ICES WGWIDE MACKEREL SUBGROUP REPORT 2014

ICES ADVISORY COMMITTEE

ICES CM 2014/ACOM:48

REF. ACOM

Report of the WGWIDE subgroup for updated Mackerel advice for 2014

April 2014

by correspondence

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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

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

Recommended format for purposes of citation:

ICES. 2014. Report of the WGWIDE subgroup for updated Mackerel advice for 2014, April 2014, by correspondence. ICES CM 2014/ACOM:48. 40pp.

Contents

1 Introduction

After the WKPELA 2014 (ICES, 2014a) where the Northeast Atlantic mackerel assessment was benchmarked, ACOM asked WGWIDE to provide an updated analytical assessment to support updated advice for 2014. The original advice for 2014 was not based on any analytical assessment (ICES, 2013a), but on average catches over the years 2010–2012. However, when the assessment became available, it was reasonable to update the advice according to this. The updated advice for 2014 was done according the benchmark carried out in WKPELA 2014 (ICES, 2014a). In this report we specify the details of the assessment and forecast.

2 Catch Data

A review of the available catch data were conducted for WKPELA 2014 (ICES, 2014a). There were minor revisions to reported catches since those described at the 2013 WGWIDE (ICES, 2013b). However, revised estimates from discard observer programmes were available and these were incorporated into the total catch, catch-at-age and catch weights data matrices. These can be found on the WKPELA 2014 SharePoint (in the assessment data>input data>nea mackerel>catch data>V2 folder). The time-series of reported catches by country and are given in Tables 2.1 and 2.2.

3 Survey Data

The surveys providing data for the NEA mackerel assessment are shown in Table 3.1., and specified below.

3.1 International Ecosystem Summer Survey in the Nordic Seas (IESSNS)

Data used as specified in WKPELA 2014 (ICES, 2014a) (see Section 3.6.2.1 for details). This time-series (2007, 2010–2013) is a pelagic swept-area survey which is used as area-standardized abundance indices and provides fishery-independent age-structure information. See Table 3.1.1.

3.2 Norwegian tagging program

Tagging data are used as defined in WKPELA 2014 (ICES, 2014a) (see Section 3.6.2.2 for details). Data on number of tagged, scanned and recaptured mackerel by year class, year of release and recapture are available in the "tag.dat" data file in the final assessment "NEAMack-for-update-advice-2014" on www.StockAssessment.org, as well as on ICES WKPELA SharePoint (WKPELA > 2014 Meeting docs > assessment data > input data > nea mackerel).

3.3 Mackerel egg Survey

The egg survey provides a SSB index (WKPELA, 2014, Section 3.6.2.3; ICES, 2014a). The index for 2013 was finalized in mid-April 2014 (ICES, 2014b (WGMEGS, 2014)). The time-series of the index is shown in Table 3.3.1.

3.4 International Bottom-trawl Survey

A recruitment index is derived from the IBTS catch data. The documentation for this can be found in WKPELA 2014 (ICES, 2014a). The time-series of the index is shown in Table 3.4.1.

4 Stock assessment

The stock assessment was performed according to WKPELA 2014 (ICES, 2014a). Input parameters and configurations are summarized in Table 4.1.

4.1 Model diagnostics

The estimated parameters for the final model and their uncertainty estimates are shown in Table 4.1.1.

The model gives a good fit to the catch data (lowest observation variance). Among surveys, the egg survey had the lowest observation variance (best fit), and a slightly higher observation variance was observed for the IESSNS indices. The recruitment index has a substantially higher observation variance. CVs on the observation variances are usually large (from 19 to 46%). The catchability of the egg survey is 1.28, significantly larger than 1, which implies that the assessment considers the egg survey index to be an overestimate. The uncertainty on the estimated catchabilities is higher for the recruitment index (due to lack of fit) and for the IESSNS indices (due to the small number of years available) and lower for the egg survey index. Post release survival for tagged fish is estimated at 37.9% with a low associated CV.

There are few strong correlations between the fitted parameters (Figure 4.1.1). There are, however, a number of exceptions with either positive or negative correlations. The random walk variance for the fishing mortalities appears to be negatively correlated to 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 F random walk variance is also negatively correlated to the observation variance and the random walk variance for the recruits, which were both positively correlated. Importantly, the scaling parameters for the model (catchabilities of the egg survey and the IESSNS indices and post-release survival rate) were all correlated. Otherwise, the majority of the other parameters appear independent of each other, which is an encouraging sign.

Residuals for the catches did not show any temporal pattern (Figure 4.1.2). 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. However, exploratory runs showed that such a configuration resulted in a more unstable model. Residuals for the surveys are given on Figures 4.1.3 to 4.1.6. Residuals for the egg survey are generally low except for a large positive residual in 1998 and a large negative one in 2010. Residuals to the recruitment index were on average larger, without sign of temporal autocorrelation. Residuals for the IESSNS indices were in general small, except for the year 2007 where large negative residuals were observed for most ages; and in 2010 and 2011 for age 11 (Figure 4.1.6.).

Residuals for the tag recaptures do not show any temporal or age pattern (Figure 4.1.7).

4.2 Assessment results

The stock is estimated to have varied between 2 million tonnes in the late 1990s and early 2000s and 5 million tonnes in the recent years (Figure 4.2.1 and Table 4.2.1). There is an indication of decline in Fbar in recent times down to 0.19. 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 superimposed (2002 and 2006).

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 and 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 the final year is estimated with a precision of +/- 25% (Figures 4.2.1 and 4.2.2). There is generally also a large uncertainty on the fishing mortality, especially before 1995. The estimate of Fbar in the final year has a precision of +/- 28%. The uncertainty on the recruitment is consistent throughout the whole time-series, except for the terminal year in the assessment, where the precision of the estimate is+/- 57%.

There is some indication of changes in the selectivity of the fishery over the last 20 years (Figure 4.2.3). 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 (5- and 6-year-olds) 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.

Given the short length of the IESSNS time-series, the retrospective analysis could not be carried out for more than 3 years (Figure 4.2.4). There was no systematic retrospective pattern. Removing one year (2012) of data (purple curve on Figure 4.2.4) had almost no effect on the assessment. Removing two and three years (2011 and 2010) affected the perception of SSB for the year 2009 and 2010 but did not affect the earlier years. This, however, changed the perception of Fbar for the recent years, starting from 2005. Removing 2 or 3 years of data leaves only 3 and 2 data points to estimate the catchability of the IESSNS, respectively, which considerably increases the uncertainty on this parameter. In this situation, the IESSNS has a much lower influence on the assessment and the output is comparable to the run that leaves out the IESSNS (Figure 3.6.4.5.2 in ICES, 2014a). Hence the strong retrospective pattern is a consequence of the short length of the IESSNS time-series and does not necessarily indicate a systematic bias in the assessment. In both SSB and Fbar, the revision when adding one additional year of data were an upwards change. For the recruits, the retrospective changes were similar to SSB. In all cases, the perceived stocks from the retrospective assessments were included within the confidence interval of the final assessment.

5 Short-term forecast

The short-term forecast was performed using MFDP (Smith 2000). The catch in the intermediate year is based on an overview of the declared quotas and transfers for 2013 as described in section 2.1 of the 2013 WGWIDE report (ICES 2013b) and is estimated to be 895 366t. The complete set of input data are given in Table 5.1. The stock numbers for 2013 are taken from the SAM assessment. Numbers-at-age 0 in 2013 (and for subsequent years) have been replaced by the geometric mean from 1990 to 2011 (4 140 087). Numbers-at-age 1 in 2013 are derived from the RCT3 estimate for the 2012 recruitment (replacing the SAM estimate), reduced by natural and fishing mortality.

Stock and catch weights and the maturity ogive are the average of 2010–2012 vectors. The proportions of fishing and natural mortality in 2013 are based on the latest egg production curves. Vectors for 2014 and 2015 are the average of 2011–2013. The selection pattern used is the average of 2010–2012, as given in the assessment output.

Tables 5.2 and 5.3 provide projections for various fishing mortality multipliers and catch constraints in 2014.

