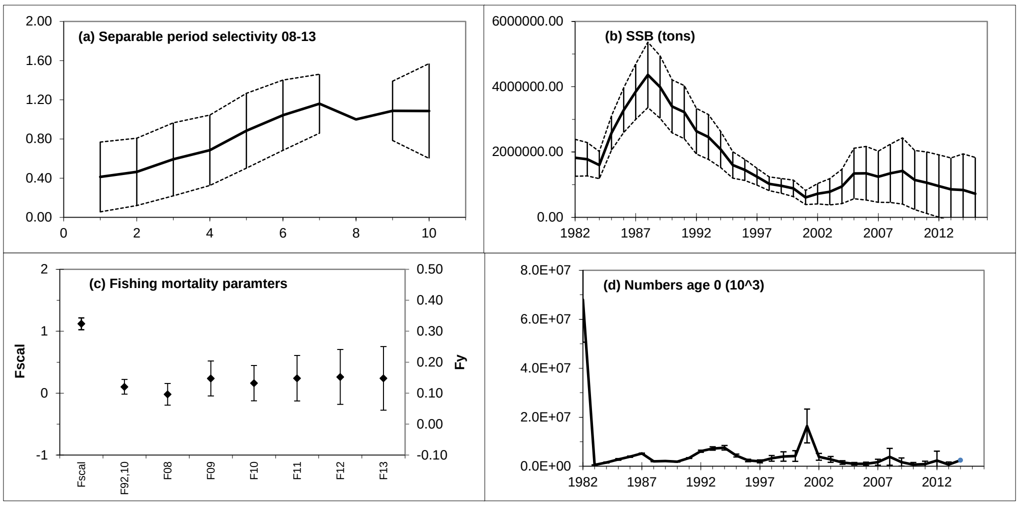


Figure 5.2.11.2: Western horse mackerel. Model with 2009-2014 separable window. Plots of (a) the selectivity pattern, (b) the SSB trajectory, (c) fishing mortality parameters (the scaling parameter F_{scal}, fishing mortality at age 10 in 1992, $F_{92,10}$, and the fishing mortality year effects for 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.

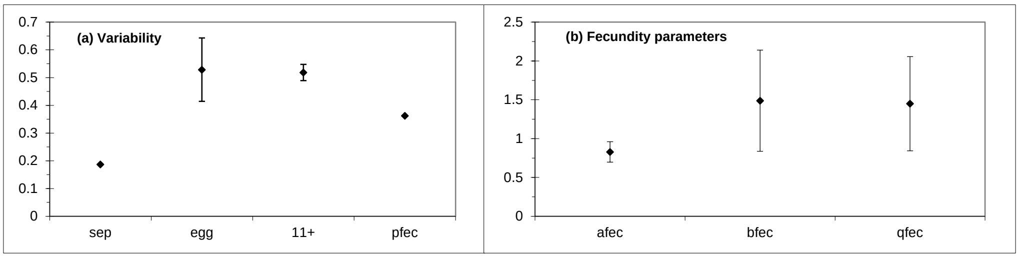


Figure 5.2.11.3: Western horse mackerel. Model with 2009-2014 separable window. Estimates for some key parameters, with (a) corresponding to variability parameters, plotted as standard deviations, for four components of the likelihood (σ_{sep}, σ_{egg}, σ_{11+} and σ_{pfec}), and (b) the fecundity parameters a_{fec}, b_{fec}, q_{fec}. The error bars are two standard deviations (indicating roughly 95% confidence bounds).

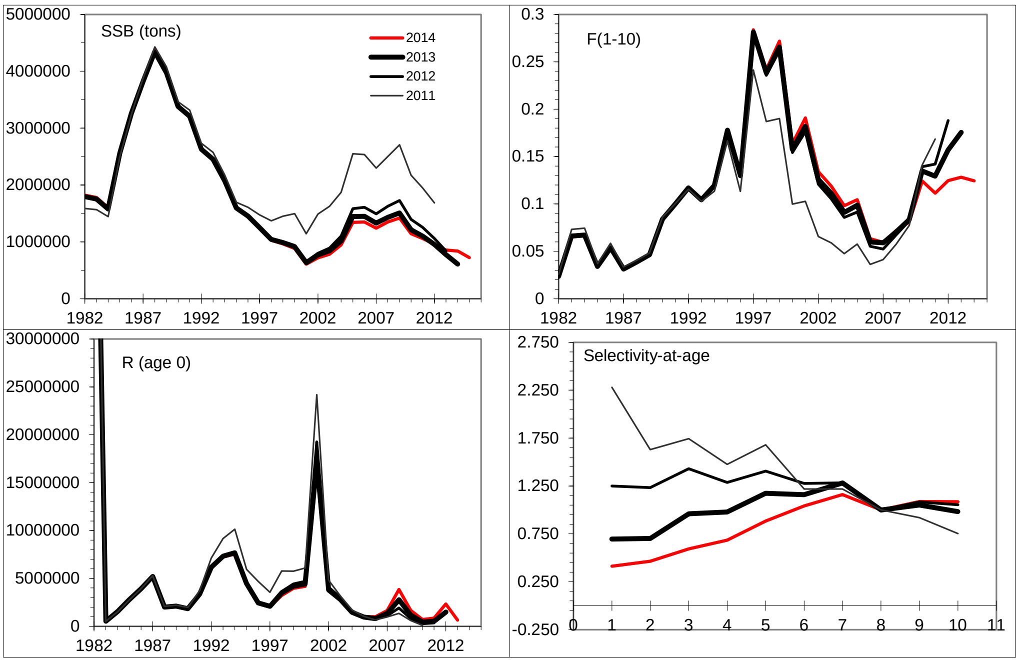


Figure 5.2.11.4: Western horse mackerel. 3-year retrospective bias for the case where the length of the separable window is kept at 6 years (the year shown is the final year shown of the window). Trajectories of SSB, F(1-10), Recruitment (age 0) and selectivity-at-age.

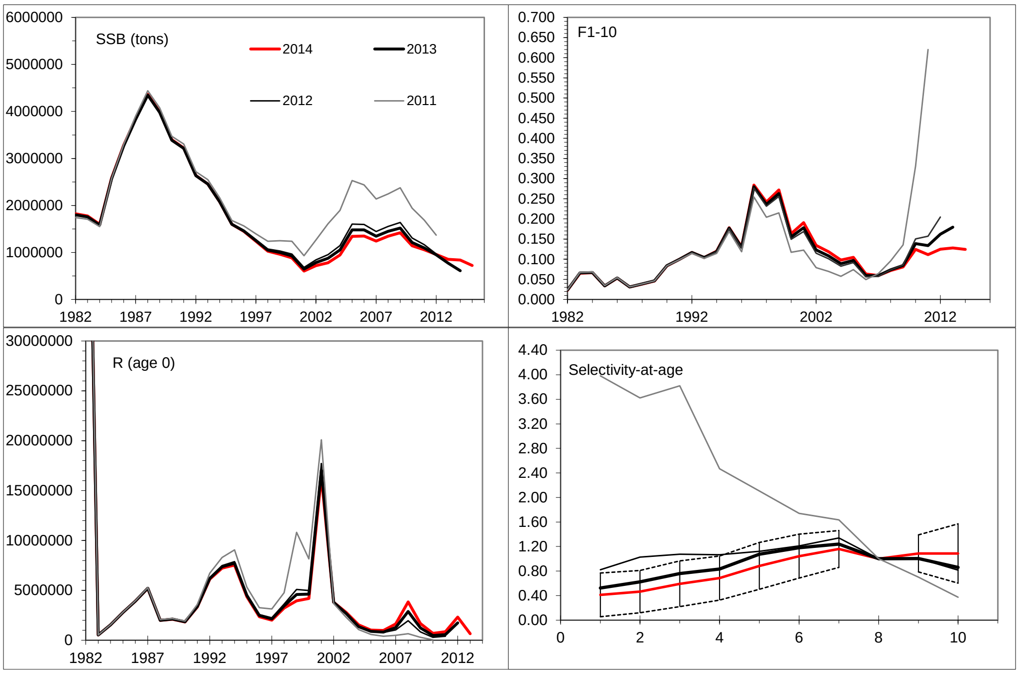


Figure 5.2.11.5: Western horse mackerel. 3-year retrospective bias for the case where the starting year of the separable window is kept at 2009, so that the window decreases in length as more years are dropped (the year shown is the final year of the window). Trajectories of SSB, F(1-10), recruitment (age 0) and selectivity-at-age including confidence bounds from the 2014 assessment.

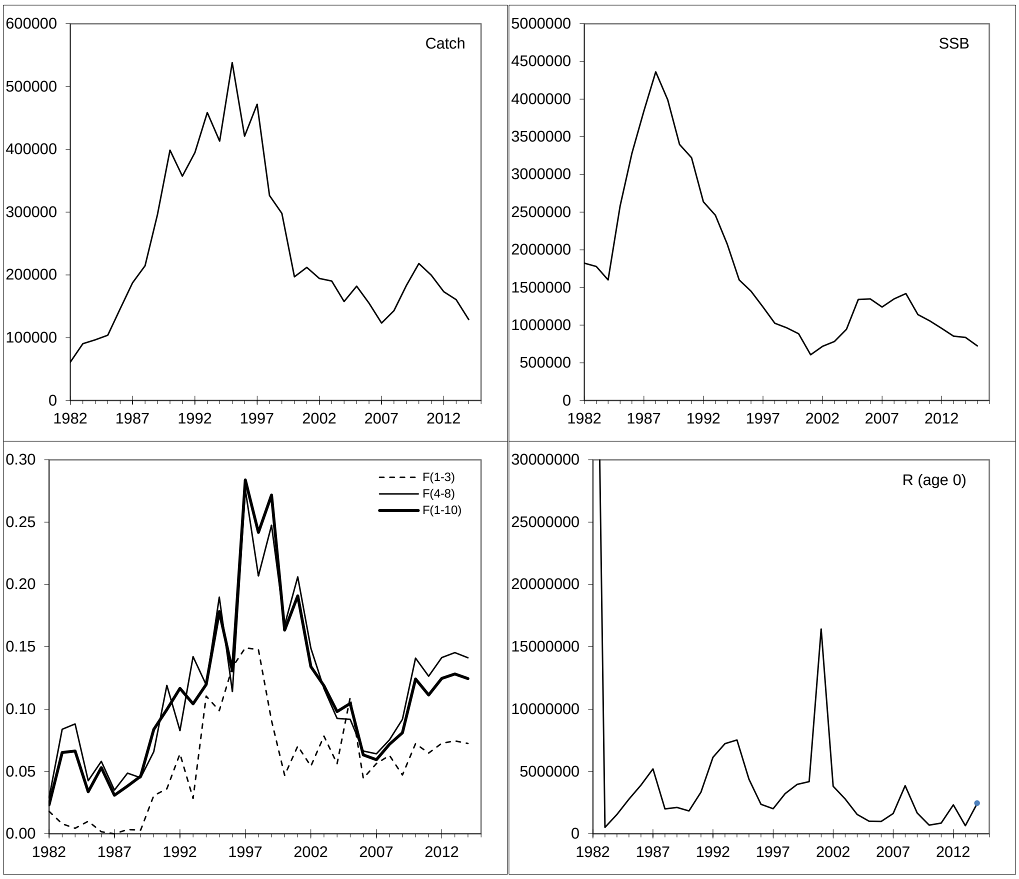


Figure 5.3.1.1: Western horse mackerel. Final assessment stock summary. Plots of catch, SSB, recruitment (age 0) and fishing mortality (average for 1-3, 4-8 and 1-10). SSB and catch are in tons, and recruitment is in thousands. The final SSB estimate assumes the same fishing mortality as in the previous year. Recruitment in 2014 is the geometric mean of the time series excluding 1982.

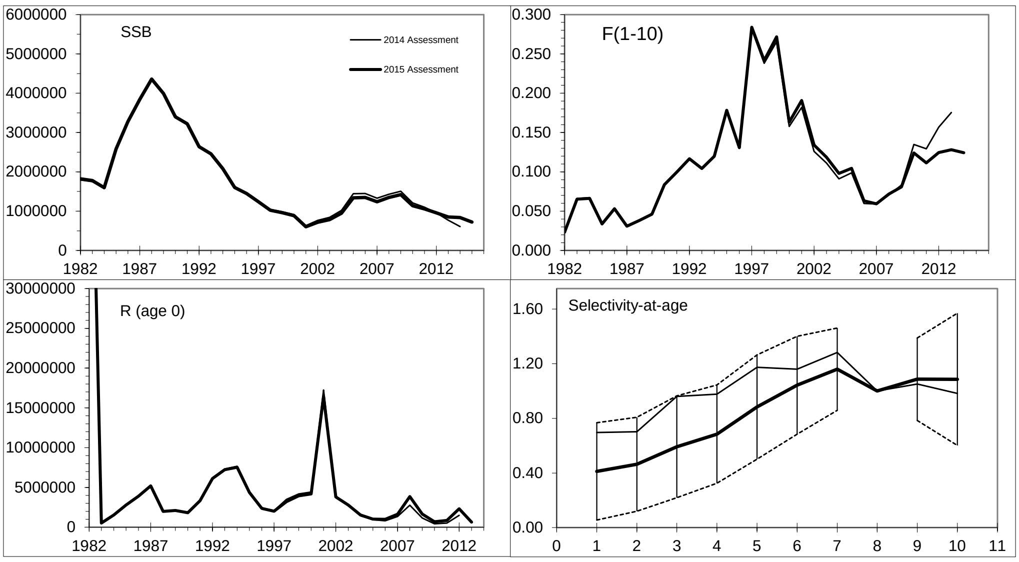


Figure 5.6.1: Western horse mackerel. Comparison of the final assessment this year with that of last year. Plots of SSB, recruitment (age 0), fishing mortality (average for ages 1-10) and selectivity-at-age for the separable period (2008-2013 for the 2014 assessment, and 2009-2014 for the 2015 assessment). SSB values are in tons, and recruitment is in thousands.

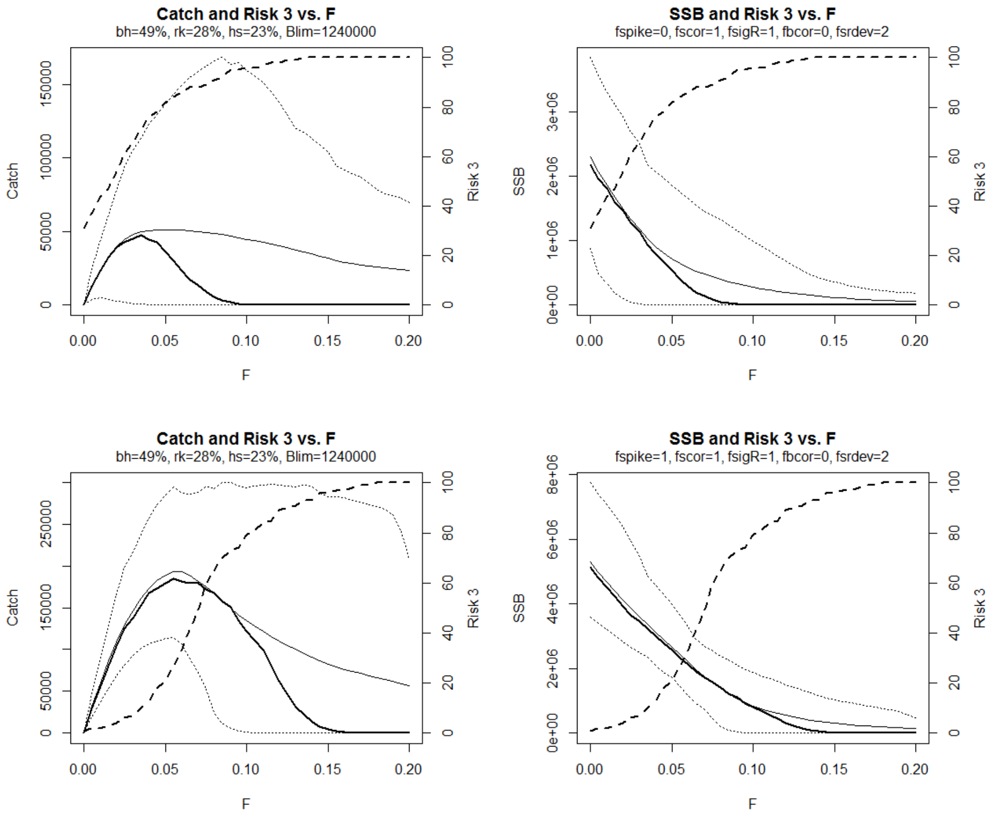


Figure 5.7.2 Western horse mackerel. Model Yield, SSB and Risk 3 vs F (med,10th & 90th pct) from projecting initial conditions forward 200 years, 100 iterations. The upper plots correspond to simulations with no recruitment spikes, results with recruitment spikes are shown on the bottom row.

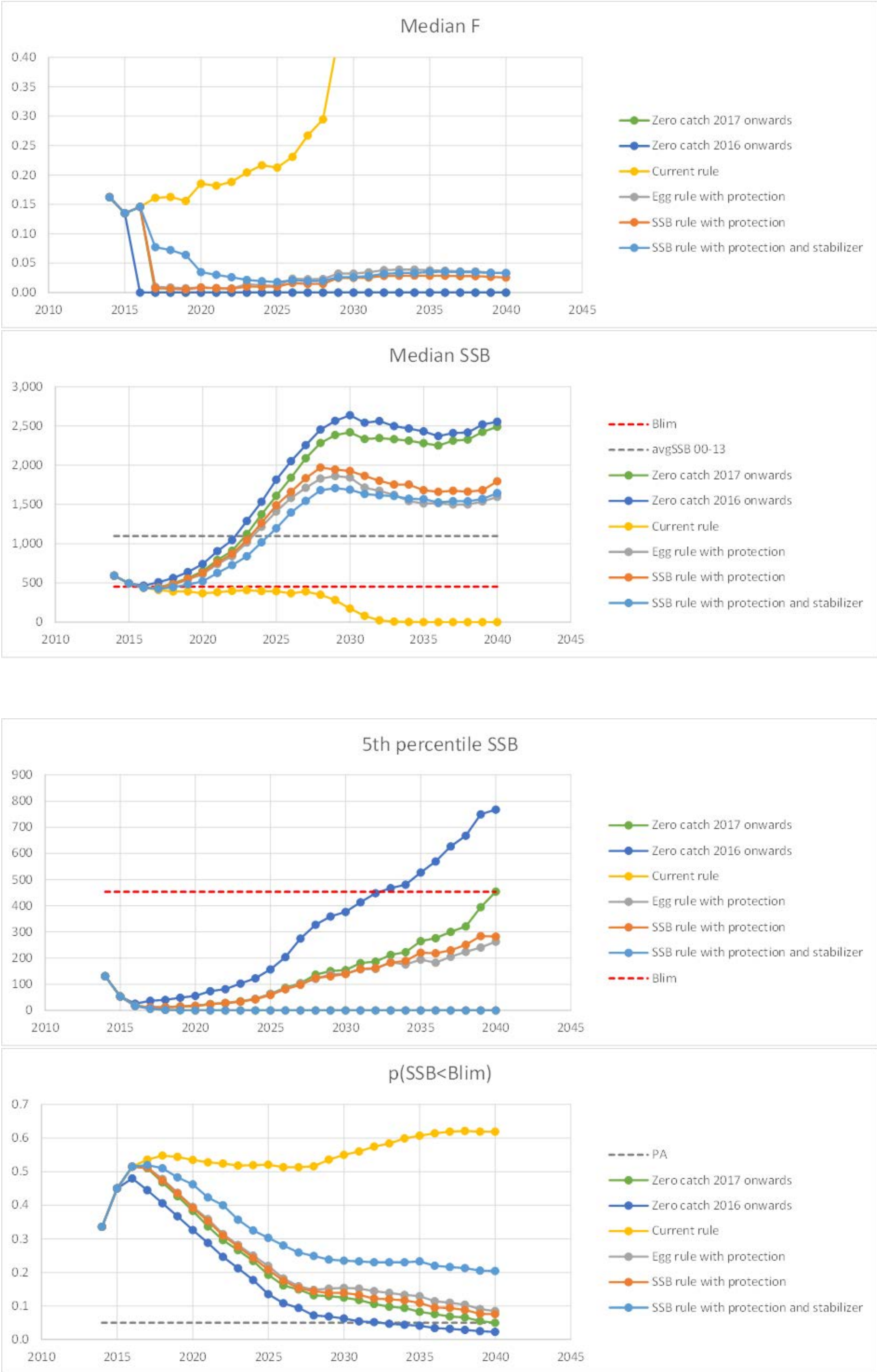


Figure 5.7.3. Western horse mackerel. Results of MSE simulations using hockey-stick recruitment model.

6 Northeast Atlantic Boarfish (*Capros aper*)

The boarfish (*Capros aper*, Linnaeus) is a deep bodied, laterally compressed, pelagic shoaling species distributed from Norway to Senegal, including the Mediterranean, Azores, Canaries, Madeira and Great Meteor Seamount (Blanchard and Vandermeirsch, 2005).

Boarfish is targeted in a pelagic trawl fishery for fish meal, to the southwest of Ireland. The boarfish fishery is conducted primarily in shelf waters and the first landings were reported in 2001. Landings were at very low levels from 2001-2005. The main expansion period of the fishery was 2006-2010 when unrestricted landings increased from 2 772 t to 137 503 t. A restrictive TAC of 33 000 t was implemented in 2011. In 2011, ICES was asked by the European Commission to provide advice for 2012. In 2015, ICES is considering this stock for the fifth year.

An analysis of bottom trawl survey data suggests a continuity of distribution spanning ICES Subareas IV, VI, VII, VIII and IX (Figure 6.1). Isolated small occurrences appear in the North Sea (ICES Subarea IV) in some years indicating spill-over into this region. A hiatus in distribution was suggested between ICES Divisions VIIIc and IXa as boarfish were considered very rare in northern Portuguese waters but abundant further south (Cardador and Chaves, 2010).Preliminary results from a dedicated genetic study on the stock structure of boarfish within the Northeast Atlantic and Mediterranean Sea suggests that this hiatus represents a true stock separation (see section 6.12). Based on these data, a single stock is considered to exist in ICES Subareas IV, VI, VII, VIII and the northern part IXa. This distribution is slightly broader than the current EC TAC area (VI, VII and VIII) and for the purposes of assessment in 2015 only data from these areas were utilised.

6.1 The Fishery

6.1.1 Advice and management applicable from 2011 to 2014

In 2011 a TAC was set for this species for the first time, covering ICES Subareas VI, VII and VIII. This TAC was set at 33 000 t. Before 2010, the fishery was unregulated. In October 2010, the European Commission notified national authorities that under the terms of Annex 1 of Regulation 850/1998, industrial fisheries for this species should not proceed with mesh sizes of less than 100 mm. In 2011, the European Parliament voted to change Regulation 850/1998 to allow fishing using mesh sizes ranging from 32 to 54 mm.

For 2012, ICES advised that catches of boarfish should not increase, based on precautionary considerations. As supporting information, ICES noted that it would be cautious that landings did not increase above 82 000 t, the average over the period 2008-2010, during which the stock did not appear to be overexploited. In 2012 the TAC was set at 82 000 t by the Council of the European Union.

For 2013, ICES advised that catches of boarfish should not be more than 82,000 t. This was based on applying a harvest ratio of 12.2% ($F_{0.1}$, as an F_{msy} proxy). For 2013, the TAC was set at 82 000 t by the Council of the European Union.

For 2014, ICES advised that, based on F_{MSY} (0.23), catches of boarfish should not be more than 133 957t, or 127 509t when the average discard rate of the previous ten years (6 448t) is taken into account. For 2014 the TAC was set at 133 957t by the Council of the European Union. This advice was based on a Schaefer state space surplus production model.

In 2014 there was concern about the use of the production model for three reasons (see section 6.6.5 for further details). ICES therefore considered that the model was no longer suitable for providing category 1 advice and further model development was required. The model is still considered suitable for category 3 advice however and the advised catch for 2015 of 53 296 t was based on the data limited stock HCR and an index calculated (method 3.1; ICES 2012) using the total stock biomass trends from the model. Further work has been undertaken in 2015 to address the issues with the surplus production model (see. Section 6.7). ICES considers the current basis for the advice on this stock to be an interim measure prior to development of an age-based assessment.

By-catch of boarfish in the horse mackerel pelagic fishery is regulated by a provision in the TAC for the latter species. This allows a certain percentage of boarfish, and other species, to be retained and deducted from the horse mackerel quota.

In 2010, an interim management plan was proposed by Ireland, which included a number of measures to mitigate potential bycatch of other TAC species in the boarfish fishery. A closed season from the 15th March to 31st August was proposed, as anecdotal evidence suggests that mackerel and boarfish are caught in mixed aggregations during this period. A closed season was proposed in ICES Division VIIg from 1st September to 31st October, in order to prevent catches of Celtic Sea herring, which is known to form feeding aggregations in this region at these times. Finally, if catches of a species covered by a TAC, other than boarfish, amount to more than 5% of the total catch by day by ICES statistical rectangle, then fishing must cease in that rectangle.

In August 2012 the Pelagic RAC proposed a long term management plan for boarfish. The management plan was not fully evaluated by ICES. However, in 2013, ICES advised that Tier 1 of the plan can be considered precautionary if a Category 1 assessment is available.

A revised draft management strategy was proposed by the Pelagic AC in July 2015. This management strategy aims to achieve sustainable exploitation of boarfish in line with the precautionary approach to fisheries management, FAO guidelines for new and developing fisheries, and the ICES form of advice. ICES evaluates that this plan follows the rationale for TAC setting enshrined in the ICES advice, but with additional caution.

Since 2011, there has been a provision for by-catch of boarfish (also whiting, haddock and mackerel) to be taken from the western and North Sea horse mackerel EC quotas. These provisions are shown in the text table below. The effect of this is that a quantity not exceeding the value indicated of these 4 species combined may be landed legally and subtracted from quotas for horse mackerel.

YEAR	NORTH SEA (T)	WESTERN (T)
2011	2031	7779
2012	2148	7829
2013	1702	7799
2014	1392	5736
2015	583	4202

6.1.2 The fishery in recent years

The first landings of boarfish were reported in 2001. Landings fluctuated between 100 and 700 t per year up to 2005 (Table 6.1.2.1). In 2006 the landings began to increase considerably as a target fishery developed. Cumulative landings since 2001 are now close to 500 000 t. The fishery targets dense shoals of boarfish from September to March.

Catches are generally free from bycatch from September to February. From March onwards a bycatch of mackerel can be found in the catches and the fishery generally ceases at this time. Information on the bycatch of other species in the boarfish fishery is sparse, though thought to be minimal. The fishery uses typical pelagic trawl nets with mesh sizes ranging from 32 to 54 mm. Preliminary information suggests that only the smallest boarfish escape this gear.

From 2001 to 2006 only Ireland reported landings of boarfish. In 2007 UK-Scotland reported landings of less than 1 000 t. Scottish landings peaked at 9 241 t in 2010. Denmark joined the fishery in 2008 and landed 3 098 t. Danish landings then increased to 39 805 t in 2010. In all years the vast majority of catches have come from ICES Division VIIj (Figure 6.2 and Tables 6.1.2.2 and 6.1.2.3). Since 2011 landings have been regulated by TAC.

Previous to the development of the target fishery, boarfish was a discarded bycatch in pelagic fisheries for mackerel in ICES Subareas VII and VIII. A study by Borges *et al.* (2008) found that boarfish may have accounted for as much as 5% of the total catch of Dutch pelagic freezer trawlers. Boarfish are also discarded in whitefish fisheries, particularly by Spanish demersal trawlers (Tables 6.1.2.1 and 6.1.2.4).

6.1.3 The fishery in 2014

In 2013 a total of 43 418 t of boarfish were caught (Tables 6.1.2.1, 6.1.2.2 and 6.1.2.3). Ireland continued to be the main participant taking 34 622 t, Denmark took 8 758 t and Scotland 38 t. Thirty five Irish registered fishing vessels reported catches with the majority made in Q4 (23 168 t) and Q1 (8 993 t). The Q3 landings of 2 463 t were all made in September. Figure 6.2 shows the majority of the Irish landings were taken in ICES divisions VIIh, j, and b. Danish landings, at 8 758 t, were significantly under the national quota of 13 079 t for 2015. Scottish pelagic vessels reported a mere 38 t landed of the 3 387 t quota.

A pre-meeting between ICES scientists and representatives of the EU pelagic industry was held on 19 August 2015 to discuss information from the fishing industry and any ongoing developments in data needs. The following points about boarfish were shared at the meeting. Denmark did not catch the quota in 2014 and it is apparent that the stock is not as large as was thought a few years ago. The decline in the ICES advice is reflected in the fishery. The price for meal and oil went down rapidly in 2014, so there was no strong economic incentive for Danish fishermen to fish for boarfish. Danish fishermen reported that boarfish schools were in very high concentrations but in small areas. The freezer-trawler fisheries obtained a de-minimis exemption of 1% of the TAC. So far this has not been utilized because the bycatch of boarfish is lower than anticipated.

6.1.4 Regulations and their effects

In 2010, the fishery finished early when the European Commission notified member states that mesh sizes of less than 100 mm were illegal. However, in 2011, the European Parliament voted to change Regulation 850/1998 to allow fishing for boarfish using mesh sizes ranging from 32 to 54 mm. The TAC (33 000 t) that was introduced in 2011 significantly reduced landings.

6.1.5 Changes in fishing technology and fishing patterns

The expansion of the fishery in the mid-2000s was associated with developments in the pumping and processing technology for boarfish catches. These changes made it easier to pump boarfish ashore. Efforts are underway to develop a human consumption market and fishery for boarfish. To date the majority of boarfish landings by Danish, Irish and Scottish vessels have been made into Skagen, Denmark and Fuglafjørður, Faroe Islands to be processed into fishmeal. A small number of Irish vessels have landed into Killybegs and Castletownbere, Ireland. These landings into Irish ports are expected to increase with the development of a human consumption fishery

6.1.6 Discards

Discard data were available from Dutch and German pelagic freezer trawlers and from Irish, Spanish and UK demersal fleets. Discards were not obtained from French freezer trawlers, though discard patterns in these fleets are likely to be similar to the Dutch fleet. Discard data from the Portuguese bottom otter trawl fleet in ICES Division IXa was also available but was not included in the assessment as it is outside the TAC area. Table 6.1.2.4 shows available data.

It is to be expected that discarding occurred before 2003, in demersal fisheries, however it is difficult to predict what the levels may have been.

Discard data were included in the calculation of catch numbers at age. All discards were raised as one métier using the same age length keys and sampling information as for the landed catches. In the absence of better sampling information on discards, this was considered the best approach. This placed the stock in Category A2 for the ICES Advice in October 2013: Discards 'topped up' onto landings calculations. With the introduction of the discard ban in 2015 this stock was placed in A4: Discards known, with discard ban in place in year +1. As such the advice will be given for catch in ICES Advice October 2014 and onwards.

6.2 Biological composition of the catch

6.2.1 Catches in numbers-at-age

For 2014 catch number-at-age were prepared for Irish, Danish and Scottish landings using the ALK in table 6.2.1.1. This general ALK was constructed based on 814 aged fish from Irish, Danish and Scottish caught samples from 2012. Allocations to unsampled métiers were made according to table 6.2.1.2. In total 43 Irish and 11 Danish samples were collected in 2014, comprising 5 072 and 1 936 fish measured for length frequency, respectively. This equated to one sample per 804 t landed.

ALKs were applied to commercial length-frequency data available for the years 2007-2014 to produce a proxy catch numbers-at-age (Figure 6.2.1.1 and Table 6.2.1.3) (see the stock annex for a description of ALKs prior to 2012). It can be seen that many older fish are still present in catches, though there appears to be a reduction of older ages since 2007. There have been no strong year classes since the 2005 year class, with the possible exception of 2010, now at age 4. The modal age from 2007-2011 was 6 and in 2012-2013 it was 7. It should be noted that in WGWIDE 2011 and 2012 the +group for boarfish was 20+. This was reduced to 15+ in WGWIDE 2013 due to potential inaccuracy of the age readings of older fish. Ageing was based on the method that has been validated for ages 0-7 by Hüssy *et al*. (2012a; 2012b). The age range is similar to the published growth information presented by White *et al*. (2011).

6.2.2 Quality of catch and biological data

Table 6.2.1.2 shows the number of samples available per year and allocations that were made to un-sampled métiers (Division*Quarter*Country). Length-frequencies of the international commercial landings by year are presented in Table 6.2.2.1.

Sampling in the early years of the fishery (2006-2009) was sparse as there was no dedicated sampling programme in place. The sampling programme was initiated in 2010 and good coverage of the landings has been achieved since then (Table 6.2.1.2). There is no DCF funded sampling of the fishery and all Irish sampling is industry funded. Irish sampling comprises only samples from Irish registered vessels. Samples are collected onboard directly from the fish pump during fishing operations and are frozen until returning to port, which ensures high quality samples. Each sample consists of approximately 6kg of boarfish. This equates to approximately 150 fish which, given the limited size range of boarfish, is sufficient for determining a representative length frequency. The established sampling target is one sample per 1 000 t of landings per ICES Division, which is also standard in other pelagic fisheries such as mackerel. All fish in each sample are measured to the 0.5cm below for length frequency. Following standard protocols 5 fish per 0.5cm length class are randomly selected from each sample for biological data collection i.e. otolith extraction, measurement to the 1mm below and sex and maturity determination.

There is no sampling programme in place for Scottish catches.

The current surplus production model used to assess boarfish is considered an interim measure prior to the development of an aged-based assessment. Therefore boarfish needs to be included in the list of DCF species and to the samples need to be aged in order to progress this assessment.

6.3 Fishery Independent Information

6.3.1 Acoustic Surveys

The Boarfish Acoustic Survey (BFAS) series was initiated in July 2011 and is now in its fifth year. Estimates of boarfish biomass by category are presented in Table 6.6.4.1 and the spatial distribution of the echotraces attributed to boarfish in each year can be seen in Figure 6.3.1.1. The survey is conducted by Marine Institute scientists aboard chartered Irish pelagic RSW vessels with a towed body system with a calibrated 38 kHz split beam transducer (O'Donnell *et al.*, 2012a). The survey was designed to extend the Malin Shelf Herring Acoustic Survey (MSHAS) conducted aboard the RV "Celtic Explorer" to the south, which increased the range of continuous coverage from approximately 58.5°N to 47.5°N (Figure 6.3.1.1). The combined surveys result in a continuous coverage over 33 days, 90 000 nmi^2 and transect coverage over 4 500 nmi. On average 25 trawls are sampled for boarfish lengths, weights, maturity data, and otoliths.

The text table below explains the categories used to report estimated biomass from all BFASs. Following standard acoustic survey protocols the Total Biomass estimate includes the '*Definitely*', '*Probably*' and '*Mixture*' categories but excludes the '*Possibly*' category.

CATEGORY	DEFINITION
Definite	"Definitely" echotraces were identified on the basis of captures of boarfish from the fishing trawls which were sampled directly. Based on the directly sampled schools echotraces were also characterised as definitely boarfish which appeared very similar on the echogram i.e. large marks which showed as very high intensity (red), located high in the water column(day) and as strong circular schools.
Probably	"Probably" was attributed to smaller echotraces that had not been fished but which had similar characteristics to "definite" boarfish traces.
Mixture	"Mixture" was attributed to NASC values arising from all fish traces in which boarfish were contained, based on the presence of a proportion of boarfish in the catch or within the nearest trawl haul. Boarfish were often taken during trawling in mixed species layers during the hours of darkness.
Possibly	"Possibly" was attributed to small echotraces outside areas where fishing was carried out, but which had the characteristics of definite boarfish traces.

The 2011 BFAS operated on a 24 hour basis as it was an exploratory survey and the distribution and behaviour of boarfish during this time of year were unknown prior to the survey. In 2012 the survey methodology was refined by switching to daylight only (04:00-00:00) surveying (O' Donnell *et al*., 2012b; Table 6.6.4.1). This change in protocol was a result of the observation during the 2011 BFAS that boarfish shoals were observed to break up during the night (00:00-04:00) and could not be acoustically detected or quantified. Until the 2015 assessment this difference in the 2011 BFAS methodology prevented its inclusion in the assessment model. However, after reworking the raw data from 2011 to exclude 00:00 – 04:00 acoustic registrations and applying the new target strength, an updated estimate of boarfish biomass was available to the assessment in 2015. The BFAS time series therefore now includes five data points, which are detailed in Table 6.6.4.1.

As no species-specific target strength (TS) previously existed for boarfish, an industry funded project was conducted to model boarfish TS. Samples were collected during the 2011 survey and MRI scans were taken of the swim bladders from the observed size range of boarfish. 3D swim bladder dimensions of each fish sample were used as input to a KRM model. An estimated TS-L relationship of -65.98dB was derived based on model calculations. This TS was used in 2012 to produce biomass estimates for the 2012 and 2011 survey. In 2013 this TS was reviewed and revised to -66.2dB (Fässler *et al.*, 2013; O'Donnell, 2013). This new TS (-66.2dB) was applied to the 2013 survey data (O'Donnell *et al.*, 2013) and retrospectively to the 2012 and 2011 BFAS survey data for use in the boarfish assessment.

The July 2014 BFAS again comprised acoustic and trawl data recorded from the FV "Felucca" and RV "Celtic Explorer" (Figure 6.3.1.1). Temporal and spatially coverage were almost identical to 2013 and the revised TS was used in the biomass calculation. Twenty one hauls were carried out during the survey, 11 of which contained boarfish. A total of 3 160 boarfish lengths, 1 102 length/weight measurements and 397 otoliths were collected during the survey. The total estimated biomass was 187 779 t, 57% less than the 2013 BFAS estimate. Of this total estimate 71% were categorised as 'definitely' boarfish, 27% as 'probably' and 1.4% 'boarfish in a mixture' (Table 6.6.4.1). It should be noted that the higher percentage of '*Probably*' boarfish this year was mainly due to technical difficulties with the trawl gear that prevented sampling of some schools that had all the characteristics of '*Definitely*' boarfish. A full breakdown of school categorisation, abundance and biomass by ICES statistical rectangle is available in O'Donnell and Nolan (2014).

The large change in estimated biomass observed between the 2013 and 2014 surveys caused difficulties in the 2014 assessment of the boarfish stock. Despite being a methodological repeat of the previous years, the possibilities were raised of the 2014 survey being an unusually low outlier or a year effect. However, the 2015 biomass estimate of 232 634 t (O'Donnell and Nolan, 2015), being only 45 000 t greater than 2014, confirms that the biomass of this stock has sharply declined in the last three years.

It should be noted that the survey does not contain the stock fully, given that concentrations of boarfish are likely to be found southward of the survey area as evidenced by both IBTS data and information from the PELACUS survey on the northern Spanish Shelf (Carrera *et al.*, 2013). However, low abundances of boarfish were observed by the IFREMER PELGAS 2014 acoustic survey in the Bay of Biscay (May-June), particularly in northern Biscay (Pettigas *pers. comm.* reported in O'Donnell and Nolan, 2014). Carrera *et al.* (2015) recorded very low boarfish abundance on the northern Spanish Shelf during the PELACUS acoustic survey in the spring.

6.3.2 International bottom trawl survey (IBTS) Indices Investigation

The western IBTS data and CEFAS English Celtic Sea Groundfish Survey were investigated for their utility as abundance indices in 2012. An index of abundance was constructed from the following surveys:

- EVHOE, French Celtic Sea and Biscay Survey, (Q4) 1997 to 2011
- IGFS, Irish Groundfish Survey, (Q4) 2003 to 2011
- WCSGFS, West of Scotland, (Q1 and Q4) 1986 to 2011 (no Q4 survey in 2010)
- SPPGFS, Spanish Porcupine Bank Survey, (Q3) 2001 to 2011
- SPNGFS, Spanish North Coast Survey, (Q3/Q4) 1991 to 2011
- ECSGFS, CEFAS English Celtic Sea Groundfish Survey, (Q4) 1982 to 2003

From the IBTS data CPUE was computed as the number of boarfish per 30 minute haul. The abundance of boarfish per year per ICES Rectangle (used for visualisation only) was then calculated by summing the boarfish in a given rectangle and dividing by the total number of hauls in that rectangle. Length frequencies are presented in Table 6.3.2.2 for each survey. The spatial extent of each constituent survey of the IBTS is shown in Figures 6.3.2.1, 6.3.2.2a and 6.3.2.2b. These surveys cover the majority of the observed range of boarfish in the ICES Area (Figure 6.1). Figure 6.3.2.1 also includes the spatial range of the Portuguese Groundfish Survey (1990-2011), however this survey is outside the current EC TAC area and was not included in the index of abundance in 2014.

Anecdotal evidence from the fisheries indicates that from September to March boarfish are found on the shelf in dense shoals often in close proximity to the bottom. These shoals are particularly abundant around the banks in ICES Division VIIj in the Celtic Sea. Therefore boarfish are likely effectively sampled by the demersal gear of the IBTS despite being a pelagic species. However the shoaling nature of the species results in occasional large hauls.

The IBTS appears to give a relative index of abundance, with good resolution between periods of high and low abundance. The main centres of abundance in the survey (Figure 6.3.2.3) correspond to the main fishing grounds (Figure 6.2). Figure 6.3.2.4 shows the signal in abundance, increasing in the 1990s, declining again in the early 2000s, before increasing again. These trends have been reported by (Farina *et al.*, 1997; Pinnegar *et al.*, 2002; Blanchard and Vandermeirsch, 2005). These authors used IBTS and other trawl survey data to show the increased abundance of the species in this area.

The preliminary results of a GAM modelling project of the IBTS data up to 2011, including the Portuguese data, are presented to illustrate the temporal and spatial distribution of boarfish in the ICES Area. A GAM based on the probability of occurrence of boarfish in a surveyed area was developed based on presence absence data from over 13,000 individual fishing hauls in 7 groundfish surveys over a 30 year period (Figures 6.3.2.2a, 6.3.2.2b, 6.3.2.5a and 6.3.2.5b). The GAM models clearly illustrate that boarfish are distributed on the shelf and have a wide area of distribution. In recent years (2003 onwards) there has been an increase in the northerly distribution of boarfish. The depth distribution profile of boarfish within these hauls was also calculated, which shows that boarfish have a depth distribution preference of approximately 100-300m and the probability of occurrence in deeper water decreases sharply (Figure 6.3.2.6). The proportion of each region over which boarfish were distributed per year was also investigated and shows an increasing trend over time (Figure 6.3.2.7). This indicates that the area of spread of boarfish within the surveyed area has increased during the period.

For subsequent surplus production modelling (see Section 6.6.2), biomass indices were extracted from each of the IBTS surveys using a delta-lognormal model (Stefánsson, 1996). Many of the surveys exhibited a large proportion of zero tows (Figure 6.3.2.8) with occasionally very large tows, hence the decision to explicitly model the probability of a non-zero tow and the mean of the positive tows. A delta-lognormal fit comprises fitting two generalized linear models (GLMs). The first model (binomial GLM) is used to obtain the proportion of non-zero tows and is fit to the data coded as 1 or 0 if the tow contained a positive or zero CPUE, respectively. The second model is fit to the positive only CPUE data using a lognormal GLM. Both GLMs were fit using ICES rectangle and year as explanatory factor variables. Where the number of tows per rectangle was less than 5 over the entire series, they are grouped into an “others” rectangle. An index per rectangle and year is constructed, according to Stefánsson (1996), by the product of the estimated probability of a positive tow times the mean of the positive tows. The station indices are aggregated by taking estimated average across all rectangles within a year. To propagate the uncertainty, all survey index analyses were conducted in a Bayesian framework using MCMC sampling in WinBUGS (Spiegelhalter *et al.*, 2004; Kéry, 2010).

6.3.3 Other Acoustic Surveys

In the Bay of Biscay two coordinated acoustic surveys take place in spring each year: PELGAS (Ifremer-France) and PELACUS (IEO-Spain).

PELACUS 0315 was carried out on board R/V Miguel Oliver from the 13th of March to the 16th of April 2015. The methodology was similar to that of the previous surveys (see Carrera and Riveiro, WD for further details). Analysis of boar fish distributed in the Spanish waters of the Bay of Biscay resulted in a remarkable decrease from c. 25 000 t estimated in 2014 to only 4 000 t estimated this year (Figure 6.3.3.1), the lowest value of the time series since 2002. Pelagic trawl hauls are routinely conducted for NASC allocation. It is noticeable that no boarfish were ever captured south of Fisterra (43ºN). At this point the water mass from the north, the subpolar ENACW mode, and the southern one, the subtropical mode of ENACW, divide the region and could explain the lack of boarfish south of Fisterra.

6.4 Mean weights-at-age, maturity-at-age and natural mortality

Mean weight-at-age was obtained from the ageing studies of Hüssy *et al*. (2012b). These mean weights are presented in the text table below. The variation in weight-at-age is due to small sample size and seasonal variation in weight and maturity stage.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MW g	0.84	6.65	14.65	19.49	23.71	26.75	33.29	37.73	40.03	47.11	50.24	51.16	62.75	56.44	62.25
Age	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
MW g	68.86	50.52	86.69	77.94	64.56	63.52	75.02	86.05	71.01	76.97	84.42	79.38	-	67.60	52.77

Maturity-at-age was obtained from the ageing studies of Hüssy *et al*. (2012a; 2012b) and the reproductive study by Farrell *et al*. (2012).

Age	0	1	2	3	4	5	6+
Prop mature	0	0	0.07	0.25	0.81	0.97	1

Natural mortality (M) was estimated over the life span of the stock using the method described by King (1995). This method assumes that M is the mortality that will reduce a population to 1% of its initial size over the lifespan of the stock. Based on a maximum age of 31, M is calculated as follows:

$$M = -\ln(0.01) / 31$$

Following this procedure M = 0.16 year^{-1}. M=0.16 is considered a good estimate of natural mortality over the life span of this boarfish stock, as it is similar to the total mortality estimate from 2007, (Z= 0.19, see Section 6.6.3). Given that catches in 2007 were relatively low, this estimate of total mortality might be considered a good estimate of natural mortality, assuming negligible fishing mortality in previous years.

Similarly, total mortality was estimated from age-structured IBTS data from 2003 to - 2006 (years from which data was available for all areas). The total mortality may be considered a good estimate of natural mortality as fishing mortality was assumed to be negligible during this period. Total mortality ranged from 0.09 – 0.2 with a mean of 0.16.

The special review of Chapter 6, in 2012, questioned the validity of a single estimate of M across the entire age range. If an age based assessment is possible in the future, age specific estimates of natural mortality are required. However, the current estimate of M, which covers the whole age range, is considered appropriate in the context of the current situation where age data are used as an indicator approach, rather than as a full assessment method. Given that Z and F are also calculated over the entire (fully selected) range (Section 6.6.3) a single value of M is considered appropriate.

Maturity-at-age was obtained from the ageing studies of Hüssy *et al*. (2012a; 2012b) and the reproductive study by Farrell *et al*. (2012).

Age	0	1	2	3	4	5	6+
Prop mature	0	0	0.07	0.25	0.81	0.97	1

Natural mortality (M) was estimated over the life span of the stock using the method described by King (1995). This method assumes that M is the mortality that will reduce a population to 1% of its initial size over the lifespan of the stock. Based on a maximum age of 31, M is calculated as follows:

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6.5 Recruitment

The IBTS data were explored as indices of abundance of 1 year olds, and 1-5 year olds as a composite recruitment index (Figures 6.5.1 & 6.5.2). The EVHOE and SPNGFS surveys provide the best indices of recruitment as this is where the juveniles appear to be most abundant (Table 6.3.2.2). It appears that recruitment was high in the late 1990s but declined to a low in 2003, before increasing again. However, this apparent dip in recruitment was not observed in the commercial catch-at-age data (Figure 6.2.1.1). Recruitment, particularly age 1 in SPNGFS and IGFS 2014, has declined since 2010.

6.6 Exploratory Assessment

In 2012, a new stock assessment method was tested. In 2013 this Bayesian state space surplus production model (BSP; Meyer and Millar 1999) was further developed following reviewers recommendations in 2012. Different applications of a Bayesian biomass dynamic model were run in 2013 incorporating combinations of catch data, abundance data from the groundfish surveys, and estimates of biomass (and associated uncertainty) from the acoustic surveys (see stock annex for more details of the sensitivity runs). The model and settings from the final accepted run in 2013 were used as the basis of ICES category 1 advice for catch in 2014. However, in 2014 there was concern about the use of the production model for a number of reasons (see Section 6.6.5) and ICES therefore considered this model as no longer suitable for providing category 1 advice. The model is still considered suitable for category 3 advice and for determining that the exploitation rate has risen in recent years. This year, as in 2014, the exploratory assessment model was used as a basis for trends for providing DLS advice (ICES category 3). ICES considers the current basis for the advice on this stock to be an interim measure prior to development of an age-based assessment.

Further development was undertaken in 2015 to address the concerns surrounding the model; this is presented below.

6.6.1 Historical literature sources

In the Northeast Atlantic region it is suggested that boarfish have historically undergone fluctuations in abundance. It should be noted that these apparent fluctuations in abundance occurred during periods when fisheries and fishery independent sampling were less widespread that the present day. The primary distribution areas of boarfish, on the Celtic Sea shelf in winter and along the shelf edge in summer, were rarely if ever sampled during this time. Therefore, the observations of peaks in abundance are only related to inshore areas. There is no evidence that boarfish were not also abundant in offshore waters throughout these periods. A literature review of historical sources suggests increases in abundance in the following periods:

- 1840s to 1880s
- 1950s
- Mid 1980s to 1990s

From the 1840s to 1880s large abundances were periodically observed in the western English Channel (Day, 1880–1884; Couch, 1844; Cunningham, 1888). Gatcombe, writing in 1879, stated that they had become an extreme nuisance in trawl fisheries. In the early 1900s boarfish were noted for their sporadic occurrence in the English Channel and were scarce or absent for many years in the area around Plymouth where they had previously been abundant (Cooper, 1952). In the mid 1900s there was another apparent increase in abundance in the English Channel, which Cooper (1952) hypothesised was caused by a ‘submarine eagre’ that swept shoals of boarfish from submarine canyons in the southern edge of the Celtic Sea onto the continental shelf. There was no sound basis for this untested hypothesis and it is at odds with more reliable survey and fisheries data which indicates boarfish are a shelf species, which migrate to the shelf edge for spawning (see below).

Increases in abundance were observed in the Bay of Biscay, Galician continental shelf waters and the Celtic Sea between the 1980s and 2000 (Farina et al., 1997; Pinnegar *et al*., 2002; Blanchard and Vandermeirsch, 2005). Based on EVHOE data the relative abundance in the Bay of Biscay was reported to have increased from 0.3% in 1973 to 16% in 2000 resulting in boarfish becoming one of the dominant species in the fish community in this region (Blanchard and Vandermeirsch, 2005).

Based on the above information the external reviewers in 2012 noted the possibility that boarfish was a deep-water species that had undergone a shoreward range extension onto the shelf in the late 1980’s. In 2013 this was deemed not to be the case; see stock annex for full descriptions of both arguments.

6.6.2 IBTS Data

The common ALK (Table 6.2.1.5) was applied to the number-at-length data. The length-frequency is presented in Table 6.3.2.2 and the age-structured index in Table 6.6.2.1 and Figure 6.6.2.1. A cohort effect can be seen with those cohorts from the early 2000s appearing weak. This coincides with a decline in overall abundance in the early 2000s. From the mid 2000s onwards recruitment improved as observed in the abundance of 1-5 year olds in the EVHOE and Spanish northern shelf surveys (see section

6.5 and Figures 6.5.1 & 6.5.2). It should be noted however that the IBTS data is measured to the 1.0cm not the 0.5cm. Therefore application of the common ALK to this data must be viewed with caution.

Some of the IBTS CPUE indices displayed marked variability with a large proportion of zero tows and occasionally very large tows (e.g., West of Scotland survey, Figure 6.3.2.8). More southern surveys displayed a consistently higher proportion of positive tows (Figure 6.3.2.8). The variability of the data is reflected in the estimated mean CPUE indices (Figure 6.6.2.2). The West of Scotland survey index had been increasing since 2000 but was highly uncertain, whereas the estimated indices from the other series are typically less variable (Figure 6.6.2.2). In 2014 four of the five current bottom trawl surveys experienced a sharp decline in CPUE, particularly the West of Scotland, the Spanish North Coast, the Spanish Porcupine and Irish Groundfish surveys. The latest EVHOE CPUE showed a slight decline on 2013. The CEFAS English Celtic Sea Groundfish Survey displays a steady increase from the mid-1980s to 2002 with a large but somewhat uncertain estimate in 2003 (Figures 6.6.2.2 and 6.6.2.3). The spatial extent of each survey is shown in Figures 6.3.2.1.

Diagnostics from the positive component of the delta-lognormal fits indicate relatively good agreement with a normal distribution on the natural logarithmic scale (Figure 6.6.2.4). There is an indication of longer tails in some of the surveys (e.g., WCSGFS, SPPGFS).

Pair-wise correlation between the annual mean survey indices varied. The IGFS, EVHOE and SPNGFS displayed positive correlation (Figure 6.6.2.5). The WCSGFS also displayed positive correlation with most other surveys except for a weakly negative correlation with the SPNGFS survey. The SPPGFS and ECSFS displayed slightly negative correlations with EVHOE (Figure 6.6.2.5). Weighting the correlations by the sum of the pair-wise variances resulted in a largely similar correlation structure, though the WCSGFS and SPPGFS were more strongly correlated with the ECSGFS (Figure 6.6.2.6). Note that though some surveys displayed weak or no correlation, we did not a-priori exclude any surveys from the assessment. Sensitivity tests were conducted in 2013, which led to the exclusion of certain surveys as explained in the section 6.6.5.

6.6.3 Pseudo-cohort Analysis

Pseudo-cohort analysis is a procedure where mortality is calculated by means of catch curves derived from catch-at-age from a single year. This is in contrast to cohort analysis, which is the basis of VPA-type assessments. In cohort analysis, mortality is calculated across the ages of a year class, not within a single year. Because only seven years of sampling data were available and owing to the large age range currently in the catches a cohort analysis would only yield information for a very limited age and year range. Therefore, pseudo-cohort analysis was performed to supplement the Bayesian state space model.

Pseudo-cohort Z estimates increased with the rapid expansion of the fishery but decreased in 2011 due to the introduction of the first boarfish TAC (Table 6.6.3.1). By subtracting M (=0.16), an estimate of F was obtained for each year (ages 7-14). This series was revised to represent ages 7-14, rather than 6-14 as in previous years, because in 2013 age 6 boarfish were not fully selected, i.e. age 7 had higher abundance at age.

It can be seen from the text table below that $Z \approx M$ in 2007, the initial year of the expanded fishery, while F is negligible. F increased to a high of 0.26 in 2012 and has reduced to 0.18 in 2014. There was a weak correlation between catches and pseudo-cohort F ($r^2 = 0.50$). Recent F estimated in this way is above F_{MSY} (0.17) and $F_{0.1}$ (0.13).

Year	Z (7–14)	F (Z–M)	Catch (t)
2007	0.18	0.02	21 576
2008	0.32	0.16	34 751
2009	0.32	0.16	90 370
2010	0.32	0.16	144 047
2011	0.28	0.12	37 096
2012	0.42	0.26	87 355
2013	0.35	0.19	75 409
2014	0.34	0.18	45 231

6.6.4 Biomass estimates from acoustic surveys

The Boarfish Acoustic Survey (BFAS) series was initiated in July 2011 and is now in its fifth year. Due to the change in survey protocol between the 2011 and 2012 acoustic surveys, the 2011 survey was not directly comparable with the others because data was collected during both day and night (24hrs). For this year's assessment the 2011 acoustic estimate has been reworked to match all subsequent years by excluding acoustic data between the hours of 00:00 and 04:00. The revised modelled TS of -66.2dB (Fässler *et al.*, 2013; O'Donnell, 2013) was applied to the 2011 and 2012 BFAS data to produce a new biomass estimate comparable to subsequent years (Table 6.6.4.1). Therefore all five acoustic surveys are now suitable for inclusion in the assessment model: 2011-2015 (Table 6.6.4.1). Over the five years of the survey biomass has been estimated in the range 187,779 t (2014) to 863 446 t (2012). The precision on the estimates has been good, with coefficients of variation in the range 10.7 to 16.7 (with the exception of the reworked 2011 biomass estimate, which had a CV of 24.2 due to the omitted hours). The 2014 survey biomass estimate of 187,779 t was 57% lower than that in 2013. There was concern that this low estimate could have been an outlier and it did cause some problems for the Bayesian model (see 'Review' this section) but the 2015 acoustic biomass estimate of 232 634 t supports the validity of the 2014 estimate. In all model runs the '*Total*' estimate of boarfish biomass was used for all years; see section 6.3.1 for more details and an explanation of the reported categories.

It should be noted that two acoustic surveys are conducted annually to the south of the southern limit of the dedicated BFAS. In 2014 the PELACUS survey recorded a sharp decline in the biomass of boarfish observed (see Section 6.3.3).

6.6.5 Biomass dynamic model

In 2012 an exploratory biomass dynamic model was developed. This was a Bayesian state space surplus production model (Meyer and Millar, 1999), incorporating the catch data, IBTS data, and acoustic biomass data. This assessment was then peer-reviewed by two independent experts on behalf of ICES. In 2013 a new assessment was provided, which was based on the previous year's work and the reviewers' comments and formed the basis of a category 1 assessment. Details of the review and the associated changes can be found in the stock annex.

In 2014 the Bayesian state space surplus production model was again fit using the catch data, delta-lognormal estimated IBTS survey indices, and the acoustic survey estimates. However, the inclusion of the low 2014 acoustic biomass estimate changed the perception on the stock, which raised concerns over the sensitivity and process error of the model (see 'Review' this section for more details). The stock was moved from a category 1 assessment to a category 3 with the results of the surplus production model being used to calculate an index for the data limited stock approach.

In 2015 the model was again run using the same procedure as last year with updated catch and survey data. Details of this exploratory run, which will again be used to calculate the DLS index, are described below. Further model development work was also undertaken in 2015 and this is presented in section 6.7.

In the Bayesian state space surplus production model the biomass dynamics are given by a difference form of a Schaefer biomass dynamic model:

$$B_t = B_{t-1} + rB_{t-1}\left(1 - \frac{B_{t-1}}{K}\right) - C_{t-1}$$

where B_t is the biomass at time t, r is the intrinsic rate of population growth, K is the carrying capacity, and C_t is the catch, assumed known exactly. To assist the estimation the biomass is scaled by the carrying capacity, denoting the scaled biomass $P_t = B_t/K$. Lognormal error structure is assumed giving the scaled biomass dynamics (process) model:

$$P_t = \left(P_{t-1} + rP_{t-1}(1 - P_{t-1}) - \frac{C_{t-1}}{K}\right)e^{u_t}$$

where the logarithm of process deviations are assumed normal $u_t \sim \mathrm{N}(0, \sigma_u^2)$; with σ_u^2 the process error variance.

The starting year biomass is given by aK, where α is the proportion of the carrying capacity in the first year. The biomass dynamics process is related to the observations on the indices through the measurement error equation:

$$I_{j,t} = q_j P_t K e^{\varepsilon_{j,t}}$$

where $I_{j,t}$ is the value of abundance index j in year t, q_j is survey-specific catchability, $B_t = P_t K$, and the measurement errors are assumed lognormally distributed with ; $\varepsilon_t \sim \mathrm{N}(0, \sigma_{\varepsilon,j,t}^2)$; where $\sigma_{\varepsilon,j,t}^2$ is the index-specific measurement error variance $\mathrm{Var}(I_{j,t})$ is obtained from the delta-lognormal survey fits. That is, the variance of the mean annual estimate per survey is inputted directly from the delta-lognormal fits (Figure 6.6.2.2) as opposed to estimating a measurement error within the assessment. The measurement error is obtained from:

$$\sigma_{\varepsilon,j,t}^2 = \ln\left(1 + \frac{\mathrm{Var}(I_{j,t})}{(I_{j,t})^2}\right)$$

For the acoustic survey, the CV of the survey was transformed into a lognormal variance via

$$\sigma_{\varepsilon,acoustic,t}^2 = \ln\left(CV_{acoustic,t}^2 + 1\right).$$

Prior assumptions on the parameter distributions were:

- Intrinsic rate of population growth: $r \sim$ U(0.001,2)
- Natural logarithm of the carrying capacity ln $K \sim U$(ln max(C), ln 10xsum C)=U(ln 144,047t, ln 4,450,407t)
- Proportion of carrying capacity in first year of assessment: $a \sim$ U(0.001, 1.0)

- Natural logarithm of the survey-specific catchabilities ln q_i ~ U(-16,0) (for IBTS only). Acoustic survey is discussed below when separate runs are described.

Process error precision $1/\sigma_u^2$ ~Gamma(0.001,0.001)

Specifications

During the 2013 WGWIDE meeting a number of different iterations of the model were run to discern the best parameters for the assessment. After four initial runs and four sensitivity runs the settings for the final run (run 2.2) were chosen. These settings are shown below and were used for the assessment model in 2014 and 2015. (More details of the trial runs in 2013 can be found in the stock annex.)

Specifications for final 2013, 2014, and 2015 boarfish assessment model; $q_{acoustic}$ is the catchability of the acoustic survey, $I_{acoustic}$ is the acoustic index value used:

Acoustic survey

Years: 2011-2015

$I_{acoustic,year}$: 'Total' in tonnes (i.e. Definitely Boarfish + Probably Boarfish + Boarfish in a Mix)

$q_{acoustic}$: Free but strong prior (i.e. the acoustic survey is treated as a relative index but is strongly informed, this allows the survey to cover <100% of the stock)

IBTS surveys

6 delta log normal indices (WCSGFS, SPPGFS, IGFS, ECSGFS, SPNGFS, EVHOE)

First 5 years omitted from WCSGFS

First 9 years omitted from ECSGFS

Discards

Average of 2004-2014 (5888t)

The final run assumes a strong prior ln $q_{acoustic}$ ~ N(1,1/4) (standard deviation of 1/4), which has 95% of the density between 0.5 and 2. Given the short acoustic series (5 years) it is not possible to estimate this parameter freely (using an uninformative prior) but assuming a strong prior removes the assumption of an absolute index from the acoustic survey and will be continually updated as data accrue.

Following plenary discussion of the sensitivity runs in 2013, it was decided that the final run be based on a run that includes all surveys with the omission of the first 5 years of the WCSGFS and first 9 years of the ECSGFS. The reasons for this decision were:

- It is unclear whether boarfish were consistently recorded in the early part of the ECSGFS
- The WCSGFS is thought to be at the northern extreme of the distribution and may not be an appropriate index for the whole stock.
- The SPNGFS commences in 1991 such that running the assessment from 1991 onwards includes at least three surveys without relying solely on the ECSGFS and WCSGFS.
- Surveys are internally weighted such that highly uncertain values receive lower weight.

Run convergence

Parameters for the 2014 model run converged with good mixing of the chains and Rhat values lower than 1.1 indicating convergence (Figures 6.6.5.1, 6.6.5.2). MCMC chain autocorrelation was also low indicating good sampling of the parameter posteriors (Figures 6.6.5.3).

Diagnostic plots are provided in Figures 6.6.5.4 showing residuals about the model fit. A fairly balanced residual pattern is evident. In some cases outliers are apparent, for instance in the English survey in the final year (2003). However, these points are down-weighted according to the inverse of their variance and hence do not contribute much to the model fit. The west of Scotland IBTS survey, located at the northern extreme of the stock distribution underestimates the stock in the early period (years) and overestimates it in the recent period from all fits. This could be indicative of stock expansion into this area at higher stock sizes and suggests that this index is not representative of the whole stock. Figure 6.6.5.5 shows the prior and posterior distributions of the parameters of the biomass dynamic model. The estimate of q is less than 1.0, leading to a higher estimate of final stock biomass than the acoustic survey.

Results

Trajectories of observed and expected indices are shown in Figure 6.6.5.6, along with the stock size over time and a harvest ratio (total catch divided by estimated biomass). Parameter estimates from the model run are summarized in Table 6.6.5.1. F_{MSY} has been recalculated by the model (r/2) as 0.175, down from 0.23 in 2013. Biomass in 2015 is estimated to be 301 415 t, a decrease on the 2013 estimate of 653 668 t but a slight increase from that in 2014 (261 003 t). Retrospective plots of TSB and F, presented in Figure 6.6.5.7, show that the perception of the stock is in general agreement with the perception in 2014, but not that of 2013 prior to the inclusion of the low biomass estimate of the 2014 and 2015 acoustic surveys. As the acoustic survey does not span the entire range of the stock, assuming its catchability and treating it as an absolute index is likely incorrect, hence the decision to use a strong prior on the acoustic survey catchability in 2013. A free but strong prior (i.e. the acoustic survey is treated as a relative index but is strongly informed) allows the survey to cover <100% of the stock.

Review

ADGWIDE 2014 provided feedback on its concerns about the Bayesian model and why it was no longer considered suitable for category 1 advice. Details are available in the minutes of the advice drafting group 2014. The working group provides feedback on these comments below:

ADGWIDE Comment	Response
Dramatic decline in the biomass for 2014. Driven by one low acoustic estimates only. Is that possible for a lond lived species while F has been constantly under F_{lim} ?	The low acoustic data in 2014 is confirmed by low 2015 acoustic data as well as by low data for 2014 in the two Spanish surveys. The steep decline in biomass estimated last year thus appears credible.
Process error appeared to increase dramatically during the last years. It may be that a better model would bound the process error to be equivalent to earlier stable part of time series	The model process error is set in the lognormal scale to insure positive biomss estimates. As a consequence the higher the biomass the higher the unncertainty. No real strong reason support challenging the current strccture of the Bayesian state space model structure. It is worth noting that the standard deviation of the process model decreased by about 10 % with the addition of new data.
The ADG propose to reduce the weight of the 2014 points	As there is concern about the sensitivity of the model to acoustic data, a senstivity analysis was performed based on the relaxation of the CVs around the mean acoustic survey biomass estimates. Details are provided in Section 6.7. Relaxing the CVs around the acoustic estimates tended to result in higher biomass particularly in the terminal year, with estimates in 2015 being more in line with the period 2005 – 2010 before the very high observations of 2010-2013.

6.6.6 State of the stock

According to the latest exploratory assessment, total stock biomass appeared to increase from low levels from the early to mid 1990s (Figure 6.6.5.6). The stock fluctuated around this level until 2009. Biomass then greatly increased to a new level in 2010 and fluctuated around this elevated level until 2012. Since 2012 there has been a sharp decline in the estimated total stock biomass of boarfish in the North East Atlantic. The initial concern in 2014 was that this decline was unrealistically exaggerated by an unusually low acoustic biomass estimate. This low 2014 acoustic estimate caused a considerable downward revision in the surplus production model. However, the comparably low biomass estimate from the latest boarfish acoustic survey (2015) support this revision and indeed the retrospective plots demonstrate substantial agreement between the 2014 and 2015 exploratory assessments. TSB in 2015 (301 415) is still considerably higher than the proposed B_{lim} but is again below the proposed MSY $B_{trigger}$ (Table 6.6.5.1; see section 6.9 for further information on reference points). The uncertainty surrounding the estimates of biomass in the final year are not as high as previous years but there is still a wide 95% credible interval (Table 6.6.5.2), this reflects the uncertainty in the survey indices, and short exploitation history of the stock and the fact that we treat the acoustic survey as a relative biomass index. As more data accumulates from this survey, we expect that the prior will become increasingly updated, and potentially less variable. Reflective of the uncertainty, short-term forecasts are presented with associated probabilities of crossing reference points for given levels of fishing mortality (see Section 6.7).

Catch data are available from 2001, the first year of commercial landings, and reasonably comprehensive discard data are available from 2003. Peak catches were recorded in 2010, when over 140 000 t were taken. Elevated fishing mortality was observed, associated with the highest recorded catch in 2010. Fishing mortality, expressed as a harvest ratio (catch divided by total biomass), was first recorded in 2003. Before that time, it is to be expected that some discarding took place, and there were some commercial landings. Fishing mortality increased measurably from 2006, reaching a peak in 2009 - 2010. F declined in 2011 as catches became regulated by the precautionary TAC but has increased year on year since then. In 2014 F was estimated to be just below F_{msy}. The considerable catches in recent years do not appear to have significantly truncated the size or age structure of the stock and 15+ group fish are still abundant (Figure 6.2.1.1).

Estimates of recruitment are not available from the stock assessment. However, an independent index of recruitment is available from groundfish surveys (Section 6.5). Observations from the survey recruitment of 1 year olds show strong negative trends since 2010 (Figure 6.5.1) and a weaker, but still negative, trend for ages 1-5 combined (Figure 6.5.2).

6.7 Short term projections and exploratory runs

6.7.1 Short term projections

As the surplus production model is no longer accepted as the basis of a category 1 assessment, the projections presented in this section are for comparative purposes only and will not form the basis of ICES advice for 2016.

A short term forecast was performed by projecting the model run forward by one year. However, as there is no recruitment estimate it is not possible to construct a traditional style catch forecast for management purposes. Instead, short term projections over a range of fishing mortality and catch options are provided on a risk based approach. An intermediate year catch constraint was applied (2015 TAC: 53 296 t). The population is then projected forward within the assessment under a range of management objectives that included the yield at:

- F_{MSY} = 0.175 based on $r/2$ from model run (Table 6.6.5.1)
- $F_{MP} = B_{2015}\ (F_{MSY}\ /\ B_{trigger}) = 0.129$
- $F_{ICES\ HCR} = B_{2015}\ (F_{MSY}\ /\ B_{trigger}) = 0.132$
- $F_{0.1}$ = 0.13 based on yield-per-recruit analysis
- F_{lim} = 0.274 based on the F associated with a long-term biomass of $K/5$ (0.2 carrying capacity used for B_{lim})
- F_{pa} = exp(-1.645*CV(TSB_{2015}))*F_{lim} = 0.152
- C_{2015} = 0 (zero catch option)
- C_{2016} = C_{2014}

Where F_{MP} is the F according to Rule 1.1b in the proposed management plan 2012, not the revised management plan of 2015 (section 6.15) and $F_{ICES\ HCR}$ is the reduced F according to the generic ICES harvest control rules for category 1 stocks, not DLS.

A forward projection on the risk of the stock falling below B_{msy} ($B_{trigger}$), B_{lim} and fishing mortality exceeding F_{lim} are estimated. Fishing mortality for the fixed catch projections is calculated as -ln(1-C_{2016}/TSB_{2016}). Catch options are presented in Table 6.7.1.1.

Given that F (0.174) is below F_{MSY} (0.175) but mean total stock biomass in 2015 (301 415 t) is less than MSY $B_{trigger}$ (347 889 t) but greater than B_{lim} (139 155 t) (Tables 6.6.5.1 and 6.6.5.2; section 6.9 for reference points), fishing at a reduced F would be required if this were a full category 1 assessment. This reduced F is calculated as B_{2015} (F_{MSY} / $B_{trigger}$) and is consistent with the ICES MSY approach. It results in an advised catch of 38 026 t for 2016. There is a high level of uncertainty associated with this F and a wide 95% CI for the biomass in 2017, which is reflected in a 11.4% probability of falling below B_{lim} in 2017 (Table 6.7.1.1). Fishing at $F_{pa,}$ which is coincidentally very close to the advised catch based on the DLS approach, produces a very similar probability or falling below B_{lim}, 11.7%. However, we note that the probability of dropping below B_{lim} even at zero catch is 9.5%, again reflecting the uncertainty of the biomass trajectory.

6.7.2 Exploratory runs

In 2014, ADGWIDE expressed concerns about the current model being too sensitive to the acoustic data. One solution to relax the influence of the acoustic survey, other than revisiting the previously addressed concerns about the priors used, is to assume that uncertainty around point estimates derived from the acoustic survey are overly precise. Indeed, they are far narrower than those derived from the bottom trawl surveys.

In the current assessment model, the acoustic data are entered in the observation layer using the following equation:

$$I_{j,t} = q_j P_t K e^{\varepsilon_{j,t}}$$

Here we expressed the error term linked to acoustic data ($\varepsilon_{j,t}$) as a coefficient of variation ($CV_{j,t}$) around the mean value ($I_{j,t}$). Then, to relax the influence of acoustic data, we multiplied $CV_{j,t}$ by a correction factor α. To illustrate the sensitivity of the model to this new parameter, and thus to acoustic data, we performed a simulation study making α vary from 1 (base scenario presented above) up to 3 (very relaxed).

As seen on figures 6.7.2.1 and 6.7.2.2, relaxing the acoustic data CVs leads to an increase in the biomass estimate, both historically and forecasted. In addition, the drop observed in 2014 tends to be buffered and the estimates are more in line with biomass estimates in the 2000 – 2004 period instead of being lower that all estimates over the last 20 years.

As a consequence, fisheries mortality reference points tend to raise with parameter α (Table 6.7.2.1). Together with increased biomass, this led to increased forecasted catch for 2016 (Table 6.7.2.1). The same occurs with forecasted biomasses and expected catch in 2017. Nonetheless, the relationship between α and the management references point is not fully linear, because relaxing acoustic data does not have exactly the same impact on the way the model relies on each bottom trawl survey data, and has to be scrutinized with care.

6.7.3 Yield per Recruit

A yield per recruit analysis was conducted in 2011 (Minto *et al.*, WD 2011) and $F_{0.1}$ was estimated to be 0.13 whilst F_{max} was estimated in the range 0.23 to 0.33 (Figure 6.7.3.1). $F_{0.1}$ was considered to be well estimated (Figure 6.7.3.2). No new yield per recruit analyses were performed in subsequent years.

6.8 Long term simulations

No long term simulations were conducted.

6.9 Candidate precautionary and yield based reference points

6.9.1 Precautionary reference points

It does not appear that boarfish is an important prey species in the NE Atlantic (Section 6.12). ICES (1997) considered that precautionary F targets (F_{pa}) should be consistent with F<M for prey species, and F = M for non-prey species. This approach would ensure that fishing does not out-compete natural predators for their prey. This would suggest that a good candidate precautionary F_{pa} is $F = M = 0.16y^{-1}$. This is considered appropriate because boarfish is not an important prey in the NE Atlantic. B_{lim} may be defined from the stock size estimates available from the stock assessment. It is proposed that B_{lim} be set at 0.2* *K*, (0.2 * 695 778 t = 139 155 t), based on the results of model run (Table 6.6.5.1).

6.9.2 Yield based reference points

Yield per recruit analysis, following the method of Beverton and Holt (1957), found $F_{0.1}$ to be robustly estimated at 0.13 (ICES WGWIDE, 2011; Minto et al., WD 2011).

An estimate of F_{msy} is available from the stock assessment model as 0.175.

An estimate of B_{msy} is available from stock assessment model (347 889 t). This is proposed as a conservative basis for MSY $B_{trigger}$.

It should be noted that these values have changed slightly since 2014. The new value is output from the surplus production model, which has revised the perception of the stock after the inclusion of the latest data.

6.10 Quality of the Assessment

ICES considers the current basis for the advice on this stock to be an interim measure prior to development of an age-based assessment. In 2013 the advice was based on the surplus production model as a category 1 assessment whereas in 2014 the exploratory assessment model was used as a basis for trends for providing DLS advice. This was due to concerns about the use of the production model for three reasons: with the short exploitation history of this stock a production model may not describe the stock dynamics well; the current model is relying too heavily on the very short time series of the acoustic survey (3 years in 2014, although 5 years are now available); and investigations of the model showed that that uncertainty is not handled consistently. The model gave a rapid increase in uncertainty during the previous two years (2012-2013) as it followed the acoustic survey too closely, leading to potential over estimation of decline in TSB and also gave inconsistent estimates of exploitation rate in the previous two years. ICES therefore considered that this model was no longer suitable for providing category 1 advice and further model development is required. The model is still considered suitable for category 3 advice. Additional work to improve the surplus production model was undertaken in 2015 (Section 6.7.2) and will continue into 2016.

The bottom trawl survey data are considered to be a good index of abundance given that boarfish aggregate on the bottom at this time of year. The trawl surveys record high abundances of the species, but with many zero hauls. The delta-log normal error structure used in the analyses is considered to be a good means of dealing with such data. The biomass dynamic model used in the stock assessment is based on the recent Benchmark of megrim in Sub-divisions IV and VI. The model was further developed by including acoustic survey biomass estimates. One drawback of the model is that it does not provide estimates of recruitment. However, an estimate of recruitment strength is available from the Spanish and French trawl surveys.

6.11 Management Considerations

As this stock is now placed in category 3, the ICES advice for 2016 will be based on harvest control rules for data limited stocks (ICES, 2012). Since the biomass estimate from the Bayesian model is considered reliable for trend based assessment, an index can be calculated according to Method 3.1 of ICES (2012). The advice is based on a comparison of the average of the two most recent index values with the average of the three preceding values multiplied by the most recent catch. Table 6.6.5.2. shows the biomass estimates from the model from which the index was calculated. The index for 2015 equals 0.398. When multiplied by the most recent catch (45 231 t) this would give an advised catch for 2016 of 18 014 t. However, this would represent a decrease in the advised catch of over 20% from 2015 to 2016. Therefore the uncertainty cap or change limit should be enforced. The advised catch for 2016 is therefore 42 637 t, 20% less than that advised for 2015. Reference points are not defined but are inferred within the exploratory assessment. The precautionary buffer was not applied as the stock is within these candidate precautionary reference points, although biomass is thought to be below the proposed MSY $B_{trigger}$.

Although no longer accepted as the basis for an analytic assessment, the surplus production model still provides the best unified view of this stock (Figure 6.6.5.6). Stock size in 2015 is estimated to be 301 415 t, though at this stage of the development of the assessment absolute estimates of stock size are uncertain. Trends in abundance over time indicate that the stock has increased from very low levels in the 1980s, to high levels in the 1990s. It declined somewhat in the early 2000s and recruitment weakened. The stock increased again in 2010 but has sharply declined since 2012. Total stock biomass in 2015 is below the proposed MSY $B_{trigger}$ but well above the propsed B_{lim} (see Section 6.9). Fishing mortality is estimated to have increased from a negligible rate in 2007 to a peak of 0.224 in 2010. After a sharp reduction in 2011 it has increased over the last three years and was estimated at 0.174 in 2014. This is almost equal to the proposed F_{MSY} (0.175). The large reduction in catch, resulting from the 2011 TAC (75% decrease in landings from 2010) reduced F considerably.

The management plan, proposed by the Pelagic RAC in 2012 and revised in 2015, has not yet been fully evaluated by ICES (see Section 6.15). Though the ICES advice for 2015 will be based on the ICES DLS harvest control rules, the WG provides a catch option based on projections of the exploratory Bayesian surplus production model for comparison. Applying F_{pa} implies catches in 2016 that are just 1.5% higher than that obtained by following the ICES category 3 HCR outlined above. In order to be faithful to the precautionary approach and FAO guidelines on new and developing fisheries, it is appropriate to obey the signals from the assessment and other indicators and to reduce the catch.

6.12 Stock Structure

A dedicated study on the stock structure of boarfish within the Northeast Atlantic and Mediterranean Sea commenced in October 2013 in order to resolve outstanding questions regarding the stock structure of boarfish and the suitability of assessment data. Specifically the project aimed to;

(1) Test the hypothesis that the current stock unit's distribution limits (TAC area) are congruent with the genetic population structure of the stock.

(2) Investigate if there is fine-scale population structure (spatial or temporal) within the current TAC area.

(3) Determine if the changes in abundance of boarfish are the result of immigration from other stocks?

Twenty samples, totalling 960 individual boarfish (40-52 individuals per sample) were collected from across the species' distribution range from 2010 to 2014 from fisheries surveys (Figure 6.12.2). Novel genetic methods utilising next generation sequencing were developed to identify species-specific polymorphic microsatellite loci and to screen samples following a genotyping-by-sequencing approach (see Farrell et al., 2015; WD to WGWIDE 2015). Preliminary analyses of results (detailed in Farrell et al., 2015) based on the genotyping of all samples at twenty-nine microsatellite markers indicated strong population structure across the distribution range of boarfish with four or five distinct populations identified (Figures 6.12.1-6.12.4). No significant spatial or temporal population structure was found within the current TAC area. The current TAC area constitutes the majority of the most northern population (Figures 6.12.2-6.12.4), however this population extends into northern Portuguese waters. Based on analyses of IBTS data (see ICES, 2013) the biomass in this area is suspected to be small relative to the overall biomass in the TAC area. There is no evidence of significant immigration to or emigration from the TAC area from populations to the south or from oceanic waters. Further analyses are underway to quantify the connectivity between adjacent populations.

6.13 Ecosystem considerations

The ecological role and significance of boarfish in the NE Atlantic is largely unknown. However, in the south-east North Atlantic, in Portuguese waters, they are considered to have an important position in the marine food web (Lopes *et al.*, 2006). The diet has been investigated in the eastern Mediterranean, Portuguese waters and at Great Meteor Seamount and consists primarily of copepods, specifically *Calanus helgolandicus*, with some mysid shrimp and euphausiids (MacPherson, 1979; Fock *et al.*, 2002; Lopes *et al.*, 2006). This contrasted with the morphologically similar species, the slender snipefish, *Macroramphosus gracilis* and the longspine snipefish, *M. scolopax*, whose diet comprised *Temora* spp., copepods and mysid shrimps, respectively (Lopes *et al.*, 2006). Despite the obvious potential for these species to feed on fish eggs and larvae, there was no evidence to support this conclusion in Portuguese waters and they were not considered predators of commercial fishes and thus their increase in abundance was unlikely to affect recruitment of commercial fish species (Lopes *et al.*, 2006). If the NE Atlantic population of boarfish is sufficiently large then there exists the possibility of competition for food with other widely distributed planktivorous species.

Both seasonal and diurnal variations were observed in the diet of boarfish in all three regions. In the eastern Mediterranean and Portuguese waters, mysids become an important component of the diet in autumn, which correlates with their increased abundance in these regions at this time (MacPherson, 1979; Lopes *et al.*, 2006). Fock *et al.* (2002) found that boarfish at Great Meteor Seamount fed mainly on copepods and euphausiids diurnally and on decapods nocturnally, indicating habitat dependent resource utilisation.

Boarfish appear an unlikely target of predation given their array of strong dorsal and anal fin spines and covering of ctenoid scales. However, there is evidence to suggest that they may be an important component of some species' diets. Most studies have focused in the Azores and few have mentioned the NE Atlantic, probably due to the relatively low abundance in the region until recent years. In the Azores, boarfish was found to be one of the most important prey items for tope (*Galeorhinus galeus*), thornback ray (*Raja clavata*), conger eel (*Conger conger*), forkbeard (*Phycis phycis*), bigeye tuna (*Thunnus obesus*), yellowmouth barracuda (*Sphyraena viridensis*), swordfish (*Xiphias gladius*), blackspot seabream (*Pagellus bogaraveo)*, axillary seabream (*Pagellus acarne*) and blacktail comber (*Serranus atricauda*) (Clarke *et al*., 1995; Morato *et al*., 1999; Morato *et al*., 2000; Morato *et al*., 2001; Barreiros *et al*., 2002; Morato *et al*., 2003; Arrizabalaga *et al*., 2008). Many of these species also occur in the NE Atlantic shelf waters although it is unknown whether boarfish represent a significant component of the diet in this region.

In the NE Atlantic boarfish have not previously been recorded in the diets of tope or thornback ray (Holden and Tucker, 1974; Ellis *et al*., 1996,). However, this does not prove that they are currently not a prey item. A study of conger eel diet in Irish waters from 1998-1999 failed to find boarfish in the diet (O'Sullivan *et al*., 2004). However, in Portuguese waters a recent study has found boarfish to be the most numerous species in the diet of conger eels (Xavier *et al*., 2010). It has been suggested that boarfish are an important component of the diet of hake (*Merluccius merluccius*), as they are sometimes caught together. However, a recent study of the diet of hake in the Celtic Sea and Bay of Biscay did not report any boarfish in the stomachs of hake caught during the 2001 EVHOE survey (Mahe *et al*., 2007).

The conspicuous presence of boarfish in the diet of so many fish species in the Azores is perhaps more related to the lack of other available food sources than to the palatability of boarfish themselves. Given the large abundance in NE Atlantic shelf waters it is likely that they would have been recorded more frequently if they were a significant and important prey item.

Boarfish are also an important component of the diet a number of sea birds in the Azores, most notably the common tern (*Sterna hirundo*) and Cory's shearwater (*Calonectris diomedea*) (Granadeiro *et al*., 1998; Granadeiro *et al*., 2002). This is surprising given that in the Mediterranean discarded boarfish were rejected by seabirds whereas in the Azores they were actively preyed on (Oro and Ruiz, 1997). Cory's shearwaters are capable of diving up to 15 m whilst the common tern is a plunge-diver and may only reach 2-3 m. It is therefore surprising that boarfish are such a significant component of their diet given that it is generally considered a deeper water fish. In the Azores boarfish shoals are sometimes driven to the surface by horse mackerel and barracuda where they are also attacked by diving sea birds (J. Hart, CW Azores, pers. comm.). Anecdotal reports from the Irish fishery indicate that boarfish are rarely found in waters shallower than 40 m. This may suggest that they are outside the range of shearwaters and gannets, the latter having a mean diving depth of 19.7±7.5 m (Brierley and Fernandes, 2001). However, the upper depth range of boarfish is within maximum diving depth recorded for auks (50 m) as recorded by Barrett and Furness (1990). Given their frequency in the diets of marine and bird life in the Azores, boarfish appear to be an important component of the marine ecosystem in that region. There is currently insufficient evidence to draw similar conclusions in the NE Atlantic.

The length-frequency distribution of boarfish may be important to consider. IBTS data shows an increase in mean total length with latitude (Table 6.3.2.2) and perhaps the smaller boarfish in the southern regions are more easily preyed upon. Length data of boarfish from stomach contents studies of both fish and sea birds in the Azores indicate that the boarfish found are generally < 10 cm (Granadeiro *et al*., 1998; Granadeiro *et al*., 2002).

6.14 Changes in the environment

Studies are underway to investigate if the increase in abundance of boarfish in the 1990s and 2000s is related to changes in the environment. Blanchard and Vandermeirsch (2005) attributed the increase in abundance of boarfish in the EVHOE survey during this time to a concurrent increase in water temperature during the spawning season which may have enhanced recruitment.

The reproductive biology of the species goes some way to supporting and developing this theory. Evidence suggests that the boarfish is an asynchronous batch spawner with indeterminate fecundity (Farrell *et al*., 2012). Given suitable conditions (i.e. suitable temperature and abundant prey) boarfish are capable of spawning repeatedly over an extended period of time. In aquarium conditions, spawning has been observed daily for males and every 2-3 days for females over a period of nine consecutive months. Natural conditions are more variable and Farrell *et al.* (2012) indicated that spawning was restricted to the summer months with a peak in July. Spawning had ceased by September and remaining oocytes were resorbed at this time.

If conditions remain favourable for an extended period of time in a particular year then boarfish are likely to continue spawning, possibly leading to enhanced recruitment. Analysis of length at age data showed recruitment to have a positive correlation with adult growth the previous year for the Spanish north coast survey index only, and that complex climate related mechanisms are responsible for the boarfish stock expansion in the Northeast Atlantic (Coad *et al*. 2014).

6.15 Proposed management plan

In 2015 the Pelagic Advisory Council submitted a revised draft management strategy for Northeast Atlantic boarfish. The EU has requested ICES to evaluate the following management plan:

This management strategy aims to achieve sustainable exploitation of boarfish in line with the precautionary approach to fisheries management, FAO guidelines for new and developing fisheries, and the ICES form of advice.

1) The TAC shall be set in accordance with the following procedure, depending on the ICES advice

a) If category 1 advice (stocks with quantitative assessments) is given based on a benchmarked assessment, the TAC shall be set following that advice.

b) If category 1 or 2 (qualitative assessments and forecasts) advice is given based on a non-benchmarked assessment the TAC shall be set following this advice.

c) Categories 3-6 are described below as follows :

i) Category 3: stocks for which survey-based assessments indicate trends.

This category includes stocks with quantitative assessments and forecasts which for a variety of reasons are considered indicative of trends in fishing mortality, recruitment, and biomass.

ii) Category 4: stocks for which only reliable catch data are available.

This category includes stocks for which a time series of catch can be used to approximate MSY.

iii) Category 5: landings only stocks.

This category includes stocks for which only landings data are available.

iv) Category 6: Category 6 – negligible landings stocks and stocks caught in minor amounts as bycatch

2) Notwithstanding paragraph 1, if, in the opinion of ICES, the stock is at risk of recruitment impairment, a TAC may be set at a lower level.

3) If the stock, estimated in the either of the 2 years before the TAC is to be set, is at or below B_{lim} or any suitable proxy thereof, the TAC shall be set at 0 t.

4) The TAC shall not exceed 75,000 t in any year.

5) The TAC shall not be allowed to increase by more than 25% per year. However there shall be no limit on the decrease in TAC.

6) Closed seasons, closed areas, and moving on procedures shall apply to all directed boarfish fisheries as follows:

a) A closed season shall operate from 31st March to 31st August. This is because it is known that herring and mackerel are present in these areas and may be caught with boarfish.

b) A closed area shall be implemented inside the Irish 12-mile limit south of 52°30 from 12th February to 31st October, in order to prevent catches of Celtic Sea herring, known to form aggregations at these times.

c) If catches of other species covered by a TAC amount to more than 5% of the total catch by day by ICES statistical rectangle, then all fishing must cease in that rectangle for 5 consecutive days.

6.16 Special request: EU request for ICES to evaluate the management strategy for boarfish (*Capros aper*) in Subareas VI-VIII (Celtic Seas and the English Channel, Bay of Biscay)

The request:

This management strategy aims to achieve sustainable exploitation of boarfish in line with the precautionary approach to fisheries management, FAO guidelines for new and developing fisheries, and the ICES form of advice.

7) The TAC shall be set in accordance with the following procedure, depending on the ICES advice

d) If category 1 advice (stocks with quantitative assessments) is given based on a benchmarked assessment, the TAC shall be set following that advice.

e) If category 1 or 2 (qualitative assessments and forecasts) advice is given based on a non-benchmarked assessment the TAC shall be set following this advice.

f) Categories 3—6 are described below as follows :

ii) Category 3: stocks for which survey-based assessments indicate trends. This category includes stocks with quantitative assessments and forecasts which for a variety of reasons are considered indicative of trends in fishing mortality, recruitment, and biomass.

ii) Category 4: stocks for which only reliable catch data are available. This category includes stocks for which a time series of catch can be used to approximate MSY.

iii) Category 5: landings only stocks. This category includes stocks for which only landings data are available.

iv) Category 6: Category 6 – negligible landings stocks and stocks caught in minor amounts as bycatch

8) *Notwithstanding paragraph 1, if, in the opinion of ICES, the stock is at risk of recruitment impairment, a TAC may be set at a lower level.*
9) *If the stock, estimated in the either of the 2 years before the TAC is to be set, is at or below Blim or any suitable proxy thereof, the TAC shall be set at 0 tonnes.*
10) *The TAC shall not exceed 75 000 tonnes in any year.*
11) *The TAC shall not be allowed to increase by more than 25% per year. However there shall be no limit on the decrease in TAC.*
12) *Closed seasons, closed areas, and moving on procedures shall apply to all directed boarfish fisheries as follows:*

a) A closed season shall operate from 31 March to 31 August. This is because it is known that herring and mackerel are present in these areas and may be caught with boarfish.

b) A closed area shall be implemented inside the Irish 12-mile limit south of 52°30 from 12 February to 31 October, in order to prevent catches of Celtic Sea herring, known to form aggregations at these times.

c) If catches of other species covered by a TAC amount to more than 5% of the total catch by day by ICES statistical rectangle, then all fishing must cease in that rectangle for 5 consecutive days.

Sections 1.a and 1.b of the proposed plan conform to the ICES category 1 assessment/forecast procedure. As such these sections are in conformity with the maximum sustainable yield (MSY) and the precautionary approach (PA) (ICES, 2015). However, the plan can be considered to be more cautious than the ICES category 1 approach, by virtue of Sections 2 and 3. These sections provide an additional clause whereby the TAC can be set lower if considered relevant (Section 2) or at zero if a category 1 assessment shows biomass to be below Blim (Section 3). The provision of Section 3 removes ambiguity that may exist in TAC decision making in the event of biomass (or SSB) < Blim.

ICES notes an apparent misprint in Section 1.c, and assumes that the purpose of this section is to follow the ICES precautionary approach for TAC setting. The EC has confirmed that ICES interpretation is correct. ICES has not evaluated the TAC decision rules in Section 1.3. However, if they are followed, they would result in management in accordance with the ICES precautionary approach. The plan is more cautious than the precautionary approach, by virtue of Sections 2 and 3, which provide an additional clause whereby the TAC can be set lower than implied by the precautionary approach if considered relevant (Section 2) or at zero if there is evidence that biomass is below Blim (Section 3). The provision of Section 3 removes ambiguity that may exist in TAC decision making in the event of biomass (or SSB) < Blim. ICES notes that this is more precautionary than the current ICES framework for advice.

Sections 4 and 5 provide TAC stability mechanisms, Section 4 placing an upper ceiling on possible TACs in any year, and Section 5 allowing limited increase but unlimited decrease in TAC. In a new, developing fishery, such as this one, management should be as reactive as possible to information from changing stock perceptions, especially negative perceptions. Therefore, ICES welcomes that there is no constraint on TAC decrease. Though ICES has not evaluated the effect of the 25% TAC increase constraint, or the 75 000 tonnes TAC ceiling, both are generally considered favourable as they limit large increases in catch.

Section 6 presents seasonal and area closures, partly to avoid bycatch of herring and mackerel. Such closures are a welcome addition to the plan. ICES identifies that the start date for the seasonal closure is 15 days later than in the previous long-term plan agreed by the Pelagic AC in 2013. ICES recommends that any such change be supported by scientific evidence that there is low risk of bycatch of herring and mackerel. This should include the results of on-board observers.

ICES notes that if the TAC was reduced to zero a 25% limit to the increase in TAC would not reopen the fishery. The simplest solution may be to suspend the 25% limit when reopening the fishery and follow ICES advice.

6.17 References

Arrizabalaga, H., Pereira, J. G., Royer, F., Galuardi, B., Goni, N., Artetxe, I., Arregi, I., et al. 2008. Bigeye tuna (*Thunnus obesus*) vertical movements in the Azores Islands determined with pop-up satellite archival tags. Fisheries Oceanography, 17: 74-83.

Barrett, R. T., and Furness, R. W. 1990. The prey and diving depths of seabirds on Hornøy, North Norway after a decrease in the Barents Sea capelin stocks. *Ornis Scandinavica*, 21: 179–186.

Barreiros, J. P., Santos, R. S. and de Borba, A. E. 2002. Food habits, schooling and predatory behaviour of the yellowmouth barracuda, *Sphyraena viridensis* (Perciformes : Sphyraenidae) in the Azores. Cybium, 26: 83-88.

Beverton, R. J. H. and Holt, S. J. (1957), On the Dynamics of Exploited Fish Populations, Fishery Investigations Series II Volume XIX, Ministry of Agriculture, Fisheries and Food

Blanchard, F. and Vandermeirsch, F. 2005. Warming and exponential abundance increase of the subtropical fish *Capros aper* in the Bay of Biscay (1973-2002). Comptes Rendus Biologies, 328: 505-509.

Borges, L., van Keeken, O. A., van Helmond, A. T. M., Couperus, B., and Dickey-Collas, M. 2008. What do pelagic freezer-trawlers discard? ICES Journal of Marine Science, 65: 605–611.

Brierley, A.S. and Fernandes, P.G. 2001. Diving depths of northern gannets: acoustic observations of *Sula Bassana* from an autonomous underwater vehicle. The Auk 118(2):529–534.

Cardador F. and Chaves, C. 2010. Boarfish (*Capros aper*) distribution and abundance in Portuguese continental waters (ICES Div. IXa).

Carrera, P., Riveiro, I., Oñate, D., Miquel, J. & Iglesias, M. 2013. Multidisciplinary acoustic survey PELACUS0313: preliminary results on fish abundance estimates and distribution. Working document for the WGWIDE 27/08-02/09/2013, Copenhagen, Denmark.

