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28 August– 3 September 2018

Torshavn, Faroe Islands

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Executive Summary

The Working Group on Widely Distributed Stocks (WGWIDE) met in Tórshavn, Faroe Islands, during 28 August3 September 2018. The meeting, chaired by Guðmundur J. Óskarsson, was attended by 31 delegates and 5 by correspondence from 14 countries. 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 6, 8 and Divisions 7.a-c, e-k and 9.a), and red gurnard (Subareas 3, 4, 5, 6, 7, and 8) stocks. Additionally, a special request from the European Commission on interarea flexibility of horse mackerel fishery was addressed.

Northeast-Atlantic (NEA) Mackerel. This species is widely distributed throughout 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 handlines on the Iberian coasts to large freezer trawlers and Refrigerated Sea Water (RSW) vessels in the Northern Area). The stock was benchmark in 2017 and the 2018 assessment was an update assessment, incorporating a new year for the catch information, for the IESSNS survey and for the RFID tagging recapture data (no new egg survey and recruitment index not available). The 2018 assessment revises the stock downward, and indicates that the SSB has been declining continuously since 2011, while the fishing mortality has been increasing. SSB in 2018 is estimated to be below MSY $B_{trigger}$ and F larger that F_{pa}, which represents a deterioration of stock status compared to last year.

Blue Whiting. This pelagic gadoid is widely distributed in the eastern part of the North Atlantic. The assessment this year followed the Stock Annex based the conclusions from the Inter-Benchmark Protocol of Blue Whiting (IBPBLW 2016). Most of the annual catches are taken in the first half-year, which makes it possible to use preliminary catches for 2018 in the assessment. This is done to reduce the effect of potential biases from the single survey used for this assessment. The SSB of the stock is large but declining since 2017. F has been reduced in recent years, but is still above F_{MSY}. Recruitments in 2017 and 2018 are estimated to be low, following a period of high recruitments.

Western Horse Mackerel. This species is widely distributed throughout the Northeast Atlantic: it 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. The stock is assessed using the Stock Synthesis integrated assessment model. The 2018 assessment is an update of the benchmark assessment with the inclusion of the 2017 data. According to the assessment results, the 20152017 recruitment estimates are the highest observed since 2008 (and higher than the geometric mean estimated over the years 19832017). Fishing mortality since 2012 has been decreasing, dropping to low values in 20152017 due to lower catches and a reduced proportion of fraction of the adult population in the exploited stock; it is currently below F_{MSY}. SSB in 2017 is estimated as the lowest in the time-series, below the precautionary reference point but above the limit reference point. The updated assessment shows the same trend as the previous ones, but rescales the absolute level of SSB and F over the most recent decade and, although this years' revision is smaller, this indicates that there is still considerable uncertainty associated with it. An inter-benchmark workshop has been scheduled for 2019: the workshop will aim at the revision of the biomass reference points and at investigate the causes of the instability in the assessment.

North Sea Horse Mackerel. After being benchmarked in January 2017, the CGFS and NS-IBTS survey indices were modelled with a zero inflated model to produce a combined index. The observed trend in the last years suggest that the stock is still at low levels in comparison with values in the early time-series. In 2017, the survey index shows a steep decline in comparison with year 2016. Despite this abrupt change in the survey abundance index, the catch advice for 2019 (decided in 2017) was not modified. The result of Length Based Methods to estimate proxy MSY reference points for the North Sea Horse Mackerel indicate that in 2016 and 2017 fishing mortality was slightly above F_{MSY}.

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 directed fishery for boarfish in the NEA is a relatively new one with large catches during the early 2000s when the fishery was unregulated. Catches have reduced significantly since 2012 to the current level. Annual catch advice is provided using the data limited category 3 approach based on output from an exploratory Bayesian surplus production assessment model. The assessment model utilises catch data, an acoustic survey estimate of stock size and indices from a number of bottom-trawl surveys. The current assessment indicates that since a historic high in 2012 biomass has declined sharply to a stable and low level since 2014.

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. This stock was benchmarked in 2016 (WKPELA). The assessment model introduced in the benchmark (XSAM), incorporates uncertainty in the input data, and has been used to provide advice after the benchmark. The SSB on 1 January 2018 is estimated by XSAM to be above B_{pa} (3.184 million t). The stock is declining and the SSB time-series from the 2018 assessment is in line with the SSB time-series from the 2017 assessment. Fishing mortality in 2017 is estimated to be above the management plan F that was used to give advice for 2017. A new management plan is being developed for the 2019 advisory year

Striped Red Mullet in North Sea, Bay of Biscay, Southern Celtic Seas, Atlantic Iberian Waters. 2016 was the first year this stock was considered by 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 was given last year for 2018, 2019 and 2020.

Northeast-Atlantic Red Gurnard. 2016 was the first year this stock was been considered by 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 was given last year for 2018 and 2019.

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8 Mackerel (*Scomber scombrus*) in subareas 1–8 and 14, and in Division 9.a (the Northeast Atlantic and adjacent waters)

8.1 ICES Advice and International Management Applicable to 2017

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 Management Strategy for 2015 and the subsequent five years. However, the total declared quotas for 2015 to 2018 all exceed the TAC advised by ICES. An overview of the declared quotas and transfers for 2018, as available to WGWIDE, is given in the text table below. Total removals of mackerel are expected to be approximately 1 000 559 t in 2018, exceeding the ICES advice for 2018 by about 450 000 t, and the agreed TAC by the three Coastal States (EU, NO and FO) and when employing the -20% interannual TAC stabiliser in the management rule by about 184 000 t.

Estimation of 2018 catch	**Tonnes**	**Reference**
EU quota	404 815	European Council Regulation 2018/120
Norwegian quota	183 857	Directorate of Fisheries in Norway
Inter-annual quota transfer 2017->2018 (NO)	-8 621	Directorate of Fisheries in Norway
Russian quota	109 415	NEAFC HOD 18/18
Discards	2 832	Previous years estimate
Icelandic quota	134 772	Icelandic regulation No. 351/2018
Faroese quota	102 924	Faroese regulation No. 1/2018
Inter-annual quota transfer 2017->2018 (FO)	4 200	Faroese regulation No. 1/2018
Greenland quota	66 365	Ministry of Fisheries, Hunting and Agriculture in Greenland
Total expected catch (incl. discard) [1,2]	1 000 559	

[1] No guesstimates of banking from 2018 to 2019

[2] Quotas refer to claims by each party for 2018

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 8.2.4.1 for an overview.

Since the mid-1970s, ICES has continuously recommended conservation measures for the North Sea component of the Northeast Atlantic mackerel stock (e.g. ICES, 1974; ICES, 1981). The recommended closure of Division 4.a 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 remain there until December before migrating to their spawning areas. Updated observations from the late 1990s suggested that this return migration actually started in mid- to late February (Jansen *et al.*, 2012). The EU TAC regulations stated that within the limits of the quota for the western component (ICES Subareas and Divisions 6, 7, 8.a,b,d,e, 5.b (EU), 2.a (non-EU), 12, 14), a certain quantity of this stock may be caught in Division 4.a during the periods 1 January to 15 February and 1 September to 31 December. Up to 2010, 30% of the Western EU TAC of mackerel (MAC/2CX14-) could be taken in Division 4.a. From 2011 onwards, this percentage has been set at 40% and from 2015 at 60%.

8.2 The Fishery

8.2.1 Fleet Composition in 2017

A description of the fleets operated by the major mackerel catching nations is given in Table 8.2.1.

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 Division 2.a is also prosecuted by freezer trawlers and partly the Icelandic fishery in Division 5.a and in some years in 14.b.

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) used refrigerated seawater (RSW), storing the catch in tanks containing refrigerated seawater (RSW). 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 dry hold 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 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 Subarea 8 and Division 9.a.N.

Lines and jigging. Norway and England have handline fleets operating inshore in the Skagerrak (Norway) and in Divisions 7.e/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 (Divisions 4.a and 4.b) and Iceland (Division 5.a) is taken by a handline fleet.

Gillnets. Gillnet fleets are operated by Norway and Spain.

8.2.2 Fleet Behaviour in 2017

The most important changes in recent years are related to the geographical expansion of the northern summer fishery (Subareas 2, 5 and 14) 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.

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 of 2017 the Russian vessels took all their catch in Division 2.a.

Total catches from Icelandic vessels were similar to those in recent years with the majority of the catch taken in Division 5.a in waters south and south-east of Iceland. Catches were also taken to the east and west of Iceland. In 2017, Iceland and Greenland targeted mackerel in Division 14.b, with 3% of the total catch coming from this area. Catches from Greenland have increased in 2017 to 46 kt from 30 kt in 2016 but are still lower than the 87 kt caught in 2014 which was 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.

8.2.3 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 4.a and 6.a 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 5.a and 6.a. In recent years, up to 25% of the Faroese quota have been granted to smaller, traditionally demersal trawlers using pair trawls.

Also targeting summer feeding mackerel, Icelandic vessels have increased effort and catch dramatically in recent years from 4 kt in 2006 to an 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 catches from Division 14.b since 2011.

In Spain part of the purse seiner fleet is using hand lines 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 driving this shift.

8.2.4 Regulations and their Effects

An overview of the major existing technical measures, effort controls and management plans are given in Table 8.2.4.1. Note that there may be additional existing international and national regulations that are not listed here.

Between 2010 and 2016 no overarching Coastal States Agreement/NEAFC Agreement was in place and no overall international regulation on catch limitation was in force. Currently there is no agreement on a management strategy covering all parties fishing mackerel. In 2014, three of the Coastal States (The EU, Faroes and Norway) agreed on a Management Strategy for 2015 and the subsequent five years. However, the total declared quotas taken by all parties since 2015 have greatly exceeded the TAC advised by ICES (see Section 8.1).

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 a 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 collapse of mackerel in the North Sea in the late 1960s was most likely driven by very high catches and associated fishing mortality. However, the lack of recovery of mackerel in the North Sea was probably associated with unfavourable environmental conditions, particularly reduced temperatures (unfavourable for spawning), lower zoo-plankton availability in the North Sea and increased wind-stress induced turbulence. These unfavourable environmental conditions probably led the mackerel to spawn in western waters instead of in the North Sea.

A review of the mackerel in the North Sea, carried out during WKWIDE 2017 (ICES, 2017a) concluded that Northeast Atlantic mackerel should be considered as a single population (stock) with individuals that show stronger or weaker affinity for spawning in certain parts of the spawning area. Management should ensure that fisheries do not decrease genetic and behavioural diversity, since this could reduce future production. Protection of mackerel that tend to spawn in the north-eastern parts of the spawning area is therefore still advisable to some extent.

In the southern area, a Spanish national regulation affecting mackerel catches of Spanish fisheries has been implemented since 2010. In 2015, fishing opportunity was distributed by region and gear and for the bottom trawl fleet, by individual vessel. This year, Spanish mackerel fishing opportunity in Divisions 8.c and 9.a was established at 39 674 t resulting from the quota established (Commission Regulation (EU) No 104/2015. This was reduced by 9 797 t due to the scheduling payback quota due to overfishing of the mackerel quota allocated to Spain in 2010 (Commission Regulation No 976/2012).

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

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

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.

8.3 Quality and Adequacy of sampling Data from Commercial Fishery

The sampling of the commercial catch of North East Atlantic (NEA) mackerel is summarised below:

Year	WG Total Catch (t)	% 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
2015	1208990	88	2132	137871	24283
2016	1094066	89	2200	149216	21456
2017	1155944	87	2183	151548	24104

Overall sampling effort in 2017 was similar to previous years with 87% of the catch sampled. It should be noted that this proportion is based on the total sampled catch. Nations with large, directed fisheries are capable of sampling 100% of their catch which may conceal deficiencies in sampling elsewhere.

The 2017 sampling levels for countries with a WG catch of greater than 100 t are shown below.

Country	Official Catch (t)	% WG catch covered by sampling programme	No. Samples	No. Measured	No. Aged
Belgium	128	0%	0	0	0
Denmark	40080	93%	3	214	214
Faroe Islands	99667	85%	14	750	712
France	23800	0%	0	0	0
Germany	24832	33%	63	13562	819
Greenland	46388	79%	15	2395	125
Iceland	167366	99%	107	4209	2431
Ireland	84915	98%	44	7751	1587
Netherlands	43766	60%	33	2174	825
Norway	222356	96%	73	2126	2126
Portugal	634	100%	136	6735	766
Russia	138061	98%	175	54185	1503
Spain	22172	100%	920	15367	7295
UK (England & Wales)	26463	3%	74	6054	3578
UK (Northern Ireland)	16888	0%	0	0	0
UK (Scotland)	182528	97%	38	4505	1081

The majority of countries achieved a high level of sampling coverage. Belgian catches are by-catch in the demersal fisheries in the North Sea. France supplied a quantity of length-frequency data to the working group which can be utilised to characterise the selection of the fleet but requires an allocation of catch at age proportions from another sampled fleet in order to raise the data for use in the assessment. England only samples landings from the handline fleet operating off the Cornish coast, representing only a small proportion of the national catch, the remainder reported from freezer trawlers. Cooperation between the Dutch and German sampling programmes (which sampled 60% and 33% respectively) is designed to provide complete coverage for the freezer trawlers operating under these national flags and also those of England and France. There is however, an absence of sampling from ICES Division 4.a in quarter 4 for this fleet with landings of 37 kt. Northern Ireland, with a WG catch of 17 kt did not provide any sampling information. Catch sampling levels per ICES Division (for those with a WG catch of >100 t) are shown below.