Assuming catches of 895 kt in 2013, F is estimated to be 0.188. Should the same catch be taken in 2014, F will rise to 0.193 with a corresponding reduction in SSB from 4.76 Mt to 4.675 Mt. Exploitation in 2014 at F_{MSY} (0.25) will yield catches of 1 134 kt with the management plan target F range (0.2 to 0.22) yielding 927 kt at F=0.2 and 1 011 kt at F=0.22.

6 Reference points

Following the ICES guidelines, WKPELA set new reference points for NEA mackerel. The new values are listed in Table 6.1, and their technical bases are described below.

6.1 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 as the F that on average would bring the stock to B_{lim}; F_{lim} = 0.39.

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 designed to avoid reaching B_{lim}. Consequently, B_{pa} was calculated as B_{lim} * exp(1.645σ) where σ = 0.15 was taken as the assessment estimate of spawning biomass uncertainty in the most recent year; B_{pa} = 2 350 000t.

F_{pa} - F_{pa} is derived from B_{pa} and is determined as the F that on average would bring the stock to B_{pa}; F_{pa} = 0.26.

6.2 MSY reference points

The ICES MSY framework specifies a target fishing mortality, FMSY, which, over the long term, maximizes yield, and also a spawning biomass, MSY Btrigger, below which fishing mortality is reduced proportionately relative to FMSY.

Following the ICES guidelines (ICES, 2013c (WKMSYREF)), WKPELA found that F=0.25 would be an appropriate F_{MSY} target as on average it resulted in the highest mean yields with a low risk 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}. ICES WKMSYREF2 (ICES, 2014c) highlighted that the values of F_{MSY} should be checked using stochastic simulation to ensure that expected errors in the advice do not result in >5% probability of SSB< B_{lim}.

Given the combination of changes described above it is to be expected that the current management plan fishing mortality target range will still be precautionary, and ICES can continue to provide advice under this plan. However, the current management plan $B_{trigger}$ is below the revised B_{pa} and consequently the management plan should be re-evaluated prior to the release of advice for 2015 in order to determine the appropriate combination of $B_{trigger}$ and fishing mortality range that are consistent with the precautionary approach.

7 Comparison with previous assessment

The last analytical assessment for NEA mackerel stock was carried out in WGWIDE 2012 (ICES, 2012; Figure 7.1). Compared to this, the perception of the stock has changed, and is now estimated to have varied between 2 million tonnes in the late 1990s and early 2000s and 5 million tonnes in the recent years (Figure 4.2.1) compared to levels between 1.6 million tonnes and 3 million tonnes in the assessment from 2012. The general trend in fishing mortality is similar to the previous assessment, except for the recent period where the new assessment indicates a strong decline in Fbar, down to 0.19; the previous assessment estimated recent Fbar to be higher than 0.23. 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 superimposed (2002 and 2006). The amplitude for the large year classes in the previous assessment was not as large (1.5 to 2 times) and 2005 was also estimated to be a large year class.

8 Management considerations

EU, Norway and the Faroe Islands have agreed of a TAC of 1.24 million tonnes for 2014 (http://www.fiskebat.no/files/documents/makrellavtale2014.pdf). The TAC of 1.24 million tonnes is above the catch levels given by the fishing mortality range in the current management plan (F = 0.2 – 0.22) and above F_{MSY} (F_{MSY} = 0.25). According to the agreement, of the total quota of 1.24 million tonnes for 2014, EU is allocated 611 205 tonnes, Faroe Islands 156 240 tonnes, Norway 279 115 tonnes and NEAFC 42 537 tonnes. The parties also set aside 15.6% of the TAC for all years 2014-2018 as a Coastal State and Fishing Party reserve. In years 2015-2018 the TACs should be based on levels advised by ICES, from these TACs the shares will be as follows: EU 58.40%; The Faroe Islands 14.93%; Norway 26.67%.

9 References

ICES. 2012. Report of the Working Group on Widely Distributed Stocks (WGWIDE). ICES CM 2012/ACOM:15. 940 pp.

ICES. 2013a. Mackerel in the Northeast Atlantic (combined Southern, Western, and North Sea spawning components). In. Report of the ICES Advisory Committee, 2013. ICES Advice, 2013. Book 9, Section 9.4.17.

ICES. 2013b. Report of the Working Group on Widely Distributed Stocks (WGWIDE). ICES CM 2013/ACOM:15. 950 pp.

ICES. 2013c. Report of the Workshop to consider reference points for all stocks (WKMSYREF). ICES CM 2013/ACOM:37. 17 pp.

ICES. 2014a. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA). ICES CM 2014/ACOM: 43. 341 pp.

ICES. 2014b. Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). ICES CM 2014/SSGESST:14. *xx* pp

ICES. 2014c. Report of the Workshop to consider reference points for all stocks (WKMSYREF2). ICES CM 2014/ACOM:47. 105 pp.

Smith, M. T. 2000. Multi Fleet Deterministic Projection (MFDP), a user's guide.

10 Figures and Tables

Table 2.1 Mackerel in the Northeast Atlantic (combined Southern, Western, and North Sea spawning components). Catches (in tonnes) by country 1988–2012 (data submitted by Working Group members).

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	20	37		125	102	191	351	106	62	114	125	177	146	97
Denmark	36853	34264	35800	41505	42164	42502	50145	36780	28526	21971	27416	30011	29177	22522
Estonia					616		3302	2286	3741	4422	7356	3595	2673	219
Faroe Islands	2622	5032	10000	11131	3347	12575	21568	31199	16851	11513	11229	11620	21023	24184
France	10706	14911	19000	6480	962	3836	11573	11782	15663	20916	17835	16367	19445	20956
Germany, Fed. Rep.	16457	22512	21600	14537	13719	13236	26508	24415	16227	15374	21412	19949	22979	25307
Germany, Dem. Rep.		2409												
Guernsey														
Iceland									92	925	357	357		
Ireland	85800	69980	74300	30138	35088	36982	89028	78534	54313	53129	66650	59675	71233	70452
Jersey														
Latvia					311	4700	1508	389	233					
Lithuania													2085	
Netherlands	28664	31343	38200	69418	82860	89543	44335	35789	36760	23700	30163	28621	32385	36095
Norway	163450	150400	151700	208266	239965	257800	258094	202205	136436	137523	158177	160738	174098	180372
Poland						600				22				
Portugal	4388	3112	3819	2789	3576	2015	2158	2893	3023	2080	2897	2002	2253	3119
Romania							2903							
Spain	21884	16609	17892	22011	17234	20864	27113	29165	33371	46470	44607	45915	38321	44142

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Sweden	1003	6601	6400	4227	5100	5934	7099	6285	5307	4714	5146	5233	4994	5098
United Kingdom	210815	187760	193900	200019	232829	256275	237841	212147	146205	321821	185948	160152	184902	192631
Russia/USSR	27924	12088	28900	13361	42440	49600	28041	44537	44545	53732	67836	51348	50772	41567
Misreported							109625	18647				−211	4816	
Unallocated	34330	25361	8100	12956	15038		4632	29228	10839	5679	11498	38996	66325	62825
Discards	35576	7090	15600	30750	25000	18380	5370	7721	11415	18864	8030		3832	1188
Total	680492	589509	625211	667713	760351	815033	931194	774108	563610	742969	666682	634545	731459	730774

Table 2.1 Mackerel in the Northeast Atlantic (combined Southern, Western, and North Sea spawning components). Continued. Catches (in tonnes) by country 1988–2012 (cont.; data submitted by Working Group members).