Carrera, P., Riveiro, I., Oñate, D., Miquel, J. & Iglesias, M. 2014. Multidisciplinary acoustic survey PELACUS0314: preliminary results on fish abundance estimates and distribution. Presentation to WGWIDE 26/08-01/09/2014, Copenhagen, Denmark.

Clarke, M. R., Clarke, D. C., Martins, H. R. and Da Silva, H. M. 1995. The diet of the swordfish (*Xiphias gladius*) in Azorean waters. Arquipe´lago. Life and Marine Sciences 13 (A): 53-69.

Coad, J. O., Hüssy, K., Farrell, E. D. and Clarke, M. W. 2014. The recent population expansion of boarfish, *Capros aper* (Linnaeus, 1758): interactions of climate, growth and recruitment. *Journal of Applied Ichthyology*, 30: 463–471.

Cooper, L. H. N. 1952. The boar fish, *Capros aper* (L.), as a possible biological indicator of water movement. Journal of the Marine Biological Association of the United kingdom, 31: 351-362.

Couch, R. Q. 1844. A Cornish fauna; being a compendium of the natural history of the county.

Cunningham, J. T. 1888. Notes and memoranda. Some notes on Plymouth fishes. Journal of the Marine Biological Association of the United kingdom, 2: 234-250.

Day, F. 1880-1884. The fishes of Great Britain and Ireland. London.

Ellis, J. R., Pawson, M. G. and Shackley, S. E. 1996. The comparative feeding ecology of six species of shark and four species of ray (elasmobranchii) in the north-east Atlantic. Journal of the Marine Biological Association of the United Kingdom, 76: 89-106.

Farina, A. C., Freire, J. and González-Gurriarán, E. 1997. Demersal fish assemblages in the Galician continental shelf and upper slope (NW Spain): spatial structure and long-term changes. Estuarine, Coastal and Shelf Science, 44: 435-454.

Farrell, E.D., Hüssy, K., Coad, J.O., Clausen, L.W. & Clarke, M.W. 2012. Oocyte development and maturity classification of boarfish (*Capros aper*) in the Northeast Atlantic. *ICES Journal of Marine Science*, 69: 498-507.

Farrell, E.D., Carlsson, J.E.L. & Carlsson, J. Preliminary results of an investigation of the genetic population structure of boarfish (*Capros aper*) for assessment and management purposes. Working Document for the Working Group on Widely Distributed Stocks (WGWIDE), Pasaia, Spain, 25-31 August 2015.

Fässler, S.M.M., O'Donnell, C. & Jech, J.M. 2013. Boarfish (*Capros aper*) target strength modelled from magnetic resonance imaging (MRI) scans of its swimbladder. *ICES Journal of Marine Science*, doi:10.1093/icesjms/fst095.

Fock, H. O., Matthiessen, B., Zidowitz, H. and Westernhagen, H. v. 2002. Diel and habitat-dependent resource utilisation by deep-sea fishes at the Great Meteor seamount: niche overlap and support for the sound scattering layer interception hypothesis. Marine Ecology Progress Series, 244: 219-233.

Gatcombe, J. 1879. Boarfish off Plymouth. Zoologist, 3: 461-462.

Granadeiro, J. P., Monteiro, L. R. and Furness, R. W. 1998. Diet and feeding ecology of Cory's shearwater *Calonectris diomedea* in the Azores, north-east Atlantic. Marine Ecology-Progress Series, 166: 267-276.

Granadeiro, J. P., Monteiro, L. R., Silva, M. C. and Furness, R. W. 2002. Diet of Common Terns in the Azores, northeast Atlantic. Waterbirds, 25: 149-155.

Holden, M. J. and Tucker, R. N. 1974. The food of *Raja clavata* Linnaeus 1758, *Raja montagui* Fowler 1910, *Raja naevus* Muller and Henle 1841 and *Raja brachyura* Lafont 1873 in British waters. Journal du Coseil International pour l'Exploration de la Mer, 35: 189-193.

Hüssy, K., Coad, J.O., Farrell, E.D., Clausen, L.W. & Clarke, M.W. 2012a. Age verification of boarfish (*Capros aper*) in the Northeast Atlantic. *ICES Journal of Marine Science*, 69: 34-40.

Hüssy, K., Coad, J.O., Farrell, E.D., Clausen, L.W. & Clarke, M.W. 2012b. Sexual dimorphism in size, age, maturation and growth characteristics of boarfish (*Capros aper*) in the Northeast Atlantic. *ICES Journal of Marine Science*, 69: 1729–1735.

ICES. 2007. Report of the Workshop on Limit and Target Reference Points [WKREF], 29 January – 2 February 2007, Gdynia, Poland. Document Number. 89 pp.

ICES. 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM 68. 42 pp.

ICES. 2013. Report of the ICES Advisory Committee 2013. ICES Advice, 2013. Book 9. Section 9.3.3.6

ICES. 2015. Advice basis. *In* Report of the ICES Advisory Committee, 2015. ICES Advice 2015, Book 1, Section 1.2.

Kéry, M. 2010. Introduction to WinBUGS for Ecologists: A Bayesian Approach to Regression, ANOVA and Related Analyses. Academic Press, Burlington, MA, USA.

King, M., 1995. Fisheries Biology, Assessment and Management. Fishing News Book. 34p.

Lopes, M., Murta, A. G. and Cabral, H. N. 2006. The ecological significance of the zooplanktivores, snipefish *Macroramphosus* spp. and boarfish *Capros aper*, in the food web of the south-east North Atlantic. Journal of Fish Biology, 69: 363-378.

MacPherson, E. 1979. Estudio sobre el regimen alimentario de algunos peces en el Mediterraneo occidental. Miscelanea Zoologica, 5: 93-107.

Mahe, K., Amara, R., Bryckaert, T., Kacher, M. and Brylinski, J. M. 2007. Ontogenetic and spatial variation in the diet of hake (Merluccius merluccius) in the Bay of Biscay and the Celtic Sea. ICES Journal of Marine Science, 64: 1210-1219.

Meyer, R. and Millar, R. B. (1999). BUGS in Bayesian stock assessments. Canadian Journal of Fisheries and Aquatic Science, 56, 1078—1086.

Minto, C., Clarke, M.W. and Farrell, E.D. 2011. Investigation of the yield- and biomass-per-recruit of the boarfish *Capros aper*. Working Document, WGWIDE 2011.

Morato, T., Encarnacion, S., Grós, M. P. and Menezes, G. 1999. Diets of forkbeard (*Phycis phycis*) and conger eel (*Conger conger*) off the Azores during spring of 1996 and 1997. Life and Marine Science, 17A: 51-64.

Morato, T., Santos, R. S. and Andrade, J. P. 2000. Feeding habits, seasonal and ontogenetic diet shift of blacktail comber, *Serranus atricauda* (Pisces : Serranidae), from the Azores, north-eastern Atlantic. Fisheries Research, 49: 51-59.

Morato, T., Sola, E., Gros, M. P. and Menezes, G. 2003. Diets of thornback ray (*Raja clavata*) and tope shark (*Galeorhinus galeus*) in the bottom longline fishery of the Azores, northeastern Atlantic. Fishery Bulletin, 101: 590-602.

Morato, T., Solà, E., Grós, M. P. and Menezes, G. 2001. Feeding habits of two congener species of seabreams, *Pagellus bogaraveo* and *Pagellus acarne* off the Azores (northeastern Atlantic) during sprong of 1996 and 1997. Bulletin of Marine Science, 69: 1073-1087.

O'Donnell, C. 2013. On the implementation of a modelled TS relationship for boarfish (*Capros aper)* abundance estimates. Working Document. ICES WGWIDE, Copenhagen, Denmark, 27 August-2 September 2013.

O'Donnell, C., Farrell, E.D., Nolan, C. & Campbell, A. (2013). Boarfish acoustic survey cruise report. 10 -31 July 2013. FEAS Survey Series: 2013/03.

O'Donnell, C., Farrell, E.D., Saunders, S. & Campbell, A. (2012a). The abundance of boarfish (*Capros aper*) along the western shelf estimated using hydro-acoustics. *Irish Fisheries Investigations*, 23.

O'Donnell, C., Farrell, E.D., Nolan, C. & Campbell, A. (2012b). Boarfish acoustic survey cruise report. 09 -26 July 2012. FSS Survey Series: 2012/03.

O'Donnell, C. & Nolan, C. (2014). Boarfish acoustic survey cruise report. 10 -31 July 2014. FEAS Survey Series: 2014/03.

O'Donnell, C. & Nolan, C. (2015). Boarfish acoustic survey cruise report. 10 -31 July 2015. FEAS Survey Series: 2015/03.

O'Sullivan, S., Moriarty, C. and Davenport, A. 2004. Analysis of the stomach contents of the European conger eel *Conger conger* in Irish waters. Journal of the Marine Biological Association of the United Kingdom, 84: 823-826.

Oro, D. and Ruiz, X. 1997. Exploitation of trawler discards by breeding seabirds in the north-western Mediterranean: Differences between the ebro delta and the balearic islands areas. ICES Journal of Marine Science, 54: 695-707.

Pinnegar, J. K., Jennings, S., O'Brien, C. M. and Polunin, N. V. C. 2002. Long-term changes in the trophic level of the Celtic Sea fish community and fish market price distribution. Journal of Applied Ecology, 39: 377-390.

Prista, N., Fernandes, A. C., Gonçalves, P., Ana Maria Costa, A. M. and Silva, A. 2014. Update on the discards of WGWIDE species by the Portuguese bottom otter trawl fleet operating in the Portuguese ICES Division IXa. Working Document for the ICES WGWIDE, Copenhagen, 26 August – 1 September 2014.

Spiegelhalter, D., Thomas, A., Best, N. and Lunn, D. 2004. WinBUGS User Manual. MRC Biostatistics Unit, Cambridge, UK, 2nd ed.

Stefánsson, G. (1996). Analysis of groundfish survey abundance data: combining the GLM and delta approaches. ICES Journal of Marine Science, 53, 577—588.

van Overzee, H.M.J. and van Helmond, A.T.M. 2014. Estimates of discarded boarfish by Dutch pelagic freezer trawler fishery in 2003-2013. Working Document for the ICES WGWIDE, Copenhagen, 26 August – 1 September 2014.

White, E., Minto, C., Nolan, C. P., King, E., Mullins, E., and Clarke, M. 2011. First estimates of age, growth, and maturity of boarfish (*Capros aper*): a species newly exploited in the North-east Atlantic. ICES Journal of Marine Science, 68: 61–66.

Xavier, J. C., Cherel, Y., Assis, C. A., Sendao, J. and Borges, T. C. 2010. Feeding ecology of conger eels (Conger conger) in north-east Atlantic waters. Journal of the Marine Biological Association of the United Kingdom, 90: 493-501.

Table 6.1.2.1. Boarfish in Subareas VI, VII, VIII. Landings, discards and TAC by year (t), 2001–2014. (Data provided by Working Group members). These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Ireland	Denmark	Scotland	Total landings	Estimated Discards	Total Catch incl. Discards	TAC
2001	120	0	0	120	NA	120	-
2002	91	0	0	91	NA	91	-
2003	458	0	0	458	10929	11387	-
2004	675	0	0	675	4476	5151	-
2005	165	0	0	165	5795	5959	-
2006	2772	0	0	2772	4365	7137	-
2007	17615	0	772	18387	3189	21576	-
2008	21585	3098	0.45	24683	10068	34751	-
2009	68629	15059	0	83688	6682	90370	-
2010	88457	39805	9241	137503	6544	144047	-
2011	20685	7797	2813	31295	5802	37096	33000
2012	55949	19888	4884	80720	6634	87355	82000
2013	52250	13182	4380	69812	5598	75409	82000
2014	34622	8758	38	43418	1813	45231	133957

Table 6.1.2.2 Boarfish in ICES Subareas VI, VII, VIII. Landings by year (t), 2001–2014 and Subarea where available. (Data provided by Working Group members). These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

	Denmark	Ireland	Scotland	Total
2001	0	120	0	120
2002	0	91	0	91
2003	0	458	0	458
VI		65		65
VII		393		393
2004	0	675	0	675
VI		292		292
VII		345		345
VIII		38		38
2005	0	165	0	165
VI		10		10
VII		117		117
VIII		38		38
2006	0	2772	0	2772
VI		21		21
VII		2750		2750
VIII		1		1
2007	0	17615	772	18386
V		6		6
VI		93		93
VII		17510	772	18282
VIII		5		5
2008	3098	21584	0	24683
VI		28	0	28
VII		21557		21557
2009	15059	68629	0	83688
VI		45		45
VII		68584		68584
2010	39805	88457	9241	137503
VI		1355	10	1365
VII	39805	87101	9231	136138
2011	7797	20685	2813	31295
VI		26		26
VII	7779	20659	2813	31251
VIII	18			
2012	19888	55949	4884	80720
VI		125		125
VII	18283	55731	4884	78898
VIII	1604	93		1697
2013	13182	52250	4380	69811
VI		538	15	553
VII	11828	50572	4365	66764
VIII	1354	1140		2494
2014	8758	34622	38	43418
VI		182	30	212
VII	8758	34321	8	43087
VIII		119		119
Total	**107587**	**364071**	**22128**	**493786**

Table 6.1.2.3. Boarfish in ICES Areas VI, VII, VIII. Landings by year (t), 2001–2014 and subarea where available. (Data provided by Working Group members). These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Denmark	Ireland	Scotland	Total
2001	**0**	**120**	**0**	**120**
2002	**0**	**91**	**0**	**91**
2003	**0**	**458**		**458**
VIa		65		65
VIIb		214		214
VIIj		179		179
2004	**0**	**675**	**0**	**675**
VIa		292		292
VIIb		224		224
VIIId		38		38
VIIj		122		122
2005	**0**	**165**	**0**	**165**
VIa		10		10
VIIb		105		105
VIIIa		38		38
VIIj		12		12
2006	**0**	**2772**	**0**	**2772**
VIa		21		21
VIIb		15		15
VIIg		375		375
VIIIa		1		1
VIIj		2360		2360
2007	**0**	**17615**	**772**	**18386**
Vb2		6		6
VIa		93		93
VIIb		1259		1259
VIIg		120		120
VIIIa		5		5
VIIj		16131	772	16903
2008	**3098**	**21584**	**0**	**24683**
VIa		28	0	28
VIIb		3		3
VIIg		184		184
VIIj		21370		21370
2009	**15059**	**68629**	**0**	**83688**
VIa		45		45
VIIb		73		73

VIIc		1		1
VIIg		4912		4912
VIIh		18225		18225
VIIj		45372		45372
2010	**39805**	**88457**	**9241**	**137503**
VIa		1349	10	1359
VIaS		7		7
VIIb		2258		2258
VIIc		35	4	39
VIIe	2			2
VIIg	672	3649		4321
VIIh	1465	8453	1712	11629
VIIj	37667	72707	7515	117889
2011	**7797**	**20685**	**2813**	**31295**
VIa		26		26
VIIb		274		274
VIIc		9		9
VIIg		811		811
VIIh	4155	8540	2813	15508
VIIIa	18			18
VIIj	3624	11025		14648
2012	**19888**	**55949**	**4884**	**80720**
VIa		125		125
VIIb	80	4501	838	5419
VIIc		108	907	1015
VIIg		616		616
VIIh	5837	10579	3139	19554
VIIIa	1604	93		1697
VIIj	12366	39928		52294
2013	**13182**	**52250**	**4380**	**69811**
VIa		538	15	553
VIIb		10405	100	10505
VIIe			883	883
VIIg		1808		1808
VIIh	955	11355	1728	14038
VIIIa	1354	870		2224
VIIId		270		270
VIIj	10873	27003	1653	39529
2014	**8758**	**34622**	**38**	**43418**
VIa		182	30	212
VIIb	12	3262		3274

VIIg		135		135
VIIh	4808	18389		23196
VIIIa		119		119
VIIj	3886	12536	8	16429
VIIk	53			53
Total	**107587**	**364071**	**22128**	**493786**

Table 6.1.2.4. Boarfish in ICES Areas VI, VII, VIII. Discards of boarfish in demersal and non-target pelagic fisheries by year (t), 2003–2014. (Data provided by Working Group members). These figures may not in all cases correspond to the official statistics and cannot be used for management purposes.

Year	Germany	Ireland	Nether-lands	Spain	UK	Total
2003		119	1998	8812		10929
2004		60	837	3579		4476
2005		55	733	5007		5795
2006		22	411	3933		4365
2007		549	23	2617		3189
2008		920	738	8410		10068
2009		377	1258	5047		6682
2010		85	512	5947		6544
2011	49	107	185	5461		5802
2012		181	88	6365	23	6657
2013	22	47	11	5518	52	5650
2014	117	50	477	1119	50	1813

Table 6.2.1.1. Boarfish in ICES Subareas VI, VII, VIII. General boarfish age length key produced from 2012 commercial samples. Figures highlighted in grey are estimated.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
7	1	1													
7.5	1	1													
8		1													
8.5		1	1												
9		1	1												
9.5			1												
10			1												
10.5			2	10	3										
11			1	29	14	2	2								
11.5				9	21	21	18	2	2	1					
12				4	17	22	38	12	8						1
12.5					5	9	42	37	14	6	2		1	1	1
13					2	4	31	28	24	12	6	2	3	1	5
13.5					1	3	25	22	21	14	6	5	4	2	11
14							6	8	18	22	8	3	7	1	20
14.5						1	1	2	3	8	1	6	6	6	30
15							1	1		2	2	2	5	2	19
15.5										2				2	19
16															8
16.5															1
17															1
17.5															1
18															1
18.5															1

Table 6.2.1.2. Boarfish in ICES Subareas VI, VII, VIII. Sampling intensity by country of commercial landings.

			DK				IRL				SCT			
Year	Q	Area	Landings	Samples	Measured	Allocated	Landings	Samples	Measured	Allocated	Landings	Samples	Measured	Allocated
2007	1	VIa					12	0	0	VIIj_Q2 and VIa_Q4				
	1	VIIIa					5	0	0	VIIj_Q2 and VIa_Q4				
	1	VIIj					5253	0	0	VIIj_Q2 and VIa_Q4	772	0	0	Irish 2007 combined
	2	VIIg					120	0	0	VIIj_Q2 and VIa_Q4				
	2	VIIj					4130	2	197	VIIj_Q2 and VIa_Q4				
	3	VIIb					0	0	0	VIIj_Q2 and VIa_Q4				
	4	Vb2					6	0	0	VIIj_Q2 and VIa_Q4				
	4	VIa					82	1	20	VIIj_Q2 and VIa_Q4				
	4	VIIb					1259	0	0	VIIj_Q2 and VIa_Q4				
	4	VIIj					6748	0	0	VIIj_Q2 and VIa_Q4				
	Total		0	0	0		17615	3	217		772	0	0	
2008	1	VIa					5	0	0	VIIj_Q4				
	1	VIIg					184	0	0	VIIj_Q4				
	1	VIIj					5041	0	0	VIIj_Q4				
	2	VIIj					46	0	0	VIIj_Q4				
	3	VIIj					4067	0	0	VIIj_Q4				
	4	VIa					23	0	0	VIIj_Q4	0.5	0	0	Irish 2008 combined
	4	VIIb					3	0	0	VIIj_Q4				
	4	VIIj					12216	1	152	VIIj_Q4				
	Total		3098	0	0		21584	1	152		0.5	0	0	
2009	1	VIIb					55	0	0	VIIj_Q3				
	1	VIIg					2979	0	0	VIIj_Q3				
	1	VIIh					1971	0	0	VIIj_Q3				
	1	VIIj					10901	2	359	VIIj_Q3				
	2	VIIg					1933	0	0	VIIj_Q3				
	2	VIIh					3169	0	0	VIIj_Q3				
	2	VIIj					2727	0	0	VIIj_Q3				
	3	VIIh					10378	0	0	VIIj_Q3				
	3	VIIj					11423	1	175					
	4	VIa					45	0	0	VIIj_Q4				
	4	VIIb					18	0	0	VIIj_Q4				
	4	VIIh					2707	0	0	VIIj_Q4				
	4	VIIj					20321	6	941					
	Total		15059	0	0		68629	9	1475		0	0	0	
2010	1	VIa									10	0	0	Irish 2010 VIIb_Q1
	1	VIIb					1069	1	102					
	1	VIIg	577	1	77		2392	0	0	VIIj_Q1				
	1	VIIh	1079	0	0	VIIg+VIIj_Q1	326	1	94					
	1	VIIj	32422	2	193		34466	12	1447		2504	0	0	Irish 2010 VIIj_Q1
	2	VIIh					102	0	0	VIIh_Q3				
	2	VIIj	344	0	0	VIIj_Q1								
	3	VIIg					338	0	0	VIIh_Q3				
	3	VIIh	377	0	0	VIIh_Q4	5540	8	1316		548	0	0	Irish 2010 VIIh_Q3
	3	VIIj	2660	0	0	VIIj_Q4	11531	31	3275		2171	0	0	Irish 2010 VIIj_Q3
	4	VIa					1355	1	117					
	4	VIIb					1189	0	0	VIIj_Q4				
	4	VIIc					35	0	0	VIIj_Q4	4	0	0	Irish 2010 VIIj_Q4
	4	VIIe	2	0	0	VIIh_Q4								
	4	VIIg	94	0	0	VIIh+VIIj_Q4	920	0	0	VIIh_Q4				
	4	VIIh	9	3	384		2484	6	715		1165	0	0	Irish 2010 VIIh_Q4
	4	VIIj	2241	2	217		26710	27	2738		2840	0	0	Irish 2010 VIIj_Q4
	Total		39805	8	871		88457	87	9804		9241	0	0	

Table 6.2.1.2 continued.

			DK				IRL				SCT			
Year	Q	Area	Landings	Samples	Measured	Allocated	Landings	Samples	Measured	Allocated	Landings	Samples	Measured	Allocated
2011	1	VIIb					39	0	0	VIIj_Q4				
	1	VIIh	32	0	0	VIIh_Q4								
	1	VIIIa	18	0	0	VIIh_Q4								
	1	VIIj	1	0	0	VIIj_Q4	38	0	0	VIIj_Q4				
	2	VIIb					1	0	0	VIIj_Q4				
	3	VIIh					820	0	0	VIIh_Q4	434	0	0	Irish 2011 VIIh_Q4
	3	VIIj					1092	0	0	VIIj_Q4				
	4	VIa					26	0	0	VIIj_Q4				
	4	VIIb					235	0	0	VIIj_Q4				
	4	VIIc					9	0	0	VIIj_Q4				
	4	VIIg					811	0	0	VIIj_Q4				
	4	VIIh	4123	11	1347		7720	3	319		2379	0	0	Irish 2011 VIIh_Q4
	4	VIIj	3623	5	611		9894	8	1789					
	Total		7797	16	1958		20685	11	2108		2813	0	0	
2012	1	VIIb					4365	3	339					
	1	VIIg					616	0	0	IRL_Q3_VIIh				
	1	VIIh	3789	1	150	IRL_Q3_VIIh	1005	0	0	IRL_Q3_VIIh				
	1	VIIj	11403	3	102	IRL_Q1_VIIj	27812	42	4987					
	1	VIIIa	1330	2	214	IRL_Q3_VIIh								
	2	VIIh	208	0	0	IRL_Q3_VIIh								
	3	VIIb					49	0	0	IRL_Q1_VIIb				
	3	VIIh					3176	5	682		1537	0	0	IRL_Q3_VIIh
	3	VIIj					834	2	341					
	4	VIa					125	1	96					
	4	VIIb	80	0	0	IRL_Q1_VIIb	87	0	0	IRL_Q1_VIIb	838	0	0	IRL_Q1_VIIb
	4	VIIc					108	0	0	IRL_Q1_VIIb	907	0	0	IRL_Q1_VIIb
	4	VIIh	1840	4	445	IRL_Q4_VIIh	6398	7	945		1602	0	0	IRL_Q4_VIIh
	4	VIIIa	274	0	0	IRL_Q4_VIIj	93	0	0	IRL_Q4_VIIh				
	4	VIIj	963	2	180	IRL_Q4_VIIj	11281	8	1175					
Total			19888	12	1091		55949	68	8565		4884	0	0	
2013	1	VIa					370	0	0	IRL_Q1_VIIb	15	0	0	IRL_Q1_VIIb
	1	VIIb					8314	15	2037		100	0	0	IRL_Q1_VIIb
	1	VIIe									883	0	0	IRL_Q1_VIIh
	1	VIIg					1443	0	0	IRL_Q1_VIIh				
	1	VIIh	955	0	0	IRL_Q1_VIIh	1319	1	113		828	0	0	IRL_Q1_VIIh
	1	VIIIa	1354	3	369		100	1	147					
	1	VIIj	10873	11	852		14338	21	2984		721	0	0	IRL_Q1_VIIj
	3	VIIb					11	0	0	IRL_Q4_VIIb				
	3	VIIg					46	0	0	IRL_Q3_VIIh				
	3	VIIh					2307	3	480					
	3	VIIIa					770	0	0	IRL_Q3_VIIh				
	3	VIIj					3892	2	436		468	0	0	IRL_Q3_VIIj
	4	VIa					167.262	1	123					
	4	VIIb					2080	2	198					
	4	VIIg					320	0	0	IRL_Q4_VIIh				
	4	VIIh					7729	10	1467		901	0	0	IRL_Q4_VIIh
	4	VIIId					270	0	0	IRL_Q4_VIIh				
	4	VIIj					8773	6	833		464	0	0	IRL Q4_VIIj
Total			13182	14	1221		52250	62	8818		4380	0	0	
2014	1	VIa					14	0	0	IRL Q1 VIIj	30	0	0	IRL Q1 VIIj
	1	VIIb					808	0	0	IRL Q1 VIIj				
	1	VIIh	2259	0	0	IRL Q1 VIIh	2409	5	550					
	1	VIIj	2992	0	0	IRL Q1 VIIj	6062	11	871		8	0	0	IRL Q1 VIIj
	2	VIIj					10	0	0	IRL Q1 VIIj				
	3	VIIb					31	0	0	IRL Q3 VIIj				
	3	VIIh					2183	8	727					
	3	VIIj					1547	4	416					
	4	VIIIa					119			IRL Q4 VIIh				
	4	VIa					167.8	0	0	IRL Q4 VIIj				
	4	VIIb	12	0	0	IRL Q4 VIIj	2424	1	44	IRL Q4 VIIj				
	4	VIIg					135	0	0	IRL Q4 VIIh				
	4	VIIh	2549	11	1936		13797	19	1914					
	4	VIIIk	53	0	0	IRL Q4 VIIj								
	4	VIIj	894	0	0	IRL Q4 VIIj	4916	6	550					
Total			8758	11	1936		34622	54	5072		38	0	0	

Table 6.2.1.3. Boarfish in ICES Subareas VI, VII, VIII. Proxy catch numbers-at-age of the international catches (raised numbers in '000s) for the years 2007-2014.

	2007	2008	2009	2010	2011	2012	2013	2014
1	0	0	1575	2415	0	28	301	0
2	352	5488	15043	11229	2894	893	7148	695
3	2114	21140	65744	72709	41913	5467	156680	49503
4	40851	105575	338931	294382	28148	41278	58522	127520
5	48915	141300	475619	567689	30116	110272	59797	93705
6	62713	195339	543707	878363	175696	146582	68949	67275
7	26132	104031	307333	522703	143967	492078	302967	193061
8	29766	66570	172783	293719	107126	365840	250341	139124
9	56075	53159	155477	276672	77861	271916	212318	121042
10	44875	46893	130148	232122	60022	173486	160137	94225
11	14019	15289	42521	78588	46079	69396	63025	36078
12	32359	21178	61350	114600	40468	40968	41490	24895
13	4848	11854	39609	59932	24352	58888	59380	36309
14	16837	13570	31569	59060	19724	30277	30355	19064
15+	109481	112947	196967	349320	157707	217260	239366	150688

Table 6.2.2.1. Boarfish in ICES Subareas VI, VII, VIII. Length-frequency distributions of the international catches (raised numbers in '000s) for the years 2007-2014.

TL (cm)	2007	2008	2009	2010	2011	2012	2013	2014	Total
6	0	0	0	156	0	0	0	0	156
6.5	0	0	0	439	0	0	0	0	439
7	0	0	0	1090	522	56	52	0	1719
7.5	0	0	1354	1574	0	0	551	0	3479
8	0	0	677	375	1345	185	1419	0	4000
8.5	0	0	0	1082	0	555	3592	1064	6293
9	0	0	677	5382	851	555	7263	327	15054
9.5	0	7473	17367	7883	7012	641	47509	4916	92800
10	9609	11209	54130	29410	33243	2791	94702	31649	266743
10.5	0	52308	174796	130889	15848	6132	59833	71344	511151
11	84555	63517	343283	361774	70615	24571	18359	108261	1074936
11.5	0	59781	321637	655875	93487	81928	20938	82470	1316116
12	44199	119561	297737	739025	189434	264888	98564	84288	1837697
12.5	0	70990	207739	564347	114904	398772	204868	112826	1674445
13	82633	52308	147965	353484	133539	419060	315063	172416	1676468
13.5	0	29890	149314	246146	51235	307533	285688	153742	1223549
14	117224	22418	105782	224611	50857	176710	210137	138549	1046289
14.5	0	14945	71273	127711	25309	89726	105571	74059	508593
15	65338	33627	47816	125463	25569	52791	62175	43347	456125
15.5	0	11209	13082	81386	5473	25065	31122	22629	189966
16	13452	11209	19397	24256	4181	13149	14990	7672	108307
16.5	0	3736	4061	6209	2280	2738	4918	2134	26076
17	0	3736	677	1913	456	827	1109	1361	10079
17.5	0	0	0	0	0	0	407	0	407
18	0	0	0	283	0	0	296	0	579
18.5	**0**	**0**	**0**	**0**	**0**	**0**	592	0	592

Table 6.3.2.2 Boarfish in ICES Subareas VI, VII, VIII. IBTS length-frequency data.

WCSGFS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	ML	ML mature	Total	Total mature
1986								1													8.0		1	0
1987								1	1	2	1										9.7	10.2	4	3
1988				1																	4.0		1	0
1989							1														7.0		1	0
1990				1		1	1	2	24	55	50	43	12	1							10.7	11.1	188	160
1991						1	1	9	38	183	267	317	48	16							11.2	11.3	877	829
1992						1		10	39	468	1145	4001	1627	486							12.0	12.1	7775	7726
1993							4		3	9	60	155	73	16		1					12.0	12.1	319	313
1994									1	1	1			1							11.0	11.7	2	2
1995									8	37	194	294	398	199	22						12.5	12.5	1150	1143
1996				2		4	3				1	55	610	1575	304						13.8	13.8	2553	2544
1997			4			1	7	9	4	6	25	109	203	157	41	4					12.9	13.1	568	544
1998				1		1	5	2		1	2		3								8.8	11.8	15	6
1999			1			2	5	1	1		1	2	1								8.2	12.0	14	4
2000							2	2	39	110	216	288	183	93	46	6					12.0	12.1	983	940
2001		1						1	4	15	28	59	134	240	103	10	4				13.5	13.6	599	593
2002						1	8	2	1	82	742	3211	5601	5772	1497	167	1				13.2	13.3	17085	17073
2003			1				3	52		53	281	1473	3066	4895	3083	309	28				13.7	13.8	13244	13188
2004				1			2	2	43	82	743	4569	8600	9514	5693	948	84				13.6	13.6	30280	30232
2005		2					24	3	23	25	110	435	1085	1708	792	130	6				13.6	13.7	4343	4291
2006		1	2	1		1	4		10	218	232	452	1396	2853	2051	435	72				13.9	13.9	7726	7707
2007			2	2		2	1	3	21	159	780	2923	5194	6888	5283	1523	116				13.8	13.8	22897	22866
2008		1	1			16	37	36	187	468	1395	3213	9893	22758	18399	6288	575	71			14.1	14.2	63338	63060
2009			1			1		5	53	2443	2093	441	331	287	246	129	10				11.2	11.2	6038	5979
2010											530	1443	1384	1357	828	149	29				13.2	13.2	5720	5720
2011		1	4	1		1	5	254	1015	2034	7613	18918	14479	6445	2006	237	23				12.4	12.4	53034	51753
2012			1			1	2		103	9	1267	6545	26337	29361	27333	15857	1505	497			14.2	14.2	108817	108710
2013				1			1			1	143	3201	15282	11288	3935	858	6	1			13.5	13.5	34716	34714
2014		48	457	387	49	3	7	63	21	98	876	11669	30267	39236	10933	1363	111	1			13.4	13.5	95587	94553
SPPGFS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**ML**	**ML mature**	**Total**	**Total mature**
2001		2		2	2	4		88	10	104	266	323	1334	2259	460	81					13.3	13.5	4934	4827
2002									1	4	90	212	791	843	313	60					13.5	13.5	2314	2313
2003						1		3	15	22	21	62	268	426	249	51	2	1			13.8	13.8	1121	1102
2004		1				5	2		4	5	18	100	312	483	319	43	1				13.8	13.9	1293	1281
2005		1		1	6	1	18	10	9	14	7	101	530	935	705	226	18				14.0	14.2	2581	2536
2006			1	1	6	91	89	21	34	75	27	45	335	670	555	197	10	1			13.3	14.1	2158	1914
2007					3	4	9	15	12	9	27	25	72	151	144	26	4				13.4	13.9	501	458
2008		1				1	13	7	16	13	55	106	237	457	302	78	5				13.7	13.8	1292	1254
2009		6	5		2	7	8	1		1	154	318	924	1201	1172	324	7				13.9	14.0	4130	4101
2010	1			1	5	14	3	1	5	2	31	284	521	717	459	123	10				13.7	13.8	2178	2148
2011								3	16	18	5	147	671	792	429	122	13		2		13.8	13.8	2220	2200
2012				1	1			2	2	1	8	70	369	468	218	66	3				13.8	13.9	1208	1202
2013				1		7	22	6	9		1	42	435	889	480	141	12	1			14.0	14.1	2045	2000
2014		10	9		1		3	17	62	11	6	85	2453	6703	3168	2115	162	82			14.3	14.4	14889	14787
IGFS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**ML**	**ML mature**	**Total**	**Total mature**
2003		1	32	22	7	22	129	172	879	2942	2322	1325	3822	4628	2898	896	163	38			12.7	13.0	20299	19035
2004		23	63	34	8	96	532	1431	369	344	410	2253	4320	4698	3966	1017	87	2	1		12.9	13.7	19654	17098
2005		8	59	52	20	203	1024	585	288	636	341	3463	11457	11348	7955	1744	382	2	1		13.4	13.7	39569	37330
2006	5	60	68	48	35	212	969	621	2046	4190	8044	7946	24208	42119	32168	12296	2454	532			13.7	13.9	138021	133957
2007	1	6	44	18	31	501	923	1251	1638	1166	2510	3581	8275	10740	7093	1934	92				12.9	13.5	39804	35391
2008			26	18	23	127	672	531	2095	13780	17664	19268	16980	19484	15953	8789	1747	76	1		12.8	12.9	117231	113741
2009		3	80	76	25	94	228	486	1000	1139	9081	7749	5138	6921	5592	1084	68	1			12.5	12.8	38763	36772
2010		6	42	3	18	199	272	463	920	393	7914	34236	28611	16063	8161	1974	433				12.8	12.9	99709	97784
2011		6	14	5	4	189	772	586	555	670	2578	20171	22082	10829	5298	2207	266	9	6		12.9	13.0	66247	64116
2012		7	36	20	10	131	271	378	702	2144	1183	11105	34010	22742	10906	3903	525	4			13.3	13.4	88077	86521
2013	1	3	9	9	20	127	352	340	1321	2833	3971	15572	51637	52868	20485	6560	492	20			13.5	13.5	156620	154439
2014		10	68	54	4	18	13	25	60	130	1127	3251	19125	23016	10355	2988	284	18			13.8	13.8	60547	60295
EVHOE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**ML**	**ML mature**	**Total**	**Total mature**
1997		5	11	7	17	197	2659	5020	3719	3598	4429	12065	16651	7198	3455	501	18	1			11.8	12.7	59548	47915
1998		1	4	26	76	2093	18283	8631	6125	5966	7095	11730	14078	9260	5076	934	8			1	10.6	12.6	89387	54148
1999			13	52	33	245	11177	26610	23947	6684	2899	4709	7868	6160	1353	267	7				9.5	12.3	92023	29947
2000		17	79	120	8	1504	26894	17674	9836	21967	16382	29585	36853	16522	5397	989	75				10.8	12.2	183903	127769
2001		1	45	687	489	913	21297	37171	13276	28355	31514	18309	12232	6471	3186	1270	81	4			10.0	11.5	175303	101422
2002		2	18	23	11	547	9631	29874	17777	13290	9470	9697	9751	6268	2484	641	37	1	1		9.9	11.9	109522	51639
2003			17	47	17	57	426	1655	7142	20018	24842	20989	21263	14493	7086	1550	36				11.8	12.1	119639	110277
2004			33	512	378	123	1248	1419	1307	1083	3102	7308	7224	6353	7866	3630	241	5			12.7	13.5	41833	36813
2005		2	93	975	1285	146	1100	2326	1229	1553	3183	13398	15758	9834	6010	1658	117	70			12.3	13.1	58738	51580
2006	1	26	112	79	75	15510	37566	10750	3622	2127	1521	1955	4131	3955	2535	921	94	2	12		8.2	13.1	84994	17253
2007		8	187	467	234	1503	22689	126065	64536	6341	6731	5431	6004	5911	4238	1409	118	11			8.8	12.5	251882	36193
2008		3	434	2807	827	5341	53189	247297	165392	163200	69382	38434	18390	17258	9178	3490	745	6	1		9.3	11.1	795371	320083
2009		6	128	194	72	1496	19769	35819	5264	3913	9556	12269	9402	10831	6720	775	38	1			10.0	12.7	116252	53505
2010		21	529	116	154	5755	46438	74986	27175	11952	37420	58313	34737	33774	14626	1561	249	8	1		10.4	12.5	347814	192641
2011		60	95	215	5	541	2247	8368	15256	33221	30237	50384	56559	36673	11867	3082	573	159	47		12.0	12.4	249590	222803
2012		9	145	584	137	2922	28865	26816	6124	11739	13606	22369	37135	44082	19963	4893	127	1			11.4	13.1	219516	153914
2013		3	48	91	10	306	2185	2165	2542	13649	9932	14987	37755	40524	20107	6918	666		2		12.9	13.2	151890	144540
2014		2	693	1386	508	84	1440	885	3074	8732	28586	39397	74122	69736	26871	3908	59	433			12.9	13.1	259915	251844
SPNGFS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**ML**	**ML mature**	**Total**	**Total mature**
1991		1			31	690	1311	313	49	9	6	7	7	4				6			7.0	12.7	2433	39
1992		57	38	9	178	3290	2743	282	48	10	8	69	162	390	779	246	95				8.2	14.7	8404	1760
1993		57	1206	488	97	3730	3753	421	105	54	7	4	8	3	2						6.0	10.8	9934	77
1994	1	40	33		342	4789	10162	8920	3195	53	106	20	9	12	1						7.4	11.1	27685	202
1995		84	108	4	342	3063	2157	220	84	65	58	105	105	90	20	4					6.7	12.4	6510	447
1996		218	537	143	245	4457	4449	267	820	722	82	145	126	219	96	39	2				7.0	11.6	12566	1431
1997	2	102	809	441	235	3458	6824	2189	1923	534	156	353	161	88	3						7.2	11.3	17277	1295
1998	3	2	7	4	49	1920	4685	1815	337	153	125	88	147	135	86	13	2	3			7.5	12.4	9573	752
1999		6	59	13	134	2736	3010	193	106	83	109	143	390	645	402	69					8.1	13.6	8098	1841
2000		7	3729	2046	17	554	1947	489	277	486	756	1252	999	1021	199	34	13				7.4	12.4	13827	4760
2001		68	4	1	153	3241	5085	659	225	206	205	236	692	407	120	22	9				7.7	12.7	11331	1896
2002		4	20		133	2333	2013	284	50	58	54	60	231	314	72	9					7.5	13.2	5634	798
2003		4	950	567	4	77	221	57	39	28	16	22	17	23	16	5	1				4.7	12.5	2047	128
2004		6	22	4	43	2289	3808	443	110	83	58	219	931	776	303	2	1				8.5	13.3	9097	2372
2005		16	451	25	9	754	1007	207	85	102	30	54	257	218	90	44	2				7.8	13.1	3349	797
2006		14	156	160	50	2238	8913	4507	175	94	9	36	229	419	169	9	2				7.4	13.5	17181	968
2007		49	40	1	111	3025	6620	1099	129	260	81	7	93	215	89	21	3				7.2	12.4	11843	768
2008	7	4	92	247	1	936	1561	1326	234	1483	304	537	11	833	201	186	11				9.2	11.9	7974	3566
2009	1	17	53	125	9	2582	3816	4105	119	250	45	142	59	819	120	17	1	1			7.8	13.1	12283	1456
2010		55	102	5	232	13090	22032	3169	1160	1056	89	82	179	1007	1981	518	9				7.5	13.6	44766	4920
2011		29	260	105	46	2805	5511	1278	148	340	145	100	144	591	724	134	3	1			7.9	13.5	12364	2182
2012		29	132	35	556	7550	7844	1364	88	53	59	170	1051	2394	1553	432	21				8.4	14.1	23331	5734
2013			2	11	126	2163	4664	854	302	609	251	61	110	123	140	64	7				7.6	11.7	9486	1364
2014		75	117	6	12	263	465	79	1083	1175	1174	1266	998	2444	3623	817	31	1			12.5	13.4	13630	11530

Table 6.6.2.1. Boarfish in ICES Subareas VI, VII and VIII. IBTS length-frequency data converted to age-structured index by application of the 2010 common ALK rounded down to 1cm length classes.

All	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20+**
1997	9186	11460	5356	4603	4209	7331	6050	4331	4970	4375	1498	2491	1741	1248	635	1242	161	676	635	3814
1998	17475	19641	6886	6423	5693	7515	5791	3814	4860	4439	1481	2883	1654	1644	685	1240	236	917	685	4965
1999	11838	33029	20031	8826	3580	3421	2837	1990	2911	2552	804	1716	1045	1010	320	705	80	539	320	2435
2000	19340	29071	12974	18627	16220	19669	14950	10117	11553	9928	3345	5427	3955	2717	1310	2709	265	1470	1310	7757
2001	20344	44451	20694	25753	22184	16593	9665	4839	5137	4484	1492	2471	1545	1362	643	1109	175	824	643	4482
2002	10040	33131	18597	13158	9120	9171	6846	4380	6006	5313	1699	3476	2053	2046	696	1430	202	1115	696	5313
2003	840	4714	8356	20850	19443	18478	13092	7863	10801	10051	3279	7063	3662	4270	1598	2792	629	2439	1598	12890
2004	5958	5660	2092	2537	3567	8255	7560	5288	8479	8618	2871	6954	2968	4378	1924	2576	866	2794	1924	16191
2005	4201	4323	2012	2784	3836	9869	9393	6931	10296	9875	3269	7332	3684	4419	1814	2913	759	2642	1814	14728
2006	44120	35631	8054	7238	6703	8802	9417	6528	14774	15648	4994	14441	5398	9659	3847	4781	1967	6478	3847	37015
2007	24531	128029	67188	19124	7326	8707	7376	4824	8405	8454	2739	7014	2967	4520	1748	2495	799	2784	1748	15325
2008	43985	262478	172674	148047	91323	53729	31280	15702	23250	22959	7433	17778	7213	11602	5022	6177	2310	7992	5022	45589
2009	18107	42788	14748	10829	12257	14366	9760	5252	7847	7656	2476	5816	2443	3766	1259	2049	642	2128	1259	11324
2010	58552	98227	37475	25665	30828	52503	37174	21833	27440	24593	8035	15093	8215	8983	3253	6110	1257	4997	3253	25820
2011	8615	17617	17110	34003	34910	52378	39952	26259	31789	27728	9181	16113	10503	8764	3850	7350	1012	5048	3850	26631
2012	32050	40410	12771	13406	14205	27201	28554	21680	36693	35756	11588	28599	13608	17833	7714	10766	2944	11650	7714	64807
2013	6803	7520	5505	13956	13771	24883	28094	22103	38364	35844	11307	27931	14497	17316	6137	10616	2170	10230	6137	51394
2014	2155	3114	4766	15071	20583	38743	39077	28420	50052	46327	14393	35894	18343	22637	6791	13256	2562	12503	6791	59768
EVHOE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20+**
1997	1876	6003	3741	3911	3938	7065	5867	4218	4832	4259	1461	2428	1699	1214	623	1215	159	659	623	3737
1998	12977	15997	6248	6247	5591	7435	5732	3777	4806	4386	1463	2843	1635	1619	676	1224	232	904	676	4888
1999	7576	31223	19915	8732	3499	3308	2715	1905	2720	2357	743	1540	975	893	285	647	62	474	285	2102
2000	17676	27730	12586	17986	15525	18740	14297	9737	11041	9490	3208	5160	3797	2556	1266	2604	253	1384	1266	7385
2001	14389	41313	20357	25467	21921	16211	9247	4525	4543	3951	1332	2057	1322	1098	578	959	153	684	578	3884
2002	6719	31728	18455	12784	8389	7115	4767	2851	3429	3018	994	1806	1123	1009	421	796	117	573	421	2964
2003	509	3993	7348	18371	17276	16113	10798	6270	7620	6852	2267	4294	2501	2456	1009	1838	326	1387	1009	7340
2004	1265	1976	1261	1722	2227	4124	3228	2061	2871	3058	1066	2426	939	1509	901	917	382	1142	901	7311
2005	2102	2603	1497	2098	3015	7160	5992	4177	5301	4873	1642	3144	1796	1776	833	1368	285	1065	833	6107
2006	35834	26593	4803	2199	1386	1489	1332	947	1521	1484	485	1170	557	725	311	445	125	464	311	2596
2007	16818	122140	65369	16986	4919	4316	2967	1715	2452	2392	788	1802	820	1124	484	678	204	715	484	4049
2008	41611	258758	168378	134061	77106	37738	18750	8277	9132	8183	2660	4868	2458	2992	1226	1876	492	1919	1226	10417
2009	13338	36829	12194	5626	5982	7788	5443	3054	4443	4230	1364	3079	1382	1965	618	1114	309	1064	618	5485
2010	33601	83903	35048	21678	23503	34210	23037	12643	16303	14519	4647	9008	4716	5551	1689	3457	690	2957	1689	14298
2011	2212	12471	14982	28729	26114	31844	23915	15535	19473	16964	5542	10176	6534	5663	2262	4513	597	3197	2262	16235
2012	20089	34348.2	11534.9	11098.2	10795	14979	13308	9004.3	15662	14714	4598.2	11467	5540.3	7325	2325	4141.7	920.1	4164.5	2325	20439
2013	1646.6	3695.13	3805.29	10387.6	9206.8	11385	11271	8299.3	14485	13797	4373.9	10961	5364.4	6893.4	2550	4068.1	980.6	4205.1	2550	21823
2014	1524	2365.12	3804.68	12987.8	17315	27692	24954	17460	27410	25016	7910.7	18266	9917.6	11160	3465	7106.7	1227	5976.6	3465	28811
IGFS+WCSGFS+EVHOE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20+**
2003	636	4552	8306	20803	19406	18414	13013	7804	10668	9916	3237	6942	3612	4190	1573	2752	617	2393	1573	12654
2004	1685	3414	1912	2444	3481	8017	7255	5037	8031	8189	2735	6610	2796	4164	1860	2446	838	2683	1860	15644
2005	2930	3604	1895	2694	3773	9738	9200	6777	9949	9514	3154	7004	3553	4203	1731	2801	721	2505	1731	13978
2006	36687	28176	6830	7100	6633	8714	9277	6421	14479	15337	4898	14144	5288	9457	3779	4686	1933	6356	3779	36365
2007	17873	124020	66810	18929	7205	8648	7322	4790	8309	8353	2708	6917	2932	4453	1729	2464	788	2746	1729	15126
2008	42240	260577	172031	147113	90691	53328	31023	15587	22918	22641	7344	17496	7113	11395	4967	6101	2285	7861	4967	44972
2009	13607	37705	13658	10616	12063	14060	9426	5030	7283	7072	2296	5275	2243	3396	1141	1878	582	1909	1141	10185
2010	33976	84649	35967	24858	30441	52245	36921	21671	26982	23992	7828	14456	8055	8546	3060	5910	1145	4712	3060	24053
2011	2884	13954	16666	33742	34724	52174	39716	26089	31387	27290	9039	15699	10356	8486	3752	7213	958	4882	3752	25707
2012	20395	35049.5	12385.8	13340.3	14140	26984	28191	21406	35924	34955	11342	27840	13323	17314	7548	10525	2861	11338	7548	63197
2013	2020.6	4557.16	5053.52	13514.9	13490	24723	27933	21993	38084	35555	11218	27662	14393	17133	6074	10529	2140	10116	6074	50796
2014	1608	2472.17	3961.48	13919.6	19658	37649	37854	27659	47709	43766	13598	33366	17513	20876	6103	12489	2234	11310	6103	53097
SPNGFS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20+**
1997	7306	5446	1609	681	249	203	121	67	69	56	18	22	18	11	4	11	0	6	4	23
1998	4493	3640	638	175	101	79	58	37	54	53	17	40	19	25	9	15	4	14	9	77
1999	4258	1802	116	93	80	112	121	85	191	195	61	175	70	117	35	58	18	65	35	333
2000	1661	1325	347	518	553	750	537	315	443	379	116	237	139	146	37	91	10	78	37	325
2001	5952	3099	308	205	161	197	190	148	199	175	58	114	77	62	25	53	6	34	25	169
2002	3315	1395	104	54	43	55	63	47	98	88	26	71	37	46	10	25	3	24	10	97
2003	203	155	38	26	16	14	10	5	9	9	3	7	3	4	2	2	1	3	2	15
2004	4267	2243	177	82	68	171	219	186	303	279	89	209	118	124	37	85	14	63	37	294
2005	1253	701	108	78	46	50	60	51	84	78	25	59	33	35	15	24	4	22	15	116
2006	7297	7378	1191	85	34	36	56	44	116	112	33	100	43	68	14	32	8	35	14	154
2007	6646	3990	367	180	106	37	30	18	55	54	16	50	20	35	8	15	4	20	8	92
2008	1736	1886	629	908	597	329	178	62	202	183	47	158	53	122	28	36	10	81	28	352
2009	4487	5077	1085	168	104	79	71	26	174	155	37	147	56	113	9	34	6	58	9	194
2010	24558	13572	1504	792	346	101	85	41	222	365	132	436	76	306	146	130	91	206	146	1347
2011	5730	3656	432	244	163	94	77	38	140	182	61	198	48	140	50	59	33	84	50	493
2012	11653	5359	383	62	55	160	276	202	620	657	201	638	228	441	140	198	73	266	140	1382
2013	4763	2947	446	439	276	110	59	30	44	49	17	44	16	28	15	16	7	21	15	132
2014	542	611	767	1131	910	875	626	323	711	914	317	926	228	635	271	291	168	402	271	2512

Table 6.6.3.1. Boarfish in ICES Subareas VI, VII, VIII. Pseudo-cohort derived estimates of fishing mortality (F) and total mortality (Z), in comparison with total catch per year. Pearson correlation coefficient of F vs. catch (tonnes) indicated.

Age	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014
	Raised numbers								ln (raised numbers)							
1	0	0	1575	2415	0	28	301	0	0	0	7	8	0	3	6	0
2	352	5488	15043	11229	2894	893	7148	695	6	9	10	9	8	7	9	7
3	2114	21140	65744	72709	41913	5467	156680	49503	8	10	11	11	11	9	12	11
4	40851	105575	338931	294382	28148	41278	58522	127520	11	12	13	13	10	11	11	12
5	48915	141300	475619	567689	30116	110272	59797	93705	11	12	13	13	10	12	11	11
6	62713	195339	543707	878363	175696	146582	68949	67275	11	12	13	14	12	12	11	11
7	26132	104031	307333	522703	143967	492078	302967	193061	10	12	13	13	12	13	13	12
8	29766	66570	172783	293719	107126	365840	250341	139124	10	11	12	13	12	13	12	12
9	56075	53159	155477	276672	77861	271916	212318	121042	11	11	12	13	11	13	12	12
10	44875	46893	130148	232122	60022	173486	160137	94225	11	11	12	12	11	12	12	11
11	14019	15289	42521	78588	46079	69396	63025	36078	10	10	11	11	11	11	11	10
12	32359	21178	61350	114600	40468	40968	41490	24895	10	10	11	12	11	11	11	10
13	4848	11854	39609	59932	24352	58888	59380	36309	8	9	11	11	10	11	11	10
14	16837	13570	31569	59060	19724	30277	30355	19064	10	10	10	11	10	10	10	10
15+	109481	112947	196967	349320	157707	217260	239366	150688	12	12	12	13	12	12	12	12
Z (age 7-14)									0.18	0.32	0.32	0.32	0.28	0.42	0.35	0.34
F (Z-M), where M = 0.16									0.02	0.16	0.16	0.16	0.12	0.26	0.19	0.18
Catches (t)									21576	34751	90370	144047	36937	86414	75409	45231
Correllation coefficient landings vs. F									0.49							

Table 6.6.4.1. Boarfish in ICES Subareas VI, VII, VIII. Acoustic survey abundance and biomass estimates for 2014 and 2015. All estimates have been reworked to reflect the most up to date target strength of -66.2. The 2011 survey has been reworked using daylight data only to match all subsequent years.

	Abundance (millions)				
	2011*	2012*	2013	2014	2015
Total estimate					
Definitely	7,165	11,684	8,834	2,227	3,742
Probably	1,397	2,072	240	830	206
Mixture	2,542	501	17	41	48
Total estimate	11,104	14,257	9,091	3,098	3,996
Possibly	103	16	-	-	-
CV TSN	21.2	10.6	17.5	15.1	15.1
SSN Estimate					
Definitely	7,133	11,615	8,120	2,223	3,211
Probably	1,389	2,050	179	829	206
Mixture	2542	500	17	41	48
SSN estimate	11,064	14,165	8,316	3,093	3,465
Possibly	101	16	-	-	-
	Biomass (t)				
	2011*	2012*	2013	2014	2015
Total estimate					
Definitely	400,746	708,019	431,571	133,713	215,337
Probably	78,224	123,723	7,187	51,461	13,990
Mixture	191,206	31,704	1,139	2,605	3,307
Total estimate	670,176	863,446	439,897	187,779	232,634
Possibly	4,548	1,017	-	-	-
CV TSB	24.2	10.7	16.7	15.1	15.1
SSB Estimate					
Definitely	400,126	706,582	416,124	133,600	209,363
Probably	78,060	123,286	5,895	51,449	13,990
Mixture	191,206	31,676	1,139	2,605	3,306
SSB estimate	669,392	861,544	423,158	187,654	226,659
Possibly	4492	1,017	-	-	-

***Biomass reworked using a modelled boarfish TS-Length relationship (-66.2dB).**

Table 6.6.5.1. Boarfish in ICES Subareas VI, VII, VIII. Key parameter estimates from the exploratory Shaefer state space surplus production model. CV(TSB_{2015}) is the coefficient of variation of the estimated total stock biomass in 2014. Posterior parameter distributions are provided in Figure 6.6.5.5.

Run	*r*	*K*	F_{MSY}	B_{MSY}	TSB_{2015}	CV(TSB_{2015})
1	0.35	695 778	0.175	347 889	301 415	0.373

Table 6.6.5.2. Boarfish in ICES Subareas VI, VII, VIII. Estimates of total stock biomass and F.

Year	Low TSB	Mean TSB	High TSB	Low F	Mean F	High F
1991	132900	267909	536800	0	0	0
1992	208700	405308	799900	0	0	0
1993	249500	485567	942200	0	0	0
1994	289800	568736	1105000	0	0	0
1995	261800	504781	990500	0	0	0
1996	264700	509954	987800	0	0	0
1997	233900	441628	855100	0	0	0
1998	313900	595626	1155000	0	0	0
1999	244300	467098	902600	0	0	0
2000	199300	388363	758800	0	0	0
2001	224700	417834	794700	0	0	0
2002	196400	365951	697400	0	0	0
2003	178500	328395	619600	0.019	0.039	0.066
2004	250700	466375	879400	0.006	0.012	0.021
2005	229700	426920	804300	0.007	0.016	0.026
2006	272900	502034	942100	0.008	0.016	0.027
2007	236400	429320	814900	0.027	0.057	0.096
2008	290100	525592	994900	0.036	0.076	0.128
2009	288000	506945	943500	0.101	0.22	0.377
2010	439500	799584	1481000	0.102	0.224	0.397
2011	387000	700749	1323000	0.028	0.06	0.101
2012	530700	907078	1671000	0.054	0.112	0.18
2013	403300	705930	1322000	0.059	0.125	0.207
2014	178100	312898	585000	0.080	0.174	0.293
2015	157300	301415	585100	-	-	-

Table 6.7.1.1. Boarfish in ICES Subareas VI, VII, VIII. Projection table based on the results of the exploratory Schaefer state space surplus production model. Basis: Catch (2015) = 53 296 thousand tonnes (EU TAC)). Note that for F projections, the fishing mortality is fixed and the credible intervals for catch (95% CI) represent the uncertainty in biomass; for fixed catch projections credible intervals on F represent the uncertainty in biomass. FMP is based rule 1.1b of the proposed management plan. FICES HCR is based on the generic ICES MSY harvest control rule.

Projection	F_{2016}	F_{2016} 95% CI	Catch 2016	Catch 2016 95% CI	TSB_{2017}	TSB_{2017} 95% CI	Probability $TSB_{2017}<B_{trigger}$	Probability $TSB_{2017}<B_{lim}$
F_{lim}	0.28	-	75177	23780-184900	290636	72720-775100	0.653	0.141
F_{MSY}	0.175	-	49423	15640-121500	321187	81170-838400	0.570	0.115
F_{pa}	0.152	-	43286	13690-106400	322287	82260-833100	0.572	0.117
$F_{ICES\ HCR}$	0.132	-	38026	12030-93510	325610	84470-844600	0.560	0.114
$F_{0.1}$	0.13	-	37487	11860-92180	327336	81630-845600	0.550	0.113
F_{MP}	0.129	-	37217	11770-91510	328266	84240-862900	0.558	0.108
Zero catch	0	0-0	0	-	369123	95170-962500	0.465	0.095
Status quo catch	0.212	-	58838	-	304931	46440-863200	0.617	0.175

Table 6.7.1.1. Boarfish in ICES Subareas VI, VII, VIII. Projection table based on the results of the additional exploratory runs of the Schaefer state space surplus production model with relaxed acoustic CVs. Basis: Catch (2015) = 53 296 thousand tonnes (EU TAC)). Note that for F projections, the fishing mortality is fixed and the credible intervals for catch (95% CI) represent the uncertainty in biomass; for fixed catch projections credible intervals on F represent the uncertainty in biomass. FMP is based rule 1.1b of the proposed management plan. FICES HCR is based on the generic ICES MSY harvest control rule. α is the multiplier used to relax acoustic data CV.

Alpha	Forecast	F2016	F2016 95% CI	Catch 2016	Catch 2016 95% CI	TSB 2017	TSB 2017 95 % CI	Probability TSB 2017 < Btrigger	Probability TSB 2017 < Blim
1.3	Flim	0.277	-	93949	25865-245552	313388	71229-847439	0.716	0.189
1.3	Fmsy	0.173	-	58718	16165-153470	344312	72663-909529	0.659	0.151
1.3	Fpa	0.133	-	45035	12398-117705	355883	82665-932776	0.629	0.138
1.3	Ficeshcr	0.154	-	52102	25865-245552	347742	82724-925818	0.654	0.154
1.3	F0.1	0.13	-	44044	12126-115117	359900	84534-977184	0.638	0.132
1.3	Fmp	0.15	-	50771	13977-132699	354187	81998-945865	0.644	0.145
1.3	Zero catch	0	0	0	0-0	401957	89624-1116981	0.562	0.101
1.3	Statu quo catch	0.182	-	61712	16990-161295	340676	74236-906066	0.663	0.147
1.6	Flim	0.295	-	121731	30210-396429	371384	76005-1254965	0.651	0.154
1.6	Fmsy	0.184	-	76082	18881-247768	410704	81977-1365528	0.6	0.118
1.6	Fpa	0.11	-	45334	11250-147635	441646	92961-1369908	0.548	0.094
1.6	Ficeshcr	0.178	-	73454	30210-396429	414086	84657-1308064	0.588	0.116
1.6	F0.1	0.13	-	53655	13315-174732	431215	94232-1418268	0.57	0.107
1.6	Fmp	0.172	-	71019	17625-231281	409598	88152-1270760	0.596	0.114
1.6	Zero catch	0	0	0	0-0	483466	98277-1519678	0.494	0.075
1.6	Statu quo catch	0.17	-	70069	17389-228188	415316	87396-1366564	0.588	0.116
1.9	Flim	0.302	-	110354	31937-277282	329192	84021-843422	0.695	0.148
1.9	Fmsy	0.189	-	68971	19961-173301	363872	91007-941293	0.63	0.12
1.9	Fpa	0.138	-	50289	14554-126359	381427	93621-998381	0.595	0.11
1.9	Ficeshcr	0.183	-	66936	31937-277282	360281	87810-900088	0.629	0.126
1.9	F0.1	0.13	-	47516	13751-119391	382342	92143-942098	0.586	0.108
1.9	Fmp	0.177	-	64605	18697-162330	367582	89908-927250	0.622	0.111
1.9	Zero catch	0	0	0	0-0	431138	104239-1098759	0.511	0.078
1.9	Statu quo catch	0.166	-	60654	17554-152402	368101	89216-940523	0.62	0.112
2.2	Flim	0.307	-	123177	29810-353012	352558	71380-997540	0.701	0.172
2.2	Fmsy	0.192	-	76986	18631-220632	386699	79063-1083149	0.641	0.148
2.2	Fpa	0.109	-	43906	10626-125828	417758	86968-1194938	0.589	0.125
2.2	Ficeshcr	0.196	-	78650	29810-353012	392008	79511-1150532	0.634	0.14
2.2	F0.1	0.13	-	52179	12628-149539	409064	85675-1159465	0.606	0.127
2.2	Fmp	0.187	-	74966	18142-214843	391663	82835-1123984	0.635	0.15
2.2	Zero catch	0	0	0	0-0	459697	98850-1278497	0.537	0.089
2.2	Statu quo catch	0.151	-	60516	14646-173432	404915	86188-1168957	0.613	0.13
2.5	Flim	0.319	-	134931	34338-383024	365984	75418-994487	0.61	0.135
2.5	Fmsy	0.199	-	84332	21461-239390	405584	86179-1128797	0.539	0.101
2.5	Fpa	0.128	-	54224	13799-153924	435219	90191-1237649	0.499	0.094
2.5	Ficeshcr	0.232	-	98033	34338-383024	397612	83868-1102575	0.561	0.112
2.5	F0.1	0.13	-	54991	13994-156102	434511	91503-1299450	0.509	0.089
2.5	Fmp	0.222	-	93894	23894-266535	402440	83670-1151900	0.557	0.11
2.5	Zero catch	0	0	0	0-0	487848	103926-1355716	0.426	0.07
2.5	Statu quo catch	0.145	-	61357	15614-174172	425428	86371-1165545	0.526	0.092

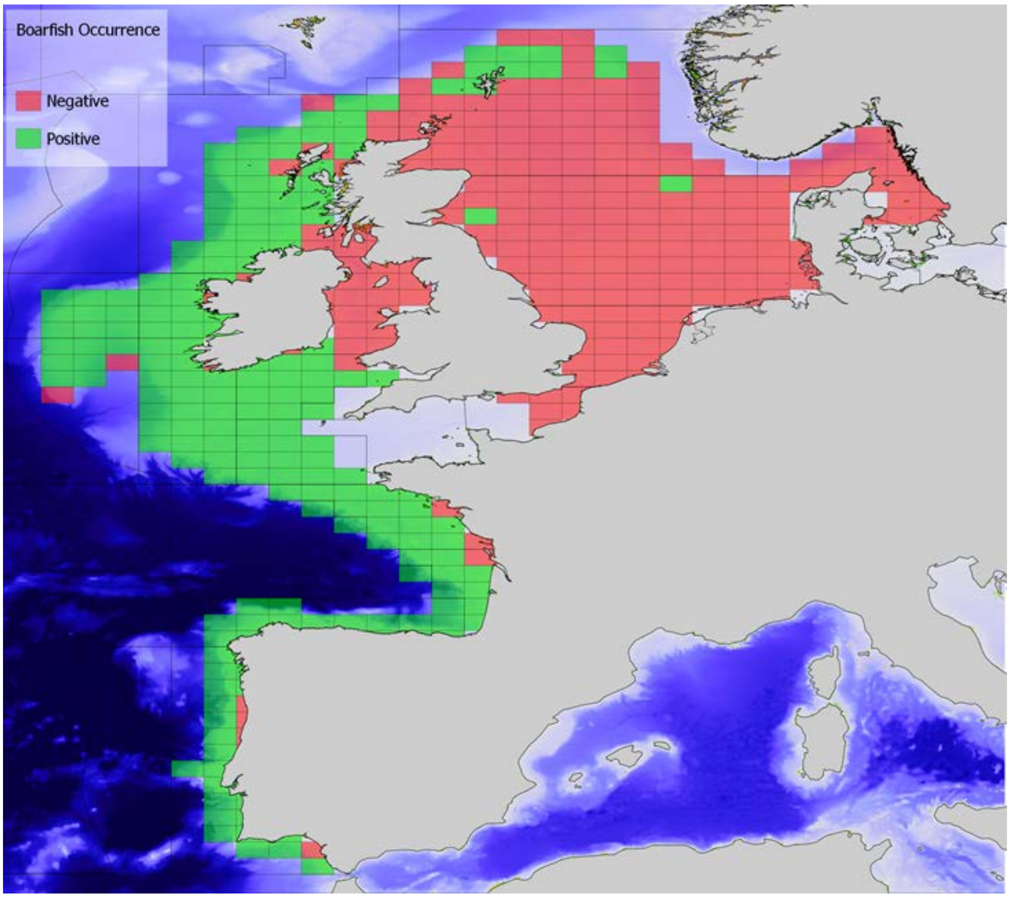
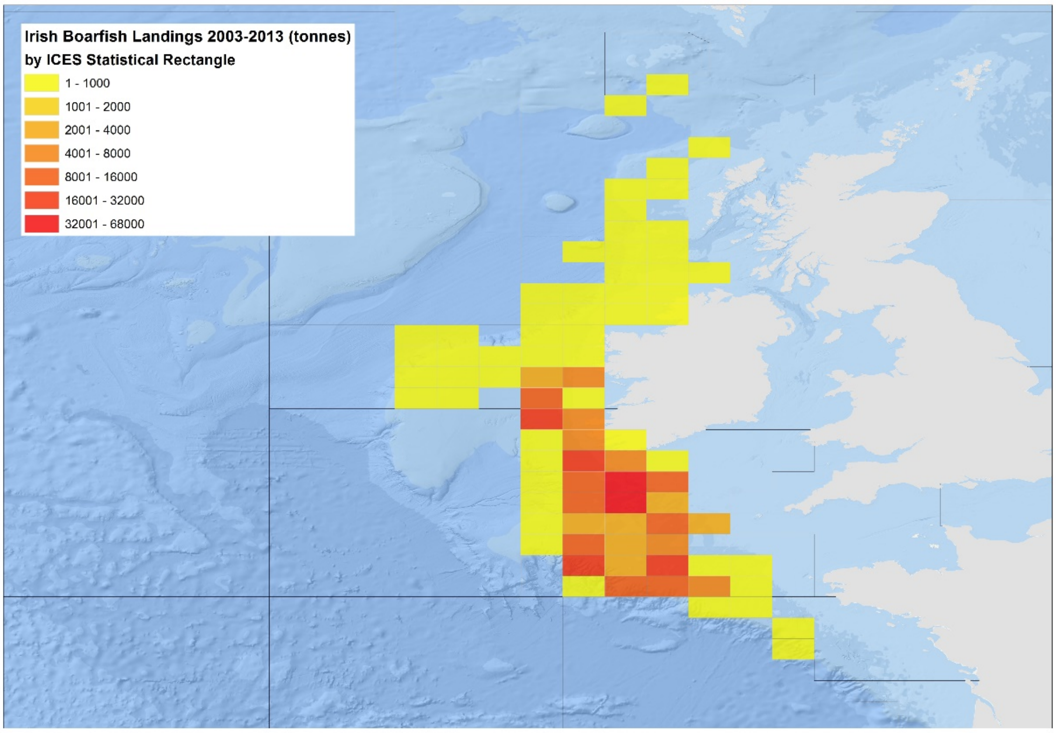


Figure 6.1. Boarfish in ICES Subareas VI, VII, VIII. Distribution of boarfish in the NE Atlantic area based on presence and absence in IBTS surveys (all years).



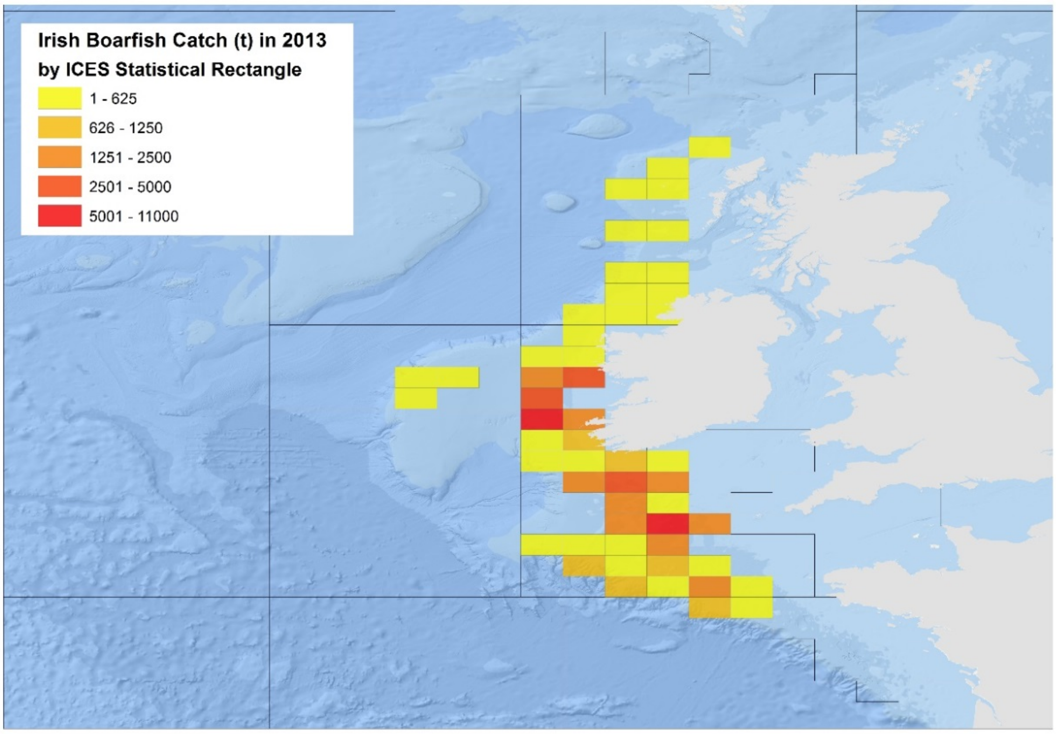


Figure 6.2. Boarfish in ICES Subareas VI, VII, VIII. Combined Irish boarfish landings 2003-2013 by ICES rectangle (Above). Irish boarfish landings 2014 by ICES rectangle (Below).

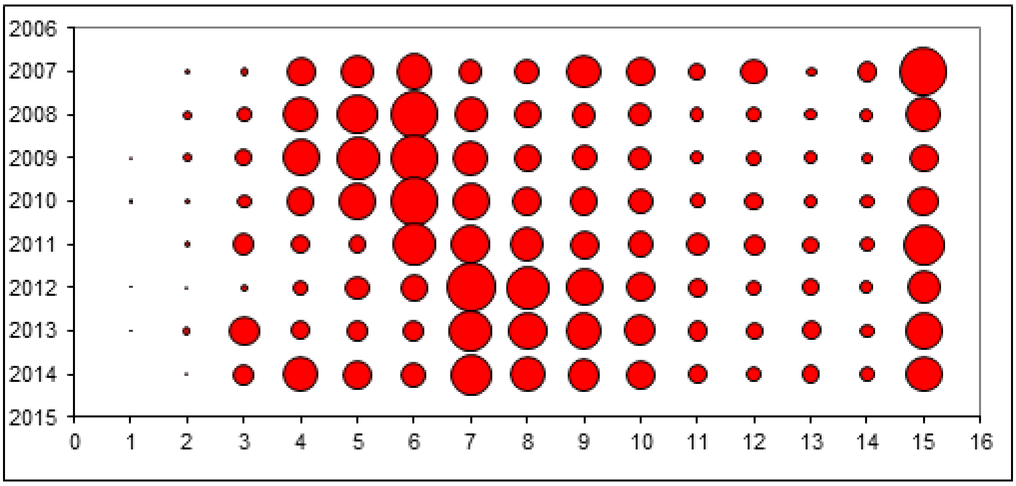
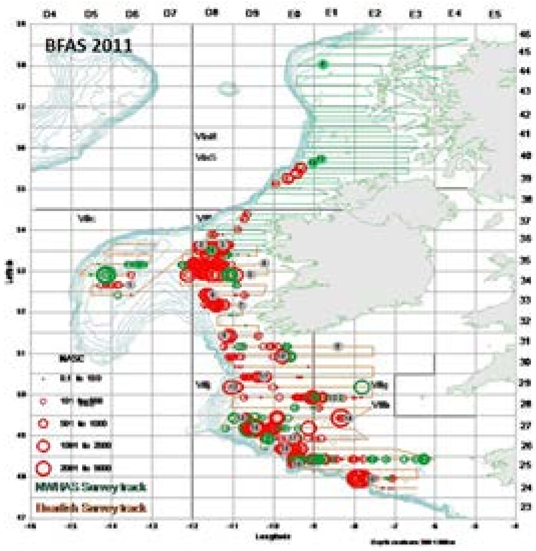
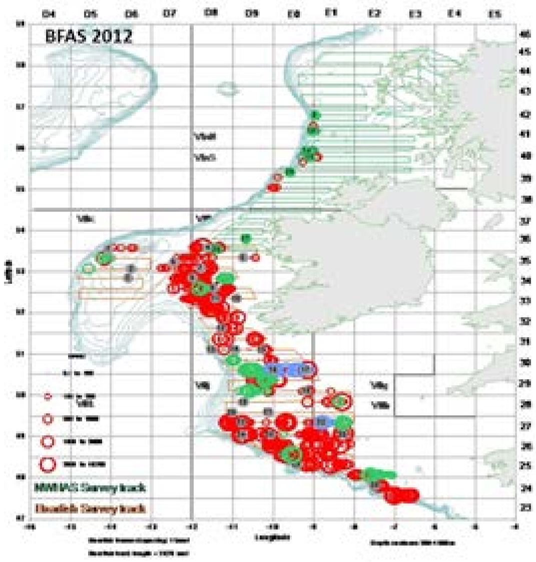


Figure 6.2.1.1. Boarfish in ICES Subareas VI, VII, VIII. Catch numbers-at-age standardised by yearly mean. 15+ is the plus group.


BFAS 2011
NWHAS Survey track
Boarfish Survey track


BFAS 2012
NWHAS Survey track
Boarfish Survey track


2013
NWHAS Survey track
Boarfish Survey track

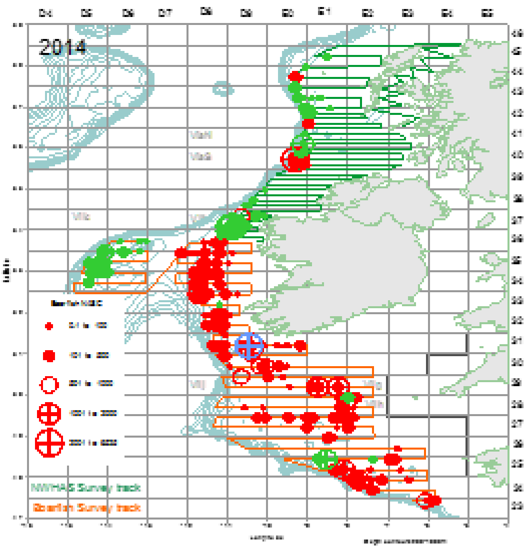


Figure 6.3.1.1a. Boarfish in ICES Subareas VI, VII, VIII. Boarfish acoustic survey track and haul positions from acoustic survey 2011-2014. Red circles represent 'definitely' boarfish, green: 'probably boarfish', blue: 'boarfish mix'.

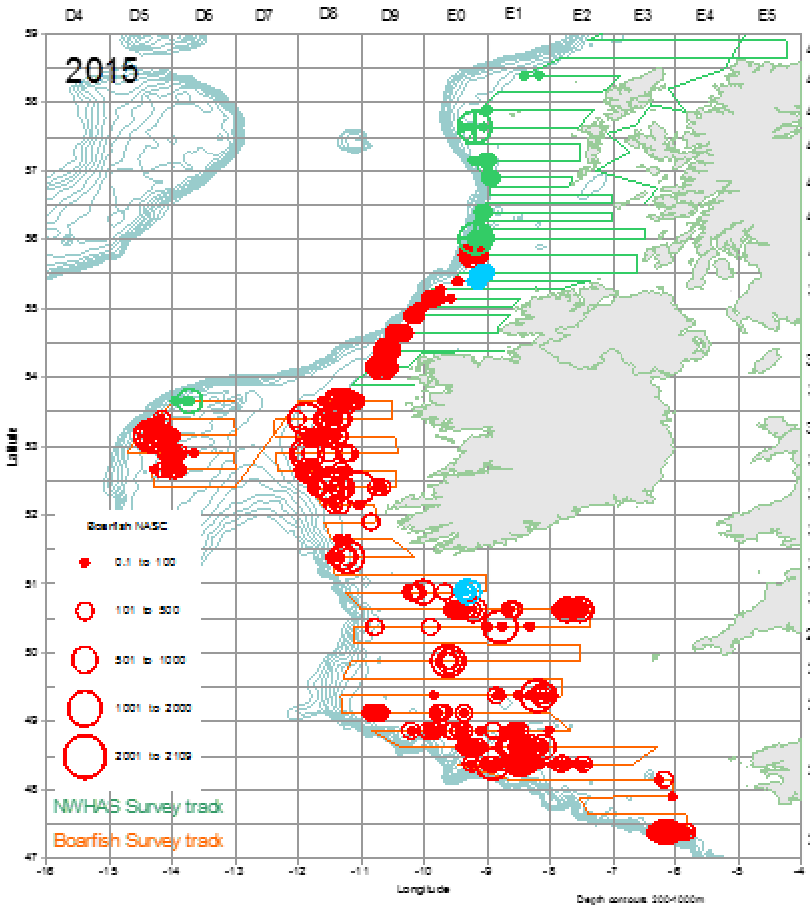


Figure 6.3.1.1b. Boarfish in ICES Subareas VI, VII, VIII. Boarfish acoustic survey track and haul positions from acoustic survey 2015. Red circles represent 'definitely' boarfish, green: 'probably boarfish', blue: 'boarfish mix'.

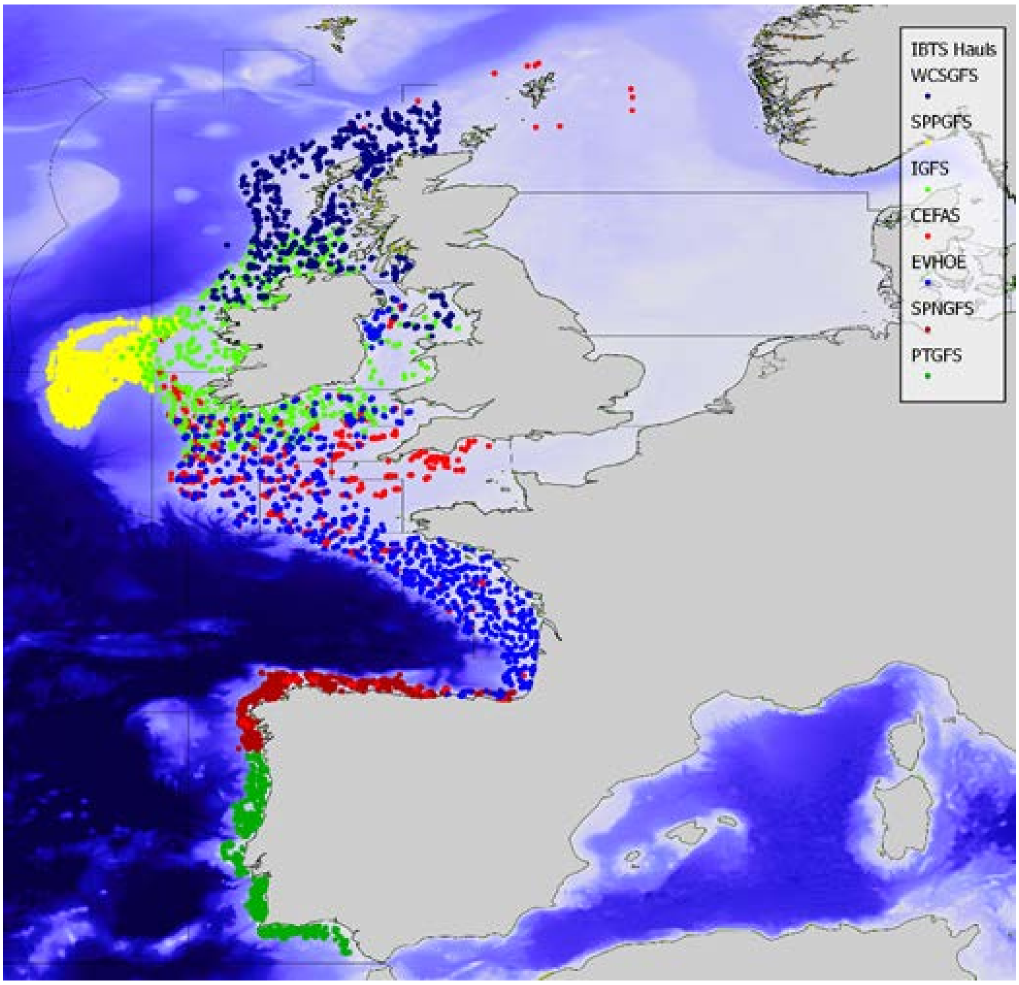


Figure 6.3.2.1. Boarfish in ICES Subareas VI, VII, VIII. The haul positions of bottom trawl surveys analysed as an index for boarfish abundance. Note the Portuguese Groundfish survey included here was not included in the 2014 assessment.

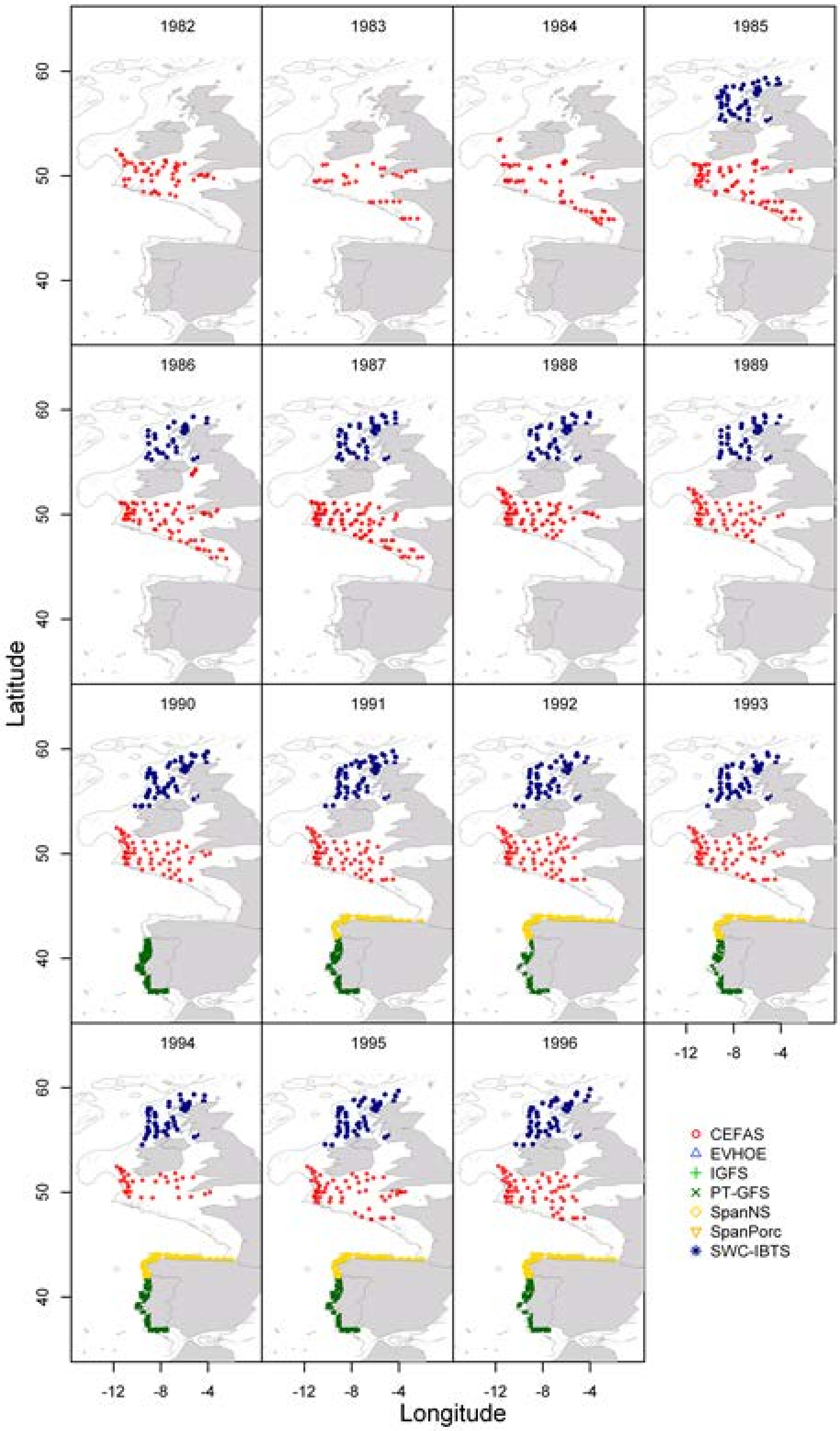


Figure 6.3.2.2a. Boarfish in ICES Subareas VI, VII, VIII. The haul positions of bottom trawl surveys by year analysed as part of the GAM modelling.

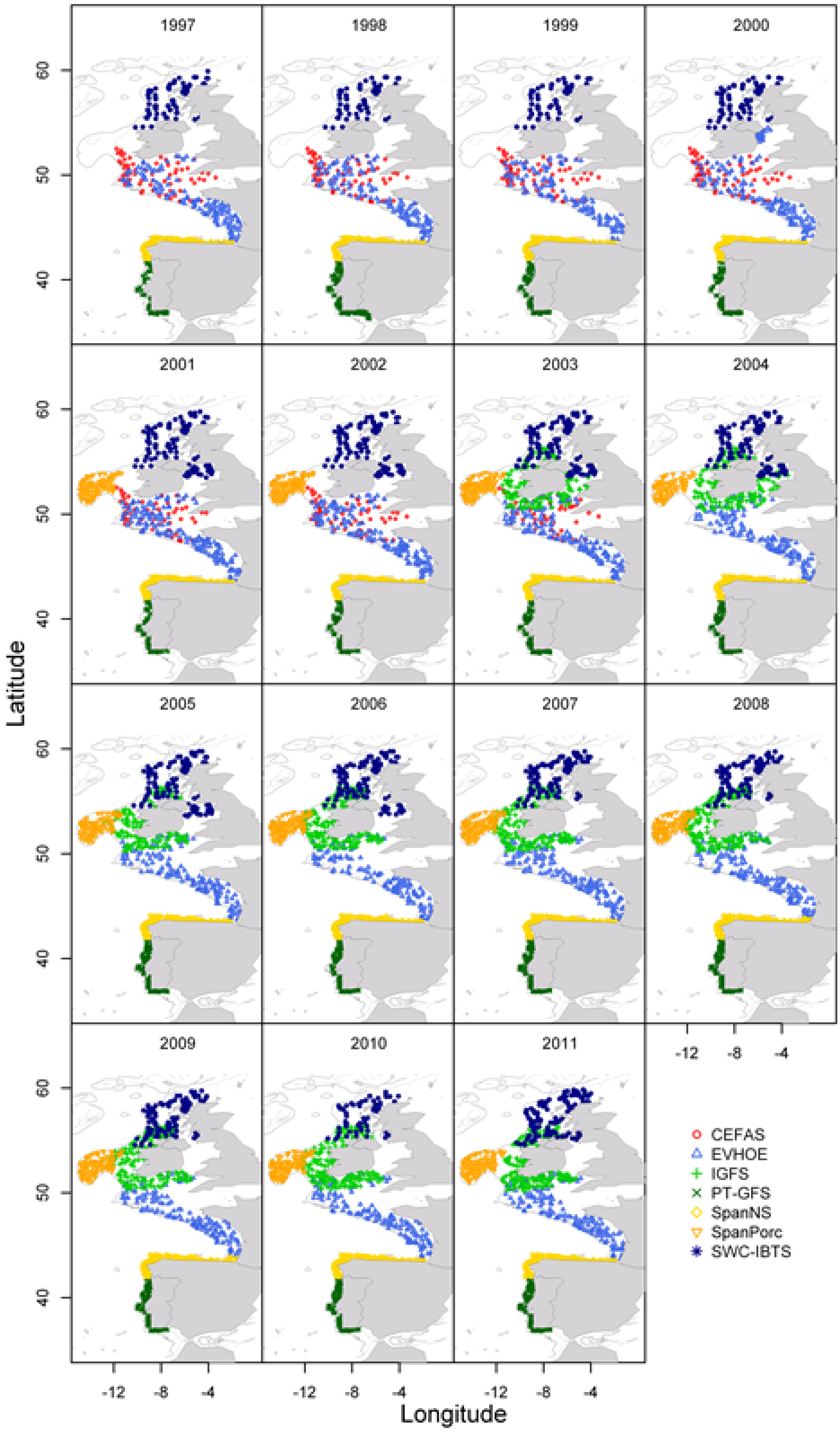


Figure 6.3.2.2b. Boarfish in ICES Subareas VI, VII, VIII. The haul positions of bottom trawl surveys by year analysed as part of the GAM modelling.

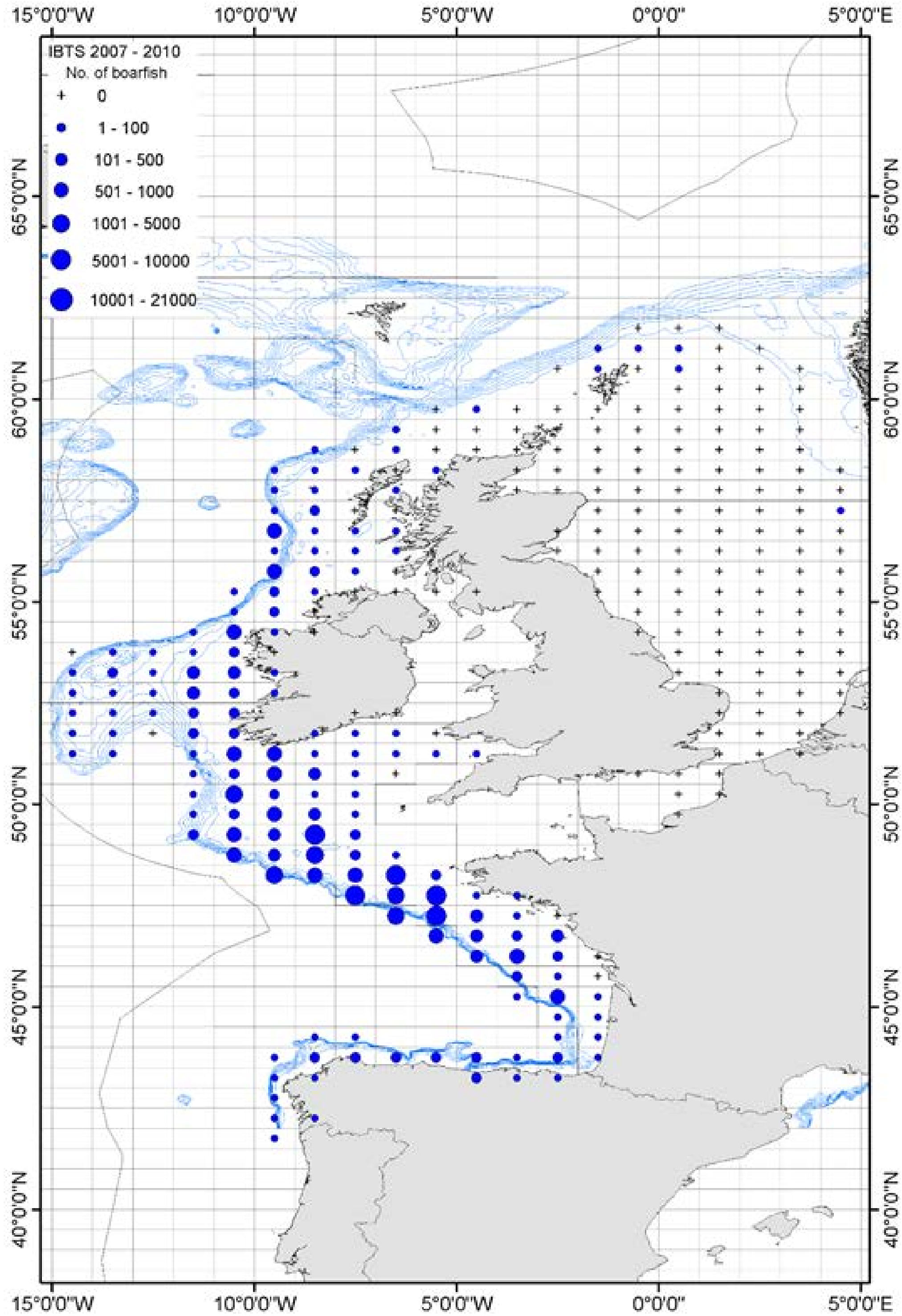


Figure 6.3.2.3. Boarfish in ICES Subareas VI, VII, VIII. Distribution of boarfish in the NE Atlantic showing proposed management area.

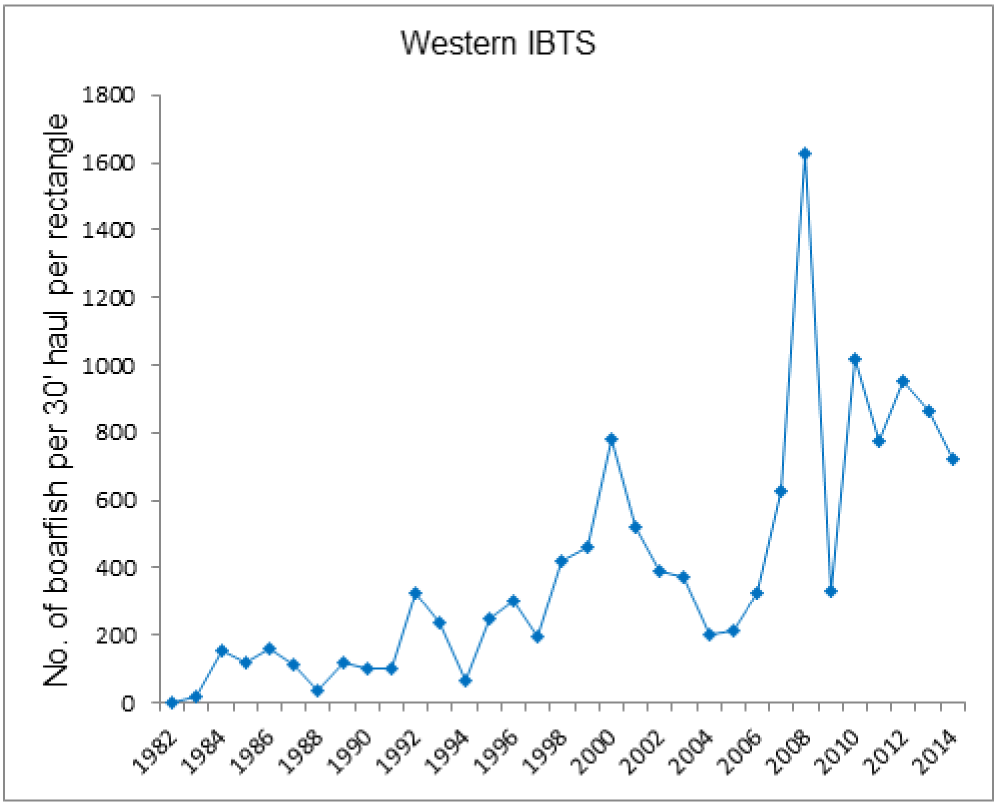


Figure 6.3.2.4. Boarfish in ICES Subareas VI, VII, VIII. CPUE in number per 30 minute haul of boarfish per rectangle in the western IBTS survey 1982 to 2014.