Division	Official Catch (t)	WG Catch (t)	No. Samples	No. Measured/ per kt	No. Aged/per kt
2.a	465355	465355	287	57988/126	4714/10
3.a	686	686	0	0/0	0/0
4.a	263825	263825	87	9200/35	2338/9
4.b	4723	4723	1	87/18	25/5
4.c	532	532	0	0/0	0/0
5.a	87734	87734	66	2794/32	1510/17
5.b	11344	11344	1	165/15	122/11
6.a	226056	226056	90	16804/74	2091/9
7.b	6421	6421	22	2306/359	435/68
7.d	6082	6082	0	0	0
7.e	956	956	38	2213/2314	2074/2169
7.f	679	679	36	3841/5657	1504/2215
7.j	1817	1817	160	366/201	3/2
8.a	2150	2150	0	0	0
8.b	4854	4854	45	1866/388	4164/116
8.c	31059	31059	362	26719/860	
9.a	777	777	345	7106/9145	1582/2036
9.a.N	1206	1206	67	3613/2995	753/624
14.a	174	174	0	0	0
14.b	39263	39263	18	2489/63	194/5

In general, areas with insufficient sampling have relatively low levels of catch. The exception is Division 7.d from which 6 kt (mainly French) was caught which was not sampled. The number of age samples in southern fleets is disaggregated by area (included in Division 8.c total)

8.4 Catch Data

8.4.1 ICES Catch Estimates

The total ICES estimated catch for 2017 was 1 155 944 t, an increase of 61 878 t on the estimated catch in 2016. Catches increased substantially from 2006—2010 and have averaged 1 089 kt since from 2011.

The combined 2017 TAC, arising from agreements and autonomous quotas, amounts to 1 194 000 t). The ICES catch estimate (1 155 944 t) represents a slight undershoot of this. The combined fishable TAC for 2018, as best ascertained by the Working Group (see Section 8.1), amounts to 1 000 559 t.

Catches reported for 2017 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.

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)		Y
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	Y

[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 the reported landings may be an underestimate of up to 18% (11% from 2004), based on logbook figures. 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 8.4.1.1. It is broken down by ICES area group 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 ICES Subareas and Divisions 6, 7/8.a,b,d,e and 3/4 (see Table 8.4.1.1) since 1978. Historical discard estimates were revised during the data compilation exercise undertaken for the 2014 benchmark assessment (ICES, 2014). The Working Group considers the estimates for these areas are incomplete. In 2017, discard data for mackerel were provided by The Netherlands, France, Germany, Ireland, Spain, Portugal, Greenland, Denmark, England, Scotland and Sweden. Total discards amounted to 2 832 t from these nations (mainly Spain and France). The German, Dutch, Irish and Portuguese pelagic discard monitoring programmes did not record any instances of discarding of mackerel. Estimates from the other countries supplying data include results from the sampling of demersal fleets.

Age-disaggregated data was limited but data available indicates that, in Divisions 8.a, 8.b and 8.c the majority of discarded fish were aged 0 to 3. In Division 9.a the majority of the discarded fish were 0 group.

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 2.a and Sub-area 4, 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 6 and 7, 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.

8.4.2 Distribution of Catches

A significant change in the fishery took place between 2007 and 2009 with a greatly expanded northern fishery becoming established, and maintained to the present. Of the total catch in 2017, Norway accounted for the greatest proportion (19%) followed by Scotland (16%), Iceland (14%), Russia (12%) and Faroe (9%). In the absence of an international agreement, Faroe, Greenland, Iceland and Russia declared unilateral quotas in 2017. Russia and Iceland both had catches over 100 kt with Faroes catching 99 kt. Greenlandic catches accounted for 46 kt of the total. Scotland had catch in excess of 100 kt and Ireland caught almost 86 kt. Germany, Netherlands, Spain, Denmark, France and England had catches of the order of 20—50 kt.

In 2017, catches in the northern areas (Subareas 2, 5, 14) amounted to 603 869 t (see Table 8.4.2.1), an increase of 40 366 t on the 2016 catch. Icelandic, Norwegian and Russian catches were all over 100 kt. Catches from Division 2.a accounted for 40% of the total catch in 2017. All the Russian catch in 2017 was taken in Division 2.a with Greenlandic catches taken further east into Division 2.a than in 2016. The wide geographical distribution of the fishery noted in previous years has continued.

The time series of catches by country from the North Sea, Skagerrak and Kattegat (Subarea 4, Division 3.a) is given in Table 8.4.2.2. Catches in 2017 amounted to 269 804 t, an increase on 2016 (21 193 t). The majority of the catch is from Subarea 4 with small catches were also reported in Divisions 3.a-d.

Catches in the western area (Subareas 6, 7 and Divisions 8.a,b,d and e) increased slightly to 249 229 t with most of the traditional fishing nations catching an increased proportion of their total catch in this area, likely due to the timing of the spawning migration. These catches are detailed in Table 8.4.2.3.

Table 8.4.2.4 details the catches in the southern areas (Divisions 8.c and 9.a) which are taken almost exclusively by Spain and Portugal. The reported catch of 33 042 t represents a decrease from 2016. The catch is close 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	2004	37	6	28	29
1991	38	5	25	32	2005	46	6	25	23
1992	34	5	24	37	2006	41	5	18	36
1993	29	7	25	39	2007	34	5	21	40
1994	32	6	28	34	2008	34	4	35	27
1995	37	8	27	28	2009	38	11	31	20
1996	37	8	32	23	2010	26	5	54	15
1997	34	11	33	22	2011	22	7	54	17
1998	38	12	24	27	2012	22	6	48	24
1999	36	9	28	27	2013	19	5	52	24
2000	41	4	21	33	2014	20	4	46	30
2001	40	6	23	30	2015	20	5	44	31
2002	37	5	29	28	2016	23	4	44	29
2003	36	5	22	37	2017	24	3	45	28

The quarterly distribution of catch in 2017 is similar to recent years (since 2010) 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 8.4.2.1 to 8.4.2.4. 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 2017 (272 514 t – 24%)

The distribution of catches in the first quarter is shown in Figure 8.4.2.1. The quarter 1 fishery is similar to that in previous years with the Scottish and Irish pelagic fleets targeting mackerel in Divisions 6.a, 7.b and 7.j. Substantial catches are also taken by the Dutch owned freezer trawler fleet. The largest catches were taken in Division 6.a, as in recent years. The Spanish fisheries also take significant catches along the north coast of Spain during the first quarter.

- Second quarter 2017 (39 972 t – 3%)

The distribution of catches in the second quarter is shown in Figure 8.4.2.2. The quarter 2 fishery is traditionally the smallest and this was also the case in 2017. The most significant catches where those in Division 8.c and at the start of the summer fishery in northern waters by Icelandic, Norwegian and Russian fleets.

- Third quarter 2017 (515 346 t – 45%)

Figure 8.4.2.3 shows the distribution of the quarter 3 catches. Large catches were taken throughout Divisions 2.a (Russian, Norwegian vessels), 4.a (Norwegian, Scottish vessels), 5.a (Icelandic vessels). Catch was also taken in Division 14.b in quarter 3.

- Fourth quarter 2017 (328 112 t – 28%)

The fourth quarter distribution of catches is shown in Figure 8.4.2.4. The summer fishery in northern waters has largely finished although there are substantial catches reported in the southern part of Division 2.a. The largest 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.

ICES cannot split the reported mackerel catches into different stock components because there is no clear distinction between components upon which a split could be determined. Mackerel with a preference for spawning in the northeast area, including the North Sea, cannot presently be identified morphometrically or genetically (Jansen and Gislason, 2013). Separation based on time and area of the catch is not a precise way of splitting mackerel with different spawning preferences, because of the mixing and migration dynamics including inter-annual (and possibly seasonal) variation of the spawning location, combined with the post-spawning immigration of mackerel from the south-west where spawning ends earlier than in the North Sea.

8.4.3 Catch-at-Age

The 2017 catches in number-at-age by quarter and ICES area are given in Table 8.4.3.1. This catch in numbers relates to a total ICES estimated catch of 1 155 944 t. These figures have been appended to the catch-at-age assessment table (see Table 8.7.1.2).

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 (length samples were provided), 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 percentage catch numbers-at-age by quarter and area are given in Table 8.4.3.2.

Over 80% of the catch in numbers consists of 3 to 8-year olds with all year classes between 2010 and 2014 contributing over 10% to the total catch by number.

There is a small presence of juvenile (age 0) fish within the 2017 catch. As in previous years catches from Divisions 8.c and 9.a have contained a proportion of juveniles.

8.5 Biological Data

8.5.1 Length Composition of Catch

The mean lengths-at-age in the catch per quarter and area for 2017 are given in Table 8.5.1.1.

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 2017 for 0 and 1 group mackerel are lower than those in 2016.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 (Ólafsdóttir *et al.*, 2015).

Length distributions of the 2017 catches were provided by England, Faroes, France, Iceland, Ireland, Germany, Greenland, the Netherlands, 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 2017 catches are given in Table 8.5.1.2.

8.5.2 Weights at Age in the Catch and Stock

The mean weights-at-age in the catch per quarter and area for 2017 are given in Table 8. 5.2.1. 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 8. 5.2.1). This decrease in the catch mean weights-at-age seems to have stopped since 2013 and values for the last five years do not show any particular trend for the older ages (age 6 and older) and are slightly increasing for younger ages (ages 1 to 5). These variations in weight-at-age are consistent with the changes noted in length in Section 8. 5.1.

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 2016 egg survey for the southern and western components and the 2017 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, the biological sampling data taken during the egg surveys and 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, 2014) 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 commercial catches collected from Divisions 4.a and 4.b in the second quarter of 2017 and the biological samples collected during the 2017 North Sea mackerel egg survey. Stock weights for the southern component, are based on samples from the Portuguese and Spanish catch taken in Divisions 8.c and 9.a in the 2nd quarter of the year. The mean weights in the three component and in the stock in 2017 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 seems to have stopped in 2013 and values in the last four years do not show any specific trend (except for weights of ages 2 to 7 which have been increasing, Figure 8.5.2.2).

	North Sea Component	Western Component	Southern Component	NEA Mackerel 2017
Age				Weighted mean
0				0.000
1			0.084	0.058
2	0.275	0.196	0.218	0.204
3	0.266	0.232	0.252	0.237
4	0.343	0.270	0.299	0.278
5	0.370	0.303	0.308	0.308
6	0.390	0.299	0.327	0.308
7	0.402	0.331	0.361	0.338
8	0.401	0.374	0.387	0.377
9	0.443	0.390	0.395	0.394
10	0.435	0.426	0.414	0.426
11	0.459	0.427	0.440	0.430
12+	0.489	0.490	0.536	0.494
Component Weighting	6.7%	83.0%	10.3%	
Number of fish sampled	399	458	1691	

8.5.3 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 2017 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, 2014 and Stock Annex). The 2017 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. A change in the opposite direction has been observed since then and the maturity ogive in 2017 is comparable with the one observed in the mid-2000s (Figure 8.5.3.1).

Age	North Sea	Western Component	Southern Component	NEA Mackerel
0	0	0	0	0
1	0	0.12	0.02	0.10
2	0.37	0.81	0.54	0.75
3	1	0.96	0.70	0.94
4	1	1	1	1
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	1	1	1	1
9	1	1	1	1
10	1	1	1	1
11	1	1	1	1
12+	1	1	1	1
Component Weighting	6.7%	83.0%	10.3%	

8.6 Fishery Independent Data

8.6.1 International Mackerel Egg Survey

8.6.1.1 Survey Planning for the 2019 Northeast Atlantic survey

The last mackerel egg survey was carried out in the NEA mackerel spawning areas in 2016 and a presentation with the final results were given during the WGWIDE meeting by the survey coordinator in 2017 (ICES, 2017b).

The ICES Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS) met in Dublin in April 2018 to plan the international mackerel and horse mackerel egg survey in 2019. The nations participating in the 2019 survey will be Portugal, Spain, UK Scotland, Ireland, The Netherlands, Germany, Norway, Iceland and the Faroe Islands.

The 2019 survey will be based on seven regular sampling periods. Additional information collated from summer surveys undertaken in 2017/2018 (Section 8.6.1.2) shows that mackerel spawning does only take place northwards the Faroe Islands if the temperature is higher than 8.5ºC at 20 m depth. In addition, in 2018 summer survey was successful in delineating a zero-spawning boundary in the region encompassing Hatton Bank, the South Iceland Basin and all the way up to the Iceland Shelf.