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Belgium	22	2	5	1	3	1	2	3	29	21	39
Denmark	34376	27900	25665	23212	24219	25223	26726	23491	41445	35958	36501
Estonia											
Faroe Islands	19768	14014	13029	9769	12067	13429	11289	14062	70987	122050	107630
France	21878	22906	20266	16338	14953	20038	15602	18340	11379	12766	20467
Germany, Fed.	26532	24061	23244	19040	16608	18221	15502	22703	19055	24083	18944
Germany, Dem. Rep.											
Greenland										62	5284
Guernsey					10					10	5
Iceland	53	122		363	4222	36706	112286	116160	121008	159263	149282
Ireland	72172	67355	61102	45687	40664	49260	44759	61056	57994	61596	63049
Jersey				9	8	6	7	8	6	7	

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Latvia											
Lithuania					95	7				23	
Netherlands	33444	30424	27532	25127	24157	24234	19972	23568	23089	28395	25817
Norway	184291	163406	157364	119678	121993	131691	121524	121229	233952	208065	176023
Poland				570		978					
Portugal	2934	2749	2289	1509	2620	2605	2381	1753	2363	962	824
Romania											
Spain	50123	23762	34455	52753	54136	62946	64648	114074	52845	18725	24623
Sweden	5232	445	4437	3204	3209	3858	3664	7303	3428	3249	4564
United Kingdom	194045	183008	174730	152801	95815	133688	112149	157010	160403	180971	169734
Russia/USSR (Russia from	45811	40026	49489	40495	33580	35408	32728	41414	59292	73601	74587
Misreported	6009		31								
Unallocated	50543	59172	46596	13171	4954	12453	1069	−139	5163		5236
Discards	23774	9481	10972	19760	17970	8615	26766	12854	6977	9012	15380
Total	771007	668833	651206	543487	471283	579367	611074	734889	880671	938819	892762

Table 2.2 Mackerel in the Northeast Atlantic (combined Southern, Western, and North Sea spawning components). Catches by area. Discards not estimated prior to 1978 (data submitted by Working Group members).

YE AR	SUB ARE A VI			SUB ARE A VII AND DIVIS IO NS VIIIAB DE			SUB ARE AS III1 AND IV			SUB ARE AS I,II,V AND XIV2			DIVIS IO NS VIIIC AND IXA			TO T AL		
	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
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

YE AR	SUB ARE A VI			SUB ARE A VII AND DIVIS IO NS VIIIAB DE			SUB ARE AS III1 AND IV			SUB ARE AS I,II,V AND XIV2			DIVIS IO NS VIIIC AND IXA			TO T AL		
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
19993	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	133,430	83	133,513	150,008	1,081	151,089	341,663	24	341,687	67,113		67,113	43,198		43,198	735,412	1,188	736,600
2002	127,960	12,931	140,891	104,142	2,260	106,402	391,855	8,583	400,438	74,109		74,109	49,575		49,575	747,647	23,774	771,421
2003	135,690	1,399	137,089	72,357	5,712	78,069	354,109	11,785	365,894	53,883		53,883	26,354		26,354	659,861	19,427	679,288
2004	133,033	1,705	134,738	103,703	5,991	109,694	306,040	11,329	317,369	62,923	9	62,932	34,786	982	35,768	640,529	19,962	660,491
2005	79,960	8,201	88,161	92,777	9,659	102,436	249,741	4,633	254,374	54,129		54,129	49,618	391	50,009	523,726	25,383	549,109
2006	88,077	6,081	94,158	66,114	8,642	74,756	200,929	8,263	209,192	46,716		46,716	52,751	3,606	56,357	454,587	26,593	481,180
2007	110,788	2,450	113,238	71,253	7,709	78,962	253,013	4,195	257,208	72,891		72,891	62,834	1,072	63,906	570,762	15,444	586,206
20084	76,358	21,889	98,247	73,954	5,462	79,416	227,252	8,862	236,114	148,487	112	148,599	59,859	73	59,932	586,090	36,398	622,488
2009	135,468	3,927	139,395	88,287	2,921	91,208	226,938	8,120	235,058	163,604		163,604	107,747	725	108,472	722,035	15,693	737,728

YEAR	SUBAREA VI			SUBAREA VII AND DIVISIONS VIIIABDE			SUBAREAS III1 AND IV			SUBAREAS I,II,V AND XIV2			DIVISIONS VIIIC AND IXA			TOTAL		
2010	106,732	2,904	109,636	104,127	4,614	108,741	246,818	883	247,700	355,725	5	355,730	49,068	4,408	53,476	862,469	12,814	875,283
2011	160,756	1,836	162,592	51,108	5,317	56,425	301,746	1,906	303,652	398,132	28	398,160	24,036	1,806	25,842	935,768	10,894	946,662
2012	121,114	952	122,066	65,723	9,532	75,255	218,400	1,046	219,446	447,207		447,207	24,941	3,848	28,789	877,382	15,380	892,762

[1] Divisions IIIb and IIId from 2000 onwards.

[2] 1976–1985 Division IIa; 1986–1999 Divisions IIa and Va; 2000–2008 Subareas I, II, and V; 2009 Subareas I, II, V, and XIV.

[3] Discards reported as part of the unallocated catches.

[4] Data revised for Northern Ireland.

Table 3.1. NEA Mackerel. The surveys providing data for the NEA mackerel assessment.

Survey name	Survey Acronym	Type	Abundance data	Area and Month	Period
Mackerel Egg Survey	MEGS	Egg survey	SSB index (Western and Southern spawning components)	March to July West Portugal to Faroe Islands	Every third year since 1992
Internation Ecosystem Summer Survey in the Nordic Seas	IESSNS	Pelagic trawl Swept-area	Abundance at age	July-August Norwegian Sea, Iceland, West of Greenland	2007,2010-2013
Internation Bottom Trawls Survey	IBTS	Bottom trawl	Recruitment index	Quarter 4 Continental shelf from Northern Spain to North of Scotland	1998-2012
Norwegian tagging program	-	Tagging-Recapture	Numbers released and numbers recaptured per year, per year class	May Northwest Ireland to North of Scotland	1968-2012

Table 3.1.1. IESSNS index

Year	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
2007	0.192833347	0.066149865	0.047027669	0.035354394	0.012980085	0.010398726
2008	-	-	-	-	-	-
2009	-	-	-	-	-	-
2010	0.62958251	0.273344863	0.18997	0.116164047	0.030974702	0.020263107
2011	0.995318947	0.463782442	0.226442003	0.099828111	0.051338264	0.046593113
2012	1.310799591	0.890325315	0.353939232	0.185671543	0.064728514	0.032820661
2013	1.300869937	1.202164384	0.572929131	0.195023604	0.078744988	0.068672101

Table 3.3.1. Mackerel egg survey index

Year	Index
1992	3370000
1993	-
1994	-
1995	2840000
1996	-
1997	-
1998	3750000
1999	-
2000	-
2001	2900000
2002	-
2003	-
2004	2750000
2005	-
2006	-
2007	3646000
2008	-
2009	-
2010	4289000
2011	-
2012	-
2013	5570000

Table 3.4.1. Recruitment index

Year	Index
1998	0.467656705
1999	0.638432004
2000	0.232791963
2001	0.638170742
2002	0.65235593
2003	0.358648186
2004	0.809318184
2005	1.190326879
2006	1.063104797
2007	0.385761958
2008	0.636563318
2009	0.330024847
2010	0.503952216
2011	0.92553681
2012	0.834884058

Table 4.1. 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	Revised by WKPELA 2014
Catch in tonnes	1980 -2012		Yes	Yes
Catch-at-age in numbers	1980 -2012	0-12+	Yes	Yes
Weight-at-age in the commercial catch	1980 – 2012	0-12+	Yes	No
Weight-at-age of the spawning stock at spawning time.	1980 - 2012	0-12+	Yes	Yes
Proportion of natural mortality before spawning	1980 -2012	0-12+	Yes	Yes
Proportion of fishing mortality before spawning	1980 -2012	0-12+	Yes	Yes
Proportion mature-at-age	1980 -2012	0-12+	Yes	Yes
Natural mortality	1980 -2012	0-12+	No, fixed at 0.15	No

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 (log transformed)	1998-2012	Age 0
Survey (abundance index)	International Ecosystem Summer Survey in the Nordic Seas (IESSNS)	2007, 2010-2013	Ages 6-11
Tagging/recapture	Norwegian tagging program	1980-2006 (recapture years)	Ages 2 and older

Table 4.1. Continued. Input data and parameters and the model configurations for the assessment.