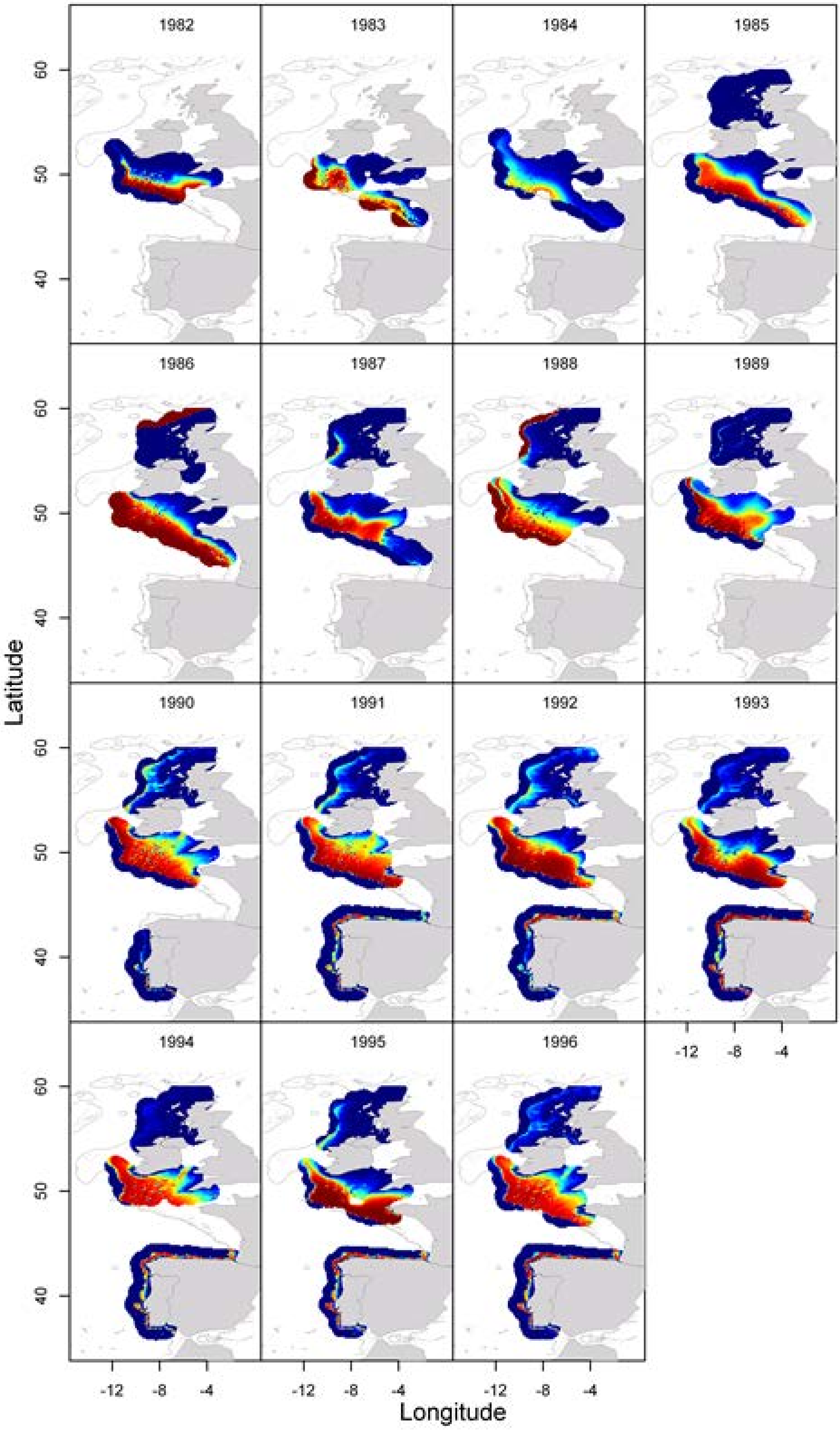


Figure 6.3.2.5a. Boarfish in ICES Subareas VI, VII, VIII. The occurrence GAM of the probability of occurrence of boarfish in a survey area 1982 – 1996. Red indicates definite occurrence and blue indicates absence.

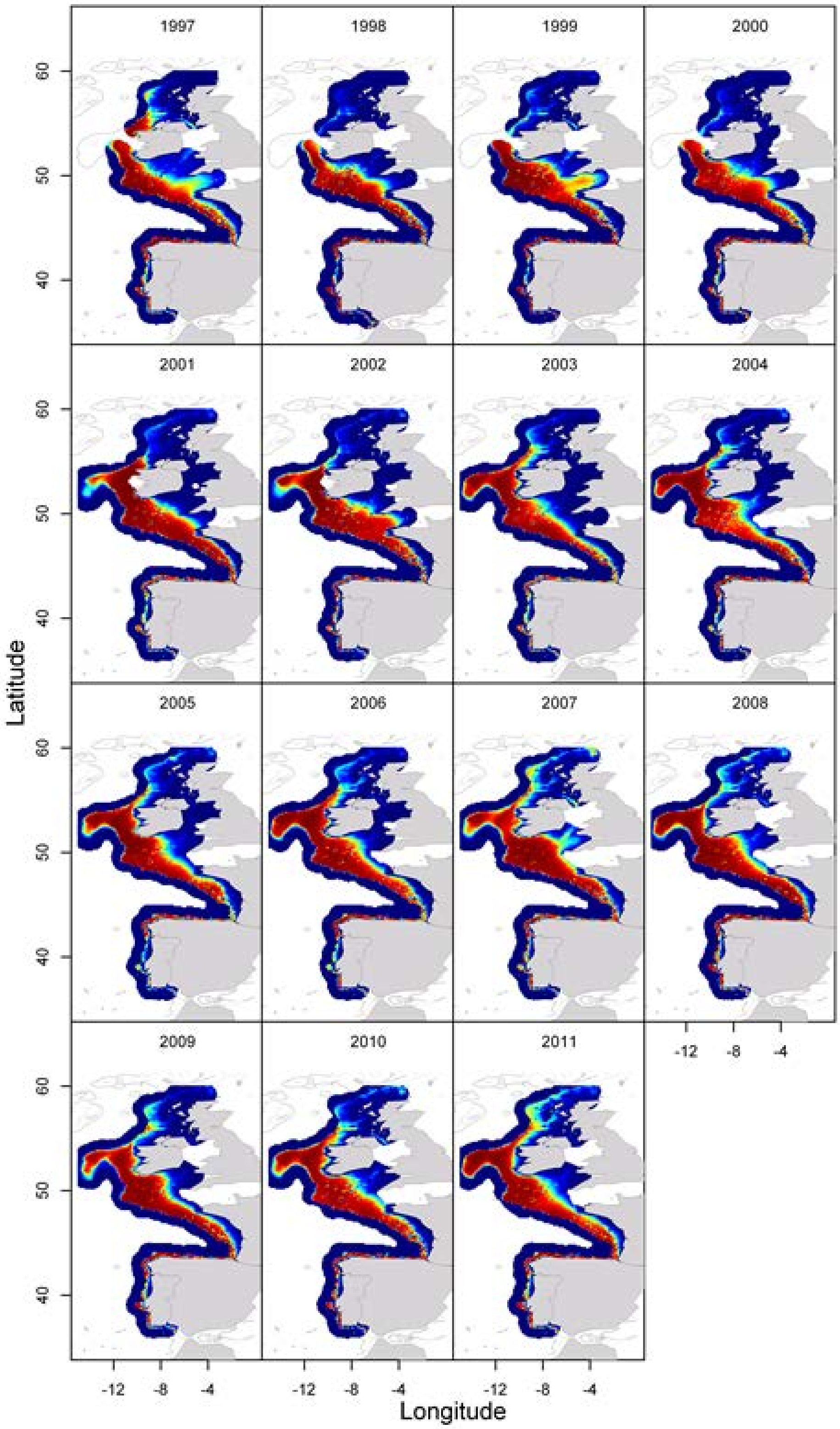


Figure 6.3.2.5b. Boarfish in ICES Subareas VI, VII, VIII. The occurrence GAM of the probability of occurrence of boarfish in a survey area 1997 – 2011. Red indicates definite occurrence and blue indicates absence.

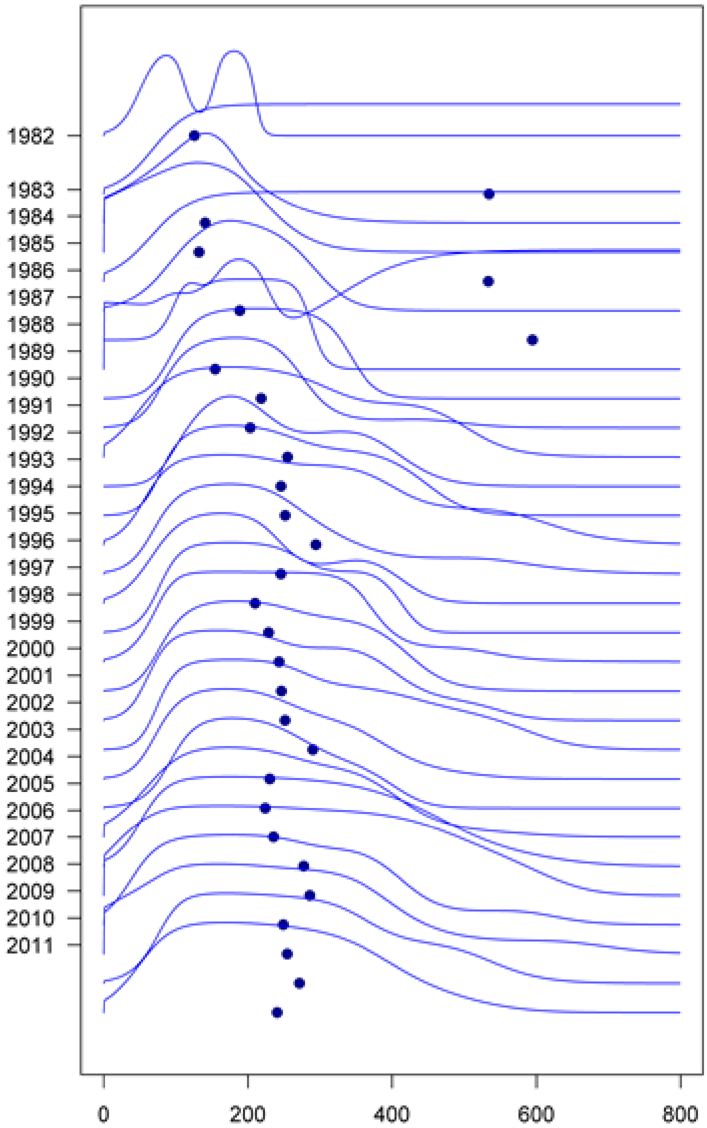


Figure 6.3.2.6. Boarfish in ICES Subareas VI, VII, VIII. The depth distribution profile of boarfish within the IBTS surveys.

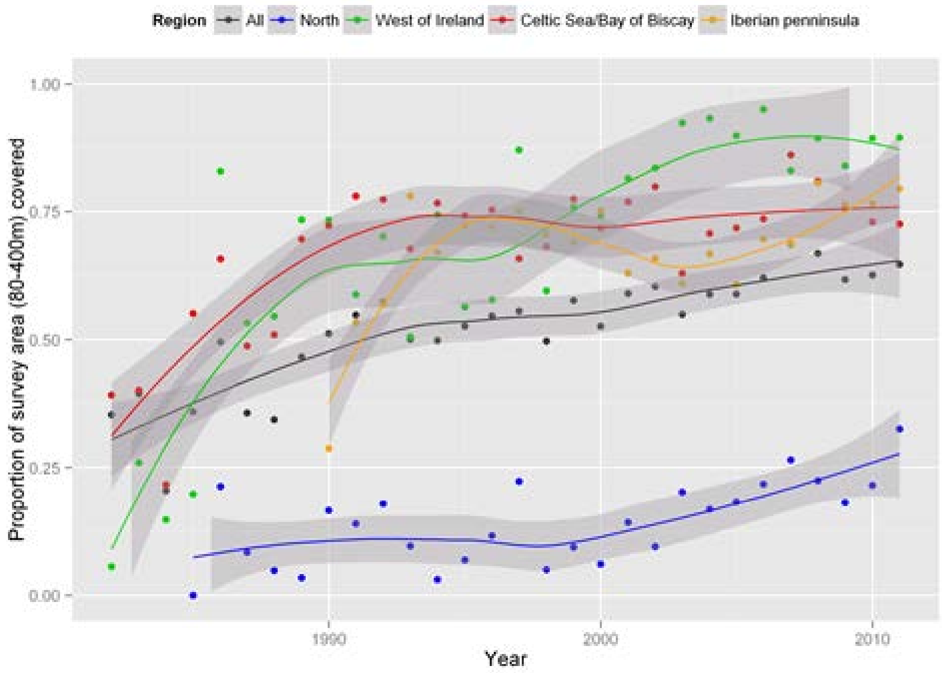


Figure 6.3.2.7. Boarfish in ICES Subareas VI, VII, VIII. The proportion of survey area covered by boarfish per region and per year.

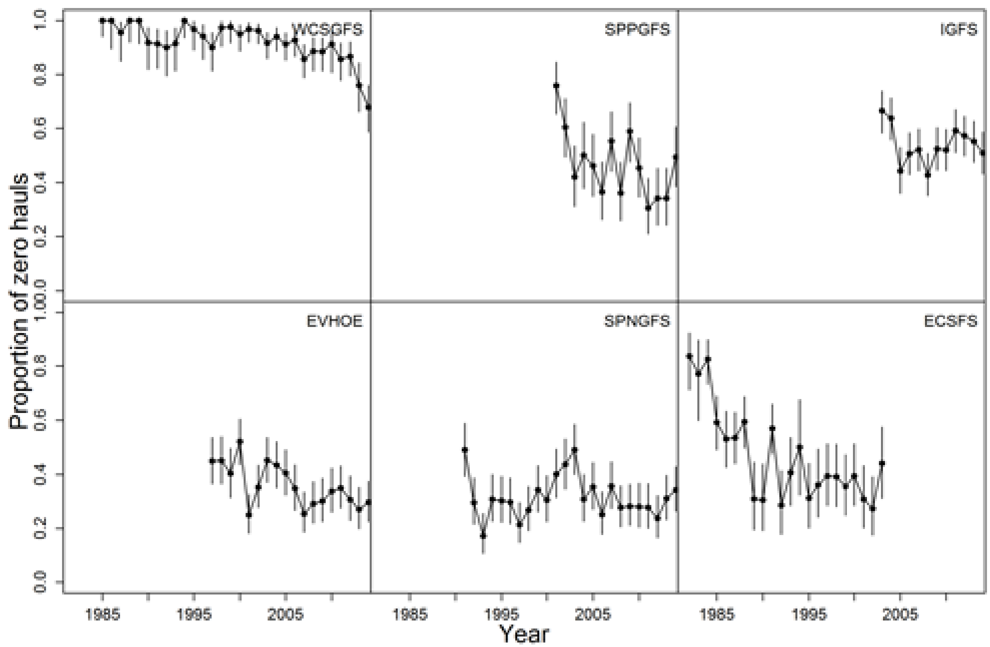
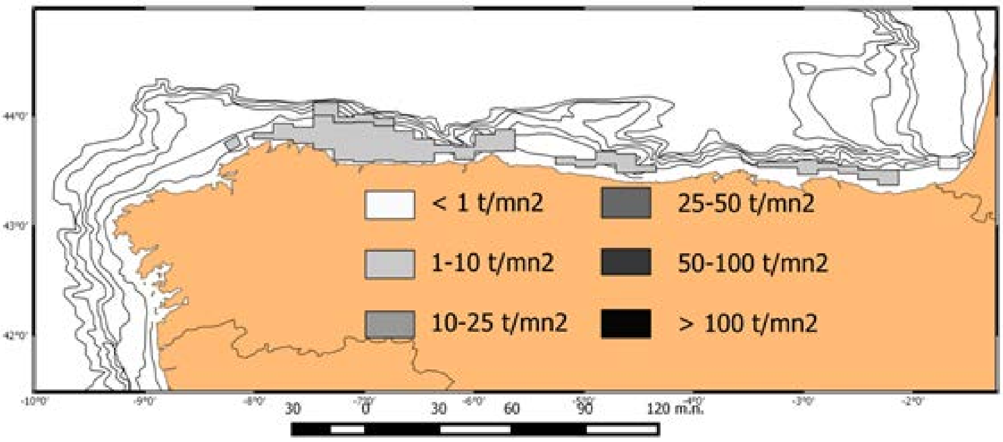


Figure 6.3.2.8. Boarfish in ICES Subareas VI, VII, VIII. The proportion of zero hauls per IBTS survey.



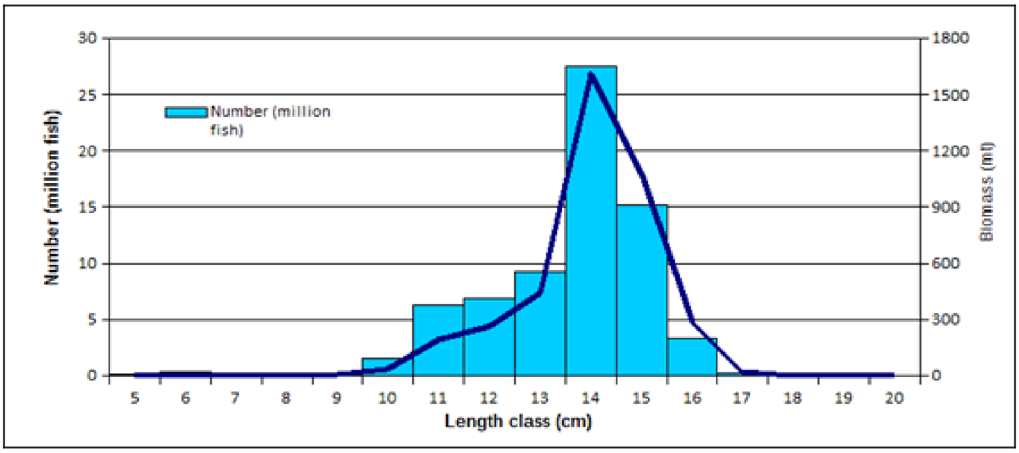


Figure 6.3.3.1. Boarfish in ICES Subareas VI, VII, VIII. Boar fish assessment from PELACUS 0351 acoustic survey: density distribution (above) and length distribution (below).

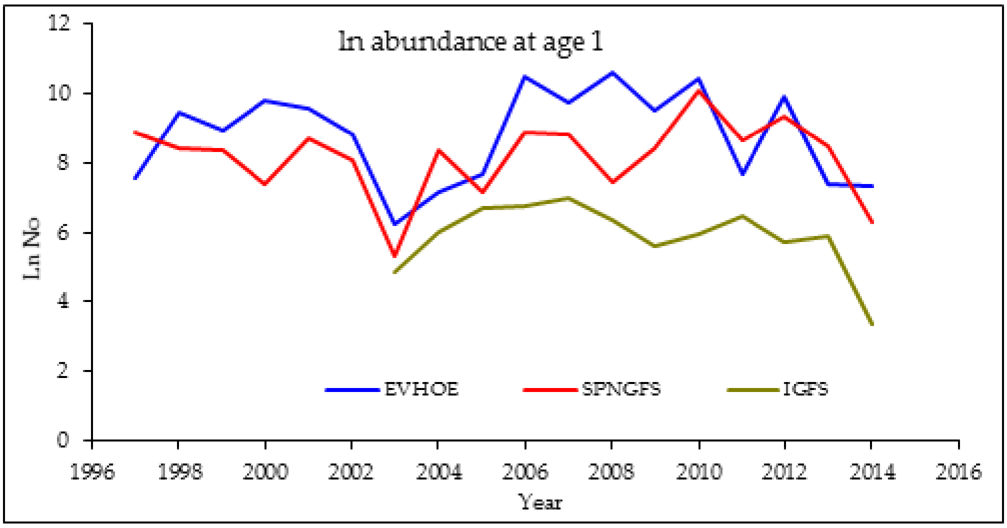


Figure 6.5.1. Boarfish in ICES Subareas VI, VII, VIII. Recruitment-at-age 1, from various IBTS.

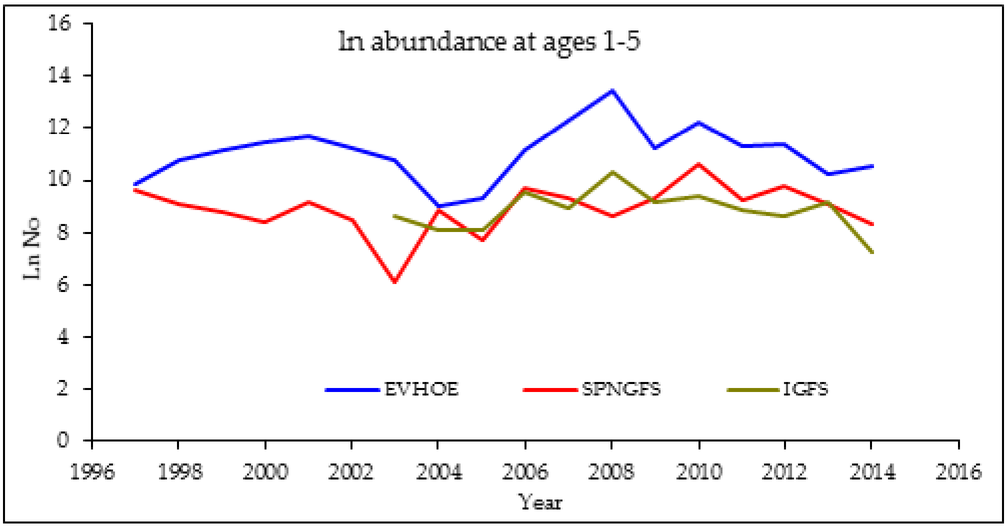


Figure 6.5.2. Boarfish in ICES Subareas VI, VII, VIII. Recruitment-at-ages 1-5, from various IBTS.

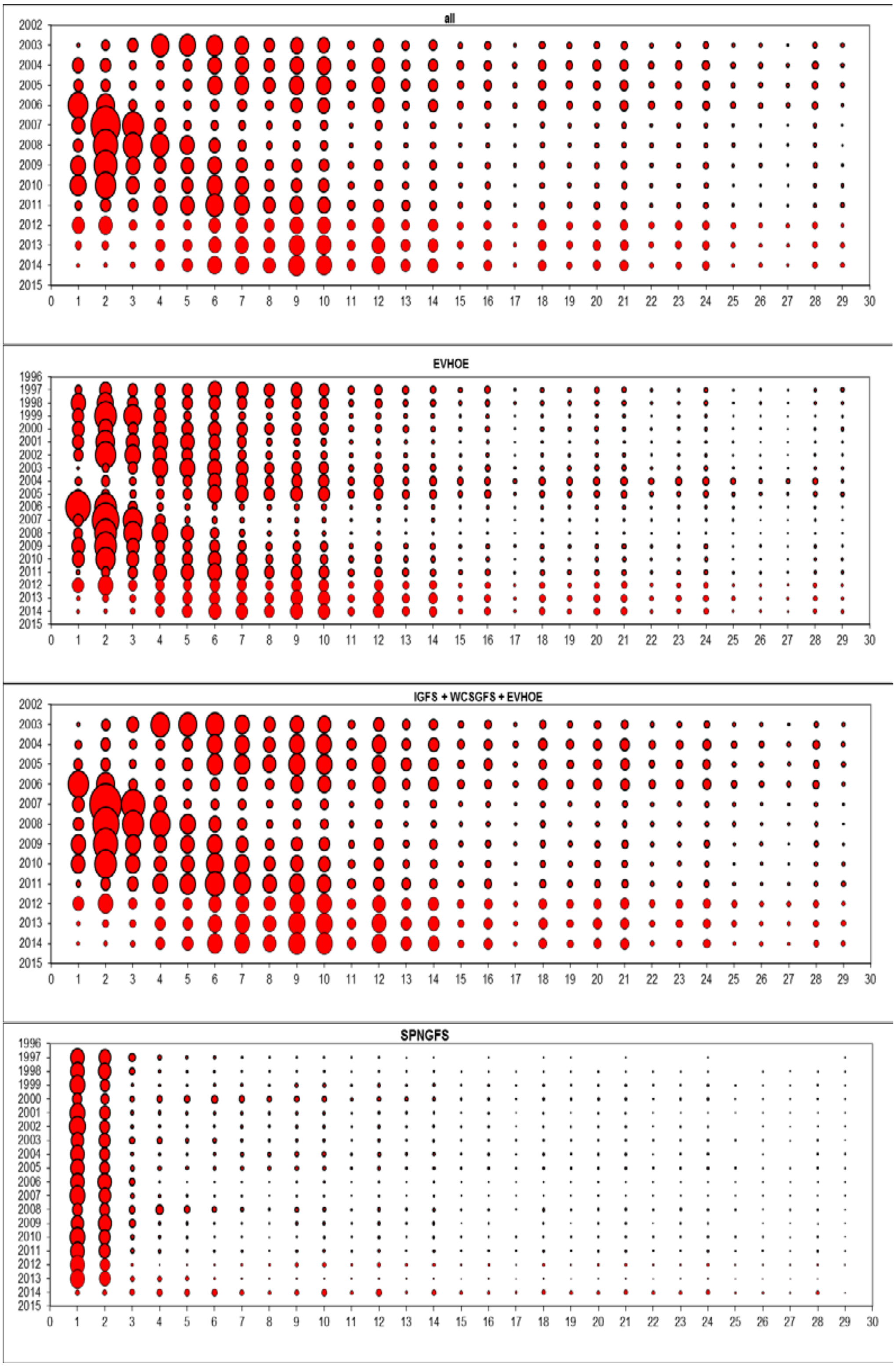


Figure 6.6.2.1. Boarfish in ICES Subareas VI, VII, VIII. Abundance-at-age in constituent western IBTS. Yearly mean standardised abundance-at-age.

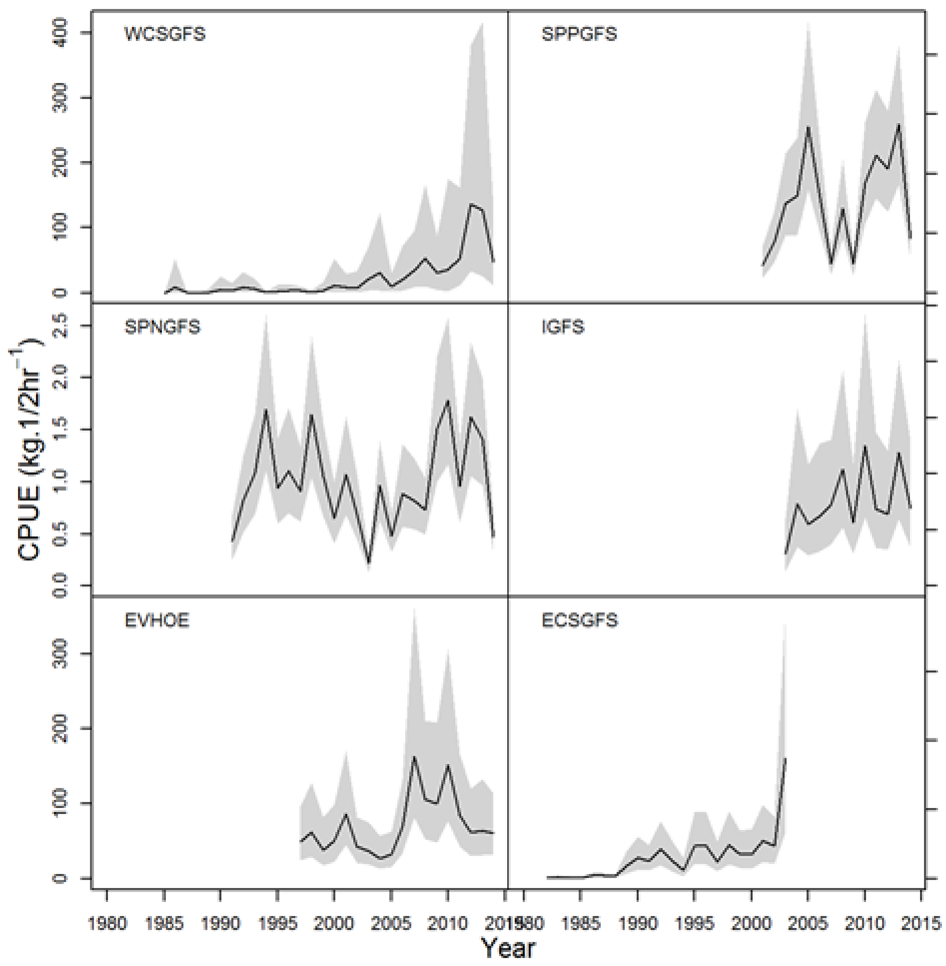


Figure 6.6.2.2. Boarfish in ICES Subareas VI, VII, VIII. Boarfish IBTS survey CPUE fitted delta-lognormal mean (solid line) and 95% credible intervals (grey region).

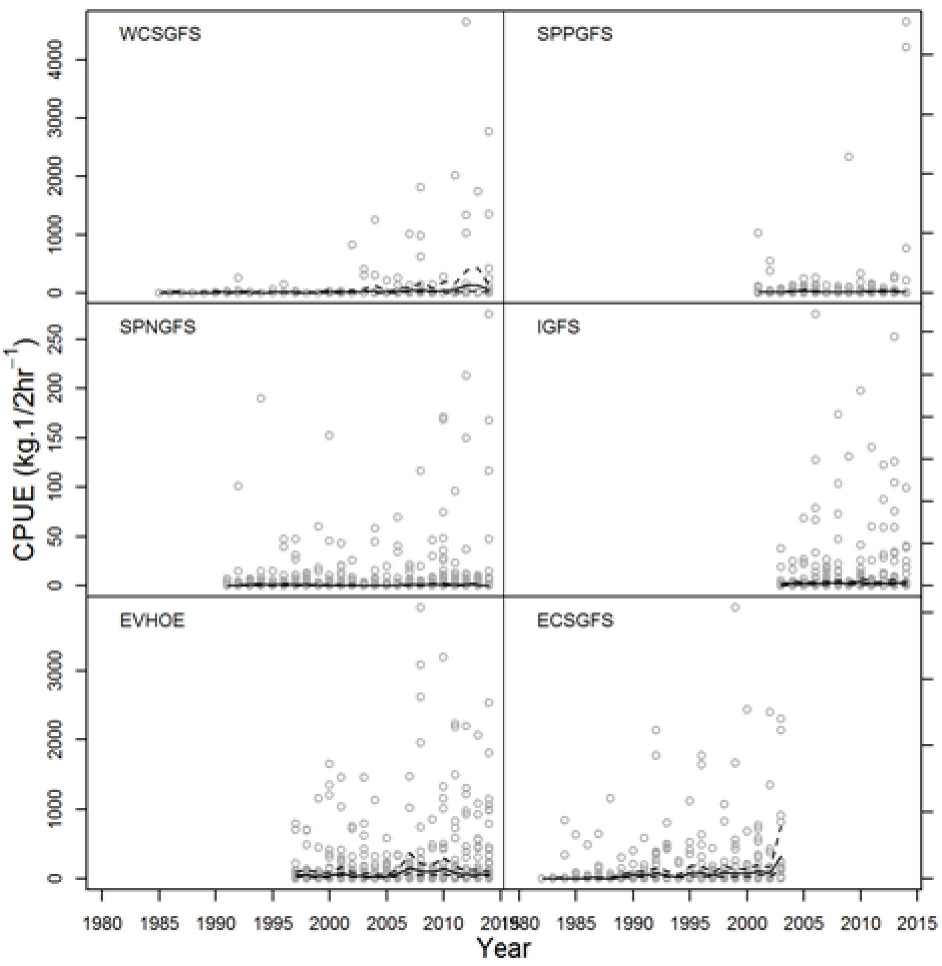


Figure 6.6.2.3. Boarfish in ICES Subareas VI, VII, VIII. Boarfish IBTS survey CPUE data (grey points) and fitted delta-lognormal mean (solid line) and 95% credible intervals (dashed lines).

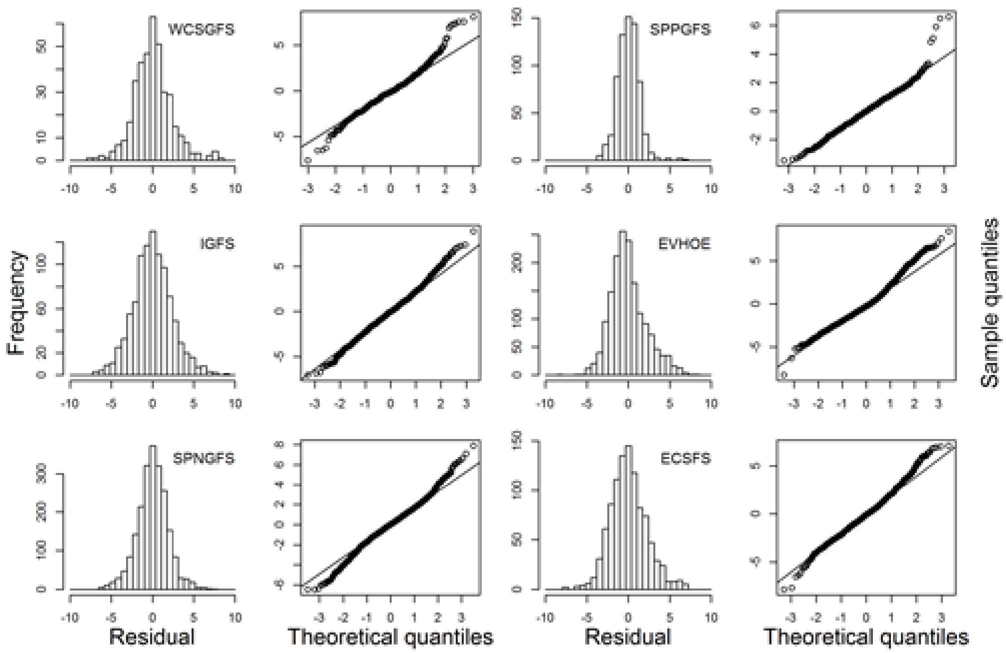


Figure 6.6.2.4. Boarfish in ICES Subareas VI, VII, VIII. Diagnostics from the positive component of the delta-lognormal fits.

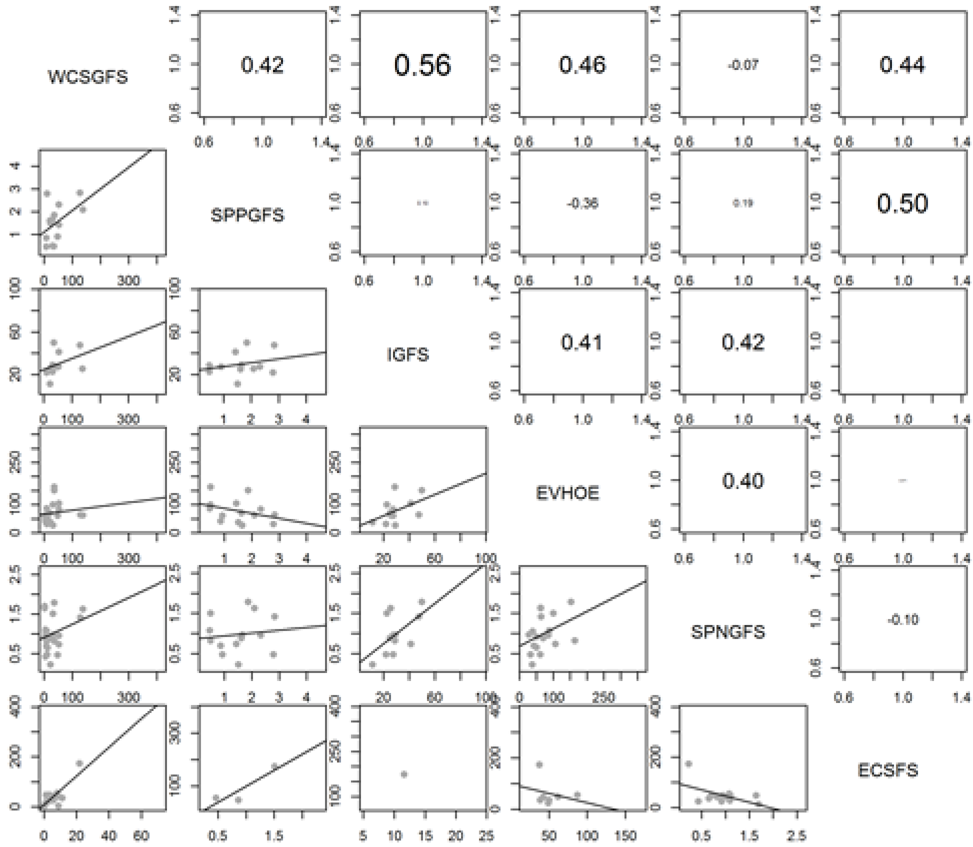


Figure 6.6.2.5. Boarfish in ICES Subareas VI, VII, VIII. Pair-wise correlation between the annual mean survey indices.

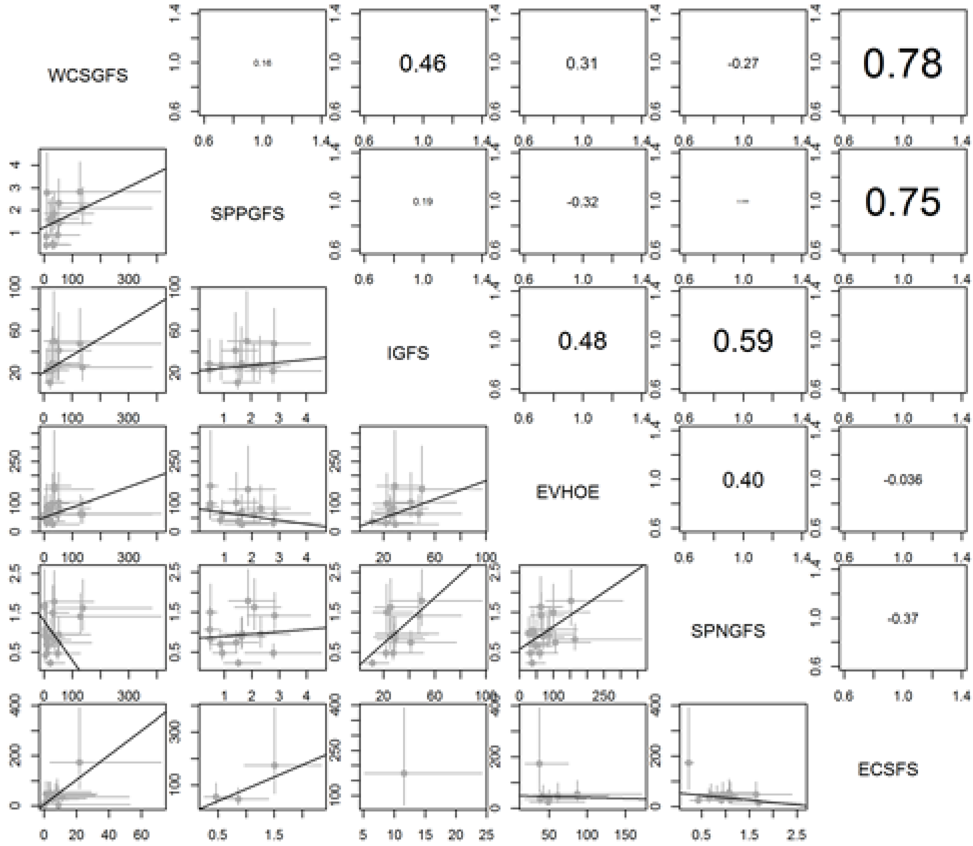


Figure 6.6.2.6. Boarfish in ICES Subareas VI, VII, VIII. Weighted correlation between the annual mean survey indices. Correlations are weighted by the sum of the pair-wise variances.

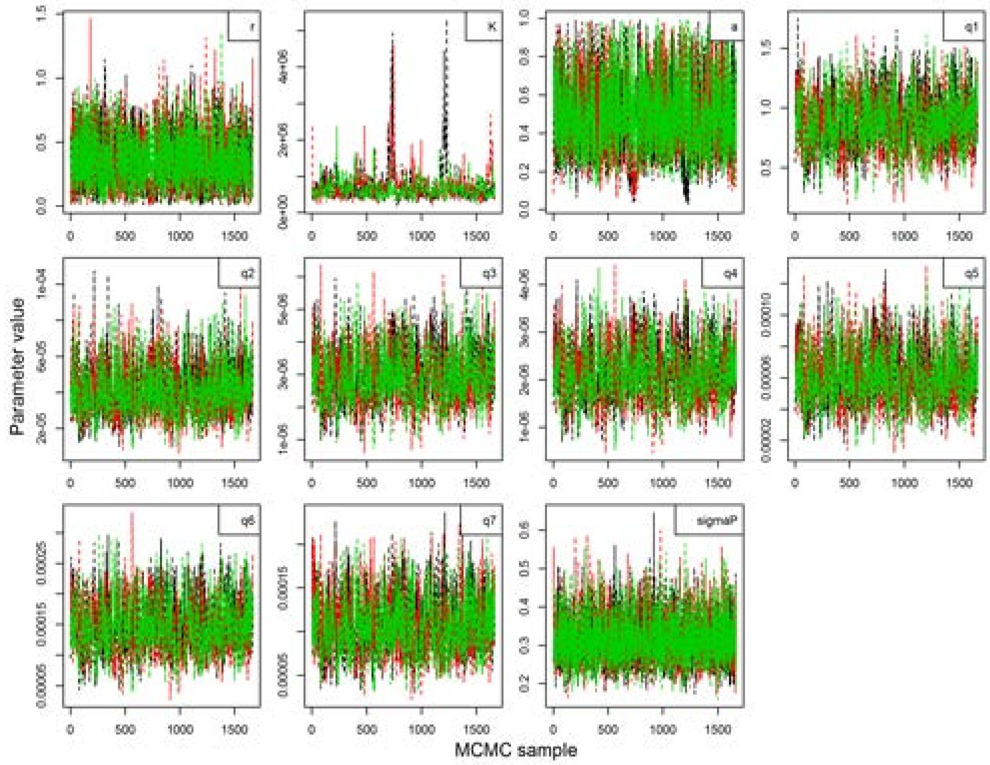


Figure 6.6.5.1. Boarfish in ICES Subareas VI, VII, VIII. Parameters for final run converged with good mixing of the chains.

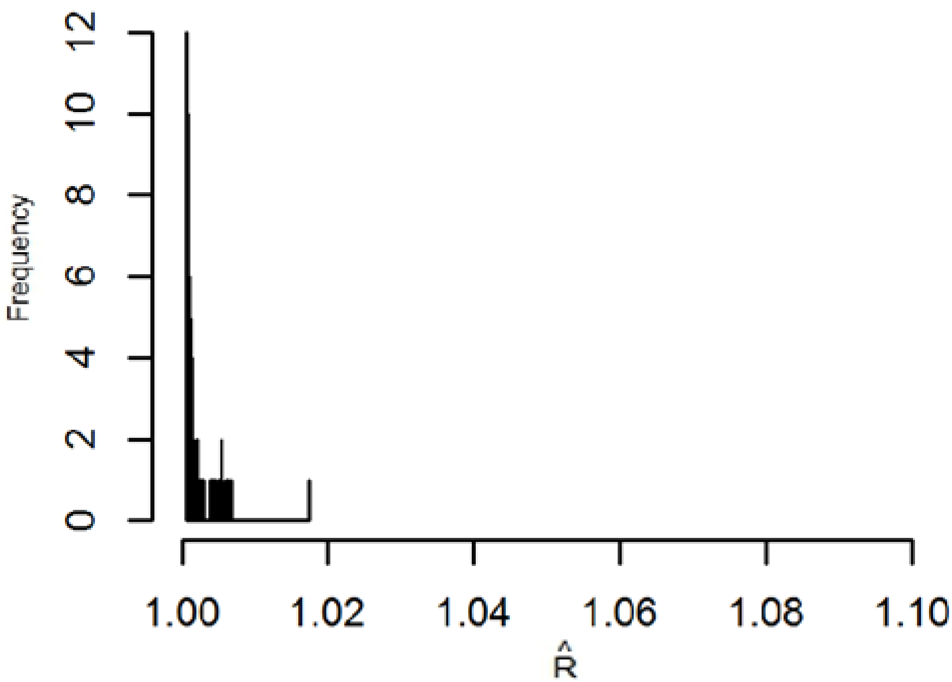


Figure 6.6.5.2. Boarfish in ICES Subareas VI, VII, VIII. Rhat values lower than 1.1 indicating convergence.

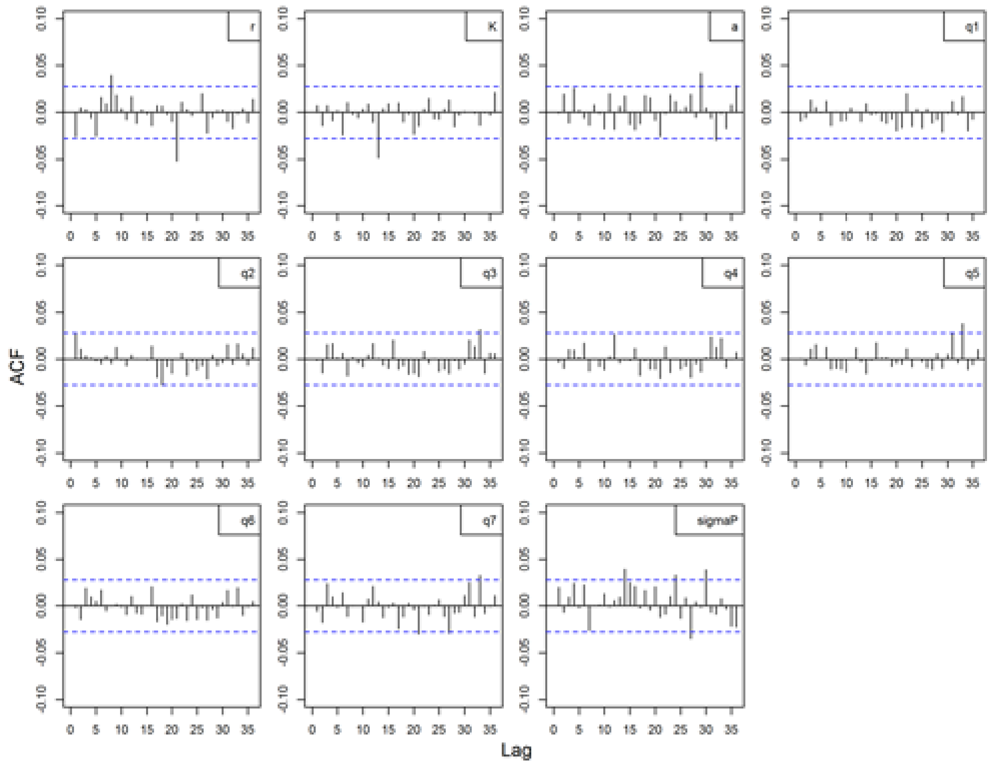


Figure 6.6.5.3. Boarfish in ICES Subareas VI, VII, VIII. MCMC chain autocorrelation for final run.

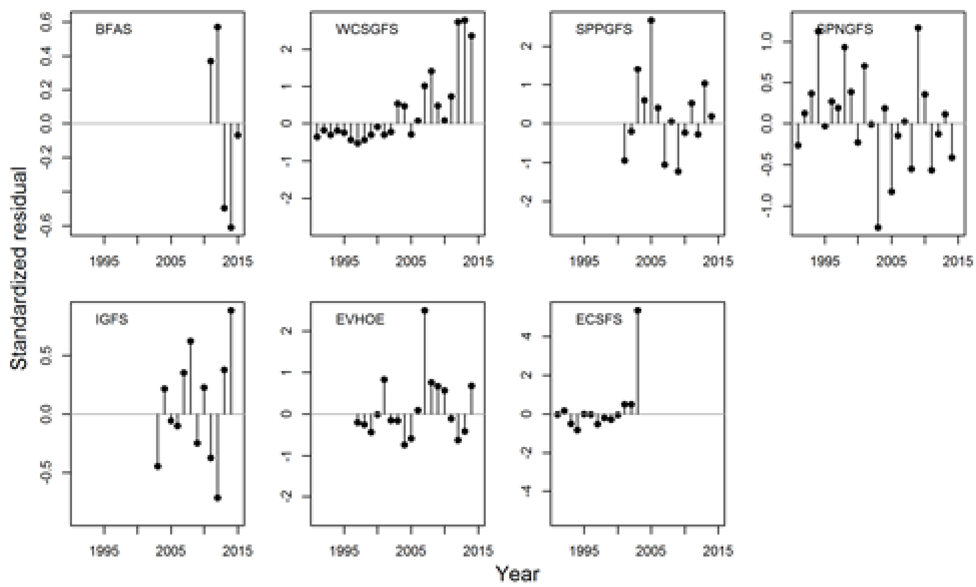


Figure 6.6.5.4. Boarfish in ICES Subareas VI, VII, VIII. Residuals around the model fit for the final assessment run.

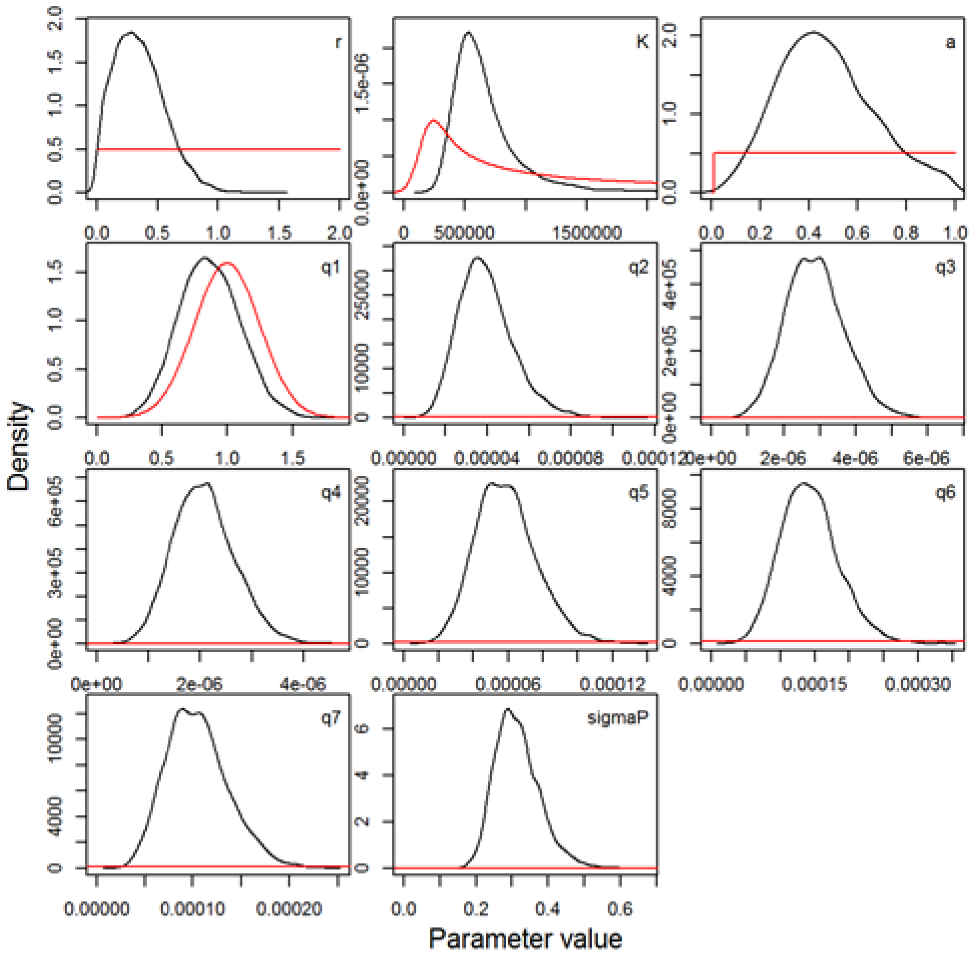


Figure 6.6.5.5. Boarfish in ICES Subareas VI, VII, VIII. Prior (red) and posterior (black) distributions of the parameters of the biomass dynamic model.

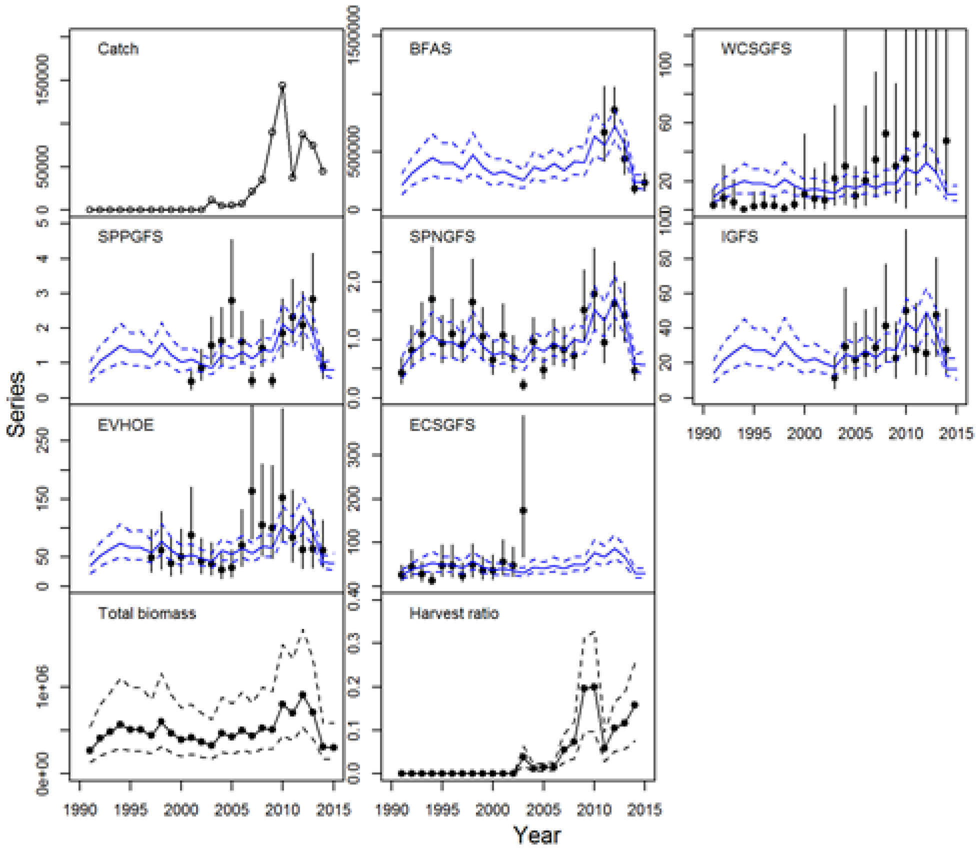


Figure 6.6.5.6. Boarfish in ICES Subareas VI, VII, VIII. Trajectories of observed and expected indices for the final assessment run. The stock size over time and a harvest ratio (total catch divided by estimated biomass) are also shown.

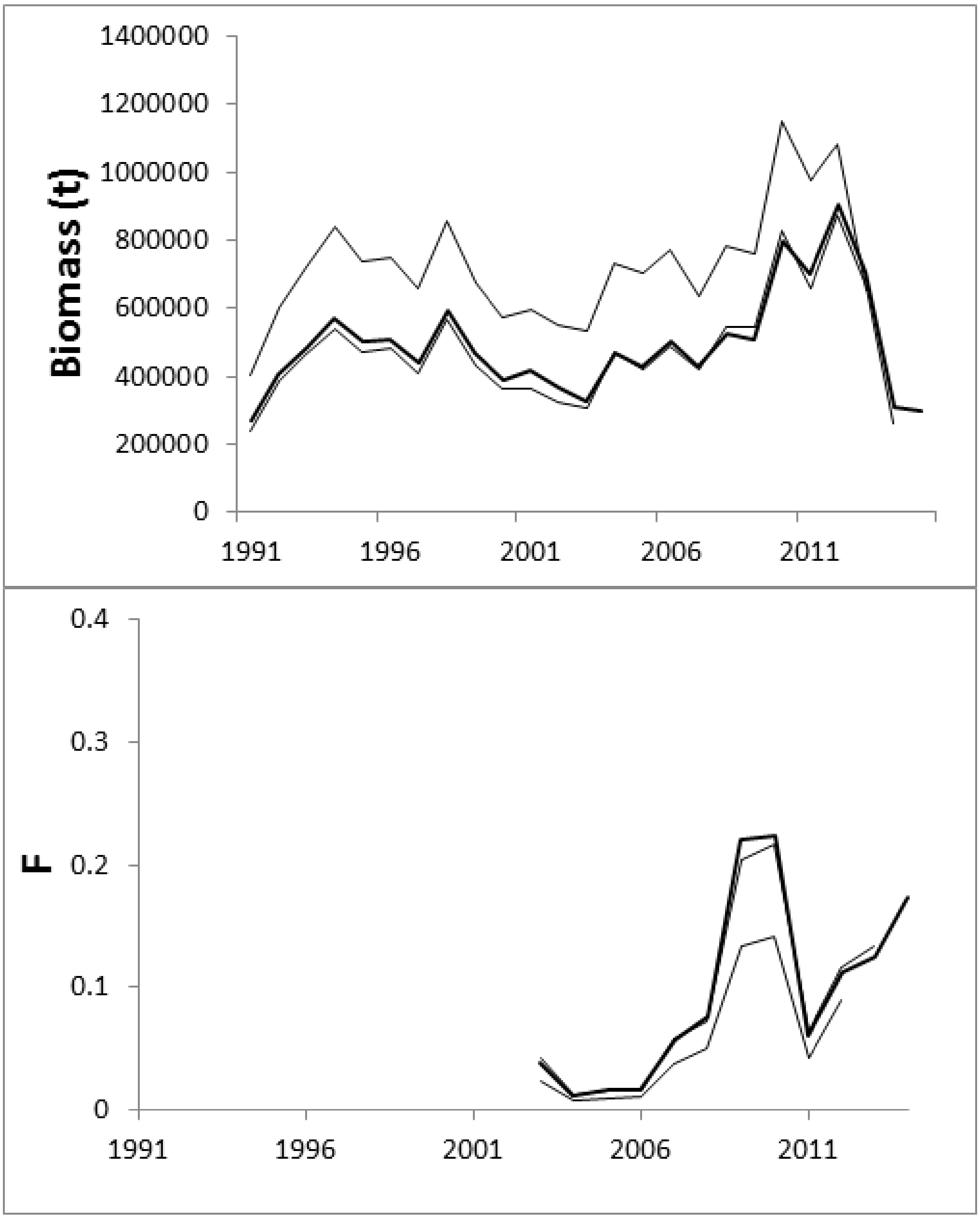


Figure 6.6.5.7. Boarfish in ICES Subareas VI, VII, VIII. Retrospective plot of total stock biomass (above) and fishing mortality (below) from the surplus production model in 2013-2015. Thick line is current assessment.

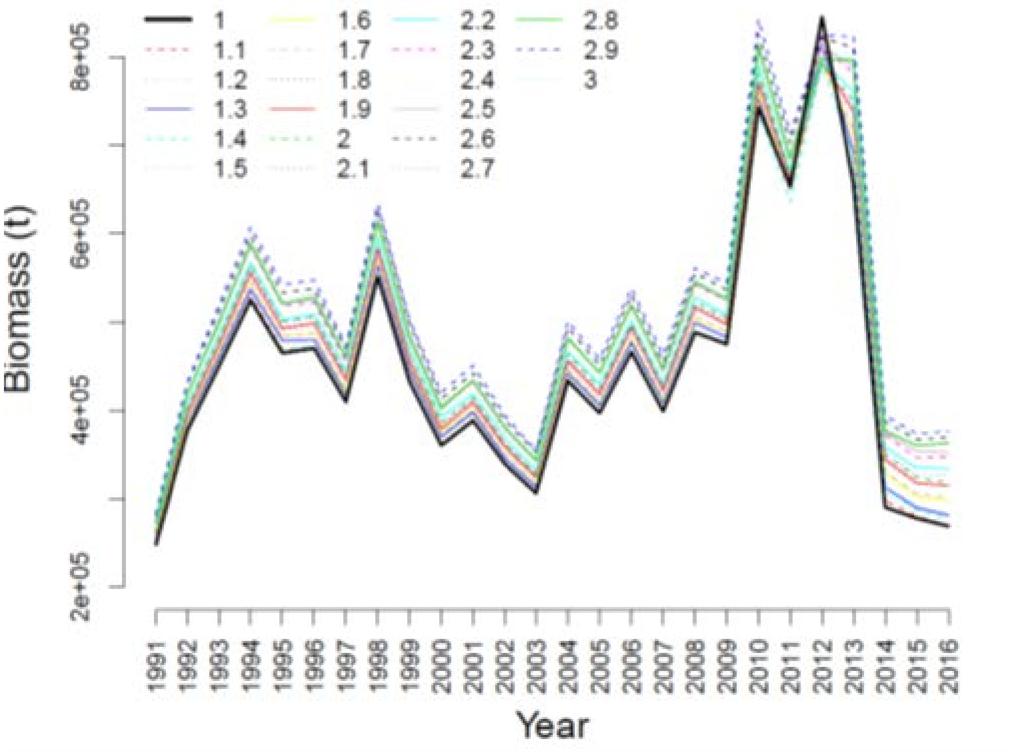


Figure 6.7.2.1. Boarfish in ICES Subareas VI, VII, VIII (model posterior density functions mean values).

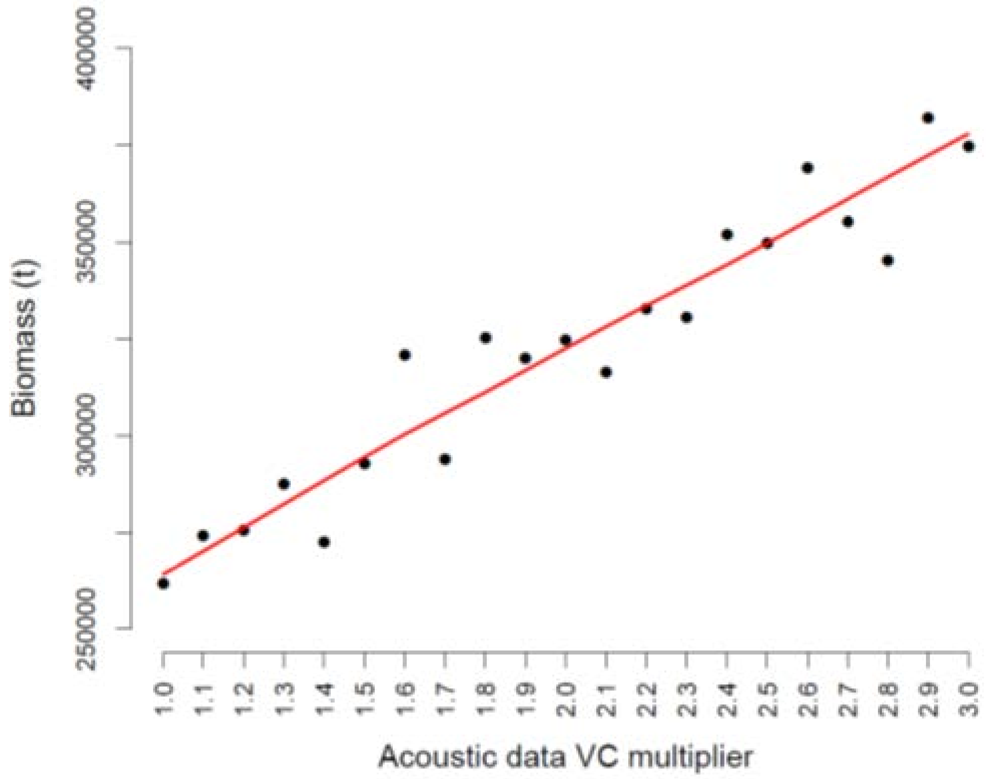


Figure 6.7.2.2. Boarfish in ICES Subareas VI, VII, VIII in 2016 (forecasted posterior density functions mean values). Red line corresponds to a lowess smoothing.

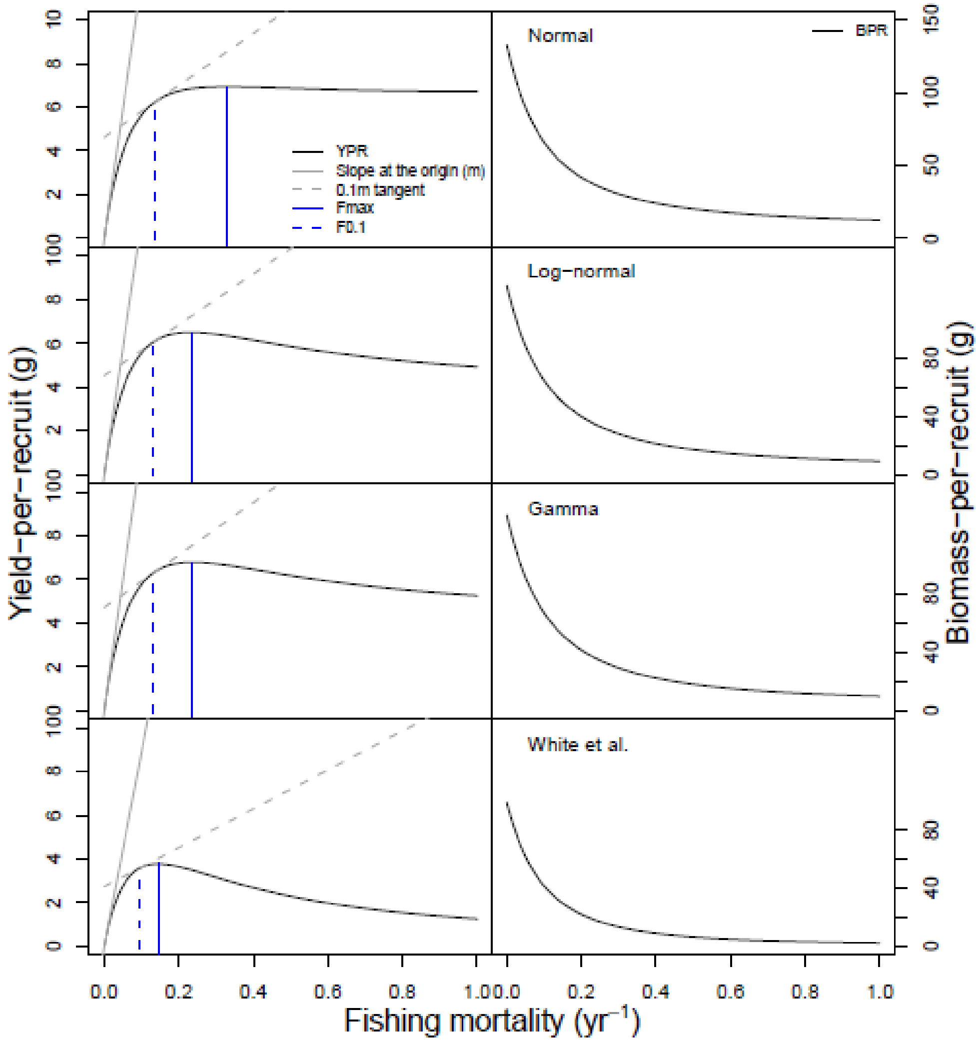


Figure 6.7.3.1. Boarfish in ICES Subareas VI, VII, VIII. Results of exploratory yield per recruit analysis. Beverton and Holt model applied to various fits of the VBGF and for comparison with the VBGF parameters provided by White *et al.*, 2011.

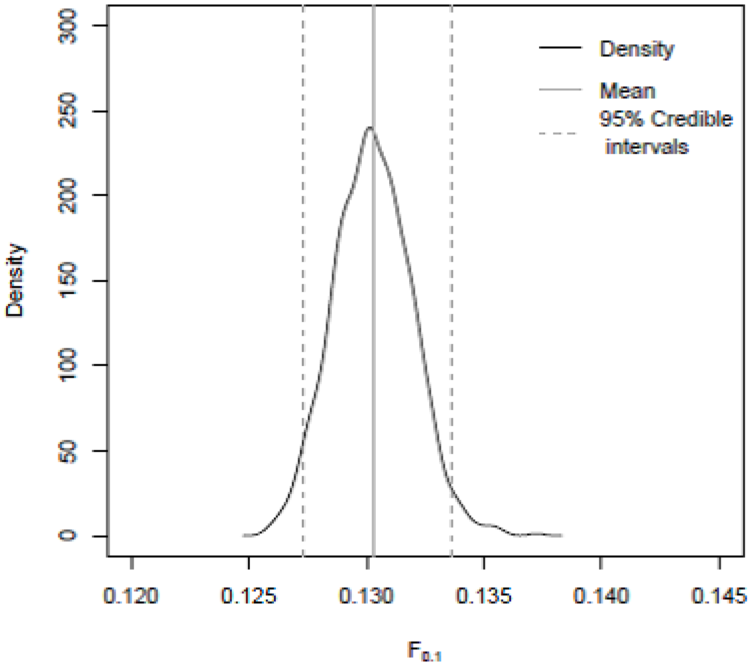


Figure 6.7.3.2. Boarfish in ICES Subareas VI, VII, VIII. Sensitivity of estimation of F0.1.

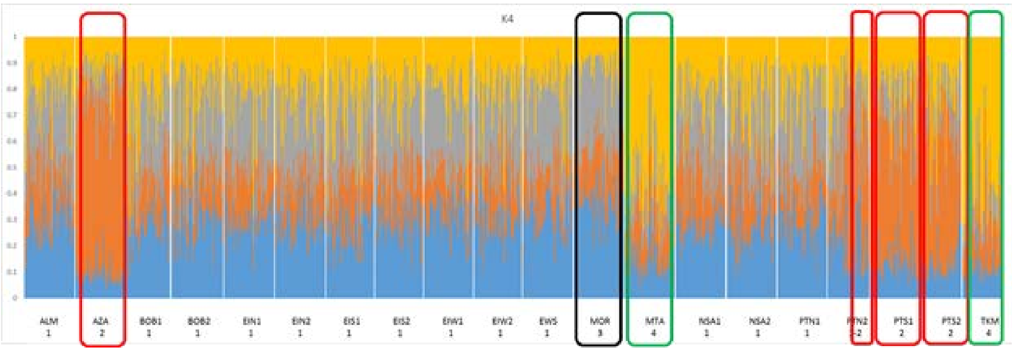


Figure 6.12.1. Boarfish in ICES Subareas VI, VII, VIII. Four clusters/populations of boarfish identified by STRUCTURE analyses.

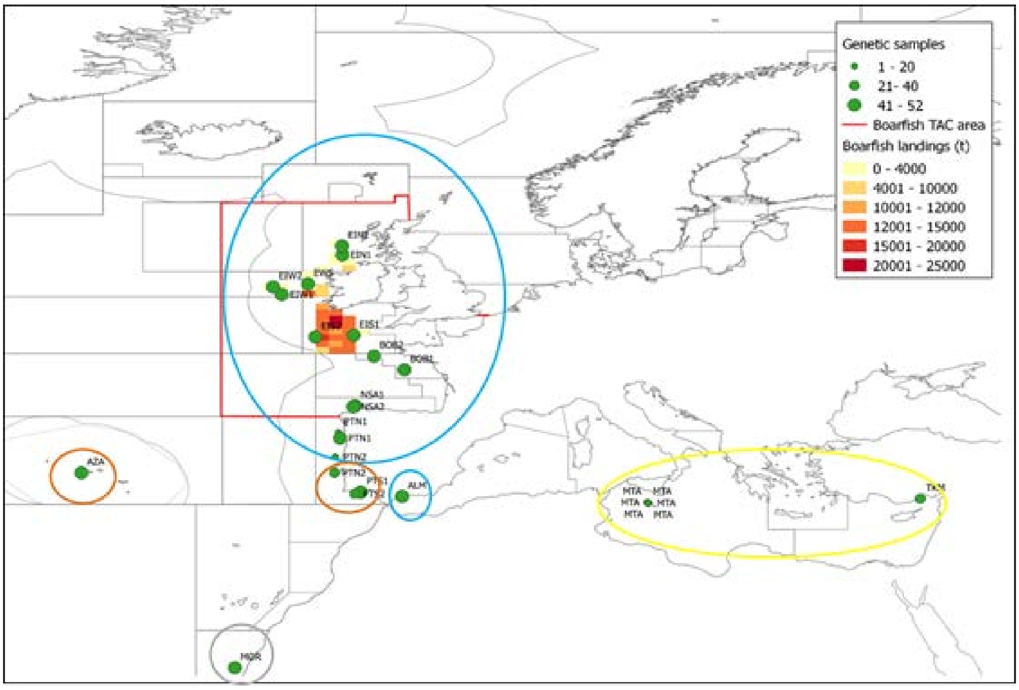


Figure 6.12.2. Boarfish in ICES Subareas VI, VII, VIII. Boarfish samples included in the genetic stock identification study are indicated in green. Population clusters identified by the STRUCTURE analyses are indicated by colour coded circles.

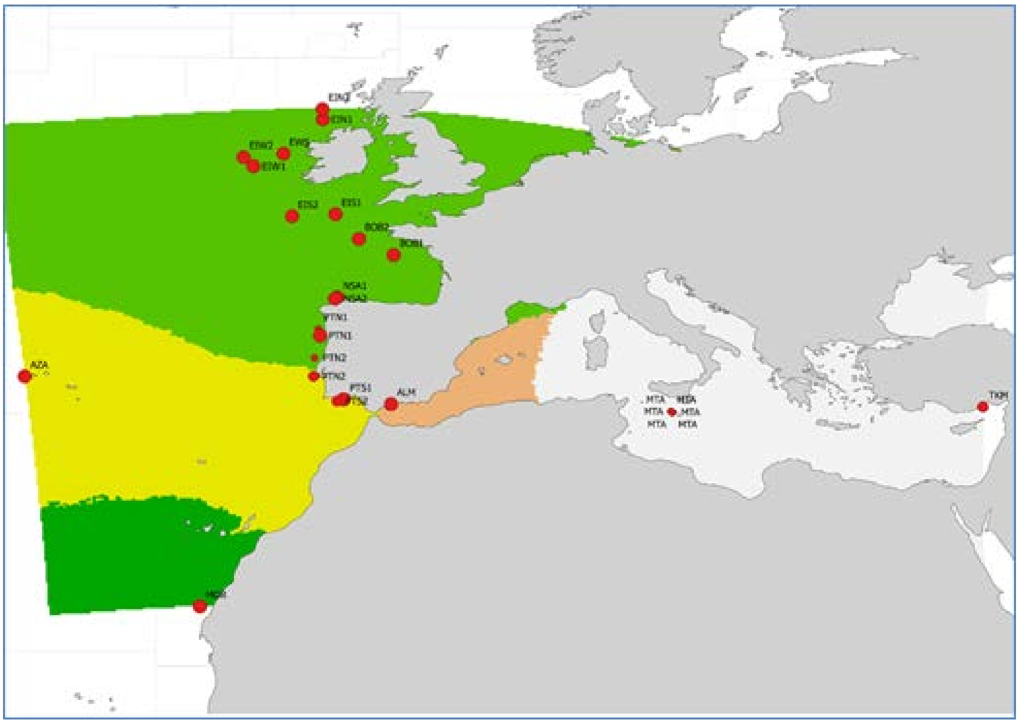


Figure 6.12.3. Boarfish in ICES Subareas VI, VII, VIII. Results of exploratory Geneland analyses which incorporated both genotype and geographic information. Populations are delineated by different coloured shading.

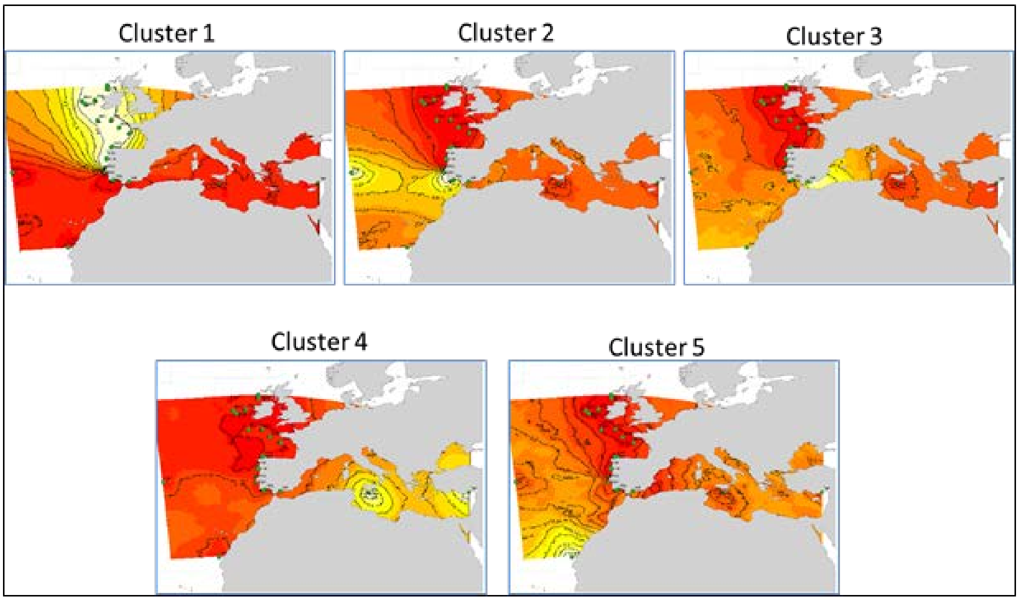


Figure 6.12.4. Boarfish in ICES Subareas VI, VII, VIII. The probability of population membership from exploratory Geneland analyses. Higher probability is indicated by whiter colour.

7 Norwegian Spring Spawning Herring

7.1 ICES advice in 2014

ICES notes that the stock is declining and estimated to be below Bpa (5 million tonnes) in 2013. Since 1998 five large year classes have been produced (1998, 1999, 2002, 2003, and 2004). Recruitment since 2005 has been at low levels. Fishing mortality in 2013 was at Fpa (0.15) and FMSY (0.15), but above the management plan target F_{MP}.

A long term management plan agreed by the EU, Faroe Islands, Iceland, Norway and Russia, is operational since 1999. ICES has evaluated the plan and concludes that it is in accordance with the precautionary approach. The management plan implies maximum catches of 283 013 t in 2015.

7.2 The fishery in 2014

7.2.1 Description and development of the fisheries

The distribution of the 2014 Norwegian spring-spawning herring (NSSH) fishery for all countries by ICES rectangles per year is shown in Figure 7.2.1.1 and for annual quarter in Figure 7.2.1.2.

The 2014 herring fishing pattern was similar to recent years, i.e. clockwise movement of the fishing fleet in the Norwegian Sea as the year progressed. The fishery began in January on the Norwegian shelf and focused on pre-spawning, spawning and post-spawning fish (Figure 7.2.1.2 quarter I). In spring, there was no fishery (Figure 7.2.1.2 quarter II). In summer, the fishery had moved into Faroese and Icelandic waters and north to Jan Mayen and Svalbard (Figure 7.2.1.2 quarter III). In autumn, the fishery shifted to the eastern part of the Norwegian Sea (Figure 7.2.1.2 quarter IV). The largest proportion of the catches was taken in the fourth quarter (58%).

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. These changes apply mostly to the Norwegian fleet and are described in Section 7.3.2. A further change in recent years, is that before 2010 the fishery in quarter IV tended to be primarily in the wintering area in the Norwegian zone, but in recent years there have also been fisheries in the international (< 68°N), Icelandic and Faroese EEZs.

In 2014, there were access limits on some countries entering the EEZs of other countries regarding Norwegian spring-spawning herring. Therefore, the fisheries do not necessarily reflect the true distribution of NSSH in the Norwegian Sea and the preferred fishing pattern of the fleets were they given free access to all zones.

7.2.1.1 Denmark

Access to the Norwegian EEZ was not granted to EU vessels before May 2014, therefore all Danish catches are from quarter IV. A total of 83% was from the international zone and 17% from the Norwegian EEZ. In total, 12 513 t out of a quota of 13 216 t was caught (Table 7.4.1.2).

7.2.1.2 Germany

The vessels targeting Norwegian spring spawning herring belong 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 consists of four large pelagic freezer-trawlers with power ratings between 4200 and 12 000 hp and crews 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. The reported landings in 2014 were 669 tonnes (Table 7.4.1.2) taken in IIa (and 1 tonne in IIb).

7.2.1.3 Greenland

The majority (about 84%) of the catches (13 108 t (Table 7.4.1.2)) was taken in Division XIVa in quarter III, while most of the remaining (about 15%) was caught in both Division IIa in quarter IV.

7.2.1.4 Faroe Islands

Faroese vessels landed 38 529 tonnes of Norwegian spring spawning herring in 2014 (Table 7.4.1.2). The majority of the landings were caught within the Faroese EEZ (93%), and the rest in international waters (7%). In contrast to recent years, the majority of the landings (80%) were from the directed herring fishery, which occurred in autumn (October to November). Herring was caught within the Faroese EEZ from July to November. The location of the directed fishery in autumn was in the northern part of the Faroese EEZ and extended into the international zone in the Norwegian Sea. Faroese fishing vessels did not catch any herring in winter (January–April).

7.2.1.5 Iceland

The total catch of the Icelandic fleet in 2014 came to 58 828 t (Table 7.4.1.2). The Icelandic TAC for Norwegian spring spawning herring in 2014 was set at 61 000 tonnes. The majority of the catch(46 112 t) was caught within the Icelandic EEZ in the period July to November 2014. The prolonged existence of the stock on the feeding grounds in the west into the autumn in recent years has therefore continued in 2014. The remaining catch was caught within the Faeroese EEZ (6849 t), in International waters (5062 t) and in Greenlandic EEZ (803 t) in September to December.

7.2.1.6 Ireland

The Irish fishery for Norwegian spring spawning herring took place in quarter IV in area IIa. Two vessels participated in the fishery and recorded landings of 706 tonnes (Table 7.4.1.2). Norwegian spring spawning herring from the Irish fleet are landed primarily for reduction to fishmeal and processed for human consumption. All landings were made into Norwegian ports.

7.2.1.7 Netherlands

Three Dutch pelagic freezer trawlers participated in the fishery for Norwegian spring spawning herring in 2014. The fishery took place in late October to early November, in ICES Division II. The Dutch catch of 8200 tonnes was taken in 3 trips.

7.2.1.8 Norway

The Norwegian quota for 2014 was taken by purse seiner (about 92%) and pelagic trawler (about 7%). The total catch during the first quarter in 2014 was 110 719 tonnes. The Norwegian fleet hardly fish herring in the oceanic feeding area during the second and third quarters. There are some catches reported from the coastal areas during this period, amounting to 663 tonnes in quarter 2 and 850 tonnes in quarter 3. This herring consists of a mix of NSSH, a summer spawning oceanic stock and local fjordic herring stocks, of which the latter two are allocated to the Norwegian spring spawning herring quota for practical reasons.. The fisheries in the fourth quarter took place on the migration route from the feeding areas in the Norwegian Sea to the wintering areas west and northwest of Vesterålen and in the fjords of Troms. The total catch in quarter 4 was 151 020 tonnes (Table 7.4.1.2).

7.2.1.9 Russia

The Russian fishery started within the wintering area of the Norwegian spring spawning herring (approximately 10—13°E) in the Vesteralen (Norwegian EEZ) in mid-January, then progressed in a south-western direction along the Norwegian coast. The fishery finished on south banks of the Norwegian shallow water (approximately 65°N) at the beginning of February. In January-February the total catch was 2145 t.

During quarter II, the Russian fleet did not target NSSH, however, a total catch of 8 t was caught in the mackerel fishery.

In quarter III, the Russian NSSH fishery started in mid-August. The vessels caught herring in the Faeroese EEZ, in areas around Spitsbergen and Jan-Mayen and in the international water westward of 15°E. 24 644 t of herring was taken in quarter III.

In quarter IV, the fishery continued in the area around Spitsbergen, Jan-Mayen and in international waters. In the second half of October the Russian fishery started in the Norwegian EEZ and finished in December. 33 495 t was taken during this period.

The Russian fishery is carried out by different types of trawl vessels. Total Russian catch of Norwegian spring spawning herring was 60 292 t (Table 7.4.1.2). The entire Russian catch was utilized for human consumption.

7.2.1.10 UK (Scotland)

Scottish vessels landed 4233 tonnes of Norwegian spring spawning herring from Division IIa into Norway in 2014. There were no Norwegian spring spawning herring landed into Scotland in 2014 by UK vessels. The fishery took place in the fourth quarter only and a total of five Scottish trawlers ranging in size from 64—72 m, participated in the fishery.

7.3 Stock Description and management units

7.3.1 Stock description

A description of the stock is given in Section A.1.1 of the Stock Annex.

7.3.2 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.

Information about changes in migration of the stock in recent years is mainly derived from the ecosystem surveys in the Nordic Seas in May (ICES, 2015c) and in July/August (ICES, 2015d). The May survey takes place when the stock is still, in part, migrating to the feeding grounds and there are no major changes in migration pattern and distribution of the stock observed in recent years. This is evident by the centre of gravity of the stock (Figure 7.3.2.1). The main concentration of the stock has been in the mid Norwegian Sea with a tail reaching southwest into Faroese and Icelandic waters; there is typically a smaller concentration further north towards Lofoten in Norway. The July/August survey shows a further westwards and northwards migration, with the main concentrations in the south-western to north-western fringes of the Norwegian Sea; herring are relatively absent from the mid Norwegian Sea. However, the main changes in the stock's migration pattern observed in recent times is derived from information from the commercial fishery. This indicates that herring are staying longer on the feeding grounds in the western part. The fishery in Faroese and Icelandic waters has reached into November in the recent three years, in contrast to September and October earlier. Such indications resulting from fishing activity have to be interpreted carefully as the behaviour of the fleet can also have changed, causing the changes in distribution of catch from one year to another.

It is not clear what drives the changes in the migration, but the biomass and production of zooplankton is a likely factor, as well as feeding competition with other pelagic fish species (e.g. mackerel) and oceanographic conditions (e.g. limitations due to cold areas). Beside the environmental forces, the age distribution in the stock is also likely to influence the migration. Changes in migration pattern of NSSH, as well as of other herring stocks, are often linked to large year classes entering the stock and them initiating a different migration pattern, which subsequent year classes will follow. No large year classes have entered the stock since 2004. Thus, at present the stock consists of old individuals, with also some younger fish coming from below average year classes, and as the largest fish move farthest west, the stock should be in the western areas presently while the opposite could be expected when strong year-classes join the adult stock from the nursery areas in the Barents Sea.

7.4 Data available

7.4.1 Catch data

Catches in tonnes by ICES division, ICES rectangle and quarter in 2014 were available from Denmark, Faroe Islands, Germany, Greenland, Iceland, Ireland, The Netherlands, Norway, Russia and the United Kingdom (UK). The total working group catch in 2014 was 461 306 tonnes (Table 7.4.1.1) compared to the ICES-recommended catch of maximum 41 8487 tonnes. The majority of the catches were taken in area IIa as in previous years.

Samples were not provided by Germany, Greenland, Ireland and UK. Sampled catches accounted for 97% of the total catches, which is fairly similar to previous years. The sampling levels of the catch in 2014 by country are shown in Table 7.4.1.2. The program SALLOC (ICES, 1998) was used to provide catches in numbers (Table 7.4.1.2).

7.4.2 Discards

In 2008, the Working Group noted that in this fishery an unaccounted mortality caused by fishing operations and underreporting probably exists (ICES, 2008). It was not possible to assess the magnitude of these extra removals from the stock, and considering the large catches taken in recent years, the relative importance of such additional mortality is probably low. Therefore, no extra mortality to account for these factors has been added since 1994. 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 low and a minor problem to the assessment. This is confirmed by estimates from sampling programmes carried out by some EU countries in the Data Collection Framework. Estimates on discarding in 2008 and 2009 of about 2% in weight were provided for the trawl fishery carried out by the Netherlands. In 2010 and 2012, this metier was sampled by Germany. No discarding of herring was observed (0%) in either of the two years. An investigation on fisheries induced mortality carried out by IMR with EU partners on fisheries induced and unreported mortality in mackerel and herring fisheries in the North Sea concluded with an estimated level of discarding at around 3%.We are not aware of attempts to quantify the amount lost specifically by slipping over the years.

In summary, the sources of unregistered mortality of sufficient magnitude to matter for the assessment seem to be what was observed during the wintering area shift period, in particular 2002–2003, and perhaps slipping of too-large catches prior to the introduction of regulations of slipping in 2015.

7.4.3 Length and age composition of the catch

The catch at age data are given in Table 7.4.3.1. The numbers are calculated using the SALLOC procedure. In 2014, about 28% of the catches (in numbers) were taken from the 2004 year class, followed by the 2009 (about 19%) and 2006 (about 14%) year classes. Lengths at age data are not used in the assessment.

7.4.4 Weight at age in catch and in the stock

The weight-at-age in the catches in 2014 was computed from the sampled catches using SALLOC. Trends in weight-at-age in the catch are presented in Figure 7.4.4.1 and Table 7.4.4.1. The mean weights at age for most of the age groups have generally been increasing in 2010–2013 but levelled off in 2014.

A similar pattern is observed in weight-at-age in the stock which is presented in Figure 7.4.4.2 and Table 7.4.4.2. These data have been taken from the survey in the wintering area until 2008. The mean weight at age in the stock for age groups 4–11 in the years 2009–2015 was derived from samples taken in the fishery in the same area and at the same time as the wintering surveys were conducted in.

7.4.5 Maturity at age

The maturity data used in the assessment were revised in 2010 following a recommendation from WKHERMAT[3]. This Workshop evaluated the existing maturity at age data because they were not available or considered in the benchmark assessment in 2008.

WGWIDE adopted the maturity ogives 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 ogives 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.

5 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

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

The maturity ogives used in the present assessment are presented in Table 7.4.5.1.

7.4.6 Natural mortality

In this year's assessment (2015), 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.

7.4.7 Survey data

The description of the surveys and use of them for tuning in the assessment are given in Stock Annex 2. This section contains and discusses the survey results from some recent years. Several surveys were stopped many years ago, but are still used for tuning of the assessment models because they were included in the benchmark. The influence of these surveys on the assessment and the need to use them in the future should be investigated in the next benchmark assessment.

7.4.7.1 Survey 1 Norwegian acoustic survey on spawning grounds in February/March (NASF)

In 2015, this survey was carried out again for the first time since 2008. The cruise report from the 2015 survey is appended as a working document. The working group decided to include estimates from 2015 for the age groups 5–10 in the tuning. (Ages below 5 and above 10 are not used for any of the previous years.). In addition to 2015, survey estimates from the period 1994–2005 are used in the tuning.

In the last benchmark assessment (in 2008) it was decided to exclude estimates from 2006–2008 due to issues with the coverage (see Stock Annex 2).

7.4.7.2 Survey 2 Norwegian acoustic survey in November/December (NASN)

No new information but the years 1992–2001 are used in the tuning (see Stock Annex 2).

7.4.7.3 Survey 3 Norwegian acoustic survey in January (NASJ)

No new information but the years 1991–1999 are used in the tuning (see Stock Annex 2).

7.4.7.4 Survey 4 and 5 International ecosystem survey in the Nordic Seas (IESNS)

The international ecosystem survey in the Nordic Seas aims for exploring the pelagic ecosystem, with a special focus on herring, blue whiting, zooplankton and hydrography. Survey coverage in the Norwegian Sea was considered adequate in 2015 and in line with previous years. It is therefore recommended that the results can be used for assessment purpose. The herring in 2015 was distributed over a comparable area as in 2014, but the highest densities were observed further east than in recent years (Figure 7.4.7.4.1). Overall the herring density was relatively low. Different from the previous four years, young herring (age 6 and younger) was observed north of 70°N, although much less than in 2010. The center of gravity of the acoustic recordings of herring reflects the distribution and shifted in a southeasterly direction compared to 2014.

As in previous years the smallest fish were found in the eastern area of the Norwegian Sea whereas size and age were found to increase to the west and south. Correspondingly, it was mainly older herring that appeared in the southwestern areas (area III).

The herring stock is now dominated by 6 year old herring (2009 year class) in numbers but, 9, 10 and 11 year old herring (the 2006, 2005 and 2004 year classes) are also numerous (Table 7.4.7.4.2). This is the first time since 2008 that the 2004 year class is not the most abundant. The 2009 year class appears to be the largest of the younger age groups even it appears to be only around 70% of average size of six year olds in the times series since 1997. However, in terms of biomass, the 2004 year class is still the largest. The four year classes 2004, 2005, 2006 and 2009 contribute to 19%, 11%, 12% and 17% respectively, of the total biomass.

The total biomass estimate of herring in the Norwegian Sea from the 2015 survey was 5.4 million tonnes. This estimate is comparable to the estimates in 2013 and 2014 (Figure 7.4.7.4.3).

The investigations of herring in the Barents Sea covered the area from 45°E to 21°00′ E. The total abundance estimate was lower than in the last two years, with 2996 million individuals of age 1 (mean length of 12.4 cm and weight of 11.6 g), 8129 million individuals of age 2 (mean length of 18 cm and mean weight of 36.8 g), 957 million individuals of age 3 herring (mean length of 21.4 cm and mean weight of 62.8 g) and 265 million individuals of age 4 herring (mean length of 26.1 cm and mean weight of 109.2 g). Only very few older herring were observed.

The total number of herring recorded in the Norwegian Sea was 14.1 billion in the northeastern area and 6.9 billion in the southwestern area, compared to 13.0 and 9.6 billion in the northeastern and 7.4 and 10.4 billion in the southwestern area in 2013 and 2014, respectively.

The age-disaggregated time-series of abundance for the Barents and Norwegian Sea are presented in Table 7.4.7.4.1 and 7.4.7.4.2, respectively. Length and age distribution for herring in the Barents and Norwegian Sea in May 2015 is show in figure 7.4.7.4.2.

7.4.7.5 Survey 6 and 7 Ecosystem survey in the Barents Sea (Eco-NoRu-Q3 (Aco))

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 has been included in the assessment since 2006.

The results from these surveys on 0–group herring are given in Table 7.4.7.5.2; those of the 1 to 3 age groups are given in Table 7.4.7.5.1.

The total number of herring in the Barents Sea (ages 1–4) in 2014 was estimated at 7.1 billion individuals, which is somewhat lower than in 2013 (12.8 billion individuals). Estimated herring biomass increased by 30%. The increase in biomass is due to increased weight of the dominant 2011 year class.

Young herring was widely distributed in the Barents Sea in 2014. The eastern distribution border was at 45°E, and in the western areas along the continental slope the herring were mostly older ages. In the central part of the Barents Sea age groups 1-3 years dominated, in particular 3-year-olds which were present in large quantities. The main concentrations were found between 30° and 45°E from the Murman coast to 73°N.

The distribution of young herring is shown in Figure 7.4.7.5.1. 0-group herring were more widely distributed than in 2012 and 2013, and were found from southeast to northwest of the Barents Sea in 2014. The main dense concentration of herring was located in the central area, between 70–75°N and 0–40°E, and west of Svalbard/Spitsbergen Archipelago. Distribution of 0–group herring is presented in Figure 7.4.7.5.2.

7.4.7.6 Survey 8 Norwegian herring larvae survey on the Norwegian shelf (NHLS)

A description of this survey is given in Stock Annex 4. Two indices are available from this survey (Table 7.4.7.6.1). The "Index 1" is used in the assessment as representative for the size of the spawning stock except for 2003 and 2009 due to incomplete coverage in these years.