The provisional survey plan of the 2019 mackerel and horse mackerel egg survey, as agreed during last the WGMEGS meeting (ICES, 2018c), is presented in Table 8.6.1.1.1.

In preparation for the 2019 survey a workshop dealing with egg identification and staging will take place during October 2018 in Bremerhaven. Procedures for fecundity and atresia estimation will be standardized and training conducted at the fecundity workshop to be held in IJmuiden in November 2018.

8.6.1.2 Results of the 2018 additional Mackerel Egg Survey in the northern survey area

The WGMEGS has been observing the offshore westwards and northwards expansion of the mackerel spawning area since 2007. In addition, results from the most recent triennial MEGS survey in 2016 provided evidence that peak spawning of NEA mackerel had moved away from the traditional hotspots between the Bay of Biscay and the Porcupine Bank and instead was dispersed over a large swathe of open ocean, well away from the continental shelf to the West and Northwest of Scotland and importantly very close to the Northern and North-western survey boundary (Figure 8.6.1.2.1).

During the last mackerel benchmark in 2017, WGMEGS proposed several areas of additional work that required to be undertaken during the interim period (2017, 2018) and prior to the next triennial survey in 2019 (ICES, 2017a). The aim was to map the mackerel spawning activity within the North and North-western boundary areas and also hopefully delineate fully the mackerel spawning boundary, something that the triennial survey has hitherto been unable to deliver. The timing for these exploratory surveys/additional sampling was set at May/June.

The first exploratory egg survey was completed by Ireland during May/June of 2017. Results were presented at the last WGWIDE meeting (ICES, 2017b). The areas selected for survey were west of Hatton Bank, Southeast Iceland and the Faroes/Shetland channel. The results show that no stage 1 mackerel eggs were recorded in any of the sampled stations where the temperature at 20 m was less than 8 degrees Celsius (Figure 8.6.1.2.2). Therefore, the expected drop in temperature as the surveys proceeded northwards provides a physical barrier to mackerel spawning and the Northern boundary used by MEGS in 2016 should be relatively secure. However, potential mackerel spawning to the West of Hatton Bank and onto the South Icelandic Basin was less clear. This last area would be the target focus of the Scottish survey which was now scheduled for the same temporal period in 2018 (Burns *et al*, 2018).

During May/June of 2018 it was carried out the second exploratory survey on board a chartered Scottish fishing vessel (Altaire) with the objective of exploring the North-western boundary region and survey as far west as required until a zero spawning boundary was established. The survey deployed the Gulf 7 plankton sampler on a series of transects commencing on Rockall Bank and tracking East to West and vice versa heading steadily North up towards the Icelandic Shelf and also surveyed the West side of Iceland. In addition, there was support of the Nordic countries collecting extra plankton samples within this period during the International Ecosystem survey in the Norwegian Sea (IESNS) and Icelandic Spring Capelin surveys.

In this exploratory survey mackerel eggs were present in 49 of the 79 stations sampled with stage 1 mackerel eggs being identified in 60% of sampled stations. Virtually no mackerel eggs were recorded on stations where the temperature at 20 m was less than 8.5 degrees Celsius which is consistent with what is already known surrounding the temperatures tolerated by spawning mackerel. The survey successfully delineated the zero-spawning boundary in the Northwest (Figure 8.6.1.2.3). The relatively warmer temperatures observed on the flanks of Hatton Bank yielding moderate numbers of mackerel eggs whereas the colder water over the South Iceland Basin and also Northwards towards the Reykjanes Ridge being sufficiently cool as to provide the physical boundary and delivering few or zero mackerel eggs.

During 2018, additional plankton samples were collected by the Faeroe Islands, Iceland and also Norway during the IESNS survey. They covered a large swathe of ocean ranging from the East side of Iceland and North of Shetland to the Norwegian Coast. In addition, Iceland also collected 27 samples during their Capelin spring survey at the end of May and additional samples were also collected on the Icelandic Ecosystem surveys in the Nordic Seas in July-August (IESSNS) survey in mid-July. Analysis of the

IESNS samples concluded that none contained mackerel eggs (Figure 8.6.1.2.3). The same was found in both the Icelandic spring capelin survey samples and also those from the Icelandic IESSNS samples from July (Figure 8.6.1.2.4).

The survey results show that during May/June the spawning mackerel are avoiding crossing the cooler waters of the South Iceland Basin and instead are favouring the conditions on the Eastern side of the basin as they head North and certainly this is a widely held view. The total absence of mackerel eggs within the analysed IESNS samples is consistent with the results that were presented in 2017 and reaffirm the assessment that for the region stretching from the East coast of Iceland across to the Faroe/Shetland channel the existing Northern boundary surveyed by MEGS should be relatively secure with very little if any mackerel spawning taking place at that time of year at latitudes North of the Faroe Islands. No mackerel eggs were found in samples from any of the surveys where the recorded temperature at 20 m was less than 8 degrees Celsius. The significantly cooler sub-surface temperatures experienced in 2018 in the sampled areas around the Southern coast of Iceland had a significant impact on the abundance of mackerel eggs reported from the Icelandic Spring Capelin Survey samples with zero mackerel being reported in 2018. This was in a marked contrast to 2017 which recorded several stations with low to moderate densities of stage 1 mackerel eggs but with correspondingly warmer temperatures. It is entirely conceivable that this temperature anomaly may have had some impact regarding the distribution of spawning mackerel over the Hatton and South Iceland Basin region in 2018. However, the limited results reported from that area in 2017 provide some evidence that the pattern may not have been very different to that seen in 2018.

8.6.2 Demersal trawl surveys (Recruitment Index)

The index of survivors in the first autumn-winter (recruitment index) could not be updated due to input data quality issues in the ICES DATRAS system that had not been updated as recommended by WKWIDE 2017 (ICES, 2017a) and WGWIDE 2017 (ICES, 2017b). The outdated time series from WGWIDE 2016 (ICES, 2016a) was therefore used in the assessment. The assessment was therefore conducted without an index value for the 2016 and 2017 year classes and with the knowledge of an upcoming revision of the time series when the data quality issues has been sorted out.

The following text describes the methods used in 2016 and the data quality issues.

The data and the model

An index of survivors in the first autumn-winter (recruitment index) was derived from a geostatistical model fitted to catch data from bottom trawl surveys conducted during autumn and winter. A complete description of the data and model can be found in Jansen *et al*. (2015) and the Stock Annex.

The data were compiled from several bottom trawl surveys conducted between October and March from 1998—2016 by research institutes in Denmark, England, France, Germany, Ireland, Netherlands, Norway, Scotland and Sweden. 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 the Bay of Biscay to North of Scotland, excluding the North Sea, while IBTS Q1 covers the shelf waters from north of Ireland, around Scotland, the North Sea, Skagerrak and Kattegat.

Trawl operations during the IBTS have largely been standardized through the relevant ICES working group (ICES, 2013a). Furthermore, the effects of variation in wing-spread and trawl speed were included in the model (Jansen *et al*., 2015). 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, although this was not expected to change catchability significantly. However, in other cases, the trawl design 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 which was accounted for by inclusion of the wing-spread parameter in the model.

A geostatistical log-Gaussian Cox process model (LGC) with spatiotemporal correlations was used to estimate the catch rates of mackerel recruits through space and time. The modelled average recruitment index (squared CPUE) surface was mapped in Figure 8.6.2.1. 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 8.6.2.2.

Survey Coverage

The combined demersal surveys have insufficient spatial coverage in some areas that can be important for the estimation of age-0 mackerel abundance, namely: (i) Since 2011, the English survey (covering the Irish sea and the central-eastern part of the Celtic sea including the area around Cornwall) has been discontinued; (ii) the Scottish survey has not consistently covered the area around Donegal Bay; and (iii) the IBTS has observed high catch rates in some years at the north-eastern edge of the survey area (towards the Norwegian trench) in winter. It is therefore possible that some recruits are also overwintering on the other side of the trench along the south western shelf edge of Norway. Consequently, the Norwegian Sea IBTS (NS-IBTS) in first quarter (Q1) should be extended to include the south-western Norwegian shelf and shelf edge in proximity to the Norwegian trench.

Data Quality

Errors in the input dataset have been detected since WGWIDE 2016. Data revisions by Scotland and Ireland were done before WGWIDE 2017, but for WGWIDE 2018 the ICES DATRAS system was not updated to deliver data and quality assurance reports as recommended by WGWIDE 2017 and WKWIDE 2017. It was therefore not possible to update the time series during the meeting. It is expected that the ICES datacentre will complete this work during autumn 2018, well before the next assessment (or intermediate benchmark), because significant progress was seen in the weeks before the meeting and during the meeting. The recommendations to ICES datacentre will therefore not be repeated this year.

This should facilitate a revision of the recruitment index in time for the 2019 assessment. For the update assessment WGWIDE 2018 used the time series from WGWIDE 2016 (Figure 8.6.2.2).

Mackerel samples collected on the EVHOE fourth quarter (Q4) survey are not aged. The current practice of applying age-length keys from Ireland and Scotland to catches in the more southern EVHOE survey is not ideal, because the mackerel growth during the first year is related to latitude (Jansen *et al.*, 2013). WGWIDE therefore recommends that Ifremer (France) initiate aging of mackerel starting from Q4 2018.

Finally, WGWIDE encourage studies of vertical distribution and catchability of age-0 mackerel in the Q4 and Q1 surveys.

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

The IESSNS was successfully conducted in the summer of 2018 (Figure 8.6.3.1). Five vessels sampled 290 predetermined surface trawl stations in the period from June 30 to August 6 which covered an area of 2.8 mill. km^2 which is the same as in 2017 (ICES, 2018a). At each surface trawl station, a standardized trawl (Multpelt832) is employed for 30-min according to a standardize operation protocol which is designed to catch mackerel. Additionally, abundance of herring and blue whiting is measured using acoustic methods and backscatter is verified by trawling on registrations as needed. The aim is to establish an index for blue whiting and herring abundance to be used in stock assessment in a few years. The cruise report is available as a working document to the current report (ICES, 2018a) and a detailed survey description is in the Stock Annex.

IESSNS provides annual age-segregated index for mackerel abundance of which age classes 3-11 are used to tune the mackerel stock assessment (Table 8.6.3.1; Ólafsdóttir *et al.*, 2017; ICES, 2017a).

Excluding the North Sea, the total swept area abundance index of mackerel in 2018 was estimated 16.9 billion individuals which is a decrease of 30% compared to 2017. Mackerel biomass index declined 40% between years (Figure 8.6.3.2). The discrepancy in decline of abundance index and biomass index is due to record high numbers of age-1 and age-2 mackerel and lower weight-at-age for these age classes in 2018 compared to 2017. The most abundant year classes were 2010, 2011, 2014, 2016 and 2017 respectively presenting 11%, 14%, 14%, 15%, and 13% of the stock in numbers (Figure 8.6.3.3). The incoming 2017-year class has the largest age-1 index value recorded in IESSNS and is 150% larger than the incoming age-1 cohort in 2017. Mackerel cohort internal consistency has improved by adding the 2018 survey data to the time series. Mackerel cohort internal consistency remained relatively high. Internal consistency is strong for ages 1 to 5 years ($r > 0.8$) and a fair/good internal consistency for ages 5 to 11 years ($r > 0.5$), except for 7-8 year old mackerel (Figure 8.6.3.4)

The North Sea (southward of latitude 60 °N) was included in the IESSNS for the first time in July 2018 and 39 predetermined surface trawl stations were sampled. The survey area was 0.25 mill. km^2, and the estimate index for mackerel abundance was 2.2 billion individuals and the biomass index was 0.4 million tonnes. The North Sea survey areas is excluded for the calculations of the mackerel abundance index used in the assessment according to the 2017 benchmark (Ólafsdóttir *et al.*, 2017; ICES, 2017a), hence the results are presented separately from the traditional survey north of latitude 60 °N.

8.6.4 Tag Recapture data

The Institute of Marine Research in Bergen has annually 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. A new RFID tagging method from 2011 onwards was accepted and used in the assessment based on the conclusions from the 2017 WKWIDE benchmark workshop (ICES, 2017a).

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

General description of data

The radio-frequency identification (RFID) tagging project on NEA mackerel was initiated in 2011 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—2016 as many as 353 541 mackerel has been tagged with the new tags and 3 337 of these tags have been recaptured (Table 8.6.4.1). This includes an experiment off the Norwegian Coast on young mackerel in September 2011 as well as three experiments carried out in August in Iceland 2015-2017, none of which is included as input data in the assessment. Data from the releases at the spawning grounds in May-June of Ireland and the Hebrides are the only data included in the assessment.