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 0/0/0/0/0/0/0/0/0/0/0/0 1/0/0/0/0/0/0/0/0/0/0/0 0/0/0/0/0/0/2/2/2/2/2/0	No catchability parameter for the catches One catchability parameter estimated for the egg One catchability parameter estimated for the recruitment index 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	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	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 0/0/0/0/0/0/0/0/0/0/0/0 2/0/0/0/0/0/0/0/0/0/0/0 0/0/0/0/0/0/3/3/3/3/3/0	Same observation variance for all ages in the catches One observation variance for the egg survey One observation variance for the recruitment index One observation variance for the IESSNS (all ages)
Stock recruitment model	0	No stock-recruiment model

Table 4.1.1.Final assessment estimated parameters.

Parameter	Parameter estimate	confidence interval	CV
F random walk variance	0.286	(0.203-0.401)	17.3%
log(N@age0) random walk variance	0.468	(0.316-0.693)	20.1%
log(N@age1 to 12+) random walk variance	0.185	(0.146-0.233)	11.9%
observation variance catches	0.101	(0.044-0.231)	46.2%
observation variance egg survey index	0.174	(0.094-0.321)	32.6%
observation variance recruit index	0.338	(0.205-0.558)	26.2%
observation variance IESSNS indices	0.223	(0.152-0.326)	19.5%
tag recaptures over dispersion	1.206	(1.352-1.120)	4.8%
catchability egg survey index	1.280	(1.074-1.526)	8.8%
catchability Recruitment index	1.150E-07	(8.565E-08-1.545E-07)	15.0%
catchability IESSNS indices	5.313E-07	(3.999E-07-7.057E-07)	14.4%
post tagging survival	0.379	(0.332-0.427)	6.3%

Table 4.2.1. NE Atlantic Mackerel. Summary of stock assessment. Low = lower limit and High = higher limit of 95% confidence interval. Recruitment in 000s, SSB and landings in tonnes.

Year	Recruits	Low	High	SSB	Low	High	Mean F Ages 4-8	Low	High	Landings
1980	6168708	2990467	12724757	3933342	1849748	8363939	0.167	0.079	0.352	713311
1981	5080905	2786007	9266164	3576875	1860061	6878286	0.168	0.084	0.335	708960
1982	2714179	1400164	5261359	3562596	2040734	6219375	0.168	0.088	0.321	691909
1983	2465734	1229945	4943183	3867040	2471510	6050552	0.169	0.092	0.309	660242
1984	4386315	2432767	7908589	4122622	2808890	6050794	0.17	0.097	0.299	629626
1985	3898101	2245458	6767078	4049079	2879882	5692955	0.176	0.103	0.299	606084
1986	3913724	2316296	6612815	3623678	2652412	4950603	0.184	0.112	0.303	594697
1987	4551648	2737183	7568913	3634565	2686205	4917742	0.194	0.122	0.309	644016
1988	3499043	2137228	5728590	3580453	2721626	4710290	0.205	0.134	0.315	644926
1989	3368574	2055932	5519291	3335056	2599007	4279557	0.225	0.151	0.336	582419
1990	2824947	1683726	4739679	3351773	2675161	4199517	0.252	0.173	0.367	611911
1991	3159739	1940352	5145433	3201084	2598695	3943109	0.289	0.202	0.413	637183
1992	3464227	2123423	5651661	2827773	2336886	3421775	0.326	0.232	0.458	735351
1993	2954973	1823157	4789421	2480573	2063888	2981383	0.36	0.261	0.497	806856
1994	2794042	1730602	4510958	2135049	1790573	2545796	0.375	0.273	0.515	816025
1995	2594748	1594834	4221580	2105366	1782793	2486304	0.343	0.254	0.462	748079
1996	3106477	1835743	5256837	2032953	1723825	2397517	0.29	0.217	0.387	552196
1997	2960889	1798566	4874363	2041101	1752125	2377738	0.26	0.194	0.35	550749
1998	3660096	2494403	5370545	2063677	1765489	2412230	0.267	0.201	0.355	658652
1999	4135009	2832867	6035686	2244515	1930871	2609105	0.297	0.23	0.384	640311
2000	2925570	2048421	4178321	2193480	1919048	2507157	0.342	0.295	0.398	736524
2001	4775456	3394816	6717590	2041101	1796513	2318989	0.393	0.34	0.455	735412
2002	7771704	5219019	11572938	1899308	1655772	2178663	0.431	0.371	0.5	747647
2003	3457305	2425043	4928967	1905014	1634749	2219961	0.46	0.393	0.539	659861
2004	4465983	2995076	6659267	2354879	1973438	2810048	0.422	0.356	0.5	640529
2005	6205832	4190288	9190859	2299035	1888173	2799300	0.311	0.26	0.373	523726
2006	9879772	6626186	14730931	2331448	1915126	2838272	0.282	0.233	0.34	454587
2007	4547099	3120551	6625789	2561235	2115636	3100686	0.333	0.274	0.406	570762
2008	4852478	3356469	7015272	3185118	2578865	3933893	0.288	0.232	0.357	586090
2009	4130876	2799244	6095979	3863175	3102131	4810925	0.241	0.191	0.304	722035
2010	4950504	3335523	7347422	4151582	3333989	5169673	0.223	0.175	0.284	862469
2011	6715978	4459111	10115101	4727939	3765157	5936914	0.213	0.165	0.276	935768
2012	5774718	3635656	9172313	4329662	3408558	5499677	0.192	0.146	0.253	877382
2013				4408301	3387220	5737189				
Average	4307738	2721046	6886292	3059425	2337199	4098527	0.273	0.204	0.374	

Table 5.1. NE Atlantic Mackerel. Short-term prediction: INPUT DATA

2013	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
0	4140087	0.15	0.00	0.000	0.246	0.000	0.005	0.055
1	5146711	0.15	0.11	0.214	0.246	0.110	0.015	0.118
2	5111482	0.15	0.55	0.214	0.246	0.166	0.042	0.216
3	3602001	0.15	0.91	0.212	0.246	0.211	0.095	0.286
4	2012725	0.15	1.00	0.212	0.246	0.257	0.167	0.335
5	2018772	0.15	1.00	0.185	0.246	0.303	0.193	0.369
6	2431454	0.15	1.00	0.185	0.246	0.340	0.215	0.410
7	2438759	0.15	1.00	0.185	0.246	0.370	0.231	0.451
8	1349170	0.15	1.00	0.185	0.246	0.400	0.231	0.483
9	525970	0.15	1.00	0.185	0.246	0.439	0.231	0.519
10	236097	0.15	1.00	0.185	0.246	0.486	0.231	0.563
11	140927	0.15	1.00	0.185	0.246	0.518	0.231	0.584
12+	101824	0.15	1.00	0.185	0.246	0.551	0.231	0.626
2014								
0	4140087	0.15	0.00	0.000	0.249	0.000	0.005	0.055
1	-	0.15	0.11	0.187	0.249	0.110	0.015	0.118
2	-	0.15	0.55	0.187	0.249	0.166	0.042	0.216
3	-	0.15	0.91	0.221	0.249	0.211	0.095	0.286
4	-	0.15	1.00	0.221	0.249	0.257	0.167	0.335
5	-	0.15	1.00	0.204	0.249	0.303	0.193	0.369

2013	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
6	-	0.15	1.00	0.204	0.249	0.340	0.215	0.410
7	-	0.15	1.00	0.204	0.249	0.370	0.231	0.451
8	-	0.15	1.00	0.204	0.249	0.400	0.231	0.483
9	-	0.15	1.00	0.204	0.249	0.439	0.231	0.519
10	-	0.15	1.00	0.204	0.249	0.486	0.231	0.563
11	-	0.15	1.00	0.204	0.249	0.518	0.231	0.584
12+	-	0.15	1.00	0.204	0.249	0.551	0.231	0.626
2015								
0	4140087	0.15	0.00	0.000	0.249	0.000	0.005	0.055
1	-	0.15	0.11	0.187	0.249	0.110	0.015	0.118
2	-	0.15	0.55	0.187	0.249	0.166	0.042	0.216
3	-	0.15	0.91	0.221	0.249	0.211	0.095	0.286
4	-	0.15	1.00	0.221	0.249	0.257	0.167	0.335
5	-	0.15	1.00	0.204	0.249	0.303	0.193	0.369
6	-	0.15	1.00	0.204	0.249	0.340	0.215	0.410
7	-	0.15	1.00	0.204	0.249	0.370	0.231	0.451
8	-	0.15	1.00	0.204	0.249	0.400	0.231	0.483
9	-	0.15	1.00	0.204	0.249	0.439	0.231	0.519
10	-	0.15	1.00	0.204	0.249	0.486	0.231	0.563
11	-	0.15	1.00	0.204	0.249	0.518	0.231	0.584
12+	-	0.15	1.00	0.204	0.249	0.551	0.231	0.626

Table 5.2 NE Atlantic Mackerel. Short-term prediction: Management option table for 895 336 t catch in 2013 and a range of F-multipliers in 2014.