In 2015 the survey was carried out from 7 to 20 April. As shown in figure (Figure 7.4.7.6.1), herring larvae were observed throughout the sampling area but in very low concentrations. The offshore extent of the larval distributions were found on all transects, but since the northern areas were not covered the survey did not cover the entire larval distribution areas. It is therefore not recommended to include the survey in the tuning of the assessment this year.

7.4.7.7 Survey 9 International ecosystem survey in the Norwegian Sea in July-August (IESSNS)

The IESSNS 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 2008 but was extended to the whole Norwegian Sea, Icelandic waters, and Faroese waters in 2009. The objectives of the survey are to quantify abundance, spatio-temporal distribution, aggregation and feeding ecology of Northeast Atlantic mackerel in relation to distribution and abundance of other pelagic fish species such as Norwegian spring-spawning herring, oceanographic conditions and prey communities. The survey has not been used in the assessment of NSS herring but the results from the surveys, with regards to herring, plankton and hydrographical investigation, has been presented to the WG every year. The participation countries in this survey are Faroe Island, Greenland, Iceland and Norway.

Four vessels (from Norway (2), Iceland (1) and Faroe Island (1)) participated in the IESSNS 2015 survey during 1 July to 10 August (ICES, 2015d). The acoustic estimate of NSSH in the survey resulted in abundance index for age 4+ of 22.7 billion, which is comparable to the May survey index in 2015 of 20.3 billion. The 2004 year class was most numerous with about 19% of the acoustic estimate, followed by the 2005 and 2009 year classes (14% each). The age composition in these two surveys was also similar with a tendency for a higher contribution of older age groups in the July/August survey compare to the May survey, where 65% vs. 53% were at age 7+ and 35% vs. 47 at age 4-6, respectively. These differences in age composition for NSS herring between the IESNS and IESSNS surveys could be due to the fact the IESSNS in July-August is only catching herring in the upper 30 m, whereas herring is also caught in deeper waters at acoustic registrations during the IESNS in May-June.

The NSS herring was mainly found north of the Faroe Islands and to the east and north off Iceland. Small concentrations were found in the northern and eastern areas, while herring were in low concentrations in the central part of the Norwegian Sea. The periphery of the distribution of the adult NSS herring was considered to be reached in all directions, which means a better spatial coverage than in recent years. It was only towards north between 14—20°W where some herring might have been missing.

7.4.8 Information from the fishing industry

A pre-meeting between ICES scientists and representatives of the EU pelagic industry was held on 19 August 2015, to discuss information from the fishing industry and any ongoing development to address data needs. The Danish fishery for NSS herring is normally executed in the beginning of the year. Because there was no agreement with Norway for 2015, the fishery is now planned for the end of the year in international waters. Norwegian fishermen have reported good catches so far.

7.5 Methods

7.5.1 TASACS 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—2015, which is regarded as the period representative of the present production and exploitation regimes, and is presumed to be of main interest for management.

The model was run with catch data 1988—2014, and projected forwards through 2015 assuming Fs in 2015 equal to those in 2014, to include survey data from 2015.

7.5.2 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.

7.6 Data Exploration

7.6.1 Catch curve analyses

Figure 7.6.1.1 shows the age disaggregated catch in numbers by years. In the years 2009—2011 the year classes from 2002—2004 were the most prominent year classes in the catches, whereas in 2012 and 2014 it was the 2004 year class alone.

Figure 7.6.1.2 shows the disaggregated catch in numbers plotted on a log scale. For comparison, lines corresponding to Z=0.3 are drawn in the background. The big year classes, in the periods of relatively constant effort, show a consistent decline in catch number by cohort, but the poor year classes exhibit just noise. For year classes 2010 and younger these curves provide hardly any information.

For survey 5 Figure 7.6.1.3 shows the age disaggregated abundance indices in numbers plotted on a log scale. The same arguments are valid for the interpretation of the catch curves from the survey as from the catches. In 2010 the number of all age groups decreased suddenly and this is seen as a drop in the catch curves that year. This drop has continued for some of the year classes and the year classes 1998 and 1999 are disappearing faster from the stock than expected. This observed fast reduction in these age classes may also be influenced by the changes in the Survey 5 catchability, with seemingly higher catchability in years 2006—2009. Like for the catch data these provide hardly any information for year classes 2010 and younger.

7.6.2 TASACS assessment

7.6.2.1 Update 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). Relatively strong retrospective pattern has, however, been observed in the NSSH assessment since the assessment year 2010. In WGWIDE 2013, an updated algorithm to estimate terminal F-values for weak year-classes was implemented in TASACS which improved the consistency of the assessment (ICES, 2013). This algorithm has been used since then, and the assessment seems to have stabilized in recent years.

7.6.2.2 Data exploration with TASACS

The model fit to the tuning data is shown with Q-Q plots in Figure 7.6.2.2.1. Surveys 1—3 and 5 seem to fit rather well to the assumed linear relationship in the TASACS model but surveys 4 and 6—8 have rather poor fit. In addition, the fitting of survey data to the model in different assessment years is not in all cases very good. Particularly Surveys 7 (0-group) and 8 (larval survey) seems to disagree a lot with the assessment (Figure 7.6.2.2.1). This can also be seen as a block of positive residuals for these surveys in later years (Figure 7.6.2.2.2). The residual plot for survey 5 (IESNS) also shows some pattern with a series of negative residuals during the early 2000s followed by a period of positive residuals. This has been thoroughly discussed in previous WGWIDE reports.

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 a comparison of what each survey indicates that the population numbers should be, and thus identify conflicting signals between surveys and outliers in the survey data. Included in this analysis was 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 (Figure 7.6.2.2.3). This year, no new survey data were excluded from further analysis.

This year, new information was available for surveys 1, 4, 5, 6 and 7. The survey on the spawning grounds in February/March (survey 1) was carried out again for the first time since 2008. The working group decided to include estimates from 2015 for the age groups 5—10 in the tuning, which are the same age groups that have been used from that survey in the tuning for the years 1994—2005. Including the survey in 2015 has a minor upwards revision (< 5%) of the spawning stock on 1 January the past few years.

7.6.2.3 Final assessment

The final results of the assessment are presented in Tables 7.6.2.3.1 (stock in numbers), 7.6.2.3.2 (fishing mortality), and Figure 7.6.2.3.1 (standard plots). Table 7.6.2.3.3 is the summary table of the assessment.

The assessment indicates that the fishing mortality (F5—14 weighted by stock numbers) in recent years has fluctuated between 0.11 and 0.20 and is estimated in 2014 at 0.110. The SSB on 1 January 2015 is estimated to 3.946 million tonnes.

7.6.3 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 7.6.3.1.

7.6.4 Retrospective analyses

The retrospective analyses of the final assessment are shown in Figure 7.6.4.1. It shows that there is a retrospective pattern since the 2010 assessment, but the retrospective pattern previously observed in the earlier parts of the SSB time series has been considerably improved with the implementation of the new algorithm for terminal F-values in 2013. The present assessment is in line with last year's assessment, but with a relatively minor revision upwards for the most recent period.

7.7 NSSH reference points

ICES reviewed the reference points of Norwegian spring spawning herring in 2013 in combination with the NEAFC request to evaluate of alternative management plans for this stock (ICES 2013d). ICES concluded that B_{lim} should remain unchanged at 2.5 million tonnes. B_{pa} is not to be revised as it is defined based on B_{lim}. ICES has evaluated F_{MSY} and considers it should remain unchanged at F_{MSY} = 0.15[4].

7.7.1 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 B_{lim}=2.5 million t and proposes that B_{pa}=5.0 million t. and F_{pa}=0.150.

7.7.2 MSY reference points

The MSY reference points originate from an analysis carried out by WGWIDE in 2010 and confirmed by reanalysis by WKBWNSSH in 2013 (ICES, 2013d). A detailed report of the analysis is provided in the stock annex. F_{MSY} is estimated at 0.15 and is based on the weighted mean of age groups 5—14. In the ICES MSY framework B_{pa} is proposed/adopted as the default trigger biomass $B_{trigger}$.

7.7.3 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 B_{pa}. If the SSB is below B_{pa}, a linear reduction in the fishing mortality rate will be applied from 0.125 at B_{pa} to 0.05 at B_{lim}.

7.8 State of the stock

The stock is declining and below B_{pa} in 2015. In the last 15 years, five large year classes have been produced (1998, 1999, 2002, 2003, and 2004). The available information indicates that year classes born in 2005—2012 have all been small. However, the present assessment estimates the 2013 year-class to be higher than the 2005-2012 year classes, although much lower than the 2004 year-class. Fishing mortality in 2014 is below F_{pa}

4 Norwegian spring spawning herring management plan operates on F values weighted with stock numbers, thus the unweighted F_{msy} is likely higher than 0.15.

and F_{MSY}, and at the management plan F. Fishing mortality for 2014 (F = 0.11) was calculated according to paragraph 3 in the management plan).

7.9 NSSH Catch predictions for 2016

7.9.1.1 Input data for the forecast

The input stock numbers at age 1 and older have been taken from the final assessment as last year. No attempt was made to estimate recent year classes separately because the available information of these year classes from surveys had already be included in the VPA. It should be noted that recent year classes are estimated poor and have little influence on predicted catches and SSB. For age 0 a geometric mean (across 1988—2011) has been used as in previous years.

The catch weight-at-age, used in the forecast, is the average of the observed catch weights over the last 3 years (2012—2014). For the weight-at-age in the stock, the values for 2015 were obtained from the commercial fisheries in the wintering areas. For the years 2016 and 2017 the average of the last 3 years (2013—2015) was used.

Standard values for natural mortality were used. Maturity at age was based on the information presented in Section 7.4.5. For all year classes born after 2004 the default maturity ogive for normal year classes were used.

Like in 2014 the exploitation pattern used in the forecast was taken as the average of the last 5 years (2010—2014). 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 7.9.1.1.

There was no agreement of a TAC for 2015. To obtain an estimate of the total catch to be used as input for the catch-constraint projections for 2016, the sum of the unilateral quotas set by the parties was used. In total, the expected outtake from the stock in 2015 amounts to 328 206 tonnes, including 20 000 tonnes set by Greenland for 2015. F in 2015 is calculated on the basis of this catch.

7.9.2 Results of the forecast

The Management Options Table with the results of the forecast is presented in Table 7.9.2.1. Detailed output of the forecast, with options corresponding to the management plan is given in Table 7.9.2.2. Assuming a total catch of 328 206 tonnes is taken in 2015, it is expected that the SSB will decline from 3.945 million tonnes on 1 January in 2015 to 3.586 million tonnes in 2016. The weighted F5-14 in 2015 is 0.085.

As the spawning stock biomass in 2016 is below the trigger reference point of 5 million tonnes, paragraph 3 of the management plan applies (see Section 7.12). The resulting fishing mortality used for predicting the TAC in 2016 is 0.083 and the corresponding TAC in 2016 is 316 876 tonnes. The expected remaining SSB on 1 January in 2017 is about 3.566 million tonnes.

7.10 Uncertainties in assessment and forecast

7.10.1 Uncertainty in the assessment

The population dynamics of Norwegian spring spawning herring is characterized by occasional strong year classes that in turn dominate the stock. This characteristic population structure seems to have consequences for how well the surveys represent the overall stock – in the presence of strong year classes they are also dominating the survey sampling. There seems to be marked changes in the survey catchability, with the stock at times appearing to be more easily available to the survey. This leads to discrepancies between the signal given by the survey and the one given by catch statistics, increasing the uncertainty in the assessment. Exploratory runs conducted (ICES, 2013) where the survey 5 catchability was changed for the period where we have a reason to assume higher catchability, show a smaller retrospective pattern in the latest years, which can be considered as a decrease in the uncertainty of the assessment.

Final assessment in 2015 includes an updated algorithm for estimating the terminal F values for year classes, where no supporting data is available. This is in accordance with a decision made in WGWIDE 2013. In these cases there is no information from the surveys and the catch statistics have a lot of stochastic noise. This update significantly reduced the uncertainty in the assessment, as it makes it more robust to the noise caused by small year classes entering age 1—4.

7.10.2 Uncertainty in the forecast

In the past, the retrospective behaviour of the assessment has contributed to the uncertainty in the forecast and predicted catches have been taken with a higher fishing mortality than intended. This retrospective behaviour of the assessment is still present but has diminished since the assessment in 2012. The present assessment is quite similar to last year's assessment, however with a slight upwards revision of the spawning stock in the last three years.

The year classes from 2011 and 2012 are estimated to be low. The estimate of the 2013 year class is still uncertain, but it is estimated by the assessment in 2015 to be below average. However, estimates of number at age 2 and younger have little impact on the prediction of the catch and the SSB in the projected period.

Uncertainty in the forecast arises from the assumption of the catch which will be taken in the intermediate year in the forecast (2015). In the forecast for each of these years, it was assumed that the total catch was equal to the sum of the national quotas set for each year. This assumption appeared to be realistic, so the same assumption is applied in 2015. In 2013, 2014 and 2015, the Coastal States did not agree on a share of the stock with the consequence that the sum of the quota of all participants in the fishery was higher than the TAC indicated by the management plan. In the forecast it has been assumed that the sum of the national quota will be taken in 2015.

7.11 Comparison with previous assessment and forecast

A comparison between the assessments 2008—2015 is shown in Figure 7.11.1. The assessment in 2015 was conducted in the same way as last year.

This year's assessment is consistent with last year's assessment, with a slight upward revision of SSB in the last few years. The table below shows the SSB (thousand tonnes) on 1 January in 2014 and F in 2013 as estimated in 2014 and 2015.

	ICES 2014	WG 2015	%difference
SSB(2014)	4 066	4 455	10%
F(2013)	0.147	0.138	-6%

Even though the spawning stock has been revised slightly upwards in this year's (2015) assessment it is still declining consistent with previous assessments and forecasts. According to last year's assessment (2014) it was expected that the SSB on 1 January in 2015 would decline to 3.502 million tonnes compared to this year's estimate of 3.946 million tonnes. In the forecast for 2016, paragraph 3 of the Management Agreement has been applied for the third time. This paragraph applies when the SSB is estimated below B_{pa} (5 million tonnes).

7.12 Management plans and evaluations

The long term management plan of Norwegian spring spawning herring (re-evaluated in 2013) aims for exploitation at a target fishing mortality below F_{pa} and is considered by ICES in accordance with the precautionary approach (WKBWNSSH, ICES, 2013d). The management plan in use contains the following elements:

- Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level (B_{lim}) of 2 500 000 t.
- For 2012 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.
- Should the SSB fall below a reference point of 5 000 000 t (B_{pa}), the fishing mortality rate, referred under Paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing to ensure a safe and rapid recovery of the SSB to a level in excess of 5 000 000 t. The basis for such adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at B_{pa} (5 000 000 t) to 0.05 at B_{lim} (2 500 000 t).
- The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

A brief history of it is in the stock annex. In general, the stock has been managed in compliance with the management plan.

7.13 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 of 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. Since 1999 catches have been regulated through an agreed management plan. The management plan is considered to be precautionary. However, since 2013, total declared catches are higher than the management plan.

In the absence of strong year classes after 2004, the stock has declined since 2009 and is expected to decline further in 2016. The short term prognoses indicate a decline of SSB from 3.9 million tonnes in 2015 to 3.6 million tonnes in 2016 and 2017, respectively, assuming that declared catches will be taken in 2015 and exploitation in 2016 is according the management plan. SSB in 2016 is below B_{pa} and $B_{trigger}$. In that situation, article 3 of the management plan will be applied, to set TACs for 2016 and future years as long as SSB remains below B_{pa}. Given the relatively low recruitment in recent years, it is expected that SSB will remain below B_{pa} in the short term. This situation will continue until large year classes recruit to the spawning stock. This year's assessment estimates the 2013 year-class to be higher than the year-classes 2005—2012. The 2013 year-class is, however, estimated considerably smaller than the 2004 year-class.

The results of the evaluation of a management plan are conditional on a number of assumptions which have to be made in any modelling exercise. The expected recruitment is one of these assumptions. In general, it is assumed that future recruitment patterns are similar as observed in the past. Under this assumption, the present management plan for Norwegian spring spawning herring is considered precautionary. In the ICES advice, released in 2013, on the NEAFC request to evaluate possible modifications of the management plan, an evaluation was presented of the expected dynamics of the stock under continued poor recruitment conditions. This evaluation indicates that in the absence of strong year classes entering SSB, under the present management plan, SSB is expected to fluctuate around 4 million tonnes and catches will vary between 300 and 400 thousand tonnes.

Since 2013, a lack of agreement by the Coastal States on their share in the TAC has lead to unilaterally set quotas which together are higher than the TAC indicated by the management plan.

7.14 Regulations and their effects

The NSSH has been fished moderately for the last six years with a target fishing mortality of 0.125 which has been reduced in 2014 and 2015 in line with the management plan. The realized fishing mortality, however, has varied between 0.1 and 0.2 for the last six years. This is higher than the target F from the management plan.

The stock is moderately harvested as compared to most other stocks.

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. The herring stock is a significant part of the ecosystem in Nordic Seas, both as predator on zooplankton but also as food resource to higher trophic levels (e.g. cod, saithe, seabirds, and marine mammals).

Compared to the early 2000s, the older part of the herring stock has had more westerly feeding migration pattern in recent years according to the IESNS survey in May (ICES, 2015c). This has been more pronounced in July/August according to the IESSNS survey (ICES, 2015d). With the absence of large recruiting year classes in the stock in recent years and thereby a small amount of young herring, less have been feeding in the north-eastern part of the Norwegian Sea. Thus herring have been mainly found in the fringe of the Norwegian Sea; i.e. from north of the Faroes, the east and north Icelandic area and north in the Jan Mayen area, with negligible numbers in the central and eastern areas. Whether this distribution pattern is a response to feeding competition with mackerel, which is distributed over the whole Norwegian Sea and adjacent waters (ICES, 2015d), is unknown. A spatial overlap of herring and mackerel has been large in the southern-most areas of the herring distribution, but less so further north (e.g. in the Jan Mayen area). This overlap was less pronounced in 2014 and 2015 compared to preceding two years (Nøttestad *et al.*, 2014; ICES, 2015d). In addition, fishery patterns suggest that herring appears to reside longer throughout the autumn in the south-western area close to Faroe Islands.

Analyses of stomach content of herring and mackerel that overlap spatially show that they are competing for food to some extent (Bachiller *et al.*, 2015; Debes *et al.*, 2012; Langøy *et al.*, 2012; Óskarsson *et al.*, 2012). Since mackerel has been shown in such studies to be a more effective feeder, herring might be partly outcompeted by the faster and more efficient mackerel in areas where they co-exist. Thus, the competition could be forcing the herring to the fringe of Norwegian Sea, although higher zooplankton biomass there (Nøttestad *et al.*, 2014; ICES, 2015d) could also attract the herring there.

The average biomass of zooplankton in the total area in May had a decreasing trend from around 2002 until 2009, but an upward trend since then until 2014. This declined again slightly in 2015 (ICES, 2015c). An upward trend of zooplankton abundance was also observed in the IESSNS surveys in the Norwegian Sea for the years 2011—2015, and the 2015 level is similar to 2014 (ICES, 2015d). At the same time (2011—2015), weight-at-age (this report) and length-at-age (ICES, 2014b) in the stock are showing an increasing trend. Thus, there are neither signs that the Norwegian Sea is being overgrazed at present by the pelagic fish stocks in the area, nor that the herring stock is suffering from a lack of food. It is unknown whether the increase in zooplankton is related to decreasing stock size of herring, but this will be explored further by WGINOR. Further work on the zooplankton index is also needed and is planned to be addressed by WGINOR (ICES, 2014b) as well as exploring the biological and stock related variables of herring and other pelagic fish stocks in relation to environmental and ecological variables. This involves revision of the data and producing indices for the different areas, as well as explorations of their relation to growth, abundance and spatial distribution of pelagic fish stocks feeding in the area.

A recent study evaluated mackerel predation in an area of overlap between mackerel and herring larvae in the Norwegian coastal shelf (between about 66°N and 69°N), with particular focus on the predation of herring larvae (Skaret *et al.*, 2015). Mackerel were dispersed close to the surface but were caught in all but one of the trawl hauls for the study; herring larvae were caught in all samples. 45% of the mackerel guts contained herring larvae, with a maximum of 225 larvae counted in a single gut. Both the frequency of guts containing herring larvae and the average amount of herring larvae increased in line with increasing abundance of larvae. On the other hand, no spatial correlation between mackerel abundance and herring larvae abundance was found at the station level. The results suggest that mackerel fed opportunistically on herring larvae, and that predation pressure therefore largely depends on the degree of overlap in time and space.

7.16 Changes in fishing patterns

No major changes were observed in the fishing patterns in 2014 relative to recent years (see Section 7.2). Minor changes observed include an extended period of the fishery in the southern and south-western areas in the Norwegian Sea during in 3rd and especially 4th quarters. Minor changes observed include more easterly distributed catches in the fourth quarter.

Mixture of mackerel and herring was apparent in the summer fishery of the Icelandic and Faroese fleets prior to 2014, but the preliminary information from the fishery in 2015 suggests less overlap between the two species as in 2014.

7.17 Changes in the environment

In the Norwegian Sea, where the herring stock is grazing, the two main features of ocean circulation are the Norwegian Atlantic Current (NWAC) and the East Iceland 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. It has been shown that atmospheric forcing largely controls the distribution of the water masses in the Nordic Seas. Hence, the lateral extent of the NWAC, and consequently the position of the Arctic Front, that separates the warm North Atlantic waters from the cold Arctic waters, is correlated with the large-scale distribution of the atmospheric sea level pressure.

Relative to the 20 year long-term mean, from 1995—2014, the temperatures at all depths in the vicinity of the Faroes were considerable lower in May 2015 (ICES, 2015c). There, the anomaly was maximum 2°C. The cold conditions reflect the relative low temperatures in the Sub Polar Gyre that have propagated north-eastward into the southern Norwegian Sea. North of about 61°N, the temperatures at all depths were in general higher than the long term mean for most of the area. In this area, the temperatures were about 0.25—0.75°C above the mean but in some areas the anomalies were higher (e.g., over the Vøring Plateu, northeast of Jan Mayen, and at the entrance to the Barents Sea).

The temperature east of Iceland in the 0—50m layer in May 2015 was lower than in 2014, which was a smaller deviation than observed west, south and southeast of Iceland in the same survey (1—2°C lower in upper layers). Thus the colder conditions around the Faroes are not considered to be related to increased flow in EIC, but to the changed conditions in the North Atlantic Current and the lower temperature in the Sub Polar Gyre, seen as a negative SST anomaly and which has been progressing north-eastwards during this spring. So the colder anomaly on the Iceland Faroes Ridge is probably more related to these colder conditions from the west and south and was likely influencing the Norwegian Sea this summer. These colder surface (and upper layers) are related to strongly positive NAO and cold/fresh waters on the Canadian site of the Atlantic this winter and spring.

General colder surface water masses in the Nordic Seas in May 2015 relative to recent years, and the last 20 years in some areas, were also observed in the IESSNS in July/August 2015 (ICES, 2015d). South of the Greenland-Iceland ridge the SST was about 1°C lower than the 20 year average, while in the central and eastern part of the Norwegian Sea the SST was close to the 20 year average. However, the temperature in the surface layer from north Iceland over Jan Mayen and to Svalbard was 1—2°C warmer in July 2015 than the average for the last 20 years, even if colder than in 2014.

7.18 Recommendation

7.18.1.1 Concerning Age reading

During the post-cruise meeting after the 2015 IESNS survey (also known as the “May survey”), age distributions of NSS herring from trawl samples from the different participating countries were compared. These age distributions were quite different, even for samples taken in the same area and time period.

The technical problems with age readings of NSS herring during the May survey may be split into two: **(1) The problem with deciding whether the herring in May has added extra growth in the otoliths or scales:** If the age readers decides there is extra growth added during the present year, they decide not to count the edge of the scales and otoliths as a winter ring. If they do decide that there is no growth yet (during the present year), they decide to count the edge as a winter ring, thereby adding one more year. As a general rule it is very seldom that NSS herring has added growth in the otoliths in May. Norwegian age readers that follow the NSS herring with age reading all over the year, see this more clearly than readers not reading age of the herring in the months prior to the May survey. Norwegian readers therefore normally count the edge. However, non-Norwegian readers have a tendency to interpret that growth is added more often and therefore do not count the edge. Typically this may lead to transfer of fish from a large year class like 2004 and down to a smaller year class like 2005. The problem will increase as a year class gets older, and growth ceases. The older they get, the closer is the distance between the winter rings, and the more difficult it is to decide if there is growth added to scales and otoliths already in May. **(2) The general problem with reduced quality of scales, and difficulties of aging old fish using otoliths.** Norwegian age readers claim that scales sampled in May are easier to read than otoliths for older NSS herring. However, in May it is difficult to get nice scales from herring samples, they are often 'washed off' during the trawling process. This makes it more difficult to read the age, and decide to count the edge or not. Hence, sometimes otoliths have to be used, which are even more difficult to read than scales.

An indication for discrepancy in ageing of the older year classes between the different institutes, especially for those around the 2004 year class, is also noticeable when comparing the age structure in spawning survey in 2015 (Table 7.4.7.1.1) and the May survey 2015 (Figure 7.4.7.4.2 and Table 7.4.7.4.2), where both surveys are considered to cover the whole spawning stock

In conclusion, an age reading workshop involving technicians from the countries participating in the IESNS (May) survey should be held before the next survey in May 2016.

7.18.2 IESSNS coverage of herring

In order to use the acoustic estimates on Norwegian spring spawning herring from IESSNS quantitatively in the assessment, a full horizontal coverage is needed. The WGIPS is asked to consider including the full coverage of Norwegian spring spawning herring in all years. The horizontal coverage of Norwegian spring spawning herring on the IESSNS has been varying throughout the time-series, and has probably not covered the complete summer distribution of herring completely in previous years.

7.19 References

Bachiller E., Skaret G., Nøttestad L., Slotte A. 2015 (submitted). Feeding ecology of Northeast Atlantic mackerel, Norwegian spring-spawning herring and blue whiting in the Norwegian Sea. PlosONE.

Debes, H., Homrum, E., Jacobsen, J. A., Hátún, H., and Danielsen, J. 2012. The feeding ecology of pelagic fish in the southwestern Norwegian Sea – Inter species food competition between herring (Clupea harengus) and mackerel (Scomber scombrus). ICES CM 2012/M:07. 19 pp.

ICES 1998. Northern Pelagic and Blue Whiting Fisheries Working Group, ICES CM 1998/ACFM:18

ICES. 2015c. International ecosystem survey in the Nordic Sea (IESNS) in April-June 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25—31 August 2015. 34 pp.

ICES. 2015d. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) with M/V ”Brennholm”, M/V “Eros”, M/V “Christian í Grótinum” and R/V “Árni Friðriksson”, 1 July—10 August 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25—31 August 2015. 47 pp.

Langøy, H., Nøttestad, L., Skaret, G., Broms, C. and Fernö, A. 2012. Overlap in distribution and diets of Atlantic mackerel (Scomber scombrus), Norwegian spring- spawning herring (Clupea harengus) and blue whiting (Micromesistius poutassou) in the Norwegian Sea during late summer. Marine biology research, 8: 442—460.

Nøttestad, L., Salthaug, A., Johansen, G.O., Utne, K.R., Anthonypillai, R., Tangen, Ø., Óskarsson, G.J., Sveinbjörnsson, S., Jónsson, S., Debes, H., Mortensen, E., Smith, L, Ólafsdóttir, A., and Jacobsen, J.A., 2014. Cruise report from the coordinated ecosystem survey (IESSNS) with M/V "Brennholm", M/V "Vendla", M/V "Finnur Fríði" and R/V "Arni Fridriksson" in the Norwegian Sea and surrounding waters, 2 July—12 August 2014. Working Document to the ICES WGWIDE 2014. 49 pp.

Óskarsson G.J., Sveinbjörnsson, S., Guðmundsdóttir, Á. and Sigurðsson, Þ. 2012. Ecological impacts of recent extension of feeding migration of NE-Atlantic mackerel into the ecosystem around Iceland. ICES CM 2012/M:03. 25 pp.

Skaret G., Bachiller E., Langøy H., Stenevik, E.K. 2015. Mackerel predation on herring larvae during summer feeding in the Norwegian Sea. ICES JMS, doi:10.1093/icesjms/fsv087

Table 7.4.1.1 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

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Netherlands	Greenland	UK (Scotland)	Germany	France	Poland	Sweden	Total
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
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
2010	871113	199472	26792	80281	205864	8061	26695	3453	24151	11133	0	0	0	1457015
2011	572641	144428	26740	53271	151074	5727	8348	3426	14045	13296	0	0	0	992997

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Netherlands	Greenland	UK (Scotland)	Germany	France	Poland	Sweden	Total
2012	491005	118595	21754	36190	120956	4813	6237	1490	12310	11945	0	0	705	826000
2013	359458	78521	17160	105038	90729	3815	5626	11788	8342	4244	0	0	23	684743
2014	263253	60292	12513	38529	58828	706	9175	13108	4233	669	0	0	0	461306

***In 2003 the Norwegian catches were raised of 39433 to account for changes in percentages of water content.**

Table 7.4.1.2. Norwegian spring spawning herring. Output from SALLOC for 2014 data.

Summary of Sampling by Country

AREA : IIIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	0.24	0	0	0	0.00
Total IIIa	0.00	0.24	0	0	0	0.00

Sum of Offical Catches : 0.24

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 0.24

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
DE	0.00	667.75	0	0	0	0.00
Danmark	12513.32	12513.32	2	249	99	100.09
Faroe Islands	26164.08	26167.23	4	406	394	100.00
Greenland	0.00	2022.00	0	0	0	0.00
Iceland	26824.00	26824.00	7	301	174	100.00
Ireland	0.00	705.57	0	0	0	0.00
Norway	260945.31	260945.31	76	2419	2419	100.04
Russia	13822.00	15975.00	39	6150	399	100.05
The Netherlands	5711.20	5711.20	2	121	50	100.00
United Kingdom	0.00	4233.34	0	0	0	0.00
Total IIa	345979.88	355764.72	130	9646	3535	100.03

Sum of Offical Catches : 355764.72

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 355764.72

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
DE	0.00	1.18	0	0	0	0.00
Norway	0.00	0.15	0	0	0	0.00
Russia	13020.00	13020.00	22	3418	100	100.00
The Netherlands	3463.92	3463.92	5	328	125	100.00
Total IIb	16483.92	16485.26	27	3746	225	100.00

Sum of Offical Catches : 16485.26

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 16485.26

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	2306.44	2307.22	1	25	25	100.24
Total IVa	2306.44	2307.22	1	25	25	100.24

Sum of Offical Catches : 2307.22

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 2307.22

AREA : Iia

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	6074.85	6074.85	5	325	310	100.00
Russia	0.00	29134.00	0	0	0	0.00
Total Iia	6074.85	35208.85	5	325	310	100.00

Sum of Offical Catches : 35208.85

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 35208.85

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Greenland	0.00	19.31	0	0	0	0.00
Iceland	31990.00	31990.00	43	1767	1043	100.00
Total Va	31990.00	32009.31	43	1767	1043	100.09

Sum of Offical Catches : 32009.31

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 32009.31

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	6287.34	6287.34	7	620	601	100.00

Russia	0.00	6.00	0	0	0	0.00
Total Vb	6287.34	6293.34	7	620	601	100.00

Sum of Offical Catches : 6293.34

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 6293.34

AREA : XIVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Greenland	0.00	11066.40	0	0	0	0.00
Iceland	14.00	14.00	5	249	24	100.0
Russia	2157.00	2157.00	11	1992	50	100.00
Total XIVa	2171.00	13237.40	16	2241	74	100.00

Sum of Offical Catches : 13237.40

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 13237.40

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	110719.45	110719.45	38	1396	1396	100.04
Russia	0.00	2145.00	0	0	0	0.00
Period Total	110719.45	112864.45	38	1396	1396	100.04

Sum of Offical Catches : 112864.45

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 112864.45

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroe Islands	0.00	3.15	0	0	0	0.00
Norway	662.23	663.25	1	25	25	100.25
Russia	0.00	8.00	0	0	0	0.00
Period Total	662.23	674.40	1	25	25	100.25

Sum of Offical Catches : 674.40

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 674.40

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
DE	0.00	165.33	0	0	0	0.00
Faroe Islands	6765.19	6765.19	9	646	616	100.00
Greenland	0.00	11052.03	0	0	0	0.00
Iceland	35796.00	35796.00	45	1907	989	100.00
Norway	849.66	849.80	1	25	25	101.03
Russia	24638.00	24644.00	66	10978	499	100.00
Period Total	68048.84	79272.36	121	13556	2129	100.01

Sum of Offical Catches : 79272.36

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 79272.36

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
DE	0.00	503.60	0	0	0	0.00
Danmark	12513.32	12513.32	2	249	99	100.09
Faroe Islands	31761.08	31761.08	7	705	689	100.00
Greenland	0.00	2055.68	0	0	0	0.00
Iceland	23032.00	23032.00	10	410	252	100.00
Ireland	0.00	705.57	0	0	0	0.00
Norway	151020.41	151020.41	37	998	998	100.03
Russia	4361.00	33495.00	6	582	50	100.00
The Netherlands	9175.12	9175.12	7	449	175	100.00
United Kingdom	0.00	4233.34	0	0	0	0.00
Period Total	231862.94	268495.13	69	3393	2263	100.02

Sum of Offical Catches : 268495.13

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 268495.13

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
DE	0.00	668.93	0	0	0	0.00
Danmark	12513.32	12513.32	2	249	99	100.09
Faroe Islands	38526.27	38529.42	16	1351	1305	100.00

Greenland	0.00	13107.71	0	0	0	0.00
Iceland	58828.00	58828.00	55	2317	1241	100.00
Ireland	0.00	705.57	0	0	0	0.00
Norway	263251.75	263252.91	77	2444	2444	100.04
Russia	28999.00	60292.00	72	11560	549	100.00
The Netherlands	9175.12	9175.12	7	449	175	100.00
United Kingdom	0.00	4233.34	0	0	0	0.00
Total for Stock	411293.44	461306.31	229	18370	5813	100.03

Sum of Offical Catches : 461306.31

Unallocated Catch : 0.00

Discards : 0.00

Working Group Catch : 461306.31

DETAILS OF DATA FILLING-IN

Filling-in for record : (1) DE 3 IIa

Unweighted Mean of :

>> (6) Faroe Islands 3 Iia

>> (16) Iceland 3 IIa

>> (24) Norway 3 IIa

>> (33) Russia 3 IIa

Filling-in for record : (2) DE 4 IIa

Unweighted Mean of :

>> (4) Danmark 4 IIa

>> (7) Faroe Islands 4 IIa

>> (17) Iceland 4 IIa

>> (20) The Netherlands 4 IIa

>> (25) Norway 4 IIa

Filling-in for record : (3) DE 3 IIb

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Using Only

  >>  ( 35)  Russia                 3 IIb


  Filling-in for record : (  5)   Faroe Islands          2 IIa

Using Only

  >>  ( 23)  Norway                 2 IIa


  Filling-in for record : ( 10)   Greenland              3 XIVa

Unweighted Mean of :

  >>  ( 15)  Iceland                3 XIVa

  >>  ( 30)  Russia                 3 XIVa


  Filling-in for record : ( 11)   Greenland              4 XIVa

Unweighted Mean of :

  >>  (  4)  Danmark                4 IIa

  >>  (  7)  Faroe Islands          4 IIa

  >>  ( 17)  Iceland                4 IIa

  >>  ( 20)  The Netherlands        4 IIa

  >>  ( 25)  Norway                 4 IIa

  >>  ( 19)  Iceland                4 Va


  Filling-in for record : ( 12)   Greenland              4 IIa

Unweighted Mean of :

  >>  (  4)  Danmark                4 IIa

  >>  (  7)  Faroe Islands          4 IIa

  >>  ( 17)  Iceland                4 IIa

  >>  ( 20)  The Netherlands        4 IIa

  >>  ( 25)  Norway                 4 IIa


  Filling-in for record : ( 13)   Greenland              3 Va

Using Only

  >>  ( 18)  Iceland                3 Va


  Filling-in for record : ( 14)   Ireland                4 IIa

Unweighted Mean of :

  >>  (  4)  Danmark                4 IIa
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  >>  (  7)  Faroe Islands         4 IIa

  >>  ( 17)  Iceland               4 IIa

  >>  ( 20)  The Netherlands       4 IIa

  >>  ( 25)  Norway                4 IIa


  Filling-in for record : ( 26)   Norway                3 IIb

Using Only

  >>  ( 24)  Norway                3 IIa


  Filling-in for record : ( 27)   Norway                2 IIIa

Using Only

  >>  ( 28)  Norway                1 IVa


  Filling-in for record : ( 29)   Norway                2 IVa

Using Only

  >>  ( 28)  Norway                1 IVa


  Filling-in for record : ( 31)   Russia                1 IIa

Using Only

  >>  ( 22)  Norway                1 IIa


  Filling-in for record : ( 32)   Russia                2 IIa

Using Only

  >>  ( 23)  Norway                2 IIa


  Filling-in for record : ( 34)   Russia                4 Iia

Using Only

  >>  ( 33)  Russia                3 IIa


  Filling-in for record : ( 37)   Russia                3 Vb

Using Only

  >>  (  8)  Faroe Islands         3 Vb


  Filling-in for record : ( 38)   United Kingdom        4 IIa

Unweighted Mean of :

  >>  (  4)  Danmark               4 IIa
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>>  (  7)  Faroe Islands         4 IIa
>>  ( 17)  Iceland               4 IIa
>>  ( 20)  The Netherlands       4 IIa
>>  ( 25)  Norway                4 IIa
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Catch Numbers at Age by Area

For Periods 1 to 4

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	264.95	0.00	0.00	0.00	0.00	0.00	0.00	264.95
2	0.00	1086.56	0.00	0.00	0.00	198.15	50.00	106.35	1441.06
3	0.01	17388.19	297.44	140.05	1788.81	5422.82	618.38	2645.30	28300.99
4	0.02	40782.85	1579.04	220.07	7893.45	5648.19	627.74	1086.87	57838.24
5	0.20	210560.94	10269.79	1890.64	14409.43	12193.77	943.60	7260.61	257529.00
6	0.04	32953.78	2965.40	350.12	6746.91	5731.58	251.38	1424.49	50423.70
7	0.04	49798.58	3310.96	420.14	9107.28	4815.24	469.49	3799.27	71721.00
8	0.10	146288.52	14840.46	990.33	17326.11	8785.31	2543.19	4039.78	194813.78
9	0.06	99210.24	7062.64	570.19	20268.82	10162.09	2357.92	7451.04	147083.03
10	0.22	329842.19	1746.30	2140.72	13137.73	22982.37	6113.15	5354.51	381317.22
11	0.03	63363.06	1951.45	330.11	5317.10	8246.46	1486.47	2354.89	83049.58
12	0.04	46705.35	1687.61	420.14	2326.06	4000.95	990.14	1184.96	57315.25

13	0.01	10275.36	415.18	100.03	399.63	975.81	232.64	347.18	12745.85
14	0.00	782.78	0.00	0.00	350.01	450.15	55.75	170.39	1809.06
15	0.01	7216.12	0.00	80.03	148.85	0.00	55.75	0.15	7500.92

Mean Weight at Age by Area (Kg)

For Periods 1 to 4

AgesIIIa		IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0570	0.0000	0.0000	0.0000	0.0000	0.0000	0.1086	0.0570
2	0.0000	0.1706	0.0000	0.0000	0.0000	0.2308	0.1748	0.1657	0.1787
3	0.1742	0.2232	0.1715	0.1742	0.2209	0.2729	0.2128	0.2352	0.2327
4	0.2211	0.2649	0.2403	0.2211	0.2831	0.3097	0.2540	0.2633	0.2708
5	0.2569	0.2868	0.3194	0.2569	0.3157	0.3355	0.3180	0.3153	0.2928
6	0.2833	0.3122	0.3211	0.2833	0.3354	0.3536	0.3574	0.3614	0.3219
7	0.3024	0.3331	0.3724	0.3024	0.3600	0.3599	0.3601	0.3745	0.3423
8	0.3161	0.3483	0.3713	0.3161	0.3688	0.3658	0.3776	0.3733	0.3534
9	0.3258	0.3595	0.3980	0.3258	0.3775	0.3712	0.3810	0.3986	0.3668
10	0.3327	0.3625	0.3859	0.3327	0.3844	0.3752	0.3942	0.4156	0.3653
11	0.3375	0.3698	0.3734	0.3375	0.3970	0.3807	0.3956	0.4068	0.3741
12	0.3409	0.3699	0.4156	0.3409	0.3884	0.3898	0.4229	0.4148	0.3750

13	0.3433	0.3697	0.3966	0.3433	0.4284	0.4028	0.4517	0.4216	0.3776
14	0.0000	0.4176	0.0000	0.0000	0.4158	0.4084	0.4864	0.4267	0.4179
15	0.3464	0.3684	0.3855	0.3464	0.4398	0.0000	0.4864	0.4362	0.3705

Mean Length at Age by Area (cm)

For Periods 1 to 4

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	18.1055	0.0000	0.0000	0.0000	0.0000	0.0000	22.0500	18.1055
2	0.0000	25.9043	0.0000	0.0000	0.0000	28.4514	26.0000	25.6255	26.2373
3	26.9700	28.6982	26.2723	26.9700	28.5086	30.4164	27.7064	29.2013	29.0068
4	29.2900	35.7981	29.7620	29.2900	31.1607	31.9633	29.4646	30.4223	34.4314
5	30.8600	37.5816	32.3484	30.8600	32.3196	32.9825	31.7745	32.4665	36.6459
6	31.9200	38.9511	32.2639	31.9200	32.8551	33.6692	32.9692	34.2584	36.9305
7	32.6600	40.1897	34.5331	32.6600	33.8702	33.9096	33.2338	34.1470	38.2947
8	33.1600	40.3700	34.3168	33.1600	34.0150	34.1324	33.7737	34.6276	38.8206
9	33.5100	56.4977	34.5847	33.5100	34.3811	34.3371	33.9082	35.1718	49.3350
10	33.7500	43.9013	34.7925	33.7500	34.5228	34.4907	34.3122	35.2405	42.6369
11	33.9200	81.3773	34.3830	33.9200	34.9300	34.6976	34.3367	36.4089	70.3585
12	34.0400	40.0449	35.5510	34.0400	35.1027	35.0503	35.1677	35.8382	39.1481

13	34.1200	53.5267	36.7949	34.1200	36.0000	35.5427	36.0000	36.1137	50.1088
14	0.0000	35.3989	0.0000	0.0000	34.5820	35.7544	37.0000	36.0909	35.4439
15	34.2300	34.6157	34.8400	34.2300	37.6677	0.0000	37.0000	35.9200	34.6899

Catch Numbers at Age by Area

For Period 1

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	244.75	0.00	0.00	0.00	0.00	0.00	0.00	244.75
2	0.00	397.72	0.00	0.00	0.00	0.00	0.00	0.00	397.72
3	0.00	5476.25	0.00	140.00	0.00	0.00	0.00	0.00	5616.25
4	0.00	11329.82	0.00	220.00	0.00	0.00	0.00	0.00	11549.82
5	0.00	94921.63	0.00	1890.00	0.00	0.00	0.00	0.00	96811.63
6	0.00	15531.33	0.00	350.00	0.00	0.00	0.00	0.00	15881.33
7	0.00	19641.07	0.00	420.00	0.00	0.00	0.00	0.00	20061.07
8	0.00	42688.22	0.00	990.00	0.00	0.00	0.00	0.00	43678.22
9	0.00	26728.58	0.00	570.00	0.00	0.00	0.00	0.00	27298.58
10	0.00	103039.13	0.00	2140.00	0.00	0.00	0.00	0.00	105179.13
11	0.00	17846.25	0.00	330.00	0.00	0.00	0.00	0.00	18176.25
12	0.00	18396.93	0.00	420.00	0.00	0.00	0.00	0.00	18816.93

13	0.00	5700.60	0.00	100.00	0.00	0.00	0.00	0.00	5800.60
14	0.00	81.58	0.00	0.00	0.00	0.00	0.00	0.00	81.58
15	0.00	3752.81	0.00	80.00	0.00	0.00	0.00	0.00	3832.81

Mean Weight at Age by Area (Kg)

For Period 1

AgesIIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0 0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1 0.0000	0.0527	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0527
2 0.0000	0.1175	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1175
3 0.0000	0.1742	0.0000	0.1742	0.0000	0.0000	0.0000	0.0000	0.1742
4 0.0000	0.2220	0.0000	0.2211	0.0000	0.0000	0.0000	0.0000	0.2220
5 0.0000	0.2578	0.0000	0.2569	0.0000	0.0000	0.0000	0.0000	0.2578
6 0.0000	0.2838	0.0000	0.2833	0.0000	0.0000	0.0000	0.0000	0.2838
7 0.0000	0.3030	0.0000	0.3024	0.0000	0.0000	0.0000	0.0000	0.3030
8 0.0000	0.3165	0.0000	0.3161	0.0000	0.0000	0.0000	0.0000	0.3165
9 0.0000	0.3266	0.0000	0.3258	0.0000	0.0000	0.0000	0.0000	0.3266
10 0.0000	0.3335	0.0000	0.3327	0.0000	0.0000	0.0000	0.0000	0.3335
11 0.0000	0.3389	0.0000	0.3375	0.0000	0.0000	0.0000	0.0000	0.3388
12 0.0000	0.3415	0.0000	0.3409	0.0000	0.0000	0.0000	0.0000	0.3414

13	0.0000	0.3448	0.0000	0.3433	0.0000	0.0000	0.0000	0.0000	0.3448
14	0.0000	0.3465	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3465
15	0.0000	0.3472	0.0000	0.3464	0.0000	0.0000	0.0000	0.0000	0.3472

Mean Length at Age by Area (cm)

For Period 1

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	17.7800	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	17.7800
2	0.0000	23.5100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	23.5100
3	0.0000	26.9700	0.0000	26.9700	0.0000	0.0000	0.0000	0.0000	26.9700
4	0.0000	29.3300	0.0000	29.2900	0.0000	0.0000	0.0000	0.0000	29.3292
5	0.0000	30.8900	0.0000	30.8600	0.0000	0.0000	0.0000	0.0000	30.8894
6	0.0000	31.9400	0.0000	31.9200	0.0000	0.0000	0.0000	0.0000	31.9396
7	0.0000	32.6800	0.0000	32.6600	0.0000	0.0000	0.0000	0.0000	32.6796
8	0.0000	33.1800	0.0000	33.1600	0.0000	0.0000	0.0000	0.0000	33.1795
9	0.0000	33.5400	0.0000	33.5100	0.0000	0.0000	0.0000	0.0000	33.5394
10	0.0000	33.7800	0.0000	33.7500	0.0000	0.0000	0.0000	0.0000	33.7794
11	0.0000	33.9700	0.0000	33.9200	0.0000	0.0000	0.0000	0.0000	33.9691
12	0.0000	34.0600	0.0000	34.0400	0.0000	0.0000	0.0000	0.0000	34.0596

13	0.0000	34.1800	0.0000	34.1200	0.0000	0.0000	0.0000	0.0000	34.1790
14	0.0000	34.2300	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	34.2300
15	0.0000	34.2600	0.0000	34.2300	0.0000	0.0000	0.0000	0.0000	34.2594

Catch Numbers at Age by Area

For Period 2

AgesIIIa		IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.01	40.67	0.00	0.05	0.00	0.00	0.00	0.00	40.74
4	0.02	61.01	0.00	0.07	0.00	0.00	0.00	0.00	61.11
5	0.20	549.09	0.00	0.64	0.00	0.00	0.00	0.00	549.92
6	0.04	101.68	0.00	0.12	0.00	0.00	0.00	0.00	101.84
7	0.04	122.02	0.00	0.14	0.00	0.00	0.00	0.00	122.21
8	0.10	284.71	0.00	0.33	0.00	0.00	0.00	0.00	285.15
9	0.06	162.69	0.00	0.19	0.00	0.00	0.00	0.00	162.94
10	0.22	620.27	0.00	0.72	0.00	0.00	0.00	0.00	621.21
11	0.03	91.52	0.00	0.11	0.00	0.00	0.00	0.00	91.66
12	0.04	122.02	0.00	0.14	0.00	0.00	0.00	0.00	122.21

13	0.01	30.51	0.00	0.03	0.00	0.00	0.00	0.00	30.55
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.01	20.34	0.00	0.03	0.00	0.00	0.00	0.00	20.37

Mean Weight at Age by Area (Kg)

For Period 2

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	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	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.1742	0.1870	0.0000	0.1742	0.0000	0.0000	0.0000	0.0000	0.1870
4	0.2211	0.2310	0.0000	0.2211	0.0000	0.0000	0.0000	0.0000	0.2310
5	0.2569	0.2643	0.0000	0.2569	0.0000	0.0000	0.0000	0.0000	0.2643
6	0.2833	0.2887	0.0000	0.2833	0.0000	0.0000	0.0000	0.0000	0.2887
7	0.3024	0.3063	0.0000	0.3024	0.0000	0.0000	0.0000	0.0000	0.3063
8	0.3161	0.3189	0.0000	0.3161	0.0000	0.0000	0.0000	0.0000	0.3188
9	0.3258	0.3278	0.0000	0.3258	0.0000	0.0000	0.0000	0.0000	0.3278
10	0.3327	0.3340	0.0000	0.3327	0.0000	0.0000	0.0000	0.0000	0.3340
11	0.3375	0.3385	0.0000	0.3375	0.0000	0.0000	0.0000	0.0000	0.3385
12	0.3409	0.3416	0.0000	0.3409	0.0000	0.0000	0.0000	0.0000	0.3416

13	0.3433	0.3438	0.0000	0.3433	0.0000	0.0000	0.0000	0.0000	0.3438
14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.3464	0.3466	0.0000	0.3464	0.0000	0.0000	0.0000	0.0000	0.3466

Mean Length at Age by Area (cm)

For Period 2

AgesIIIa		IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	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	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	26.9700	27.6400	0.0000	26.9700	0.0000	0.0000	0.0000	0.0000	27.6390
4	29.2900	29.7400	0.0000	29.2900	0.0000	0.0000	0.0000	0.0000	29.7393
5	30.8600	31.1600	0.0000	30.8600	0.0000	0.0000	0.0000	0.0000	31.1595
6	31.9200	32.1300	0.0000	31.9200	0.0000	0.0000	0.0000	0.0000	32.1297
7	32.6600	32.8000	0.0000	32.6600	0.0000	0.0000	0.0000	0.0000	32.7998
8	33.1600	33.2600	0.0000	33.1600	0.0000	0.0000	0.0000	0.0000	33.2598
9	33.5100	33.5800	0.0000	33.5100	0.0000	0.0000	0.0000	0.0000	33.5799
10	33.7500	33.8000	0.0000	33.7500	0.0000	0.0000	0.0000	0.0000	33.7999
11	33.9200	33.9600	0.0000	33.9200	0.0000	0.0000	0.0000	0.0000	33.9599
12	34.0400	34.0700	0.0000	34.0400	0.0000	0.0000	0.0000	0.0000	34.0700

13	34.1200	34.1400	0.0000	34.1200	0.0000	0.0000	0.0000	0.0000	34.1400
14	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15	34.2300	34.2400	0.0000	34.2300	0.0000	0.0000	0.0000	0.0000	34.2400

Catch Numbers at Age by Area

For Period 3

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	119.82	0.00	106.06	225.88
3	0.00	1003.68	160.62	0.00	217.67	4448.94	18.41	2641.68	8490.99
4	0.00	4529.18	597.38	0.00	169.72	4673.77	27.77	1082.50	11080.32
5	0.00	9305.79	6309.91	0.00	1072.98	10508.36	141.82	7248.28	34587.15
6	0.00	4054.23	755.16	0.00	1125.18	5086.07	101.39	1420.60	12542.63
7	0.00	5097.85	2103.77	0.00	1028.22	4312.33	119.50	3795.72	16457.40
8	0.00	9397.20	9516.27	0.00	3202.13	7898.14	372.23	4029.79	34415.76
9	0.00	11253.00	3884.68	0.00	2549.10	9138.59	290.60	7439.21	34555.18
10	0.00	10799.65	0.15	0.00	4441.56	20671.83	510.46	5327.57	41751.23
11	0.00	3901.41	0.02	0.00	1393.30	7444.08	162.06	2343.25	15244.12
12	0.00	2121.78	542.81	0.00	569.87	3611.74	66.25	1180.97	8093.42

13	0.00	289.02	134.72	0.00	209.14	879.09	24.32	345.81	1882.10
14	0.00	231.93	0.00	0.00	49.47	411.34	5.75	170.23	868.72
15	0.00	68.59	0.00	0.00	49.47	0.00	5.75	0.00	123.82

Mean Weight at Age by Area (Kg)

For Period 3

AgesIIIa		IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	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	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.2411	0.0000	0.1656	0.2056
3	0.0000	0.2311	0.1711	0.0000	0.2829	0.2740	0.2769	0.2352	0.2552
4	0.0000	0.2909	0.2534	0.0000	0.3169	0.3117	0.3065	0.2632	0.2954
5	0.0000	0.3236	0.3230	0.0000	0.3353	0.3373	0.3361	0.3153	0.3263
6	0.0000	0.3446	0.3439	0.0000	0.3397	0.3545	0.3363	0.3614	0.3500
7	0.0000	0.3604	0.3734	0.0000	0.3732	0.3604	0.3737	0.3745	0.3662
8	0.0000	0.3691	0.3715	0.0000	0.3726	0.3660	0.3716	0.3733	0.3699
9	0.0000	0.3774	0.4044	0.0000	0.3817	0.3713	0.3808	0.3986	0.3838
10	0.0000	0.3809	0.3724	0.0000	0.3930	0.3752	0.3924	0.4158	0.3839
11	0.0000	0.3915	0.3772	0.0000	0.3935	0.3807	0.3928	0.4070	0.3888
12	0.0000	0.3989	0.4360	0.0000	0.4155	0.3896	0.4148	0.4149	0.4009

13	0.0000	0.4073	0.4080	0.0000	0.4361	0.4024	0.4354	0.4217	0.4113
14	0.0000	0.4055	0.0000	0.0000	0.4615	0.4083	0.4610	0.4267	0.4145
15	0.0000	0.4162	0.3855	0.0000	0.4615	0.0000	0.4610	0.0000	0.4364

Mean Length at Age by Area (cm)

For Period 3

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	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	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	28.6013	0.0000	25.6224	27.2025
3	0.0000	28.9599	26.2223	0.0000	29.2500	30.3994	29.0000	29.2009	29.7448
4	0.0000	31.3959	30.1729	0.0000	31.0000	32.0002	30.5000	30.1980	31.4595
5	0.0000	32.5887	32.4445	0.0000	31.8500	33.0292	31.9130	32.3863	32.6281
6	0.0000	33.2749	32.5865	0.0000	32.0476	33.6951	31.9375	34.1257	33.3793
7	0.0000	33.9204	34.6401	0.0000	33.4500	33.9207	33.5000	34.1010	34.0217
8	0.0000	34.1446	34.3472	0.0000	33.4194	34.1380	33.4032	34.5038	34.1657
9	0.0000	34.4424	34.6401	0.0000	33.7800	34.3413	33.7755	35.0914	34.5231
10	0.0000	34.5464	34.4200	0.0000	34.2442	34.4929	34.2471	34.9843	34.5400
11	0.0000	34.8675	34.5800	0.0000	34.2593	34.7042	34.2593	36.1582	34.9241
12	0.0000	35.3519	36.0000	0.0000	35.1818	35.0549	35.1818	35.6584	35.2942

13	0.0000	35.4494	37.0000	0.0000	36.0000	35.5482	36.0000	35.9148	35.7604
14	0.0000	34.5660	0.0000	0.0000	37.0000	35.7717	37.0000	36.0913	35.5905
15	0.0000	37.0495	34.8400	0.0000	37.0000	0.0000	37.0000	0.0000	37.0273

Catch Numbers at Age by Area

For Period 4

Ages	IIIa	IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	20.20	0.00	0.00	0.00	0.00	0.00	0.00	20.20
2	0.00	688.85	0.00	0.00	0.00	78.34	50.00	0.28	817.46
3	0.00	10867.58	136.82	0.00	1571.14	973.88	599.97	3.62	14153.02
4	0.00	24862.84	981.66	0.00	7723.73	974.42	599.97	4.38	35147.00
5	0.00	105784.43	3959.88	0.00	13336.45	1685.42	801.78	12.33	125580.27
6	0.00	13266.53	2210.23	0.00	5621.74	645.52	149.99	3.90	21897.91
7	0.00	24937.64	1207.19	0.00	8079.06	502.90	349.98	3.56	35080.33
8	0.00	93918.37	5324.19	0.00	14123.98	887.17	2170.96	9.99	116434.66
9	0.00	61065.96	3177.96	0.00	17719.72	1023.50	2067.32	11.83	85066.31
10	0.00	215383.13	1746.14	0.00	8696.18	2310.54	5602.68	26.94	233765.61
11	0.00	41523.89	1951.43	0.00	3923.80	802.38	1324.41	11.64	49537.54
12	0.00	26064.62	1144.79	0.00	1756.19	389.21	923.89	3.99	30282.70

13	0.00	4255.23	280.46	0.00	190.49	96.72	208.32	1.37	5032.60
14	0.00	469.26	0.00	0.00	300.54	38.81	50.00	0.16	858.76
15	0.00	3374.38	0.00	0.00	99.38	0.00	50.00	0.15	3523.92

Mean Weight at Age by Area (Kg)

For Period 4

AgesIIIa		IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.1086	0.0000	0.0000	0.0000	0.0000	0.0000	0.1086	0.1086
2	0.0000	0.2012	0.0000	0.0000	0.0000	0.2151	0.1748	0.1944	0.2010
3	0.0000	0.2472	0.1719	0.0000	0.2123	0.2677	0.2109	0.2468	0.2425
4	0.0000	0.2798	0.2323	0.0000	0.2824	0.3002	0.2516	0.2837	0.2791
5	0.0000	0.3098	0.3137	0.0000	0.3141	0.3242	0.3148	0.3135	0.3106
6	0.0000	0.3357	0.3133	0.0000	0.3346	0.3462	0.3717	0.3387	0.3337
7	0.0000	0.3514	0.3707	0.0000	0.3583	0.3558	0.3555	0.3655	0.3538
8	0.0000	0.3608	0.3710	0.0000	0.3679	0.3637	0.3786	0.3622	0.3625
9	0.0000	0.3706	0.3901	0.0000	0.3769	0.3703	0.3810	0.3719	0.3729
10	0.0000	0.3756	0.3859	0.0000	0.3800	0.3754	0.3944	0.3780	0.3763
11	0.0000	0.3812	0.3734	0.0000	0.3982	0.3804	0.3960	0.3827	0.3826
12	0.0000	0.3878	0.4060	0.0000	0.3796	0.3917	0.4235	0.3940	0.3892

13	0.0000	0.4006	0.3911	0.0000	0.4200	0.4070	0.4536	0.4039	0.4031
14	0.0000	0.4360	0.0000	0.0000	0.4083	0.4094	0.4893	0.4227	0.4282
15	0.0000	0.3912	0.0000	0.0000	0.4290	0.0000	0.4893	0.4362	0.3936

Mean Length at Age by Area (cm)

For Period 4

AgesIIIa		IIa	IIb	IVa	Iia	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	22.0500	0.0000	0.0000	0.0000	0.0000	0.0000	22.0500	22.0500
2	0.0000	27.2866	0.0000	0.0000	0.0000	28.2222	26.0000	26.7811	27.2974
3	0.0000	29.5489	26.3310	0.0000	28.4059	30.4940	27.6667	29.5093	29.3761
4	0.0000	39.5624	29.5120	0.0000	31.1642	31.7868	29.4167	85.8929	37.0531
5	0.0000	44.0587	32.1951	0.0000	32.3573	32.6917	31.7500	79.6489	42.2143
6	0.0000	48.9459	32.1536	0.0000	33.0167	33.4655	33.6667	82.6452	42.6066
7	0.0000	47.4221	34.3467	0.0000	33.9237	33.8143	33.1429	83.1761	43.5295
8	0.0000	44.2825	34.2623	0.0000	34.1500	34.0830	33.8372	84.5583	42.3262
9	0.0000	70.6716	34.5169	0.0000	34.4676	34.2995	33.9268	85.6887	60.4509
10	0.0000	49.2415	34.7925	0.0000	34.6651	34.4713	34.3182	85.9110	48.0919
11	0.0000	106.2265	34.3830	0.0000	35.1681	34.6359	34.3462	86.8885	94.6820
12	0.0000	44.6791	35.3381	0.0000	35.0770	35.0071	35.1667	89.1091	43.3605

13	0.0000	80.8117	36.6964	0.0000	36.0000	35.4923	36.0000	86.2055	73.9325
14	0.0000	36.0139	0.0000	0.0000	34.1840	35.5709	37.0000	35.7379	35.4108
15	0.0000	34.9641	0.0000	0.0000	38.0000	0.0000	37.0000	35.9200	35.0786

Table 7.4.3.1. 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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
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

	AGE														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
2009	0	3468	113424	192641	149075	1193781	914748	1929631	142931	262037	423972	238174	45519	9337	10153	70538
2010	0	75981	61673	101948	209295	189784	1064866	711951	1421939	175010	180164	340781	179039	12558	11602	49773
2011	0	126972	249809	61706	104634	234330	210165	755382	543212	642787	90515	117230	136509	45082	6628	11638
2012	0	2680	13083	211630	49999	119627	281908	263330	747839	314694	357902	53109	44982	64273	12420	3604
2013	0	1	20715	60364	276901	71287	112558	283658	242243	591912	169525	145318	24936	10614	9725	2299
2014	0	265	1441	28301	57838	257529	50424	71721	194814	147083	381317	83050	57315	12746	1809	7501

Table 7.4.4.1. 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

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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						
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	

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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

	age														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
2009	0	0.040	0.156	0.184	0.220	0.251	0.291	0.311	0.338	0.347	0.363	0.375	0.382	0.375	0.375	0.387
2010	0	0.059	0.107	0.177	0.218	0.261	0.279	0.311	0.325	0.343	0.362	0.370	0.388	0.391	0.376	0.441
2011	0	0.011	0.098	0.200	0.257	0.273	0.300	0.316	0.340	0.348	0.365	0.371	0.387	0.374	0.403	0.401
2012	0	0.034	0.126	0.211	0.272	0.301	0.308	0.331	0.335	0.351	0.354	0.370	0.389	0.389	0.382	0.388
2013	0	0.048	0.163	0.237	0.276	0.300	0.331	0.339	0.351	0.357	0.370	0.373	0.394	0.391	0.389	0.367
2014	0	0.057	0.179	0.233	0.271	0.293	0.322	0.342	0.353	0.367	0.365	0.374	0.375	0.378	0.418	0.371

Table 7.4.4.2. 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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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

	AGE															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
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
2011	0.001	0.01	0.044	0.118	0.185	0.209	0.246	0.277	0.310	0.322	0.339	0.349	0.364	0.363	0.389	0.393
2012	0.001	0.01	0.044	0.138	0.185	0.256	0.273	0.290	0.305	0.330	0.342	0.361	0.390	0.377	0.389	0.393
2013	0.001	0.01	0.044	0.138	0.204	0.267	0.305	0.309	0.320	0.328	0.346	0.350	0.390	0.377	0.389	0.393
2014	0.001	0.01	0.044	0.138	0.198	0.274	0.301	0.326	0.333	0.339	0.347	0.344	0.362	0.362	0.389	0.393
2015	0.001	0.01	0.044	0.138	0.187	0.243	0.299	0.326	0.319	0.345	0.346	0.354	0.382	0.376	0.389	0.393

**** mean weight at ages 11 and 13 are mean of 5 previous years at the same age. These age groups were not present in the catches of 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 7.4.5.1. Norwegian Spring-spawning herring. Mature at age. The time series was provided by WKHERMAT in 2010 and are used in the assessment since 2010.

	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

	age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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
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
2011	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
2012	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
2013	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
2014	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1
2015	0	0	0	0	0.4	0.8	1	1	1	1	1	1	1	1	1	1

Table 7.4.7.1.1. Norwegian spring spawning herring. Estimates from the international acoustic surveys on the spawning areas in February-March. Numbers in millions. Biomass in thousands. Shaded data are not used in the TASACS assessment. ***Survey 1.***

								survey 1 Age								Total
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total	Biomass
1988		0	255	146	6805	202	0	0	0	0	0	0	0	0	0	7408	
1989		101	5	373	103	5402	182	0	0	0	0	0	0	0	0	6166	
1990		183	187	0	345	112	4489	146	0	0	0	0	0	0	0	5462	
1991		44	59	54	12	354	122	4148	102	0	0	0	0	0	0	4895	
1992*		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1993*		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1994		16	128	676	1375	476	63	13	140	35	1820	0	0	0	0	4742	
1995		0	1792	7621	3807	2151	322	20	1	124	63	2573	0	0	0	18474	3514
1996		407	231	7638	11243	2586	957	471	0	0	165	0	2024	0	0	25722	4824
1997*		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
1998		0	0	381	1905	10640	6708	1280	434	130	39	0	175	0	804	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	361	19566	4913
2001**		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2002**		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2003**		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2004**		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2005		103	281	811	3310	7545	10453	887	563	159	122	610	1100	686	17	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
2009**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2010**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2011**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2012**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2013**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2014**	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		
2015	385	384	2585	747	3098	448	693	2572	813	7338	422	1693	85	237	21498	6332

*** Poor weather conditions**

**** No surveys**

Table 7.4.7.4.1. 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. Shaded data are not used in the TASACS assessment. ***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
2011	0.6	3.6	0.02	0	0
2012	0.370	0.120	0	0	0
2013	0.036	1.912	0.377	0.024	
2014	5.876	2.185	2.156	0.242	0.045
2015	2.996	8.129	0.957	0.265	9

[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 7.4.7.4.2. 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. Shaded data are not used in the TASACS assessment. ***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
2011	0	1058	1576	1753	4550	2692	8693	2879	4830	572	898	837	281	13	34	30666	7298
2012	0	1588	2995	415	844	1835	2321	4346	1890	2338	329	615	344	112	54	20026	4629

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2013	0	395	653	2900	496	1120	1923	2794	4311	2600	1782	538	573	209	62	20356	5291
2014	62	673	1632	1106	3146	548	930	2161	2357	3667	1656	1062	489	192	193	19874	5064
2015	0	245	448	2565	1881	3836	1284	1224	2251	1996	3359	878	691	278	121	21057	5402

Table 7.4.7.5.1. 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	
2010	1.0	0.3	
2011	0.10	1.50	0.01
2012	2.0	1.1	
2013	7.7	5.0	
2014	2.6	0.4	

Table 7.4.7.5.2. 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. Data in shaded cells are not used in the assessment *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
2010	20367
2011	13674
2012	26480
2013	70972
2014	16674

Table 7.4.7.6.1. Norwegian Spring-spawning herring. The indices for herring larvae on the Norwegian shelf for the period 1981—2007 (N*10^{-12}). Data in shaded cells are not 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
2011	73.4	192.1
2012	65.6	224.4

Continues on next page

Continued from previous page

2013	71.6	345.3
2014	75.9	
2015	-1	

Index 1. The total number of herring larvae found during the cruise.

Index 2. Back-calculated number of newly hatched larvae with 10% daily mortality. The larval age is estimated from the duration of the yolk sac 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 7.6.2.3.1. Norwegian spring spawning herring. Stock in numbers (billions).

	Age (in years)															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1988	26.074	4.008	1.628	3.496	0.731	14.073	0.046	0.013	0.012	0.027	0.012	0.008	0.006	0.004	0.003	0.001
1989	71.555	10.591	1.628	0.656	2.951	0.606	11.602	0.030	0.008	0.005	0.010	0.002	0.004	0.002	0.001	0.001
1990	109.337	29.088	4.305	0.646	0.562	2.537	0.516	9.685	0.023	0.006	0.004	0.005	0.001	0.003	0.002	0.002
1991	308.891	44.452	11.826	1.740	0.538	0.481	2.172	0.434	8.126	0.019	0.004	0.001	0.002	0.000	0.002	0.002
1992	368.283	125.586	18.071	4.806	1.490	0.461	0.413	1.856	0.366	6.791	0.014	0.003	0.001	0.001	0.000	0.003
1993	113.173	149.732	51.059	7.346	4.125	1.252	0.392	0.354	1.586	0.309	5.636	0.010	0.002	0.001	0.000	0.002
1994	38.662	46.008	60.876	20.755	6.297	3.451	0.997	0.329	0.302	1.338	0.249	4.470	0.008	0.002	0.001	0.002
1995	19.595	15.718	18.706	24.745	17.833	5.317	2.633	0.705	0.269	0.252	1.117	0.181	3.249	0.004	0.001	0.002
1996	58.595	7.967	6.391	7.604	21.245	15.028	3.999	1.674	0.392	0.217	0.202	0.897	0.078	1.950	0.000	0.002
1997	33.552	23.823	3.239	2.579	6.513	17.624	11.477	2.569	1.064	0.242	0.182	0.167	0.710	0.051	0.903	0.001
1998	208.991	13.641	9.686	1.303	2.099	5.355	13.503	8.029	1.505	0.613	0.152	0.138	0.114	0.528	0.026	0.434
1999	167.923	84.969	5.546	3.885	1.056	1.582	4.267	9.989	5.738	0.942	0.407	0.091	0.095	0.095	0.350	0.305
2000	57.648	68.273	34.546	2.252	3.216	0.876	1.236	3.274	7.109	3.859	0.540	0.252	0.065	0.045	0.075	0.410
2001	34.915	23.438	27.758	14.036	1.860	2.248	0.722	0.961	2.443	4.913	2.352	0.264	0.151	0.041	0.017	0.278
2002	350.094	14.195	9.529	11.284	11.986	1.452	1.539	0.585	0.738	1.828	3.450	1.554	0.159	0.108	0.032	0.202
2003	159.928	142.338	5.771	3.835	9.528	9.720	1.013	1.022	0.476	0.549	1.328	2.354	1.023	0.087	0.081	0.154
2004	286.575	65.022	57.868	2.344	3.231	7.901	7.688	0.708	0.724	0.388	0.403	0.941	1.500	0.677	0.039	0.180
2005	72.272	116.513	26.435	23.499	1.995	2.695	6.402	5.955	0.507	0.495	0.310	0.298	0.653	0.919	0.387	0.044
2006	83.339	29.384	47.370	10.735	19.811	1.629	2.162	4.913	4.262	0.323	0.312	0.231	0.196	0.433	0.471	0.240
2007	30.173	33.883	11.945	19.230	9.169	16.374	1.326	1.701	3.555	2.952	0.196	0.197	0.171	0.115	0.249	0.413
2008	20.350	12.267	13.773	4.851	16.343	7.551	12.419	1.000	1.239	2.384	2.066	0.125	0.146	0.133	0.076	0.409
2009	69.104	8.274	4.962	5.521	4.142	13.556	5.877	8.559	0.675	0.829	1.507	1.435	0.080	0.092	0.092	0.270
2010	15.307	28.096	3.362	1.945	4.573	3.426	10.561	4.210	5.577	0.449	0.470	0.904	1.015	0.027	0.071	0.274
2011	34.827	6.223	11.374	1.327	1.580	3.742	2.773	8.102	2.963	3.481	0.224	0.238	0.462	0.707	0.011	0.244
2012	18.200	14.160	2.449	4.465	1.085	1.263	3.003	2.192	6.272	2.046	2.400	0.109	0.096	0.271	0.567	0.079
2013	100.481	7.399	5.755	0.987	3.647	0.888	0.976	2.323	1.642	4.705	1.469	1.733	0.044	0.041	0.174	0.543
2014	47.406	40.852	3.008	2.327	0.794	2.882	0.698	0.735	1.737	1.189	3.500	1.107	1.357	0.015	0.025	0.579
2015		19.274	16.609	1.222	1.976	0.630	2.242	0.554	0.566	1.314	0.887	2.659	0.876	1.115	0.001	0.480

Table 7.6.2.3.2. Norwegian spring spawning herring. Fishing mortality.

	Age (in years)															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1988	0.001	0.001	0.009	0.020	0.038	0.043	0.253	0.360	0.750	0.875	1.475	0.500	0.920	1.221	0.897	0.897
1989	0.000	0.000	0.025	0.005	0.001	0.010	0.031	0.131	0.116	0.160	0.458	0.934	0.201	0.184	0.312	0.312
1990	0.000	0.000	0.006	0.032	0.005	0.005	0.023	0.026	0.062	0.316	0.927	0.682	1.856	0.070	0.556	0.556
1991	0.000	0.000	0.000	0.005	0.006	0.003	0.007	0.022	0.030	0.157	0.141	0.079	0.392	-1.000	0.131	0.131
1992	0.000	0.000	0.000	0.003	0.024	0.012	0.003	0.007	0.017	0.037	0.218	0.279	0.316	-1.000	0.140	0.140
1993	0.000	0.000	0.000	0.004	0.028	0.078	0.024	0.011	0.020	0.067	0.082	0.000	0.000	0.000	0.059	0.059
1994	0.000	0.000	0.000	0.002	0.019	0.121	0.196	0.052	0.030	0.031	0.168	0.169	0.469	0.374	0.226	0.226
1995	0.000	0.000	0.000	0.003	0.021	0.135	0.303	0.436	0.064	0.070	0.070	0.689	0.360	-1.000	0.336	0.336
1996	0.000	0.000	0.007	0.005	0.037	0.120	0.292	0.303	0.334	0.029	0.040	0.083	0.277	0.621	0.294	0.294
1997	0.000	0.000	0.011	0.056	0.046	0.116	0.207	0.385	0.402	0.317	0.126	0.234	0.148	0.517	0.584	0.584
1998	0.000	0.000	0.014	0.060	0.133	0.077	0.151	0.186	0.319	0.259	0.360	0.221	0.034	0.262	0.262	0.262
1999	0.000	0.000	0.001	0.039	0.037	0.096	0.115	0.190	0.247	0.406	0.330	0.189	0.605	0.085	0.317	0.317
2000	0.000	0.000	0.001	0.041	0.208	0.044	0.102	0.143	0.219	0.345	0.567	0.366	0.315	0.793	0.406	0.406
2001	0.000	0.000	0.000	0.008	0.098	0.229	0.060	0.114	0.140	0.204	0.265	0.359	0.186	0.097	0.232	0.232
2002	0.000	0.000	0.010	0.019	0.060	0.210	0.260	0.057	0.147	0.170	0.232	0.268	0.446	0.133	0.270	0.270
2003	0.000	0.000	0.001	0.021	0.037	0.085	0.207	0.195	0.053	0.158	0.194	0.301	0.263	0.646	0.114	0.114
2004	0.000	0.000	0.001	0.011	0.031	0.060	0.106	0.185	0.230	0.077	0.151	0.215	0.340	0.409	1.456	1.456
2005	0.000	0.000	0.001	0.021	0.052	0.071	0.115	0.184	0.300	0.313	0.142	0.269	0.261	0.519	0.436	0.436
2006	0.000	0.000	0.002	0.008	0.041	0.056	0.089	0.174	0.217	0.351	0.310	0.153	0.383	0.405	0.394	0.394
2007	0.000	0.000	0.001	0.013	0.044	0.127	0.133	0.167	0.250	0.207	0.301	0.150	0.102	0.260	0.330	0.330
2008	0.000	0.005	0.014	0.008	0.037	0.101	0.222	0.242	0.252	0.308	0.214	0.296	0.310	0.214	0.439	0.439
2009	0.000	0.001	0.037	0.038	0.040	0.100	0.184	0.278	0.259	0.417	0.361	0.197	0.953	0.116	0.126	0.126
2010	0.000	0.004	0.029	0.058	0.051	0.062	0.115	0.201	0.321	0.546	0.533	0.521	0.211	0.715	0.195	0.195
2011	0.000	0.033	0.035	0.051	0.074	0.070	0.085	0.106	0.220	0.222	0.573	0.759	0.384	0.071	1.021	1.021
2012	0.000	0.000	0.008	0.052	0.051	0.108	0.107	0.139	0.138	0.181	0.175	0.749	0.706	0.295	0.024	0.024
2013	0.000	0.000	0.006	0.068	0.085	0.091	0.133	0.141	0.173	0.146	0.133	0.095	0.937	0.330	0.062	0.062
2014	0.000	0.000	0.001	0.013	0.082	0.101	0.081	0.111	0.129	0.143	0.125	0.084	0.047	2.551	0.081	0.081

Negative fishing mortality -1 means that the fishing mortality was not defined, see TASACS manual.

Table 7.6.2.3.3 Norwegian spring spawning herring. Final stock summary table.

Summary	output					
Run	id:	20150826	174634.451			
Process:	Ordinary	assessment				
Model:	VPA					
Year	Recruit	TSB	SSB	Landings	Unweighted	Weighted F with stock numbers
	Age 0 in billions	Million tonnes	Million tonnes	tonnes	F5-14	WF5-14
1988	26.074	3.424	2.002	135301	0.729	0.049
1989	71.555	4.083	3.253	103830	0.254	0.031
1990	109.337	4.616	3.833	86411	0.452	0.022
1991	308.891	5.255	3.741	84683	0.107	0.024
1992	368.283	6.295	3.823	104448	0.114	0.028
1993	113.173	7.366	3.769	232457	0.034	0.065
1994	38.662	8.419	3.898	479228	0.184	0.133
1995	19.595	9.210	3.857	905501	0.274	0.235
1996	58.595	9.297	4.333	1220283	0.239	0.202
1997	33.552	9.185	5.547	1426507	0.304	0.190
1998	208.991	7.998	6.229	1223131	0.213	0.161
1999	167.923	8.828	6.347	1235433	0.258	0.198
2000	57.648	8.306	5.390	1207201	0.330	0.231
2001	34.915	6.887	4.381	766136	0.188	0.196
2002	350.094	7.095	3.796	807795	0.219	0.216
2003	159.928	8.512	4.408	789510	0.222	0.150
2004	286.575	10.285	5.413	794066	0.323	0.130
2005	72.272	10.811	5.445	1003243	0.261	0.176
2006	83.339	11.715	5.641	968958	0.253	0.184
2007	30.173	11.153	6.276	1266993	0.203	0.158
2008	20.350	11.064	6.820	1545656	0.260	0.199
2009	69.104	10.299	7.829	1687373	0.299	0.191
2010	15.307	8.934	7.408	1457014	0.342	0.198
2011	34.827	7.478	6.392	992998	0.351	0.147
2012	18.200	6.703	5.634	825999	0.262	0.146
2013	100.481	6.058	5.000	684743	0.224	0.138
2014	47.406	5.617	4.455	461306	0.345	0.110
2015		5.292	3.946			

The GM recruitment over the years 1988—2011 is 76.8 billion.

Table 7.9.1.1 Norwegian Spring-spawning herring. Input to short-term prediction. Stock size is in millions and weight in kg.

2015								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of M bef. spaw.	Prop. of F bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	76800	0.90	0	0	0	0.001	0.000	0.000
1	19274	0.90	0	0	0	0.010	0.007	0.046
2	16609	0.90	0	0	0	0.044	0.016	0.156
3	1222	0.15	0	0	0	0.138	0.049	0.227
4	1976	0.15	0.4	0	0	0.187	0.069	0.273
5	630	0.15	0.8	0	0	0.243	0.086	0.298
6	2242	0.15	1	0	0	0.299	0.104	0.320
7	554	0.15	1	0	0	0.326	0.140	0.337
8	566	0.15	1	0	0	0.319	0.196	0.347
9	1314	0.15	1	0	0	0.345	0.248	0.358
10	887	0.15	1	0	0	0.346	0.308	0.363
11	2659	0.15	1	0	0	0.354	0.442	0.372
12	876	0.15	1	0	0	0.381	0.457	0.386
13	1115	0.15	1	0	0	0.376	0.793	0.386
14	1	0.15	1	0	0	0.389	0.277	0.396
15	480	0.15	1	0	0	0.393	0.277	0.375

2016 and 2017								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of M bef. spaw.	Prop. of F bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	76800	0.90	0	0	0	0.001	0.000	0.000
1		0.90	0	0	0	0.010	0.007	0.046
2		0.90	0	0	0	0.044	0.016	0.156
3		0.15	0	0	0	0.138	0.049	0.227
4		0.15	0.4	0	0	0.196	0.069	0.273
5		0.15	0.8	0	0	0.261	0.086	0.298
6		0.15	1	0	0	0.302	0.104	0.320
7		0.15	1	0	0	0.320	0.140	0.337
8		0.15	1	0	0	0.324	0.196	0.347
9		0.15	1	0	0	0.337	0.248	0.358
10		0.15	1	0	0	0.346	0.308	0.363
11		0.15	1	0	0	0.349	0.442	0.372
12		0.15	1	0	0	0.378	0.457	0.386
13		0.15	1	0	0	0.372	0.793	0.386
14		0.15	1	0	0	0.389	0.277	0.396
15		0.15	1	0	0	0.393	0.277	0.375

Table 7.9.2.1. Norwegian spring spawning herring. Short term prediction.

Basis:
SSB(2015)=3.945 million t
Landings (2015)=328 206 t (sum of national quota)
Fw(2015)=0.085
SSB(2016)=3.586 million t
The fishing mortality applies according to the agreed management plan (F(management plan)) is 0.083

Rationale	Catch (2016)	Basis	F(2016)	SSB(2017)	%SSB change	%TAC change
Zero catch	0	F=0	0.000	3.836	7	-100
Status quo	322874	F(2015)	0.085	3.560	-1	14
Agreed Management Plan	195025	Management plan, if SSB < 2.5 mt	0.050	3.669	2	-31
	232666		0.060	3.637	1	-18
	269405		0.070	3.606	1	-5
	316876	Management plan	0.083	3.566	-1	12
	378057		0.100	3.514	-2	34
	465388	Management plan, if SSB > 5.0 mt	0.125	3.440	-4	64
	549988		0.150	3.368	-6	94
	566525		0.155	3.354	-6	100
MSY	406787	0.717*Fmsy	0.108	3.489	-3	44

Landings weights in thousand tonnes, stock biomass weight in million tonnes.

F_w = Fishing mortality weighted by population numbers (age groups 5-14).

Table 7.9.2. 2 Norwegian spring-spawning herring. Detailed short term prediction.

2015

Age	Stockno. 1-Jan.	Stockno. spawning time	Biomass 1-Jan	Biomass spawning time	SSB 1-Jan	SSB spawning time	F	Catches in numbers	Catches in weight
0	76800	76800	77	77	0	0	0.000	0	0
1	19274	19274	193	193	0	0	0.002	24	1
2	16609	16609	731	731	0	0	0.004	45	7
3	1222	1222	169	169	0	0	0.013	14	3
4	1976	1976	370	370	148	148	0.018	32	9
5	630	630	153	153	122	122	0.022	13	4
6	2242	2242	670	670	670	670	0.027	56	18
7	554	554	181	181	181	181	0.036	18	6
8	566	566	181	181	181	181	0.051	26	9
9	1314	1314	453	453	453	453	0.064	76	27
10	887	887	307	307	307	307	0.080	63	23
11	2659	2659	941	941	941	941	0.115	268	100
12	876	876	334	334	334	334	0.119	91	35
13	1115	1115	419	419	419	419	0.206	193	74
14	1	1	0	0	0	0	0.072	0	0
15	480	480	189	189	189	189	0.072	31	12
	127205	127205	5366	5366	3945	3945	0.085	951	328
	(millions)	(millions)	(thous.)	(thous.)	(thous.)	(thous.)	WF5-14	(millions)	(thous.)

2016

Age	Stockno. 1-Jan.	Stockno. spawningtime	Biomass 1-Jan	Biomass spawningtime	SSB 1-Jan	SSB spawningtime	F	Catches in numbers	Catches in weight
0	76800	76800	77	77	0	0	0.000	0	0
1	31225	31225	312	312	0	0	0.002	44	2
2	7821	7821	344	344	0	0	0.005	23	4
3	6725	6725	928	928	0	0	0.014	86	20
4	1039	1039	204	204	82	82	0.020	19	5
5	1671	1671	437	437	349	349	0.025	38	11
6	530	530	160	160	160	160	0.030	14	5
7	1878	1878	602	602	602	602	0.040	68	23
8	460	460	149	149	149	149	0.056	23	8
9	463	463	156	156	156	156	0.071	29	11
10	1061	1061	367	367	367	367	0.088	83	30
11	705	705	246	246	246	246	0.126	78	29
12	2041	2041	771	771	771	771	0.130	232	89
13	670	670	249	249	249	249	0.226	126	49
14	781	781	304	304	304	304	0.079	55	22
15	385	385	151	151	151	151	0.079	27	10
	134254	134254	5457	5457	3586	3586	0.083	945	317
	(millions)	(millions)	(thous.)	(thous.)	(thous.)	(thous.)	WF5-14	(millions)	(thous.)

2017

Age	Stockno. 1-Jan.	Stockno. spawningtime	Biomass 1-Jan	Biomass spawningtime	SSB 1-Jan	SSB spawningtime	F	Catches in numbers	Catches in weight
0	76800	76800	76.8	76.8	0	0	0.000	0	0
1	31225	31225	312	312	0	0	0.002	38	2
2	12668	12668	557	557	0	0	0.004	33	5
3	3165	3165	437	437	0	0	0.012	35	8
4	5708	5708	1121	1121	448	448	0.017	90	25
5	877	877	229	229	183	183	0.022	17	5
6	1403	1403	423	423	423	423	0.026	33	11
7	443	443	142	142	142	142	0.035	14	5
8	1553	1553	503	503	503	503	0.049	69	24
9	374	374	126	126	126	126	0.062	21	7
10	372	372	129	129	129	129	0.077	26	9
11	836	836	292	292	292	292	0.110	81	30
12	535	535	202	202	202	202	0.114	54	21
13	1542	1542	573	573	573	573	0.198	258	99
14	460	460	179	179	179	179	0.069	28	11
15	928	928	365	365	365	365	0.069	58	22
	138889	138889	5667	5667	3566	3566	0.082	855	284
	(millions)	(millions)	(thous.)	(thous.)	(thous.)	(thous.)	WF5-14	(millions)	(thous.)

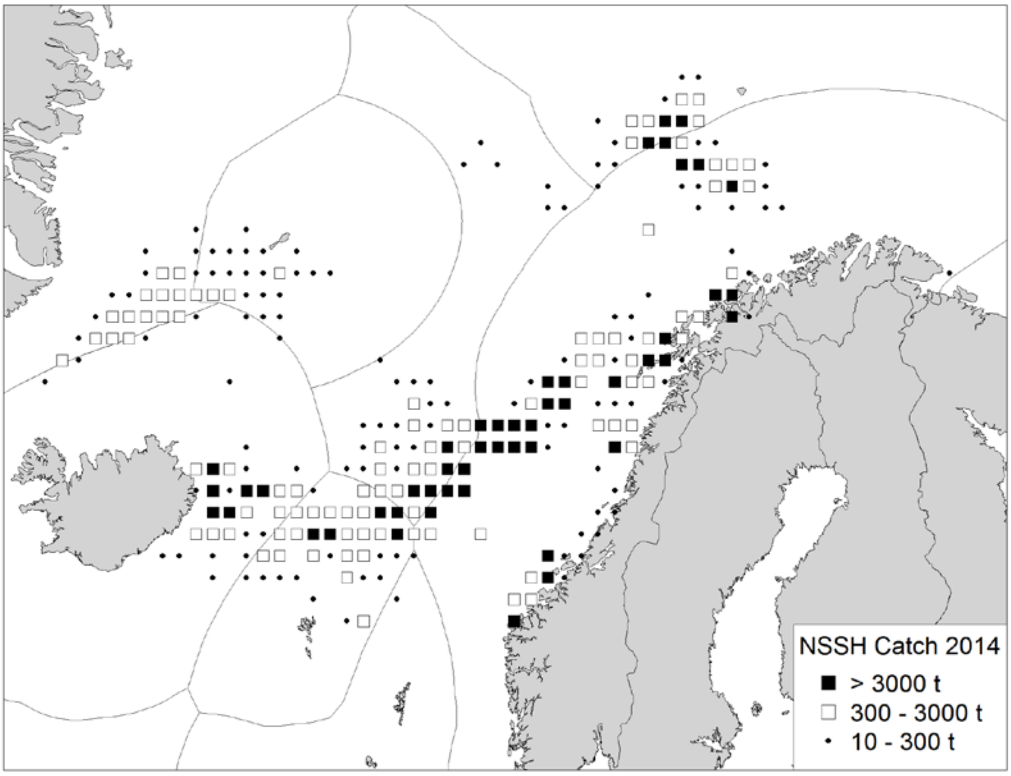


Figure 7.2.1.1. Total reported catches of Norwegian spring-spawning herring in 2014 by ICES rectangle. Grading of the symbols: black dots less than 300 tonnes, open squares 300—3000 tonnes, and black squares > 3000 tonnes.

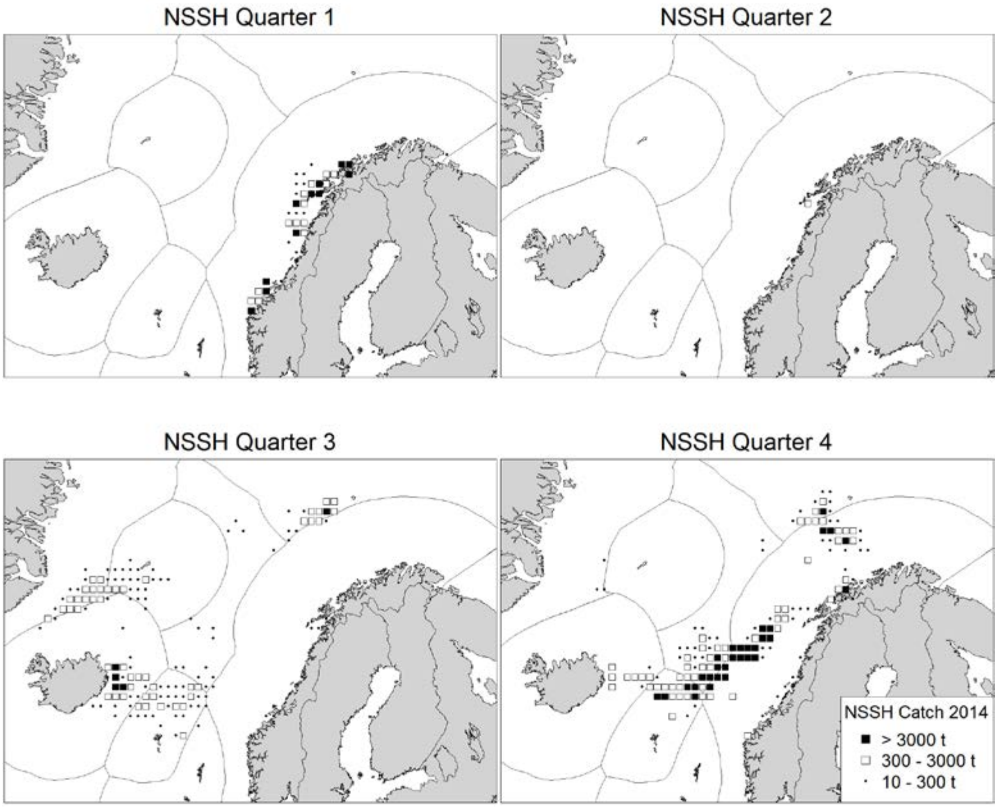


Figure 7.2.1.2. Total reported catches of Norwegian spring-spawning herring in 2014 by quarter and ICES rectangle. Grading of the symbols: black dots less than 300 tonnes, open squares 300—3000 tonnes, and black squares > 3000 tonnes.

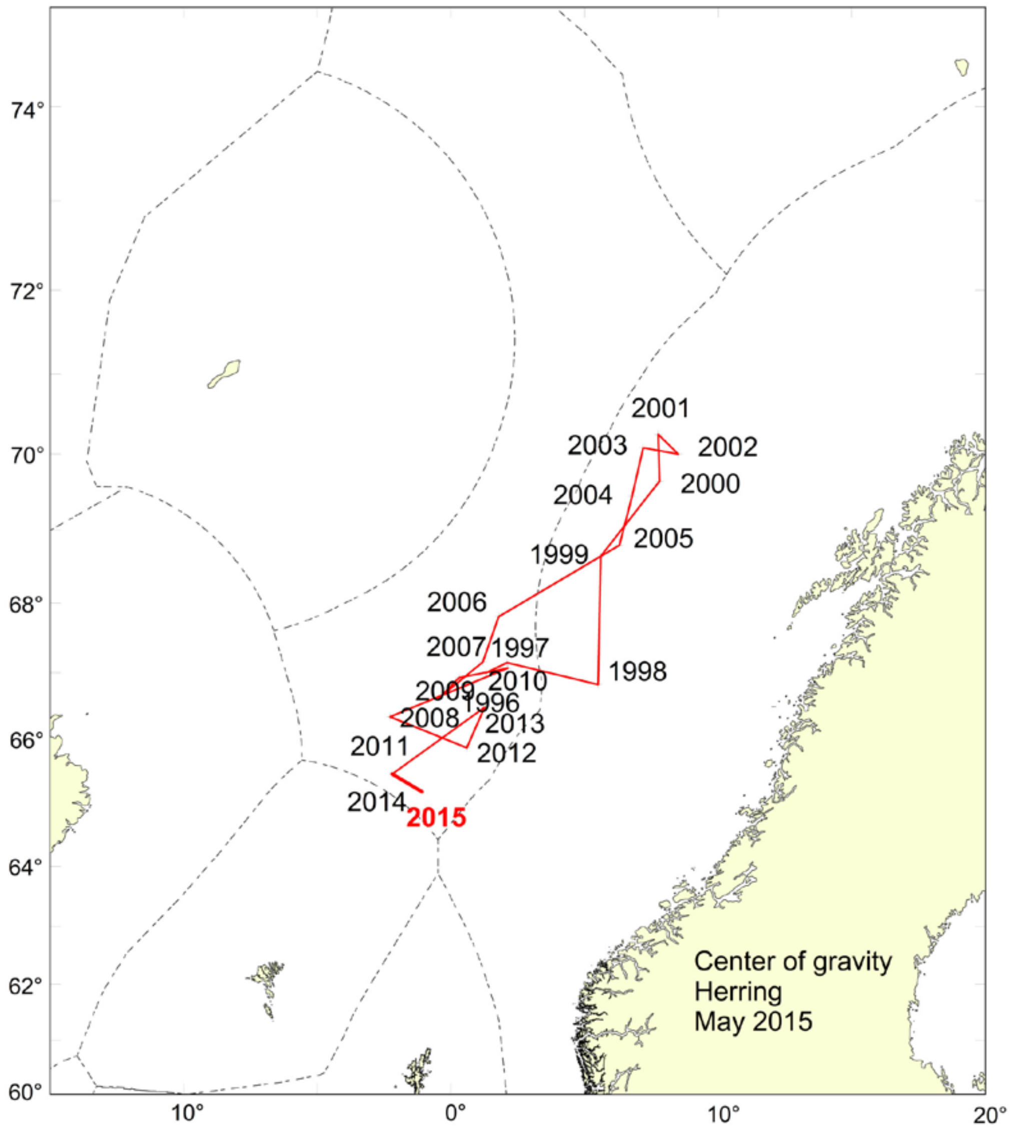


Figure 7.3.2.1 Norwegian spring spawning herring: Centre of gravity of herring during the period 1996—2015 derived from the acoustic survey. Acoustic data from area II and III only, i.e. west of 20°E.