The RFID-tagged mackerel recaptured up to 1st September 2018, came from 22 European factories processing mackerel for human consumption (Table 8.6.4.2). The project started with RFID antenna reader systems connected to conveyor belt systems at 8 Norwegian factories in 2012. Now there are 6 operational systems at 5 factories in UK (Denholm has 2 RFID systems) and 2 in Iceland. Norway has installed RFID systems at 8 more factories in 2017-2018, most of which with the purpose of scanning Norwegian spring spawning herring catches (IMR started tagging herring in 2016), but some also processing mackerel. More systems are also bought by Ireland (3), which up to now has been non-operational. Note also that in the current assessment data from the factories Sæby (Denmark), Lunar Freezing Frazerburgh (Scotland), Höfn (Iceland), Austevoll and Egersund (after 2013) in Norway are all excluded due to problems with efficiencies and low recapture rates. The factories having operational systems are all online on internet 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 and database 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 every year, and the concurrent numbers screened and recaptured over the next years (by year class), which is what is used in the assessment. The development of the tagging data time series is dependent on the work from each country's research institutes, fisheries authorities or the industry its selves 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. Responsible scientists in Norway, Iceland, Faroes and Scotland has been following up the factories, and delivering the catch data and biological data. In the future, it is planned that annual workshops should occur prior to the assessment, where more scientists go through the new data being updated from new tagging experiments, as well as recaptures from all previous experiments, and undertake analyses of the trends in the data outside of the assessment model, see suggestions to terms of reference for such an annual workshop at the end of this section.

Trends and bias concerns in the RFID tag-recapture data

The way the tagging data is used in the SAM assessment model is more of a raw data format, rather than an abundance index adding one new number per age per year (one line in a table). What is used is number released every year of a year class, and the numbers scanned and recaptured every year of the same year classes in all the years after release. The model is estimating the size of a year class in the release year, based on data from all recapture years. This means for example that the recaptures from the 2011 experiment in year 2017, in fact influences the prediction of the abundance in 2011, meaning that the prediction of 2011 abundance may change over time with more recapture years. This is very different from other typical indexes of abundance normally used in assessments.

The way the tagging data are handled also means that there is no index presented really showing the trends in the data, such as with the egg survey and the IESSNS trawl survey. However, this is possible by estimating the abundance/biomass in the release year using the Petersons model (N=numbers released/numbers recaptured*numbers scanned). During WGWIDE 2018 several results were shown to demonstrate the trends in the RFID tag data based on Peterson's estimation, some of which indicated biases in the data that could influence the assessment. In the following the main results will be described. All estimates are scaled to the 10% survival also used as scaling in SAM, not taking into account the mortality happening over the year (which also currently is not being taken into account in SAM).

When only estimating the biomass in release year based on recaptures the first year after release, one is able to follow the trend from 2011-2017 (Figure 8.6.4.1), where the estimate in 2017 is based only on quarter 1 recaptures in 2018. The trends in biomass of age2+, 3+ and 4+ mackerel show some similarities, all decreasing in the end towards 2017. However, the age2+ index seems to have a jump in 2013, suggesting some noise in the data when the large 2010-2011 year classes are entering in the tagging experiments at the ages 2-3 years.

However, given that SAM takes into account all recapture years, it is important to look at potential changes in the estimates related to recaptures at longer times after release than 1 year. The results when estimating the trends in biomass of age2^{+}, but based on different numbers of years out (1-6 years), clearly show a trend for release years 2011-2012 that is indicating a bias in the data (Figure 8.6.4.2), the estimates increasing heavily with the numbers of years out. This is not according to the assumption in using tag data for abundance estimation, where it is expected that it should be stable when the fish has mixed in the stock. The bias is not so clear for the years after 2012.

When looking closer into the bias in estimating biomass by age groups from tagging data with numbers of years out, from all release years (Figure 8.6.4.3), it indicates that the problem is highest in the young fish, where the change over time is highest. Especially, this can be seen for the strong 2010-2011 year classes entering the tagging data.

There seems to be some change in the estimates from tagging data happening after 2012, and it is important to notice that this also corresponds to a large change in the distribution and abundance of catches scanned for tags (Figure 8.6.4.4). From 2014 onwards Icelandic, Faroes and Scottish factories really contributed to a tripling of the scanned biomass, and a change with a broader distribution of scanned catches in the Norwegian Sea and eastwards to Iceland during quarter 3-4, as well as a significant increase in quarter 1 along the British Isles and Ireland. This change alone could have caused changes in the ways the tagging data effect the assessment, especially if the recapture rates in different areas/seasons vary, according to lack of mixing of tagged fish, or according to mortality happening between seasons (for instance between quarter 1 and quarter 4 catches), which is not taken account for in SAM assessment today.

To check for potential area/season effects on the tag recapture data, the data were reanalysed, based on a splitting in 4 different areas/seasons (Figure 8.6.4.5). The results when looking at trends in the biomass of age 2+ mackerel, when estimated based on recaptures from the 4 areas in the year 1 after release, shows more noise and variation, but still the same trend towards lower biomass in 2016-2017 (Figure 8.6.4.6). The area that seems to stick out is the central Norwegian Sea, which tend to have higher estimates than the others, indicating lower recapture rates, which could suggest a problem with mixing. When looking more detailed into this potential problem, estimating the biomass by age for each release year, based on each of the 4 recapture areas, and different numbers of years after release (Figure 8.6.4.7), even more of the variability in the data are shown. One thing to notice is the noise in the data in 2013, especially coming from the estimate of the 2010 year class based on recaptures from area in the central Norwegian Sea.

Exploratory runs in SAM related to concerns of bias issues in the RFID tagging data

Based on the results above it was decided to do some exploratory runs in SAM to look for sensitivity to the inclusion of different ranges of age groups, different numbers of years of recaptures included after releases, and different areas/seasons.

- Using ages 2+, 3+, 4+
- Using years out=all years or years out < 3
- Using the new tag data set split into 4 areas/seasons

The results of these exploratory runs are shown under SAM assessment results (see Section 8.7.4).

Alternative use of tag data in the assessment – use an index?

In WGWIDE 2018 there was a lot of discussion with regard to the handling of the tag data in SAM. One point raised was that the "raw data" format used for tag data, results in a lot more data, increasing for every year, and how this is handled for instance with regard degrees of freedom. It was discussed in the group that a simpler use of the tag data, in terms of a regular abundance index, perhaps would be more appropriate. At least this would open up for an easier way for other assessment models to use the data for comparisons, especially given the circumstances of the current assessment, where the tag data seems to get a very high weight. There are several ways to make such and index, one attempt is shown in Table 8.6.4.3 and Figure 8.6.4.8. Here it is assumed that by only including recapture data from the two first years after release (YearsOut=1-2), the estimation in all release years are treated in the same way, and a potential bias with reduced recapture rates with increasing numbers of years after a release is reduced. It is also assumed that data from fish at ages 2-3 are more uncertain, noisier, for instance the 2010-2011 year classes tagged at ages 2-3 years seems noisy. Hence, only data from ages 4-12 were included. For the sake of comparison, the data were also scaled down to the 10% survival used in SAM assessment. This index is something that can be tried out in SAM and other models as an alternative way to use the data, at least for exploration.

Regarding the issue with low survival rate in the RFID tag data

Work is being done to try understanding the different estimated scaling parameters on the 'old' steel tag (survival= 40%) vs the new RFID tag times series (survival=10%), that cannot be explained by suggested bias issues in the new RFID-time series, but actual change in tagging mortality, tag loss or detection-efficiencies at factories. This needs focus and attention as it is not understood by the responsible taggers who evaluate every single fish prior to tagging, nor the responsible scientists.

Some work is already done, such as testing off detection efficiencies at the factories. However, there is clearly need for more testing, several times over the season at all factories. This is something that needs priority, and the plan is to carry out extensive testing until next WGWIDE meeting, or potentially prior to an intermediate benchmark at an earlier date. We need to make sure if the efficiency is stable at high levels, or to adjust for potential variability if this should be the result of extensive testing.

With regard to testing of tagging mortality, some tests are also carried out already. One test is that Iceland in fact has started their own experiments, where the handling of the fish is a little different than in the experiments of Ireland, and where the fish itself perhaps is less sensitive as it is not in a spawning condition as it is off Ireland. However, a comparison in biomass estimates by age and totally between the two experiments in 2016 based on recaptures in 2017 (Figure 8.6.4.9), showed overlapping estimates. This suggests equal survival rates from the two experiments despite the different handling, and condition of the fish. There has also been experiments of Iceland in 2017 and 2018, and it will be of value to follow and compare with the experiments off Ireland in the years to come, to follow up on the discussion of low survival rate on RFID tagged fish estimated by SAM.

Another test for evaluating if the change of handling of the mackerel from the old steel tagging to the new RFID tagging, is that in 2017 a proportion of the tagged fish was handled in the exact same way as used for the steel tags; meaning that: (i) using manual jigging instead of automatic jigging machines; and (ii) using old rectangular tanks for keeping the fish compared with circular tanks, and releasing the fish directly to the sea on starboard side instead of through pipes on the port side. The difference is only in the tag type used, and to some extent the placement of tags; meaning that the old steel tags were inserted into abdomen of the fish, if not in a spawning stage, and into the muscle of the fish when in a spawning stage, as compared with RFID tags, which always are inserted into the abdomen. The decision to always insert the RFID tags into abdomen is to avoid that tags are going all the way to the consumer. The result from the 2017 experiments may help understanding if the handling of the fish is a reason to the differences in survival rates estimated by SAM, but some time with recaptures is necessary prior to conclusion from this experiment.

Another alternative is to carry out large scale tagging experiments at sea, releasing tagged fish into large sea pens, floating around for a period, after which the mortality could be assessed. Such experiments are possible to conduct, but they will not necessarily show realistic mortalities, as swimming in a pen is not comparable to swimming in the open ocean. Still, such experiments may increase the understanding of the low estimated survival rate, and it is clearly something that should be considered in the future. It must, however, be emphasized that all previous experiments on tagging mortality on mackerel are not realistic with regard to the actual mortalities that are happening out at sea. To underline this, IMR has carried out experiments on both herring and mackerel, with close to zero mortality due to tagging process, when the fish were in really good condition under low stress prior to tagging. The conclusion is that most of the mortality happening is caused by all the handling and stress caused from being hooked with jigging, until the release at sea, not the tag insertion itself. This means that realistic experiments must be carried out under the same conditions normally experienced when tagging in the open ocean with the vessels currently used.

Suggested terms of references for an annual ICES workshop on tagging data

As mentioned above, there is need for an annual workshop dealing with the tagging data for mackerel, but also for Norwegian Spring Spawning herring where tagging started in 2016. Below are the suggested terms of reference for such a working group that should preferably meet in spring prior to the WGWIDE assessment.

- Update the tagging database with all new data needed (catch data and biological data) and carry out estimations needed for updating the tag data table used in the SAM assessment.
- Quality assurance of the tag data table, hereunder to consider if adjustments are needed in tag data table, such as removal of data previously used from factories with low efficiency or alternative use of biological data (such as ALKs) to estimate numbers released and scanned by age.
- Carry out analyses of the trends (indexes of abundance by age and biomass) in the tag data outside the SAM model that can be presented to WGWIDE.
- Plan experiments and carry out analyses that may be used to shed light on the low survival rate estimated for the RFID tags, such as proper testing and control of detection efficiency at factories, survival experiments, special tagging experiments.
- Prepare a full report of the results from the workshop to be presented at WGWIDE.

8.6.5 Other surveys

8.6.5.1 International Ecosystem survey in the Norwegian Sea (IESNS)

After the mid-2000s an increasing amount of mackerel has been observed in catches in the Norwegian Sea during the combined survey in May (IESNS) targeting herring and blue whiting (Rybakov *et al.*, 2016; 2017). The spatial distribution pattern was slightly reduced in 2018, where mackerel was caught within a more limited area and in fewer trawl stations of the Norwegian Sea compared to 2017 (Rybakov *et al.*, 2017; ICES, 2018b). Mackerel at age 2 (mean length 26.4 cm) was most numerous in the combined samples and amounted to 26%, followed by age 1 (17%) and age 5 (13%) (ICES 2018b).

The mackerel distribution was further east in 2018 compared to in 2017. In 2018, the northernmost mackerel catch was at 70°N and the westernmost catch was at 2°W. In 2017, the northernmost mackerel catch was at 71°N and the westernmost catch was at 10°W. There was a less pronounced distribution of 1-year old mackerel found in 2018 compared to in 2017. There was still a northerly distribution of 1-year old mackerel in the northeast, whereas it was indicated that the 2017-year class also was the most dominant one year later, now as 2-year old mackerel in 2018. The IESNS survey provide valuable although limited quantitative information can be drawn. This acoustic based survey is not designed to monitor mackerel, and do not provide proper mackerel sampling in the vertical dimension, and also involve too low trawl speed for representative sampling of all size groups of mackerel. The trawl hauls are mainly targeting acoustical registrations of herring and blue whiting during the survey in May (IESNS).