2013							
TSB	SSB	Fmult	Fbar	Landings			
6047077	4759572	0.9071	0.188	895336			
2014					2015		
TSB	SSB	Fmult	Fbar	Landings	TSB	SSB	Implied change in the landings
5775820	4837582	0.00	0.000	0	6223360	5370619	-100%
	4819774	0.10	0.021	104179	6135150	5266198	-88%
	4802039	0.20	0.042	206402	6048629	5164204	-77%
	4784378	0.30	0.062	306708	5963762	5064575	-66%
	4766790	0.40	0.083	405137	5880517	4967254	-55%
	4749274	0.50	0.104	501727	5798858	4872183	-44%
	4731831	0.60	0.124	596515	5718753	4779307	-33%
	4714460	0.70	0.145	689539	5640171	4688571	-23%
	4697160	0.80	0.166	780834	5563079	4599922	-13%
	4679932	0.90	0.187	870435	5487447	4513309	-3%
	4662775	1.00	0.207	958377	5413245	4428681	7%
	4645688	1.10	0.228	1044694	5340443	4345990	17%
	4628672	1.20	0.249	1129418	5269013	4265187	26%
	4611726	1.30	0.270	1212582	5198927	4186227	35%
	4594850	1.40	0.290	1294218	5130156	4109064	45%
	4578044	1.50	0.311	1374356	5062675	4033654	54%

4561307	1.60	0.332	1453026	4996455	3959953	62%
4544638	1.70	0.353	1530259	4931472	3887921	71%
4528039	1.80	0.373	1606083	4867701	3817515	79%
4511508	1.90	0.394	1680528	4805116	3748696	88%
4495044	2.00	0.415	1753619	4743693	3681426	96%

Table 5.3. NE Atlantic Mackerel. Short-term prediction: Catch options for 2014.

Rationale	Fbar (2013)	Catch 2013 (kt)	SSB 2013 (Mt)	Fbar (2014)	Catch 2014 (kt)	SSB 2014 (Mt)	SSB 2015 (Mt)
Catch(2014) = Zero	0.188	895	4.760	0	0	4.838	5.371
Catch(2014) = 2013 catch - 20%	0.188	895	4.760	0.151	716	4.709	4.663
Catch(2014) = 2013 catch	0.188	895	4.760	0.193	895	4.675	4.489
Catch(2014) = 2013 catch +20%	0.188	895	4.760	0.235	1,074	4.640	4.318
Catch(2014) = 1.2Mt	0.188	895	4.760	0.267	1,200	4.614	4.198
Catch(2014) = 1.24Mt	0.188	895	4.760	0.277	1.240	4.606	4.161
Catch(2014) = 1.3Mt	0.188	895	4.760	0.291	1.300	4.594	4.104
Catch(2014) = 1.4Mt	0.188	895	4.760	0.318	1.400	4.573	4.010
Fbar(2014) = 0.20 (MP lower)	0.188	895	4.760	0.2	927	4.669	4.459
Fbar(2014) = 0.21	0.188	895	4.760	0.21	969	4.661	4.418
Fbar(2014) = 0.22 (MP upper)	0.188	895	4.760	0.22	1,011	4.652	4.378
Fbar(2014) = 0.25 (Fmsy)	0.188	895	4.760	0.25	1,134	4.628	4.261
Fbar(2014) = 0.26 (Fpa)	0.188	895	4.760	0.26	1,174	4.620	4.223
Fbar(2014) = 0.39 (Flim)	0.188	895	4.760	0.39	1,666	4.515	3.762

Table 6.1 ICES Reference points for NEA mackerel as proposed by WKPELA (ICES, 2014a).

Type		Value	Technical basis
Management Plan	SSBtrigger	N/A	Revision required
	F target	N/A	Revision required
MSY Approach	MSY Btrigger	2.36 million t	Proxy based on Bpa
	MSY target	0.25	Stochastic simulation conducted at WKPELA 2014
Precautionary Approach	Blim	1.84 million t	Bloss in 2002 from WKPELA 2014 benchmark assessment
	Bpa	2.36 million t	exp(1.654*σ)*Bim, σ=0.15
	Flim	0.39	Floss, the F that on average leads to Blim
	Fpa	0.26	F that on average leads to Bpa

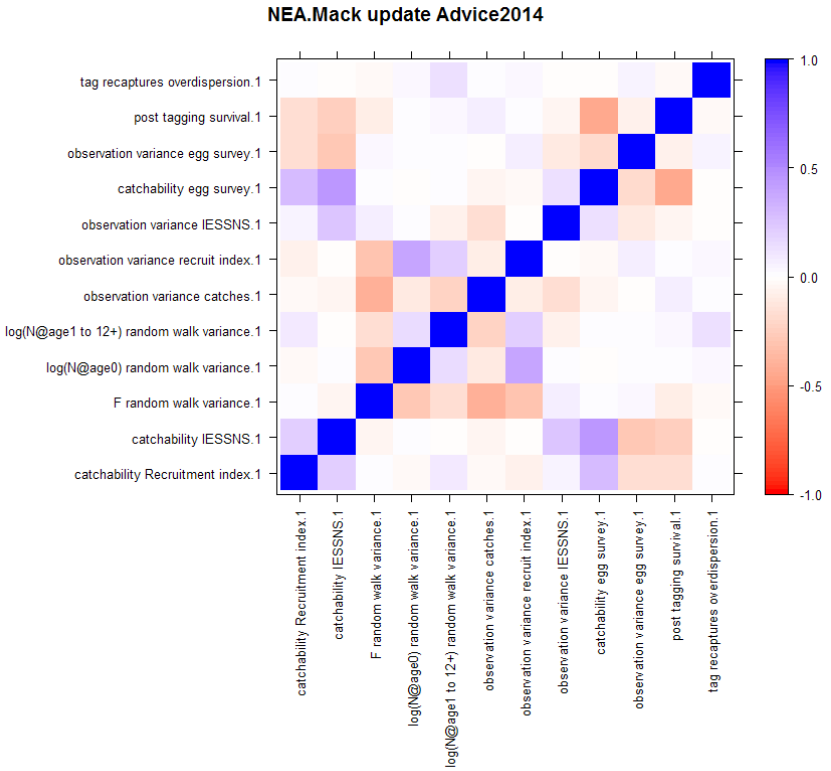

Figure 4.1.1 : parameter correlations for the final model. The horizontal and vertical axes show the parameters estimated by the model. The colouring indicates the (Pearson) correlation between the two parameters.