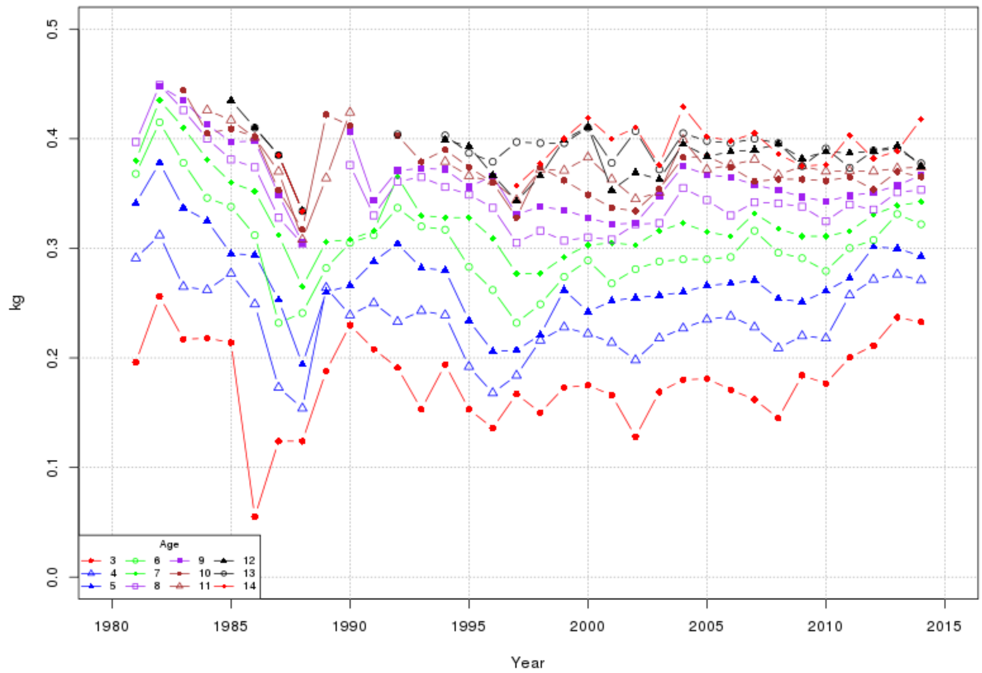


Figure 7.4.4.1. Norwegian spring spawning herring. Mean weight at age by age groups 3—14 in the years 1980—2014 in the catch (weight at age for zero catch numbers were omitted).

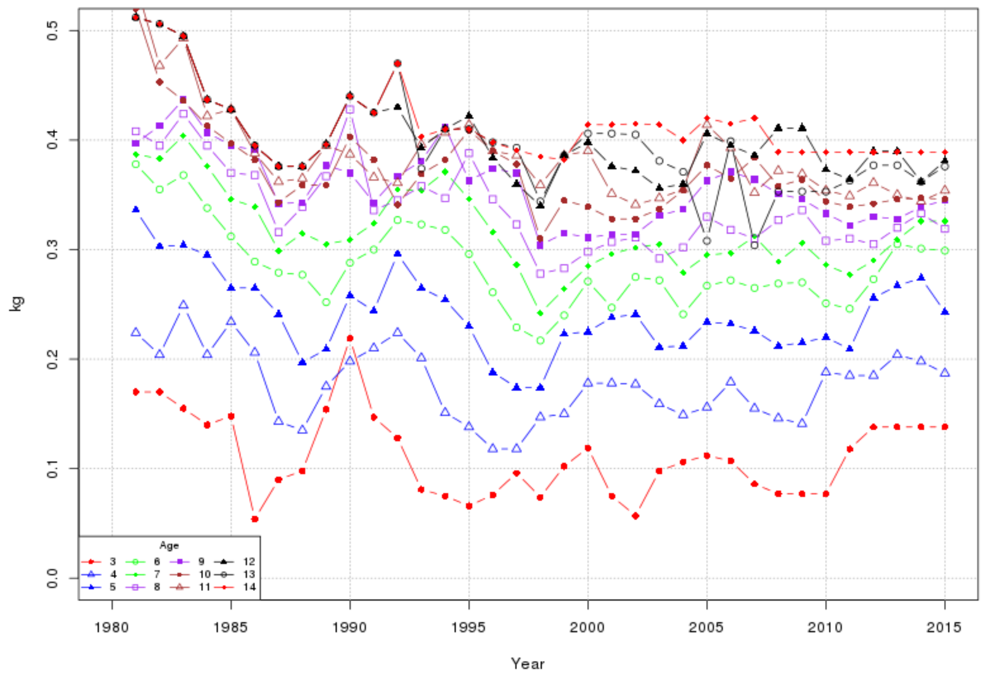
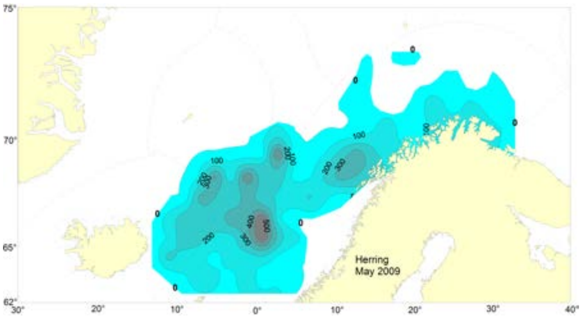
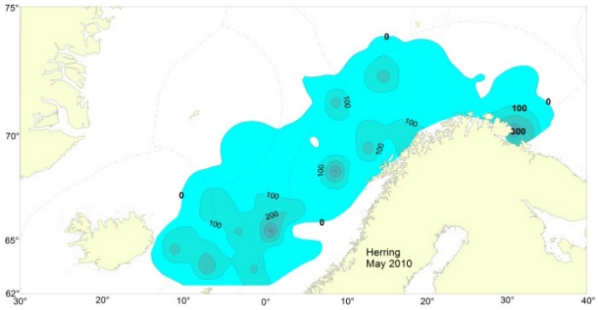


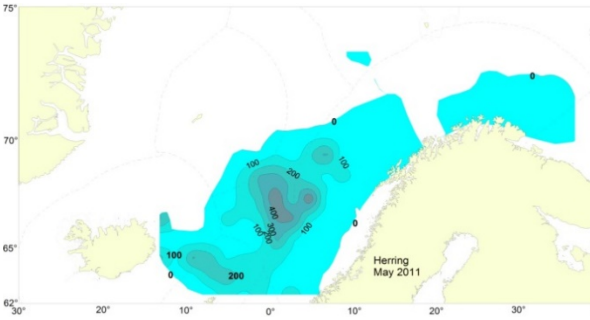
Figure 7.4.4.2. Norwegian spring-spawning herring. Mean weight at age in the stock 1981—2015.



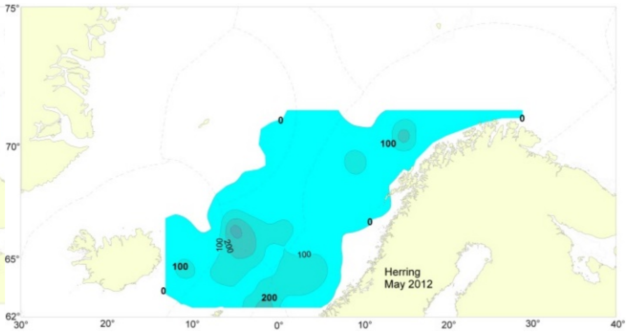
2009



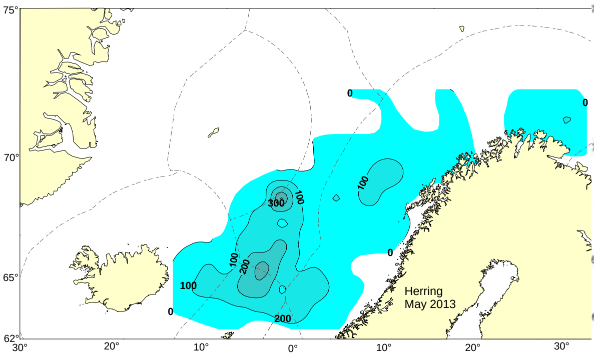
2010



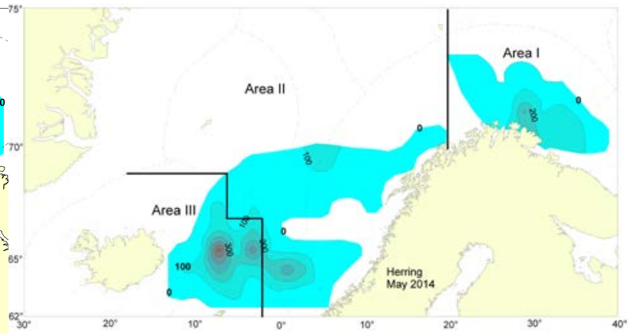
2011



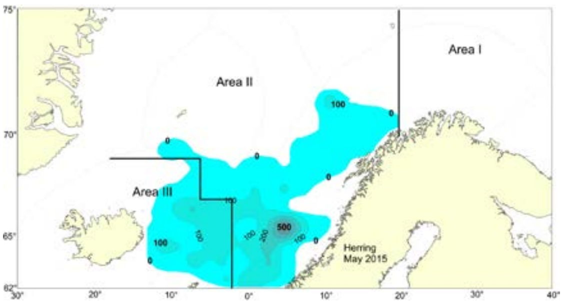
2012



2013



2014



2015

Figure 7.4.7.4.1. Norwegian Spring-Spawning herring. Schematic map of herring acoustic density (sA, m²/nm²) found during the survey in May 2009 to 2015.

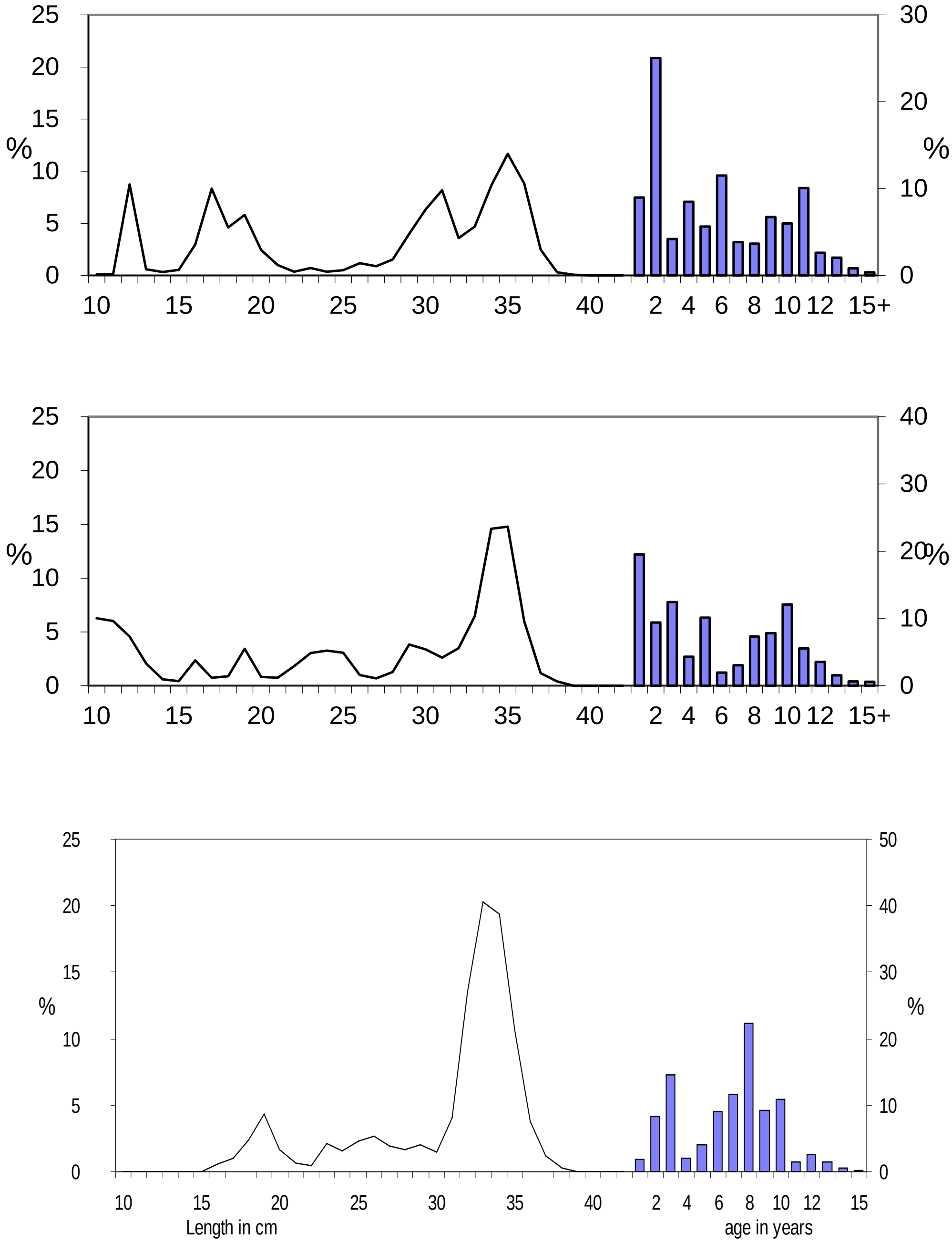


Figure 7.4.7.4.2. Length and age distribution of Norwegian spring spawning herring in the area in the Norwegian Sea and Barents Sea in May 2015 (upper most panel), in 2014 (mid panel) and in 2013 (lowest panel).

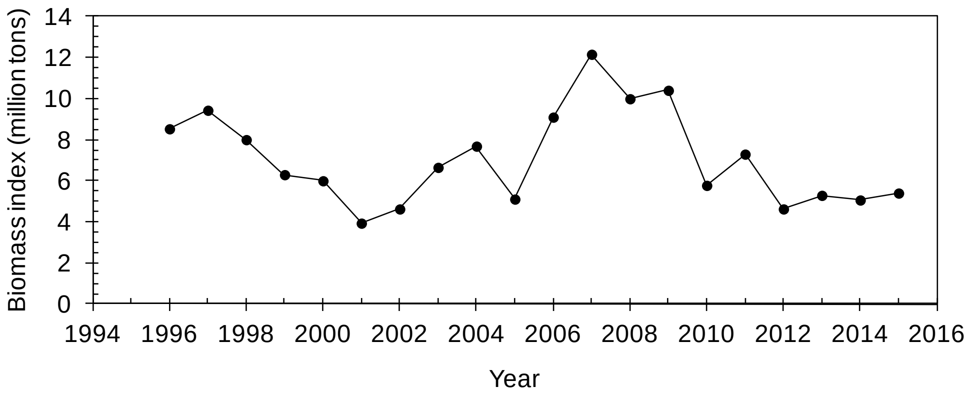


Figure 7.4.7.4.3. Biomass estimate index of Norwegian spring spawning herring in the Norwegian Sea from the International Ecosystem Survey in the Nordic Seas (survey 5) 1996—2015.

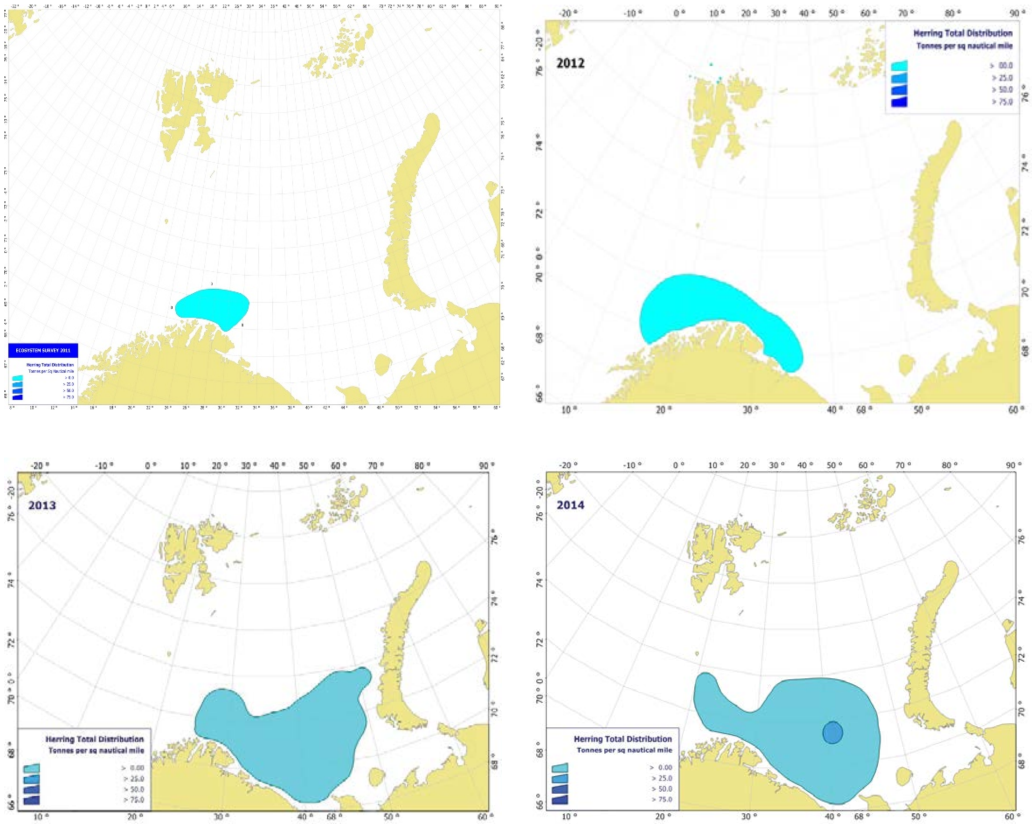


Figure 7.4.7.5.1. Norwegian Spring-Spawning herring. Estimated total density of herring (tonnes/nautical mile²) in August-September 2011 (upper left panel), 2012 (upper right panel) and 2013 (lower left panel), 2014 (lower right panel) in Barents Sea. ***Survey 6.***

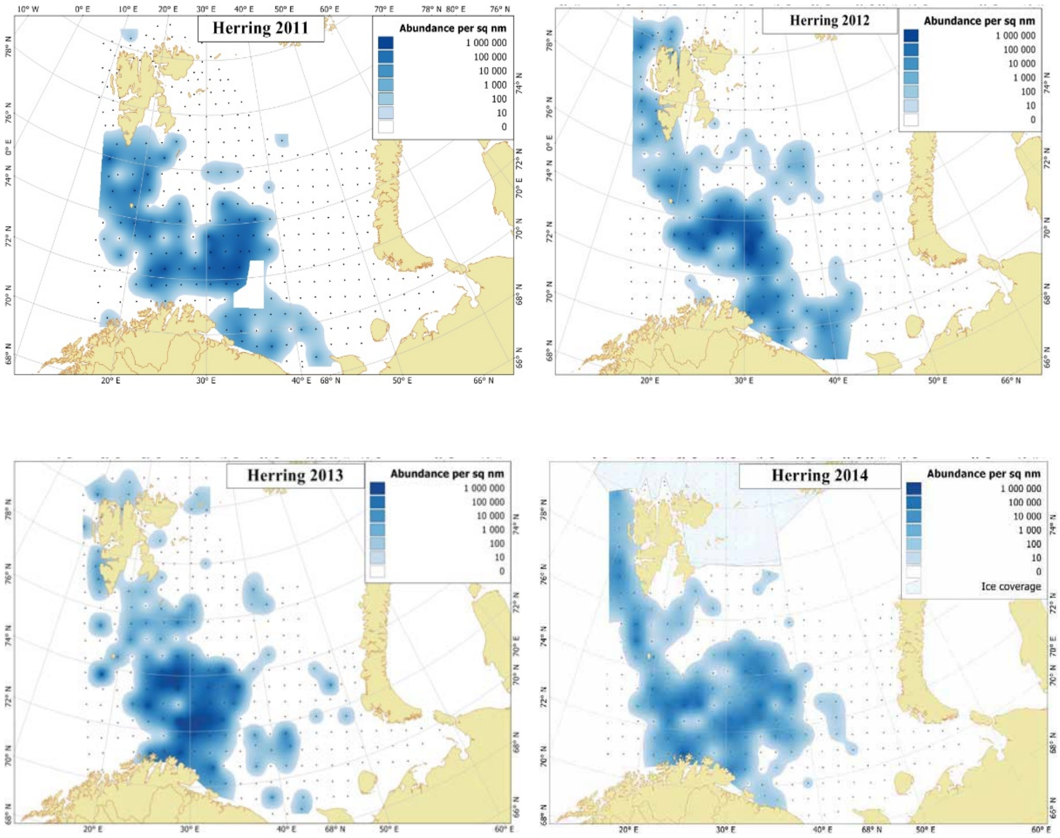


Figure 7.4.7.5.2. Norwegian Spring-Spawning herring. O–group surveys in August/September in the Barents Sea in 2011 to 2014. ***Survey 7.***

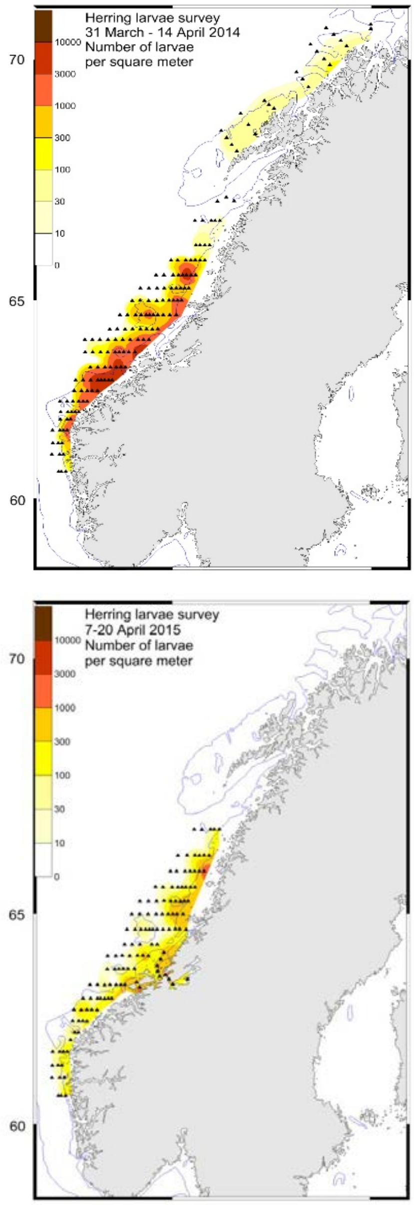


Figure 7.4.7.6.1. Norwegian Spring-Spawning herring. Distribution of herring larvae on the Norwegian shelf in 2014 (upper panel) and 2015 (lower panel). The 200 m depth line is also shown. ***Survey 8.***

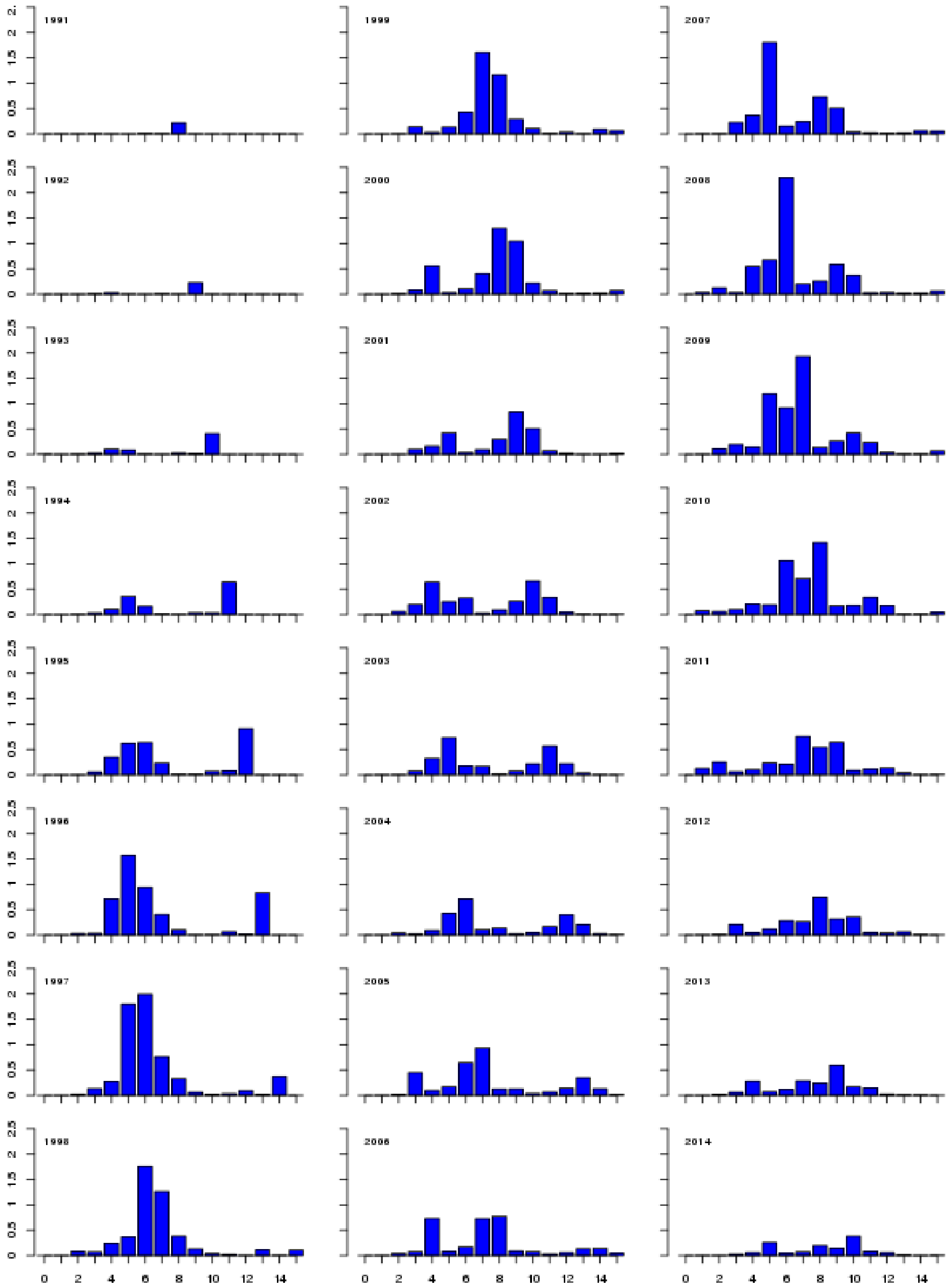


Figure 7.6.1.1. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted. Age is on x-axis. The labels indicate years.

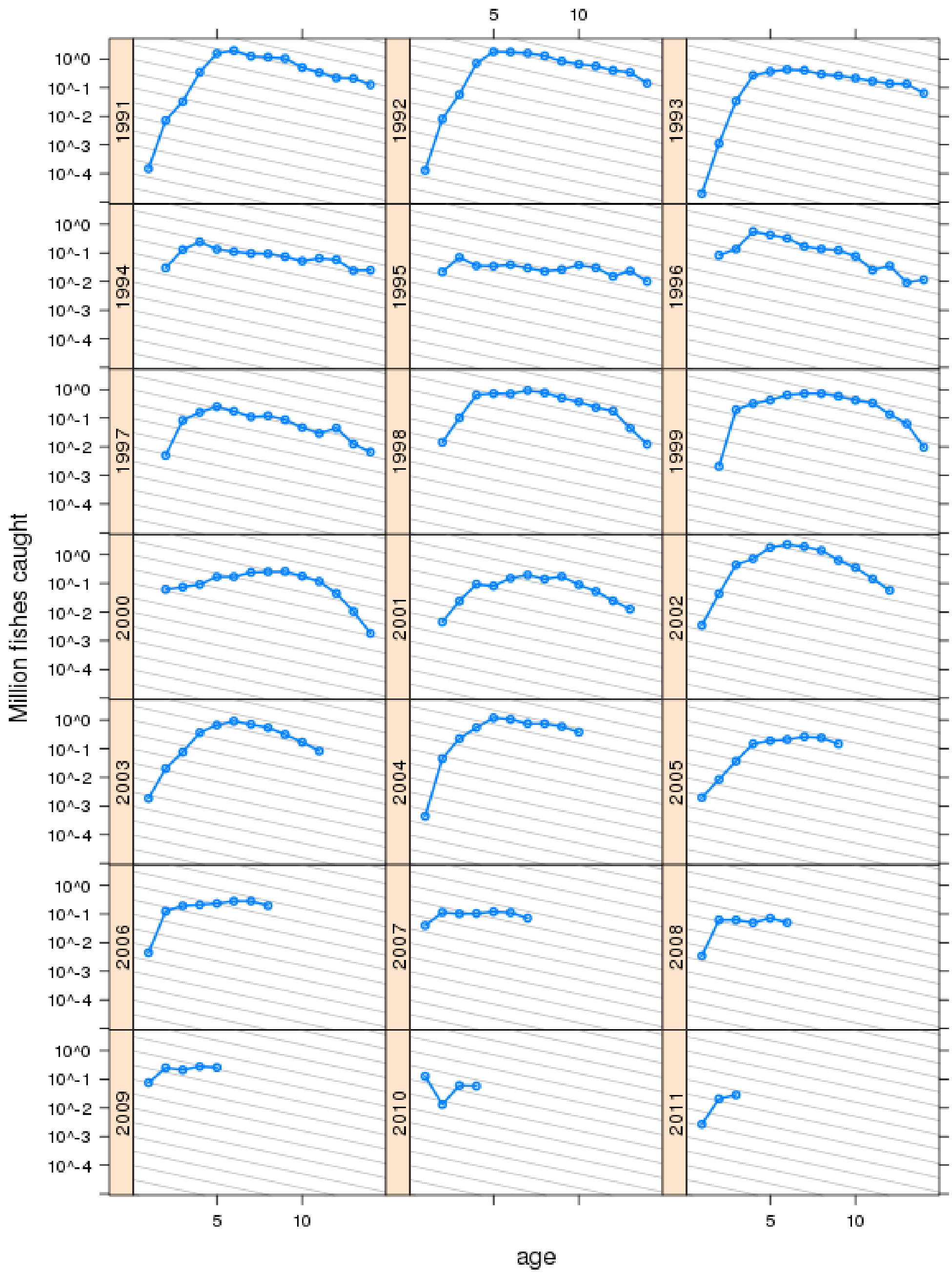


Figure 7.6.1.2. Norwegian spring spawning herring. Age disaggregated catch in numbers plotted on a log scale. Age is on x-axis. The labels indicate year classes and grey lines correspond to Z = 0.3.

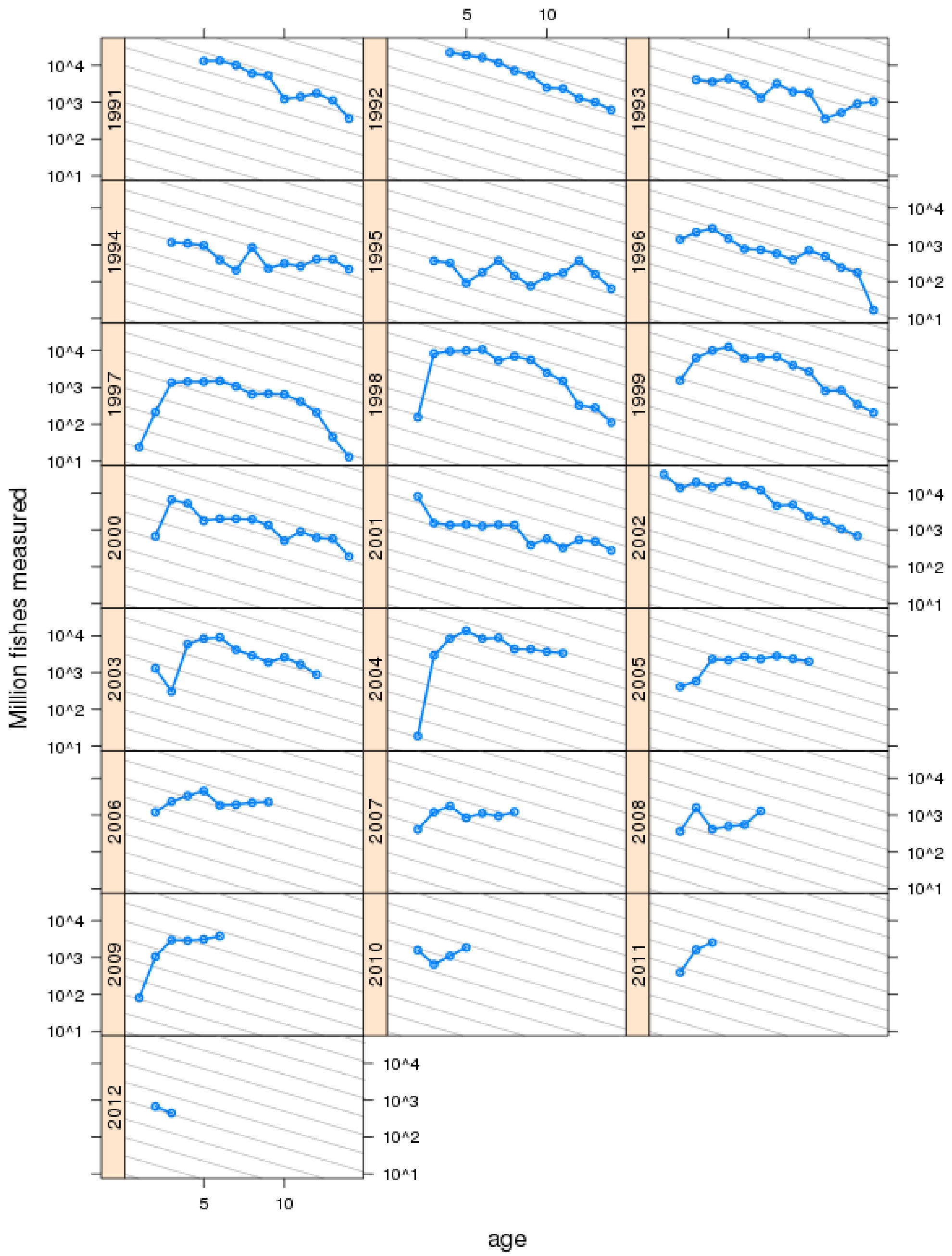


Figure 7.6.1.3. Norwegian spring spawning herring. Age disaggregated abundance indices (billions) from the acoustic survey on the feeding area in the Norwegian Sea in May (survey 5) plotted on a log scale. The labels indicate year classes and grey lines correspond to Z = 0.3.

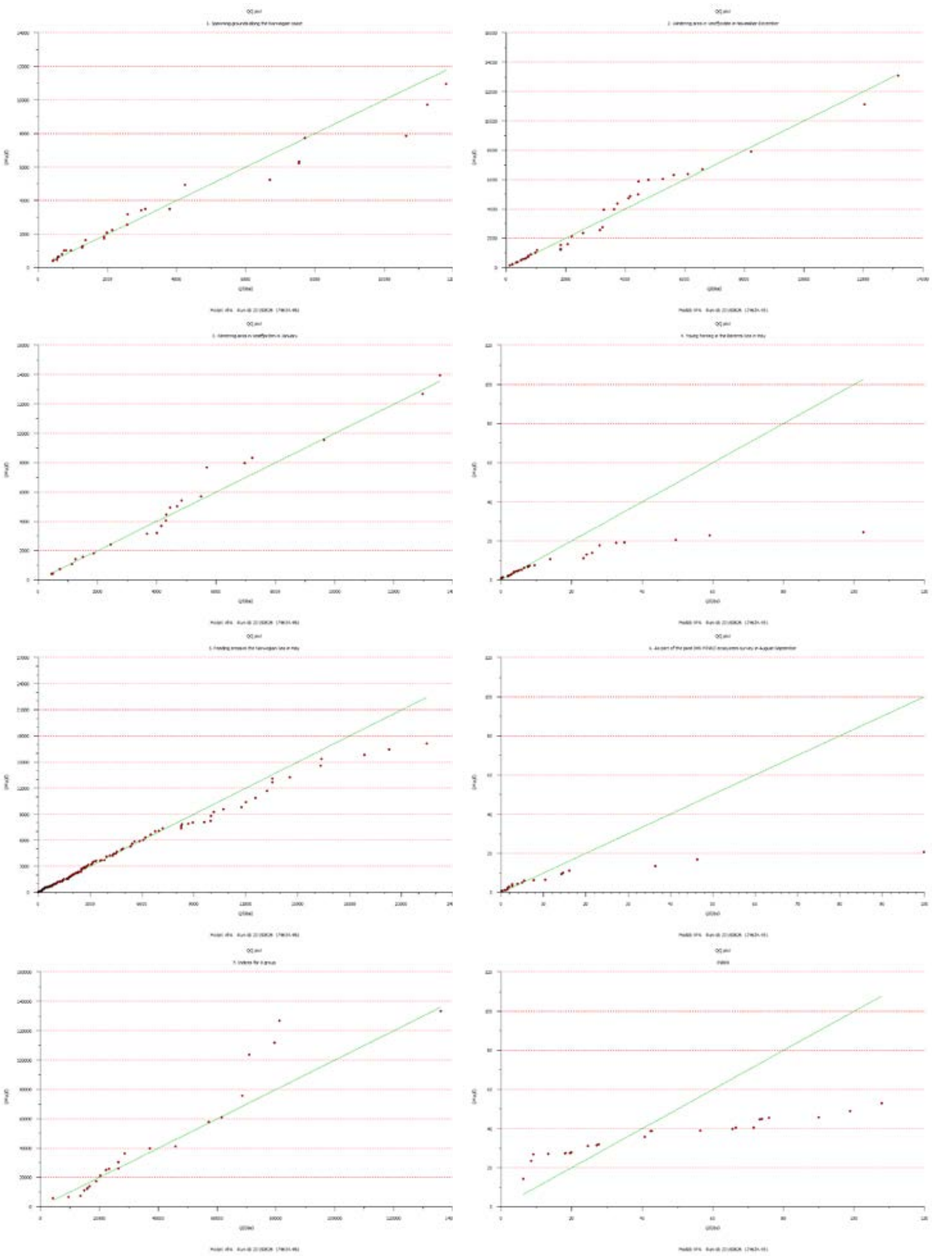


Figure 7.6.2.2.1. Norwegian spring spawning herring. Q-Q plot from the eight different surveys used in tuning in TASACS. First row starts with survey 1 and the last one in row four is larval survey.

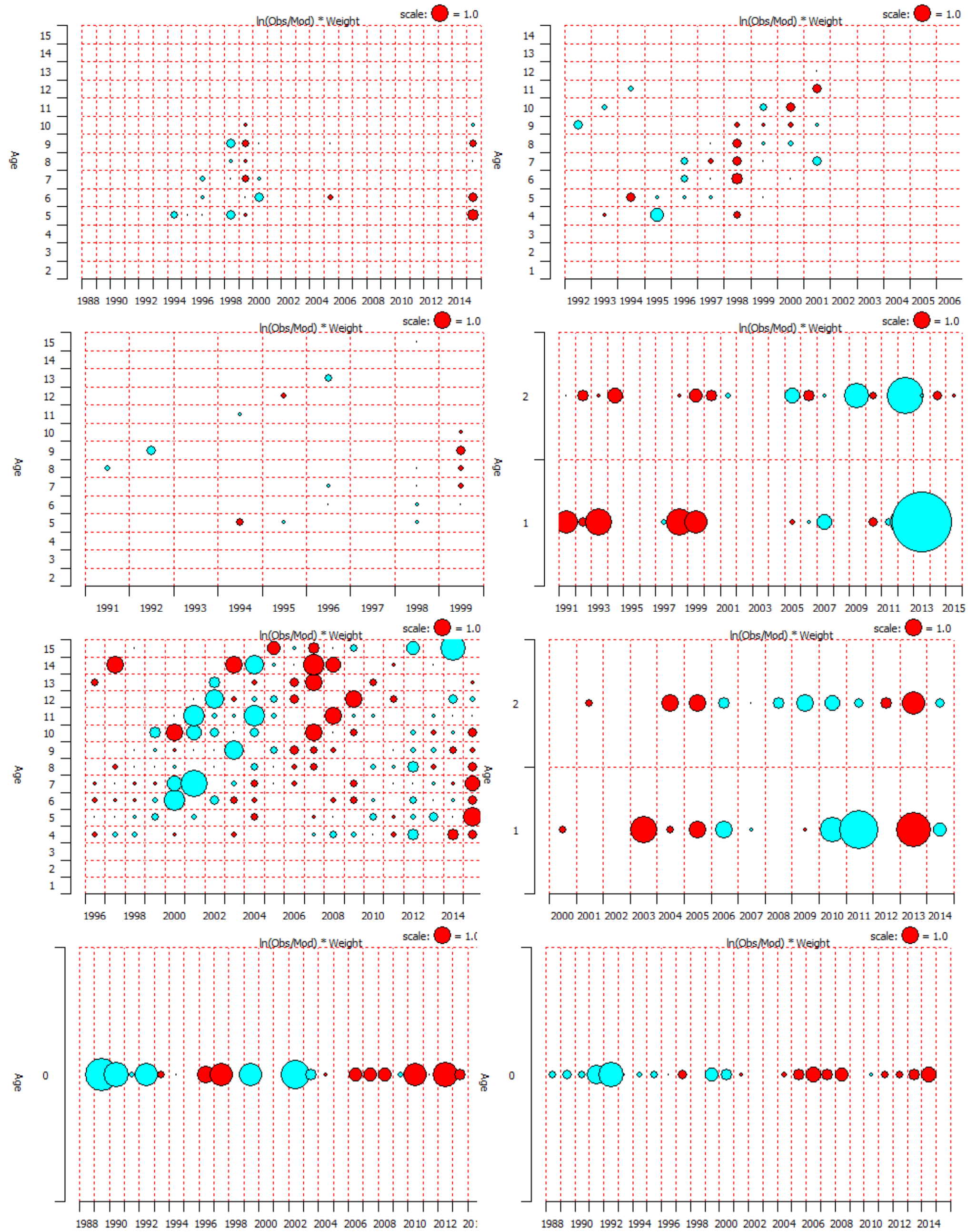


Figure 7.6.2.2.2. Norwegian spring-spawning herring. Residual sum of squares in the surveys separately from TASACS. First row starts with survey 1 and the last one in row four is larval survey.

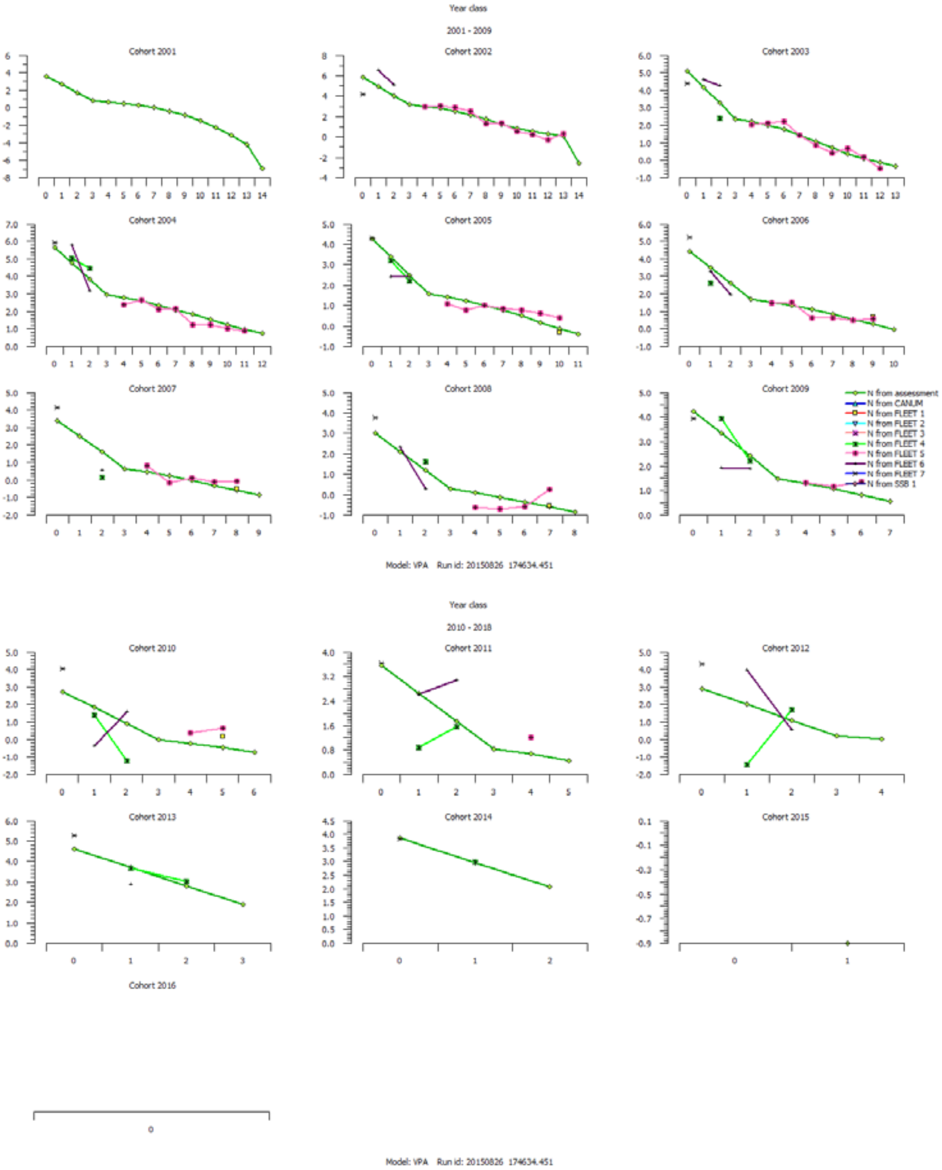


Figure 7.6.2.2.3 Norwegian spring spawning herring. Year class Ns, excluding values with zero weight.

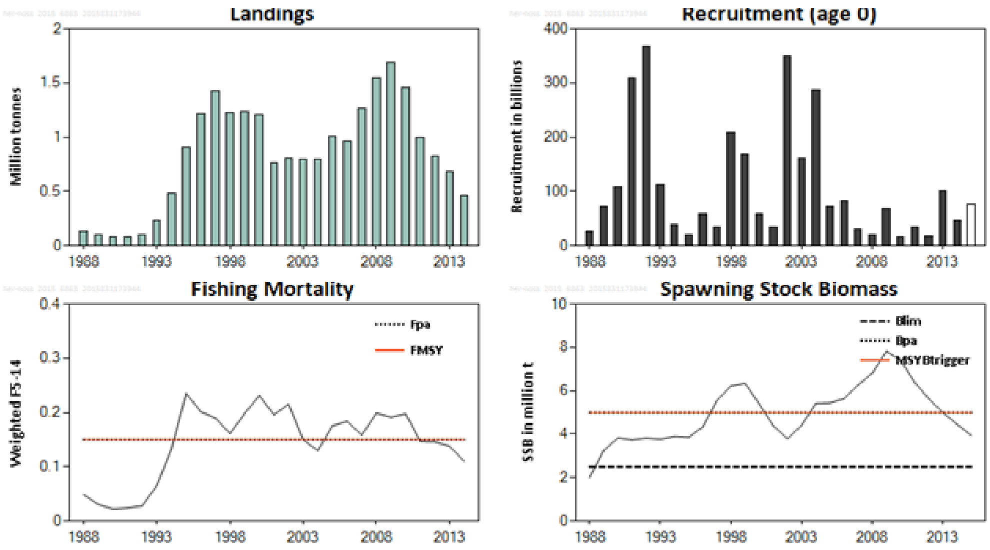


Figure 7.6.2.3.1. Norwegian spring-spawning herring. Standard plots from final assessment (TASACS VPA) in 2015.

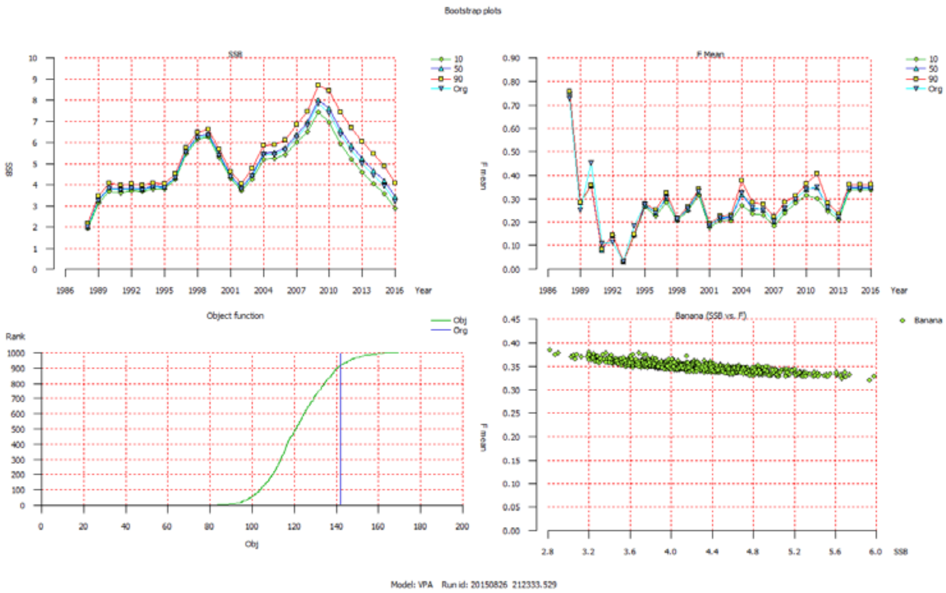


Figure 7.6.3.1. Norwegian spring-spawning herring. Percentiles for spawning stock biomass (top left), mean F 5—10 (top right), SSQ (bottom left) and "Banana"-plot (bottom right) from bootstrap results for final assessment.

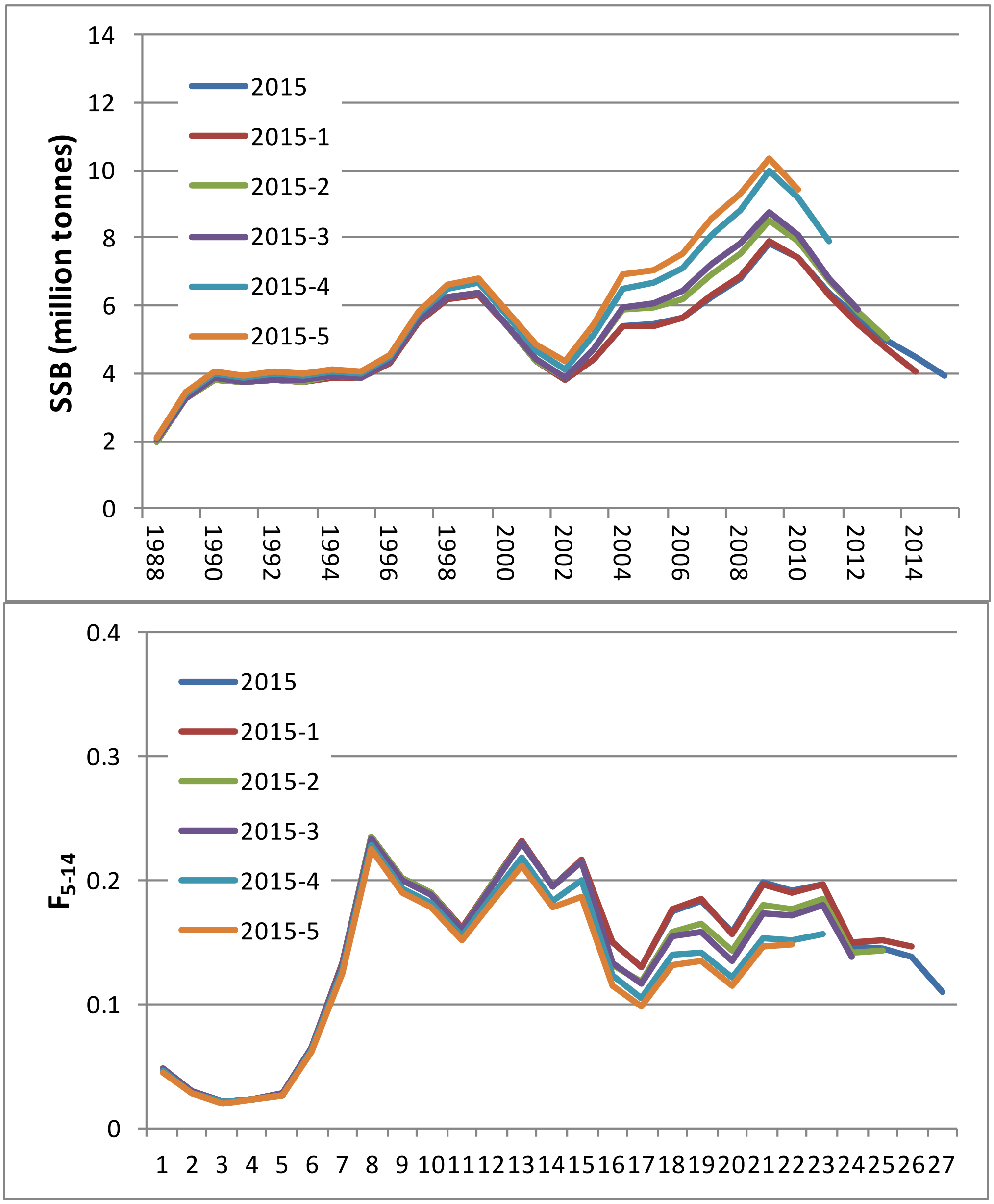


Figure 7.6.4.1 Norwegian spring-spawning herring. Retrospective run for SSB and F.

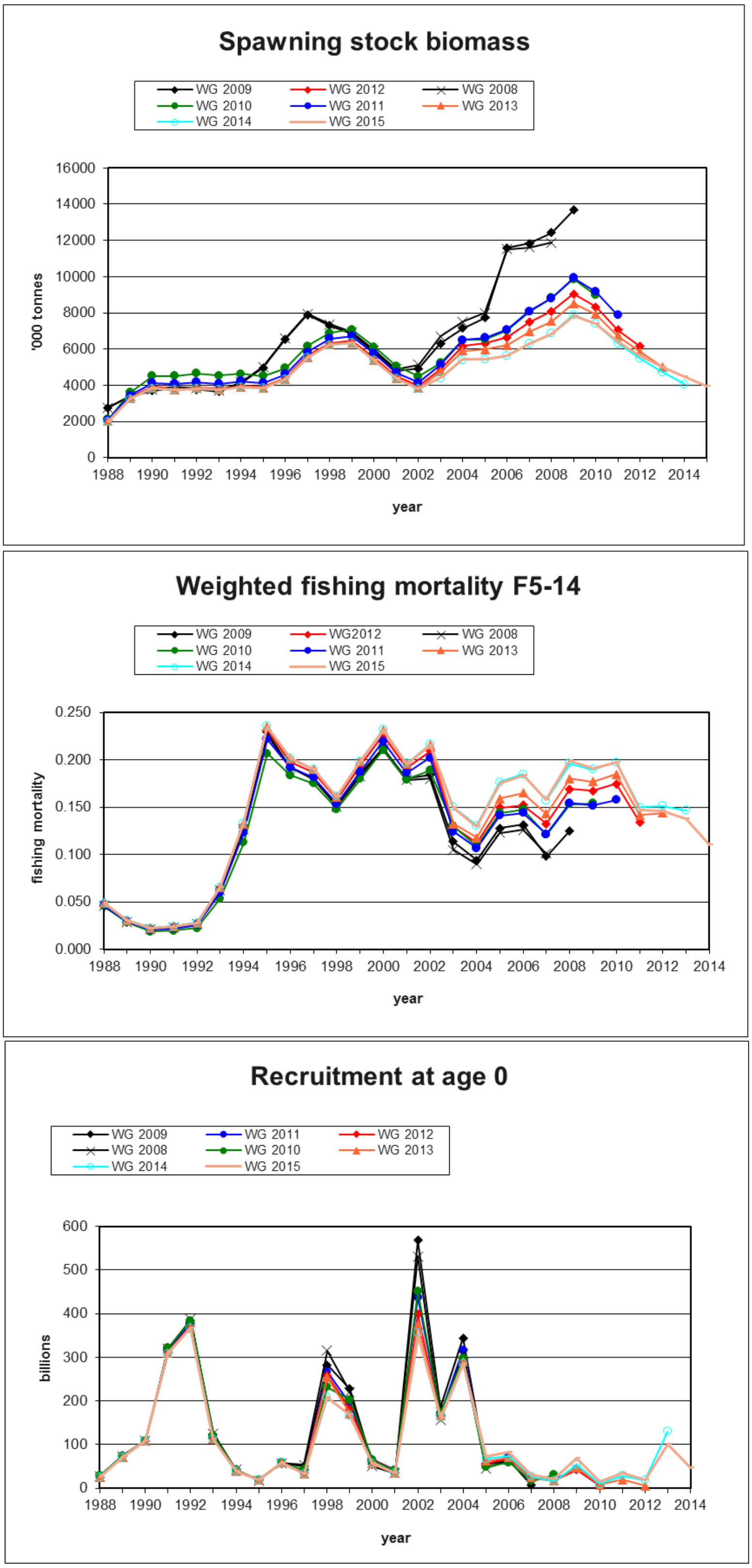


Figure 7.11.1. Norwegian spring spawning herring. Comparisons of spawning stock, weighted fishing mortality F5—14 and recruitment at age 0 with previous assessments.

8 Blue Whiting – Subareas I–IX, XII and XIV

Blue whiting (*Micromesistiuspoutassou*) 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. Blue whiting reaches maturity at 2—7 years of age. Adults 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 2014

ICES noted that SSB almost doubled from 2010 (2.9 million tonnes) to 2014 (5.5 million tonnes) and is well above Bpa (2.25 million tonnes). This increase is due to the lowest Fs in the time-series in 2011—2013, in combination with increased recruitment since 2010 (at age 1).

ICES advised on the basis of the management plan agreed by Norway, the EU, the Faroe Islands, and Iceland that catches in 2015 should be no more than 839 886 tonnes. All catches are assumed to be landed.

8.2 The fishery in 2014

The total catch in 2014 was 1 155 279 tonnes while the agreed TAC was 1 200 000 tonnes. The main fisheries on blue whiting were targeting spawning and post-spawning fish in the EU region, International waters west of Porcupine Bank/Rockall Bank areas, west of Scotland and the Faroese region (Figure 8.3.1.2-8.3.1.3). Most of the catches (92%) were taken in the first two quarters of the year. 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, some with capacity to process or freeze on board others with RSW tanks. Thirteen countries reported blue whiting landings in 2014. Specific details from some of these fisheries are provided below. Even though the majority of the blue whiting quotas for most national fleets are 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.

8.2.1 Denmark

Danish landings of blue whiting in 2014 were 35 256 tonnes, which corresponds to around 90% of the national quota. The fishery took place in quarter 2 with the vast majority of catches being taken in EU EEZ in VIA and VIIC. All Danish catches are taken by large pelagic RSW vessels with trawl. In 2014 all Danish catches was used for reduction.

8.2.2 Germany

The vessels targeting blue whiting belong to the pelagic freezer trawler fleet and are owned by a Dutch company and operating under German flag. Depending on season and the economic situation these vessels are targeting other pelagic species in European and international waters. This fleet consists of four large pelagic freezer-trawlers with power ratings between 4200 and 12 000 hp and crews of about 35 to 40 men. Total landings increased from 278 tonnes in 2011 to 6238 tonnes in 2012 to 11 418 tonnes in

2013 and was in 2014 24 487 tonnes. In 2014 the majority of catches was taken in areas Vb, VIa and VIIc.

8.2.3 Faroe Islands

The reported landings of blue whiting from Faroese vessels were 224 700 tonnes in 2014. The majority (71%) of the blue whiting fishery occurred near the southern boundary of the Faroese EEZ in winter and early spring, January to May, and in December. There was also a fishery west of the British Isles in March and April, which constituted 24% of the landings. Later in the year scattered catches (5%) were taken, partly as by-catch in the herring and mackerel fisheries in the northern part of the Faroese EEZ. The fishing fleet consists of seven large trawlers/purse-seiners and one factory freezer utilizing pelagic trawls.

8.2.4 Iceland

The Icelandic landings in 2014 were in excess of 183 000 tonnes. Around 85% of the catches were taken within the Faroes EEZ, thereof 72% in April-May. Around 9% were caught the Icelandic EEZ during May-December and the remaining 6% in international waters west of the British Isles in March-April. The majority of the catches within in the Icelandic EEZ were from a mixed fishery with mackerel and Norwegian spring-spawning herring. Seventeen trawlers participated in the fishery.

8.2.5 Ireland

The Irish Fishery in 2014 took place mainly in the first quarter, with a catch of 17 762 tonnes landed. In quarter two 3674 tonnes was landed. The fishery was concentrated on spawning aggregations to the west and northwest of Ireland. The majority of the catches were taken in VIIc (7550 tonnes), VIb (5349 tonnes), VIa (4917 tonnes) and VIIk (2602 tonnes) with smaller catches in IIa, VIIb and VIIj. 26 vessels participated in the fishery.

8.2.6 Netherlands

The Dutch catches of blue whiting in 2014 were mostly taken in the period March-June in area VIa (78%), VII (12%) and IVa (10%). All catches of blue whiting were taken by freezer trawlers. The total catch was 38 500 tonnes. Almost all the catch (~100%) was recorded from 16 fishing trips. The remaining catches (62 tonnes) were taken as by-catch in the fisheries directed to other pelagic species. Estimated discards of blue whiting in 2014 are 1% in weight originating from non-directed fisheries.

8.2.7 Norway

After the coastal states agreement in 2013 and quota transfers in other international agreements, the Norwegian TAC for 2014 was set to 386 697 tonnes (up to 100 000 tonnes could be taken in the EU zone). The flexibility between years increased the total Norwegian catch to 399 500 tonnes. The majority of the Norwegian catches (388 000 tonnes) 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 4°W).

8.2.8 Russia

2—4 Russian trawlers operated in the Faroese area since the beginning of the year until end of January. From beginning of the February number of vessels operating in this area increased to 6. Fishery of Blue Whiting in Faroese area was stopped 16 February and restarted 1 April then number of trawlers increased to 18 and reduced to 3—4 in May. Direct fishery in the Faroese area was completed in 27 June and restarted 16 November. Total catches in Faroese area were 93 100 tonnes. Since 12 June from 1 to 8 trawlers were operating in the central part of Norwegian Sea until 20 November on direct fishery of Blue Whiting and mixed fishery (blue whiting, herring and mackerel) until the total catch in the international waters closed to the allowed value 57 600 tonnes. Majority of this amount refers to the spring fishery in the spawning area west of British Isles. That fishery was from 17 February to 18 April, 15 trawlers were participated. The total Russian landings of blue whiting in 2014 were 152 256 tonnes.

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 as by-catch by single bottom otter trawlers (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 Spanish fleet has decreased from 279 vessels in the early 1990s to 135 vessels in 2008.After a period of decreasing trend, Spanish landings increased in 2014 to a total catch of 32 065 tonnes, and 99% of it was obtained in Spanish waters.

8.2.10 Portugal

Blue whiting is commonly caught as 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 and is rarely used for human consumption in Portugal and there is no market demand for industrial transformation. Total catches in 2014 were about 2150 tonnes.

8.2.11 UK

The whole catch, 26 846 tonnes was obtained in the first half of 2014.The vessels from Northern Ireland caught 2205 tonnes in the area VIIk. The Scottish trawlers operated in VIa-b and VIIc landing 24 630 tonnes. The rest of the catch was taken by English trawlers in the same areas in the 1st quarter.

8.2.12 France

The total French catch in 2014 was 10 410 tonnes, and 80% of it was obtained in the first half of year west of the British Isles.

8.3 Input to the assessment

8.3.1 Catch data

Total landings in 2014 were estimated to1 155 279 tonnes based on data provided WGWIDE members. Data provided as catch by rectangle represented more than 96% of the total WG catch in 2014. Total catch by country for the period 1988 to 2014 is presented in Table 8.3.1.1.

After a minimum of 104 000 tonnes in 2011, catches increased to around 1 155 200 tonnes in 2014. The spatial and temporal distribution in 2014 (Figure 8.3.1.1, 8.3.1.2 and 8.3.1.3 and Table 8.3.1.2), is quite similar to the distribution in previous years. The majority of catches is coming from the spawning area, but compared to previous years, the 2014 catches have a much larger contribution from Division Vb (Figure

8.3.1.4 and 8.3.1.5). The temporal allocation of catches has been relatively stable in recent years (Figure 8.3.1.6) however with an increase of the proportion of catches from the second quarter that was also observed in 2014. 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 II and in the North Sea (Division IVa), Division V and VIIIC. The proportion of landings originating from the Norwegian Sea has been decreasing steadily over the recent period to less than 5% of the total catch in 2014.

8.3.1.1 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.

Reports on discarding from fisheries which catch blue whiting were available from the Netherlands for the years 2002—2007 and 2012—2014. 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.

Information on discards was available for Spanish fleets since 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.

The blue whiting discards data produced by Portuguese vessels operating with bottom otter trawl within the Portuguese reaches of ICES Division IXais available since 2004. The discards data are from two fisheries: the crustacean fishery and the demersal fishery. The blue whiting estimates of discards in the crustacean fishery for the period of 2004-2011 ranged between 23% and 40% (in weight). For the same period the frequency of occurrence in the demersal fishery was around zero for the most of the years, in the years were it was significant (2004, 2006, 2010) was ranging between 43% and 38% (in weight). In 2014, discards were 39% of the total catches for blue whiting in the Portuguese coast (Table 8.3.1.1.1).

In general, discards are assumed to be minor in the blue whiting directed fishery. Discard data are provided by the Denmark, Netherlands, UK (England and Wales), Spain and Portugal to the working group. The discards rates of blue whiting in Denmark, Netherlands, UK (England and Wales) fisheries are low and were not used in the assessment (a mistake!, but very low and insignificant). The discards of Portugal and Spain which constituted respectively 39% and 20% of the total catches were considered in this year's assessment.

8.3.1.2 Sampling intensity

Sampling intensity for blue whiting from the commercial catches by fishery and quarter is shown in Table 8.3.1.2.1, while detailed information on the number of samples, number of fish measured, and number of fish aged by country and quarter is given in Table 8.3.1.2.2 and are presented and described by year, country and area in section 1.3 (Quality and Adequacy of fishery and sampling data). In total 912 samples were collected from the fisheries in 2014. 111 316 fish were measured and 39 738 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 with one sample for every 102 tonnes. In the directed fishery where there was one sample for every 2056 tonnes caught an overage. Norway had the largest catch in 2014 with only one sample per 7134 tonnes. No sampling data were submitted by France, Germany, Lithuania, Sweden and UK, all with relatively small catches.

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. The Fisheries Regulation 1639/2001, requires EU Member States to take a minimum of one sample for every 1000 tonnes landed in their country. For other countries there are no regulation.

8.3.1.3 Length and age compositions

Data on the combined length composition of the 2014 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, France, Germany, Iceland, Ireland, the Netherlands, Norway, Russia and Scotland (Table 8.3.1.3.1). Length composition of blue whiting varied from 13 to 47 cm, with 95% of fish ranging from 22—35 cm in length, a size range similar to that observed in 2013.The mean length in the fishery was 27 cm, which is 1.6 cm smaller than 2013, confirming the decreasing trend in the mean length observed last year, after a period of increasing trend in the mean length observed in recent years.

The Spanish and Portuguese length distribution of catches showed a length range of 9—39 cm with 95% of fish ranging from 18 to 29 cm (Table 8.3.1.3.2).This distribution is similar as last year. The mean length was 23 cm, 0.9 cm higher than the previous year.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the by-catch 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 Inter Catch 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 are given in Table 8.3.1.4.1.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. The mean age of the catch (and stock) has been increasing in the period 2001—2010, followed by a drop in 2011, due to the relatively high catches of age groups one and two that year.

Catch proportions at age are plotted in Figure 8.3.1.3.1.Strong year classes that dominated the catches can be clearly seen in the early 1980s, 1990 and the late 1990s. In recent years the age compositions are more evenly distributed.

Catch curves made on the basis of the international catch-at-age (Figure 8.3.1.3.2) indicate a consistent decline in catch number by cohort and thereby reasonably good quality catch-at-age data. Catch curves from 2003 and onwards show a more flat curve indicating a lower F or changed exploitation pattern.

8.3.1.4 Weight at age

Table 8.3.3.1 and Figure 8.3.1.4.1 show the mean weight-at-age for the total catch during 1983—2014 used in the stock assessment. Mean weight at age for ages 3—9 reached a minimum around 2007, followed by an increase until 2010—2012, and a decrease in the most recent years.

The weight-at-age for the stock is assumed to be the same as the weight-at-age for the catch.

8.3.2 Information from the fishing industry

A pre-meeting between ICES scientists and representatives of the EU pelagic industry was held on 19 August 2015, to discuss information from the fishing industry and any ongoing development to address data needs. The EU industry reported that the fishery for blue whiting in 2015 was very good. High catch rates were maintained all through the season.

8.3.3 Maturity and natural mortality

Blue whiting natural mortality and proportion of maturation-at-age is shown in Table 8.3.3.2. See the Stock Annex for further details.

A working document (Heino, 2014, WD to WGWIDE 2014) showed a higher proportion mature for age 1 (from 11% to 22%) and slightly higher for ages 2—6. These values have not fully been evaluated by the WG and as the assessment is an update assessment they have not been used in the assessment.

8.3.4 Fisheries independent data

Data from the International Blue Whiting spawning stock survey are used by the stock assessment model, while recruitment indices from several other surveys are used qualitatively to adjust the most recent recruitment estimate by the assessment model and to guide the recruitments used in forecast. This section gives a brief description of all the surveys and most recent results.

8.3.4.1 International Blue Whiting spawning stock survey

Background and status

The International Blue Whiting Spawning Stock Survey (IBWSS) is carried out on the spawning grounds west of the British Isles in March-April. The survey started in 2004 and is carried out by Norway, Russia, the Faroe Islands and the EU. This international survey, allowed for broad spatial coverage of the stock as well as a relatively dense amount of trawl and hydrographical stations. The survey is coordinated by WGIPS (ICES CM 2015/ SSGIEOM:05).

Use of this survey in stock assessment

Indices of age 3—8 from the IBWSS survey have been used in the assessment since 2007.

Quality of the survey

WGIPS decided that in 2015, the survey design should follow the principle of the one used during the previous surveys. The focus was still on a good coverage of the shelf slope in areas west of Ireland. However, given the increasing stock biomass observed over recent years, it was expected that the distribution was more extended over the whole survey area as well. In previous years when larger stock sizes were observed (2004—2011), blue whiting aggregations were distributed more evenly over the whole survey area, including the Rockall Bank and Rockall Trough. Therefore, the survey design in 2015 was to allocate more effort in these areas as well. The design was the same as in the previous years and the design is based on variable transect spacing, ranging from 30 nmi in areas containing less dense aggregation (e.g. south Porcupine), to 7.5 nmi in the core survey area (i.e. the Hebrides). To ensure transect coverage was not replicated, transects were allocated systematically with a random start location.

Transects of all vessels were consistent in spatial coverage and timing, delivering full coverage of the respective distribution areas within 17 days.

A post-cruise meeting held in Bergen 21—23 April 2015 compiled a joint survey report. This will be reviewed in the next WGIPS meeting. The post-cruise meeting concluded that the 2015 estimate of abundance can be considered as robust.

Uncertainties in spawning stock estimates based on bootstrapping of available data have been assessed again in 2015 (Figure 8.3.4.1.1 A). At present, only one source of uncertainty is considered namely the spatio-temporal variability in acoustic re-cordings. The overall trend indicates a continued decrease year-on-year in biomass from 2007—2011 for this stock. The uncertainty around the decline in biomass from 2008 to 2011 is more than could be accounted for from spatial heterogeneity alone and is regarded as statistically significant. The biomass estimate from 2010 was omitted in the assessment process due to coverage problems in the survey and a resulting possibility of biomass underestimation. The 2015 estimate shows a major decrease in biomass again when compared to the previous two years (-58% compared to 2014) and fish older than 4 years were nearly absent from the samples.

The International spawning stock survey shows worse internal consistency for the main age groups compared to the previous years (Figure 8.3.4.1.1 B).

Results

The distribution of acoustic backscattering densities for blue whiting for the last 4 years is shown in Figure 8.3.4.1.2. The bulk of the mature stock was located from the north Porcupine to the Hebrides core area in a narrow corridor close to the shelf edge. This is in contrast to the generally denser and dispersed western distribution extending into the Rockall Trough observed in 2014 and was unexpected. The blue whiting spawning stock estimates based on the international survey are given in Table 8.3.4.1.1

The estimated total abundance of blue whiting for the 2015 international survey on the spawning grounds was 1.4 million tonnes, representing an abundance of 16.6×10^9 individuals. The spawning stock was estimated at 1.1 million tonnes and 11.2×10^9 individuals. In comparison to the results in 2014, there is a major decrease (-58%) in the observed stock biomass and a decrease in stock numbers (-47%).

The stock biomass within the survey area is dominated by young fish and the age structure of the stock was notably different with the absence the previous year’s strongest age classes namely the 4, 5 and 6 year old fish.

Mean length (24.6 cm) and weight (83 g) are lower than in 2014 and in previous years. This can be attributed to the increasing contribution of young fish to the total stock biomass (Figure 8.3.4.1.3).

8.3.4.2 International ecosystem survey in the Nordic Seas

The international ecosystem survey in the Nordic Seas (IESNS) 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—2014 are available both for the total survey area and for a “standardized” survey area (Figure 8.3.4.2.1). The latter is more meaningful as the survey coverage has been rather variable in the non-standard areas. However, the historical time series has not been recalculated using the new TS-value for blue whiting, thus the estimates are not directly comparable. The new TS-value gives estimates of roughly 1/3 of the old calculations (i.e. around 3.1 times the current values corresponds to the old value).

The survey is coordinated by WGIPS (ICES CM 2015/ SSGIEOM:05).

After the benchmark in February 2012 (ICES, 2012b) it was decided to not use this survey in the assessment, but it is used as basis for a qualitative estimate of recruitment

The estimate of 1-group in 2015 is 10.6 billion compared to 3.7 billion in 2014. The number of 2 year olds was higher than in 2014, 3 billion compared to 2.5 billion. These results confirm that the 2013 and 2014 year classes are stronger. These year classes constituted to 88% of the total number and 70% of the total biomass.

An estimate was also made from a subset of the data or a "standard survey area" between 8°W—20°E and north of 63°N and this standard survey area estimate is used as an abundance index in WGWIDE. The age-disaggregated total stock estimate in the "standard area" is presented in Table 8.3.4.2.1, showing that the blue whiting in this index area was dominated by fish at age 1 interms of numbers.

The main concentrations were observed both in connection with the continental slopes of Norway and south and southwest of Iceland (Figure 8.3.4.2.1). It should be noted that the spatial survey design was not intended to cover the whole blue whiting stock during this period.

Age and length distributions from the last five years are shown in Figure 8.3.4.2.2.

8.3.4.3 Norwegian bottom trawl survey in the Barents Sea (BS-NoRu-Q1(Btr))

Blue whiting are regularly caught as a by-catch species in this survey, and have in some years been among the numerically dominant species. 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 8.3.4.3.1.

In 2015 1-group blue whiting were found in substantial amounts and the index was the third highest in the time series indicating a strong 2014 year class.

The survey is not used in the assessment, but as basis for a qualitative estimate of recruitment.

8.3.4.4 Other surveys

The stock Annex provides information and time series from surveys covering just a small fraction of the stock area. The International Survey in Nordic Seas and adjacent waters in July-August (IESSNS) 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.

The working group discussed the necessity of having more than one survey giving information to the assessment and a subgroup of IESSNS participating countries decided that the survey from 2016 also should include blue whiting as target species.

8.4 Stock assessment

Blue whiting was benchmarked in February 2012 (ICES, 2012b) and the SAM model (Nielsen and Berg, 2014) was chosen as the default assessment model for the stock. ICES has classified the assessment this year as an update assessment. However, the low 2015 IBWSS index (Table 8.4.1) caused unforeseen diagnostics and results, which required additional explorative runs with the SAM and other models.

8.4.1 Survey timing

The period for the IBWSS survey, start and end dates for all survey years combined, must be given as input to the SAM model such that the average stock number at age can be calculated by the assessment model for the survey period and compared with the survey indices. This year, the SAM model output was highly sensitive to the actual dates used. At the benchmark survey dates were set at 10% and 20% of the year. These values were originally chosen to reflect that the survey took place early in the year (without actually looking at the realised survey dates). For 2015 the survey period was 23 March to 7 April (corresponding to 22% and 27% of the year), which also corresponds well to the survey timing throughout the time series.

A SPALY run (using 10—20% of the year as survey period) gave a SSB (2015) at 1 978 kt while setting the survey period to 22—27% of the year gave SSB (2015) at 3 261 kt. The model diagnostics were practically identical for the two runs. Explorative runs investigating the model sensitivity to the parameter reflecting survey timing using 2014 assessment gave a much smaller difference (200 kt) for SSB (2014). The largest SSB was obtained in the 2014 assessment when the earliest survey period was applied, while the 2015 assessment gave the opposite result. Based on these runs it was concluded that the model is sensitive to the parameter for survey period and that the survey timing should be set to the actual dates. The survey has been conducted almost within the same period since its start, and the 2015 survey dates, 22—27% of the year, were used as the new input dates for the survey. However, using the actual dates for setting the parameter reflecting survey timing does not take into account the skewed distribution of the fishery over the year and the resultant proportion of F and M before the survey.

8.4.2 Alternative model runs

Several models (ADAPT, SMS, and another separable model implemented in ADMB (Björnsson, 2015) and XSA) were run to investigate the effect of the low survey indices in simpler models than the default SAM model. The ADAPT, SMS and a separable model implemented in ADMB gave all quite similar result with a substantial reduction in SSB and a steep increase in F for 2014. SSB for 2015 was estimated considerably lower than for the final SAM run this year. XSA gave extreme outliers for the 2015 survey observation (back-shifted) and maintained the SSB at the high level as estimated last year. This report will just present the detailed results from the default SAM method.

8.4.3 SAM model

The configuration of the SAM model (see the Stock Annex for details) is the same as agreed during the Benchmark WK (ICES, 2012b) except that the timing of the IBWSS survey was changed to fit the actual period for the survey (see section 8.4.1).

Residuals from the catch at age observations and survey indices are shown in Figure 8.4.1. The catch residuals for 2012—2014 show a tendency for a higher observed catch of older fish than estimated by the model. Survey residuals for older fish are without a clear pattern. For the younger fish in 2012—2014, catch residual are mainly negative while survey residuals are mainly positive. Residuals from the IBWSS survey showed a “year effect” (positive or negative for all age-groups in a year) in 2013 and partly in 2014 with higher indices for ages 3—7 than estimated by the model using all data sources. Such year effects are however often seen in time series from acoustic surveys. The IBWSS residuals for 2015 do not show a clear pattern.

The estimated 13 parameters from the SAM model in 2014 and 2015 are shown in Table 8.4.2. The main difference between the two years is a higher variance for the F random walk parameter, probably an effect of the steep increase in F due to the high 2014 catches and the low 2015 IBWSS indices. The CV of the catch and survey observations of the main age groups in the fishery are low for both catch observations (age 3—8, 0.15) and survey (age 4+, 0.27—0.30). Survey catchability is estimated higher this year, as the stock size for most recent years are estimated lower in this year's assessment.

Figure 8.4.2 presents estimated F at age and exploitation pattern for the whole time series. There are no abrupt changes in the exploitation pattern from 2010 to 2014, even though the landings in 2011 were just 19% of the landings in 2010, which might have given a different fishing practice. The estimated rather stable exploitation pattern might be due to the use of correlated random walks for F at age with a high estimated correlation coefficient (rho = 0.94, Table 8.4.2).

F in 2015, estimated without catch data, but from random walk in F and the IBWSS 2015 indices, is estimated unrealistically high (mean F at 3.8). This is discussed further in section 8.10.3

The retrospective analysis shows a substantial reduction in SSB and recruitment for the most recent years, while F seems more stable (Figure 8.4.3). Previous years estimates of SSB and recruitment are within the 95% confidence limits of this year's assessment.

Stock summary results with added 95% confidence limits (Figure 8.4.4 and Table 8.4.5) show a decreasing trend in fishing mortality in the period 2004—2011, followed by a steep increase in F, especially between 2013 and 2014. Recruitment decreased substantially in the period 2000—2009 with a resulting strong decreasing SSB up to 2010. SSB has increased substantially from 2010 (2.5 million tonnes) to 2014 (4.0 million tonnes) followed by a decrease to 3.3 million tonnes in 2015, which is above Bpa (2.25 million tonnes). Recruitment has decreased since 2011, but additional survey information not included in the SAM assessment indicates a rather high recruitment in 2014 and 2015 (see the short term forecast section).

8.5 Final assessment

Input data are catch numbers at age (Table 8.3.1.4.1), mean weight-at-age in the stock and in the catch (Table 8.3.3.1) and natural mortality and proportion mature in Table 8.3.3.2. Applied survey data are presented in Table 8.3.4.1.1.

This is the fourth year that the SAM model has been applied for this stock. The model settings can be found in the Stock annex.

The model was run for the period 1981—2015, with catch data up to 2014 and survey data from March-April, 2004—2015. SSB 1 January in 2015 is estimated from survivors and estimated recruits (with an assumption of random walk for recruitment, which in this case gives recruitment in 2015 as estimated for 2014). 11% of age-group 1 is assumed mature thus the recruitment influences the size of SSB. The key results are presented in Tables 8.4.3—8.4.4 and summarized in Table 8.4.5 and Figure 8.4.4. Residuals of the model fit are shown in Figures 8.4.1.

8.6 State of the Stock

F has increased from a historic low at 0.04 in 2011 to 0.45 in 2014, which is just below Flim (0.48). SSB increased from 2010 (2.5 million tonnes) to 2014 (4.0 million tonnes) followed by a decrease to 3.3 million tonnes in 2015, which is above Bpa (2.25 million tonnes).

The uncertainty around the recruitment in the most recent year is high. Recruitment (age 1 fish) in 2006—2009 are in the very low end of the historical recruitments, but recruitment 2010—2012 are estimated higher. Information on the 2014 and 2015 recruitment is uncertain, but SAM estimates the 2014 recruitment lower (based on catch data) than in the three previous years. Qualitative analysis of survey indices not included in the SAM assessment indicates however strong in recruitment in 2014 and 2015.

8.7 Biological reference points

As a response to a special request from NEAFC, ICES re-evaluated in May 2013 (ICES advice, 2013) the reference points for the stock. ICES concluded that Blim and Bpa should remain unchanged. Fpa and Flim were undefined. Equilibrium stochastic simulations have been used to give a new value for Flim = 0.48. On the basis of this and the uncertainty in the assessment, a corresponding value for Fpa = 0.32 was derived. Currently MSY advice is based on a management strategy evaluation which used F0.1 as a proxy for FMSY and an MSY Btrigger = Bpa. The new simulations provide estimates of FMSY = 0.30. There are no scientific reasons to reduce MSY Btrigger below Bpa, and no estimates of MSY Btrigger are above Bpa. Under these circumstances it is proposed that Bpa be retained as MSY Btrigger for the MSY framework.

In a new request from NEAFC, June 2013, ICES was requested to confirm the suggested reference points, more specifically to confirm:

a) That the value of F0.1 is considered to be 0.22 rather than 0.18, as stated in the advice of September 2012

b) That the value of Fmsy is considered to be 0.30 rather than 0.18, as stated in the advice of September 2012

ICES confirmed (ICES advice, October 2013) that the value of F0.1 is currently estimated to be 0.22. ICES advises that the value of FMSY is considered to be 0.30 and this replaces the F0.1 proxy for FMSY of 0.18 from the advice of September 2012.

The present reference points and their technical basis are:

Reference point	Blim	Bpa	Flim	Fpa
Value	1.5 mill t	2.25 mill. t	0.48	0.32
Basis	Bloss	Blim* exp(1.645* σ), with σ= 0.25.	Equilibrium stochastic simulations, (ICES advice, 2013)	Based on Flim and assessment uncertainties (ICES advice, 2013)

Reference point	FMAX	F0.1	FMSY	MSY Btrigger
Value	NA	0.22	0.30	2.25 mill. t
Basis	FMAX is poorly defined	Yield per recruit (ICES advice, 2013 and WGWIDE, 2013)	Equilibrium stochastic simulations, (ICES advice, 2013)	Bpa

The result from an additional request for advice on options for a revised long-term management strategy on blue whiting from NEAFC, July 2016 were not ready during WGWIDE 2015.

8.8 Short term forecast

8.8.1 Recruitment estimates

The benchmark WKPELA in February 2012 concluded that the available survey indices should be used in a qualitative way to estimate recruitment, rather than using them in a strict quantitative model framework. The WGWIDE has followed this recommendation and investigated several survey time series indices with the potential to give quantitative or semi-quantitative information of blue whiting recruitment. The investigated survey series were standardized by dividing with their mean and are shown in Figure 8.8.1.1.

The International Ecosystem Survey in the Nordic Seas (IESNS) only partially covers the known distribution of recruitment from this stock. Both the 1-group (2014 year class) and 2-group (2013 year class) indices from the survey in 2015 were near the middle of the historical range.

The International Blue Whiting Spawning Stock Survey (IBWSS) is not designed to give a representative estimate of immature blue whiting. However, the 1-group indices appear to be fairly consistent with corresponding indices from older ages. The 1-group (2014 year class) index from the survey in 2015 was the highest in the time series. Also the 2-group in 2015 (2013 year class) was high, second highest in the time series, confirming the indication of a good 2013 year class.

The Norwegian bottom trawl survey in the Barents Sea (BS-NoRu-Q1(Btr)) in February-March 2015, showed that 1-group blue whiting was present and the index was the third highest in the time series (Table 8.3.4.3.1). This index should be used as a presence/absence index, in the way that when blue whiting is present in the Barents Sea this is usually a sign of a strong year-class, as all known strong year classes have been strong also in the Barents Sea.

The Icelandic bottom trawl survey (March) has a time series from 1996 to present. This survey is aimed at demersal species, but blue whiting juveniles are caught as bycatch. Some signals in recruitment are evident in the time series. The recruitment index of age 1 fish was obtained by a cut-off length at 22 cm. The 1-group estimate in 2015 (2014 year class) was lower than in 2014, but still in the high end and the second highest in the time series.

The Faroese Plateau spring (March) bottom trawl survey has a time series from 1994 to present. While this survey is not specifically aimed at blue whiting, nor has it been used in any assessments, there are some signals in recruitment evident in the time series. An index (number per trawl hour) was created based on a length split at 22 cm as an estimate of the abundance of age 1 blue whiting. The 1-group estimate in 2015 (2014 year class) was lower than in 2014, but still at the high end in the time series.

In conclusion, the indices from available survey time series indicate that the 2013 and 2014 year classes are assumed to be strong and the WG decided to use the 75th percentile as input (23.27 billion at age 1 in 2014 and 2015). No information is available for the 2015 and 2016 year classes and the geometric mean of the period (1981—2012) was used for these year classes (13.40 billion at age 1 in 2015 and 2016) (Table 8.8.1.1). Moreover, the new information regarding the 2012 year class suggests that this is around average and the WG therefore decided to use the estimate from the assessment for the 2012 year class (approximately at the 60th percentile).

8.8.2 Short term forecast

As decided at WGWIDE 2014 a deterministic version of the SAM forecast was applied.

8.8.2.1 Input

Table 8.8.2.1.1 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 (2012—2014). Selection (exploitation pattern) is based on average F in the most recent three years. The proportion mature for this stock is assumed constant over the years and values are copied from the assessment input.

Recruitment (age 1) in 2013 is assumed as estimated by the SAM model. Based on additional survey information recruitment in 2014 and 2015 is assumed to be somewhat higher than the SAM estimate and are set to be the 75^{th} percentile of SAM the estimated recruitment 1981—2012. The recruitment in 2016 and 2017 are assumed at the long term average (geometric mean for the period 1981—2012).

Information from the WG members indicates a total catch of blue whiting in 2015 at 1.3 million tonnes. F in 2015 is calculated on the basis of this total catch.

8.8.2.2 Output

A range of predicted catch and SSB options from the deterministic short term forecast used for advice are presented in Table 8.8.2.2.1.

The option table provides TAC calculation for F in the range 0.00 to 0.32 (Fpa). All of them will produce a SSB in 2017 higher than Bpa.

Following the ICES MSY framework implies fishing mortality to be at F_{MSY} = 0.30 which will give a TAC in 2016 at 776 391 tonnes (40% decrease).

With F in the range 0-Fpa, SSB is predicted to increase from 2016 to 2017, due to the relatively large 2014 and 2015 recruitments.

8.9 Comparison with previous assessment and forecast

Comparison of the final assessment results from the last 5 years is presented in Figure 8.9.1. This year's assessment gave a substantial revision of the historical SSB, F and recruitment with a downward revision of recruitment and SSB and an upward revision of F.

Disregarding this year's assessment, the historical assessments show stable and consistent output except for the 2010 assessment. In 2010 the survey results from the IBWSS 2010 survey were applied, which gave a too low stock estimate and a corresponding too high F. An evaluation of the survey coverage led to a later exclusion of the 2010 observations.

8.10 Quality considerations

Based on the confidence interval produced by the assessment model SAM there is a low to moderate uncertainty of the absolute estimate of F and SSB, and a higher uncertainty on the recruiting year classes (Figure 8.4.4). The retrospective analysis (Figure 8.4.3) and the comparison of the 2009—2014 assessments (Figure 8.9.1) do however show a substantial revision of the historical F, SSB and recruitment between years, which indicate much higher realized uncertainty than indicated by the summary graphs for this year's assessment.

There are several sources of uncertainty: age reading, stock identity, and survey indices. As there is only one survey (IBWSS) that covers the spawning stock, the quality of the survey influences the assessment result considerably. The following sections discuss the quality of the data that enter the model and the credibility of the SAM model in the present configuration.

8.10.1 Age reading and stock identity

The quality of age readings of blue whiting was evaluated at a workshop (WKARBLUE) on age reading of blue whiting which took place in Bergen, Norway, from 10—14 June 2013 chaired by Jane Amtoft Godiksen and Manolo Meixide. Blue whiting otoliths have proven to be quite difficult to age, and though guidelines have been constructed, the experience of the reader determines the interpretation of the otolith structure. This strongly indicates that biased readings might have been present in many cases for the historical data used in the assessment, even for experienced age-readers. It was therefore recommended to have regular exchanges and workshops in order to improve the agreement between readers. WKARBLUE recommends a new workshop in 2017, and the survey group recommended that the age readers look closer into a discrepancy problem for ages 1—3 in the 2014 blue whiting age reading material.

The population structure of blue whiting in the NE Atlantic appears to be more complex than the current single-stock structure used for management purposes. The ICES SIMWG (Stock Identification Methods Working Group) has concluded "Blue whiting in the NE Atlantic should be considered as two stock units: Northern and Southern". WGWIDE therefore recommended that during the next "Age Reading Workshop for Blue Whiting", otoliths from the whole distribution area of this stock should be collected to perform shape analysis, aiming to clarify the blue whiting stock structure composition.

An internal age reading for blue whiting has already taking place at IPMA. The main results will be presented during the WGBIOP (7-11 September 2015) were the next blue whiting international age reading workshop will be planned to 2017, taking the previous recommendation into account.

8.10.2 Quality of the IBWSS abundance indices

Assessment results for blue whiting are highly dependent on the quality of the only survey that covers the spawning stock (IBWSS). A post-cruise meeting compiled a joint survey report (Anon, 2015) where it was concluded that "2015 estimate of abundance can be considered as robust". The post-cruise meeting noted that the stock containment was achieved for both core and peripheral stock areas. The survey effort although reduced was considered to ensure full coverage and is not considered to be responsible for the large reduction in biomass observed this year. The post-cruise meeting also noted that there were reports indicating that large volumes of blue whiting were taken by the international fleet working outside the Irish EEZ to the southwest of the Porcupine Bank again this year prior to the survey (Feb/Mar). Estimated uncertainty around the mean acoustic density is low and comparable to the previous two years.

8.10.2.1 Comparison of 2015 age and length compositions in commercial catches with the acoustic survey results.

The blue whiting acoustic survey for 2015 gives a different perception of stock status and distribution over age groups compared to the earlier surveys and compared to the 2014 assessment. The 2015 survey was carried out under bad weather conditions which could potentially have influenced the possibility of effectively surveying the whole area. A striking issue in the 2015 survey is the low abundance of older fish (> 5 years) in the survey.

The post cruise meeting (Anon., 2015) concluded that the survey had been performed according to the survey plan and without major issues. However, there is a possibility that there has been some change in the timing of spawning or migratory behaviour of the blue whiting. In order to investigate whether any evidence for such changes could be observed in the catch data, we compared the age and length compositions of commercial catches by area during the spring fishery in 2014 and 2015 with the acoustic survey results by area. Data was available from Iceland, Faroe Islands, Norway, Denmark, the Netherlands and Germany.

From the Icelandic catches in the 2nd quarter of 2014 and 2015, it can be concluded that the 2015 spatial distribution of catches was rather different compared to 2014. In 2015 the fishery was mostly conducted east of the Faroe Islands compared to the fishery south-west of the Faroe Islands in 2014 (Figure 8.10.2.1.1 below).

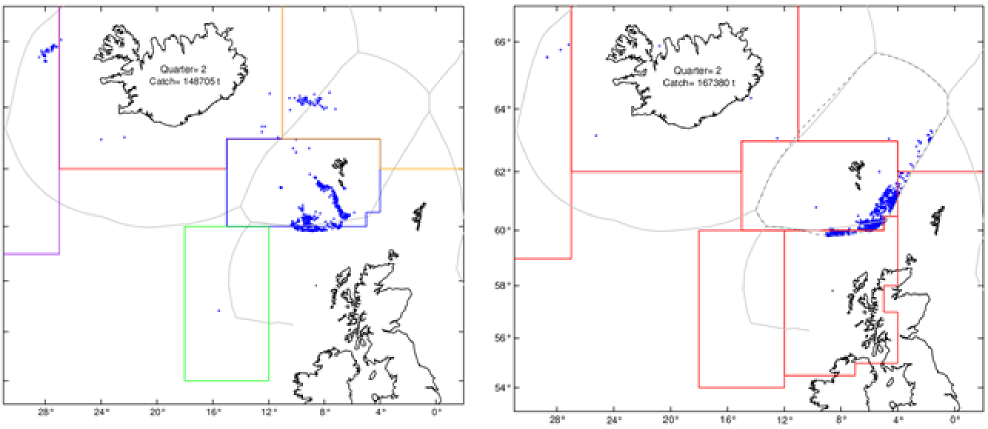


Figure 8.10.2.1.1. Spatial distribution of Icelandic Blue whiting catches I quarter 2 of 2014 and 2015.

The Faroe catch sampling (not raised to the total catch) indicates that the catch composition in 2014 and 2015 in VIa is very similar. The main difference observed for VIIc is that the catches in 2015 consisted more of younger fish and less of older fish, which is similar to the trends observed in the survey (Figure 8.10.2.1.2).

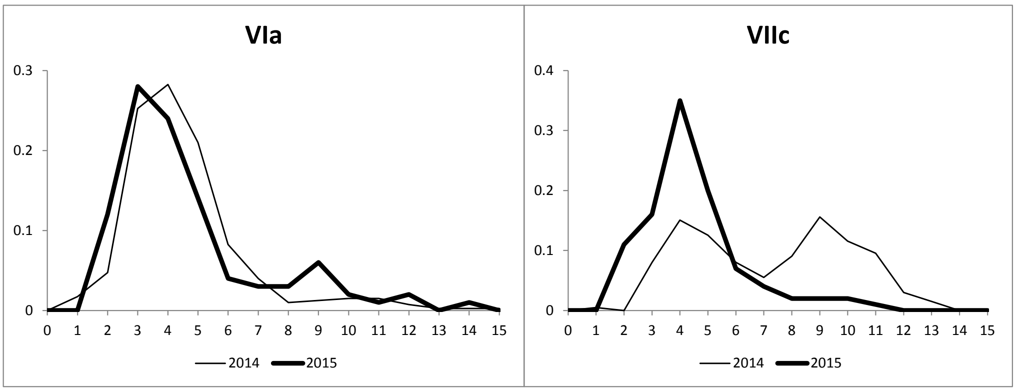


Figure 8.10.2.1.2.Age composition in Faroese catches of blue whiting in 2014 and biological samples in 2015 by area.

The Norwegian cumulative catches by year were analysed to explore potential changes in the timing of the blue whiting fishery in 2015. The results (not shown here) indicate that 2015 did not show a different timing of the Norwegian blue whiting fishery compared with the most recent years. The Norwegian catch sampling (not raised to the total catch) compared to the survey age distribution is shown in the Figure 8.10.2.1.3. Catches are split into catches before and catches during the survey period. Unfortunately, these samples were not yet split by area. There is a close alignment of the age compositions in 2014. In 2015, no samples were available (yet) for catches during the survey period. However, catches before the survey period generally show the same pattern as the survey.