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

Due to the participation in the International Blue Whiting Spawning Stock Survey (IBWSS), PELACUS 0318, was started a little bit later than previous years (25/03 instead 16/03), and the area was clockwise steamed, from the inner part of the Bay of Biscay to the Spanish –Portuguese border, thus contrary to the normal procedure (Carrera *et al.*, 2018a,b). Weather conditions were adverse, with a continuous low-pressure fronts with dominant SW/W winds and swell of about 4 m height, resulted in an important haline front all around the surveyed area due to the river run-offs, and a poleward current with clear influence up to 6ª30′ W (Galician waters). These conditions might have been an important influence in both aggregation pattern and spatial distribution in most of the fish species. In the case of mackerel, the distribution area was mainly restricted to coastal waters (<150 m depth) and mainly occurring in thick bottom layers. Together with mackerel, other swim bladder species were also found in these layers, as revealed by the frequency response done in those echotraces. The increase towards higher frequencies was lower than expected. Ground truth fishing stations confirmed this presence, although mackerel accounted up to 95% of the total catch in number. For this reason, instead of direct allocation, the Nakken and Dommasnes (1975) method for multiple species was used to split backscattering energy into those fish species caught at the ground truthing trawl hauls.

The bulk of the distribution, as in previous years, was located just in the middle of the Cantabrian Sea (Cape Peñas), extending throughout the surveyed area (Figure 8.6.5.2.1). A total of 557 thousand tonnes, corresponding to 1 640 million fish were estimated, most of them, as expected, in central Cantabrian Sea (Figure 8.6.5.2.2, Tables 8.6.5.2.1-2). This is similar to that assessed in 2017 (548 thousand tonnes corresponding to 1 777 million fish). As observed in previous years, only few individuals younger than 5 years were estimated (less than 10% in weight, 14% in number) Age group 6 was dominant (25 %). Mean length was 36.1 cm with a mean weight of 318.3 g, without any significant change in mean length nor in length distribution along the surveyed area.

On the other hand, this year mackerel egg collected by CUFES were counted and staged. 98% (364 of 373 station- each of them corresponding to 3 nmi on average-) resulted positive for mackerel eggs, with a mean of 248 egg per station (24 eggs/m^3). These figures are much higher than those collected at the Porcupine Sea Bight, where only few eggs were counted, with only 0.62 eggs/station (0.05 eggs/m^3) (Figure 8.6.5.2.3).

8.7 Stock Assessment

8.7.1 Update assessment in 2017

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 R library stock assessment (downloadable at install_github("fishfollower/SAM/stockassessment", ref="mack")) and adopting the configuration 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 2017 (with a strong down-weighting of the catches for the period 1980-1999) and three surveys: (i) the SSB estimates from the triennial Mackerel Egg survey (every three years in the period 1992-2016); (ii) the recruitment index from the western Europe bottom trawl IBTS Q1 and Q4 surveys (1998-2015, not updated for the last 2 years); and (iii) the abundance estimates for ages 3 to 11 from the IESSNS survey (2010, 2012-2018). The model also incorporates tagging-recapture data from the Norwegian tagging program (for fish recaptured between 1980 and 2005 for the steel tags time series, and fish recaptured between 2012 and 2017 for the radio frequency tags time series).

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

The differences in the new data used in this assessment compared to the last year's assessment were:

- No update of the IBTS recruitment index was available and the time series did not include any 2016 and 2017 estimates (see Section 8.6.2).
- Addition of the 2018 survey data in the IESSNS indices.
- Addition of the 2017 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.
- The inclusion of the tag recaptures from 2017, and minor revision in the tagging recapture data set for the RFID tagging program for the earlier recapture years (differences less than 1% in the recapture rates).

Input parameters and configurations are summarized in Table 8.7.1.1. The input data are given in Tables 8.7.1.2 to 8.7.1.9. Given the size of the data base the tagging data are not presented in this report, but are available on www.stockassessment.org in the data section (files named tag.dat and tag3.dat).

8.7.2 Model diagnostics

Parameter estimates

The estimated parameters and their uncertainty estimates are shown in Table 8.7.2.1 and Figure 8.7.2.1. The model gives a good fit to the catch data (lowest observation standard deviation). The observation standard deviations for the egg survey is also low, indicating a good fit to this survey. The observations standard deviations for the recruitment index and the IESSNS surveys ages 4 to 11 are higher indicating that the assessment gives a lower weight to the information coming from these surveys. The IESSNS age 3 has a very low weight in the assessment (high observation standard deviation). Overdispersion of the tag recaptures is not directly comparable with observation standard deviation, but has the same meaning. The model assigns a similar overdispersion to the steel tag data and the RFID tag data.

The catchability of the egg survey is 1.37, significantly larger than 1, which implies that the assessment considers the egg survey index to be an overestimate. The catchabilities at age for the IESSNS increase from close to 1 for age 3 to 2.69 for age 7 and decreases slightly for older ages. Since the IESSNS index is expressed as fish abundance, this also means that the assessment considers the IESSNS to provide over-estimated abundance values for the oldest ages. The post tagging survival estimate is higher for the steel tags (around 40%) than for the RFID tags (around 10%).

The process error standard deviation (ages 1-11) is moderate (lower than in previous assessments) as well as the standard deviation of the F random walk.

The catchability parameters appear to be estimated more precisely than the observation standard deviations, except for the catchability of the IESSNS at age 3 which has a higher standard deviation. Uncertainty on the tags post release survival is low. Uncertainty on the observation standard deviations is larger for the egg survey and the IESSNS age 3 than for the other survey indices. Uncertainty on the overdispersion of the RFID tag data is high.

The estimated AR1 error correlation structure for the observations from the IESSNS survey age 3 to 11 a high correlation between the errors of adjacent ages (r=0.82), then decreasing exponentially with age difference (Figure 8.7.2.2.). This high error correlation implies that the weight of this survey in the assessment in lower than for a model without correlation structure, which is also reflects in the high observation standard deviation for this survey.

There are some strong correlations between parameter estimates (Figure 8.7.2.3):

- Catchabilities are positively correlated (especially for the IESSNS age 4 to 11), and negatively correlated to the survival rate for the RFID tags. This implies that the model cannot distinguish well between low catchabilities / high tag survival (larger stock) and high catchability / low survival (smaller stock).
- The observation variance for the IESSNS age 4-11 is positively correlated to the autocorrelation in the errors for these observations. This implies that when the model estimates highly correlated errors between age-groups, the survey is considered more noisy.
- The observation variance of the catches is negatively correlated to the variance of the fishing mortality random walk. This implies that when the model tends to consider the catches as more precise, this implies a more variable fishing mortality.

These correlations mean that the model is not able to estimate these parameters independently and may indicate that it is overparameterised.

Residuals

The "one step ahead" (uncorrelated) residuals for the catches did not show any temporal pattern (Figure 8.7.2.4) except for 2014 for which they were mainly positive for 2014 (modelled catches lower than the observed ones). This may result from the random walk that constraints the variations of the 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 10. Residuals for ages 11 to 12 are also larger than for ages 2 to 10. This suggest that decoupling the observation variance of the catches (for example by grouping age 0 and 1, ages 2 to 10 and ages 11 and older) could be more appropriate. This has been investigated during the last benchmark assessment, but the model with decoupled observation variances gave a very tight fit to the recruitment index (observation standard deviation close to 0.05) and a very large observation standard deviation for the catches of ages 0 and 1. WKWIDE 2017 regarded the tight fit to the recruitment index as unrealistic and chose to retain the current model structure because there was insufficient time to continue with this analysis (ICES, 2017a). WGWIDE recommends that this work is prioritized during the next benchmark, because the problem with juvenile catches remained unsolved.

The residuals for the egg survey show a slight temporal pattern with negative residuals in the period 2001-2004 and followed by positive residuals for the period 2007-2013. The residual for the 2016 point is large and negative, indicating that the model has difficulties fitting to this low estimate, despite the overall decrease in the estimated SSB over the recent years.

Residuals for the IESSNS indices do not show any marked pattern, except the predominance of positive residuals for the two recent years (2016 and 2017) which indicate that the model does not agree with the high value of the survey observed for these 2 years. Residuals for the latest year are more balanced.

Residuals to the recruitment index show no particular pattern.

Finally, inspection of the residuals for the tag recaptures (Figure 8.7.2.5) did not show any sign of model misspecification. The only minor concern was for fish released at age 2 for which the predominance of positive residuals suggested that the post-release mortality for those fish may have been lower than for other ages (more tags return than expected). This issue is studied in more details in Section 8.7.4.

Leave one out runs

In order to visualise the respective impact of the different surveys on the estimated stock trajectories, the assessment was run leaving out successively each of the data sources (Figure 8.7.2.6). All leave out one runs showed parallel trajectories in SSB and F_{bar}, except the run removing the tagging data which shows a different dynamics in the early period of the assessment (before 2000) and in the recent years (since the start of the RFID time series). Further inspection of the output of the run without the tagging data showed that the model is not able to estimate accurately the parameters (it resulted this year in a variance for the F random walk close to 0, corresponding to constant F for the whole time series). This is explained by the fact that, without tagging data, the model has no information on the period prior to 2000, expect 3 egg survey points. The leave one out run excluding the tagging data should therefore be disregarded.

Removing the recruitment index had only on minor effect on the estimated stock trajectory. Removing the IESSNS resulted in lower SSB estimates and higher Fbar estimates for the period covered by the survey. On the opposite, removing the egg survey results in a larger estimated stock, exploited with a lower fishing mortality. These 2 surveys have a notable contribution to the assessment (even if the leave one out runs fall within the confidence intervals of the assessment using all data), and in a way, the final assessment seems to make a trade-off between the information coming from the IESSNS which lead to a more optimistic perception of the stock, and the information from the egg survey which suggest a more pessimistic perception of the stock. This conflict between the 2 surveys seem to have decreased compared to previous years, as the difference between the 2 leave one out runs is less pronounced this year than in the past.

The sensitivity of the assessment was tested for the RFID data alone in a separate analysis (Figure 8.7.2.7). Removing this source of data result in a very different perception of the development of the stock after 2012: the SSB in the assessment without RFID tag data continues to increase to reach close to 5.5 million tonnes in 2015 before declining to 4 million tonnes in 2017, while the SSB in the assessment using the RFID tags decreases continuously since 2011 to reach levels close to 3 million tonnes in 2017. The influence of a single year of data for the RFID tags was also tested by removing the recaptures from 2017 (Figure 8.7.2.8). This also resulted in a higher estimated SSB for the period since 2012, although the magnitude of the difference was less than when the entire RFID data set was removed. For comparison, the same exercise was done removing the last year of data for the IESSNS (Figure 8.7.2.9). This resulted only in a minor (downward) revision of the recent estimates of SSB.

This shows that the RFID tagging data has a very strong weight on the assessment, and pulls recent estimates of abundance downward. This feature of the assessment has not been investigated in the previous years, although it was noted during the previous benchmark that the decision to include the RFID data resulted in a lower SSB in the recent years. WGWIDE recommends that this aspect of the assessment should be further studied, and that the better understanding of the relative weight of the different data sources should be gained. Since the tag recaptures are modelled with an error distribution (negative binomial) different from the error distribution used for the other observations (log normal), model parameters cannot be used to compare their relative weight.

8.7.3 State of the Stock

The stock summary is presented in Figure 8.7.3.1 and Table 8.7.3.1. The stock numbers-at-age and fishing mortality-at-age are presented in Tables 8.7.3.2-3, respectively. The spawning stock biomass is estimated to have increased almost continuously from just below 2 million tonnes in the late 1990s and early 2000s to 4.79 million tonnes in 2011 and subsequently declined continuously to reach a level just above 3 million tonnes in 2017. The fishing mortality has declined from levels close to F_{lim} (0.46) in the mid-2000s to 0.26 in 2012 and has increased again since then to levels above F_{pa}. The recruitment time series from the assessment shows a clear increasing trend since the late 1990s with a succession of large year classes (2002, 2006, 2011 and 2014). The estimates for the year classes 2015 and 2016 indicate low recruitment, likely the lowest in the time series for the 2016 year class. There is insufficient information to estimate accurately the size of the 2017 year class. The estimate is very high but highly uncertain as it relies only on the age 0 catch data (in absence of a 2017 IBTS index).

There is some indication of changes in the selectivity of the fishery over the last 20 years (Figure 8.7.3.2.). In the year 1994, 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 towards a lower fishing mortality on the age-classes younger than 6 years until 2008 when it changed again towards a higher selection on the fish age 3 to 6.

8.7.4 Additional exploratory runs with different selection criteria for the tagging data

8.7.4.1 Accounting for the geographic area of recapture

Exploratory analyses presented in Section 8.6.4 suggest that the tag recapture rates may change according to the area of recapture. Potential biological explanations are given in the Section 8.6.4. If such is that case, it may be appropriate to take account of these differences in the assessment model. This can be done by estimating a different post release survival rate for the different areas considered in Section 8.6.4 (see Figure 8.6.4.5).

The RFID tag dataset structured by area is different from the one used in the update assessment: for each recapture year, there can be up to 4 data points (for the 4 areas) instead of one for each cohort in each release year. In order to assess the effect of using an area effect in the model, the model without area effect therefore had to be run first on the data set structured by area.