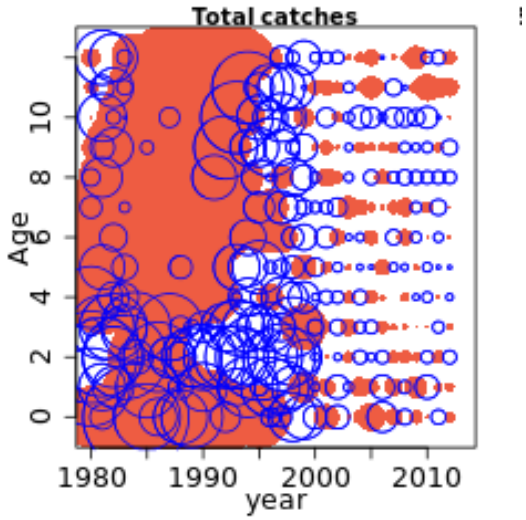

Figure 4.1.2 : Normalized residuals for the fit to the catch data (catch data prior to 2000 were not use to fit the model). Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

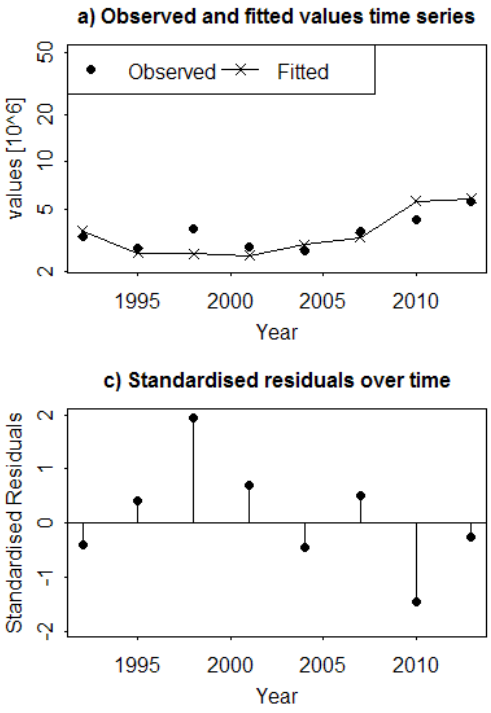

Figure 4.1.3 : model diagnostics for the fit to the egg survey index time-series

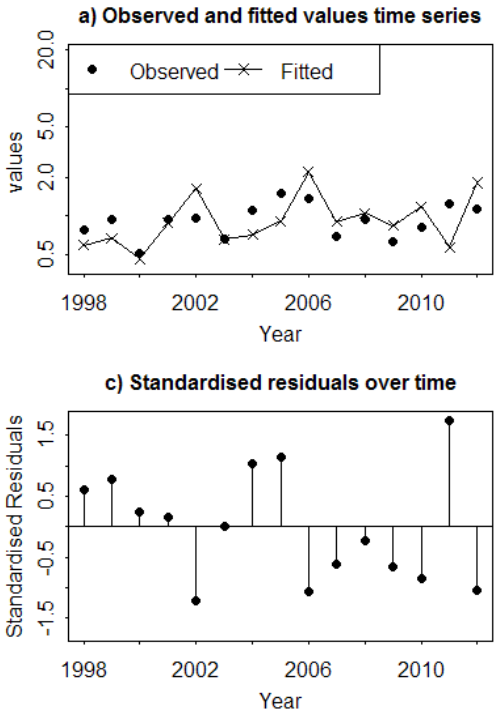

Figure 4.1.4 : model diagnostics for the fit to the recruitment index time-series

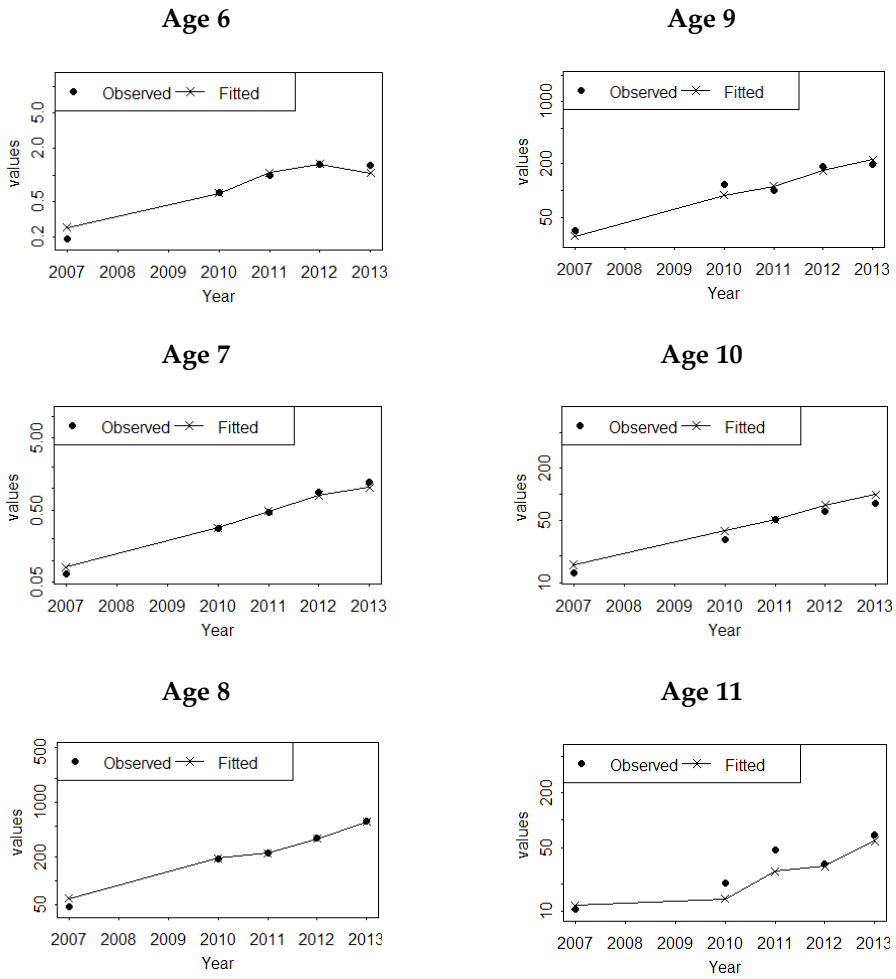

Figure 4.1.5. fit of the final assessment to the IESSNS indices for ages 6 to 11 (observed vs. fitted)

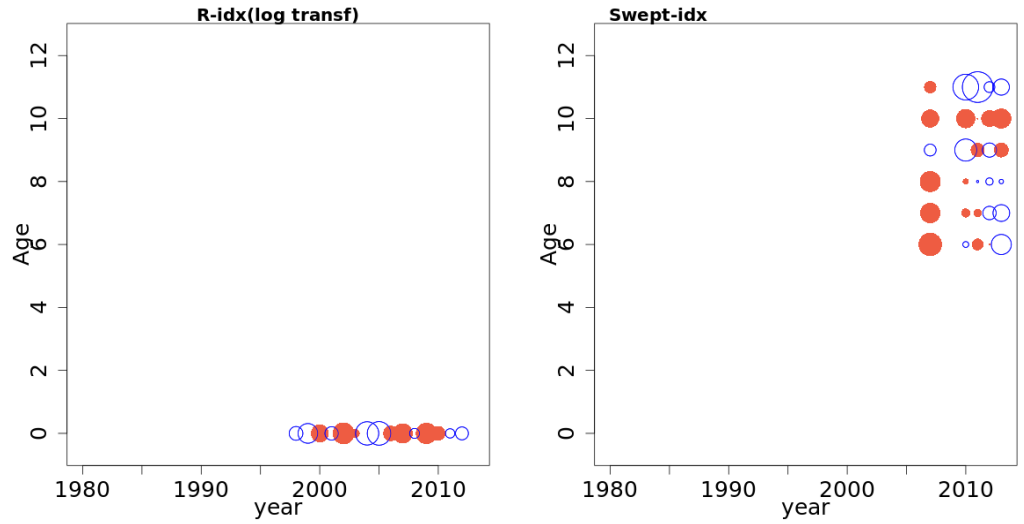

Figure 4.1.6. Normalized residuals for the fit to egg survey index, recruitment index, and IESSNS-survey in the final assessment.