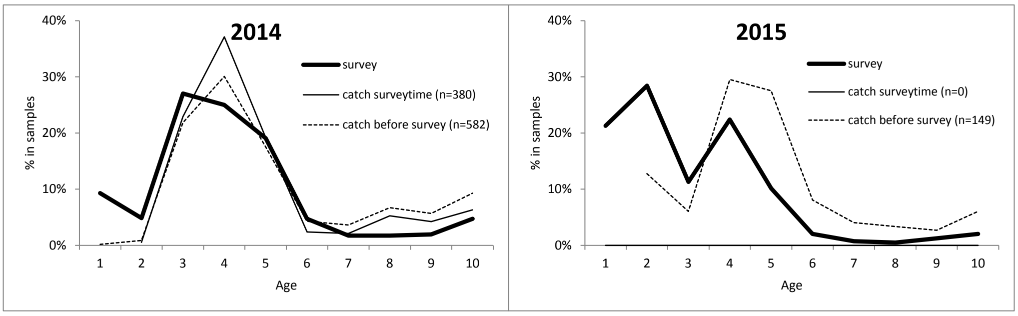


Figure 8.10.2.1.3. Norwegian age composition of blue whiting catches in 2014 and biological samples in 2015 together with age composition from IBWSS.

The Danish catch sampling data (not raised to the total catch) indicates no real differences in the age compositions between 2014 and 2015 in either ICES area VI or VII (Figure 8.10.2.1.4).

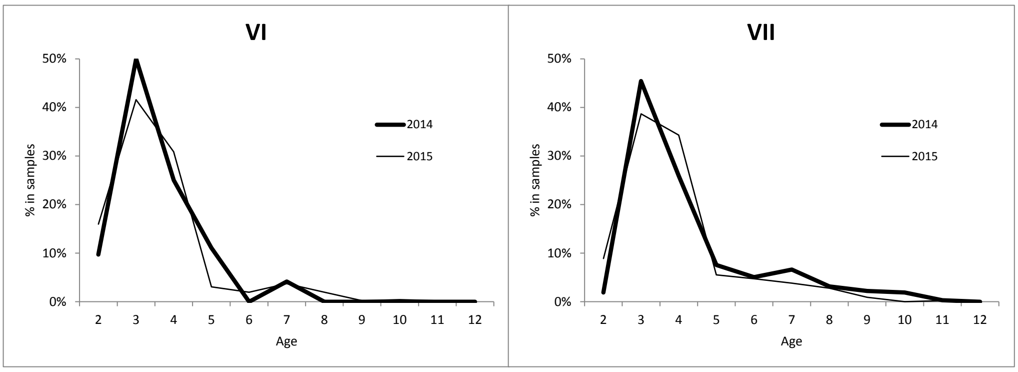


Figure 8.10.2.1.4. Age compositions of Danish and international landings of blue whiting in Denmark in 2014 and 2015 by catch area.

Germany provided information on one observer trip (not raised to the total catch of the trip) carried out during April 2015 on a vessel fishing for argentines in VIa. During their fishery, they caught substantial amounts of blue whiting as well. The age composition of those blue whiting (Figure 8.10.2.1.5) is very different from the age compositions observed in the blue whiting fisheries shown above showing larger proportion of older fish.

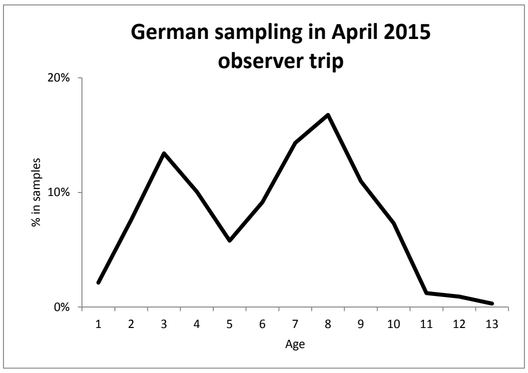


Figure 8.10.2.1.5.Age composition of blue whiting from one German observer trip in 2015.

The catch compositions of the Dutch freezer-trawler vessels were analysed based on length compositions of the total catch of around 8 vessels in 2014 and 2015, supplied by one of the fishing companies. Length distributions are not directly available from the standard monitoring carried out on the vessels, but there is information on the number of fish per carton for each of the batches produced. The number of fish per carton was converted to mean length per batch by using additional sampling data from the vessels. The mean length on board of freezer-trawls is measured in standard lengths, i.e. without tail. In order to convert this to total length the formula TL = SL * 1/0.835 (whereby 0.835 was taken from Fishbase) was used. Most of the blue whiting catches were taken in area VI where no real difference in length compositions was found between 2014 and 2015. In area VII, the number of observations in 2014 was very limited, but catches in 2015 were generally of smaller lengths (below 30 cm).

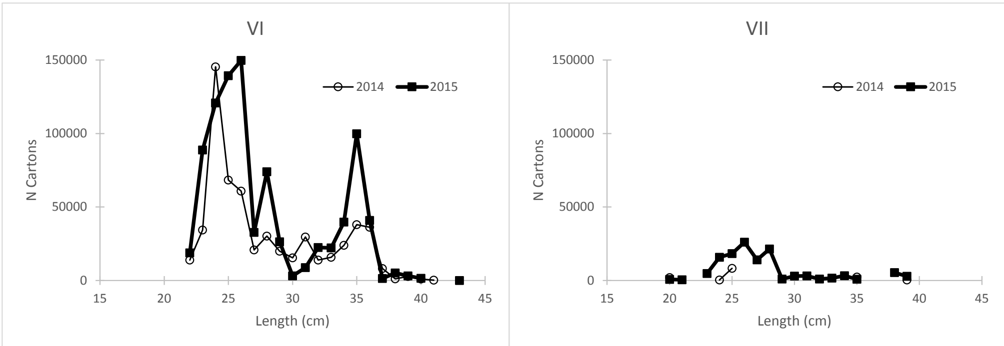


Figure 8.10.2.1.6. Quantity by mean length of blue whiting within each batch of landings carton from Dutch freezer-trawler vessels in 2014 and 2015 by area.

Conclusions on the comparisons of commercial catch data with the blue whiting acoustic survey

The general conclusion from the comparisons is that in the commercial catches there is a similar tendency as in the 2015 acoustic survey that the catches in 2015 contain relatively fewer fish above age 5 compared to the fishery in 2014. This is most noticeable in ICES area VII. In area VI, no real differences are perceived between the age compositions in 2014 and 2015.

Germany provided information on the age composition of an observer trip in April 2015 in a fishery aimed at Argentines, where substantial catches of blue whiting were generated with a high proportion of fish older than age 5.

Even though there are some mixed signals from the catch compositions of the commercial fishery, there are no compelling arguments that the acoustic survey could have missed an important component of the blue whiting stock that has been picked up by the commercial fishery.

8.10.3 Credibility of the SAM model in the present configuration

The SAM model includes catch data, 1981—2014 and survey data for 2004—2015. To actually use the 2015 survey indices the stock is projected forward in time based on a constant M and an F in 2015 based entirely on F in 2014 and random walk of F, as there is no catch data available for 2015.

This is the normal situation with survey data that extend one year later than catch data. In last year's assessment, F for 2013 (estimated with 2013 catches) and F in 2014 (estimated without 2014 catches) were practically identical. This year's assessment is very different. Mean F in 2014 is estimated to be 0.43 while F in 2015 is estimated to be 3.85. This value is not at all considered realistic. However the model gets the best fit to all data, including the low abundance indices for 2015 if it is assumed that F in 2015 is extremely high, such that the stock sizes are reduced considerably before the survey takes place. This does also explain why the model results are sensitive to the survey timing this year (see section 8.4.1), as the F deviations (random walk) from 2014 to 2015 affect the variance of the common pool of random walk deviations for F, and as such the whole assessment period. Different timing requires different deviations which might affect the full assessment.

As SSB is estimated by 1 January, SSB for 2015 is not affected by the very high 2015 F, and SSB (2015) is estimated to 3.259 kt. This is more than 1.5 million tonnes higher than the SSB estimated by the SMS model where it assumed that the survey takes place 1 January and is as such independent of F in 2015. In previous years, the SMS and the SAM model produced similar results.

Another indication that the default SAM configuration is inappropriate with the present data is the results from a SAM model where the IBWSS is back-shifted (one age and year) to take place 31 December. By this well-known trick the full IBWSS data series are used without the need to estimate F in 2015. With that configuration SSB is estimated much lower compared to the default SAM configuration (SSB in 2014 at 3969 kt for the default SAM and SSB at 2395 kt for the "back-shifted" version). F in 2014 is estimated twice as high (at 0.86) for the "back-shifted" version.

The WGWIDE was not in a position to actually fully evaluate if the high F in 2015 estimated by the default SAM is a sensible way of handling the very low 2015 stock indices until catch information from 2015 becomes available in the next assessment, or should this be seen as a misfit to data. It could also be that the 2015 IBWSS is an extreme outlier and should not be used, but no compelling reasoning for discarding the survey indices was found. Given the chosen use of the 2015 IBWSS indices, the default SAM configuration applied for stock advice seems however to estimate the stock size considerably higher than models without estimates of F in 2015. This high uncertainty should be reflected in the final choice of TAC for 2016.

8.10.4 Conclusion and potential solutions

There seems to be no clear justification for exclusion of the 2015 IBWSS data, so data are included in the assessment as the default choice. The assessment model does however estimate F for 2015 unrealistically high to fit the model. This is done without any information on catches in 2015 in the model.

One solution for a better evaluation the survey results in the most recent year is to actually get the catch data from the present year. For blue whiting almost all catches are made in the first half year such that the catch at age number could be made ready before WGWIDE in the end of August. This will however require a reorganisation of the timeline for the national institutes to complete data collation for blue whiting in the present year. It is important to get preliminary catch data that is so close to the final data as possible, to avoid endless discussions about if the assessment result is due to a potential misspecification of the available age composition in the present year. Data from the first quarter of the year might be sufficient, but analysis of potential shift in age composition over the year should be made before this shorter period is selected.

Another simpler solution is to fix the F in the present year to F in the previous year. This is what practically done by SAM in the 2014 assessment, whereas F in the present year for the 2015 was estimated very different from F in the previous year.

A third solution might be to actually estimate the "year effect" for the individual years, so "survey bias" is eliminated. Attempts to do that in the previously used model, SMS, were not promising (over parameterisation), however it has not been tried with the SAM model.

8.11 Management considerations

The abundance indices from the International Blue Whiting spawning stock survey, IBWSS, in 2015 showed to be unexpectedly low, especially for the older age groups. Survey experts consider the result as "robust" as the survey was conducted as planned, even though the weather conditions were not as favourable as in the two previous years, which could bias the result. Preliminary data from the commercial landings in 2015 partly supported the decline in abundance of older fish. The age composition of landings showed a decline in the proportion of old fish for some countries, while other countries have a similar age composition in 2014 and 2015. Based in these considerations, WGWIDE made the (default) choice to use the IBWSS 2015 data in the stock assessment.

The default stock assessment model, SAM, estimates an unrealistically high F for 2015 to fit the low survey indices. With a high F before the survey takes place the stock numbers are reduced considerably and make a better fit the 2015 survey indices. F in 2015 is determined by the model without any catch data.

The WGWIDE was not in a position to actually fully evaluate if the high F in 2015 estimated by the default SAM is a sensible way of handling the very low 2015 stock indices until catch information from 2015 becomes available in the next assessment, or should this be seen as a misfit to data. It could also be that the 2015 IBWSS is an extreme outlier and should not be used, but no compelling reasoning for discarding the survey indices was found.

Given the chosen use of the 2015 IBWSS indices, the default SAM configuration applied for stock advice seems however to estimate the stock size considerably higher than models without estimates of F in 2015. This high uncertainty should be reflected in the final choice of TAC for 2016.

8.12 Ecosystem considerations

An extensive overview of ecosystem considerations relevant for blue whiting can be found in the stock annex and a more general overview of the pelagic complex in the NE Atlantic in section 1 of this report. Here are only some recent and relevant features addressed.

In May 2015, the temperatures at all depths in the vicinity of the Faroes were considerable lower compared to 20 years long-term mean (ICES, 2015c). The cold conditions reflect the relative low temperatures in the Sub Polar Gyre (SPG) that have propagated northeast ward into the southern Norwegian Sea during the spring and the summer. These colder surface (and upper layers) is related to strongly positive NAO (North Atlantic Oscillation index) and cold/fresh waters on the Canadian site of the Atlantic this winter and spring. As a response to high NAO, extent of Atlantic water in Nordic Seas can be reduced resulting in freshening and cooling of the upper layer (Blindheim *et al.*, 2000), while favourable winds supporting a strong Atlantic influence in the waters west of the British Isles are more frequent.

The temperature in the Norwegian Sea is considered to be positively related to productivity and the feeding conditions for pelagic fish stock (Holst *et al,* 2004; Skjoldal 2004). The time series from IESSNS survey in July/August 2010—2015 shows, however, an average dry weight of zooplankton in Norwegian Sea in 2015 at similar level as in 2014 and 2013 (ICES, 2015d) despite a lower temperature. The zooplankton biomass index for the same area in May, declined slightly from 2014 (ICES, 2015c). There, the index had a decreasing trend from around 2002 until 2009 and upward since then until 2014.

8.13 Regulations and their effects

Currently there is no agreement between the Coastal States EU, Norway, Iceland and the Faroe Island on the share of the blue whiting stock. Consequently the previous management plan is no longer in force. Although a TAC of 1.26 million tonnes was agreed for 2015, the parties have set unilateral quotas for the 2015 fishing year. The Working Group estimated the total expected outtake from the stock to be around 1.3 million tonnes in 2015 based on information from WGWIDE members.

No minimum landing size is associated with blue whiting.

8.13.1 Management plans and evaluations

There is currently no management plan for blue whiting. NEAFC has asked ICES on behalf of the Coastal States to evaluate a long-term management strategy for blue whiting in the short term. Initial results and the MSE conditioning and modelling framework were presented at WGWIDE. The short term timeframe of the request increases the importance of initial starting conditions on the outcome of the evaluation. Initial results prepared before the group were based on the 2014 assessment. Following the revision in the blue whiting assessment at the group it was decided to re-run simulations based on the latest assessment. Hence results were not ready before the end of the WG meeting, but were reviewed by correspondence.

8.14 References

Anon. 2015.Report of the International Blue Whiting Spawning Stock Survey.(IBWSS), spring 2015. Working document to WGWIDE, 2015

Björnsson, H., 2015 BW: Problem., Working Document to WGWIDE 2015

Blindheim, J., Borovkov, V., Hansen, B., Malmberg, S. A., Turrell, W. R., and Osterhus, S. 2000. Upper layer cooling and freshening in the Norwegian Sea in relation to atmospheric forcing. Deep Sea Research I, 47: 655–680.

Heino. 2014. Revising the maturity ogive for blue whiting. Working document to WGWIDE 2014.

Holst, J. C., Røttingen, I., and Melle, W. 2004. The herring. In The Norwegian Sea Ecosystem. Ed. by H. R. Skjoldal. Tapir Academic Press, Norway. 559 pp.

ICES 2015.Report of the Working Group of International Pelagic Surveys (WGIPS). ICES CM 2015/ SSGIEOM:05.

ICES 2012b. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2012) 13–17 February 2012 Copenhagen, Denmark.ICES CM 2012/ACOM:47

ICES.2015c. International ecosystem survey in the Nordic Sea (IESNS) in April-June 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015. 34 pp.

ICES. 2015d. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) with M/V "Brennholm", M/V "Eros", M/V "Christian í Grótinum" and R/V "Árni Friðriksson", 1 July - 10 August 2015. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), AZTI-Tecnalia, Pasaia, Spain, 25 – 31 August 2015. 47 pp.

Nielsen, A., and Berg, C.W. 2014.Estimation of time-varying selectivity in stock assessments using state-space models. Fisheries Research, 158: 96-101.

Table 8.3.1.1.Blue whiting. ICES estimates of landings (tonnes) by country for the period 1988–2014.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
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
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
France		2 191				1 195		720	6 442	12 446	7 984	6 662	13 481	13 480	14 688	14 149
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
Iceland		4 977						369	302	10 464	68 681	160 430	260 857	365 101	287 336	501 493
Ireland	4 646	2 014			781		3	222	1 709	25 785	45 635	35 240	25 200	29 854	17 825	22 580
Japan					918	1 742	2 574									
Latvia					10 742	10 626	2 582									
Lithuania						2 046										
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
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
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
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
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
UK (England)****																
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
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
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

Table 8.3.1.1 (continued).ICES estimates (tonnes) of landings by country for the period 1988–2014.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Denmark	89 500	41 450	56 979	48 659	18 134	248	140	165	340	2 167	35 256
Estonia	**										
Faroes	322 322	266 799	321 013	317 859	225 003	58 354	49979	16405	43290	85 768	224 700
France		8 046	18 009	16 638	11 723	8 831	7839	4337	9799	8 978	10 410
Germany	15 293	22 823	36 437	34 404	25 259	5 044	9108	278	6239	11 418	24 487
Iceland	379 643	265 516	309 508	236 538	159 307	120 202	87942	5887	63056	104 918	182 879
Ireland	75 393	73 488	54 910	31 132	22 852	8 776	8324	1195	7557	13 205	21 466
Japan											
Latvia											
Lithuania			4 635	9 812	5 338						4 717
Netherlands	95 311	147 783	102 711	79 875	78 684	35 686	33762	4595	26526	51 635	38 524
Norway	957 684	738 490	642 451	539 587	418 289	225 995	194317	20539	118832	196 246	399 520
Poland											
Portugal	3 937	5 190	5 323	3 897	4 220	2 043	1482	603	1955	2 056	2 150
Spain	15 612	17 643	15 173	13 557	14 342	20 637	12891	2416	6726	15 274	32065
Sweden ***	19 083	2 960	101	467	4	3	50	1	4	199	2
UK (England + Wales)	2 593	7 356	10 035	12 926	14 147	6 176	2475	27	2866	4 100	11
UK (Northern Ireland)										1 232	2 205
UK (Scotland)	57 028	104 539	72 106	43 540	38 150	173	5496	1331	6305	8 166	24 630
USSR / Russia *	346 762	332 226	329 100	236 369	225 163	149 650	112553	45841	88303	120 674	152 256
Greenland***										2 133	
Unallocated									3 499		
TOTAL	2377568	2026953	1968456	1612330	1246465	635639	523832	103592	385297	626036	1155279

*** From 1992 onlyRussia**

**** Reported to the EU but not to the ICES WGNPBW. (Landings of 19,467 tonnes)**

***** Estimates from Sweden and Greenland: are not included in the Catch at Age Number**

****** From 2012**

Table 8.3.1.2.Blue whiting.ICES estimates of catch (tonnes) by country and area for 2014.

Area	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Lithuania	Netherlands	Norway	Portugal	Russia	Spain	Swedeen	UK (England + Wales)	UK (Northern Ireland)	UK(Scotland)	Grand Total
IIa	327.21	8725.36		26.282	12817	32.23		93.308	1555.261		18567					22.204	42 166
IIb				0.993				92.324			465						558
IIIa				0.012									1.93				2
IVa	1282.302	92.12		2626.758				3664.153	20788.356		97		0.045			1.5	28 552
IVb	32.716								8.82								42
IVc	0.027							0.014									0
IXa										2149.7795		7699.479					9 849
V	503.926																504
Va		131.04			1816												1 947
Vb		150141.99	552.13409	6965.651	124107			3149.6			79919						364 835
VIa	19892.03	46158.27	4177.9812	7358.06	32167	4917.424	1180.659	27487.479	114298.94		10987					5610.578	274 235
VIb		12701.3		62.16	11961	5349.426			63033.419		15716					5513.702	114 337
VIIb	757.364		1275.8866			850		198.421									3 082
VIIc	10108.67	6249.74	623.49821	7447.213		7550.453	3536.572	2731.897	74263.172		5824	97.87767				10060.322	128 493
VIIe														10.65			11
VIIg												0.93676					1
VIIh	2351.78		2.09432									14.93126					2 369
VIIIa			496.45617														496
VIIIb												20.281					20
VIIIc												23863.17					23 863
VIIId			2537.4495														2 537
VIIj			16.9			165.015		658.82				330.548					1 171
VIIk			727.68			2601.848		448.293	125572.22		20287	37.92186			2205.089	3422.135	155 302
XII		500															500
XIVa											394						394
XIVb					11												11
Grand Total	**35 256**	**224 700**	**10 410**	**24 487**	**182 879**	**21 466**	**4 717**	**38 524**	**399 520**	**2 150**	**152 256**	**32 065**	**2**	**11**	**2 205**	**24 630**	**1 155 279**

*** Note: the value for area IXa is summed across CN, CS and S subdivisions of this area.**

Table 8.3.1.3.Blue whiting. ICES estimates of catch (tonnes) by quarter and area for 2014.

Area	1	2	3	4	Total
IIa	620	24447	9634	7465	42166
IIb			346	212	558
IIIa		0	2		2
IVa	81	16693	9769	2010	28552
IVb		25	15	2	42
IVc				0	0
IXa	1855	2593	3115	2286	9849
V		504			504
Va	142	153	1454	198	1947
Vb	62251	260441	404	41739	364835
VIa	23637	248823		1776	274235
VIb	79463	34874			114337
VIIb	3082				3082
VIIc	124096	4306	70	21	128493
VIIe		11			11
VIIg	1	0			1
VIIh	2355	2	12	1	2369
VIIIa			345	151	496
VIIIb	6	5	7	1	20
VIIIc	5888	5125	7729	5121	23863
VIIId			1711	826	2537
VIIj	323	545	199	105	1171
VIIk	155270	20	12		155302
XII	500				500
XIVa			394		394
XIVb	5	5	1		11
Total	459574	598572	35219	61915	**1155279**

Table 8.3.1.1.1. Blue whiting total catches (tonnes), total landings (tonnes) and discards (tonnes) for 2014.

Country	Catches	Landings	Discards	% Discards
Denmark*	35315	35256	59	0.17
Faroe Islands	224700	224700	-	
France	10410	10410	-	
Germany	24487	24487	0	
Iceland	182879	182879	-	
Ireland	21466	21466	-	no sampling
Lithuania	4717	4717	-	
Netherlands*	38658	38524	134	0.3
Norway	399520	399520	-	
Portugal	2150	1304	846	39
Russia	152256	152256	-	
Spain	32065	25606	6459	20
Sweden	2	2	-	
UK (England + Wales)*	13	11	2	13
UK (Scotland)	24630	24630	-	
UK (Northern Ireland)	2205	2205	-	

* discards do not included on the assessment

Table 8.3.1.2.1.Blue whiting. Sampling intensity for blue whiting from the commercial catches by fishery in 2014.

		Fisheries		
	Period	Directed	Southern	Total
No. of samples	Quarter 1	226	62	288
WG Catch		451779	7795	459574
No. of samples	Quarter 2	235	100	335
WG Catch		590811	7761	598572
No. of samples	Quarter 3	54	88	142
WG Catch		24078	11141	35219
No. of samples	Quarter 4	31	77	108
WG Catch		54396	7519	61915
Total No. of samples	**2014**	**585**	**327**	**912**
Total WG Catch	**2014**	**1520585**	**34215**	**1155279**
tonnes per sample	**2014**	**2526**	**105**	**1267**

Table 8.3.1.2.2 Blue whiting. ICES estimates of landings (tonnes), No. of samples, No. of fish measured and No. of fish aged by country and quarter for 2014.

Country	Quarter	Landings (t)	No. Samples	No. Fish Measured	No. Fish Aged
Denmark	1	11279	6	338	338
	2	23314	0	0	0
	3	67	0	0	0
	4	597	0	0	0
	Total	**35256**	**6**	**338**	**338**
Faroe Islands	1	72385	16	2162	1589
	2	133983	12	1354	858
	3	2474	5	571	359
	4	15858	6	600	600
	Total	**224700**	**39**	**4687**	**3406**
France	1	3745	0	0	0
	2	3612	0	0	0
	3	2059	0	0	0
	4	994	0	0	0
	Total	**10410**	**0**	**0**	**0**
Germany	1	8221	0	0	0
	2	16239	0	0	0
	3	13	0	0	0
	4	14	0	0	0
	Total	**24487**	**0**	**0**	**0**
Iceland	1	20514	9	773	449
	2	148631	43	3638	1894
	3	1998	0	0	0
	4	11736	5	496	122
	Total	**182879**	**57**	**4907**	**2465**
Ireland	1	17761	11	2643	968
	2	3674	0	0	0
	3		0	0	0
	4	32	0	0	0
	Total	**21466**	**11**	**2643**	**968**
Lithuania	1	**4717**	0	**0**	**0**
	2		0	**0**	**0**
	3		0	**0**	**0**
	4		0	**0**	**0**
	Total	**4717**	**0**	**0**	**0**
Netherlands	1	4967	74	9659	1849
	2	31851	1	131	25
	3		0	0	0
	4	1707	0	0	0
	Total	**38524**	**75**	**9790**	**1874**
Norway	1	238029	39	2215	1143
	2	149912	11	658	319
	3	9729	5	239	163
	4	1851	1	60	30
	Total	**399520**	**56**	**3172**	**1655**
Portugal	1	325	14	218	142
	2	966	24	722	384
	3	553	10	1112	573
	4	306	9	1050	564
	Total	**2150**	**57**	**3102**	**1663**
Russia	1	49067	110	19347	1310
	2	73869	168	37662	2085
	3	7737	44	8288	422
	4	21583	19	4105	127
	Total	**152256**	**341**	**69402**	**3944**
Spain	1	**7470**	**48**	**1859**	**4193**
	2	**6795**	**76**	**3872**	**4193**
	3	**10588**	**78**	**3885**	**7520**
	4	**7213**	**68**	**3659**	**7519**
	Total	**32065**	**270**	**13275**	**23425**
Sweden	1		0	0	0
	2	0	0	0	0
	3	2	0	0	0
	4		0	0	0
	Total	**2**	**0**	**0**	**0**
UK (England + Wales)	1		0	0	0
	2	11	0	0	0
	3		0	0	0
	4		0	0	0
	Total	**11**	**0**	**0**	**0**
UK (Northern Ireland)	1	2205	0	0	0
	2		0	0	0
	3		0	0	0
	4		0	0	0
	Total	**2205**	**0**	**0**	**0**
UK (Scotland)	1	18891	0	0	0
	2	5716	0	0	0
	3		0	0	0
	4	24	0	0	0
	Total	**24630**	**0**	**0**	**0**
	Grand Total	**1155279**	**912**	**111316**	**39738**

Table 8.3.1.3.1.Blue whiting. Catch numbers ('000) by length group (cm) and quarter for the directed fishery in 2014.

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13				50	50
14				249	249
15	1		9	3 980	3 990
16	58	143	18	8 856	9 076
17	575	1 325	132	11 096	13 127
18	2 156	5 272	750	4 389	12 567
19	19 061	11 015	1 803	2 787	34 667
20	14 634	23 059	2 985	13 994	54 673
21	8 177	21 750	8 094	19 668	57 689
22	262 005	16 571	9 218	18 874	306 668
23	2833 828	17 932	10 311	10 985	2873 057
24	4698 430	54 723	11 808	13 082	4778 042
25	13418 078	201 043	19 492	21 074	13659 687
26	5007 174	223 794	27 532	19 908	5278 408
27	8777 915	281 880	18 141	20 744	9098 679
28	4141 791	202 325	13 710	13 820	4371 645
29	3372 852	141 168	9 913	6 982	3530 915
30	4776 062	99 754	6 410	4 649	4886 875
31	3979 407	121 999	5 608	4 256	4111 270
32	4405 605	140 623	5 415	4 497	4556 141
33	2087 158	131 399	4 418	4 801	2227 776
34	1573 178	96 339	3 786	4 966	1678 269
35	1774 707	64 534	2 824	5 709	1847 774
36	632 051	31 505	1 334	3 252	668 141
37	621 708	10 673	467	1 732	634 579
38	492 134	4 673	191	978	497 976
39	5 033	2 446	16	460	7 954
40	3 324	1 537	24	104	4 989
41	1 344	882	5	3	2 233
42	113 114	603	3	1	113 720
43	850	485		1	1 337
44	80	252	1	1	334
45	59	143			202
46		36			36
47	60	36			96
48					
49					
50					
51					
52					
53					
54					
55					
TOTAL numbers	63022 609	1909 917	164 416	225 949	65322 890

Table 8.3.1.3.2. Blue whiting. Catch numbers ('000) by length group (cm) and quarter for the southern fishery in 2014.

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5					
6					
7					
8					
9	1	1	1	1	4
10					
11					
12					
13	5	8	8	5	25
14	50	79	81	57	266
15	241	382	65 678	2 007	68 308
16	414	654	4 532	1445 874	1451 474
17	1698 805	31 814	4 779	3379 620	5115 018
18	19184 381	221 731	601 769	6920 293	26928 175
19	29091 735	854 647	1144 094	7064 553	38155 029
20	13359 596	3388 044	1764 394	8026 533	26538 567
21	12664 075	11818 213	5334 440	8803 254	38619 982
22	10573 150	25717 095	14300 579	10892 240	61483 064
23	9561 495	27776 360	23972 525	11398 225	72708 604
24	11524 953	22752 003	26729 147	12508 609	73514 712
25	9533 604	21368 128	26928 762	11424 362	69254 855
26	8158 637	15410 466	20173 670	11983 058	55725 831
27	5834 145	8229 151	10623 332	8407 603	33094 231
28	3179 377	4902 934	5913 217	3847 348	17842 875
29	4514 566	2198 128	7509 345	2518 441	16740 480
30	2472 074	854 864	7728 830	1601 021	12656 788
31	2274 571	626 116	3193 942	755 899	6850 528
32	1160 292	518 251	670 072	329 068	2677 683
33	1390 519	207 175	273 735	180 459	2051 887
34	718 385	32 156	72 646	91 967	915 154
35	886 369	14 854	8 801	20 644	930 669
36	495 736	14 326	12 815	17 418	540 294
37	280 108	4 936	3 728	165	288 938
38	57	2 532	408		2 996
39	75		735	1 416	2 226
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
TOTAL numbers	148557 413	146945 048	157036 063	111620 139	564158 663

Table 8.3.1.4.Blue whiting. ICES estimates of landings (tonnes) from the main fisheries, 1988–2014.

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**
2011	20 599	72 279	7 524	**100 401**	3 191	**103 592**
2012	24 391	324 545	5678.346	**354 614**	29401.78	**384 016**
2013	31 759	481 356	8749.0505	**521 864**	103973.479	**625 837**
2014	45 580	885 483	28 596	**959 659**	195 620	**1 155 279**

Table 8.3.1.4.1.Blue whiting. Catch at age numbers (millions). Discards included since 2014.

Year/Age	1	2	3	4	5	6	7	8	9	10+
1981	258	348	681	334	548	559	466	634	578	1460
1982	148	274	326	548	264	276	266	272	284	673
1983	2283	567	270	286	299	304	287	286	225	334
1984	2291	2331	455	260	285	445	262	193	154	255
1985	1305	2044	1933	303	188	321	257	174	93	259
1986	650	816	1862	1717	393	187	201	198	174	398
1987	838	578	728	1897	726	137	105	123	103	195
1988	425	721	614	683	1303	618	84	53	33	50
1989	865	718	1340	791	837	708	139	50	25	38
1990	1611	703	672	753	520	577	299	78	27	95
1991	267	1024	514	302	363	258	159	49	5	10
1992	408	654	1642	569	217	154	110	80	32	12
1993	263	305	621	1571	411	191	107	65	38	17
1994	307	108	368	389	1222	281	174	90	79	31
1995	296	354	422	465	616	800	254	160	60	42
1996	1893	534	632	537	323	497	663	232	98	83
1997	2131	1519	904	578	296	252	282	407	104	169
1998	1657	4181	3541	1045	384	323	303	264	212	86
1999	788	1549	5821	3461	413	207	151	153	69	140
2000	1815	1193	3466	5015	1550	514	213	151	58	140
2001	4364	4486	2962	3807	2593	586	170	97	77	66
2002	1821	3232	3292	2243	1824	1647	344	169	103	143
2003	3743	4074	8379	4825	2035	1117	400	121	20	27
2004	2156	4426	6724	6698	3045	1276	650	249	75	37
2005	1427	1519	5084	5871	4450	1419	518	249	100	55
2006	413	940	4206	6151	3834	1719	506	181	68	37
2007	167	307	1795	4211	3867	2353	936	321	130	89
2008	409	179	545	2917	3263	1919	736	316	113	127
2009	61	156	232	595	1596	1157	592	252	89	49
2010	350	223	160	208	646	992	703	257	70	44
2011	163	102	64	54	70	116	120	55	26	13

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2012	240	352	663	142	107	203	364	357	212	158
2013	228	508	849	897	463	224	321	398	344	384
2014	589	584	231	202	127	417	386	462	526	663

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
1981	0.052	0.065	0.103	0.125	0.141	0.155	0.170	0.178	0.187	0.213
1982	0.045	0.072	0.111	0.143	0.156	0.177	0.195	0.200	0.204	0.231
1983	0.046	0.074	0.118	0.140	0.153	0.176	0.195	0.200	0.204	0.228
1984	0.035	0.078	0.089	0.132	0.153	0.161	0.175	0.189	0.186	0.206
1985	0.038	0.074	0.097	0.114	0.157	0.177	0.199	0.208	0.218	0.237
1986	0.040	0.073	0.108	0.130	0.165	0.199	0.209	0.243	0.246	0.257
1987	0.048	0.086	0.106	0.124	0.147	0.177	0.208	0.221	0.222	0.254
1988	0.053	0.076	0.097	0.128	0.142	0.157	0.179	0.199	0.222	0.260
1989	0.059	0.079	0.103	0.126	0.148	0.158	0.171	0.203	0.224	0.253
1990	0.045	0.070	0.106	0.123	0.147	0.168	0.175	0.214	0.217	0.256
1991	0.055	0.091	0.107	0.136	0.174	0.190	0.206	0.230	0.232	0.266
1992	0.057	0.083	0.119	0.140	0.167	0.193	0.226	0.235	0.284	0.294
1993	0.066	0.082	0.109	0.137	0.163	0.177	0.200	0.217	0.225	0.281
1994	0.061	0.087	0.108	0.137	0.164	0.189	0.207	0.217	0.247	0.254
1995	0.064	0.091	0.118	0.143	0.154	0.167	0.203	0.206	0.236	0.256
1996	0.041	0.080	0.102	0.116	0.147	0.170	0.214	0.230	0.238	0.279
1997	0.047	0.072	0.102	0.121	0.140	0.166	0.177	0.183	0.203	0.232
1998	0.048	0.072	0.094	0.125	0.149	0.178	0.183	0.188	0.221	0.248
1999	0.063	0.078	0.088	0.109	0.142	0.170	0.199	0.193	0.192	0.245
2000	0.057	0.075	0.086	0.104	0.133	0.156	0.179	0.187	0.232	0.241
2001	0.050	0.078	0.094	0.108	0.129	0.163	0.186	0.193	0.231	0.243
2002	0.054	0.074	0.093	0.115	0.132	0.155	0.173	0.233	0.224	0.262
2003	0.049	0.075	0.098	0.108	0.131	0.148	0.168	0.193	0.232	0.258
2004	0.042	0.066	0.089	0.102	0.123	0.146	0.160	0.173	0.209	0.347
2005	0.039	0.068	0.084	0.099	0.113	0.137	0.156	0.166	0.195	0.217
2006	0.049	0.072	0.089	0.105	0.122	0.138	0.163	0.190	0.212	0.328

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2007	0.050	0.064	0.091	0.103	0.115	0.130	0.146	0.169	0.182	0.249
2008	0.055	0.075	0.100	0.106	0.120	0.133	0.146	0.160	0.193	0.209
2009	0.056	0.085	0.105	0.119	0.124	0.138	0.149	0.179	0.214	0.251
2010	0.052	0.064	0.110	0.154	0.154	0.163	0.175	0.187	0.200	0.272
2011	0.055	0.079	0.107	0.136	0.169	0.169	0.179	0.189	0.214	0.270
2012	0.041	0.072	0.098	0.140	0.158	0.172	0.180	0.185	0.189	0.203
2013	0.051	0.077	0.094	0.117	0.139	0.162	0.185	0.188	0.198	0.197
2014	0.050	0.078	0.093	0.112	0.128	0.155	0.178	0.190	0.202	0.217

Table 8.3.3.2. 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 8.3.4.1.1.Blue whiting age composition (millions) from the IBWSS for 2004—2015.

Year\Age	1	2	3	4	5	6	7	8	9	10+	Total
2004	1559	5 650	11086	14353	5426	1785	1007	635	367	40	41908
2005	1159	1427	6034	8178	8526	2657	646	233	105	1	28967
2006	1010	1 775	10332	12504	5338	2570	798	261	95	0	34685
2007	552	855	5 270	10606	8001	4501	2348	810	308	135	33461
2008	301	566	1440	5668	6516	3845	2122	1050	248	299	20943
2009	245	620	373	2057	5066	4181	2037	516	125	15	15238
2010*	580	648	212	452	982	2264	2456	1242	352	47	9311
2011	202	2617	942	912	1647	2301	1767	1221	430	31	12075
2012	1178	1832	6678	1013	544	1343	2077	1444	1078	1025	18393
2013	502	1682	7056	7776	3122	1287	1327	1515	867	1892	27026
2014	2886	1502	8396	7771	5927	1468	532	536	599	1468	31085
2015	3530	4713	1871	3713	1682	335	119	82	208	335	16588

*** The quality of the survey was regarded as not satisfactory.**

Total stock biomass (kt)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TSB (1000t)	3612	2557	3357	3583	2458	1981	1266	1578	2219	3347	3251	1377

Table 8.3.4.2.1. Estimated blue whiting stock numbers from the International Norwegian Sea ecosystem survey, 2000–2015. 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	10	107	165	68	96				446
2011*	1447	3138	1	43	204	226	431	120	84			5694
2012	9425	3142	427	153	87	169	98	31				13532
2013	241	5723	457	81	22	42	62	125	102	26	42	6938
2014	1402	1966	1024	438	97	33	28	50	37	22	11	5112
2015	8728	1671	515	310	120	46	18	21	11	19	19	11478

***Using the old TS-value. To compare the results with 2012 all values should be divided by approximately 3.1**

Table 8.3.4.3.1 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	< 19 cm
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	5.80	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	17.03	0.04
2009	4.50	0.01
2010	3.30	0.08
2011	1.48	0.01
2012	127.89	126.83
2013	39.54	2.33
2014	31.95	25.2
2015	148.4	128.34

Table 8.4.1.Blue Whiting. Survey indices used in the assessment.

IBWSS

	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8
2004	11086	14353	5426	1785	1007	635
2005	6034	8178	8526	2657	646	233
2006	10332	12504	5338	2570	798	261
2007	5270	10606	8001	4501	2348	810
2008	1440	5668	6516	3845	2122	1050
2009	373	2057	5066	4181	2037	516
2010	-1	-1	-1	-1	-1	-1
2011	942	912	1647	2301	1767	1221
2012	6678	1013	544	1343	2077	1444
2013	7056	7776	3122	1287	1327	1515
2014	8396	7771	5927	1468	532	536
2015	1871	3713	1682	335	119	82

Table 8.4.2.Blue Whiting. Parameter estimates, from the 2014 and 2015 SAM assessments.

	2014		2015	
	estimate	CV	estimate	CV
Randomwalkvariance				
--- F	0.405	0.13	0.496	0.14
--- log(N@age1)	0.619	0.15	0.612	0.15
Process error				
--- log(N@age2 to 10+)	0.195	0.15	0.206	0.13
Observation variance				
--- Catch age 1	0.424	0.18	0.423	0.18
--- Catch age 2	0.282	0.22	0.271	0.23
--- Catch age 3-8	0.152	0.14	0.152	0.15
--- Catch age 9-10	0.429	0.13	0.416	0.13
--- IBWSS age 3	0.388	0.27	0.384	0.25
--- IBWSS age 4-6	0.221	0.18	0.273	0.19
--- IBWSS age 7-8	0.293	0.20	0.296	0.20
Survey catchability				
--- IBWSS age 3	0.346	0.16	0.468	0.16
--- IBWSS age 4	0.579	0.11	0.818	0.13
--- IBWSS age 5-8	0.807	0.10	1.151	0.11
Rho	0.903		0.935	

Table 8.4.3.Blue whiting.Estimated fishing mortalities.

Year\Age	1	2	3	4	5	6	7	8	9+	F37
1981	0.069	0.116	0.173	0.221	0.265	0.352	0.379	0.480	0.489	0.278
1982	0.055	0.092	0.138	0.178	0.210	0.280	0.303	0.381	0.386	0.222
1983	0.065	0.109	0.163	0.210	0.247	0.336	0.363	0.451	0.451	0.264
1984	0.079	0.129	0.196	0.256	0.305	0.415	0.441	0.544	0.540	0.323
1985	0.083	0.132	0.205	0.270	0.329	0.442	0.464	0.570	0.565	0.342
1986	0.108	0.170	0.267	0.366	0.454	0.591	0.619	0.760	0.754	0.460
1987	0.097	0.151	0.244	0.338	0.421	0.549	0.574	0.701	0.687	0.425
1988	0.095	0.147	0.248	0.339	0.432	0.571	0.581	0.702	0.679	0.434
1989	0.109	0.168	0.296	0.402	0.508	0.663	0.684	0.820	0.786	0.511
1990	0.113	0.172	0.314	0.428	0.537	0.691	0.734	0.867	0.833	0.541
1991	0.054	0.081	0.154	0.213	0.265	0.332	0.357	0.416	0.401	0.264
1992	0.047	0.070	0.139	0.193	0.233	0.284	0.312	0.367	0.354	0.232
1993	0.041	0.060	0.125	0.175	0.210	0.249	0.276	0.327	0.315	0.207
1994	0.037	0.054	0.116	0.164	0.196	0.228	0.256	0.307	0.292	0.192
1995	0.046	0.068	0.151	0.219	0.250	0.292	0.327	0.398	0.372	0.248
1996	0.056	0.082	0.188	0.279	0.304	0.362	0.402	0.496	0.459	0.307
1997	0.053	0.079	0.183	0.279	0.295	0.352	0.389	0.484	0.447	0.300
1998	0.072	0.107	0.251	0.395	0.412	0.494	0.539	0.671	0.612	0.418
1999	0.059	0.088	0.211	0.339	0.353	0.425	0.451	0.565	0.515	0.356
2000	0.076	0.113	0.269	0.439	0.479	0.575	0.594	0.732	0.673	0.471
2001	0.072	0.108	0.254	0.419	0.473	0.567	0.572	0.699	0.650	0.457
2002	0.077	0.114	0.267	0.444	0.526	0.636	0.634	0.761	0.711	0.502
2003	0.071	0.103	0.246	0.411	0.504	0.598	0.596	0.689	0.649	0.471
2004	0.082	0.118	0.280	0.472	0.603	0.709	0.715	0.796	0.755	0.556
2005	0.077	0.108	0.257	0.443	0.584	0.678	0.691	0.754	0.716	0.531
2006	0.063	0.088	0.208	0.363	0.491	0.567	0.578	0.620	0.589	0.441
2007	0.064	0.089	0.206	0.361	0.504	0.588	0.604	0.634	0.604	0.452
2008	0.059	0.083	0.189	0.330	0.471	0.548	0.572	0.589	0.564	0.422
2009	0.036	0.053	0.120	0.202	0.296	0.345	0.370	0.375	0.353	0.267
2010	0.029	0.042	0.095	0.154	0.232	0.271	0.299	0.294	0.276	0.210
2011	0.006	0.009	0.020	0.032	0.048	0.057	0.064	0.062	0.058	0.044
2012	0.016	0.024	0.055	0.085	0.131	0.155	0.177	0.175	0.162	0.121
2013	0.027	0.039	0.089	0.137	0.215	0.253	0.293	0.290	0.266	0.197
2014	0.058	0.083	0.192	0.295	0.461	0.548	0.643	0.636	0.577	0.428

Table 8.4.4.Blue Whiting. Estimated stock numbers at age (million).

Year\Age	1	2	3	4	5	6	7	8	9	10+
1981	4106	3602	4723	2021	2439	2072	1645	1801	1469	3256
1982	5554	3012	2663	3269	1530	1394	1195	946	895	2189
1983	21617	4395	2015	1792	1843	1166	951	809	549	1506
1984	20978	16802	2777	1291	1269	1351	779	521	425	1019
1985	10252	15417	10843	1580	779	908	758	446	252	736
1986	7074	6563	9850	5909	1011	481	496	406	231	521
1987	8598	4906	4127	6703	2572	419	247	243	163	298
1988	6274	6524	3396	2879	3727	1257	207	117	94	174
1989	8521	4565	5010	2506	2150	1635	374	99	50	115
1990	17418	5880	2911	2658	1473	1213	595	139	38	74
1991	9426	14828	4198	1773	1491	853	536	185	39	38
1992	7297	7897	13204	3358	1243	785	466	290	101	42
1993	5325	5368	5559	10150	2336	973	508	277	160	79
1994	7467	3645	3753	3433	6817	1535	773	354	184	139
1995	9830	5649	3160	2556	2783	3790	1015	524	216	190
1996	28948	7557	4033	2306	1521	1773	2211	623	300	239
1997	45627	22499	5649	2518	1370	1006	989	1168	302	303
1998	28233	39193	17244	3503	1357	903	720	565	574	292
1999	20999	21445	29503	10864	1750	736	487	364	227	386
2000	36763	15919	16502	16175	4561	1144	475	304	161	303
2001	55450	30280	13111	11007	7587	1725	497	223	133	194
2002	46782	42798	18868	7953	5352	3482	768	278	104	155
2003	49625	39114	36324	13908	5091	2720	1169	298	91	95
2004	31611	38302	29385	21168	7312	2608	1294	550	132	80
2005	18532	24325	26245	17558	10596	3220	1057	482	204	87
2006	6859	14318	22522	19580	9733	4404	1316	433	192	115
2007	3734	4965	11864	15526	10533	5215	2207	722	219	156
2008	4574	2766	3949	10089	9020	4926	2035	883	297	186
2009	4965	3166	2131	3524	6517	4529	2174	823	362	208
2010	15007	4360	2141	1757	3169	4181	2613	1142	415	290
2011	20563	13270	3214	1612	1625	2429	2371	1271	681	401
2012	18718	16079	12152	2245	1091	1563	2311	2103	1088	903
2013	11162	16273	12176	8113	2285	1087	1359	1719	1464	1446
2014	11410*	8701	14549	9240	4506	1292	794	924	1097	1792
2015	11410*	8815	6676	10049	5460	1903	589	349	400	1328

***Replaced by the 75% percentile of recruitment 1981—2012 (23 271 millions) in forecast.**

Table 8.4.5.Blue whiting. Estimated recruitment in millions, total stock biomass (TBS) in 1000 tonnes, spawning stock biomass (SSB) in 1000 tonnes, and average fishing mortality for ages 3 to 7 ($F_{3,7}$).

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	$F_{3,7}$	Low	High
1981	4106	2558	6592	3419	2786	4197	2917	2339	3638	0.278	0.219	0.354
1982	5554	3456	8924	2825	2328	3428	2318	1883	2852	0.222	0.175	0.280
1983	21617	13580	34410	3097	2527	3796	1901	1589	2275	0.264	0.212	0.328
1984	20978	13372	32910	3399	2734	4225	1860	1563	2213	0.323	0.262	0.397
1985	10252	6561	16020	3517	2889	4281	2251	1881	2695	0.342	0.281	0.417
1986	7074	4601	10878	3249	2757	3830	2390	2028	2817	0.460	0.380	0.555
1987	8598	5600	13201	2772	2354	3263	1918	1634	2252	0.425	0.350	0.516
1988	6274	4071	9670	2379	2027	2791	1615	1389	1878	0.434	0.358	0.527
1989	8521	5515	13165	2395	2024	2834	1550	1335	1801	0.511	0.421	0.619
1990	17418	11075	27392	2412	1951	2982	1334	1135	1569	0.541	0.436	0.670
1991	9426	5941	14955	3150	2476	4008	1732	1399	2145	0.264	0.207	0.338
1992	7297	4646	11460	3686	2941	4620	2546	2028	3196	0.232	0.181	0.297
1993	5325	3365	8429	3563	2880	4407	2637	2121	3277	0.207	0.162	0.263
1994	7467	4790	11640	3375	2775	4106	2523	2065	3083	0.192	0.152	0.243
1995	9830	6315	15302	3355	2793	4031	2294	1927	2732	0.248	0.198	0.309
1996	28948	18692	44831	3749	3070	4578	2180	1853	2565	0.307	0.248	0.380
1997	45627	29491	70591	5526	4370	6988	2471	2077	2940	0.300	0.244	0.368
1998	28233	18390	43345	7039	5689	8709	3757	3112	4534	0.418	0.344	0.509
1999	20999	13556	32530	7452	6145	9037	4611	3796	5601	0.356	0.292	0.433
2000	36763	23687	57058	7422	6169	8930	4291	3659	5031	0.471	0.390	0.570
2001	55450	35898	85652	9029	7404	11011	4648	3971	5441	0.457	0.378	0.552
2002	46782	30144	72603	9870	8078	12059	5184	4405	6099	0.502	0.415	0.606
2003	49625	32099	76721	11793	9797	14196	6934	5850	8219	0.471	0.392	0.567
2004	31611	20063	49805	10262	8644	12183	6689	5725	7815	0.556	0.464	0.666
2005	18532	11734	29268	8261	6924	9855	5850	4971	6885	0.531	0.438	0.643
2006	6859	4331	10862	7595	6405	9006	5885	4986	6948	0.441	0.362	0.539
2007	3734	2340	5958	5598	4728	6630	4672	3953	5521	0.452	0.366	0.559
2008	4574	2837	7376	4189	3488	5032	3489	2909	4183	0.422	0.333	0.535
2009	4965	2952	8352	3230	2596	4019	2610	2103	3241	0.267	0.204	0.349
2010	15007	9021	24964	3559	2749	4607	2538	1986	3244	0.210	0.158	0.280
2011	20563	12187	34694	4356	3233	5869	2572	1970	3357	0.044	0.033	0.059
2012	18718	10767	32540	5071	3794	6778	3396	2611	4416	0.121	0.092	0.158
2013	11162	5966	20881	5548	3999	7697	3918	2897	5298	0.197	0.143	0.272
2014	11410*	4656	27964	5315	3578	7895	3965	2736	5746	0.428	0.274	0.669
2015							3259	1911	5559			

***Replaced by the 75% percentile of recruitment 1981—2012 (23 271 millions) in forecast.**

Table 8.8.1.1.Blue Whiting. Upper part: Recruitment candidates (R_1, number at age 1, millions) to be used in the forecast section. Lower part: Geometric means of age 1 blue whiting from the final assessment run.

Year	Number at age 1
2014	23271
2015	23271
2016	13403
2017	13403
Year range	Geometric mean
1981-1995, 2006-2009	7822
1981-2012	13403
1996-2005	34172

Table 8.8.2.1.1.Blue Whiting. Input to short term projection (median values for exploitation pattern and stock numbers).

Age	Mean weight in the stock (kg)	Mean weight in the catch (kg)	Proportion mature	Natural mortality	Exploitation pattern	Stock numbers 2015 (millions)
1	0.047	0.047	0.11	0.20	0.136	23271*
2	0.075	0.075	0.40	0.20	0.195	17979**
3	0.095	0.095	0.82	0.20	0.451	6676
4	0.123	0.123	0.86	0.20	0.694	10049
5	0.142	0.142	0.91	0.20	1.082	5460
6	0.163	0.163	0.94	0.20	1.281	1903
7	0.181	0.181	1.00	0.20	1.493	589
8	0.188	0.188	1.00	0.20	1.476	349
9	0.196	0.196	1.00	0.20	1.348	400
10	0.206	0.206	1.00	0.20	1.348	1328

***Changed to 75% percentile of recruitment 1981—2012.**

****Changed to match75% percentile of recruitment 1981—2012.**

Table 8.8.2.2.1.Blue whiting. Deterministic forecast.

Basis: F(2015) = 0.501 (catch constraint = 1300).SSB(2016) = 3619. R(2014) and R(2015)=75% percentile of recruitment 1981-2011=23271 million, R(2016) and R(2017) = GM(1981-2012) = 13404 million at age 1.

	Catchin 2016	Fbar in 2016	SSB in 2017	% SSB change*	% TAC change**
F=0.05	143.814	0.05	4431.664	22	-89
F=0.10	281.446	0.10	4299.828	19	-78
F=0.15	413.222	0.15	4173.845	15	-68
F=0.16	438.902	0.16	4149.323	15	-66
F=0.17	464.362	0.17	4125.020	14	-64
F=0.18	489.605	0.18	4100.934	13	-62
F=0.19	514.633	0.19	4077.063	13	-60
F=0.20	539.449	0.20	4053.403	12	-58
F=0.21	564.054	0.21	4029.954	11	-57
F=0.22	588.451	0.22	4006.712	11	-55
F=0.23	612.641	0.23	3983.676	10	-53
F=0.24	636.629	0.24	3960.842	9	-51
F=0.25	660.414	0.25	3938.210	9	-49
F=0.26	684.000	0.26	3915.776	8	-47
F=0.27	707.389	0.27	3893.539	8	-46
F=0.28	730.582	0.28	3871.497	7	-44
F=0.29	753.582	0.29	3849.647	6	-42
F=0.30	776.391	0.30	3827.988	6	-40
Fpa 0.32	821.443	0.32	3785.232	5	-37
Flim 0.48	1156.430	0.48	3468.474	-4	-11
zerocatch	0	0.00	4569.654	26	-100
0.5*F(2015)	662.093	0.25	3936.613	9	-49
1.0*F(2015)	1198.073	0.50	3429.248	-5	-8
1.5*F(2015)	1637.036	0.75	3018.104	-17	26

Weights in thousand tonnes.

***) SSB 2017 relative to SSB 2016.**

****) Catch 2016 relative to expected catch in 2015 (1300 tonnes).**

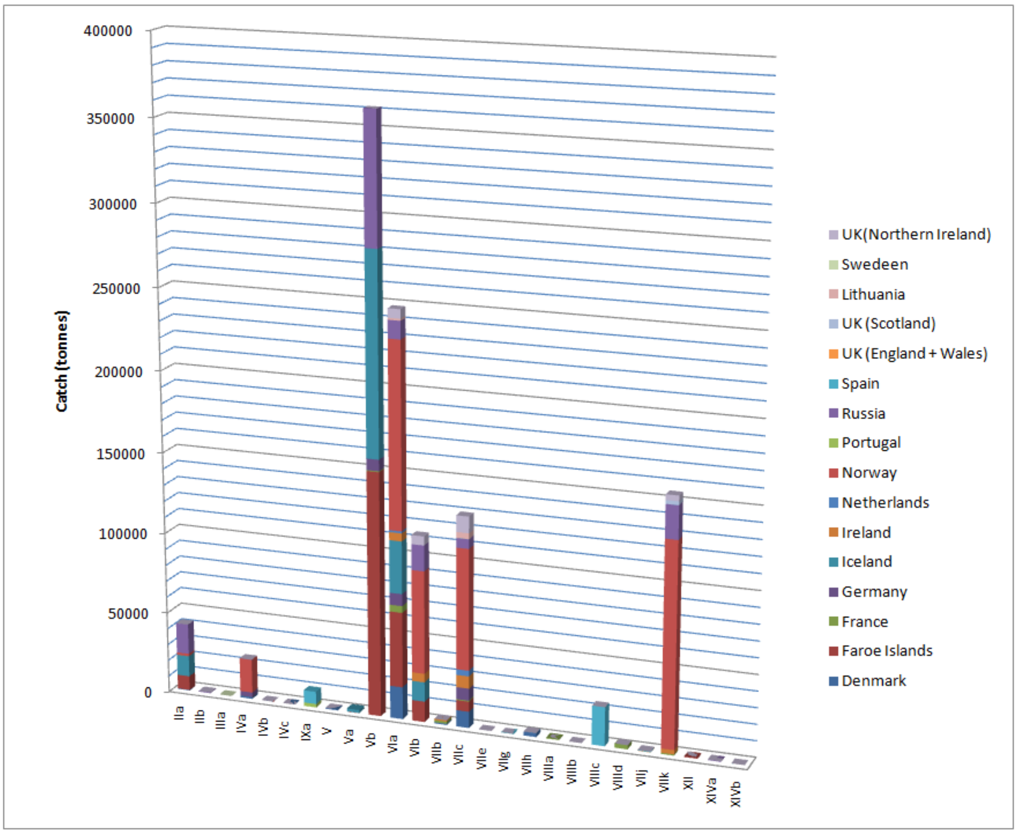


Figure 8.3.1.1 Blue whiting ICES estimates (tonnes) in 2014 presented by ICES area and country.

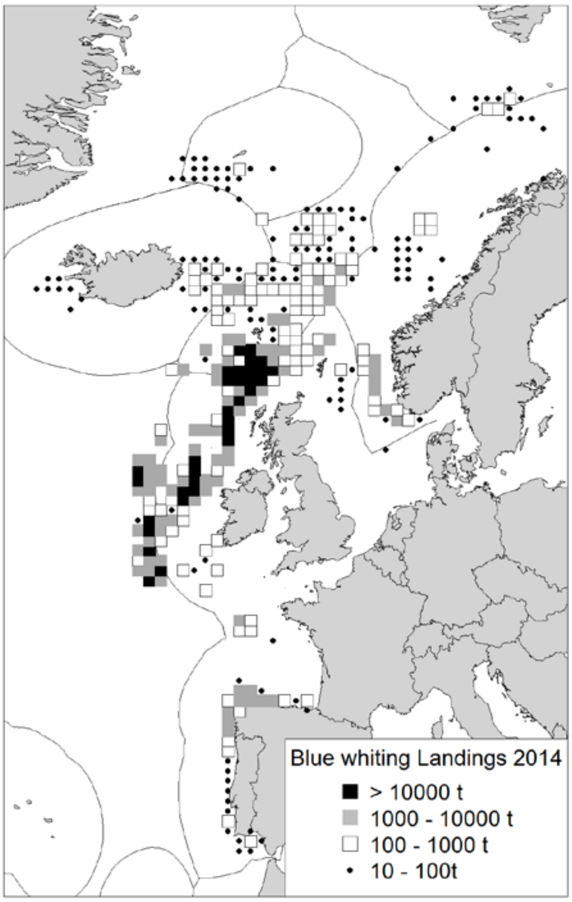


Figure 8.3.1.2. Blue whiting landings (tonnes) in 2014 by ICES rectangle. Catches below 10 t are not shown on the map. Landingss between 10 and 100 tonnes (black dots), between 100 and 1000 tonnes (open squares), 1000 and 10 000 tonnes (gray squares) and exceeding 10 000 tonnes black squares. The catches on the map constitute close to 100 % of the total landings.

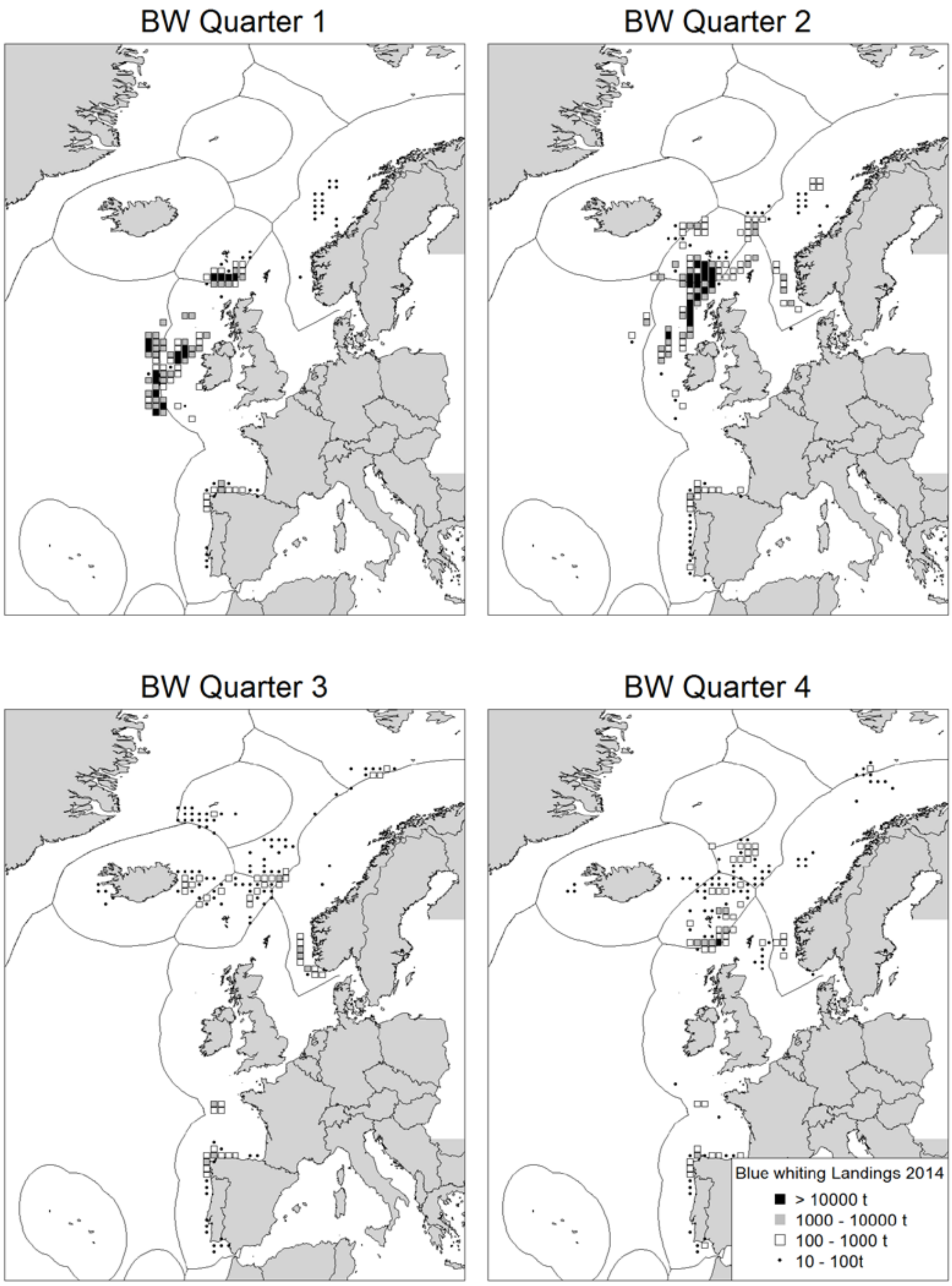
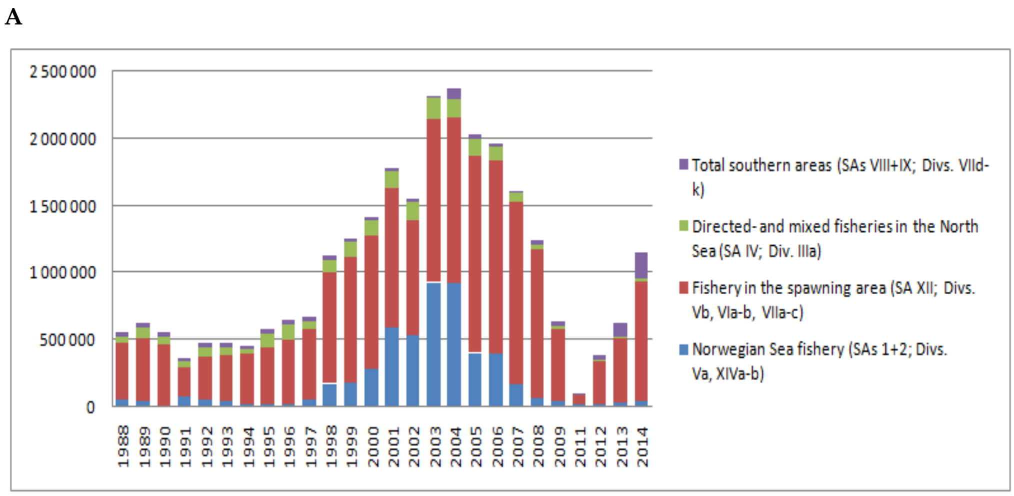


Figure 8.3.1.3. Blue whiting total catches (t) in 2014 by quarter and ICES rectangle. Landings between 10 and 100 tonnes (black dots), between 100 and 1000 tonnes (open squares), 1000 and 10 000 tonnes (gray squares) and exceeding 10 000 tonnes black squares. The catches on the maps constitute close to 100 % of the total catches.



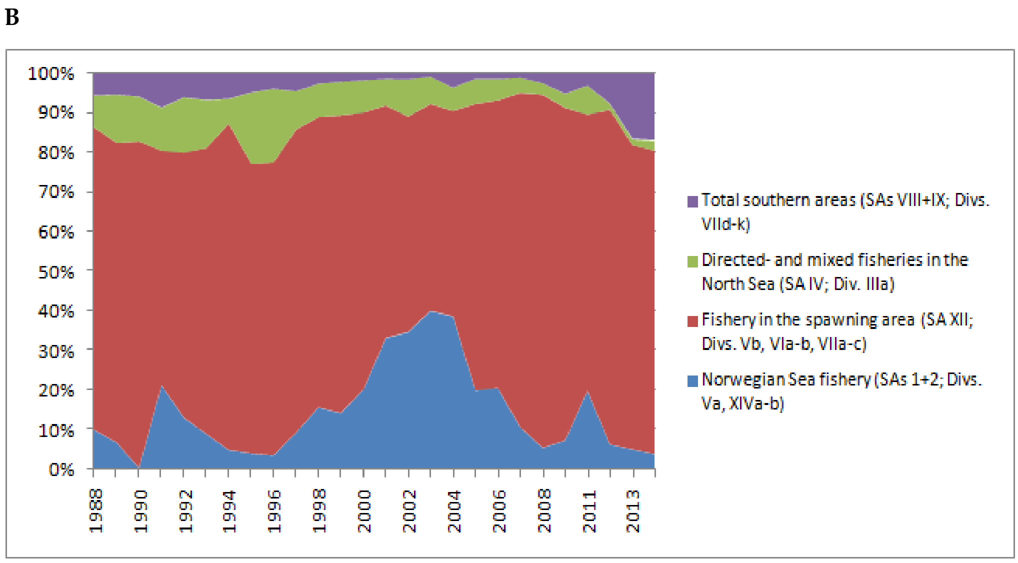


Figure 8.3.1.4. Blue Whiting. (A) Annual catch (tonnes) of blue whiting by fishery sub-areas from 1988-2014 and (B) the percentage contribution to the overall catch by fishery sub-area over the same period.

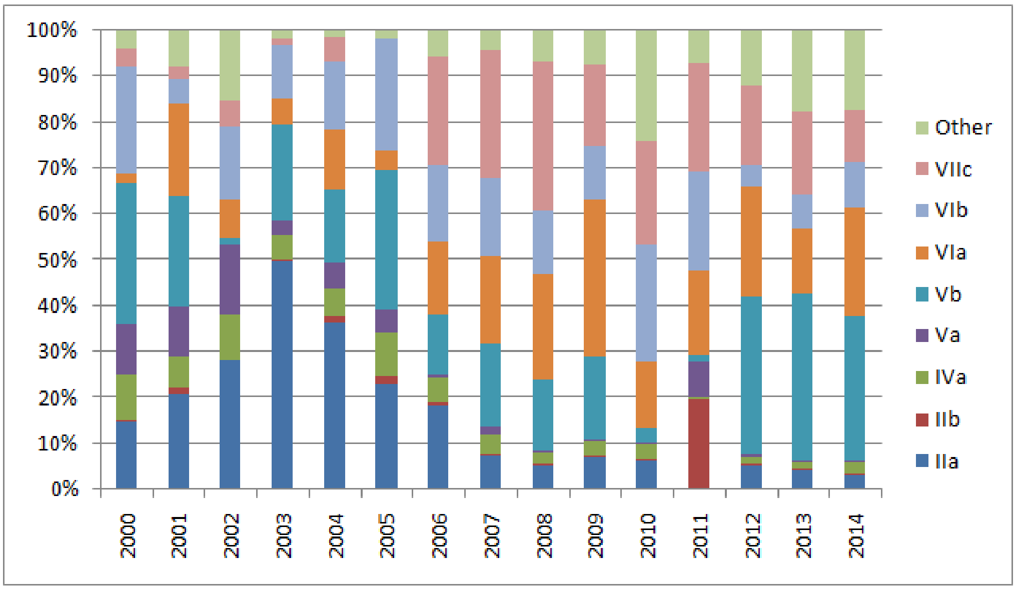


Figure 8.3.1.5. Blue whiting. Distribution of catch of blue whiting by ICES sub-area.

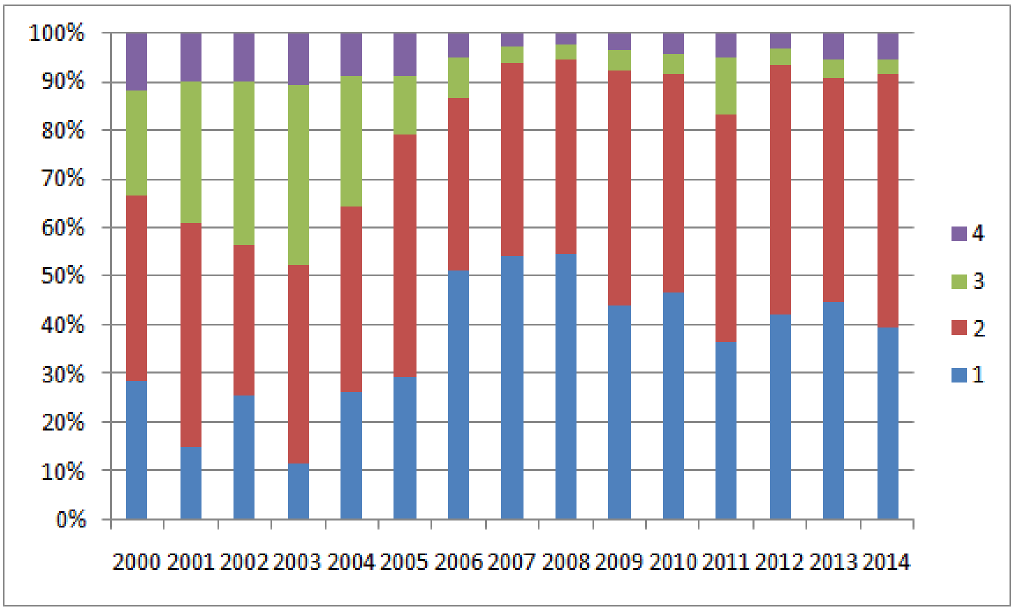


Figure 8.3.1.6.Blue whiting. Distribution of catch of blue whiting by quarter.

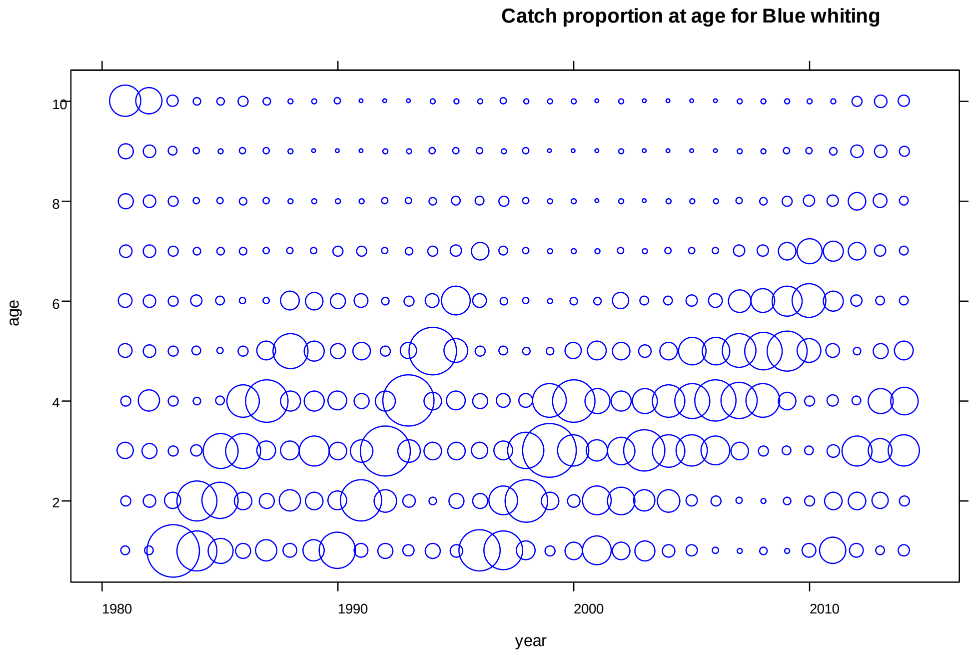


Figure 8.3.1.3.1. Blue whiting. Catch proportion at age of blue whiting, 1981-2014.

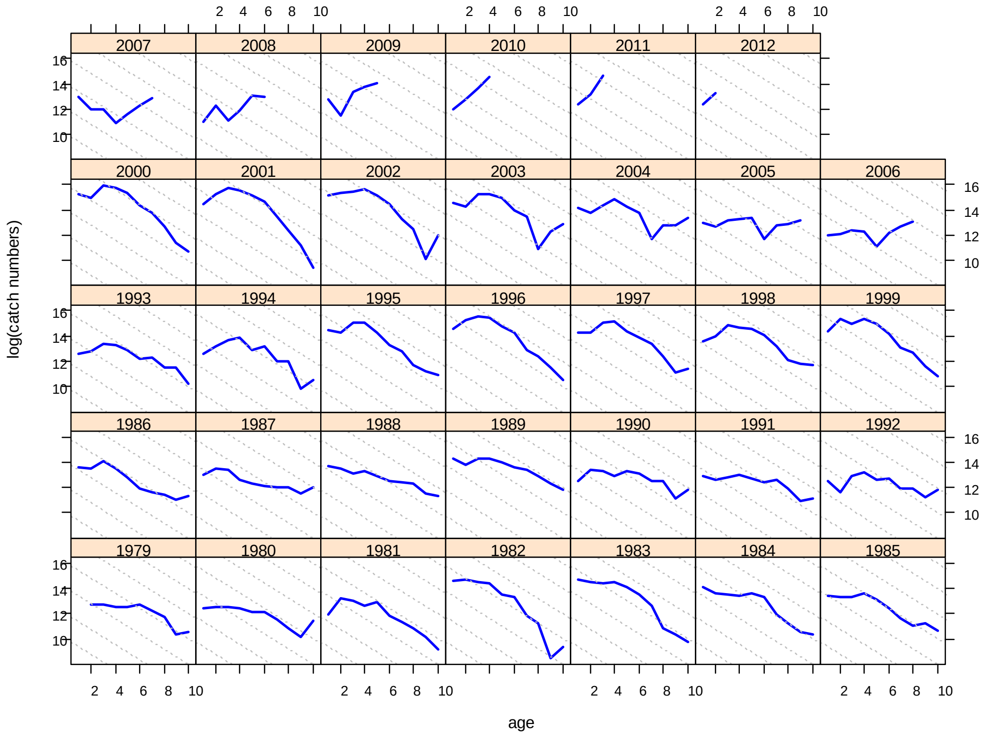


Figure 8.3.1.3.2. Blue whiting. Age disaggregated blue whiting catch (numbers) plotted on log scale. The labels behind each panel indicate year classes. The grey dotted lines correspond to *Z*=0.6.

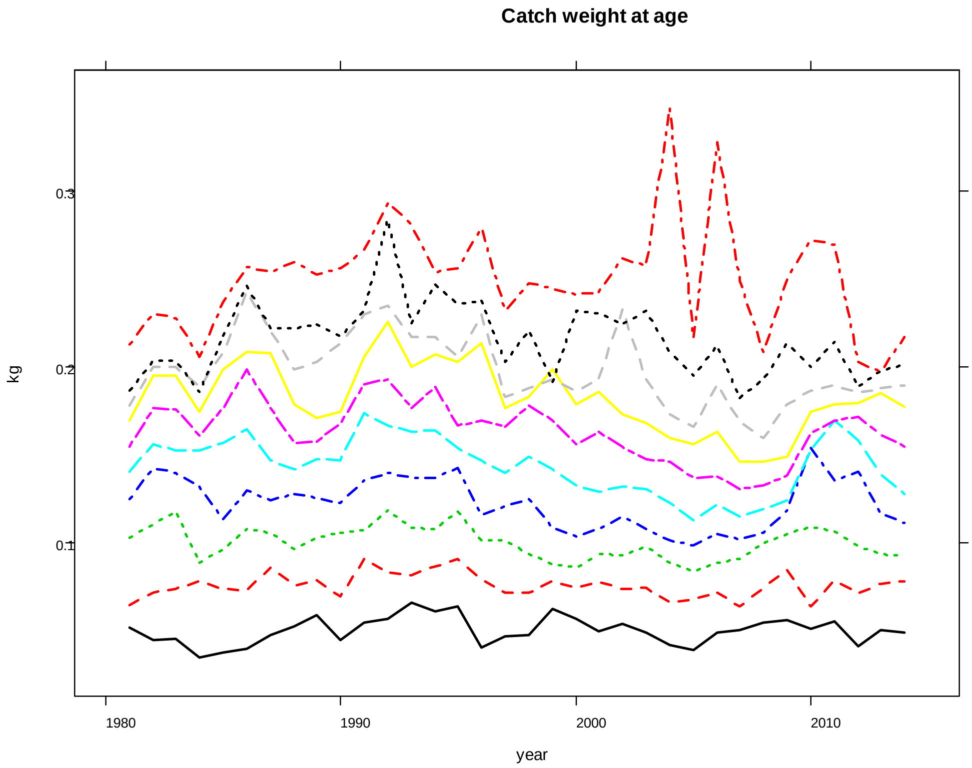


Figure 8.3.1.4.1. Blue whiting. Mean catch (and stock) weight (kg) at age of blue whiting by year.

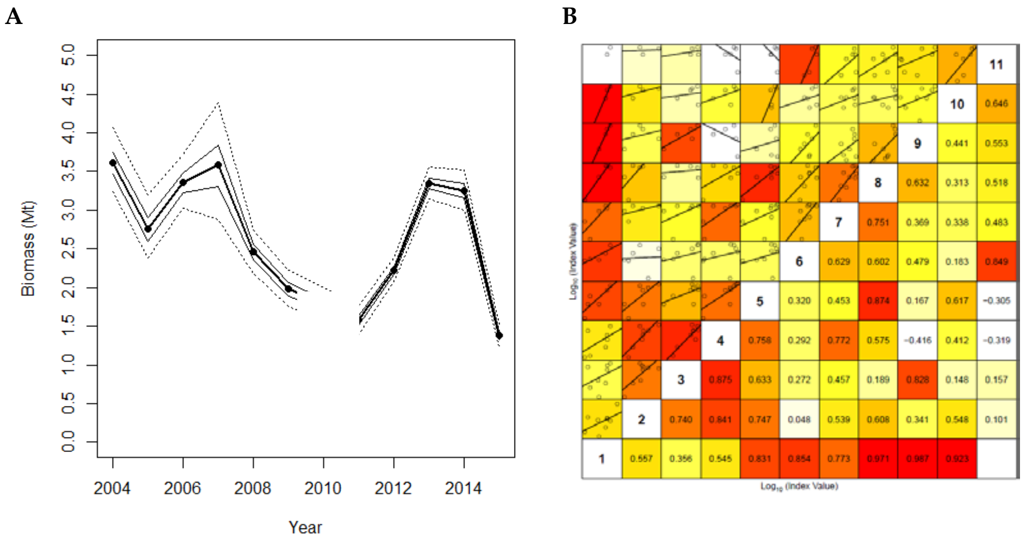


Figure 8.3.4.1.1. Blue whiting. (A) Approximate 50% and 95% confidence limits for blue whiting biomass estimates. The confidence limits are based on the assumption that confidence limits for annual estimates of mean acoustic density can be translated to confidence limits of biomass estimates by expressing 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<0.

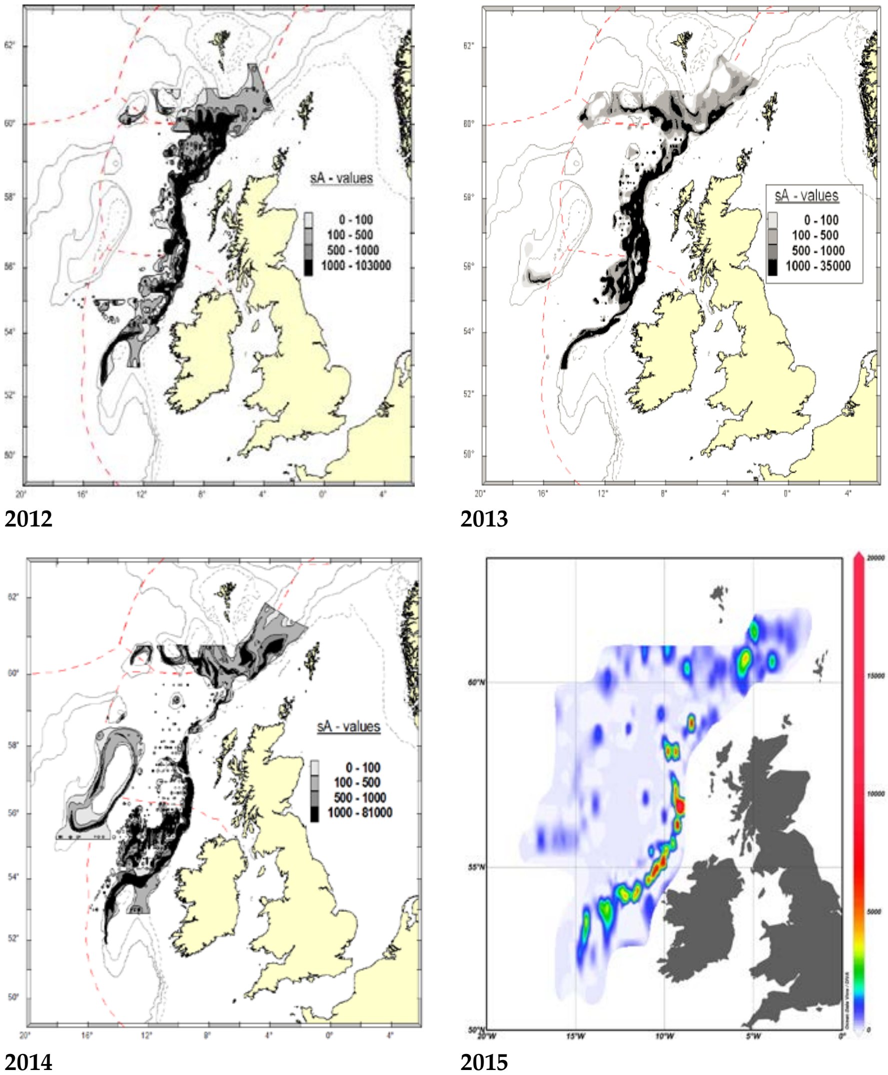


Figure 8.3.4.1.2. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the spawning survey in spring 2012—2015.

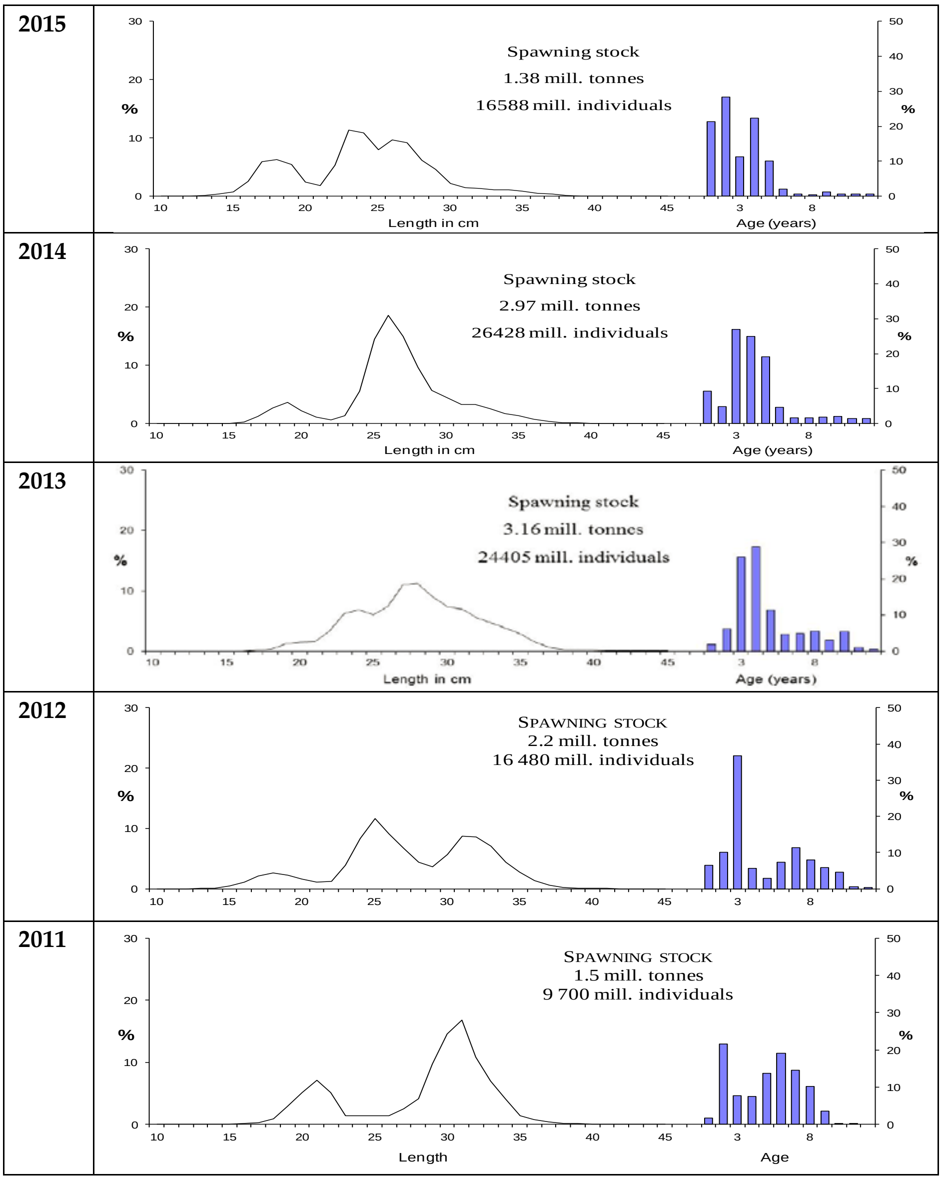


Figure 8.3.4.1.3 Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2011 (lower panel) to 2015 (upper panel). Spawning stock biomass and numbers are given.

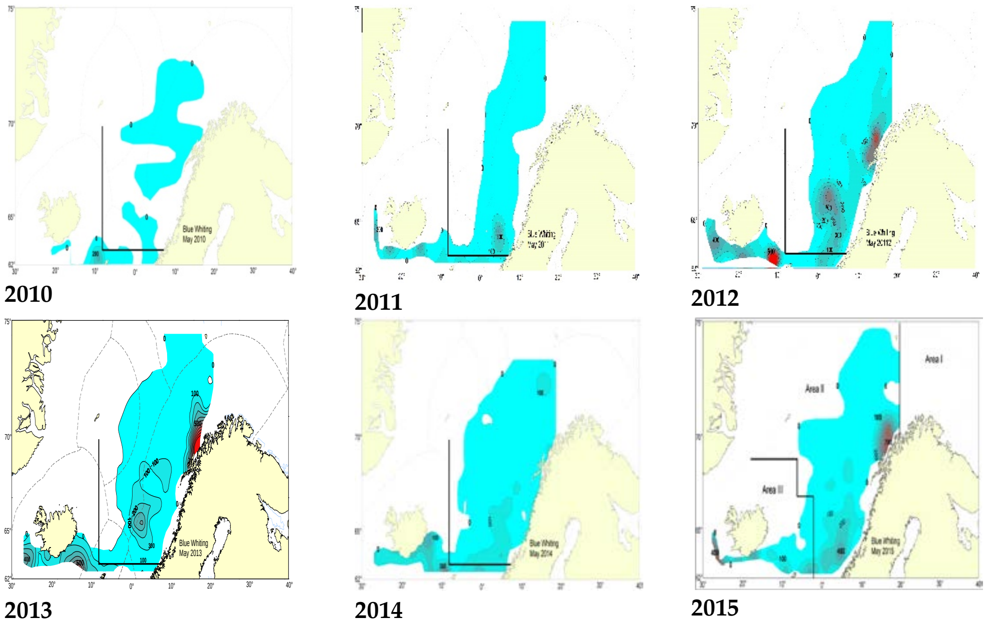


Figure 8.3.4.2.1. Schematic map of blue whiting acoustic density (sA, m2/nm2) found during the International Ecosystem survey in the Nordic Seas in spring 2010—2015.

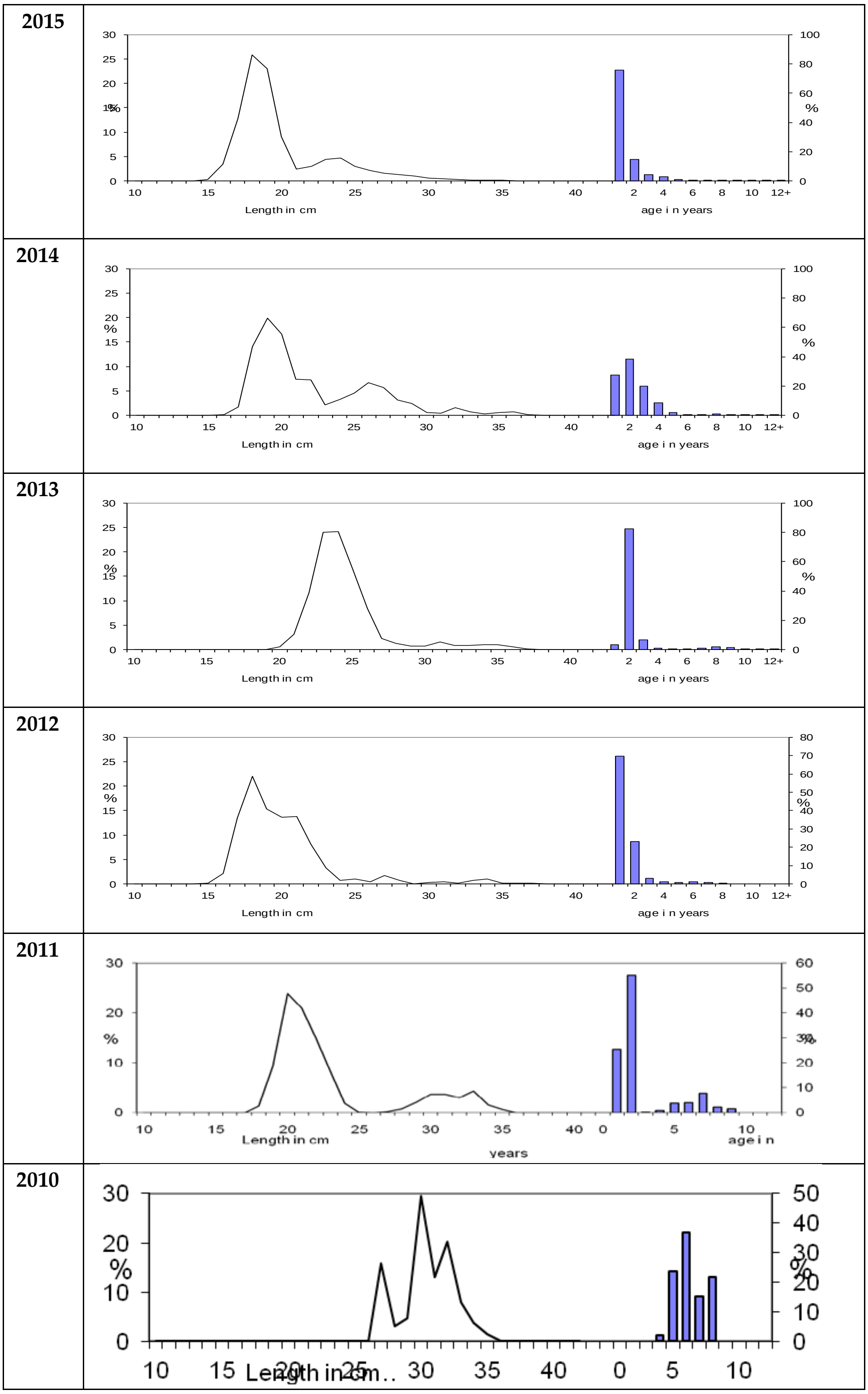


Figure 8.3.4.2.2 Estimated length (line) and age (bar) distributions of blue whiting in the International Ecosystem Survey in the Nordic Seas in May–June for 2010-2015 based on the "standard survey area" between 8°W-20°E and north of 63°N.

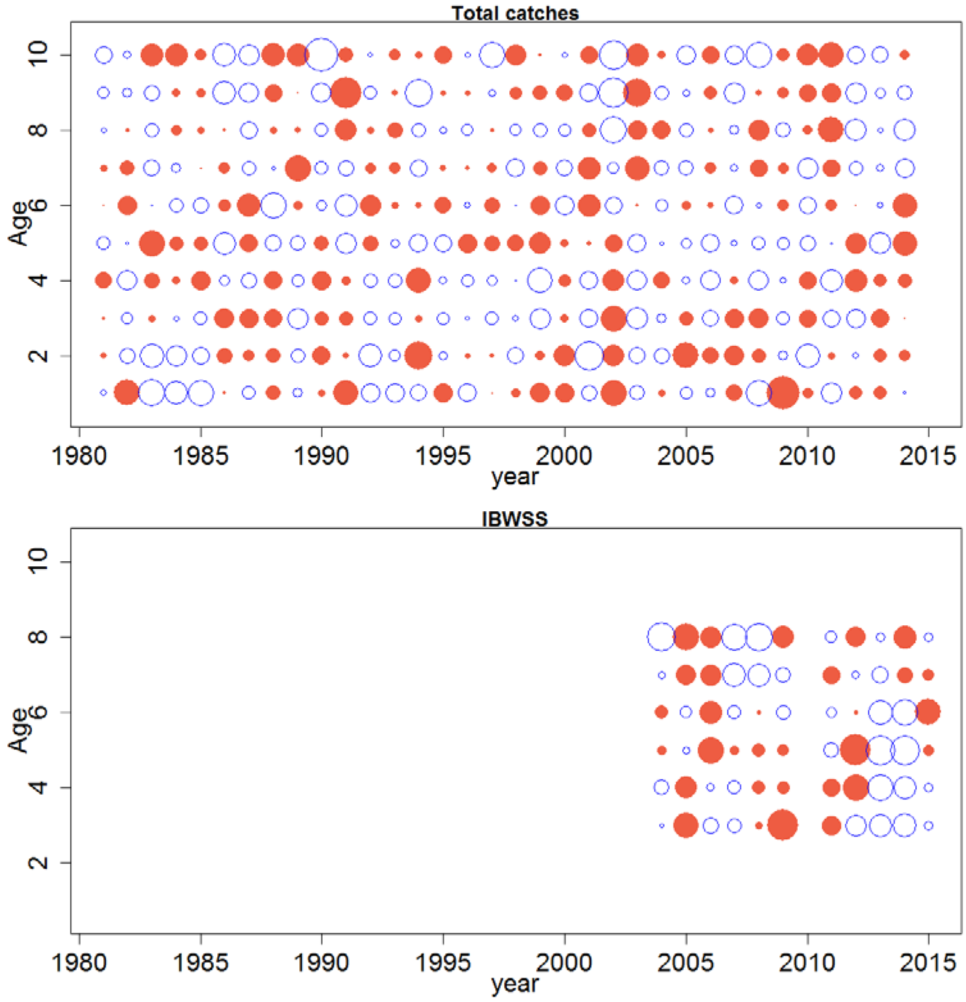


Figure 8.4.1 Blue Whiting. Standardized residuals from catch at age and the IBWSS survey. Red (dark) bubbles show that the observed value is less than the expected value.