Model parameters were slightly changed when replacing the RFID tagging data by the data set structured by area (Figure 8.7.4.1.1). A small reduction of the observation variance for the egg survey and an increase for the IESSNS are observed. The overdispersion for the RFID tags decreases slightly, but the parameter is extremely badly defined (such that the parameter standard deviation could not be estimated). Including the area effect has only a minor effect on the parameters, and the problem with the high uncertainty on the overdispersion for the RFID tag remains. The problem with the estimation of the parameters was even more acute when the model was configured with separate overdispersion parameters for each geographical area (result not shown). The estimated survival rates show some differences between areas, with lower values for the area 3, average values for the areas 1 and 4 (similar to the parameter estimate without area effect) and high value for the area 2 (Figure 8.7.4.1.2). These values are consistent with the observations made in Section 8.6.4. Introducing an area specific survival rate resulted in smaller changes in the recent SSB and F (+7% and – 7% for 2018 SSB and Fbar respectively). Changing the RFID tagging dataset without any change in model configuration resulted in a downward revision by -18% of the recent SSB estimates and an upward revision of the same magnitude in the fishing mortality (Figure 8.7.4.1.3).

Although the differences in model AIC and the differences in estimated survival rates between areas suggest that it might be appropriate to take account of recapture area in the model, the issues found with parameter estimation deserve further attention. It is likely that data series may still be too short for some areas where the scanning of the RFID tags started only in the recent years.

8.7.4.2 Influence of the number of years before recapture

Investigations presented in Section 8.6.4 suggest that the recapture rates of a cohort tagged in a given year tend to decrease with the number of years separating tagging and recapture. In the context of the assessment model, this could be translated in differences in survival rate with the number of years between release and recapture. Since the model assumes a unique rate, this would result in a pattern in the residuals, with larger values (for a given cohort tagged in a given years) for the first recapture years, and lower residuals for fish that remained longer in the sea.

In order to investigate the existence of such patterns, the residuals were grouped by year-class and release year (or equivalently age at release). For each group, the residuals for the different recapture years were then centred (subtracting the mean) and inspected for pattern. Figure 8.7.4.2.1 shows that for a number of instances the residuals tend to decrease with the number of years spent at sea, which supports the hypothesis that mortality increase with the number of years after tagging. However, this is not the case of each cohort/age at release combination.

The existence of such patterns may indicate that the model is not formulated appropriately, and that the cumulative mortality with the successive years spent before recapture should be explicitly accounted for in the model. As an attempt to remove this potential bias in the assessment, the model was run using only the recapture of the first

2 years after tagging. This assessment estimated a lower overdispersion of the RFID tags, and a 20% higher estimated survival rate (which was to be expected if indeed mortality due to tagging continues in the years after release). There was however a slight increase in the uncertainty around these parameters. The corresponding stock trajectories are substantially revised (by +20% for 2017 SSB and by -21% for Fbar) (Figure 8.7.4.2.2).

This issue deserves further investigations, and potential model modifications to better model mortality after release should be investigated in a future benchmark.

8.7.5 Quality of the assessment

Parametric uncertainty

Large confidence intervals are associated with the SSB in the years before 1992 (Figure 8.7.3.1 and Figure 8.7.5.1). This results from the absence of information from the egg survey index, the downweighing 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 slightly in the most recent years and the SSB estimate for 2017 is estimated with a precision of +/- 28% (Figure 8.7.3.1 and Table 8.7.3.1). There is generally also a corresponding large uncertainty on the fishing mortality, especially before 1995. The estimate of Fbar4-8 in 2017 has a precision of +/- 31%. The uncertainty on the recruitment is high for the years before 1998 (precision of on average +/- 63%). The precision improves for the years for which the recruitment index is available (+/- 39%) except for the last estimated recruitment (+/- 99%).

Model instability

The retrospective analysis was carried out for 5 retro years, by fitting the assessment using the 2018 data, removing successively 1 year of data (Figure 8.7.5.2). Since some of the time series are still short (8 years for the IESSNS index, 6 years for the RFID tags), the parameters corresponding to these sources of data are expected to change from year to year, until the time series are long enough to have stable estimates.

There is no strong retrospective pattern observed in the SSB, as indicated by the reasonably low Mohn's rho value (i.e. average relative bias of retrospective estimates; Mohn, 1999; Brooks and Legault, 2016). All runs, except the one removing 5 years of data, provide estimates which are within the confidence intervals of the current assessment. Differences in the estimated F_{bar} values are larger than for SSB and tend to show a pattern to towards systematic overestimation, as indicated by the Mohn's rho value of 0.23. Recruitment appears to be quite consistently estimated.

Model behaviour

The realisation of the process error in the model was also inspected. The process error expressed as annual deviations in abundances-at-age (Figure 8.7.5.3) shows indications of some pattern across time and ages. There is a predominance of positive deviations in the recent years for age-classes 4 to 8. While process error is assumed to be independent and identically distributed, there is clear evidence of correlations in the realisation of the process error in the mackerel assessment, which appears to be correlated both across age-classes and temporarily.

The temporal autocorrelation can also be visualised if the process error is expressed in term of biomass (process error expressed as deviations in abundances-at-age multiplied by weight at age and summed over all age classes, Figure 8.7.5.4). Periods with positive values (when the model globally estimates larger abundances-at-age than corresponding to the survival equation) have been alternating with periods with negative values (between 2004 and 2007). For the years since 2010 the cumulated process error remains positive, with the magnitude reaching a third of the volume of the catches for 2009. The reason for this misbehaviour of the model could not be identified. It should be noted, however, that the magnitude and autocorrelation of the biomass cumulated process error in the 2018 assessment is lower than in the previous year's assessment.

8.8 Short term forecast

The short-term forecast provides estimates of SSB and catch in 2019 and 2020, given assumption of the current year's (also called intermediate year) catch and a range of management options for the catch in 2019.

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

8.8.1 Intermediate year catch estimation

Estimation of catch in the intermediate year (2018) is based on declared quotas and interannual transfers as shown in the text table in Section 8.1.

8.8.2 Initial abundances at age

The recruitment estimate at age 0 from the assessment in the terminal assessment year (2017) was considered too uncertain to be used, because this year class has not yet fully recruited into the fishery. The last recruitment estimate is normally 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 the year before the terminal year. The recruitment is then calculated as a weighted mean of the prediction from this linear regression based on the IBTS index value, and a time tapered geometric mean of the SAM estimates from 1990 to the year before the terminal year. The time tapered geometric mean gives the latest years more weight than a geometric mean. This is done because the recent productivity of the stock appears different than in the 1990's.

The recruitment index for 2016 and 2017 could not be calculated (see Section 8.6.2). The time tapered geometric mean (5 267 776) from 1990—2015 was therefore used as the recruitment in 2016 and 2017 in the forecast. This is equivalent to the standard method using RCT3, except that (missing) recruit index value has no influence.

8.8.3 Short term forecast

A deterministic short-term forecast was calculated using FLR. Table 8.8.3.1 lists the input data and Tables 8.8.3.2 and 8.8.3.3 provide projections for various fishing mortality multipliers and catch constraints in 2019.

Assuming catches for 2018 of 1 001 kt, F was estimated at 0.46 (close to F_{lim}) and SSB at 2.35 Mt (below B_{pa}) in spring 2018. If catches in 2019 equal the catch in 2018, F is expected to increase to 0.66 (above F_{lim}) in 2019 with a corresponding reduction in SSB to

1.98 Mt in spring 2019, which is close to B_{lim} (1.94 Mt). Assuming an F of 0.66 again in 2020, the SSB will decrease further to 1.71 Mt in spring 2020.

Following the MSY approach, exploitation in 2019 shall be at F_{MSY} * SSB(2019) /MSY $B_{trigger}$, because SSB is predicted to be below MSY $B_{trigger}$ (2.57 Mt) in spring 2019. This is equivalent to an F at 0.173, catches of 318 kt and a reduction in SSB to 2.12 Mt in spring 2019 (-10 % change). This is still below $B_{trigger}$. During the subsequent year, SSB is predicted increase with 10% to 2.33 Mt in spring 2020.

8.9 Biological Reference Points

A long-term management plan evaluation was conducted in 2017 (ICES, 2017b) which resulted in the adoption of new reference points for NEA mackerel stock by ICES.

8.9.1 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} = 1 940 000 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} = 0.48.

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 $B_{lim} \cdot exp(1.645 \cdot \sigma)$ where $\sigma = 0.17$ (the estimate of uncertainty associated with spawning biomass in the terminal year in the assessment, 2016, as estimated in the 2017 management plan evaluation); B_{pa} = 2 570 000 t.

F_{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 F_{pa}, which is a fishing mortality reference point designed to avoid reaching F_{lim}. Consequently, F_{pa} was calculated as F_{lim} * exp(1.645 σ) where σ = 0.20 default value was taken following the guidelines, as the estimated standard deviation of ln(F) in the final assessment year (2016) provided by the SAM assessment (i.e. σ = 0.14 corresponding to the uncertainty of ln(F_{2015})) was smaller than 0.20 but considered unrealistically low.; F_{pa} = 0.35.

8.9.2 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, 2013b), long term equilibrium simulations indicated that F=0.21 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 B_{pa}. Following the ICES procedure MSY $B_{trigger}$ was set equal to B_{pa}, 2 570 000 t.

Updated ICES reference points for NEA mackerel

Type		Value	Technical basis
MSY approach	MSY $B_{trigger}$	2.57 million tonnes	B_{pa} [1]
	F_{MSY}	0.21	Stochastic simulations [1]
Precautionary approach	B_{lim}	1.94 million tonnes	B_{loss} in 2002 [2]
	B_{pa}	2.57 million tonnes	$B_{lim} \times \exp(1.654 \times \sigma)$, $\sigma = 0.17$ [1]
	F_{lim}	0.48	F that on average leads to B_{lim} [1]
	F_{pa}	0.35	$F_{lim} \times \exp(1.654 \times \sigma)$, $\sigma = 0.20$[1]

[1] 2017 management plan evaluation (ICES, 2017b)

[2] 2017 benchmark assessment (ICES, 2017a)

8.10 Comparison with previous assessment and forecast

Assessment

The last available assessment used for providing advice was carried out in 2017 at WGWIDE. The new 2018 WGWIDE assessment gives a slightly different perception of the recent development of the stock (Figure 8.10.1). While the previous assessment gave the perception of a stock stable at high levels after 2011, the new assessment now indicates that the stock has been declining since 2011. Conversely the new assessment suggests that F has been increasing constantly since 2011, while the previous assessment indicated a less pronounced increase.

The differences in the 2016 TSB and SSB estimates between the previous and the present assessments are moderate, of -11% in both cases. The upward revision of the 2016 fishing mortality estimate is small, of 4%.

	TSB 2016	SSB 2016	F_{4-8} 2016
Values			
2017 WGWIDE	4752576	3970992	0.322
2018 WGWIDE	4216702	3527235	0.335
% difference	-11%	-11%	+4 %

The exploratory runs presented in Section 8.7. 2 showed that removing the last year of tagging data (recaptures from 2017) modified strongly the perception of the stock. The estimated SSB is in this case more similar to last year's assessment (see Figure 8.7.2.8). The same section shows that the 2018 IESSNS data point has little influence on the recent SSB and F_{bar} estimates (Figure 8.7.2.9). The recaptures from 2017 added in this update assessment inform the model on the abundance-at-age for ages 2 to 12 for the period 2011 to 2017 (so basically 1 additional year of RFID data may potentially provide as much information as the entire IESSNS index).

Inspecting the changes in the estimated model parameters can help understand the reason for these revisions (Figure 8.10.2). The addition of an additional year of data has slightly modified the relative weight of the different data sources: the estimated observation standard deviation has decreased for the catches and the egg survey, and increased for the IESSNS age 4-11 and the recruitment index. The overdispersion for the

RFID tags also increased. The model also estimates this year more variable recruitment and fishing mortality, and a smaller process error.

The uncertainty on the parameter estimates has decreased for a number of parameters (Figure 8.10.2). It is for instance the case for the observation standard deviations for the IESSNS, the overdispersion of the RFID tags, and some of the catchabilities estimates. However, the observation standard deviation for the catches has become slightly more uncertain. The joint uncertainty on recent SSB and F_{bar4-8} in this year's assessment is lower than for last year's assessment (Figure 8.10.3).

Forecast

The prediction of the mackerel catch for 2017 used for the short-term forecast in the advice given last year was very close to the actual 2017 catch reported in 2018 and used in the present assessment (text table below). The new assessment produced an estimate of the SSB in 2017 10.5% lower than the 2017 forecast prediction. The fishing mortality F_{bar4-8} for 2017 estimated this year is 6.2% lower 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 (2017)	**SSB (2017)**	**F4-8(2017)**
2017 WGWIDE forecast	1 178 850 t	3 443 926 t	0.405
2018 WGWIDE assessment	1 155 944 t	3 081 442t	0.38
% difference	-1.9%	-10.5%	-6.2%

8.11 Management Considerations

Details and discussion on quality issues in this year's assessment is given in Section 8.7 above.