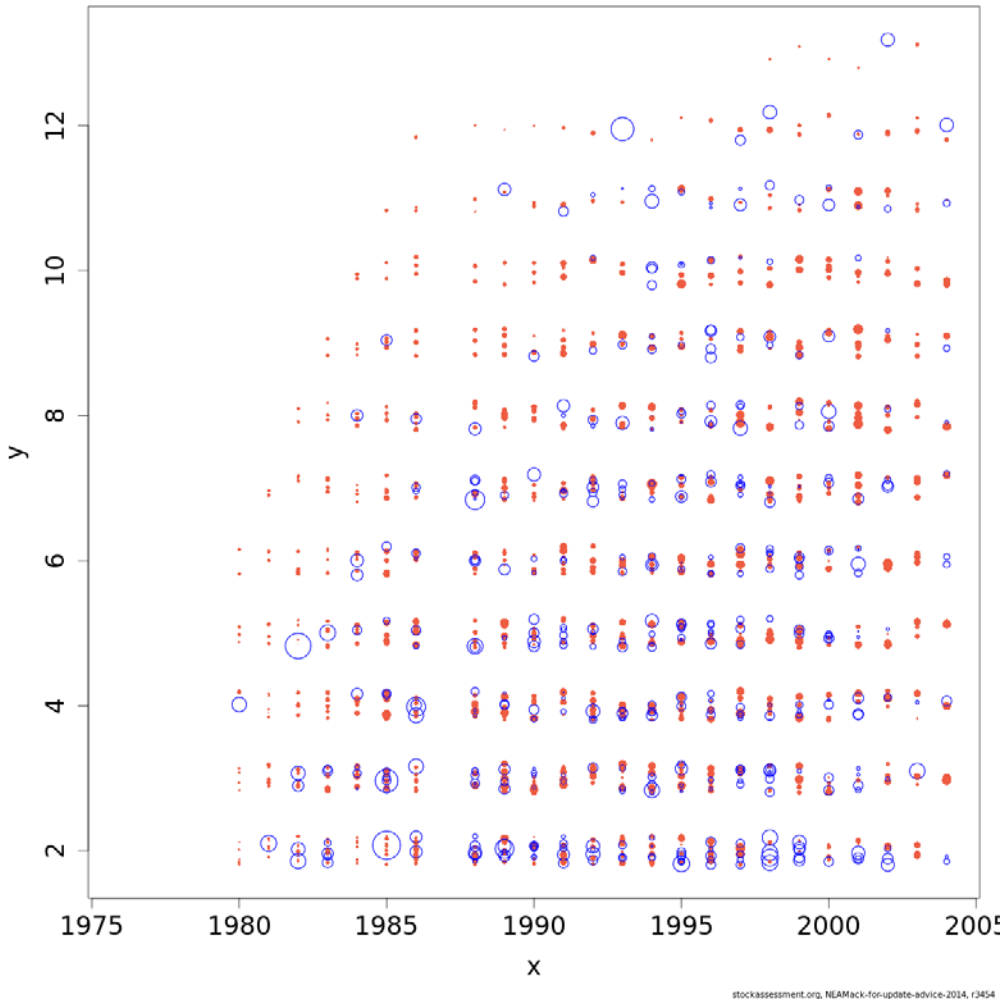

Figure 4.1.7. Normalized residuals for the fit to the recaptures of tags in the final assessment. The x-axis represents the release year, and the y-axis is the age of the fish at release. The different circles for a same x-y point represent the successive recaptures. Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

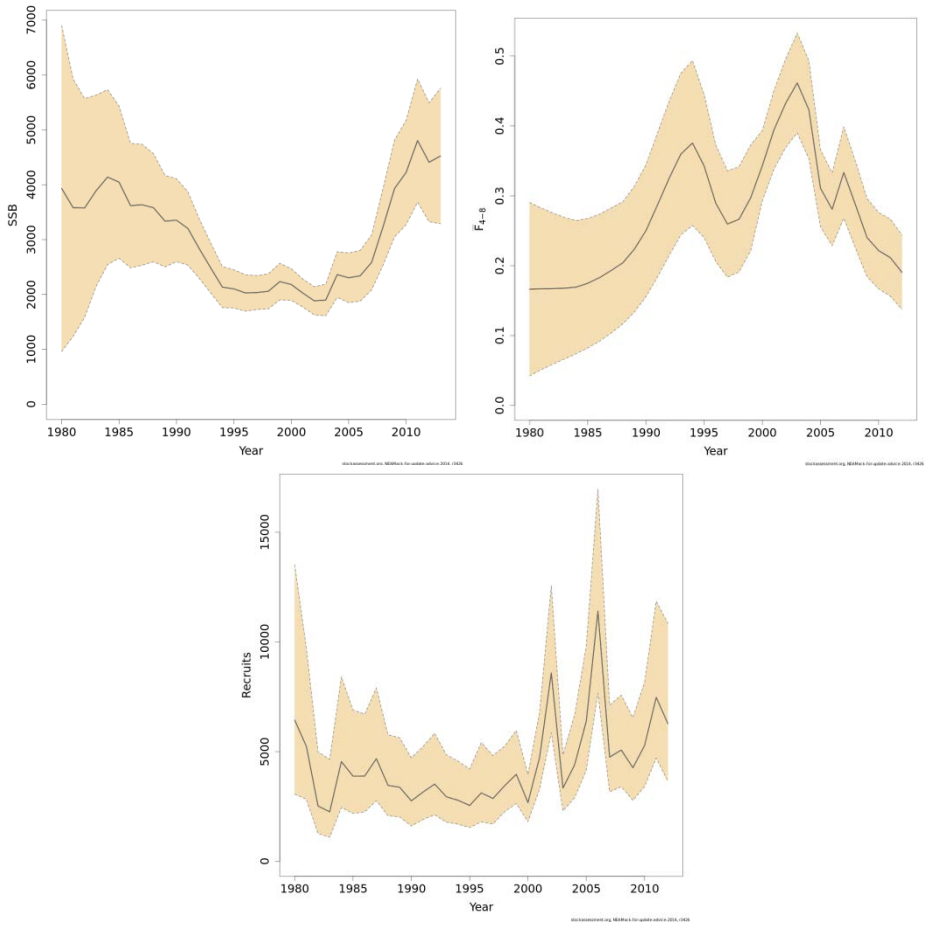

Figure 4.2.1: Perception of the NEA mackerel stock, showing the SSB, Fbar4-8 and recruitment (with 95% confidence intervals) from the benchmarked SAM assessment.

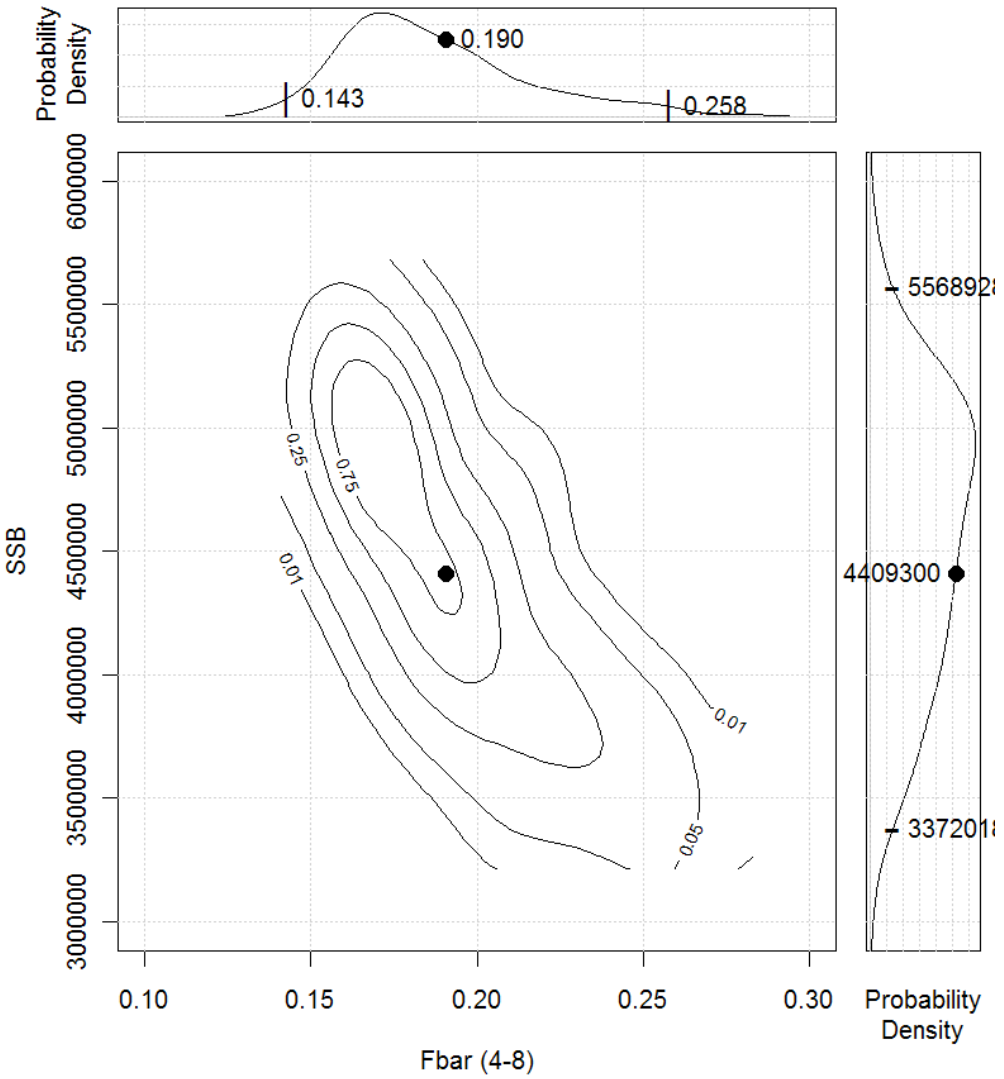

Figure 4.2.2. Joint distribution of the estimates of SSB and Fbar in 2012 resulting from the uncertainty in the parameters estimated by resampling parameters from the variance covariance matrix estimated by SAM.