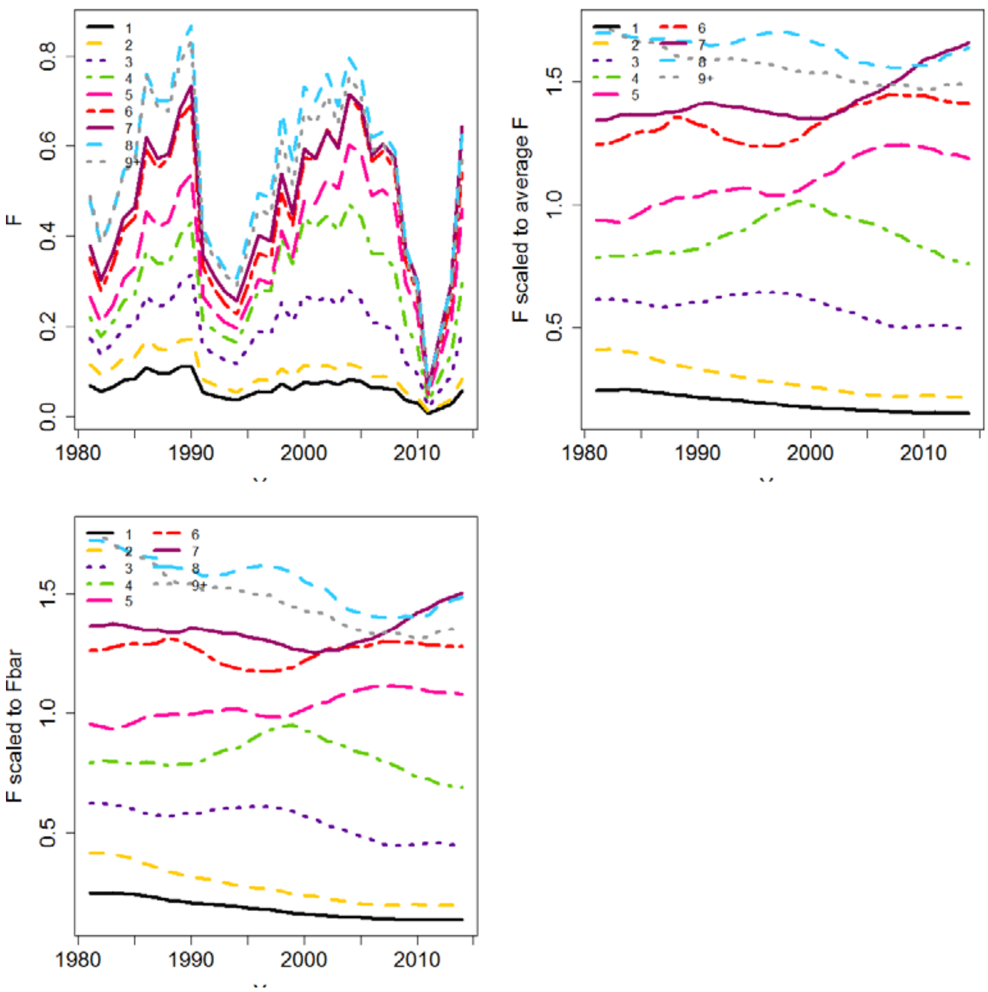


Figure 8.4.2.Blue Whiting. F at age and exploitation pattern (F scaled to mean F all ages, and F scaled to mean F ages 3-7).

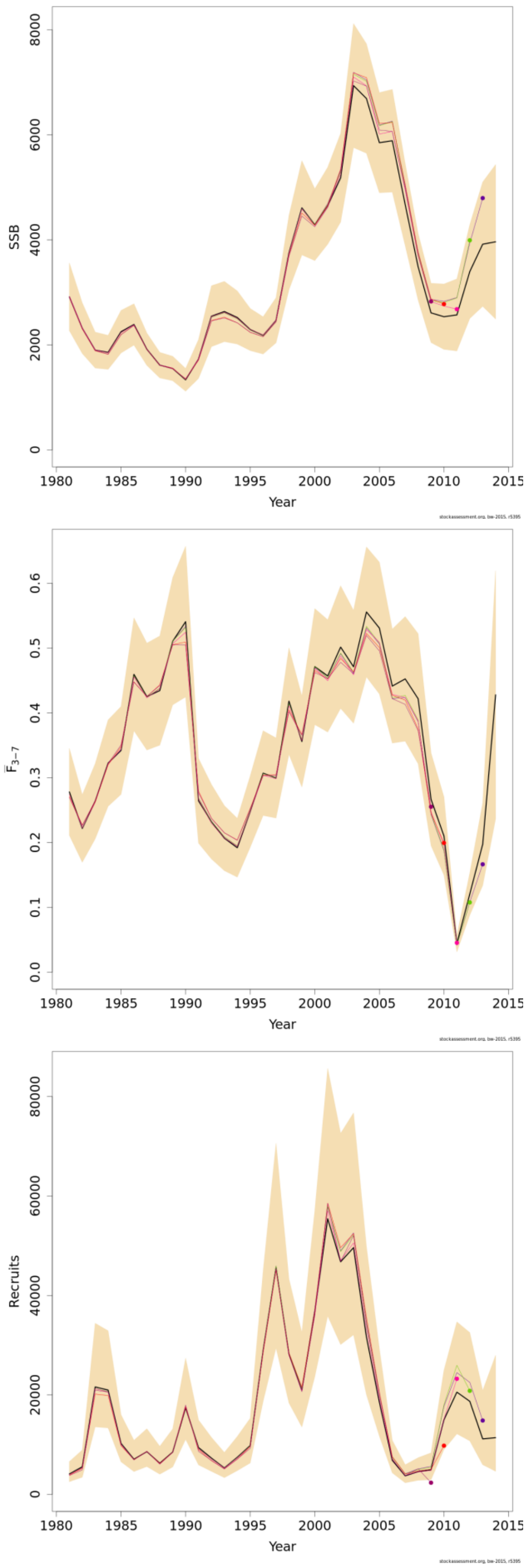


Figure 8.4.3. Blue Whiting. Retrospective analysis of SSB, F and recruitment (age 1) using the SAM model. The 95% confidence interval is shown for the most recent assessment.

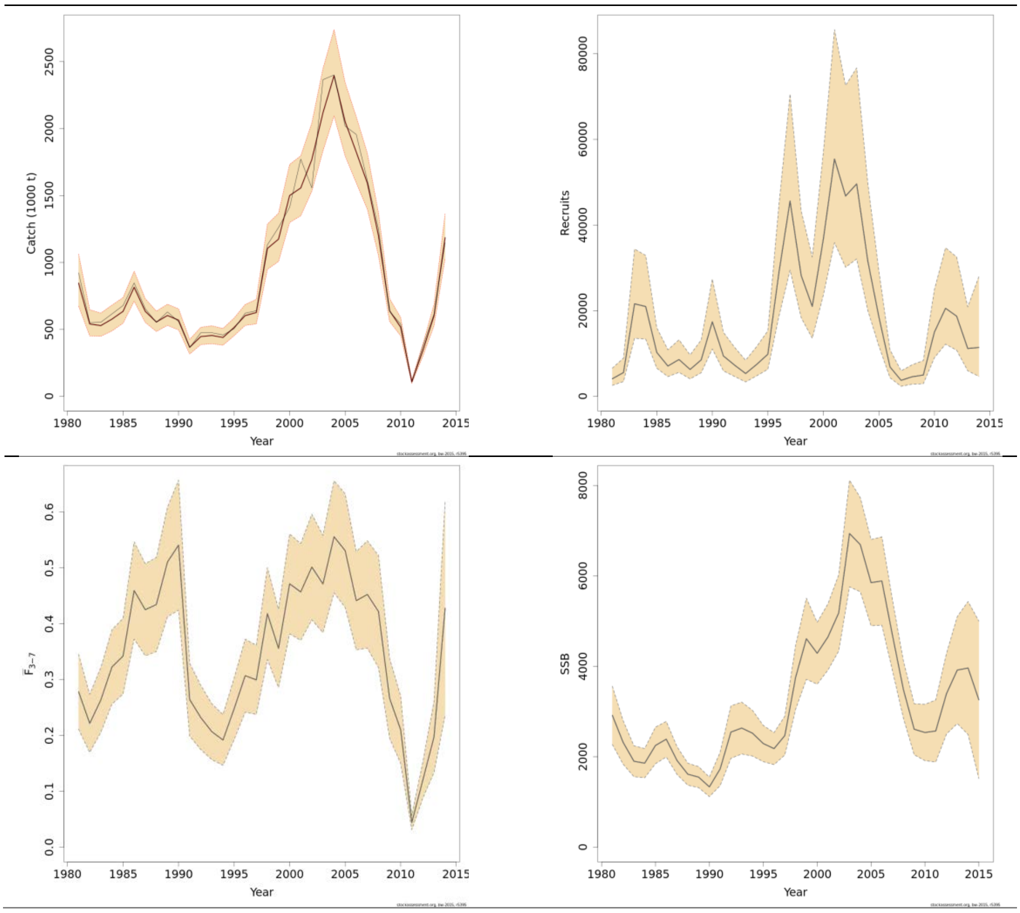


Figure 8.4.4. Blue whiting. SAM final run: Stock summary landings, recruitment (age 1), F and SSB. The graphs show the median value and the 95% confidence interval. The landings plot does also include the observed landings.

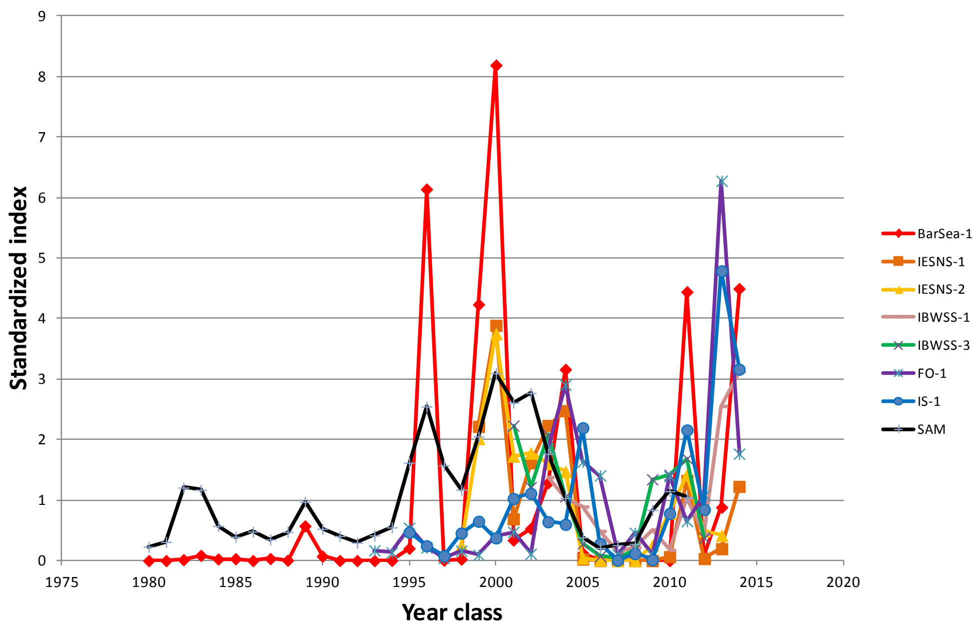


Figure 8.8.1.1. Blue whiting young fish indices from five different surveys and recruitment index from the assessment, standardized by dividing each series by their mean. BarSea - Norwegian bottom trawl survey in the Barents Sea, IESNS: International Ecosystem Survey in the Nordic Seas in May (1 and 2 is the age groups), IBWSS: International Blue Whiting Spawning Stock survey (1 and 3 is the age groups), FO: the Faroese bottom trawl surveys in spring, IS: the Icelandic bottom trawl survey in spring, SAM: recruits from the assessment.

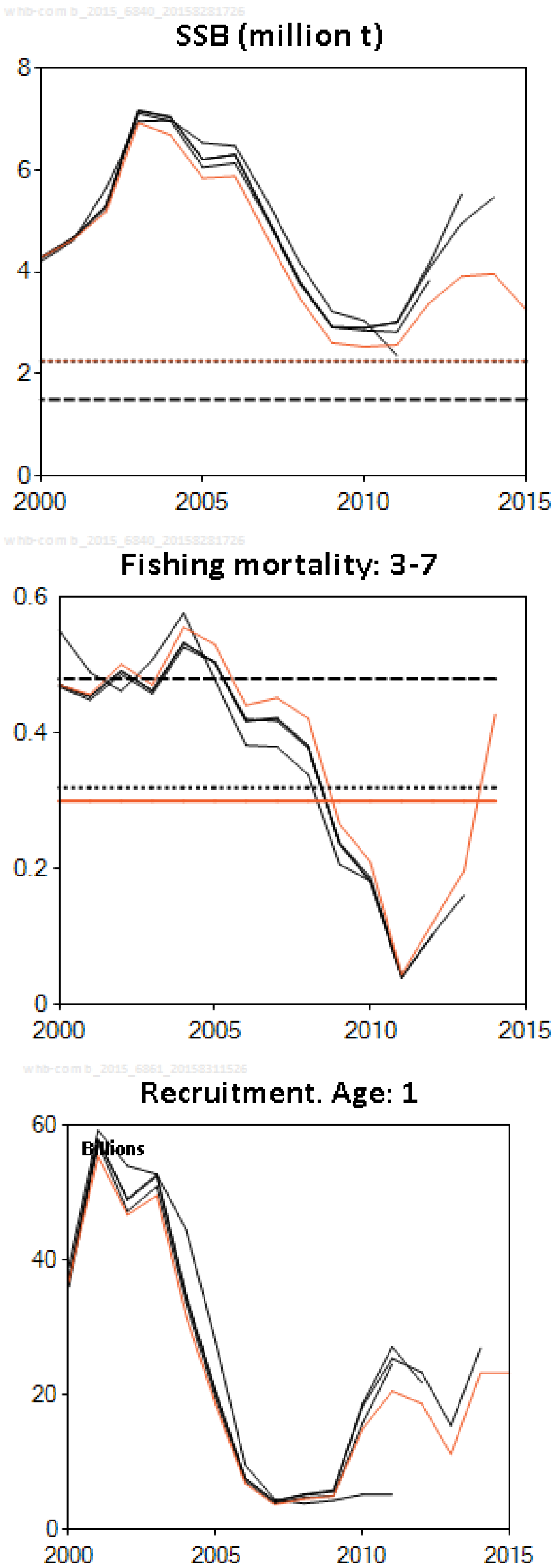


Figure 8.9.1. Blue whiting. Comparison of the 2009 - 2014 assessments results.

9 Red gurnard in the Northeast Atlantic

9.1 General biology

The main biological features known for red gurnard (*Aspitrigla (Chelidonichthys) cuculus*) are described in the stock annex. This species is widely distributed in the Northeast Atlantic from South Norway and North of the British Isles to Mauritania on grounds between 20 and 250 m. This benthic species is abundant in the Channel (VIIde) and on the shelf West of Brittany (VII h, VIII a), living on gravel or coarse sand. In the Channel, the size at first maturity is ~25 cm at 3 years old (Dorel, 1986).

9.2 Stock identity and possible assessments areas

A compilation of datasets from bottom-trawl surveys undertaken within the project 'Atlas of the marine fishes of the northern European shelf' has produced a distribution map of red gurnard. Higher occurrences of red gurnard with patchy distribution have been observed along the Western approaches from the Shetlands Islands to the Celtic Seas and the Channel.

A continuous distribution of fish crossing the Channel and the area West of Brittany does not suggest a separation of the Divisions VIId from VIIe and VIIh. Therefore a split of the population between the Ecoregions does not seem appropriate. Further investigations are needed to progress on stocks boundaries such as morphometric studies, tagging and genetic population studies.

9.3 Management regulations

There is currently no technical measure specifically applied to red gurnard or other gurnard species. The exploitation of red gurnard is submitted to the general regulation in the areas where they are caught. There is no minimum landing size set.

9.4 Fisheries data

Red gurnard is mainly caught as bycatch by demersal trawlers in mixed fisheries, mainly in Divisions IVbc, VIIdj, and VIIIab.

9.4.1 Historical landings

Official landings reported at ICES are available in Table 9.1 and Table 9.2. Before 1977, red gurnard was not specifically reported. Still, gurnards are not always reported by species, but rather as mixed gurnards. This makes interpretations of the records of official landings difficult.

International landings have fluctuated between 3700 tonnes and 5100 tonnes since 2006. France is the main contributor of 'red gurnard' landings. The main area for the landings is ICES Subarea VII. In the North Sea red gurnard is mainly landed from Divisions IVb,c. This year was the first time this stock was included in a datacall, unfortunately this was not completed by all countries involved (Table 9.1).

9.4.2 Discards

French discards data for gurnards have been recorded from at-sea observers within the EU Data Collection Framework. For the French trawlers, the 2010 length compositions of the catch of red gurnard in Divisions VIId and VIIe have been estimated. The discards rate is estimated at 63% and 55% in VIId and VIIe respectively. Estimates of the Dutch discards data for bottom-trawl fisheries in the North Sea and Eastern English indicate very low discards rates, even for the beam trawlers using a smaller mesh size. Spanish discards were provided for 2014 via Intercatch and were almost entirely from demersal otter trawl fleet. As discard information is incomplete it is not possible to interpret these figures.

9.5 Survey data

The time-series of the IBTS-Q1 survey in the North Sea and the French EVHOE-WIBTS-Q4 survey in the Celtic Sea and Bay of Biscay and CGFS-Q4 in Division VIId. Each of these surveys covers a specific area of red gurnard distribution. These have not been updated this year.

• IBTS-Q1 series

Before 1990, red gurnard was scarce in North Sea and the abundance index was close to 0. The appearance of red gurnard in the index in recent years is in line with an increase of the abundance in the northern border of the North Sea (IVa). The length distribution of the IBTS-Q1 catches is bimodal and a substantial part of the catches is > 25 cm.

• CGFS-Q4 series

Over the time-series 1988—2011, the abundance index has fluctuated, peaked in 1994 and has been declining since 2008.

• EVHOE-WIBTS-Q4 series

Over the period 1997—2011, the abundance index in Nb or kg/hr has increased over time. Length measurements show a similar bimodal pattern as is observed in the IBTS-Q1 survey. However, relatively fewer large individuals are observed in the EVHOE-WIBTS-Q4 survey. Age reading of red gurnards caught during EVHOE survey has been carried out in 2006 and routinely since 2008. They indicate that the individuals caught are mainly of age 1 and 2.

9.6 Biological sampling

There was a lack of regular sampling for red gurnard in commercial landings and discarding to provide series of length or age compositions usable for a preliminary analytical assessment.

Since 2003, under EU DCR sampling programme at sea, length data have been collected, in a sporadic way during the first years by observers at sea but more intensively since 2009 when the new DCF came into force.

9.7 Biological parameters and other research

There is no update of growth parameters and available parameters from several authors are summarized in the Stock Annex. They vary widely. Available length–weight relationships are also shown in Stock Annex. Natural mortality has not been estimated in the areas studied at this Working Group.

9.8 Analyses of stock trends

In the North Sea, the appearance of red gurnard in the index of the IBTS Survey since 1990 is in line with an increase of the abundance in IVa. In Eastern Channel, the abundance index of the CGFS-Q4 survey has widely fluctuated, with a weak decline. The EVHOE-WIBTS-Q4 survey has slightly increased since its beginning in the 1990s.

9.9 Data requirements

Still, gurnards are not always reported by species, but rather as mixed gurnards. This makes interpretations of the records of official landings difficult. Indices of red gurnard from UK (Scotland) and Irish surveys in the Celtic Seas Ecoregion should be made available. Extending the studied area by a survey in VIIe and collecting length and age data of red gurnard in the main area of production should help in better understanding the biology and dynamics of this species in the area.

9.10 References

Dorel, D. 1986. Poissons de l'Atlantique nord-est relations taille-poids. Institut Francais de Recherche pour l'Exploitation de la Mer. Nantes, France. 165 p.

Table 9.1 Red gurnard in the Northeast Atlantic official landings by country in tonnes

Year	Belgium	Spain	France	Guernsey	Ireland	IM	Netherlands	Portugal	UK	Total
2006	313	0	4551	10	0	0	57	125	115	5171
2007	327	0	4495	0	0	0	66	127	156	5171
2008	353	0	4045	0	0	0	92	112	166	4768
2009	227	0	3307	0	0	1	160	150	262	4107
2010	238	0	3426	2	0	0	251	115	363	4395
2011	306	0	3169	3	0	1	295	135	256	4165
2012	305	0	2697	4	25	0	329	148	257	3765
2013	287	576	3152	6	15	2	267	112	329	4746
2014*	261	398	3765	5	3	5	241	101	279	5058
2014**		596	1007				2	216	0	1821

***Preliminary Data, **Intercatch Data**

Table 9.2 Red gurnard in the Northeast Atlantic official landings by area in tonnes

Year	IVa	IVb	IVc	IXa	IXnk	Vb	VIa	VIb	VIIa	VIIb	VIIc	VIId	VIIe	VIIf	VIIg	VIIh	VIIIa	VIIIb	VIIIc	VIIId	VIIj	VIInk	Xa	XIVa	Xnk	Total
2006	13	83	64	9	115	0	32	1	10	9	12	1102	2803	230	16	446	153	60	1	5	5	1	0	0	1	5171
2007	12	120	55	125	0	2	21	0	7	7	15	1229	2670	247	15	437	139	59	3	2	4	0	0	0	2	5171
2008	34	63	55	109	0	0	28	3	5	7	16	1236	2443	249	9	408	66	25	3	1	5	0	3	0	0	4768
2009	58	58	92	148	0	0	95	2	4	7	6	1292	1550	112	23	510	98	40	1	3	7	0	1	0	0	4107
2010	79	63	86	114	0	0	101	46	14	8	10	1531	1609	132	23	433	100	34	0	2	9	0	0	0	1	4395
2011	66	29	52	133	0	0	69	54	13	5	6	1295	1753	124	20	372	112	46	2	3	9	0	1	1	0	4165
2012	83	71	79	136	4	0	51	7	7	2	5	1245	1438	145	53	293	83	50	8	1	2	0	1	1	0	3765
2013	88	108	60	154	0	0	47	0	9	2	6	1193	1687	169	58	477	79	72	532	1	2	0	2	0	0	4746
2014*	102	51	65	132		0	47	3	8	1	2	1289	1627	115	21	1069	82	75	363	3	1		2	0		5058
2014**	102	9		126			47	3									3	15	206	0	0					510

10 Striped red mullet in Subareas and Divisions VI, VIIa–c, e–k, VIII, and IXa

10.1 General biology

Striped red mullet (*Mullus surmuletus*) is a benthic fish found along the European coasts from southern Norway and the Faroe Islands in the North, to the Strait of Gibraltar in the South (Davis and Edward, 1988; Gibson and Robb, 1997). The species is also found in the northern part of western Africa and in the Mediterranean and Black Seas (Quéro and Vayne, 1997).

Analysis of British commercial landings revealed a strong concentration of this species in the central pit of the western Channel during winter (Dunn, 1999). The CGFS (Channel Ground Fish Survey) in the eastern English Channel showed that young individuals are distributed in coastal areas, while adults exhibit preferentially an offshore distribution in the eastern part (Carpentier *et al.*, 2009).

Nurseries are located in the Bay of Saint-Brieuc and at the Falklands coasts (Morizur *et al.*, 1996). Striped red mullet is accommodated to deep water and elevated temperatures (ICES, 2007b), and tolerates weak and high salinity (corresponding respectively to juvenile and adult habitats) and is rarely found in the transitions zones of intermediate salinity. This species is found mostly on sandy substrata (Carpentier *et al.*, 2009). Food of striped red mullet is primarily composed of crustaceans and molluscs.

In the English Channel, sexual maturity was identified on fish of 16.2 cm for males and 16.7 cm for females (Mahé *et al.*, 2005).

10.2 Management regulations

Before 2002, a minimum landing size was set at 16 cm in France. Since this minimal size requirement has been removed, it resulted in catch of immature individuals (< 14 cm), which has recently been targeted and landed. There is no TAC for this stock.

10.3 Stock ID and possible management areas

In 2004 and 2005, a study using fish geometrical morphometry was carried out in the Eastern English Channel and the Bay of Biscay. It pointed out a morphological difference on striped red mullets between those from the Eastern English Channel and those from the Bay of Biscay.

Benzinou *et al.* (2013) suggest that the population of striped red mullet can be geographically divided in three zones:

- The Bay of Biscay (NBB + SBB)
- A mixing zone composed of the Celtic Sea and the Western English Channel (CS + WEC)
- A northern zone composed of the Eastern English Channel and the North Sea (EEC + NS)

10.4 Fisheries data

Official landings have been recorded since 1975 and after early increases they have declined in recent years. Landings are mainly taken from Subarea VII and VIII and France accounts for the majority of removals (Table 10.1). The striped red mullet is a target species for this country and is mainly caught by bottom trawlers with a mesh size of 70—99 mm. In the Western English Channel striped red mullet is also caught by gillnets. The north of the Bay of Biscay (VIIIa,b) is exploited by France and Spain.

The south (VIIIc) is only exploited by Spain. The trawlers in the striped red mullet fishery have a length and a power respectively of about 20 meters and 400 kilowatts. In 2014 this species was not recorded as being discarded by French vessels or Portuguese vessels and was infrequent in Spanish sampling. In contrast UK discarding was found to have increased to 13% of catch in 2014 (Table 10.3).

10.5 Survey data, recruit series

Since 1988, striped red mullet abundance indices are available for the Bay of Biscay and the Celtic sea (EVHOE survey). There are few peaks of abundance of striped red mullet in Celtic sea and the Bay of Biscay (EVHOE-WIBTS Q4) and the Eastern English Channel (UK-WCBTS Survey). During EVHOE-WIBTS-Q4 Survey, 2001, 2003, 2005 and 2009 present peaks of abundance of striped red mullet (from 16 to 23 per hour, Figure 5.6). Abundance indices per size class during EVHOE-WIBTS-Q4 show mainly fish between 8 and 17 cm (TL). In consequently, the abundance of this survey gives recruitment index. UK-WCBTS survey in the Eastern English Channel.

Since 1979, the PGFS (Portuguese Autumn Groundfish Survey) covers the whole Portuguese continental coast, within depths ranging from 20 to 500 m. The PCTS (Portuguese Crustacean Trawl Survey) covers the South-western and the Southern regions of the Portuguese continental coast, with depths ranging from 200 to 750 m. Data from these surveys shows that striped red mullet distributes along the Portuguese coast, at depths ranging between 20 and 700 m deep. Some investigations on potential distribution of this species should be carried out in the Spanish coasts between the Portuguese coasts and the Bay of Biscay.

10.6 Biological sampling

In the Bay of Biscay sexual maturity and length measures were taken in 2009 by AZTI. French samplings started in 2004 in the Eastern Channel and in the south North Sea, and since 2008 in the Bay of Biscay.

10.7 Biological parameters and other research

Since 2004, data (age, length, sexual maturity) are usually collected by France for the Eastern English Channel and the southern North Sea. France started to collect data for VIIIa,b at the end of 2007. In 2007—2008, the striped red mullet otolith exchange had for goal to optimize age estimation between countries .

In 2011, an Otolith Exchange Scheme has been realized, which was the second exercise for the Striped red mullet (*Mullus surmuletus*). Four readers of this exchange interpreted an images collection coming from the Bay of Biscay, the Spanish coasts and the Mediterranean coasts (Spain and Italy). A set of *Mullus surmuletus* otoliths (N=75) from the Bay of Biscay presented highest percentage of agreement (82%). On 75 otoliths, 34 were read with 100% agreement (45%) and thus a CV of 0%. Modal age of these fishes was comprised between 0 and 3 years (Mahé *et al*., 2012).

10.8 Analysis of stock trends/ assessment

Currently, age structured analytical stock assessment is not possible due to a too short time-series of available data.

10.9 Data requirements

Regular sampling of biological parameters of striped red mullet catches must be continued under DCF. Sampling in the Celtic Sea and in the Bay of Biscay started in 2008. In 2010 and 2011, sampling for age and maturity data was reduced compared to 2009, due to the end of the Nespman project. Since 2009, a concurrent sampling design carried out, should provide more data (length compositions) than in recent years.

10.10 References

Carpentier, A. Martin, CS. Vaz, S. (Eds.) 2009. Channel Habitat Atlas for marine Resource Management, final report / Atlas des habitats des ressources marines de la Manche orientale, rapport final (CHARM phase II). INTERREG 3a Programme, Ifremer, Boulogne-sur-mer, France. 626 pp. and CD-rom.

Benzinou, A. Carbini, S. Nasreddine, K. Elleboode, R. Mahé, K. 2013. Discriminating stocks of striped red mullet (*Mullus surmuletus*) in the Northwest European seas using three automatic shape classification methods. Fisheries Research 143 (2013) 153–160.

Davis, P.S. and Edward, A.J. 1988. New records of fishes from the northeast coast of England, with notes on the rediscovery of part of the type collection of marine fishes from the Dove Marine Laboratory, Cullercoats. Trans. Nat. Hist. Soc. Northumbria, 55 : 39–46.

Dunn, M.R. 1999. The exploitation of selected non-quota species in the English Channel. Lowestoft: 323pp.

Gibson, R.N. and Robb, L. 1997. Occurrence of juvenile red mullet (*Mullus surmuletus*) on the west coast of Scotland. Journal of the Marine Biological Association of the United King-dom, 77(3): 911–912.

ICES. 2007b. Report of the Working Group on Fish Ecology (WGFE), 5–9 March 2007, Nantes, France. ICES CM 2007/LRC:03. 217 pp.

Mahé, K. Destombes, A. Coppin, F. Koubbi, P. Vaz, S. Leroy, D. and Carpentier, A. 2005. Le rouget barbet de roche *Mullus surmuletus* (L. 1758) en Manche orientale et mer du Nord, 186pp.

Mahé, K. Elleboode, R. Charilaou, C. Ligas, A. Carbonara, P. and Intini, S. 2012. Red mullet (*Mullus surmuletus*) and striped red mullet (*M. barbatus*) otolith and scale exchange 2011, 30pp.

Morizur, Y. Pouvreau, S. and Guenole, A. 1996. Les rejets dans la pêche artisanale française de Manche occidentale. Editions IFREMER, Brest, 127p.

Quéro, J.C. and Vayne, J.J. 1997. Les poissons de mer des pêches françaises. Ifremer, Ed. Delachaux and Niestlé, 304pp.

Table 10.1 Striped red mullet in Subareas and Divisions VI, VIIa–c, e–k, VIII, and IXa official landings by country in tonnes

Year	Belgium	Spain	France	Guernsey	Ireland	Netherlands	Portugal	UK	Total
2006	32	379	1936	8	15	115	11	170	2666
2007	42	391	1926	9	16	148	222	193	2947
2008	26	379	1385	8	16	165	169	164	2312
2009	19	491	1541	5	9	110	199	131	2505
2010	20	466	1726	0	4	128	276	132	2752
2011	21	505	1722	0	5	130	244	154	2781
2012	37	327	1317	0	4	125	217	122	2149
2013	29	245	925	5	3	50	187	70	1514
2014*	12	203	911	5	2	1	214	53	1401
2014**		596	1007			2	216	0	1821

*** Preliminary Data**

**** Intercatch Data**

Table 10.2 Striped red mullet in Subareas and Divisions VI, VIIa–c, e–k, VIII, and IXa official landings by area in tonnes

Year	VIa	VIb	VIIa	VIIb	VIIc	VIIe	VIIf	VIIg	VIIh	VIIj	VIIk	VIIIa	VIIIb	VIIIc	VIIId	VIIIe	IXa	Total
2006	0	0	0	1	0	868	50	24	103	6	0	1022	468	71	14	0	39	2666
2007	1	0	1	1	0	1045	53	22	104	12	0	860	474	90	17	0	267	2947
2008	0	0	0	1	0	879	46	15	72	13	0	639	246	87	18	0	296	2312
2009	2	0	0	2	1	592	26	8	73	18	0	879	460	156	45	0	243	2505
2010	2	0	1	3	1	637	25	11	59	16	1	1033	468	146	18	0	331	2752
2011	1	1	0	0	0	665	19	10	56	5	0	970	513	214	18	0	309	2781
2012	0	0	0	0	0	493	24	6	34	4	0	696	387	199	26	0	280	2149
2013	0	0	0	1	0	232	23	7	37	2	0	472	328	165	6	0	241	1514
2014*	1	0	0	0	190	15	2	40	1	0	524	238	125	0	11	0	254	1401
2014**	0		0	0	0	180	5	1	35	1	0	543	364	269	13	0	409	1821

*** Preliminary Data**

**** Intercatch Data**

Table 10.3 Striped red mullet in Subareas and Divisions VI, VIIa–c, e–k, VIII, and IXa discards by country in 2012-201

Country	2012	2013	2014	Total
ES			3.7	3.7
PT	0.0	0.0	0.0	0.0
UK	2.0	1.3	4.9	8.1
Total	2.0	1.3	8.6	11.8

11 Recommendations

11.1 Blue whiting

11.1.1 Concerning age reading validation and calibration exercises

Recipient: WGBIOP

It is recommended to have regular exchanges and workshops in order to improve the agreement among age readers.

11.1.2 Concerning stock structure

Recipient: SIMWG, WGBIOP

The working group recommends that during the next "International Age Reading Workshop for Blue Whiting", otoliths from the whole distribution area of this stock should be collected to perform shape analysis, aiming to clarify the blue whiting stock structure composition.

11.2 Norwegian spring spawning herring

11.2.1 Concerning age reading

Recipient: WGBIOP

During the post-cruise meeting after the 2015 IESNS survey (also known as the "May survey"), age distributions of NSS herring from trawl samples from the different participating countries were compared. These age distributions were quite different, even for samples taken in the same area and time period.

The technical problems with age readings of NSS herring during the May survey may be split into two: **(1) The problem with deciding whether the herring in May has added extra growth in the otoliths or scales:** If the age readers decides there is extra growth added during the present year, they decide not to count the edge of the scales and otoliths as a winter ring. Opposite, if they do decide that there is no growth yet (during the present year), they decide to count the edge as a winter ring, thereby adding one more year. As a general rule it is very seldom that NSS herring has added growth in the otoliths in May. Norwegian age readers that follow the NSS herring with age reading all over the year, see this more clearly than readers not reading age of the herring in the months prior to the May survey. Norwegian readers therefore normally count the edge. However, non-Norwegian readers have a tendency to interpret that growth is added more often and therefore do not count the edge. Typically this may lead to transfer of fish from a large year class like 2004 and down to a smaller year class like 2005. The problem will increase as a year class gets older, and growth ceases. The older they get, the closer is the distance between the winter rings, and the more difficult it is to decide if there is growth added to scales and otoliths already in May. **(2) The general problem with reduced quality of scales, and difficulties of aging old fish using otoliths.** Norwegian age readers claim that scales sampled in May are easier to read than otoliths for older NSS herring. However, in May it is difficult to get nice scales from herring samples, they are often 'washed off' during the trawling process. This even makes it more difficult to read the age, and decide to count the edge or not. Hence, sometimes otoliths have to be used, which are even more difficult to read than scales.

In conclusion, an age reading workshop involving technicians from the countries participating in the IESNS (May) survey should be held before the next survey in May 2016.

11.3 NEA Mackerel

11.3.1 Concerning stock structure

Recipient: SIMWG

The management measures in place in the North Sea to protect the North Sea component of NEA mackerel have been agreed a long time ago. The traditional explanation of the decline of the North Sea spawning component has been to point to the overexploitation, which has led to recruitment failure since 1969. A recent scientific paper (Jansen, 2014) has shown that this narrative may require revision, as it could be the combination of high fishing pressure, followed by decreasing temperatures that led to reduced spawning migration into the North Sea. So rather than a local stock collapse, this could also be constituted as a southwest shift in spawning distribution.

In addition, very little information is provided in the WG files on the catches of mackerel from different components. There appear to be no biological techniques available to separate the catches of the North Sea and the Western spawning components of mackerel. However, as a minimum, the catches should be reported according to the areas where the North Sea component is thought to exist, i.e. in subareas IVb and IVc during the whole year, and in subarea IVa from 15 February to 1 September.

The group recommends to include in the future benchmark for mackerel (2017), 1) a thorough review of all available knowledge on the North Sea spawning component and to evaluate whether the current protection measures would need to stay in place, and 2) a exploration of the potential techniques to split up catches in the North Sea into the different spawning components.

11.4 IESSNS survey

11.4.1 Concerning IESSNS coverage of NSS herring and blue whiting

Recipient: WGIPS

The International Ecosystem Survey in Nordic Seas and adjacent waters in July-August (IESSNS) is an expansion of the Norwegian Sea summer survey (Stock Annex), however the coverage and main focus has changed. In the latest years, mackerel has been the main target of the survey, but the survey gives useful information of the blue whiting and NSS herring stocks in this period. This survey started in 2009.

The working group discussed the necessity of having more than one survey giving information to the blue whiting assessment and a subgroup of members from IESSNS participating countries decided that the survey from 2016 also should include blue whiting as target species. It may also be valuable to the NSS herring assessment to use information from IESSNS survey, and WGWIDE recommends to include NSS herring as target species from 2016.

11.5 Discards

11.5.1 Concerning observer programmes

Recipient: ACOM

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.

11.6 WGWIDE – timing of meeting

Recipient: ACOM

WGWIDE has quite a big problem with very tight schedule, as many of the surveys used for assessments of our stocks only finish shortly before the meeting. For example, this year we only got the final index from the IESSNS survey for the NEA mackerel assessment on the second day of the meeting - this means that the stock assessor has no possibility to assess possible problems before we are long into the meeting. Also, precious meeting time was used for the survey group finalizing the index.

The working group recommends that the meeting be postponed with 2 weeks, this would already make the situation much better.

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Annex 02 Stock Annexes

The table below provides an overview of the WGWIDE Stock Annexes. Stock Annexes for other stocks are available on the ICES website Library under the Publication Type "Stock Annexes". Use the search facility to find a particular Stock Annex, refining your search in the left-hand column to include the *year*, *ecoregion*, *species,* and *acronym* of the relevant ICES expert group.

Stock ID	Stock name	Last updated	Link
boc-nea_SA	Northeast Atlantic Boarfish (Subareas IV,V, VI, VII, VIII)	September 2014	boc-nea_SA.pdf
gur-comb_SA	Red Gurnard (*Aspitrigla cuculus*) in the Northeast Atlantic	March 2012	gur-comb_SA.pdf
her-noss_SA	Norwegian Spring Spawning Herring (*Clupea harengus*) in the Northeast Atlantic	November 2013	her-noss_SA.pdf
hom-west_SA	Western Horse Mackerel (Divisions IIa, IIIa-west, IVa, Vb, VIa, VIIa-c, VIIe-k, VIIIa-e)	August 2011	hom-west_SA.pdf
mac-nea_SA	Mackerel (*Scomber scombrus*) in the Northeast Atlantic	September 2015	mac-nea_SA.pdf
whb-comb_SA	Blue Whiting (Subareas I-IX, XII and XIV)	February 2012	whb-comb_SA.pdf

Annex 03 Assessment Audits

Audit of Norwegian Spring Spawning Herring

Date: 9. September 2015

Auditor: Leif Nøttestad

General

- This is an updated assessment; and is consistent with the NSS-herring assessment from last year. A new updated index from the NSS-herring spawning survey was included as input to this year's assessment.
- No apparent changes in the assessment or in the forecast methodology.
- Challenges in understanding and explaining the rather large changes (scaling issue) in the retrospective pattern and revisions leading to a down-scaling of Spawning Stock Biomass (SSB) and up-scaling Fishing mortality (F), from one year to the next in recent years.
- New benchmark in February 2016.

For single stock summary sheet advice:

1) **Assessment type:** update – was last benchmarked in 2008
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: TASACS model, including altogether eight survey series. Nevertheless, there is presently only one major survey series left as the driving input time series to the assessment model, namely the International Ecosystem Survey in the Norwegian Sea (IESNS) in May-June each year. The model was run with catch data spanning from 1988 to 2014, and projected forwards through 2015.
5) **Data issues:** All data specified in the stock annex were available and have been used in the assessment.
6) **Consistency**: This is a category 1 stock. A relatively strong retrospective pattern has been observed in the NSS-herring assessment the last five years since the assessment year 2010. The strong retrospective pattern in the NSS-herring assessment is a matter of concern for this important fish stock, which need to be dealt with in more detail during the upcoming benchmark.
7) The revisions of the assessment compared to the 2014 assessment were slightly positive with +10% (SSB 2014), -6% (F 2013) and -34% (Recruit 2014).
8) **Stock status**: The stock has been on a significant decline for some time already. SSB 2013 is estimated at Bpa, SSB 2014 and 2015 are estimated below Bpa (but above Blim). Fishing mortality is appropriate for both the MSY and PA approach. There have not been any strong year classes for more than a decade (since 2004), although the 2009 and 2013 year classes may have contributed to a moderate extent in rebuilding of the stock.
9) **Management Plan**: The long-term management plan of Norwegian spring spawning herring (NSSH) was re-evaluated in 2013. The plan aims for exploi-

tation at a target fishing mortality below Fpa and is considered by ICES in accordance with the precautionary approach. However, since 2013 there has been a lack of agreement by the Coastal States on their share in the TAC, leading to higher catches than the TAC indicated by the management plan.

10) **General comments**

The assessment is well documented and structured. The substantial changes in the retrospective pattern during the period 2010-2015 could be presented more clearly, even though it may be difficult at this stage to scientifically explain why this is happening. Hopefully, the benchmark in 2016 will shed more clarity on this important issue related to the assessment of Norwegian spring-spawning herring.

Technical comments

The assessment and forecast are done according to the stock annex, although model diagnostics and aspects related to the model fit may have been more clearly presented and evaluated.

Conclusions

The assessment on Norwegian spring-spawning herring (NSSH) and the short term forecast on Norwegian spring-spawning herring (NSSH) have been performed correctly.

Audit of Red Gurnard

Date: 9. September 2015

Auditor: Kjell Rong Utne, Eneko Bachiller

For single stock summary sheet advice:

1) **Assessment type: NA**
2) **Assessment**: Not presented
3) **Forecast**: Not presented
4) **Assessment model**: NA
5) **Data issues:** There are 3 different timeseries availble, IBTS-Q1, CGFS-Q4 and EVHOE-WIBTS-Q4. Data on total landings are partly available
6) **Consistency**: NA
7) **Stock status**: Highly uncertain.
8) **Man. Plan.**: NA

General comments

There is currently no technical measure specifically applied to red gurnard. The exploitation of red gurnard is submitted to the general regulation in the areas where they are caught. There is no minimum landing size defined.

There is no assessment of red gurnard. There are fishery independent information available, but information about total landings, the age composition in the catches and discards are partly lacking (e.g. gurnards are not always reported by species but as mixed gurnards) and hence highly uncertain.

Technical comments

NA

Conclusions

No assessment is provided.

Audit of Northeast Atlantic Mackerel

Date: 9 September 2015

Auditor: Are Salthaug and Kjell Rong Utne

General

The stock assessment for NEA mackerel in 2015 has been done according to the stock annex, with a small exception. The assessment for NEA mackerel was last benchmarked in February 2014. All inputs to the assessment were as described in the stock annex.

For single stock summary sheet advice:

1) **Assessment type: update –** was benchmarked February 2014
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: state-space assessment model (SAM). Tuning: 3 surveys (SSB from Triennial Egg Survey, IBTS recruitment abundance index (log transformed) and IESSNS abundance index) and Tagging/Recapture data from Norwegian tagging program.
5) **Data issues:** All data described in the stock annex were available for this year's assessment of NEA mackerel. There have been a revision of the historic values for both the recruitment index and the egg survey index prior to this year's assessment.
6) **Consistency**: There is a significant change in the assessment compared to last year. The estimated SSB for 2014 was downscaled There are several reasons for the changes, mainly due to revised recruitment index and egg survey index as well as one more year with data from IESSNS.
7) **Stock status**: SSB at spawning time in 2015 was 3.6 mio tonnes, which is above Bpa. The stock has been large for several years, but is now estimated to decline. $Fbar_{4\text{-}8}$ (0.34) is above Fpa . Recruitment has shown an increasing trend since the late 1990s and 2014 is estimated to be strong.
8) **Man. Plan.**: A management plan is not in place.
9) **General comments**

The NEA mackerel section is well structured and easy to follow. The assessment procedure has been described in sufficient detail.

Technical comments

The assessment and forecast are generally done according to the stock annex. However, a deviation from the model settings described in the stock annex had to be implemented in order to improve to model fit: a Ricker stock-recruitment model is now used while the recruitment before (as described in the stock annex) was modeled as a random walk process. This is well documented in the report.

Conclusions

The assessment and forecast have been performed correctly according to the stock annex.

Audit of Blue whiting

Date: 9 September 2015

Auditor: Eydna í Homrum

Audience to write for: ADGWIDE, ACOM, WGWIDE

General

The blue whiting assessment was benchmarked in 2012. The 2015 assessment has been in accordance with the 2012 benchmark. All input to the assessment was as described in the stock annex.

For single stock summary sheet advice:

1) **Assessment type: update** – was benchmarked in 2012
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: state-spaced assessment model (SAM). Tuning: International Spawning stock Survey (IBWSS)
5) **Data issues:** all data described in stock annex were available to the assessment. There were issues with the last point in the tuning series (much lower acoustic abundance estimates than last year – and few adult fish in trawl catches). It was, however, decided to use the datapoint, because 'there seems to be no clear justification for exclusion of the 2015 IBWSS data'. Discards for Denmark, Netherlands and UK were not included by mistake – however, these were insignificant in relation to landings (195 of 1155279 tonnes).
6) **Consistency**: Last year the assessment was accepted.
7) **Stock status**: B>Blim – also the lower uncertainty limit. Flim<F<Fpa. Recruitment 2010-2013 high compared to 2007-2009 (lowest 3 years on a row on record)
8) **Man. Plan.**: No agreed management plan.

General comments

The blue whiting section is well written and easy to follow. Tables and Figures are chronological and easy to find.

However, perhaps the stock annex could be written a bit more in depth – e.g. describing the input data (for example it was not easy to find what was used as West). Also, parts of the stock annex are outdated, e.g. in 2014 it was decided to use deterministic forecast instead of stochastic.

Technical comments

The assessment has been done according to the stock annex. (With the exception that the stock annex has not been updated to the change from 2014 to use deterministic forecast.)

Conclusions

The assessment has been performed correctly.

Audit of Western Horsre Mackerel

Date: 9 September 2015

Auditor: Pablo Carrera, Cormac Nolan

General

Full assessment, following the stock annex

For single stock summary sheet advice:

1) **Assessment type: Update**
2) **Assessment**: analytical
3) **Forecast**: presented
4) **Assessment model**: SAD (linked Separable-ADAPT VPA), Tuning: SSB from Triennial Egg Survey; last survey carried out in 2013. SAD: 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.
5) **Data issues:** The following issues are identified:
    - 7 335 t were omitted from the assessment due to a late amendment to the catch data
    - Maturity ogive, although the triennial egg surveys, is the same since 1998.
    - Mean weight at age is based on mature fish caught in VIIj,k. However acoustic surveys are performed during the same period in the Bay of Biscay covering VIIIa-c. For 2014, data were poor, and not available for age group 3.
    - Catch data only included discard from 2014, although several countries are reported. Nevertheless are assumed to be low, representing less than 2% of the total catch.
    - Triennial Egg Survey only covers the full stock distribution since 1992.
6) **Consistency**: The assessment is consistent with previous years (MSY approach since 2012). However, due to the separable constraint, retrospective analysis gave contradictory patterns.
7) **Stock status**: The SSB shows a declining trend, now approaching Btrigger; F relatively stable for the last five years, just below Fmsy; no strong year class has been estimated since 2001. However, there are some signs of improved recruitment in the last year but more data is required.
8) **Man. Plan.**: Originally proposed by Pelagic AC in 2007; based on the trend in egg production. Upon evaluation in 2013, ICES considered the plan not to be precautionary. However, the request was not fully addressed therefore certain aspects are currently being revisited. Progress to date is presented. In short: "in all scenarios, the risk to Blim remains above 5% for around 30 years. This happens even though the expected fishing mortality is very low (below half of Fmsy). Given these results, it has not been possible, yet, to select a viable strategy for management for the coming years."

General comments

The Western Horse Mackerel section is well structured and easy to follow. The assessment procedure has been described in sufficient detail, highlighting the most important issues and uncertainties.

It is stated in the text (section 5.5) that 'fishery-independent data for this stock is extremely limited'. New work on a combined IBTS index using GLM modelling was presented during the EG meeting. It would be beneficial if this work was further explored in this section.

Technical comments

Section 5

Tables 5.1.1.1 to 5.1.1.5. should specify whether the catches belongs to the Western horse mackerel stock.

In subsection 5.2, a consistency in the definitions TAEP (total annual egg production) vs egg production would clarify the text; this is also extensive to tables and figues.

Table 5.2.4.1. VIIIc is split into "west" and "east" but there is an additional column for VIIIc with some data; this should be better explained.

Table 5.2.4.1 and 5.2.4.2. should unify units ('000 or thousands of fish, but not both)

Text for section 5.1.2. concerning discard estimates. There is a discrepancy between the text of the stock annex and the information provided in this section; neither the number of countries, nor the amount of discard match. A better explanation should be required.

Some clarification may be needed regarding the management plan evaluation. Section 5.7.2 states 'Upon evaluation in 2013, ICES considered the plan not to be precautionary'. Whereas the last paragraph of section 5.8 states 'The management plan proposed by the Pelagic RAC in 2007 was evaluated by ICES and considered to be precautionary in the short term'.

Some inconsistency in the styles used, for example: Fmsy vs. F_{MSY} ; Figure X.X.X vs. figure X.X.X. ; age readings in 2014 covered 84%, in 2013 covered 71%, 2012 covered 71% and 62% in 2011.

The version reviewed still had tracked changes and figures without numbering in the main text. The final version may address many of these issues.

Conclusions

The assessment and forecast have been performed correctly according to the stock annex.

Audit of Norwegian Spring Spawning Herring

Date: 9 September 2015

Auditor: Martin Pastoors

General

- Update assessment; consistent with assessment from last year
- No changes in assessment or forecast methodology proposed or implemented
- Benchmark is foreseen in 2016

For single stock summary sheet advice:

11) **Assessment type: update**

12) **Assessment**: analytical

13) **Forecast**: presented

14) **Assessment model**: TASACS model, 8 survey series. The model was run with catch data 1988—2014, and projected forwards through 2015

15) **Data issues:** All data specified in the stock annex were available and have been used in the assessment.

16) **Consistency**: This is a category 1 stock that has been accepted as basis for assessment for many years already. A relatively strong retrospective pattern has been observed in the NSSH assessment since the assessment year 2010. In WGWIDE 2013, an updated algorithm to estimate terminal F-values for weak year-classes was implemented in TASACS which improved the consistency of the assessment (ICES, 2013). This algorithm has been used since then, and the assessment seems to have stabilized in recent years.

    The revisions of the assessment compared to the 2014 assessment were +10% (SSB 2014), -6% (F 2013) and -34% (Recruit 2014)

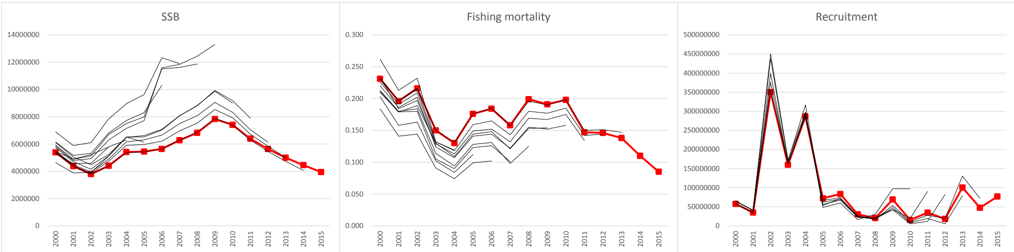
17) **Stock status**: The stock is on a declining limb for some time already. SSB 2013 is estimated at Bpa, SSB 2014 and 2015 are estimated below Bpa (but above Blim). Fishing mortality is appropriate for both the MSY and PA approach. Recruitment is uncertain. No strong yearclasses have appeared after 2004.

18) **Man. Plan.**: The long term management plan of Norwegian spring spawning herring was re-evaluated in 2013). The plan aims for exploitation at a target fishing mortality below Fpa and is considered by ICES in accordance with the precautionary approach. However, since 2013 there has been a lack of agreement by the Coastal States on their share in the TAC. This has lead to unilaterally set quotas which together are higher than the TAC indicated by the management plan. The report suggests that there is more information on the history of the management in the stock annex, but that appeared to be missing.

General comments

This was a well documented, well ordered and considered section. It was easy to follow the logic of the assesment and the links with the stock annex. Small improvements could be made to the descriptions of the surveys, by making direct links to the survey numbering in the descriptive parts.

The retrospective revisions apparent in the previous assessments appears to have disappeared.



Technical comments

There are no model diagnostics included in the tables to the section. This is apparently common practice for this stock. However, in order to evaluate the model fit, it would be required to include the parameters estimated and the weighting of the different components.

The input and output data for the assessment and short term forecast are not stored on the sharepoint system. It is recommended to document the data on sharepoint so that the link between the report and the actual input data can be verified. This also has the benefit of being able to redo assessments if needed.

Conclusions

The assessment and the short term forecast have been performed correctly.

Audit of North Sea Horse Mackerel: Divisions IVa (1st and 2nd quarter), IIIa (excluding Western Skagerrak in 3rd and 4th quarter), IVb, IVc and VIId

Date: 9 September 2015

Auditor: Jens Ulleweit, Andrew Campbell

For the attention of: ACOM, Advisory drafting group and WGWIDE

Stock is considered as data poor stock with no approved stock assessment model.

There is no stock annex for this stock.

General

No quantitative assessment is available for this stock and no reference points are defined. Data exploration in the form of catch curve analysis and groundfish survey CPUE indices has been carried out.

For single stock summary sheet advice:

The new index data for the IBTS and additional indices explored to not change the perception that the North Sea horse mackerel stock remains at a low level. There are some potential signs of improved recruitment.

1. **Assessment type:** SALY
2. **Assessment**: No analytical assessment available. Trends based on data exploration with the input of survey data (IBTS and CGFS) and catch data
3. **Forecast**: Not presented.
4. **Assessment model**: Data limited approach (Category 3) based on IBTS survey data. Alternative survey indices have been explored and CGFS (French Channel Groundfish Survey) data included.
5. **Data issues:** The following issues are identified
    - Catch at age data questionable due to low sampling coverage.
    - No information on maturity at age and natural mortality.
    - Poor quality of cohort signals in the catch curves and therefore highly uncertain Z estimate.
    - Datasets used for the exploratory indices may not cover sufficiently the distribution area of the NS Horse Mackerel stock
6. **Consistency**: Recent advice has been based on the DLS approach and the trends in exploratory indices. This remains the case and the most recent advice should remain valid for at least 2 years since any potential changes in stock status are highly uncertain. Therefore, no change in advice is proposed for 2015 *i.e.* catches should not exceed 15 200t
7. **Stock status**: Exploratory indices do not change the perception that the stock remains at a low level. There are some signs of improved recruitment in recent years but more data is required.
8. **Man. Plan.**: There is currently no agreed management plan in place.

General comments

The section was well documented and ordered. Exploratory indices were well described and the results presented clearly. The conclusions regarding advice are appropriate given the index trends and the high levels of uncertainty.

Technical comments

Inconsistent use of 't', 'tonnes' and 'tons' throughout the chapter text.

Section 4.1

In referring to the advice published in 2012, the text refers to ICES division VIa, first and second quarter. This should be division IVa.

Paragraph refers to ICES advice for 2013 and 2014 but TAC for 2015. As TAC does not necessarily follow the advice the 2015 advice should be given (less then 15 200t)

Section 4.2

'lead' (fourth line, second paragraph) should be 'led'

Figure quoted for catches in 2000 (4,400t) is incorrect. According to table 3.3.3, 48,425t is the correct figure.

Catches for 2000-2010 quoted as varying from 22,255t and 46,400t. These figures do not match table 3.3.3 (23,379t – 48,425t)

Final sentence refers to Landings whereas associated figure (4.2.2) refers to catch.

Section 4.3.1

Total column in final section of table 4.3.1 incorrect.

Paragraph 2 – year ranges for aged data need to be updated

Table 4.3.2 caption refers to numbers, weights and lengths but only numbers and weights are present

Section 4.4.1

Figure caption for figure 4.4.1 references 1992-1999 yet plot shows 1994-2003, as referenced in the text.

Section 4.4.3.1

Missing reference for Eaton et al (1983)

Section 4.4.4

Repitition of the word 'the' (final paragraph)

Section 4.4.5

Caption for figures 4.4.4 and 4.4.5 incorrect spelling (lornormal)

Section 4.4.6

Spelling error paragraph 5 (observered)

Section 4.7

Fournier et al (2012) reference not in text

Conclusions

A number of methods including catch curve analysis and indices from groundfish surveys were explored to investigate the stock. There is significant uncertainty associated with all methods although they indicate that the stock is stable but at a low level. The results presented support the proposed advice.

There is no stock annex available.

It is hoped that a project initiated by the Pelagic Freezer Trawler Association and University College Dublin to provide additional information on stock boundaries and mixing between North Sea and Western horse mackerel, and to explore or develop potential new abundance indices for North Sea horse mackerel can contribute to the development of advice in the future.

Template for audit of assessments made by EG members

Audit of Striped red mullet (*Mullus surmuletus*)

Date: 9 September 2015

Auditor: Patrícia Gonçalves

For the attention of: Advisory drafting group, ACOM and WGWIDE

General

There is no assessment, only landings and discards data are used.

Landings are available from 2006 to 2014.

Discards data are available from 2012 to 2014, from Portugal and UK; and for 2014 from Spain. Discards for Portugal and France are considered negligible.

The advice is based on a precautionary reduction of catches because of missing or non-representative data is the same since 2013.

The precautionary approach for 2016 stats a decrease of catches by at least 20%.

No reference points were defined for this stock.

For single stock summary sheet advice:

1) **Assessment type:** no assessment
2) **Assessment**: none
3) **Forecast**: none
4) **Assessment model**: none
5) **Data issues:** data limited stock, only landings were available
6) **Consistency:** -
7) **Stock status**: Undefined
8) **Man. Plan.**: There is no management plan

General comments

In general, the text are well structure.

Technical comments

There is an editing error in the name of the species "*Mullus surmuletus*" appears as

"*Mullussurmuletus*"

Table 12.3 has no units.

Table 9.3.42.8 not filled in.

Table 9.3.42.9 has no units.

Table 9.3.42.10 has no units.

Conclusions

The advice was based on the precautionary approach of 2013, of decrease the catch in 20%.

Audit of Blue Whiting - Subareas I–IX, XII and XIV

Date: 9 September 2015

Auditor: Gersom Costas

General

The assessment of Blue Whiting - Subareas I–IX, XII and XIV is based on data handling procedures and assessment modeling as described in Stock annex. Blue whiting assessment was benchmarked in 2012.

For single stock summary sheet advice:

1) **Assessment type:** update
2) **Assessment**: analytical
3) **Forecast**: presented. A deterministic version of the SAM forecast was used
4) **Assessment model**: State-space assessment model (SAM). Tuning: 1 survey index (International Spawning Ground survey, IBWSSS) and Fishing mortality random walks are allowed to be correlated.
5) **Data issues:**

   All data described in the stock annex were available in the assessment . The model was run for the period 1981-2015, with catch data up to 2014 and IBWSSS survey data from March-April, 2004-2015 . Timing of the IBWSS survey was changed to fit the actual period for the survey

   In general discards in the blue whiting fishery are considered to be low . Discards were no used in the assessment a exception discards from Spain and Portugal

6) **Consistency:**

   There is a significant change in the assessment compared to last year. Mean F in 2014 is estimated to be 0.43 while F in 2015 is estimated to be 3.85 This value is not at all considered realistic. This does explain why the model results were sensitive to the survey timing this year and the 2015 survey index showed a major decrease in biomass again when compared to the previous two years, , especially for the older age groups.

7) **Stock status**:

   Flim<F<Fpa. F has increase from a historic low at 0.04 in 2011 to 0.45 in 2014, which is just below Flim (0.48).

   B>Blim – also the lower uncertainty limit. SSB increased from 2010 (2.5 million tonnes) to 2014 (4.0 million tonnes) followed by a decrease to 3.3 million tonnes in 2015, which is above Bpa (2.25 million tonnes).

   The uncertainty around the recruitment in the most recent year is high

8) **Man. Plan.:**

   There is currently no management plan for blue whiting

9) **General comments**

The blue whiting section is well structured and easy to follow. The assessment procedure has been described in sufficient detail . The population structure of blue whiting appears to be more complex than the current single-stock structure used for management purposes

Technical comments

The assessment has been done according to the stock annex. (With the exception that the stock annex has not been updated to the change from 2014 to use deterministic forecast.)

Section 8.2.4

The Icelandic landings in 2014 were in excess of 183 000 t according table 8.3.1.1.landings were less than 183000 t.

Section 8.3.3

In text Table 8.3.3.1 should be Table 8.3.3.2

Section 8.3.4.1

Reference WGIPS (ICES CM 2015/ SSGIEOM:05) should be ICES, 2015

Table 8.3.1.3 not cited in text

Table 8.3.1.1.1 : not cited in text

Table 8.3.1.4 : not cited in text

Table 8.4.1 : not cited in text

Text "*Comparison of 2015 age and length compositions in commercial catches with the acoustic survey results*"+ *Figures* should be assigned to a new section.

Conclusions

The assessment has been performed correctly (

Audit of Boarfish (*Capros aper*) in Subareas VI-VIII (Celtic Seas and the English Channel, Bay of Biscay)

Date: 9 September 2015

Auditor: Sonia Sanchez & Claus Reedtz Sparrevohn

General

- Fisheries and historic is very well described,
- The acustic survey estimated for 2011 has been re-calculated and is now included in the Scharfer production model. Before this survey value was excluded.
- Boarfish directed fishery is very new, as a consequence time series of catch are short. Moreover, the time series of the surveys are shorter. There is very low age sampling, therefore the use of a production model is very sensitive.
- Very well documented the reviewer comments and how they have been addressed.

For single stock summary sheet advice:

19) **Assessment type:** update
20) **Assessment**: trends (DLS cat. 3.1. Index originates from a Shaefer production model)
21) **Forecast**: not presented
22) **Assessment model**: None
23) **Data issues:** One additional year in the acustic survey (BFAS) time series has been added. This is the year 2011 which was previously excluded due to that the survey covered both daytime and nighttime observations. Nighttime observations has now been removed and hence a direct comparison with other survey, only including daytime observations, can be achieved.
24) **Consistency**: Previous year the Schaefer production model was used to provide a cat. 1 assessment. Last year the method was rejected and a DLS cat. 3.1 was applied. This method is the basis for present advice.
25) **Stock status**: Unknown. However, survey indices and an exploratory assessment indicate that the stock is declining.
26) **Man. Plan.**: Currently there is a management plan proposal by the Pelagic RAC in 2012 and revised in 2015. The plan describes a procedure depending on the ICES advice. It aims to follow ICES advice and additionally sets a maximum TAC and limits the TAC increase to a maximum of 25%, but no limits in decrease and determines a fishery closure in case SSB < B_{lim}. ICES evaluates that this plan follows the rationale for TAC setting enshrined in the ICES advice, but with additional caution. There has been an EU request on management strategy evaluation of boarfish, but there has not been mentioned neither how it has been addressed or why hasn't been addressed this request.

General comments

The Schaefer surplus production model and the way the TSB index are calculated is well documentet in WG raport. This is not the case for how the change in abundance index is calculated (the two most recent values relative to the three preceding). These calculations are missing from the WG report, although present in the advice sheet.

Technical comments

Last year the assessment was not accepted and the stock was classified in ICES cathegory 3, therefore the biomass estimates are only used as an indicator on the stock status, not as an absolute value.

Comments of the stock annex text:

- The following phase: *"A hiatus in distribution is apparent between Divisions VIIIc and IXa south. Boarfish are considered very rare in northern Portuguese waters but are abundant further south (Cardador and Chaves, 2010). Based on these results, a single stock is considered to exist in Subareas IV, V, VI, VII and VIII. This distribution is broader than the current EC TAC area: VI, VII, and VIII."* is repeated twice in the text (see A.1. Stock definition text).
- Instead of "…only RSW trawlers…", it would be helpful to put "…Refrigerated Seawater (RSW) trawlers…"
- There are many references to main text, but this can change from year to year. For example: *"…(see main text Section 6.6.2)."*
- Some information is repeated both in the stock annex and in the main text.

Conclusions

The assessment has been performed correctly.

Annex 04

University of Maine RG

Technical Minutes of the Review Group for the Advice Drafting Group on Widely Distributed Stocks

September 3 - 12, 2015

University of Maine Orono, Maine, USA

Student Reviewers: Dr. Jie Cao (Chair), Kisei Tanaka (Co-Chair), Jocelyn Runnebaum (Co-Chair), Robert Boenish, Lisha Guan, Bai Li, Mackenzie Mazur, Derek Olson, Mattie Rodrigue, Max Ritchie, Kevin Staples, Katherine Thompson, Michael Torre, and Fang Zhou

Faculty Advisor: Dr. Yong Chen (Professor, School of Marine Sciences, University of Maine)

Working Group on Widely Distributed Stocks: WGWIDE 2015 was attended by delegates from Netherlands, Ireland, Spain, Norway, Portugal, Iceland, United Kingdom (England and Scotland), Faroe Islands, Greenland, Denmark, Russia and Germany. Other fisheries scientists participated by correspondence. The full list of participants is in Annex 1.

Secretariat: Dr. Anne Cooper, Michala Ovens, Henrik Sparholt, Jette Fredslund,

Review Process: The Review Group (RG) met on September 3, 2015 to discuss the review process and to assign individuals to a group of 2-3 students focusing on a particular stock(s). In total we had 5 groups, typically giving each stock 2-3 primary reviewers. The relevant stock assessment materials were distributed to each review group when they became available on September 3. On September 4, the groups met and discussed their preliminary findings and asked for input on specific points. On September 6 the groups met together again to discuss their major findings for the review and to raise any further questions. Draft reports were sent to Dr. Yong Chen for review and comments. The reviewers finalized their reports and met with a representative from each group on September 8 to determine the status of each group's report, their final decision of accepting or rejecting the assessment, and discuss any remaining issues. The reports were then compiled, reviewed, and edited by Dr. Yong Chen and Dr. Jie Cao. Eight stocks were originally scheduled for review, but review of two data poor stocks (striped red

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mullet and red gurnard) were not reviewed as they were not posted to the Sharepoint site in time for a thorough review. The table below lists the stocks reviewed by the RG along with the RG suggestion.

Table 1: List of stocks reviewed by the University of Maine RG

Code	**Stock Name**	**Assessment Model**	**RG Suggestion**	**Page Number**
boc-nea	Northeast Atlantic Boarfish (*Capros aper*) in Subareas V, IV, VI, VII	Bayesian biomass state space production model (BPA)	Accepted	10
her-noss	Northeast Atlantic Herring (*Clupea harengus*) in Subareas I, II, V, and Divisions IVa and XIVa	Virtual Population Analysis (VPA)	Accepted	18
hom-nsea	Horse mackerel (*Trachurus trachurus*) in Division IIIa, Division IVb,c and VIId (North Sea stock)	JAXassessment	Accepted with caveats	22
hom-west	Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)	Separable-ADAPT VPA model (SAD)	Accepted with caveats	32
mac-nea	Mackerel (*Scomber scombrus*) in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)	State-space assessment model (SAM)	Accepted with caveats	41
whb-comb	Blue whiting (*Micromesistius poutasso*) in Subareas I-IX, XII and XIV (Combined stock)	State-space assessment model (SAM)	Accepted with caveats	47
mur-west	Striped red mullet (*Mullus surmuletus*) in Subarea VI, VIII and Divisions VIIa-c, e-k and IXa (North Sea, Bay of Biscay, Southern Celtic Seas, Atlantic Iberian Waters)	*Report was not provided in time for review*		
gur-comb	Red gurnard (*Chelidonichthys cuculus*) in Subareas III, IV, V, VI, VII, and VIII (Northeast Atlantic)	*Report was not provided in time for review*		

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Stock Specific Issues

The RG suggested following four stocks to be accepted as long as certain conditions are addressed. These stocks are:

<u>Blue whiting (*Micromesistius poutasso*) in Subareas I-IX, XII and XIV (Combined stock)</u>

The 2015 model outputs yielded an unrealistically high F value (F = 3.85) for 2015 compared to 2014. The RG agrees with the WG's conclusion that this model outcome is possibly due to the lack of 2015 catch data. The 2015 survey data showed a low abundance index, and the WG could not justify the exclusion of 2015 survey data. The RG supports this decision. With the inclusion of 2015 survey, the SAM produced different estimates compared to the previous year. Because (1) the model fit is good and (2) SSB (2015) is independent of F(2015), the RG accepts the model configuration of this year. However, the RG suggests conducting more explanatory runs to determine other solutions of F(2015) being too high, including downweighting of 2015 survey data in the SAM if possible.

<u>Mackerel (*Scomber scombrus*) in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)</u>

The WG decided that the model with the Ricker stock recruitment function can be accepted and used to provide catch advice for 2016. However, the RG has some concerns about this decision due to the following considerations: 1) the WG does not provide in-depth explanation of why incorporating a Ricker stock recruitment model results in a more realistic fit; 2) the stock-recruitment pairs shown in the 2015 report suggest there is a weak relationship between SSB and recruitment. The WG concludes that the modeled recruitment could be almost considered as a random process. This result is contradictory to the assumption made in this final run (i.e., there is a functional relationship between SSB and recruitment). Given that the recruitment could be considered as a random process, why was a stock recruitment relationship assumed for improving the model fitting?

<u>Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (North Sea Stock)</u>

The RG is concerned that the zero-inflated negative binomial GLM is built on data lacking the spatial and temporal coverage of the fishery by using Q3 IBTS data only. The majority of the fishery occurs in area VIId in Q4 and Q1 (Table 4.3.1 from the report) but the IBTS data, from which the biomass index is derived, do not include this area nor this time frame. The GLM used to standardize the abundance index is missing key variables needed to completely standardize the index (e.g. month, bottom temperature, SST, bottom and surface salinity). The biomass index, derived from the standardized abundance index, appears to be estimated from length data derived from commercial length frequency data rather than survey data. This ignores possible selectivity and catchability biases. It is also unclear if the biomass index is estimated for each age group or based on an average weight. Lastly, the RG is concerned about the use of an arithmetic mean to compare skewed data from recent years to past years for management decisions. The RG recommends the use of a geometric mean to better reflect the skewed nature (Poisson distribution) of the data.

Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)

The RG was concerned about diagnostic issues (e.g., lack of fit for egg data during the early years and the model’s high sensitivity to 2013 egg data). The RG understands the limitation in the quality and quantity of egg survey data. The RG suggests that exploratory assessment runs should be conducted to investigate the model fitting issue. Also, the RG has concerns about the catch data. The final model should use the amended catch data, as opposed to using biased catch data. Since the bottom trawl survey data are available the RG strongly recommends consideration to incorporate these in the model.

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General Comments

<u>Review Procedure</u>

The University of Maine Student Review Group (RG) would like to thank the three ICES personnel for providing logistical assistance during this review process. In general, the RG finds the layout of the SharePoint (one folder for each stock containing the report, figures, and tables) very helpful in terms of gathering necessary documents. The RG wished this method of document sharing had been adhered to more closely to make document retrieval more efficient for members of the RG. The time-stamp on documents to the WG draft report folder did help the RG determine when to reevaluate stock reports if need be. The RG recommends adding stock annexes to each folder and standardizing stock names to avoid confusion. The RG appreciated the responsiveness of the WGWIDE personnel in making sure we received any missing information.

<u>Review Comments</u>

The RG highly recommends including the Mohn's Rho as a default quantitative criteria for retrospective analyses.

The RG also recommends further evaluation of retrospective analyses. For example, retrospective analysis presented by the WG generally resemble the left figure below which shows no apparent deviations in the retrospective peels. The RG recommends that WGs look into the relative differences compared to the terminal year, figure on the right (Figure 1), which might reveal a pattern otherwise missed because of data scales.

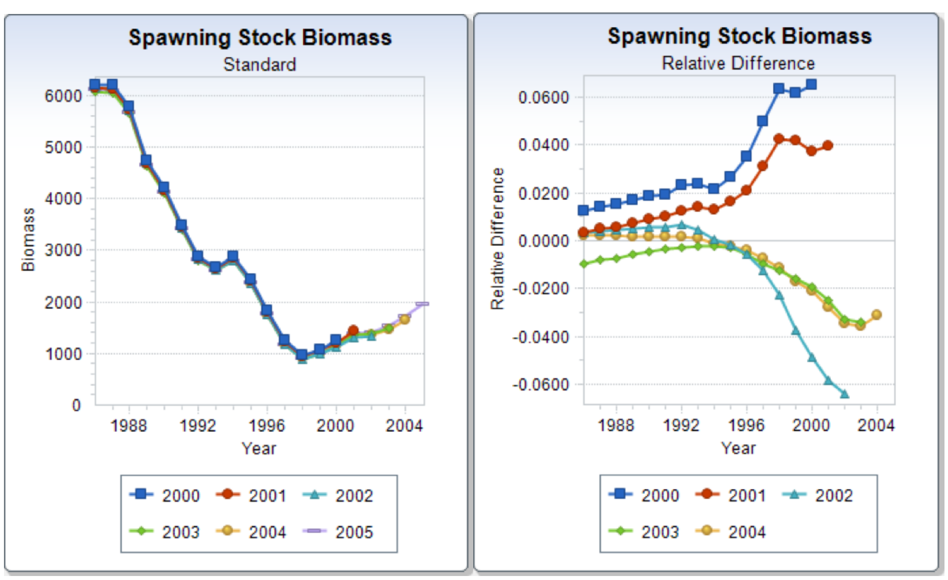

Figure 1: Example of standard retrospective analysis (left) and relative difference among retrospective peels (right) derived using the Age Structured Assessment Program (ASAP).

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The number of retrospective peels were not clearly stated in many of the reports, because relative differences were not presented and the RG was not able to visually count the number of retrospective peels on the presented figures. The RG suggests that the captions should clearly indicate number of years considered in retrospective analysis, which should also reflect the life-span of the given stock.

It was sometimes unclear whether the retrospective analyses were used to evaluate patterns of retrospective peels, or trends in parameters and population dynamics (*"The retrospective analysis shows a substantial reduction in SSB and recruitment for the most recent years, while F seems more stable"* - Figures 8.4.3 in Blue whiting report). The RG recommends that the description of retrospective analyses be further clarified.

The most recent recruitment estimates usually are subject to large uncertainty. The RG noticed that the uncertainty is not reflected in the forecast. The RG highly recommends that alternative recruitment levels be explored in the forecast and presented to determine what the consequences would be for different recruitment scenarios.

The RG suggests adding an explicit list of model assumptions, data requirements, and outputs for models to each report. This would help reviewers assess the appropriateness of the relatively new models such as the state-space assessment model (SAM). The RG further encourages addition of an explicit list of sources of uncertainty in the assessment.

The natural mortality in many reports was fixed or weight-dependent without adequate biological justification. The RG recognizes the difficulty in estimating natural mortality but notes a single species can have varying natural mortality rates among different stocks. Natural mortality also tends to be time and age variant. The RG recommends (1) comparing the rate employed to the rates used for similar species in the same area or the same species in different areas, and (2) conducting structured sensitivity analyses to evaluate impacts of uncertainty in time-varying and age-varying natural mortality in the stock assessment.

Some reports include a table of current biological reference points alongside the technical basis (Table 2). This was extremely helpful to the reviewers to keep track of when two references points were reported to be equivalent (e.g. $B_{trigger} = B_{msy}$). The RG recommends the comprehensive biological reference points table to be a default information in all reports. The RG also noted that yield-based reference points should still be provided even if these are not to be used in the ICES management plans. Common yield-per-recruit F reference points such as F_{max}, $F_{0.1}$ and $F_{X\%}$ are good management indicators to be compared to ICES reference points. It is also important to explicitly state that the parameters used to calculate reference points are

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consistent with the parameters estimated in the stock assessment models, otherwise they are not comparable.

Table 2: Blue whiting. The present reference points and their technical basis

Reference point	**B_{lim}**	**B_{pa}**	**F_{lim}**	**F_{pa}**
Value	1.5 mill.t	2.25 mill.t	0.48	0.32
Basis	B_{loss}	B_{lim}*exp(1.645*σ), with σ= 0.25.	Equilibrium stochastic simulations, (ICES advice, 2013)	Based on F_{lim} and assessment uncertainties (ICES advice, 2013)
Reference point	**F_{MAX}**	**$F_{0.1}$**	**F_{MSY}**	**MSY $B_{trigger}$**
Value	N/A	0.22	0.3	2.25 mill.t
Basis	F_{MAX} is poorly defined	Yield per recruit (ICES advice, 2013 and WGWIDE, 2013)	Equilibrium stochastic simulations, ICES advice, 2013)	B_{pa}

The RG noted that the survey methodologies in general require more clarification especially with regard to survey design, timing, duration, and frequency; changes in survey design or gear; and types of environmental variables recorded during survey. The RG also recommends providing more technical details of methods if the survey index is standardized, and distinguishing the use of commercial catch data as opposed to survey data.

The RG noted that a standardized format of assessment reports would be preferable for future assessments. While different assessment methods would require different figures and tables, it is recommended to include certain tables and figures as default information (e.g. a table or figure of biological reference points, residual plots that can show patterns in age/year/cohort...)(Figures 2 and 3). It is also recommended to include the scientific name for each stock in the heading of each report.

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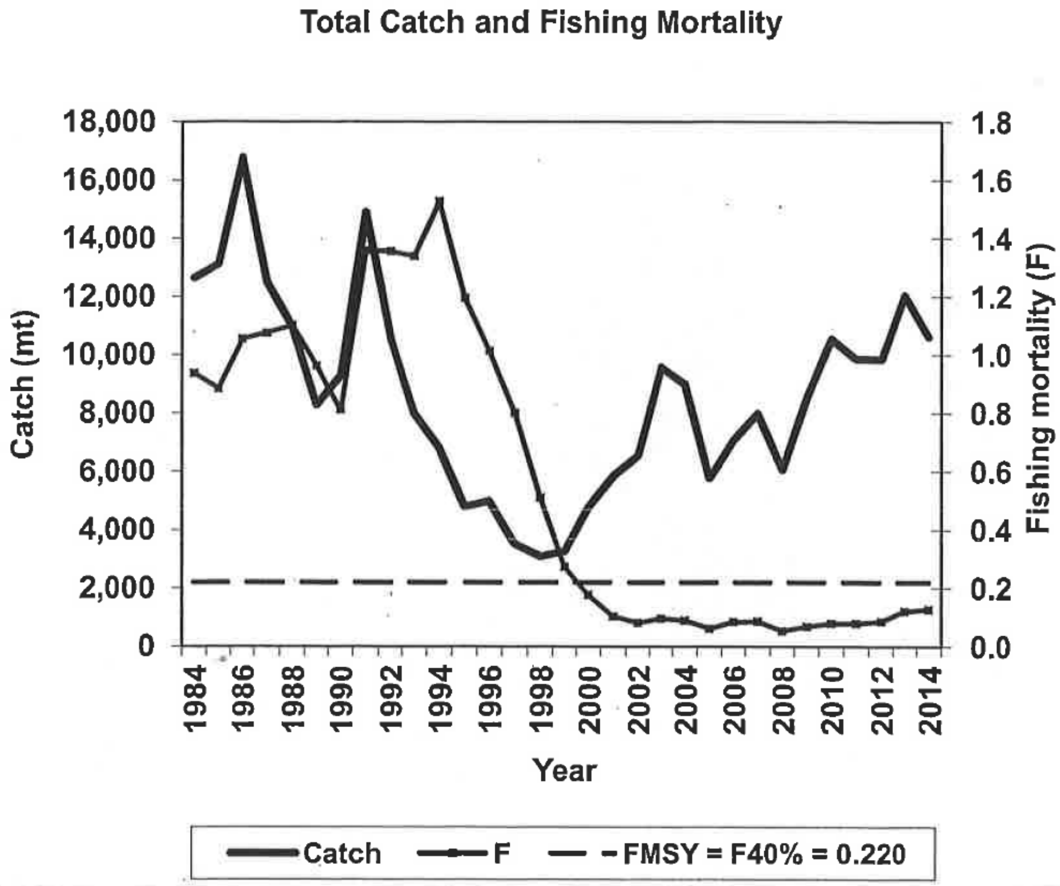

Figure 2: Change in catch and fishing mortality (F) for scup (Stenotomus chrysops):1984-2014

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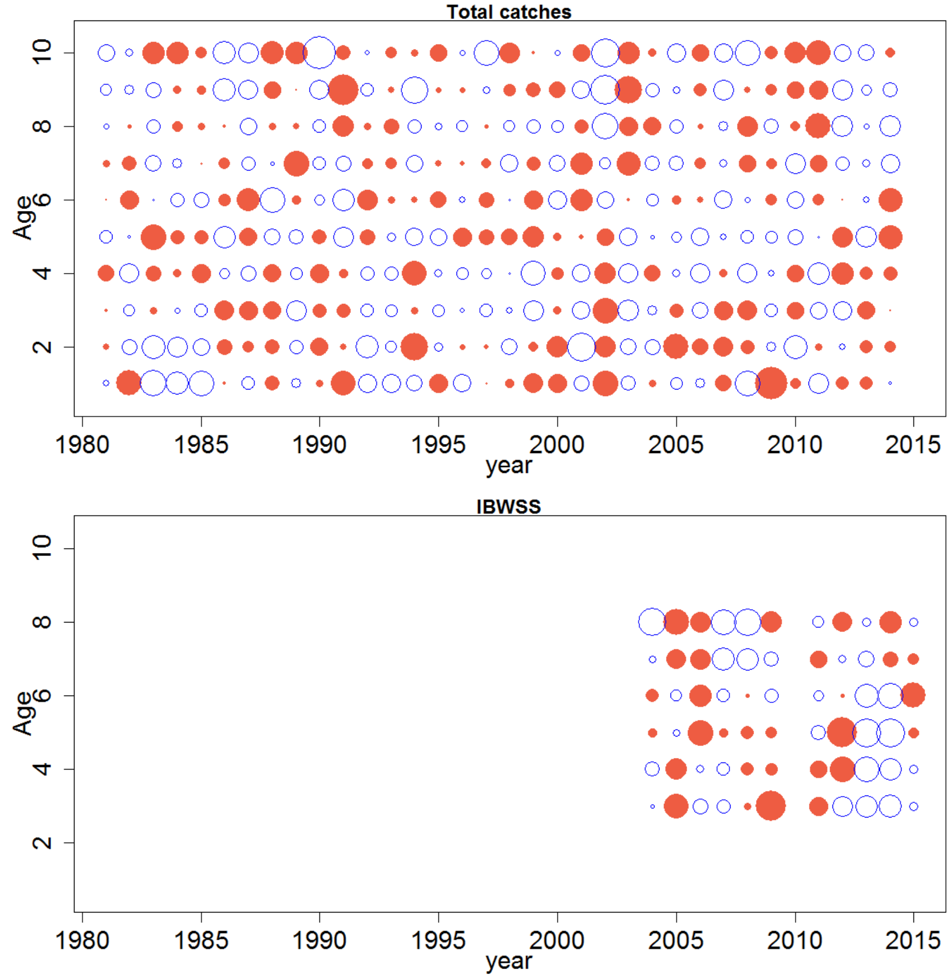

Figure 3: Blue Whiting. Standardized residuals from catch at age and the IBWSS survey. Red (dark) bubbles show that the observed value is less than the expected value.

The RG noted that the captions for figures and tables were lacking descriptions, and were often difficult to interpret correctly. The RG recommends providing figures in self-summarized format in general.

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boc-nea: Northeast Atlantic Boarfish (*Capros aper*) in Subareas V, IV, VI, VII

1. **Assessment Type:** Updated assessment including;
   - 2014 international landings and catch data
   - 2014 delta-lognormal International Bottom Trawl Survey (IBTS) indices
   - Renewed acoustic biomass data from 2011 - 2015.

2. **Assessment:** Accepted.

3. **Forecast:** Accepted short-term forecast.
   - Short-term projections were calculated using a risk based approach, using an intermediate year catch constraint (2015 TAC 53,296 t), with the population projected within the assessment using a range of management objectives.
   - No medium or long term forecasts were provided.

4. **Assessment method:** Bayesian Schaefer state space surplus production model (BSP) (Meyer and Millar, 1999).

5. **Consistency:**
   - The model configuration is the same as the final accepted run (2.2) from 2013, using additional years of catch and IBTS indices and renewed acoustic total biomass estimates from 2011-2015.
   - Key parameter estimates from the BSP model (Table 6.6.5.1) exhibited large changes from 2013 to 2014 (Table C1.2). F_{MSY} was recalculated as 0.175 (r/2), which was down from 0.23 in 2013. Estimated carrying capacity (K) decreased from 911,209 t to 695,778 t. B_{MSY} dropped from 455,605 t to 347,889 t over the same period. These rapid changes might explain the differences in total stock biomass (TSB) and F (1991-2014) estimates between 2013 and 2014 (Table 6.6.5.2).
   - Retrospective plots of TSB and F from the BSP models in 2013 - 2015 show consistency in both estimated TSB and F for the recent two years 2013 and 2014 (Figure 6.6.5.7). Compared with the BSP model in 2013, Large decrease in the estimates of TSB and increase in F estimates before 2011 from the 2014 and 2015 BSP models were explained by the inclusion of the low acoustic biomass estimates in 2014 and 2015.
   - Diagnostic plots (Figure 6.6.5.4) mostly show a balanced residual pattern. Residuals of most of the IBTS indices do not reflect temporal patterns, except the Scotland IBTS (WCSGFS). Also, there is an outlier in the English Celtic Sea Groundfish Survey (ECSGFS). The WG report addressed these issues by:

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- ○ Diagnosing the Scotland IBTS (WCSGFS) as a possibly inappropriate index of stock biomass because of its temporal residual pattern.
- ○ Internally weighting each survey by uncertainty, greatly reducing the contribution of outliers to the BSP model fit.
- Allowable mesh sizes will remain at 32-54 mm, which was set in 2011. Prior mesh size was 100 mm.
- Since boarfish has been determined to be an unimportant prey species in the NE Atlantic, precautionary F targets should follow the F = M approach.
- Measures to reduce bycatch in other fisheries have remained unchanged since 2013.

6. Stock Status:

- Recruitment cannot be estimated from the BPS model, however, indices of abundance at age 1 and indices of 1-5 year olds were regarded as a composite recruitment index. According to observations from these indices, various components of the IBTS show an overall decline in recruitment since 2010, particularly in 2014 (Figures 6.5.1 and 6.5.2).
- No strong year classes are present since 2005, except possibly in 2010 (Figure 6.2.1.1).
- The acoustic surveys have reflected a rapid decrease in boarfish stock biomass in 2014 and 2015.
- The mean TSB in 2015 was estimated to be 301,415 t, which is less than $B_{trigger}$ (347,889 t) (Table 6.6.5.1), but greater than B_{lim} (139,155 t), which is set as 0.2 of K (665,778 t). These values are outputs of the 2014 BSP. The estimate of mean TSB in 2015 indicates a small decrease from the 2014 estimate of 312,898 t (Table 6.6.5.2).
- The estimate of F for 2014 (0.18) was derived from the Pseudo-cohort analysis (Table 6.6.3.1). This F is above F_{MSY} (0.175) and $F_{0.1}$(0.13)(Table 6.6.5.1). Meanwhile, the F estimated from the BPS model was calculated as 0.174 in 2014, below F_{MSY} (Table 6.6.5.2), likely a result from decreases in stock biomass and prices for harvested fish.

7. Management Plan:

- WG advice for 2015 is based on the ICES generic Harvest Control Rules (HCR). The reduced F was set as $F_{ICES\ HCR}$ (0.132) and calculated by $B_{2015}(F_{MSY}/B_{trigger})$, which is consistent with the ICES MSY approach. Using the $F_{ICES\ HCR}$, the proposed TAC in 2015 was set to be no more than 33,875 t, reflecting the recent decline in TSB estimates.
- Based on the 2015 BSP model, the probability of TSB in 2017 falling below B_{lim} fishing at F_{lim} is 14.1%, compared a probability of 11.4% fishing at the

recommended F ($F_{ICES\ HCR}$) for 2015 and a probability of 9.5% with a zero-catch F (Table 6.7.1).

- The WG estimated the total landings at 45,231 t in 2014, which did not exceed the targeted 2014 TAC (133,957 t).
- Bycatch management is outlined by the following provisions:
    - The pelagic horse mackerel fishery is allowed to retain a certain percentage of boarfish to be deducted from the horse mackerel quota since 2011.
    - The boarfish fishery is closed from 15 March- 01 September to avoid horse mackerel bycatch, which is caused by mixed aggregations at this time.
    - The boarfish fishery is closed in ICES Division VIIg from 01 September-31 October to prevent bycatch of Celtic Sea herring.
    - The boarfish fishery must cease in a given ICES statistical rectangle if any other species covered by a TAC amount to a 5% of the total catch by day by the ICES statistical rectangle.

8. General Comments

- The BSP assumes that the catch data are without error, yet neither the report, nor the stock annex provide detailed descriptions of the catch data for each year. The RG is left to wonder about the reliability of these data, as the table caption states *"These figures may not in all cases correspond to the official statistics and cannot be used for management purposes."* The RG requests that the WG make a clear justification for using the selected catch data within the assessment.

- The BSP model assumed acoustic surveys were a relative index of stock biomass when making biomass estimates, even though the acoustic surveys did not cover the entire stock area. The WG justifies the use of these acoustic surveys within the BSP model quite well, but the RG still has concerns over the validity of this assumption. If there are any spatio-temporal patterns or heterogeneity in the distribution and density of the boarfish stock, the biomass estimates from the acoustic surveys may not be proportional to the total stock biomass. Any extension of acoustic surveys southward would do much to reassure the RG of the assessment's ability to reflect such shifts in population.

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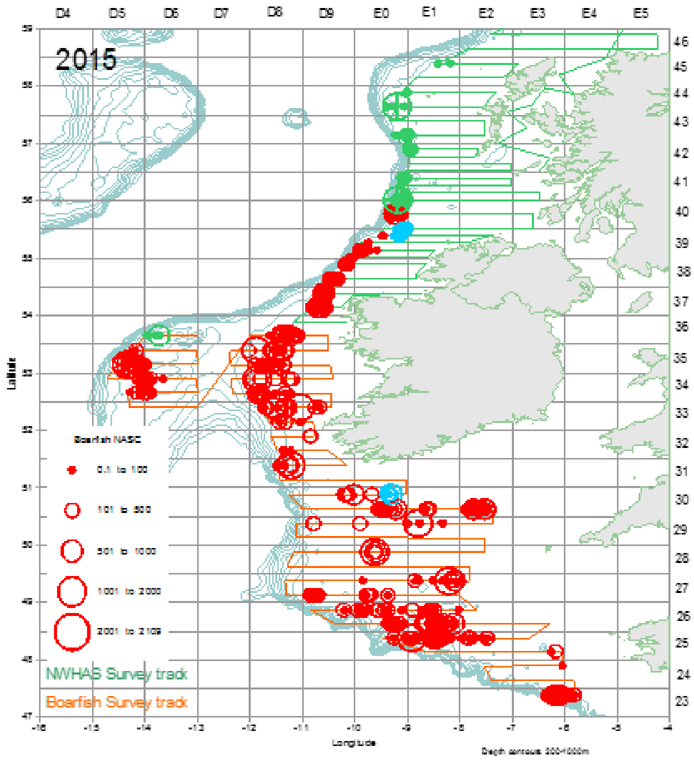

Figure 6.3.1.1b Boarfish in ICES Subareas VI, VII, VIII.Boarfish acoustic survey track and haul positions from acoustic survey 2015. Red circles represent 'definitely' boarfish, green: 'probably boarfish', blue: 'boarfish mix'.

- The RG cannot see any mention in the text of estimating uncertainties associated with the BSP parameters such as r, K, B_{MSY} and F_{MSY}, although the WG provided a figure of posterior distributions of these parameters. The RG anticipates a table of mean values and CVs, together with the visual plots and descriptions of how the uncertainties or posterior distributions were incorporated into the short term projections.
- The RG have reservations about how the WG uses mean weight-at-age to estimate biomass. The mean weight-to-age table provided by the WG shows variation in boarfish weight at advanced ages. The RG suggests that a typical growth curve (e.g. weight-at-age version of von Bertalanffy) be fit to these data, predicting mean weight-at-age curves, to incorporate a more realistic increasing of weight with age within the model.

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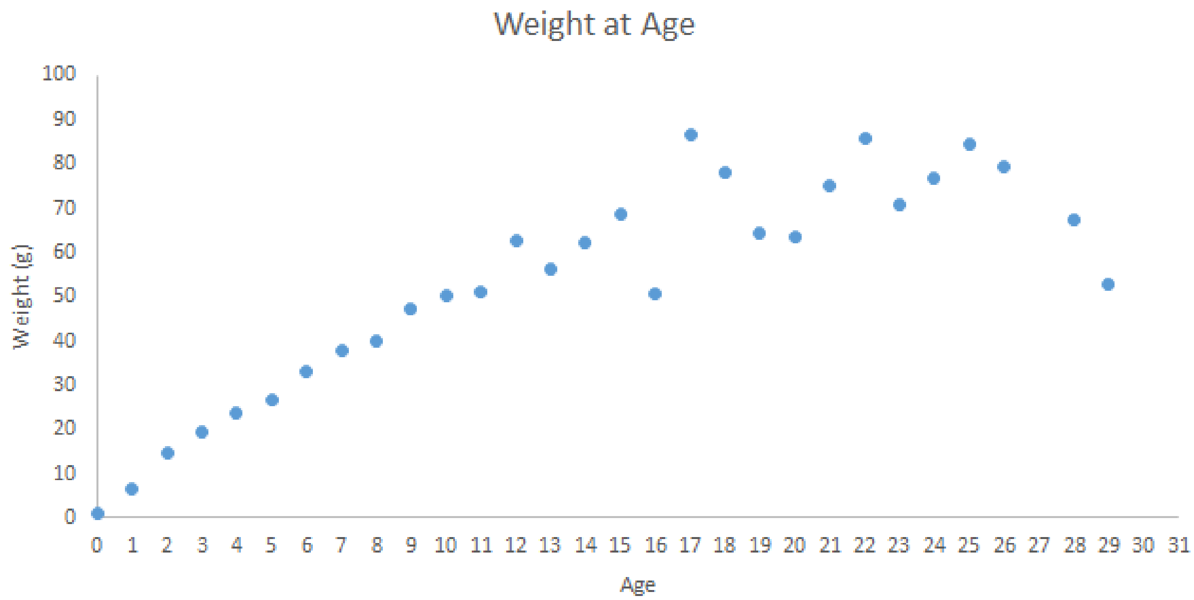

Plot of mean weight-at-age, using data in the table from Section 6.4 of the WGWIDE report.

9. Technical Comments

- WG report, while thoroughly written, is not concise and provides ample confusion with respect to which values are attributed to the current assessment or previous assessments. The WG report often repeats the stock annex, with much overlap and inconsistency. For example, many parameter estimates and projections used in the report are not consistent with those listed in the tables and figures provided. For example:
  - Within the caption of Table 6.7.1, it writes "Catch (2015) = 53296 thousand tonnes (EU TAC)". Such a large discrepancy between this number and the TAC advised for 2015 (33,875 t), whose relationship is not stated in the WG report, is alarming to the RG.
  - In Section 6.6, results of the biomass production model estimates of F_{MSY}, and TSB for 2014 are not consistent with Figure 6.6.5.7 cited.
  - In Section 6.7, short term projections, data they used for F, F_{MSY}, $B_{trigger}$, B_{lim} and so on we expect are from the previous stock assessment; they are inconsistent with values showed in Table 6.6.5.2 and Table 6.7.1.
- Stock assessment structure and configuration have been consistent since 2013 and no major change was undertaken in the current assessment. The RG agrees with the decisions of the WG in configuring the stock assessment model (i.e., BSP).
- Figure 6.1 was cited to illustrate ICES Subareas and the spatial distribution of Northeast Atlantic boarfish, but this selected figure does not provide the desired information. This makes it difficult to determine boarfish stock structure and

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management units. The RG suggests adding a more appropriate ICES Subdivision figure.