The Atlantic mackerel in the Northeast Atlantic is traditionally characterised as three distinct 'spawning components': the southern component, the western component and the North Sea component. The basis for the components is derived from tagging experiments (ICES, 1974), however, the methods normally used to identify stocks or components (e.g. ectoparasite infections, blood phenotypes, otolith shapes and genetics) have not been able to demonstrate significant differences between animals from different components. The mackerel in the Northeast Atlantic appears on one hand to mix extensively whilst, on the other hand, exhibit some tendency for homing (Jansen *et al.*, 2013; Jansen and Gislason, 2013). Consequently, it cannot be considered either a panmictic population, nor a population that is composed of isolated components (Jansen and Gislason, 2013).

Nevertheless, stock components are still being used to identify the different spawning areas where mackerel are known to spawn. The trends in the different components is derived from the triennial egg survey in the western and southern area and a dedicated egg survey in the North Sea the year following the western survey.

Since the mid-1970s, ICES has continuously recommended conservation measures for the North Sea component of the Northeast Atlantic mackerel stock (e.g. ICES, 1974; ICES, 1981). The measures advised by ICES to protect the North Sea spawning component (i.e. closed areas and minimum landing size) aimed to promote the conditions that make a recovery of this component possible.

The recommended closure of Division 4.a 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 remain there until December before migrating to their spawning areas. Updated observations from the late 1990s suggested that this return migration actually started in mid- to late February (Jansen *et al*., 2012). The EU TAC regulations stated that within the limits of the quota for the western component (ICES Subareas and Divisions 6, 7, 8.a,b,d,e, 5b (EU), 2a (non-EU), 12, 14), a certain quantity of this stock may be caught in 4.a during the periods 1 January to 15 February and 1 September to 31 December. Up to 2010, 30% of the Western EU TAC of mackerel (MAC/2CX14-) could be taken in 4.a. From 2011 onwards, this percentage has been set at 40% and from 2015 at 60%.

The minimum landing size (MLS) for mackerel is currently set at 30 cm for the North Sea and 20 cm in the western area. The historical basis for the setting of minimum landing sizes is described in a working document to WGWIDE in 2015 (Pastoors, 2015). The MLS of 30 cm in the North Sea was originally introduced by Norway in 1971 and was intended to protect the very strong 1969 year class from exploitation in the industrial fishery. The 30 cm later became the norm for the North Sea MLS while the MLS for mackerel in western waters was set at 20 cm. In the early 1990s, ICES recommended that, because of mixing of juvenile and adult mackerel on western waters fishing grounds, the adoption of a 30 cm minimum landing size for mackerel was not desirable as it could lead to increased discarding (ICES, 1990; 1991). A substantial part of the catch of (western) NEA mackerel is taken in ICES division 4.a during the period October until mid-February to which the 30 cm MLS applies even though there is limited understanding on the effectiveness of minimum landing sizes in achieving certain conservation benefits (STECF, 2015).

8.12 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.

Production (recruitment and growth)

Mackerel recruitment (age 1) has been higher since 2001 compared to previous decades with several very large cohorts (Jansen, 2016). Increasing stock size was suggested to have an effect through density driven expansion of the spawning area into new areas with Calanus in oceanic areas west of the North European continental shelf (Jansen, 2016). There are several indications of a shift in spawning and mackerel recruitment/larvae and juvenile areas towards northern and north-eastern areas preceding the 2016 mackerel spawning (ICES, 2016b; Nøttestad *et al*. 2018). This northerly shift in spawning and recruitment pattern of NEA mackerel seem to have continued also in 2017 and 2018 (Nøttestad *et al*., 2018). The incoming 2017-year class has the largest age-1 index value recorded in IESSNS and is 150% larger than the incoming age-1 cohort in 2017 (ICES, 2018a).

During the recent decade, mackerel length- and weight-at-age declined substantially for all ages (Jansen and Burns, 2015; Ólafsdóttir *et al*., 2015). Growth of 0–3 years old mackerel decreased from 1998 to 2012. Mean length at age 0 decreased by 3.6 cm, however the growth differed substantially among cohorts (Jansen and Burns, 2015). For the 3-8 years old mackerel, the average size was reduced by 3.7 cm and 175 g from 2002 to 2013 (Ólafsdóttir *et al*., 2015). The variations in growth of mackerel in all ages are correlated with mackerel density. Furthermore, the density dependent regulation of growth from younger juveniles to older adult mackerel, appears to reflect the spatial dynamics observed in the migration patterns during the feeding season. (Jansen and Burns, 2015; Ólafsdóttir *et al*., 2015). Growth rates of the juveniles were tightly correlated with the density of juveniles in the nursery areas (Jansen and Burns, 2015). For adult mackerel (age 3-8) growth rates were correlated with the combined effects of mackerel and herring stock sizes (Ólafsdóttir et al., 2015). Conspecific density-dependence was most likely mediated via intensified competition associated with greater mackerel density.

Furthermore, the last few years after 2014, the recruitment appear weaker for NEA mackerel (ICES, 2017b; 2018c) and the density dependent growth has stabilized and mean weights per age group have even slightly increased during the last 2-3 years for several age groups (ICES, 2018c).

Spatial mackerel distribution and timing

In the mid-2000s, summer feeding distribution of Northeast Atlantic mackerel (*Scomber scombrus*) in Nordic Seas began expanding into new areas (Nøttestad *et al*., 2016). During 2007 - 2016 period mackerel distribution range increased three-fold and the centre-of-gravity shifted westward by 1650 km and northward by 400 km. Distribution range peaked in 2014 and was positively correlated to Spawning Stock Biomass (SSB).

After a mackerel stock expansion during the feeding season in summer from 1.3 million km^2 in 2007 to at least 2.9 million km^2 in 2014, mainly towards western and northern regions of the Nordic seas (Nøttestad *et al*., 2016c), we have now a slightly decreased distribution area of mackerel in the Nordic Seas (Nøttestad *et al*. 2017; ICES, 2018a). The survey coverage area was 2.8 million square kilometres in 2018, which is the same as in 2017 (Nøttestad *et al*. 2017; ICES, 2018a). The mackerel appeared more evenly distributed within the survey area and more easterly distributed in 2018 than in 2017 (ICES, 2018a). This difference in distribution primarily consists of a marked biomass decline of 76% in the west. In the eastern areas, the decline was less with 21%. Furthermore, there was also an eastward shift of distribution and centre of gravity within the Norwegian Sea (ICES, 2018a).

Geographical distribution of the 2016 cohort at age 0 and 1 was different from the traditional juvenile distribution patterns. The 2016 cohort was observed from latitude 60-71°N along the coast and offshore areas of Norway based on various survey data and fishing data (Nøttestad *et a*l., 2018). Traditional, 0- and 1-group of mackerel reside further south in waters of the southernmost part of Norway.

An historical and very pronounced shift in distribution of juvenile mackerel took place along the Norwegian coast starting off during the autumn of 2016 onwards (ICES, 2017b; Nøttestad *et al*., 2017; Nøttestad *et al*., 2018). This also coincided with increased number of adult and mature mackerel in northern waters from May to July 2016 (ICES, 2016) as well as from May to July 2017-2018 (ICES, 2017; Nøttestad *et al*. 2018). The prevalence of adult mackerel in the northern North Sea and southern Norwegian Sea increased markedly in first quarter and second quarter 2016, compared to the two previous years in 2014 and 2015, suggesting a shift in spawning of mackerel towards the north and northeast (Nøttestad *et al*., 2018).

The results showed also a marked increase in the presence of zero-year and one-year old mackerel in the northern North Sea and Skagerrak first quarter 2017, compared to first quarter 2014-2016. In the second quarter there were strong indications of spawning mackerel outside and north of the spatial and temporal coverage during the 2016 mackerel egg survey (Nøttestad *et al*., 2018).

Spatial mackerel distribution related to environmental conditions

Mackerel was present in temperatures ranging from 5 °C to 15 °C, but preferred areas with temperatures between 9 °C and 13 °C according to univariate quotient analysis according to Ólafsdóttir *et al.* (2018). Generalized additive models showed that both mackerel occurrence and density were positively related to location, ambient temperature, meso-zooplankton density and SSB, explaining 47% and 32% of deviance, respectively (Ólafsdóttir *et al.* 2018). Mackerel relative mean weight-at-length was positively related to location, day-of-year, temperature and SSB, but not with meso-zooplankton density, explaining 40% of the deviance. Geographical expansion of mackerel during the summer feeding season in Nordic Seas was driven by increasing mackerel stock size and constrained by availability of preferred temperature and abundance of meso-zooplankton (Ólafsdóttir *et al.*, 2018). Marine climate with multidecadal variability probably impacted the observed distributional changes but were not evaluated. Our results were limited to the direct effects of temperature, meso-zooplankton abundance, and SSB on distribution range during the last two decades (1997-2016) and should be viewed as such. In the 2018 IESSNS a marked change in the spatial distribution of mackerel was observed with lower densities of mackerel in the western distributions areas (East Greenland and Iceland) as compared to the recent years (see Figure 8.6.3.1). It is not clear what causes this distributional shift, but the SST were 1-1.5°C lower in the western and south-western areas as compared to a 20 years mean (1999-2009) might partly explain such changes (ICES, 2018a).

Trophic interactions

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), Óskarsson *et al.* (2015) and Bachiller *et al.* (2016), 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 when mackerel stock size was smaller. Langøy *et al* (2012) and Debes *et al.* (2012) also found that mackerel consumed wider range of prey species than herring. Mackerel may thus be thriving better in periods with low zooplankton abundances. Feeding incidence increased with decreasing temperature as well as stomach filling degree, indicating that feeding activity is highest in areas associated with colder water masses (Bachiller *et al.*, 2016). A bioenergetics model being developed by Bachiller *et al.* (2016) estimates that the NEA mackerel, NSS herring and blue whiting can consume between 122 and 135 million tonnes of zooplankton per year (2005-2010) This is higher than that estimated in previous studies (e.g. Utne *et al.*, 2012; Skjoldal *et al.*, 2004). NEA mackerel feeding rate can consequently be as high as that of the NSS herring in some years. Geographical distribution overlap between mackerel and NSS herring during the summer feeding season is highest in the south-western part of the Norwegian Sea (Faroe and east Icelandic area) (Nøttestad *et al.* 2016; 2017; Ólafsdóttir *et al.*, 2018). The spatio-temporal overlap between mackerel and herring was highest in the southern and south-western part of the Norwegian Sea in 2018 (ICES, 2018a). This is similar as seen in previous years (Nøttestad *et al.* 2016; 2017). There was practically no overlap between NEA mackerel and NSSH in the central and northern part of the Norwegian Sea in 2018, mainly because of very limited amounts of herring in this area (ICES, 2018a).

The increase of 0- and 1-groups of NEA mackerel found along major coastlines of Norway both in 2016 and 2017 (Nøttestad *et al.*, 2018), has created some interesting new trophic interactions. Increasingly numbers of adult Atlantic bluefin tuna (*Thynnus thunnus*), with an average size of approximately 200 kg, have been documented to feed on 0-group mackerel from the 2016, 2017-year classes during the commercial bluefin tuna fishery in Norway (Nøttestad *et al*., 2017b). Additionally, the new situation of numerous 0- and 1-group mackerel in Norwegian coastal waters have created favourable feeding possibilities for larger cod, saithe, marine mammals and seabirds in these waters. Repeated stomach samples from several species document that smaller sized mackerel is now eaten by different predators in northern waters (60-70°N).

8.13 References

Bachiller, E., Skaret, G., Nøttestad, L. and Slotte, A. 2016. Feeding ecology of Northeast Atlantic mackerel, Norwegian spring-spawning herring and blue whiting in the Norwegian Sea. PLoS ONE 11(2): e0149238. doi:10.1371/journal.pone.0149238

Burns F., O' Hea, B. and Gunnarsson, B. 2018. Mackerel egg exploratory survey. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Havstovan, Tórshavn, Faroe Islands, 28. August – 3. September 2018, 11 pp.

Brooks, E.N. and Legault, C.M. 2016. Retrospective forecasting — evaluating performance of stock projections in New England groundfish stocks. Canadian Journal of Fisheries and Aquatic Sciences 73: 935–950.

Carrera, P., Díaz, P., Domínguez, R., González-Bueno, G. and Riveiro, I. 2018a. Pelagic ecosystem acoustic-trawl survey PELACUS 0318: mackerel, horse mackerel, blue whiting and boar fish abundance estimates. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Havstovan, Tórshavn, Faroe Islands, 28. August – 3. September 2018, 35 pp.

Carrera, P., Díaz, P., Domínguez, R., González-Bueno, G. and Riveiro, I. 2018b. Pelagic ecosystem acoustic-trawl survey PELACUS-IBWSS 0318: blue whiting and müeller's pearlside fish abundance estimates in Porcupine Seabight. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Havstovan, Tórshavn, Faroe Islands, 28. August – 3. September 2018, 22 pp.

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.