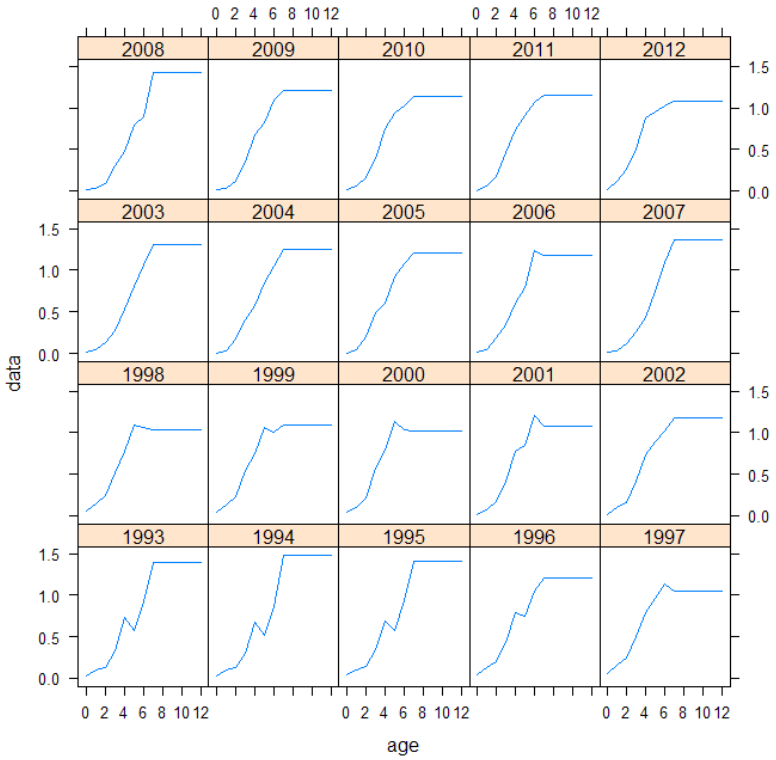

Figure 4.2.3: Estimated selectivity (fishing mortality divided by Fbar4-8) for the period 1993 to 2012, calculated as the ratio of the estimated fishing mortality-at-age and the corresponding Fbar4-8 values.

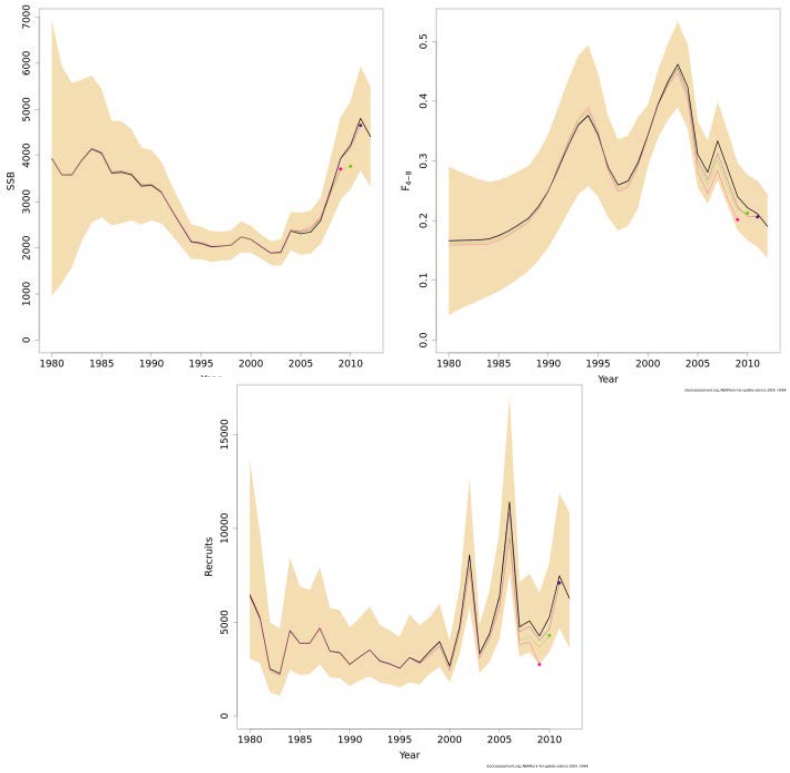

Figure 4.2.4. Analytical retrospective patterns (2012 to 2010) of SSB, Fbar4-8 and recruitment from the benchmarked SAM assessment.

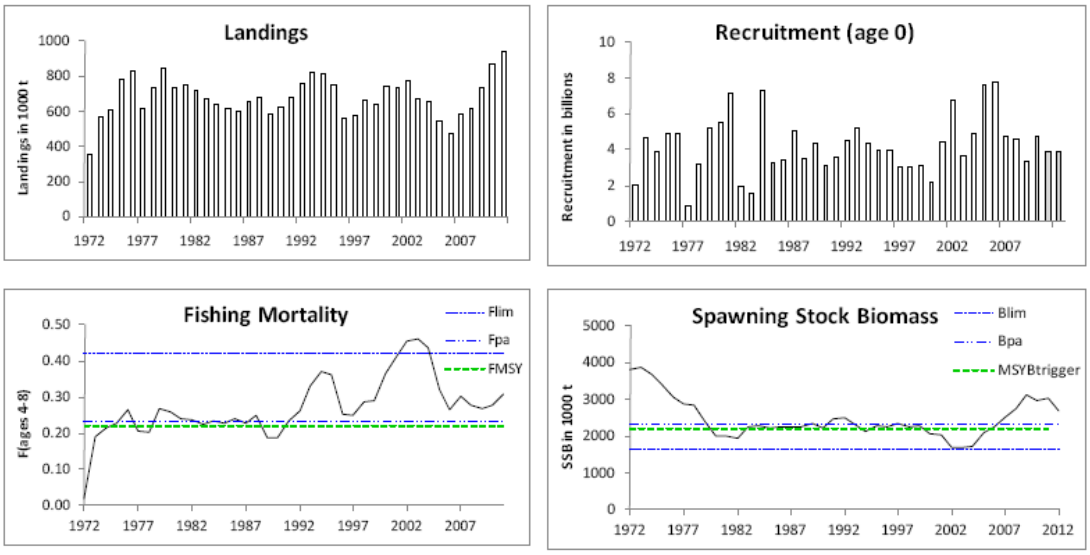

Figure 7.1. Summary of the stock assessment from the last accepted ICA assessment for NEA mackerel at WGWIDE 2012.

List of Participants

Name	Institute	E-mail
Katja Enberg	**IMR, Norway**	**Katja.enberg@imr.no**
Thomas Brunel	**IMARES, The Netherlands**	**thomas.brunel@wur.nl**
Andrew Campbell	**Marine Institute, Galway, Ireland**	**andrew.campbell@marine.ie**
Teunis Jansen	**GINR, Greenland Institute of Natural Resources**	**tej@aqua.dtu.dk**
Beatriz Roel	**CEFAS, UK**	**beatriz.roel@cefas.co.uk**
Emma Hatfield	**Marine Scotland Science, UK**	**e.hatfield@marlab.ac.uk**