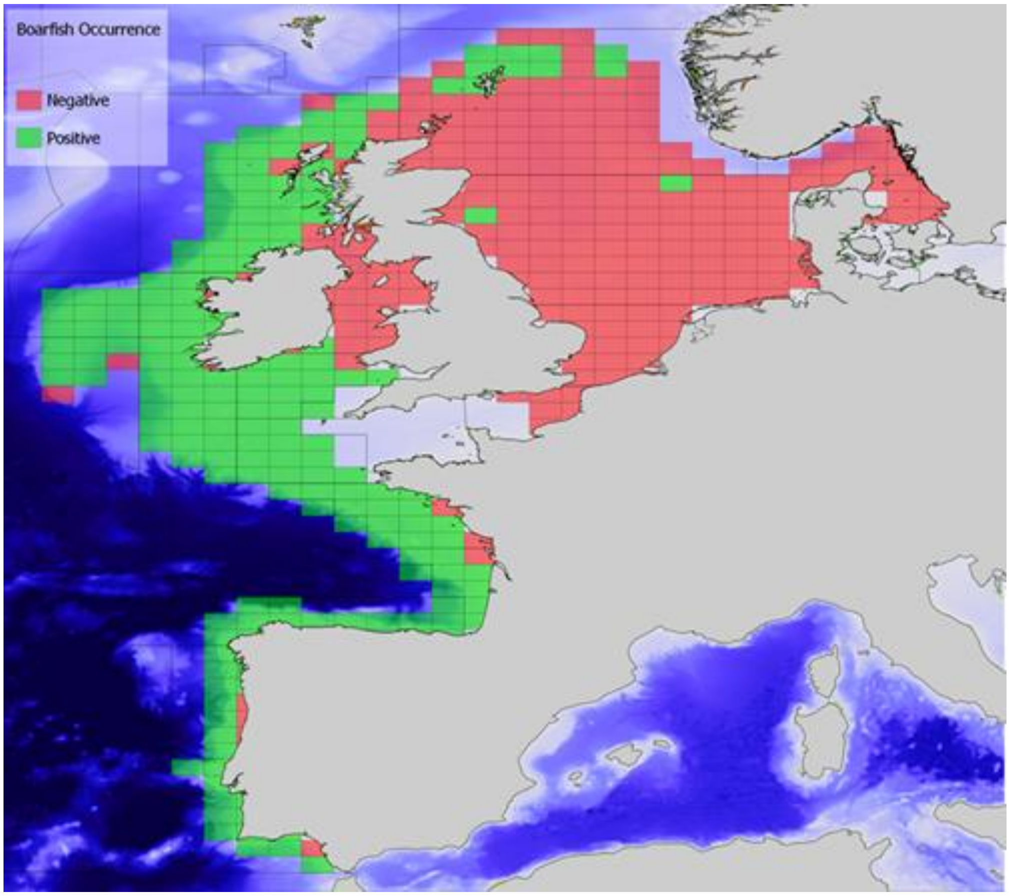

Figure 6.1 Boarfish in ICES Subareas VI, VII, VIII. Distribution of boarfish in the NE Atlantic area based on presence and absence in IBTS surveys (all years).

- Broader comments on figures and captions:
  - Figures should be saved as .png files, this should allow for higher resolution graphics and reduce the necessary file size.
  - Figure captions are frequently missing spaces between words and sentences.
- Specific figure and caption comments
  - Figure 6.2: This figure shows two different scales for catch, this is misleading, perhaps use the same scale.
  - Figure 6.3.1.1a: The maps for 2011, 2012, and 2013, are blurry and unreadable. They should perhaps be saved as higher resolution files.

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- Figure 6.3.2.5a/b: Reading these maps would be assisted by a color bar scale on the side of the graph indicating the presence or absence of boarfish.
- Figure 6.3.2.6: Lacks axis labels and units, while the years are clear the depth is not also both the dots and the lines on the graph should be explained.
- Figure 6.6.2.2/3: There is overlap of the years on the x axis, this can be solved by saving the plot as a larger file in R or with different dimensions.
- Figure 6.6.5.1: Explain more what each color and line means, these graphs are busy and slightly overwhelming.
- Figure 6.6.5.2: Rhat should be explained further either in the caption or in the text.
- Figure 6.6.5.3: ACF should be spelled out on the y axis title or the figure caption.
- Figure 6.6.5.6: The dots, dotted line, and solid line should be explained in the figure caption.
- Figure 6.6.5.7: Both plots should have standardized and more clear differences between the lines, thickness is not obvious enough as a difference especially given the closeness of the 2014 and 2015 model runs.
- Figure 6.12.1: The color of the boxes and the meaning of the colors within the plots should be explained in the figure caption.
- Figure 6.12.2: This would also be helped by explanation of the color of boxes on the prior plot.
- Figure 6.12.3: These color delineations could be made clearer by using more different colors.

10. Conclusion

- The assessment of the Northeast Atlantic Boarfish in ICES Subareas V, IV, VI, VII appears to be well done and indicates no large retrospective errors or major diagnostic issues. Considering the short time series of the fishery and related data, the RG agrees with the use of the BSP model for the stock assessment prior to development of an age/size-based assessment.
- The RG agrees with the WG recommendation of proposing a TAC based on the ICES generic HCR and ICES MSY approach to be used for management, as there is no recruitment estimate for construction of a traditional catch forecast. The proposed reduction in F is in line with the apparent decrease in total stock biomass for boarfish. However, as the acoustic surveys do not cover the whole stock, using the biomass estimates from these surveys as the total stock biomass index may impact accuracy of the assessment.

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- It is unknown how uncertainty within the catch data, assumed to be zero, may also impact the assessment results. There is inadequate explanation and presentation of any uncertainty associated with parameters within the BSP model including how such uncertainty is incorporated within the model projections.
- Further research needs to be focused on the evaluation of catch and survey numbers-at-age data, recruitment measurement, and improvement of the stock biomass estimates for developing an age/size based assessment.

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her-noss: Northeast Atlantic Herring (*Clupea harengus*) in Subareas I, II, V, and Divisions IVa and XIVa

1. **Assessment Type -** Update

2. **Assessment -** Accepted

3. **Forecast -** Short-term forecast

4. **Assessment Method -** Tuned VPA population model in the TASACS toolbox

5. **Consistency:**
    - This year's assessment was run with the same model options as the benchmark assessment in 2008.
    - Catch data and survey data from eight surveys were used in this assessment. New survey data were not excluded from further analysis this year. New data were obtained from surveys 1, 4, 5, 6, and 7.
    - M = 0.15 for ages 3+ and M = 0.9 for ages 0-2 in all years.
    - This assessment continues using an updated algorithm to estimate terminal-F values. This method was introduced in 2013 to address retrospective patterns of SSB and $F_{5\text{-}14}$.
    - The WG continues examining the uncertainty of the assessment by bootstrap (1000 replicas).
    - Residual plots show some patterns for survey 5. There was a series of negative residuals during the early 2000s and a period of positive residuals followed. This indicates potential issues in model fitting (Fig 7.6.2.2.2).
    - Retrospective patterns exist in SSB and F with a tendency to overestimate SSB and under-estimate F over the last 5 years (Fig 7.6.4.1). The previous assessment revealed the same retrospective patterns.

6. **Stock Status:**
    - There is a decreasing trend in Recruitment (R), Fishing mortality (F), and Spawning Stock Biomass (SSB).
    - The fishing mortality has fluctuated between 0.11 and 0.2 in recent years. F in 2014 dropped to 0.11, which is below Fmsy (0.15), but above the management plan F (0.099).
    - There is a decreasing trend in the stock and the stock was below Bpa in 2015. Bpa = 5 million tons and Blim = 2.5 million tons.
    - NSSH is currently not overfished and no overfishing is occurring

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7. Management Plan:

- There was no reconsideration of the reference points because the new assessment did not give different perceptions of the dynamics and levels of SSB and F compared to the basis assessment for establishing the reference points. The reference points since 2010 have not been updated. The reference points for this assessment are derived from an analysis carried out by WGWIDE in 2010 which was reevaluated and confirmed by WKBWNSSH in 2013. F_{msy} is estimated to be 0.15, F_{target} = 0.125, unless SSB is below B_{Pa} in which F is reduced to 0.05 at B_{lim}.
- The estimated TAC is 0.3282 mt in 2015 and 0.3169 mt in 2016. The expected SSB is 3.945 mt in 2015 and 3.586 mt in 2016.
- Maintains a level of SSB greater than the Blim of 2.5 mt. Bpa was not revised and kept at 5.0 mt. Fmsy should remain unchanged at 0.15.
- Restricting fishing on the basis of TAC and maintain fishing mortality rate less than 0.125 for appropriate age groups defined by ICES. If the SSB is below Bpa, the fishing mortality rate should be changed from 0.125 at Bpa to 0.05 at Blim.

8. General Comments:

- The WG report is well written and follows the stock annexes. Both input data and tuning data are well discussed. The uncertainty of the assessment and forecast is well documented.
- For the retrospective patterns it would be useful to provide some type of quantification in the discussion. The RG suggests the WG use Mohn's Rho to measure the amount of retrospective pattern. A remodeling of these data with the Mohn's Rho correction would complement the current analysis. For comparable herring application of post hoc retrospective correction, see Deroba, J. J. *North American Journal of Fisheries Management* 34:380–390, 2014. Regarding the current retrospective analysis with a 5-year peel, the RG feels this may not be long enough. Given the relatively long lifespan of herring, a longer peel may provide additional retrospective information and would incorporate additional year classes.
- Although the WG suggests the exceptionally high *q* of survey 5 was mostly responsible for the strong retrospective pattern, the shift in stock movement patterns may also have an effect on *q*. The RG suggests a re-evaluation of *q* at the next benchmark given the spatiotemporal movements of the stock in recent years. Further, the RG also recommends investigation into M specifically in recent years when stock movement patterns have changed. The RG proposes a sensitivity analysis be conducted for M in the next benchmark assessment.
- Per the current management plan, conflicting survey data is semi-subjectively removed from analysis. Reasons stated include removing data when it conflicts or

comes from a poor year class. Following the initial exclusion process, all data are weighted equally. The RG suggests weighting all survey data by CV. This approach avoids excluding data, but accomplishes many of the same goals. The report for example *"Excludes poor year classes with mostly noise"*, but following the RG suggestion, a survey with noise would be down weighted accordingly due to high CV. With the uncertainty of NSSH in recent years, the RG suggests that this approach be considered.

- Several surveys stopped many years ago. The RG feels the influence of these surveys on the assessment is underdeveloped and should be investigated in the next benchmark assessment.
- The WG examined the uncertainty of the assessment using a bootstrap approach. However, the RG could not find any discussion of the bootstrap results.
- There were some potential technical problems with age readings of herring and acoustic surveys. The RG agreed with WG's recommendations such as involving technicians for age reading workshops and conducting acoustic surveys for a better coverage of spring spawning herring in all years forward.

9. Technical Comments:

- The WG speculated that wintering location changed to open ocean most likely due to an exceptionally large year class. They went further to stay that other herring stocks have exhibited this shift, but failed to cite any relevant examples (pp. 378, lines 10-14).
- Different formats were used when the WG cited the stock annex. The RG suggests that the WG use the same format as the stock annex (e.g. in section A.1.1 of the stock annex 02). Multiple times there was reference to an Annex 4, which was not provided in the documentation.
- The figures were often missing labels, mislabeled, or were uploaded in a low resolution with small font making interpretation at times difficult.
    - Fig 7.4.7.4.2 Graphics are not consistent between plots, figures do not line up and mid panel axis label intersects with units.
    - Fig 7.4.7.5.1 The upper left panel was missing axis labels and year label. Also, the legend in this panel is different with the figures in the other panels. Resolution is poor and legend too small, unreadable.
    - Fig 7.6.1.1 Unclear units on Y axis (thousands, millions of fish?)
    - Fig 7.6.2.2.1 & throughout: The axis labels were too small and very difficult to read. RG suggests making higher resolution and larger font and plot markers.
    - Fig 7.6.2.2.3 Labels for various fleets too small to read.
    - Fig 7.6.4.1 The Y labels were unreadable codes.
    - Table 7.4.1.2 The font of the output from SALLOC were too small

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- Table 7.4.7.1.1 Please change “Februar-March” to “February-March” in caption. The format of numbers and biomass were not consistent in this table.
- Table 7.4.7.4.2 There are two different colors for shades.
- There are two blank pages in front of the Table 7.6.2.3.1.
- Fig B.3.5.2. (Annex 2) Vertical figures inappropriately labeled left and right, year is omitted from top figure (2008?)

- Although generally well written, there were slight grammatical errors throughout the report. These were generally inconsequential but some sentences were hard to interpret.

10. Conclusions:

- The RG found the assessment to be thorough and well done. The RG suggests that the VPA is appropriate for the stock and should continue to be used for future assessment.
- In future assessments the WG should more thoroughly consider uncertainty associated with the newly observed spatial and temporal dynamics of the stock.
- The RG suggests that a quantification of the retrospective error in model development and an extension of time peeled in the retrospective analysis be conducted.
- The RG found the current methods of eliminating data are subjective and recommends that a survey index weighting based on CV be incorporated into the model.

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hom-nsea: Horse mackerel (*Trachurus trachurus*) in Division IIIa, Division IVb,c and VIId (North Sea stock)

1. **Assessment Type:** Multiyear

2. **Assessment:** Accept with caveats

3. **Forecast:** None; uncertainty was too large to warrant making model projections.

4. **Assessment Method:** Exploratory JAXassessment with advice based on a GLM biomass index in accordance with the guidelines for Data Limited Stocks

5. **Consistency:**
   - The UK Beamtrawl Survey in VIIe (WBEAM) in Quarter 1 and CGFS survey indices were evaluated, but it seems that they were not used in the assessment.
   - Unclear how the biomass index was derived in previous years for management decisions.
   - There was some lack of consistency in references to the stock classification. The WG refers to North Sea horse mackerel as a Category 5 DLS stock in ICES Advice Applicable to 2014 and in section 4.6.1 but also refers to it as Category 3 DLS stock in section 4.6.1. (pg 218). Which seems to imply different harvest control rules to be implemented for the stock.

6. **Stock Status:**
   - F and SSB are highly uncertain, but the abundance index has increased moderately since 2010.
   - Overall, comparing the most recent two years with the preceding three years shows a 54% increase in the biomass index, based on biomass indices estimated using a GLM. However, indices remain low with a correspondingly higher mean F.
   - Target and limit reference points of F and B are not defined for this stock due to the inadequacy of the catch at age model's performance.
   - Discards are not quantified.

7. **Management Plan:**
   - Management is based on the ICES approach to Category 3 DLS stock and uses an index-adjusted status quo catch.
   - The ICES harvest control rule of comparing biomass indices apply a 20% uncertainty cap with a 20% precautionary margin.

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- For 2014 ICES advice recommended a status quo TAC of no more than 25,500 tonnes.
- The 2015 TAC for IVbc and VIId was reduced to 15,200 tonnes.
- The 2014 TAC was underutilized by about 50% owing to the management scheme with only 13,388 tons of landings in 2014.

8. General Comments:

- The JAXassessment (statistical catch at age model) is a good first step in developing a model-based stock assessment for North Sea horse mackerel, which has significant uncertainty in fishery and survey data. The RG would like to encourage further development of quantitative stock assessment models for future management decisions and to evaluate the impacts of uncertainty in data on the selected models.
- The report indicates that environmental variables may influence North Sea horse mackerel recruitment more than SSB. Since the age data has such a high level of uncertainty the RG recommends exploring a biomass-dynamic model as a comparative analysis. Environment is considered to drive overall recruitment, so linking the biomass-dynamic model to the environment would be advisable. A habitat suitability index model could be derived for this species to track changes in habitat quality over time. This could then be linked to carrying capacity in such a model. Abaunza et al. (2003) applied a biomass dynamics model to the Southern stock of horse mackerel.
- An alternative to the biomass dynamic model would be further exploring the "Robin Hood" approach. The RG agrees that methods suggested by Punt et al. (2011), referenced in the draft report, for data poor species could be further explored for North Sea horse mackerel. The RG recommends exploring these models in conjunction with the Western and Southern stocks of horse mackerel following references cited in Punt et al. (2011).
- The WG indicates that recruitment for this fishery is environmentally driven, but the proposed harvest control rule for data-limited stocks is based on SSB. The RG recognizes that this is outside the realm of the WG's scope, but the RG has concerns that environmental variables were not included in the GLM.
- The RG would like to applaud the WG effort to develop catch-at-age model and to evaluate its performance. Although such a model may not be appropriate with current data availability, it is a step forward. The RG encourages the WG to (1) further explore the feasibility of statistical catch-at-age data, and (2) identify key data gaps for the improvement of stock assessment.
- The RG is concerned about the data used to estimate the biomass index from the GLM and the potential exclusion of important variables.

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- Important variables appear to be missing from the GLM. The RG recommends adding month to address seasonality and explicit environmental variables (e.g. bottom and sea surface temperature, salinity) into the GLM to standardize the abundance index.Variables that could influence local abundance should also be included in the standardization to account for known variability in the survey data and unknown catchability of the species.
- The RG recommends including all IBTS data available (not just Quarter 3) in the zero-inflated negative binomial GLM and adding the response variable month (in addition to explicit environmental variables) to standardize the abundance index. The data used to justify the use of Q3 data only is over a short time series (about 20 years) which may or may not reflect the current IBTS catch trends.
- The source of the length frequency data used to generate the biomass index is unclear. Figure 4.4.3 presents the only length distribution in the report, which comes from commercial catch (not survey catch) for divisions IVbc and VIId in the Q3. The report does not specify whether the conversion to a biomass index relies on this length frequency data or on data from the IBTS. In the former case, application of a commercial length frequency to a survey-based abundance index ignores differences in selectivity and catchability between the two. Commercial selectivity may vary spatially and has also likely changed over time, particularly since the Dutch fleet acquired the Danish quota. Furthermore, the use of size data from only a subset of the stock area likely introduces spatial and temporal biases into the length frequency distribution and the resulting biomass index. This is particularly true given that most fishing takes place in division VIId.

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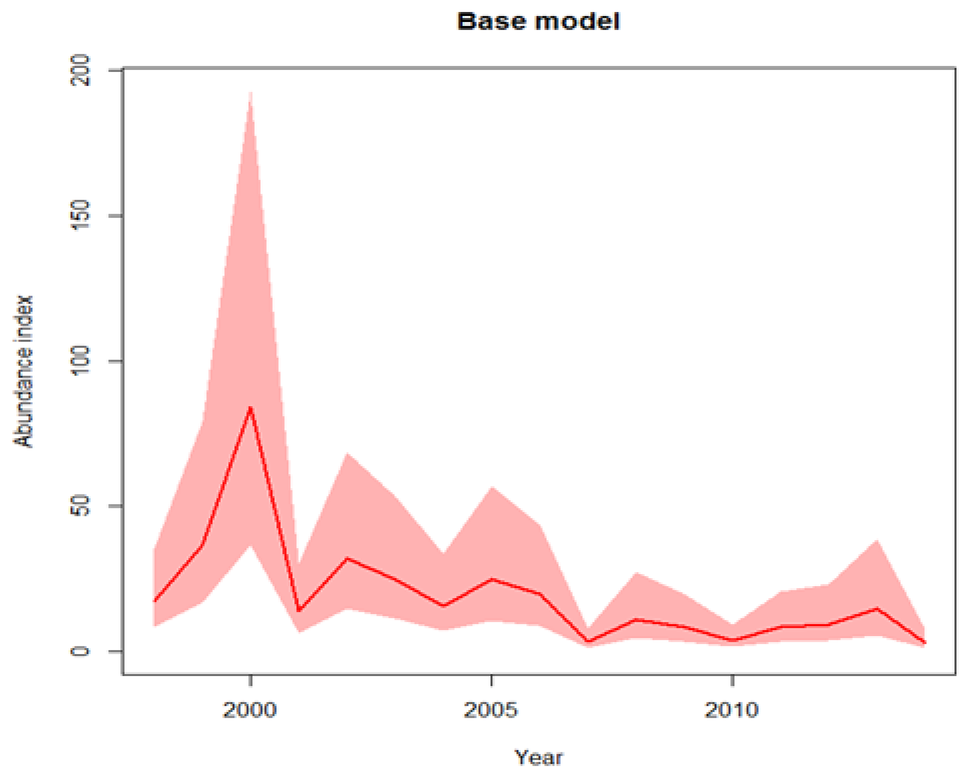

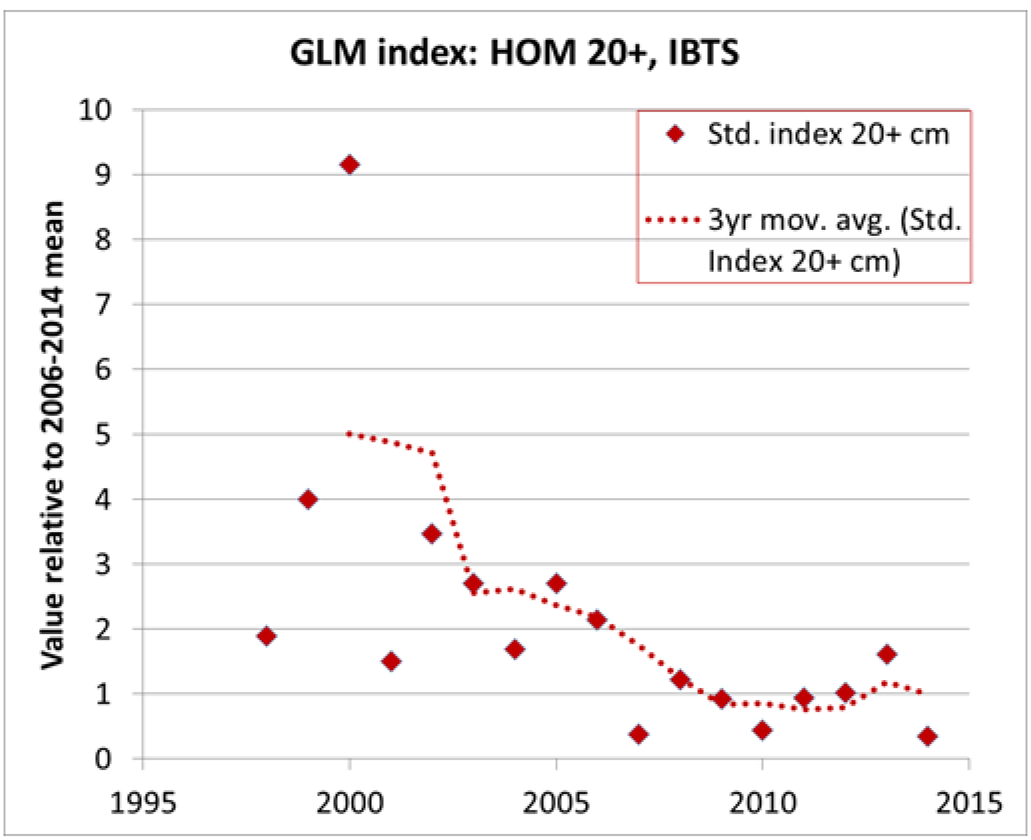

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Figure 4.4.3. North Sea horse mackerel. GLM abundance indices. Top: Abundance index, the shaded area indicates the 95% confidence intervals for the estimated index values. Bottom: The abundance index standardised to the 2006-2014 mean, with 3yr running mean trendline.

- Uncertainties in the length frequency data and length-weight relationship are not presented or addressed. These uncertainties should carry over into the estimated biomass index. Additionally, age composition data cover only a small proportion of the total catch, which may not be representative of catch-at-age data over the whole stock area.
- To address these issues, the RG recommends the use of length frequency data derived from the IBTS rather than the commercial fishery.
- Increasing patchiness of the stock would challenge the validity of the model-based index, and may cause the GLM to be more sensitive to significant parameters (Figure 4.4.6. in the draft report from Sept 3, 2015; not included in the most recent draft).
- Assessment data are problematic because they do not not cover area VIId, but is used for the management advice through the GLM abundance index. The survey used does not have adequate coverage for the division with the highest fishing effort (VIId). The RG recognizes the limitations the WG has in this regard and would encourage further expansion of survey programs for horse mackerel in the future.
- Poorly defined stock structure and inadequate survey coverage have both contributed to possible poor quality of data which in turn contributes to high uncertainty in stock assessment.
- Survey methods need to be further explained. Abundance indices were derived from the IBTS, however no details were provided on survey timing or survey design. The survey appears to be of a systematic design (but it is not clear if the first station was selected randomly for each survey, which is the key element for a systematic design), which is appropriate for a stock with patchy spatial distribution. It is also appropriate to standardize the abundance index because subsamples were taken from the systematic survey. However, the RG needs more detailed information on how the first station was selected, which is critical in evaluating data quality as well as information on when the survey was conducted.

- These data issues are the likely culprit of the large confidence intervals in the GLM biomass index.
    - The RG has concerns regarding how comparisons of the most recent index were made to previous mean abundance indices.

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- Very little background on the last assessment is provided. It is also not stated how the TAC was initially set prior to the application of the DLS harvest control rules.
- In applying the harvest control rule to the GLM biomass index, it appears that the WG used the arithmetic mean to compute mean biomass in recent years versus prior years. The RG would suggest using the geometric mean to better account for the lognormal abundance distribution of the stock.

9. Technical Comments:

- **GLM**
  - The procedure used to produce the abundance index is not clearly described and consequently is difficult to evaluate. In particular, the report does not explain how abundance per length class was estimated. The GLM used to estimate μ_i, the expected catch per haul, appears to only yield estimates of total expected catch, not catch per age or size class. The report does not describe the procedure used to convert this overall catch to catch per length class. Table 4.4.1 states that the GLM abundance index is converted to a biomass index using the observed length frequency in each year. However, this vital explanation is not given in the text of the report.
  - The method of accounting for “false zeros” when constructing the biomass index requires additional explanation. Both process error and observation error can contribute to false zeros, and it is not clear how they were accounted for.
  - How was the biomass or abundance index derived from the survey subsample?
  - The RG cannot verify that the GLM biomass index can capture temporal variability in stock biomass, since the WG did not report the sensitivity tests for the GLM that show the index is robust to the inclusion of new years of data.
  - Text needs to be updated to describe 0-19 cm and 20+ cm groups used in both DLM and GLM.

- **Data**
  - Survey CPUE increased since 2010 while the number of positive hauls decreased over the same period (Fig. 4.4.6). The RG cannot determine if this is due to increased patchiness of the species or from changes in the sampling program. The RG would like to know if the increase in CPUE at locations of positive hauls is a reflection of changes in sampling or truly an increase in patchiness of the species. If increased patchiness is

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happening the RG would strongly recommend conducting an analysis on habitat suitability.

- It is unclear whether the data that were utilized are fishery dependent or fishery independent data. More information is needed to better describe the quality and quantity of the data available for the stock assessment.
- The RG is unclear if the survey data goes until 2014 or is only up to 2012 based on information provided in section 4.4.3. first sentence, last paragraph.
- A thorough explanation of the fishery needs to be included besides mentioning that the Dutch freezer-trawler fleet is responsible for a large portion of the catch. The specifics of the gear need to be described (i.e. pelagic trawl fisher with nets X size and mesh Z size). While the Dutch freezer-trawler fleet accounts for most of the landings it is important to know about the other fleets. This is important in understanding if there are differences in catchability and/or selectivity in different areas of the fishery. What time of day does the fishery occur: day or night?
- The maturity ogive is outdated (1998) and derived from the western stock. Changes in age structure over time suggest fishery-induced effects on growth and maturation may be occurring.
- No information is provided on whether the survey timing coincides with the timing of the fishery. This appears to be a year-round fishery in most areas, but the report fails to explicitly state the timing of the fishery.
- Has the degree of stock mixing with the western horse mackerel stock been quantified to include in future models? There is no description of seasonal migration or life history (no stock annex provided). The RG learned from western stock report that a portion of the western stock migrates northward into the North Sea stock area during spawning (Abaunza et al. 2003).
- Given the uncertainty on the spatial extent of the stock, changes in the defined index area could impact the relative biomass index, which should be taken into consideration for the index based HCR.
- More dependable age data are needed in order to apply a catch at age model to this stock. The age data are based on the Dutch fleet and research vessels. We encourage additional analysis of the age structure of landings from other fleets, since selectivity could vary between fleets.
- It is recommended that discard data are incorporated into future quantitative stock assessment models. Inclusion of discard data will be necessary in determining if this stock is experiencing overfishing.
- Selectivity values need to be more specific in order to accommodate a statistical catch at age model. Selectivity at a given age, selectivity of

different fleets based on fishing gear, changes in selectivity over time, as well as selectivity in different regions of the index area need to be taken into account.

- **Tables and Figures**
  - General Comment: Captions to tables and figures need to cite a data source.
  - **Tables**
    - Table 3.3.1 and 3.3.3 (in Section 3, stated on pg 1 of the report text) do not exist.
    - Table 4.3.1. Summations seem to be wrong compared to individual age catches
    - Table 4.3.2 "millions" is over age in the table but would be less confusing in parenthesis after "catch number".
    - Table 4.3.2 is from 1995-2014, please update in text where it states it is 2013 (pg 211)
    - Table 4.3.3. does not include mean weight at age for 2014? Include a statement about annual mean values as well.
    - Table 4.3.4. does not include mean weight at age for 2014? Include a statement about annual mean values as well.
  - **Figures**
    - No map included in the final figures, would be helpful for the RG to see the survey area
    - Figure 4.2.1 no source for data
    - Figure 4.2.2 no source for data. The text refers to this figure as landings data. Please clarify in figure caption that this isn't total catch (including discards) but landings only.
    - Figure 4.3.1 shows 1995-2014, but captions reads "1987-2014." In reference to this figure, the text reads "1995-2013." Please make sure that the text, figure and figure caption are consistent.
    - Figure 4.3.2 shows age distribution for 1998-2014, whereas caption says "1987-2014" and the text refers to this figure as plotting "1995-2013." Please make sure that the text, figure and figure caption are consistent.
    - Figure 4.4.1 shows catch curves for 1994-2003, whereas the caption says "1992-1999."
    - In section "4.4.3.1 IBTS Survey in area IV" in text, the 3rd and 4th paragraphs cite Figures 4.4.3 and 4.4.4 (in WGWIDE 2014). This is confusing referring to the same figure numbers in the past report. Please just include figures in current (2015 report) and renumber figures.

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- Figure 4.4.3 presents 20+ cm GLM results but not 0-19 cm results.
- In last paragraph of section "4.4.5 Survey Analyses: . . " in text, second to last sentence should end "for the IBTS in Figure 4.4.4 and the CGFS in Figure 4.4.5." (The GFS plot should be Fig. 4.4.5 not "Fig. 4.4.4".)g

- **Consistency in the document**
  - The report shifts between using the terms "tonnes" and "tons." These represent different units, not just different spellings.
  - Division VIa is used in section 4.1, should be IVa.
  - In section 4.1 the sentence "Hence the TAC for 2015 was set at 15 200t, almost half that of 2015" should say "Hence the TAC for 2015 was set at 15 200t, almost half that of 2014".
  - Section 4.2 , third paragraph the RG believes that 2000 (4,400 tons) should be 46,400 tons.
- **JAXassessment**
  - For future quantitative stock assessment models it would be important to understand the sources of uncertainty that contribute to the weak cohort signals observed in the catch-at-age model. Aging errors are said to be large, but the report presents no age validation work to quantify this error. Stock mixing may also obscure cohort structure and is not considered in this model. Shifts in the spatial distribution of fishing effort contribute additional uncertainty, owing to the fishery-dependent nature of the biological data.
  - The assumption of time-invariant fishery selectivity produces significant retrospective patterns in the assessment results and bias in estimated fishing mortality. Future stock assessment models should incorporate time-varying selectivity from across the relevant fishing fleets.
  - The underestimation of total catch from the JAXassessment in recent years is problematic because it results in biases in estimation of fishing mortality, stock biomass and recruitment. This may also introduce biases in determination of reference points and the stock status and projection of future stock dynamics.

10. Conclusions

- The RG agrees that the GLM generally is a good method of CPUE standardization, especially given that the survey area was subsampled. However, the RG has some concerns regarding the data available for the assessment.
- The RG recommends further development of quantitative stock assessment models using either a.) a biomass-dynamic model that incorporates

environmental data via a habitat suitability index that provides insight into changing carrying capacity or b.) the “Robin Hood” method, fitting North Sea, Southern and Western horse mackerel all together.

- The RG strongly recommends that determination of the TAC for 2015 for North Sea horse mackerel considers the level of uncertainty in the biomass index.
- Clarification regarding data sources and model diagnostics would help the RG in understanding sources of uncertainty in this stock.
- The RG encourages further development of surveys for North Sea horse mackerel in area VIId for improved biomass estimates where the majority of the fishery is taking place.

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hom-west: Horse mackerel (*Trachurus trachurus*) in Divisions IIa, IVa, Vb, VIa,, VIIa-c, e-k, VIIIa-e (Western stock)

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

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

4. **Assessment Method:** Separable-ADAPT VPA model (SAD)

5. **Consistency:**
   - Egg survey in this year had an updated time-series and was covered in all the surveyed areas.
   - Bottom trawl survey was not used in assessment, but can be an index of recruitment or abundance.
   - Catch data were amended during the working group which accounted for an additional 5% of total catch (7335 tonnes in division VIIb). This was not used in the assessment due to time limitations.
   - The assessment was conducted with a 6-year separable window as in recent assessments.
   - Discard data were used in the 2014 assessment, with relatively complete data from different European countries in 2015.
   - Model estimates and residual patterns are similar to those presented in 2013 and 2014.
   - TAC in 2015 is less than 2014.

6. **Stock Status:**
   - SSB peaked in 1998 following a strong 1982 year class. Subsequently, SSB peaked following the moderate year classes in the early-to-mid-90s and the moderate-to-strong year class of 2001 (a third of the size of the 1982 year class).
   - Year classes following 2001 have been weak, 2013 recruitment in particular was estimated as the lowest in the time series closely followed by recruitment in 2010.
   - 2008 and 2012 year classes were estimated to be higher than the recent average.
   - Fishing mortality has been increasing since 2007 as a result of increasing catches and decreasing biomass as the 2001 year-class was reduced.
   - SSB in 2014 is the fourth-lowest in the time series.

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7. Management Plan:

- The management plan proposed by the Pelagic RAC in 2007 was evaluated by ICES and considered to be precautionary in the short term.
- The catch advice for 2014-2016 is 137,534 t based on the egg survey time-series.
- The management 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.

8. General Comments:

- The WG report is concise and follows the stock annex. The WG does an excellent good job outlining the uncertainties in the assessment and forecast. However, the RG recommends addressing these uncertainties through structured sensitivity analyses. These include:
    - Natural mortality is listed as uncertain but assumed to be low, M=0.15 and assumed to be constant over years. The WG has stated that previous reviewers have commented that the assumed value for M should be investigated. The RG suggests that alternative values of natural mortality should be run through the model to determine how an over or underestimation of M would impact the stock status.
    - The model relies on a ‘prior’ distribution for realized fecundity, which is used for scaling. Is there any other information available besides the study of Abaunza et al. (2003)? Given this study was conducted more than 10 years ago, the RG would like to see how robust the model result is to the ‘prior’ distribution for realized fecundity.
    - The WG has stated that the precision of recruitment estimates for the most recent year is poor, with CVs of 51-81% for the most recent 5 years. Given large uncertainty associated with recent recruitment estimates, the RG suggests that alternative recruitment levels should be explored in the forecast.
- The WG states that bottom trawl survey information is available but has not been used in the assessment because it only covers a small proportion of the stock; however, because of all the uncertainty in the assessment the RG suggests that an alternative assessment run with these data included should be worthwhile.
- Commercial catch data was amended to account for an additional 5% of the total catch (7,335 tons) but was not used in the assessment due to time limitations. The RG feels that this is a significant amount and should be incorporated into the catch data for the assessment.

9. Technical Comments

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- The assessment contains a fecundity model that links egg production to SSB, however there is only one egg survey data point for every three years. The recruitment estimates are stated as poor, with uncertainty increasing as the assessment is updated without egg survey information. This should highlight the importance of including egg survey data if possible. As shown in the two cases of retrospective analysis, the exclusion of the egg production data in 2013 has a large effect further back in the time-series estimates (Figure 5.2.10.4 and Figure 5.2.10.5)

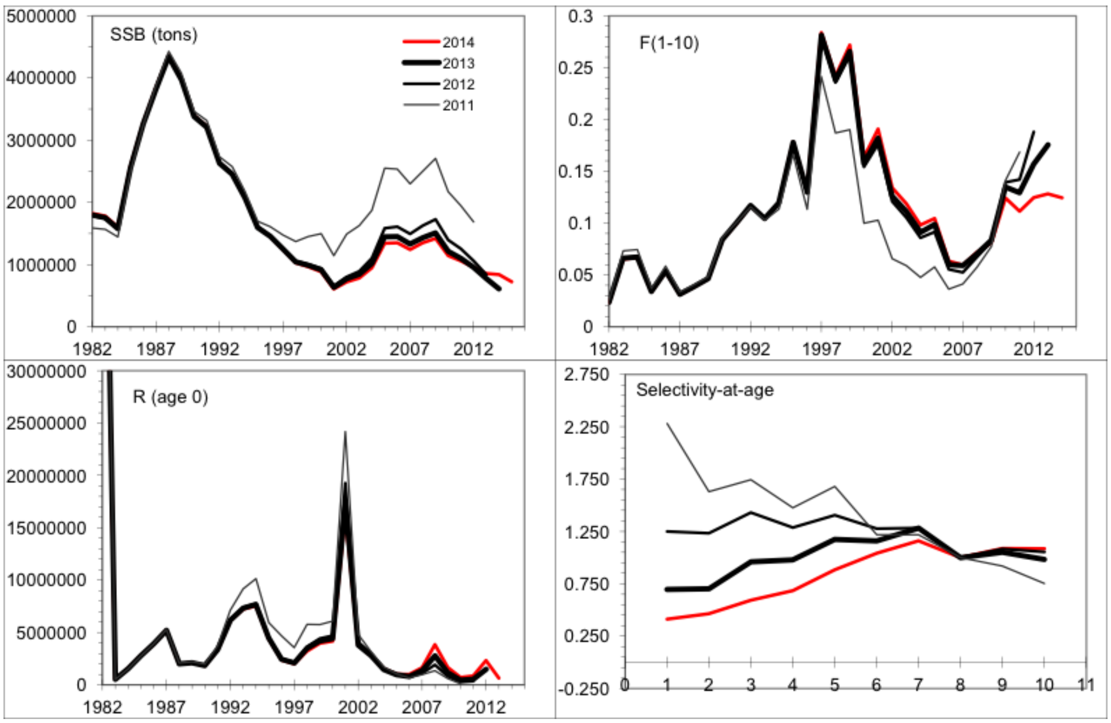

Figure 5.2.10.4: Western horse mackerel. 3-year retrospective bias for the case where the length of the separable window is kept at 6 years (the year shown is the final year shown of the window). Trajectories of SSB, F(1-10), Recruitment (age 0) and selectivity-at-age.

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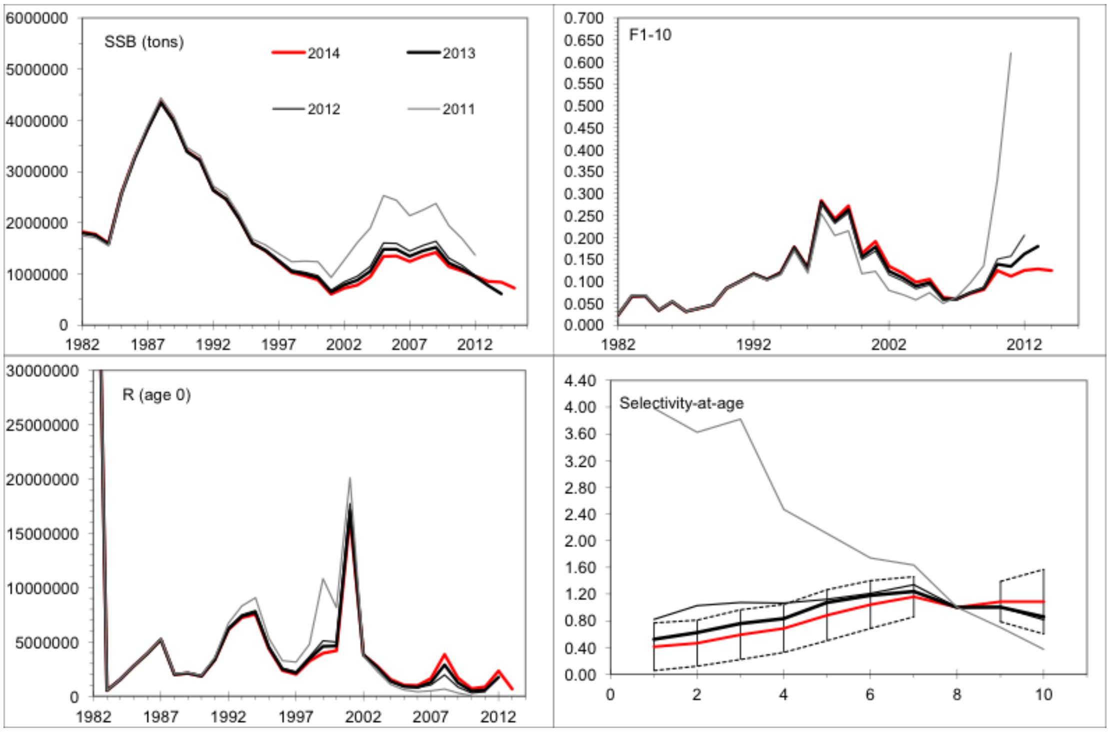

Figure 5.2.10.5: Western horse mackerel. 3-year retrospective bias for the case where the starting year of the separable window is kept at 2009, so that the window decreases in length as more years are dropped (the year shown is the final year of the window). Trajectories of SSB, F(1-10), recruitment (age 0) and selectivity-at-age including confidence bounds from the 2014 assessment.

- The model shows lack of fit for the egg data during the early years (Figure 5.2.10.1). The WG considers this could be related to the model assumption of constant fecundity and this is consistent with the observation that spawning may have continued beyond the survey period. The RG suggests this needs to be further investigated and the RG recommends an alternative run with the down weighted early egg data.

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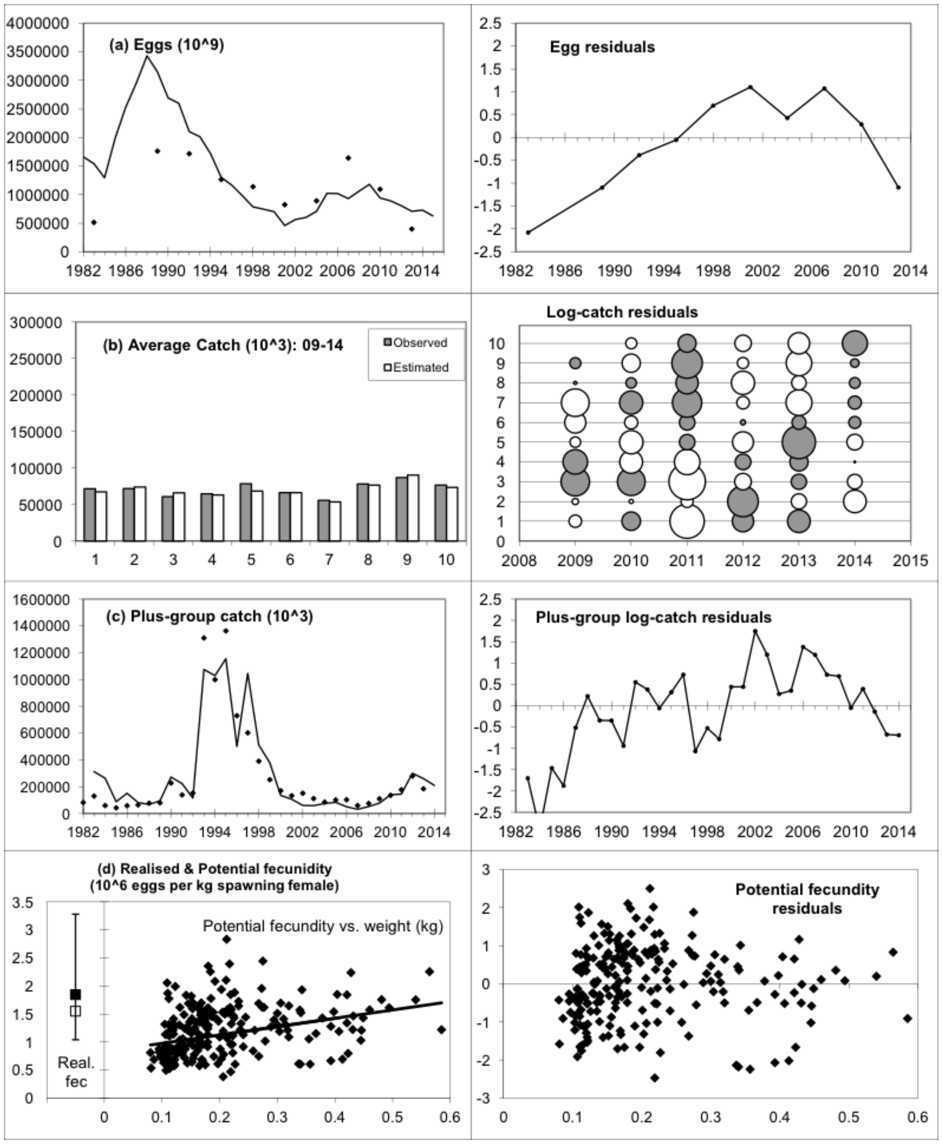

Figure 5.2.10.1: Western horse mackerel. SAD model with 2009-2014 separable window. Model fits to data for the five components of the likelihood, corresponding to (a) the egg estimates, (b) the catches in the separable period, (c) to the catches in the plus-group, and (d) population-mean realised fecundity (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 □□ – ln □̂□̂ / □□. 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.

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- The RG suggests to quantify the retrospective error using Mohn's rho.
- The statement "anecdotal information from Spanish fisheries independent surveys confirms the good incoming recruitment" should potentially be removed, as there is no factual evidence backing this up.
- Figure 5.2.2.1 should make the label of lower panel more clear.

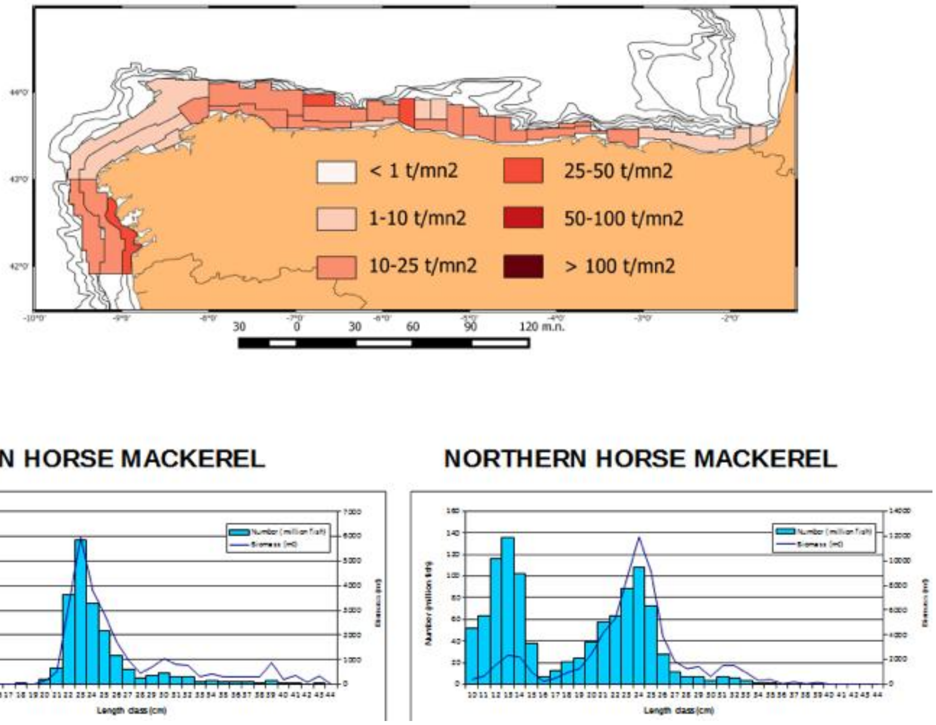

Figure 5.2.2.1: Horse mackerel assessment from PELACUS 0315., including fish density distribution. Note that the scales for the length distribution are different.

- Figure 5.2.5.1 and 5.2.5.2 should use different line types for different ages to make it more distinguishable.

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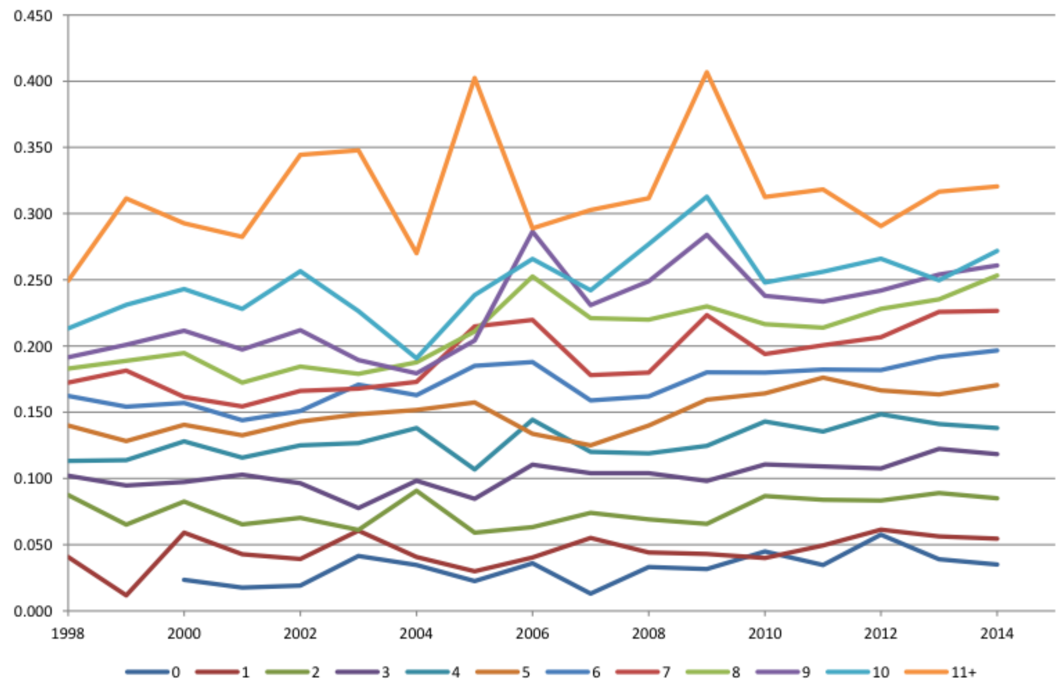

Figure 5.2.5.1: Western horse mackerel. Weight in the catch (kg) by year.

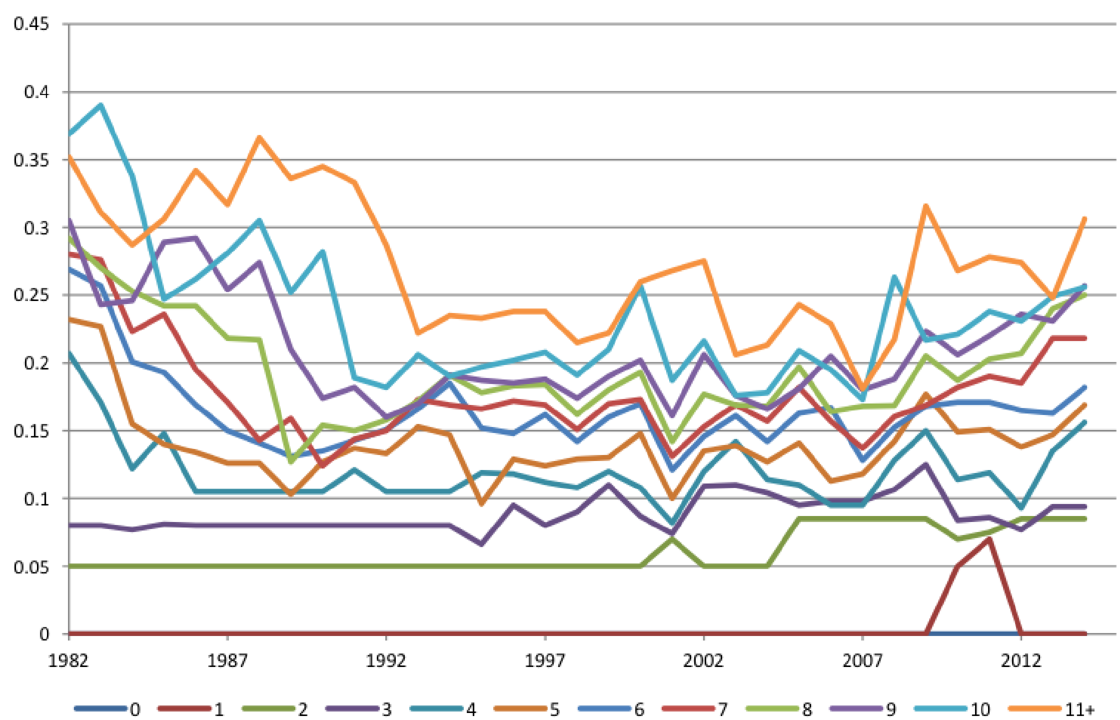

Figure 5.2.5.2: Western horse mackerel. Weight in the stock (kg) by year.

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- Figure 5.2.9.2 is too busy to see what is going on, the RG recommends removing the labels at the very least.

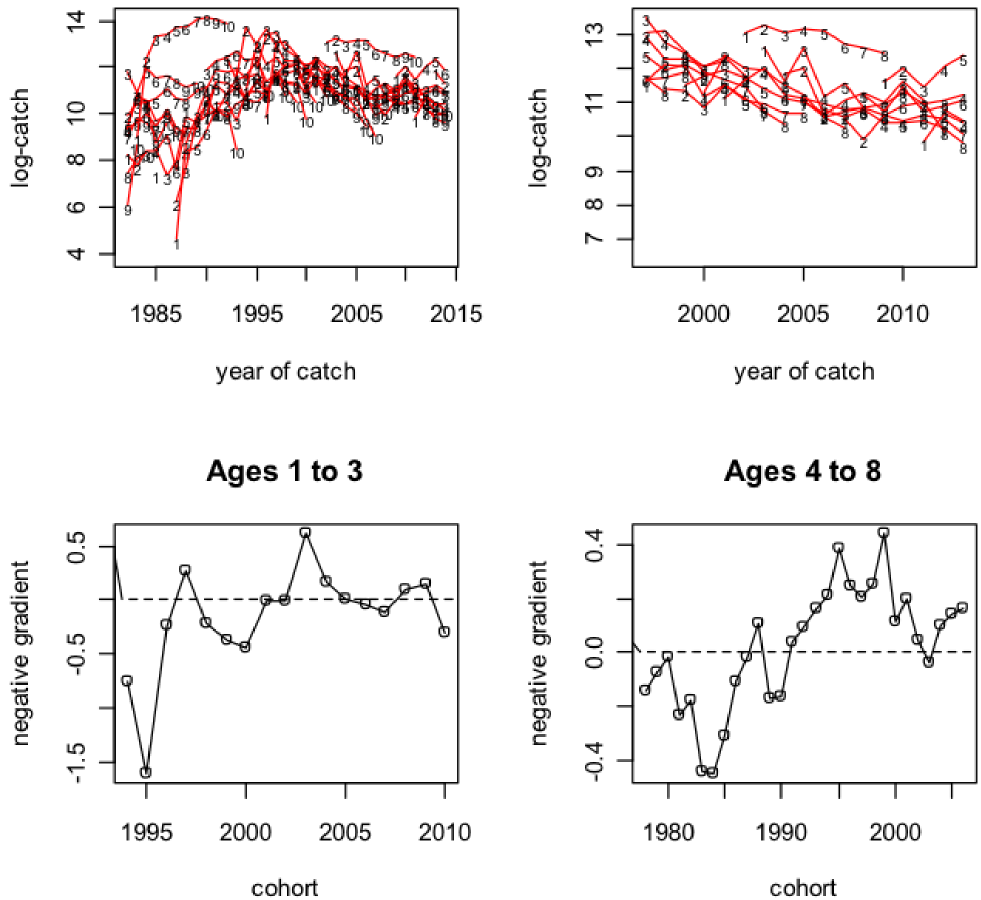

Figure 5.2.9.2: Western horse mackerel. Data exploration. Log-catch cohort curves (top row shows the full time series on the left, and the most recent period for ages 1-8 on the right) and the associated negative gradients for each cohort across the reference fishing mortality of ages 1-3 (bottom left) and 4-8 (bottom right).

10. Conclusions

- The 2015 assessment of western horse mackerel appears to be well done. However, there are some diagnostic issues (e.g., lack of fit for egg data during the early years and the model being highly sensitive to 2013 egg data). The RG understands the limitations in the quality and quantity of egg survey data.
- The RG suggests that exploratory assessment runs should be conducted to investigate the model fitting issue. Also, the RG has concerns about the catch data. The final model should use the amended catch data, as opposed to using the

biased catch data. Since the bottom trawl survey information is available, the RG strongly recommends considering to incorporate them in the model.

- The uncertainties in the assessment and forecast as discussed in the general comments should be addressed.
- Therefore, the RG suggests western horse mackerel to be accepted as long as the above concerns are addressed.

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mac-nea: Mackerel (*Scomber scombrus*) in the Northeast Atlantic (combined Southern, Western and North Sea spawning components)

1. **Assessment Type:** Update of 2014 benchmark assessment including new data and revisions to model configurations

2. **Assessment:** Accepted with caveats

3. **Forecast:** A deterministic short-term forecast using FLR (package in R).
    - No medium- and long-term forecast provided

4. **Assessment Method:** State-space assessment model (SAM) using the web interface following the settings defined by the 2014 benchmark assessment

5. **Consistency:**
    - New data used in this assessment:
        - Revision of the entire egg survey SSB time series
        - Revision of the entire IBTS recruitment index
        - Addition of the 2015 survey data in the IESSNS indices
        - Addition of the 2014 catch-at-age, weights-at-age in the catch and in the stock and maturity ogive, proportions of natural and fishing mortality occurring before spawning.
    - Model parameters for the 2015 update assessment were examined and found to be very different from the 2014 update assessment.
    - Different changes in the model configuration were investigated:
        - Narrower constraints were used for observation variance values.
        - To give the model more freedom, a model with an increased number of parameters was run.
        - The random walk constraint was relaxed on recruitment to give more flexibility to the model.
    - The WG accepted the model using the Ricker stock recruitment function to provide a catch advice for 2016.
    - The new 2015 assessment gives a revised perception of the stock. The differences in the 2013 TSB and SSB estimates between the previous and the present assessments are moderate. However, the upward revision of the 2013 fishing mortality estimate is much larger.

6. **Stock Status:**

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- The SSB is estimated to have increased almost continuously from just under 2 million tons in the late 1990s and early 2000s to 4.2 million tons in 2014.
- The estimate for 2015 suggests a slight decline from 2014 to 2015.
- F has been declining since the mid-2000s and was stable in the early 2010s at around 0.3 and increased to 0.34 in 2014.
- There is insufficient information to estimate the size of the 2014 year class accurately.

7. Management Plan:

- The RG noticed that in the stock annex the WG mentioned a need to re-evaluate the management plan in order to determine the appropriate combination of $B_{trigger}$ and fishing mortality range that are consistent with the precautionary approach. However, neither the report nor any updated versions of the report shows this re-evaluation.

8. General Comments:

- The WG report is well written and follows the stock annex. There are substantial changes in input data and model configurations made in the 2015 assessment. These changes are generally well documented and justified in the report. The WG also listed the factors that might explain the revision of the perception of the stock.
- The protocol of fishery-independent surveys is well documented in the report. However, the methodology used to estimate the abundance indices which are used in the assessment model is not explained in depth. Also the uncertainty associated with the abundance indices is not explicitly considered in the stock assessment.
- The update assessment with the new data produced a perfect fit for the IBTS which is considered to be unrealistic by the WG, however, catch data were not fitted well. The WG rejected this particular run and conducted a series of exploratory runs by changing the input data (revision or/and addition of one extra year of data) and model configurations. The WG decided the model with the Ricker stock recruitment function can be accepted and used to provide catch advice for 2016. The RG has some concerns about this decision: 1) the WG does not provide in-depth explanation of why incorporating a stock recruitment model in the assessment results in a more realistic fit; 2) the resulting stock-recruitment pairs shown in Figure 2.6.2.4 suggest there is a very weak relationship between SSB and recruitment, and the WG concludes that the modeled recruitment could almost be considered a random process. This result is contradictory to the assumption made in this final run (i.e., there is a functional relationship between SSB and recruitment). Given that recruitment could be considered a random

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process, why does assuming a stock recruitment relationship improve the model fit?

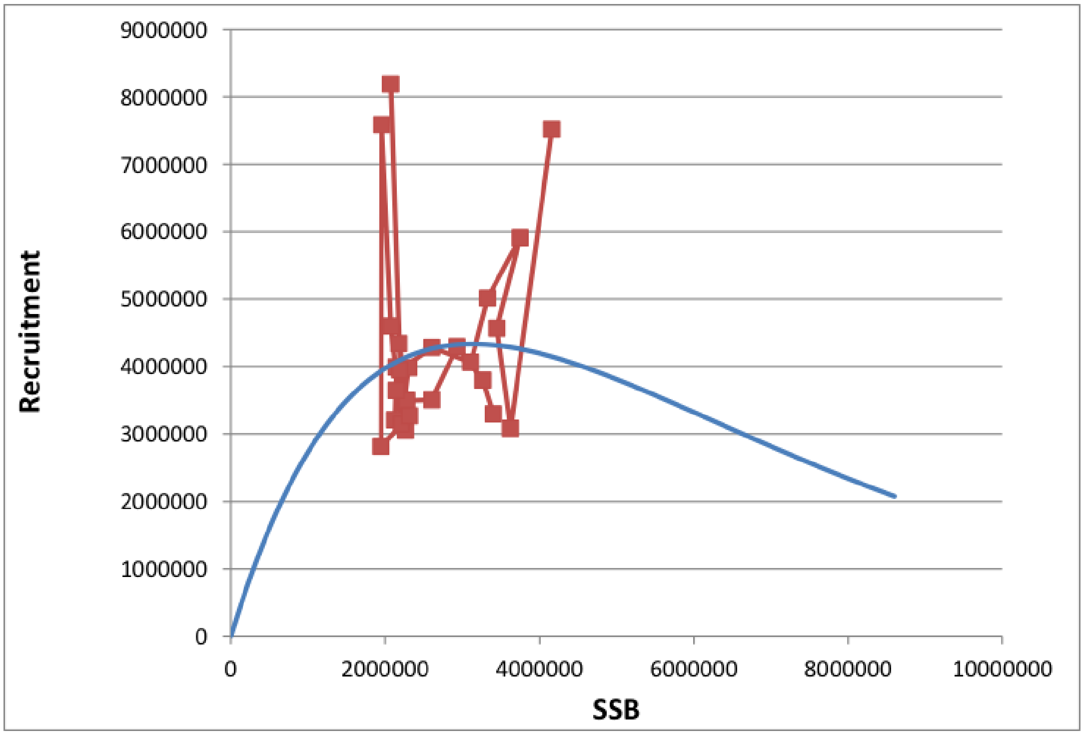

Figure 2.6.2.4. NE Atlantic mackerel. Stock recruitment estimates and underlying Ricker model for the 2015 assessment model in which the random walk on recruitment has been replaced by a Ricker stock recruitment relationship.

- It appears that the model is very sensitive to individual data sources, and often even single data points. Given the potential issues associated with the survey data (i.e., 2007 and 2015) the WG should be very careful to include them in the model. The spatial coverage of the IESSNS in 2007 was quite small compared to the other years. The residual plot (Figure 2.6.3.5) suggests there is an age pattern for 2007 (consistent overestimation for ages 6 to 11). The RG suggests an exploratory run excluding or downweighting the 2007 data point should be investigated. Also, the 2015 IESSNS survey has spatial coverage issues. It seems that this data point is used in the final assessment run. The exploratory runs conducted by the WG suggest this data point has large influence on the assessment result. Therefore, the inclusion of this data point needs to be well justified.

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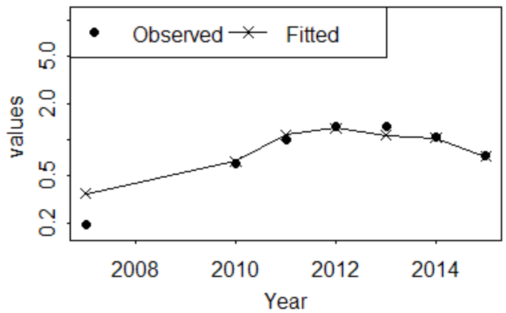
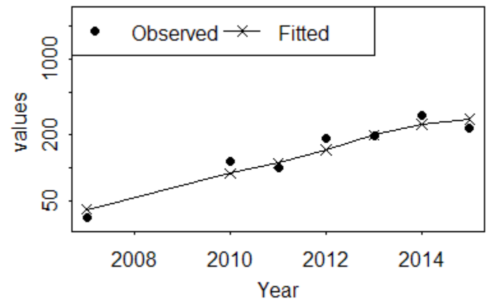
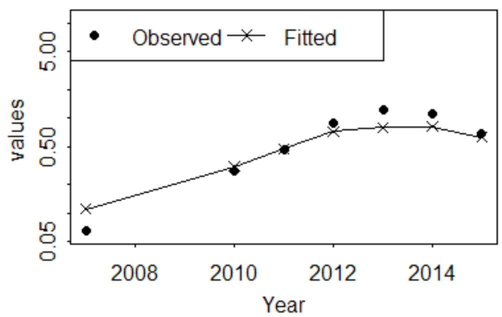
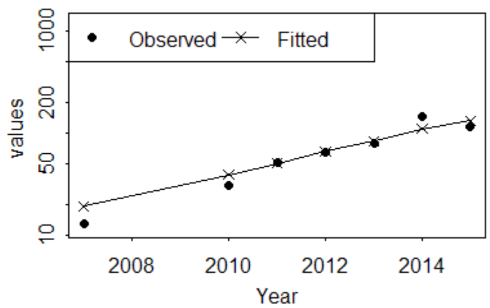
AGE 6 **AGE9**



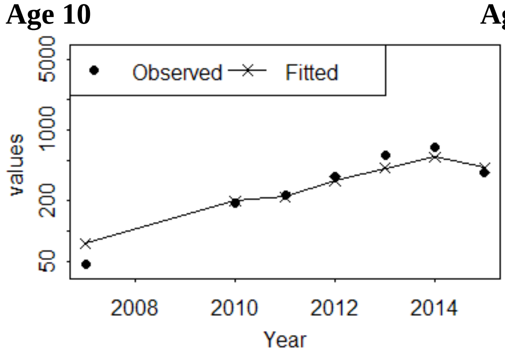


Age 7 **Age 10**





Age 10 **Age 11**



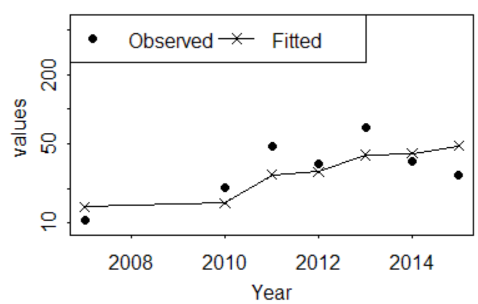


Figure 2.6.3.5. NE Atlantic mackerel. Fit of the final assessment to the IESSNS indices for ages 6 to 11 (observed vs. fitted).

- The recruitment estimate at age 0 from the assessment in the terminal assessment year was considered too uncertain to be used in the short-term forecast. The last recruitment estimate was therefore replaced by predictions from the RCT3 software. The RG suggests alternative recruitment levels should be explored in the forecast.

9. Technical Comments:

- Figure 2.5.2.3 is missing.
- Figure 2.5.1.1 is missing

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- Figure 2.6.2.1 there should be six runs as indicated by the caption, however the figure only shows five.

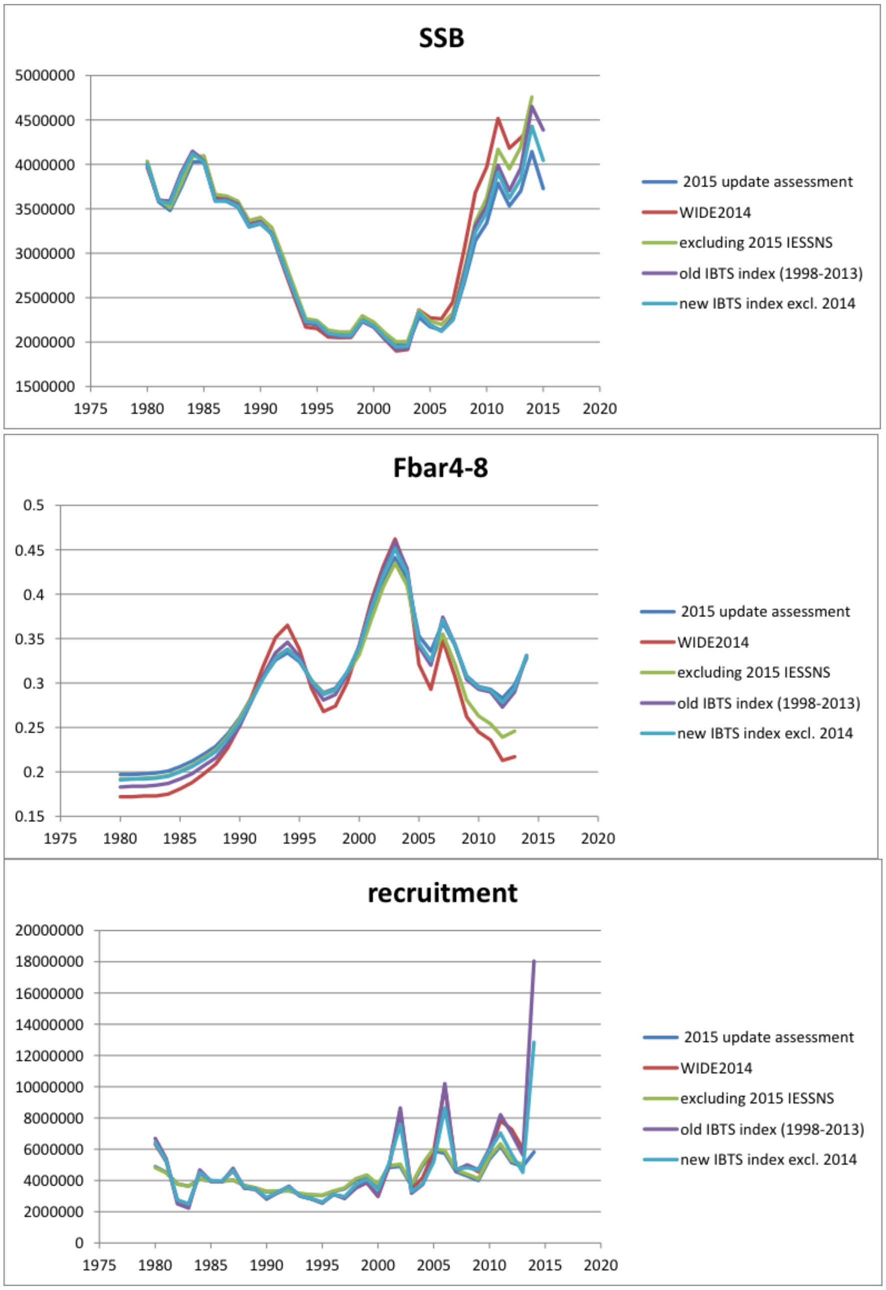

Figure 2.6.2.1. NE Atlantic mackerel. Comparison of stock trajectories from the 2015 update assessment, the 2014 WGWIDE assessment and 4 different assessment in which part of the survey data was modified

- The RG suggests retrospective analysis with a 5-year peel might not be long enough.

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- There is a retrospective pattern for the fishing mortality. The RG suggests quantifying the retrospective error using Mohn's rho.
- Natural mortality is assumed to be 0.15, but the RG found little information to justify the choice of natural mortality. No structured sensitivity analysis was shown for evaluating impacts of uncertainty in natural mortality on the stock assessment.

10. Conclusions:

- The assessment of Northeast Atlantic Mackerel appears well done in general and indicates no large retrospective errors or major diagnostic issues. However, given the substantial changes of data and model configurations made in this assessment, the RG suggests that the selection of final assessment run should be further justified.
- Also, because relatively few data points have a large impact on the assessment results as shown in the report, the RG suggests that more sensitivity runs for the final model setting regarding inclusion, exclusion, or downweighting the data points might be beneficial.
- Therefore, the RG recommends that this assessment could be used as a basis for management as long as the above concerns are addressed.

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whb-comb: Blue whiting (*Micromesistius poutasso*) in Subareas I-IX, XII and XIV (Combined stock)

1. **Assessment Type:** Update

2. **Assessment:** Accept with caveats

3. **Forecast:**
   - Short term projection - Carried out by a deterministic version of the SAM forecast for 2016 and 2017.
   - No medium or long term was carried out.

4. **Assessment Method:** State- Space Assessment Model (SAM) was used.

5. **Consistency:**
   - The model configuration is the same as the 2012 Benchmark, however the time interval of the IBWSS survey was changed to reflect the actual period for the 2015 survey.
   - The 2015 SAM output showed extreme sensitivity to input (i.e. the actual survey dates). The 2012 benchmark survey dates were set at 10%-20% of the year to reflect the timing of the survey conducted early in the year. In 2015, the actual survey period was set at 22%-27% (3/23-4/7). A model run using benchmark 10-20% estimated 2015 SSB at 1.98 million tonnes, while a model setting with 22-27% period gave an estimate of 3.26 million tonnes. Such extreme model sensitivity was not observed with 2014 assessment.
   - This year's model output suggested a downward revision of the historical trends for SSB and recruitment, and upward revision of F.
   - A higher variance for the F random walk parameter was observed in this year's model output (possibly a result of the steep increase in F coupled with high 2014 catches and low 2015 IBWSS indices).
   - The 2015 IBWSS catchability is estimated to be higher than the previous years. As a result, the stock sizes for the recent years are estimated lower in the 2015 assessment.

6. **Stock Status:**
   - The blue whiting stock in Subareas I–IX, XII, and XIV is not overfished. The current SSB is above B_{pa} that is set at 2.25 million tonnes. SSB has increased from 2.9 million tonnes in 2010 to 5.5 million tonnes in 2014.

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- Overfishing is not occurring. F increased from 0.04 in 2011 to 0.45 in 2014, but is still below F_{lim} = 0.48.
- Total catch in 2014 was 1,155,279 while the TAC was 1,200,000
- Catches increased from 104,000 in 2011.
- SSB increased from the mid 1990's, peaked in 2004 and has declined in recent years.
- Recruitment shows increasing trend in recent years.

7. Management Plan:

- No management plan has currently been established for blue whiting in Subareas I–IX, XII, and XIV.
- Biological reference points were re-evaluated in 2013.
- B_{lim} and B_{pa} remained unchanged.
- F_{pa} and F_{lim} were previously undefined. A new F_{lim} and F_{pa} were set at 0.48 and 0.32 respectively.
- TAC of 1.26 million tonnes set for 2015, but coastal EU, Norway and Faroe Islands set their quota unilaterally. The WG estimated the total removal to be 1.3 million tonnes in 2015.
- No minimum landings size has been defined.
- MSY advice currently uses $F_{.01}$ as a proxy for F_{MSY} (=0.3), while $B_{trigger}$ is considered as equivalent to B_{pa}.
- Current biological reference points;
  - B_{lim} = 1.5 million tonnes
  - B_{pa} = 2.25 million tonnes
  - F_{lim} = 0.48
  - F_{pa} = 0.32
  - F_{max} = NA
  - F0.1 = 0.22
  - F_{MSY} = 0.3
  - MSY $B_{trigger}$ = 2.25 million tonnes

8. General Comments:

- The WG report is well written and follows the stock annex. The data and data issues are well documented and discussed at length. The WG does an excellent job providing the sources of uncertainty. The WG did extensive work for this year’s assessment including running other assessment models for comparison.
- The low 2015 IBWSS index caused unforeseen diagnostics and results. 2015 survey abundance indices were so low that the SAM produced an unrealistically high estimate of F in 2015 (=3.85), while the model shows the best fit to the data. The WG did some exploratory runs to investigate this issues and ended up with

the final model including 2015 survey indices. The RG agrees with the WG that without clear justification for exclusion of 2015 IBWSS data, they should be included in the assessment. Because of the low 2015 indices the model was forced to fit a high fishing mortality for 2015 so that the stock sizes are reduced considerably before the survey takes place (this is done without any information on catches in 2015 in the model). The RG agrees with the WG that it is difficult to figure out how biased the estimate of the 2015 F is until catch of 2015 becomes available. However, the RG suggests that more exploratory runs could be done. The WG proposes some solutions, including fixing the 2015 F and setting 'year effect' to eliminate the 'survey bias'. The RG suggests these solutions are worthwhile to try and would like to see the results. Alternatively, the RG suggests downweighting the 2015 survey index if possible.

- This year, the survey date input to the SAM model was revised to the actual dates (22% and 27% of the year). The SAM model output was highly sensitive to this change. The RG agrees with the WG that the survey timing should be set to the actual dates.
- The uncertainty around the recruitment in the most recent year is high. The RG has some concerns about the recruitment levels used in the short-term projection. "Based on additional survey information recruitment in 2014 and 2015 is assumed to be somewhat higher than the SAM estimate and are set to be the 75th percentile of SAM the estimated recruitment 1981—2012. The recruitment in 2016 and 2017 are assumed at the long term average (geometric mean for the period 1981—2012)". The RG suggests the higher recruitment set in the projection in 2014 and 2015 needs to be further justified or at least alternative recruitment levels should be explored.
- Natural mortality is fixed at M = 0.2. However, the RG suggests adding more biological clarification to justify the choice of fixed natural mortality, coupled with a structured sensitivity analysis to evaluate impacts of uncertainty in natural mortality.

9. Technical Comments

- *"The retrospective analysis shows a substantial reduction in SSB and recruitment for the most recent years, while F seems more stable (Figures 8.4.3)."* The RG was unclear whether this statement refers to the retrospective pattern or the trends in population dynamic. Retrospective analyses should be used to evaluate the model performance, not for the evaluation of trends in population dynamics. It is also unclear how many years were peeled in the retrospective analysis. The RG suggests that the caption should clearly indicate number of years considered in the retrospective analysis. The RG also recommends that the number of retrospective

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peels should reflect the life-span of blue whiting. Finally, the RG recommends using Mohn's Rho to quantify the uncertainty for this retrospective analysis.

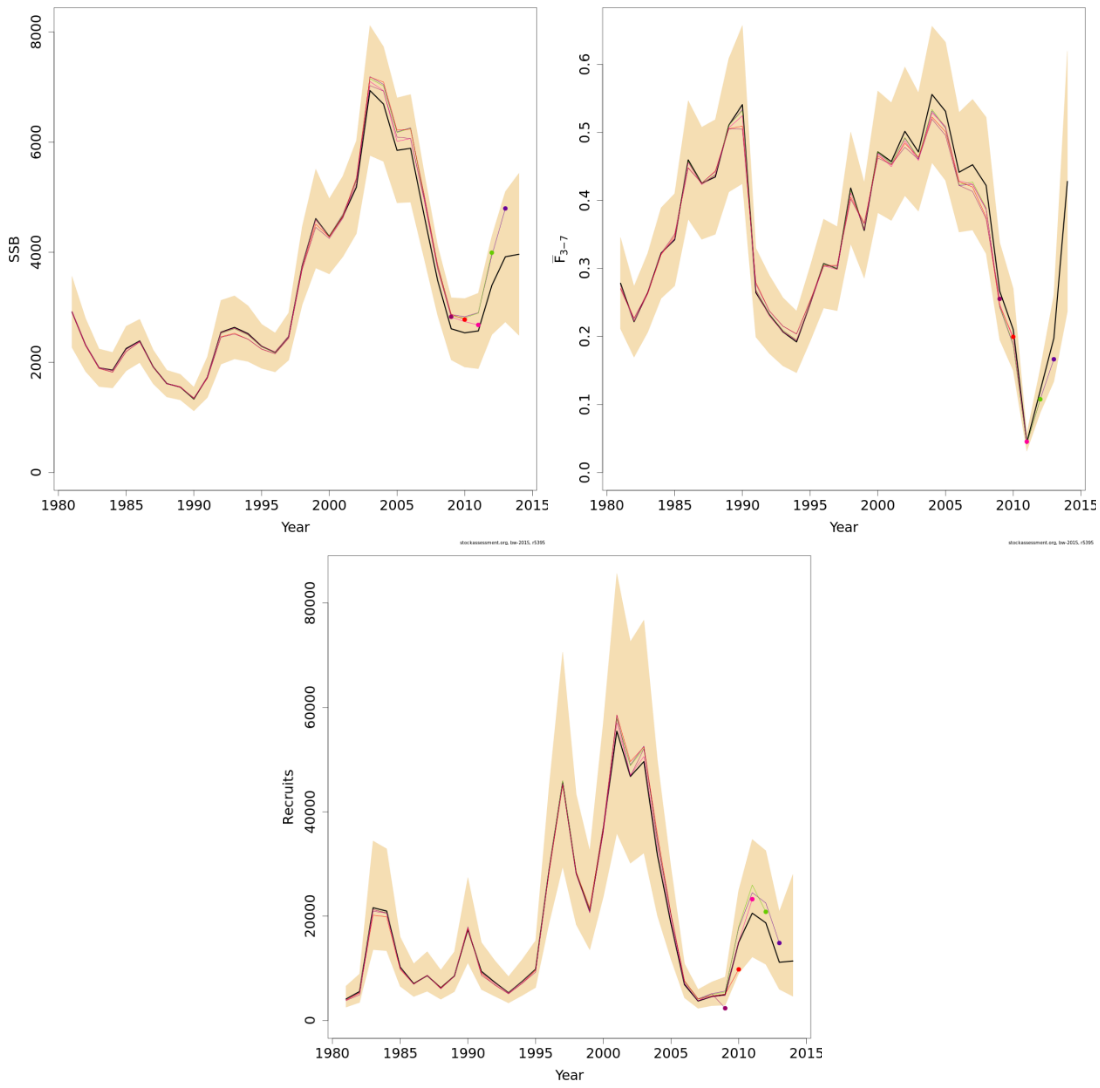

Figure 8.4.3. Blue Whiting. Retrospective analysis of SSB, F and recruitment (age 1) using the SAM model. The 95% confidence interval is shown for the most recent assessment.

- Types of input data for the assessment should be made clear earlier in the report.
- The residual plots show no significant patterns in both age and year. The catch residuals for 2002-2003 show an inverse pattern of discrepancy between younger and older fish. The IBWSS residuals show a higher observed value for age 3-6 in 2012-2013. The "year effect" in 2013 from the IBWSS survey might be worthwhile to examine from ecosystem perspectives (i.e. below/above average water temperature during the 2013 survey).

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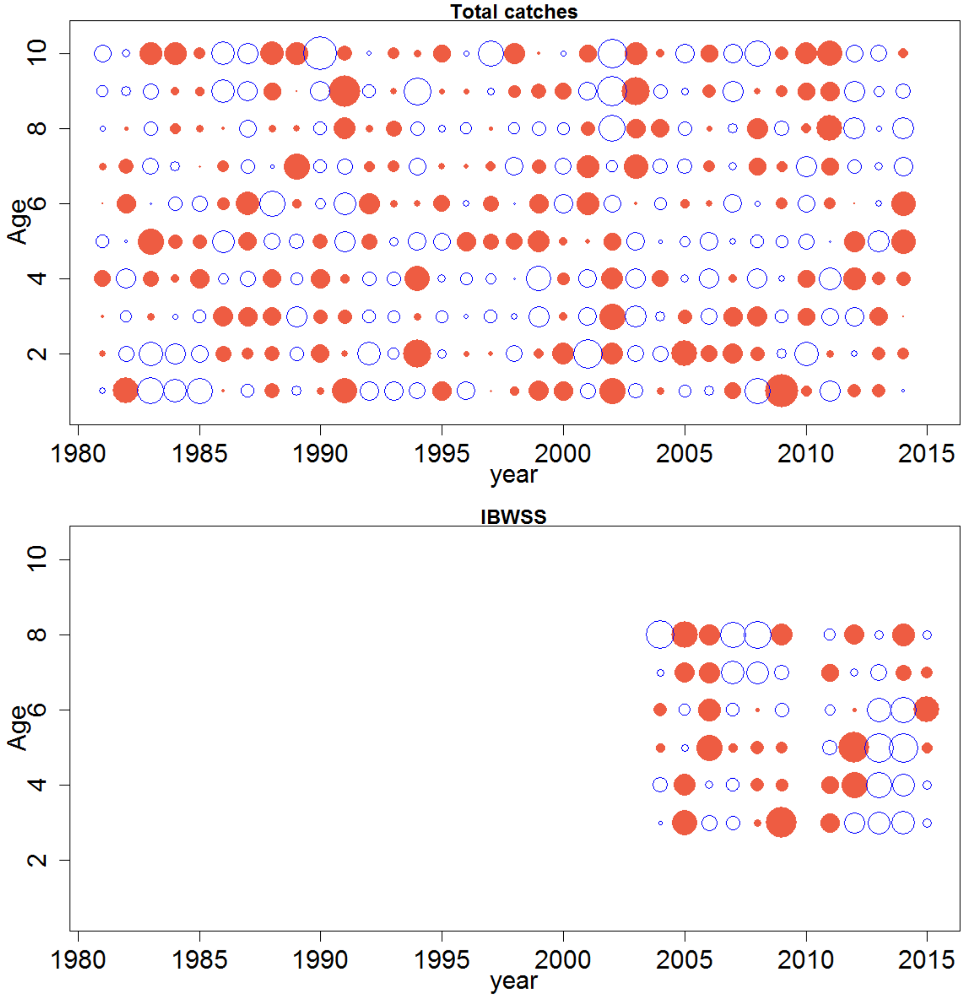

Figure 8.4.1 Blue Whiting. Standardized residuals from catch at age and the IBWSS survey. Red (dark) bubbles show that the observed value is less than the expected value.

- Section 8.6: Needs further clarification on why qualitative analysis of recruitment in 2014 and 2015 does not match with SAM estimates.
- Section 8.8.1 - *"The investigated survey series were standardized by dividing with their mean"*. The RG believes that this statement should be clarified with more technical details and references. The purpose of standardization should also be clarified, and standardizing survey indices by dividing by their mean may not be an appropriate approach. Alternative methods such as converting to z-scores might be a better approach so that each data set has equal means and SDs but different ranges. The RG also suggests converting to presence/absence of different year classes as an alternative.
- Tables need to be listed in descending order according to table number.
- Figure 8.3.1.1 - The figure does not need to be in 3-d format. The y-axis needs to be log-transformed so that areas with low catches are signified.

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- Table 8.3.1.1 - column should be resized so numbers are not squashed. Blanks cells need to be filled with NAs.
- Section 8.3.1 - “Data provided as catch by rectangle represented more than 96% of the total WG catch in 2014.” The use of word “rectangle” needs to be clarified.
- It should be stated up front and made obvious that the IBWSS survey is accoustic.
- Figure 8.3.1.4.1 Needs to include a legend. The figure caption needs to be clarified. The use of term “Internal consistency” is confusing, the figure seems to refer to correlation among different age groups.
- Figure 8.3.4.1.2. No explanation is provided as to why the maps of previous years are different from the 2015 map. Font size for axes needs to be larger. Color ramp for 2015 would be better if the colors are equally distributed within the color ramp. Legend values between years are inconsistent making it difficult to visually compare changes in distribution/abundance.
- Figure 8.3.4.1.3. Should separate age and length into two separate figures or change into an easier to understand format.
- Figure 8.3.4.2.1 The report indicate that the figure refers to 2000-2014, but the actual figure is referring to 2010-2015. The axis texts need to be much larger, and the caption needs to explain the meaning of color envelopes and L-shaped lines.
- Figure 8.3.4.2.2 Text is overlapping in the figure for 2010.
- Figure 8.3.1.1. The figure caption should clarify how the estimates were found.
- Figure 8.3.1.2. Typos in the figure caption. The grey lines are assumed to be EEZs, but should be clarified in the figure caption.
- Figure 8.3.1.3. Range of a quarter should be defined in figure caption. The grey lines are assumed to be EEZs, but should be clarified in the figure caption.
- Figure 8.3.1.4. The axes should be labeled.
- Figure 8.3.1.5. The axes should be labeled. The figure caption needs to be revised.
- Figure 8.3.1.6. The axes should be labeled. The years should be placed vertically on the x axis. The figure caption needs to be revised.
- Figure 8.3.1.3.1. A legend should describe the size of a bubble. The x-axis should have more increments.
- Figure 8.3.1.3.2. The selection of Z=0.6 needs to be justified.
- Section 8.3.3 The section should be referring to table 8.3.3.2, not 8.3.3.1.
- Table 8.4.2. Needs space between “Randomwalkvariance”
- Figure 8.4.2. The RG was unclear about the distinction between F and exploitation pattern discussed by this figure. The 2nd and 3rd panel need much more details in the caption. It seems that the upper right panel represents F scaled to mean F all ages, and the lower left panel represents F scaled to mean F age 3-7. The difference needs to be highlighted in y-axis label. Additionally, the legend is visibly hard to see as it overlaps with lines. Finally, the RG was unclear how “the landings in 2011 were just 19% of the landings in 2010” suppose to be interpreted

by this figure. Finally, it is unclear which panel shows “There are no abrupt changes in the exploitation pattern from 2010 to 2014” as the upper left panel does show abrupt change in F between 2011-2014.

- Section 8.3.4.2 - should provide a unit for the biomass or individuals
- Figure 8.9.1 - Inadequate figure caption. Needs to clarify how each line corresponds to 2009-2014 assessment results. The word “Billions” is over the recruitment lines.
- Figure A1 - Needs to specify which panel corresponds to 2014/2015. The grey lines are assumed to be EEZs, but should be clarified in the figure caption. The different boxes should be labeled.
- Figure A2 - Needs a legend to describe each plot. Axes should be labeled. Revise figure caption.
- Figure A3 - Needs a legend to describe each plot. Axes should be labeled.
- Figure A4 - Needs a legend to describe each plot. Axes should be labeled.
- Figure A5 - Figure incomprehensible
- Figure A6 - Figure incomprehensible
- Figure 8.8.1.1. The x-axis should should be shortened to 1980 to 2015 to make the plot more legible.
- Table 8.8.1.1. “Year range” and “Geometric mean” should be in bold.

10. Conclusions

- The assessment of blue whiting in Subareas I–IX, XII, and XIV appears well done and indicates no large retrospective errors. However, because of including 2015 survey indices and lack of 2015 catch data the estimate of fishing mortality seems to be unrealistically high.
- Given the model shows the best fit to the data and SSB estimate of 2015 is independent of fishing mortality, the RG suggests blue whiting to be accepted as long as following concerns are addressed: a) more exploratory runs on the solution of unrealistically high F as discussed in the general comments needs to be conducted; b) the recruitment levels used in the short-term projection need to be further justified or at least alternative recruitments levels explored for comparison.

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Review of the response to the EU, Faroe Island and Norwegian special request for advice concerning options for a revised management strategy for mackerel.

Analyzes were completed by the Working Group on Widely Distributed Stocks to evaluate 5 points regarding the Coastal States request to ICES on the long term management plan for mackerel. The Working Group provided complete responses to all 5 points and their conclusions are well supported by the associated analyses. The results build on the simulation work reported by WKMACLTMP (ICES CM 2014/ACOM:63) and the recently completed mackerel assessment.

As in all simulations exercises, certain assumptions are inevitable. Given the tight deadlines between this review and release of the information it is unreasonable to expect these assumptions could be explored much further. However it may be useful to consider the possible implications of such changes based on understanding of the model configuration.

The advice cites the recent assessment results which produced a CV of 0.15 and was considered unreasonably small. To account for process error the CV was inflated to 0.3 to for use in calculation of B_{pa}. Given the uncertainties in the assessment data (i.e. poor discard estimates and historic landings) and model as highlighted in 2014 by reviewers in the Report of the Benchmark Workshop on Pelagic Stocks (ICES CM 2014/ACOM:43) it would stand to reason even a doubling of the CV might be conservative. The report acknowledges the uncertainty in the chosen CV but it would be worthwhile to test the implication to the resulting probabilities if a higher CV were chosen. The choice of the CV is important because if B_{lim} remains constant, the increase in the uncertainty results in an exponential increase in B_{pa} while the increased uncertainty in the assessment results would have little impact on setting the TAC since it is constrained by a deviation limit of 20% and/or the F target deviation of 10%.

Life history characteristics (mean weight at age, age at maturity, etc.) were significantly different in recent years and consequently the model used the averages of the most recent 3 years. It was noted that there is no scientific basis to conclude that these characteristics would revert to the long term average over time. However there is evidence (Overholtz,W. J. Northw.Atl.Fish Sci. Vol 9:115-121) that growth in mackerel is density dependent. If would be a reasonable hypothesis to conclude that in the long term, when the population reaches an equilibrium state, these life history features would revert to the long term average. Retaining lower mean weights into an equilibrium state will likely result in a conservative conclusion regarding biomass. It would be reasonable to evaluate this assumption if for no other reason than to confirm the direction of potential bias.

The simulations were based on 1000 iterations randomly choosing among three different stock recruitment relationships (weighted by some associated probability). This would imply that for each S/R relationship there was less than 1000 possible iterations. The WKMACLTMP concluded that 1000 iterations would be about the minimum but a greater number would require a fair amount of time. Since the relative weighting of each S/R model also has some associated uncertainty, it would be useful to increase the number of iterations and perhaps vary the associated model weighting. Without details about the time required, more iterations would need to be held to a reasonable number (or get a faster computer) and would not be possible until a later time. One would expect any increase in iterations to reduce the uncertainty (to so some unknown degree) and reduce the confidence bounds in the simulation results. The median values would likely remain relatively unchanged.

Although these issues might influence the probability distributions and associated risk profile, it is the chosen CV in the B_{pa} calculation which is likely to have the greatest influence on the conclusion. Regardless of these issues, the advice presented is based on reasoned logic and adequately address the five points in the request to ICES.

Review comments on the management strategy evaluation of blue whiting (*Micromesistius poutassou*) in Subareas I–IX, XII, and XIV (Northeast Atlantic)

Ghislain Chouinard, Canada

There was little time to conduct the review of the MSE for blue whiting. The review was based on the methods and results descriptions contained in the advice text which are actually relatively well detailed. It is noted that the addition of the 2015 data changes the perception of the stock in 2013-2014 substantially. The assessment in the previous 3 years had been relatively consistent.

Generally, the analyses provided address the elements contained in the special request. Though simple, the approach to resample past residuals in the observation model is likely adequate. Some of the concerns regarding the analysis relate to the issues that are noted in the advice to have an impact on the results regarding P(SSB<Blim). As such, I agree with the comment that the analysis is not considered sufficiently robust to draw conclusions on whether the HCR is precautionary.

It is indicated that P(SSB<Blim) largely affected by what scaling value is used for vcov (higher value = fewer extreme runs). It would be useful to have some description of the analysis that led to the choice of the scaling value. Ideally, it would be good to have an objective approach to set the scaling value.

By increasing the number of iterations from 200 to 500 or 1000, the probabilities change such that in the cases presented the P(SSB<Blim) was always higher with 500 or 1000 iterations. Analyses with 200 iterations had always the lowest P(SSB<Blim). Furthermore, the results for F=0.25 always indicated that the HCR was not precautionary when using 500 or 1000 iterations while marginally precautionary with 200 iterations. However, nothwithstanding the point above regarding the scaling value, it would appear that the F=0.22 is likely to be precautionary even with 1000 iterations given the results presented and the negligeable impact of the banking and borrowing approach. I was not too concerned with the lack of autocorrelation of recruitment used in the analysis given that the recent period was being used to sample recruitment.

The statement 'The STF used in the evaluations assumes geometric mean recruitment since it is not possible to simulate the WG qualitative procedure for estimating incoming year class sizes.' Will need to be explained more fully if the advice is to go forward. This should also be clarified in the advice document for blue whiting.