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. 1974. Report of the Mackerel Working Group, 30 January - 1 February 1974. Charlottenlund, Denmark. ICES C.M. 1974/H:2. 20pp.

ICES. 1981. Report of the ICES Advisory Committee on Fishery Management, 1980, ICES. Cooperative Research Report no. 102.

ICES. 1990. Report of the ICES Advisory Committee on Fishery Management, 1989, ICES. Cooperative Research Report no. 168.

ICES. 1991. Report of the Mackerel Working Group. 29 April – 8 May 1991. Copenhagen, Denmark. ICES C.M. 1991/Asess: 19. 90 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. 2014. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA). 17–21 February 2014. Copenhagen, Denmark. ICES CM 2014/ACOM:43. 344 pp.

ICES. 2016a. Report of the Working Group on Widely Distributed Stocks (WGWIDE). 31 August – 6 September 2016, Copenhagen, Denmark. ICES CM 2016/ACOM:16. 506 pp.

ICES. 2016b. Second Interim Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). By correspondence. ICES CM 2016/SSGIEOM:09.

ICES. 2017a. Report of the Benchmark Workshop on Widely Distributed Stocks (WKWIDE), 30 January–3 February 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:36. 196 pp.

ICES. 2017b. Report of the Working Group on Widely Distributed Stocks (WGWIDE). 30 August – 5 September 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:23. 1003 pp.

ICES 2017c. International ecosystem survey in the Nordic Sea (IESNS) in May-June 2017. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Copenhagen, Denmark, 30 August – 5 September 2017. 33 pp.

ICES. 2018a. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) 30th of June – 6th of August 2018. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Havstovan, Tórshavn, Faroe Islands, 28. August – 3. September 2018, 39 pp.

ICES. 2018b. International Ecosystem Survey in Nordic Sea (IESNS) in May-June 2018. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Havstovan, Tórshavn, Faroe Islands, 28. August – 3. September 2018, 54 pp.

ICES. 2018c. Report of the Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS), 9-13 April 2018, Dublin, Ireland. ICES CM 2018/EOSG:17. 74 pp.

Jansen, T. 2016. First-year survival of North East Atlantic mackerel (*Scomber scombrus*) from 1998 to 2012 appears to be driven by availability of Calanus, a preferred copepod prey. Fisheries Oceanography 25: 457–469. doi:10.1111/fog.12165

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

Jansen, T. and Gislason, H. 2013. Population Structure of Atlantic Mackerel (*Scomber scombrus*). PLoS ONE 8(5): e64744. doi:10.1371/journal.pone.0064744

Jansen, T., Campbell, A., Brunel, T. and Clausen, L.A.W. 2013. Spatial segregation within the spawning migration of North Eastern Atlantic Mackerel (*Scomber scombrus*) as indicated by juvenile growth patterns. PLoS ONE 8(2): e58114. doi:10.1371/journal.pone.0058114

Jansen, T., Campbell, A., Kelly, C.J., Hátún, H. and Payne, M.R. 2012. Migration and Fisheries of North East Atlantic Mackerel (*Scomber scombrus*) in Autumn and Winter. PLoS ONE 7(12): e51541. doi:10.1371/journal.pone.0051541

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. and Hatfield, E.M.C. 2015. Nursery areas and recruitment variation of North East Atlantic mackerel (*Scomber scombrus*). ICES Journal of Marine Science 72(6): 1779-1789.

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(5-6): 442-460.

Mohn, R. 1999. The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. ICES Journal of Marine Science 56: 473–488.

Nakken, O. and Dommasnes, A. 1975. The application of an echo integration system in investigation of the stock strength of the Barents Sea capelin (*Mallotus Villosus*, Müller) 1971-1974. ICES CM 1975/B:25. 20pp.

Nielsen, A. and Berg, C.W. 2014. Estimation of time-varying selectivity in stock assessment using state–space models. Fisheries Research 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. 2016. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) with M/V "M. Ytterstad", M/V "Vendla", M/V "Tróndur í Gøtu", M/V "Finnur Fríði" and R/V "Árni Friðriksson", 1 – 31 July 2016. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE). ICES HQ, Copenhagen, Denmark, 31 August – 6 September 2016. 41 pp.

Nøttestad, L., Ólafsdóttir, A.H., Anthonypillai, V. Homrum, E., Jansen, T. et al. 2017. Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) with M/V "Kings Bay", M/V "Vendla", M/V "Tróndur í Gøtu", M/V "Finnur Fríði" and R/V "Árni Friðriksson", 3rd of July – 4th of August 2017. ICES Working Group on Widely Distributed Stocks (WGWIDE), ICES HQ, Copenhagen, Denmark, 30. August – 5. September 2017. 45 p.

Nøttestad, L. Utne, K.R., Sandvik, A., Skålevik, A., Slotte, A. and Huse, G. 2018. Historical distribution of juvenile mackerel northwards along the Norwegian coast and offshore following the 2016 mackerel spawning. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Havstovan, Tórshavn, Faroe Islands, 28. August – 3. September 2018, 25 pp.

Ólafsdóttir, A.H., Utne, K.R., Jacobsen, J.A., Jansen, T., Óskarsson, G.J., Nøttestad, L., Elvarsson, B.Þ., Broms, C. and Slotte, A. 2018. Geographical expansion of Northeast Atlantic mackerel (*Scomber scombrus*) in the Nordic Seas from 2007 to 2016 was primarily driven by stock size and constrained by low temperatures. Deep-Sea Research Part II (2018), https://doi.org/10.1016/j.dsr2.2018.05.023

Ólafsdóttir, A.H., Slotte, A., Jacobsen, J.A., Oskarsson, G.J., Utne, K.R. and Nøttestad, L. 2015. 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 73(4): 1255-1265. doi:10.1093/icesjms/fsv142

Ólafsdóttir, A.H., Utne, K.R., Nøttestad, L., Jacobsen, J.A., Jansen, T., Óskarsson, G.J., Jónsson, S. Þ., Smith, L., Salthaug, A., Hömrum, E. and Slotte, A. 2017. Preparation of data from the International Ecosystem Summer Survey in Nordic Seas (IESSNS) for use as an annual tuning series in the assessment of the Northeast Atlantic mackerel (*Scomber scombrus L.*) stock. Working Document to the Benchmark Workshop on Widely Distributed Stocks (WKWIDE), Copenhagen, Denmark, 30 January–3 February 2017. 36 pp.

Óskarsson, G.J., Guðmundsdóttir, A., Sveinbjörnsson, S. and Sigurðsson, T. 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 12: 16–29. doi:10.1080/17451000.2015.1073327

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., Kanischeva, O., Anthonypillai, V., Salthaug, A., Høines, Å., Mork, K.A., Melle, W., Skagseth, Ø, Skaret, G., Stæhr, K., Couperus, B., Kloppmann, M., Óskarsson, G.J., Valdimarsson, H., Pétursdóttir, H. Homrum, E., Mortensen, E., Vestergaard, P., Thomassen, J.A. and Smith, L. 2016. International ecosystem survey in the Nordic Sea (IESNS) in May-June 2016. Working Document to ICES Working Group on Widely Distributed Stocks (WGWIDE), Copenhagen, Denmark, 31 August – 6 September 2016. 33 pp.

Rybakov, M., Kharlin, S., Kanischeva, O., Anthonypillai, V., Salthaug, A., Høines, A., Mork, K.A, Broms, C.T., Skagseth, Ø., Stæhr, , K.J., Bergès, B., Kloppmann, M., Óskarsson, G.J., Ólafsdóttir, A.H., Pétursdóttir, H., Homrum, E., Smith, L. 2017. ICES Working Group on Widely Distributed Stocks (WGWIDE), ICES HQ, Copenhagen, Denmark, 30. August – 5. September 2017. 45 p.

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.

Skjoldal, H.R., Sætre, R., Fernö, A., Misund, O.A. and Røttingen, I. 2004. The Norwegian Sea ecosystem. Trondheim, Norway. Tapir Academic Press.

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

STECF. 2015. Expert Working Group on Technical measures part III (EWG 15-05), 2-6 March 2016, Dublin. N. Graham and H. Doerner. Brussels.

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

Utne, K.R., Hjøllo S.S., Huse G. and Skogen M. 2012. Estimating the consumption of Calanus finmarchicus by planktivorous fish in the Norwegian Sea using a fully coupled 3D model system. Marine Biology Research 8: 527–547. doi:10.1080/17451000.2011.642804

8.14 Tables

Table 8.2.1. 2017 Mackerel fleet composition of major mackerel catching nations.

Country	Len (m)	Engine power (hp)	Gear	Storage	No vessels
Denmark	57-88	4077-8158	Trawl	Tank	8
Faroe Islands	50-69	3460-8000 kw	Purse Seine/Trawl	RSW	3
	70-76	3920-7500 kw	Purse Seine/Trawl	RSW	4
	73-104	6000-6600 kw	Trawl	Freezer	2
	15-49	300-1940 kw	Trawl		20
	50-79	3000-7680 kw	Trawl		7
France	<24		Trawl		1230
	>24		Trawl		36
Germany	90-140	3800-12000	Single Midwater Trawl	Freezer	4
Greenland	66-80	4011-10034	Trawl	RSW	9
	55-88	3712-8164	Trawl	Freezer/RSW	5
	65-120	3002-9517	Trawl	Freezer	12
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	27m-65m	522-2720	Pair Midwater Trawl	RSW	14
	14m-45m	160-1119	Pair Midwater Trawl	Dryhold	23
	51m-71m	1007-3840	Midwater Trawl	RSW	8
	12m-17m	90-171	Midwater Trawl	Dryhold	2
Netherlands	55	2125	Pair Midwater Trawl	Freezer	1
	88-145	4400-10455	Single Midwater Trawl	Freezer	9
Norway	60-85 m		Purse seiner	RSW	78
	30-40 m		Purse seiner	Dryhold, RSW	16
	10-17 m		Purse seiner	Dryhold	178
	10-17 m		Hook and line/nets	Dryhold	169
	10-17 m		PS/hooks/nets	Dryhold	200
	30-40 m		Trawl	Dryhold.Tankhold	17
Portugal	0-10		Other		94
	10-20		OTB		3
	10-20		Other		86
	20-30		OTB		27
	20-30		Other		16
	30-40		Trawl		7
Spain	12-18	80-294	Trawl	Dryhold	12
	18-24	96-344	Trawl	Dryhold	30
	24-40	191-876	Trawl	Dryhold	72
	40-	353	Trawl	Dryhold	2
	0-10	34-44	Purse Seine	Dryhold	2
	10-12	20-106	Purse Seine	Dryhold	13
	12-18	21-245	Purse Seine	Dryhold	112
	18-24	70-397	Purse Seine	Dryhold	100
	24-40	140-809	Purse Seine	Dryhold	99
	0-10	3-74	Artisanal	Dryhold	329
	10-12	12-118	Artisanal	Dryhold	203
	12-18	18-239	Artisanal	Dryhold	208
	18-24	59-368	Artisanal	Dryhold	40
	24-40	129-368	Artisanal	Dryhold	11

1 RSW = refrigerated seawater.

Table 8.2.4.1. Overview of major existing regulations on mackerel catches.

Technical measure	National/International level	Specification	Note
Catch limitation	Coastal States/NEAFC	2010-2018	Not agreed
Management strategy (EU, NO, FO agreement London 12. Oct. 2014)	European (EU, NO, FO)	If SSB >= 3.000.000t, F = 0.24 If SSB is less than 3.000.000t, F = 0.24 * SSB/3.000.000 TAC should not be changed more than 20% A party may transfer up to 10% of unutilised quota to the next year	Not agreed by all parties
Management strategy with updated reference points 2017 (EU, NO, FO agreement London 11. Oct. 2017)	European (EU, NO, FO)	If SSB >= 2.570.000t, F = 0.21 If SSB is less than 2.570.000t, F = 0.21 * SSB/2.570.000 TAC should not be changed more than +25% or -20% A party may transfer up to 10% of unutilised quota to the next year A party may fish up to 10% beyond the allocated quota, that have to be deduced from next years quota.	Not agreed by all parties
Minimum size (North Sea)	European (EU, NO, FO)	30 cm in the North Sea	
Minimum size (all areas except North Sea)	European (EU, NO)	20 cm in all areas except North Sea	10% undersized allowed
Minimum size	National (NO)	30 cm 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.	
National catch limitations by gear, semester and area	National (ES)	28.74% of the Spanish national quota is assigned for the trawl fishery, 34.29% for purse seiners and 36.97% for the artisanal fishery	Since 2015, the trawl fishery has the individual quotas assigned by vessel.
Discard prohibition	National (NO, IS, FO)	All discarding is prohibited for Norwegian, Icelandic and Faroese vessels	
Landing 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. Since 2016 is also partly in place for demersal fisheries.	

Table 8.4.1.1. NE Atlantic Mackerel. ICES estimated catches by area (t). Discards not estimated prior to 1978 (data submitted by Working Group members).

Year	Subarea 6			Subarea 7 and Divisions 8.abde			Subareas 3 and 4			Subareas 1 2 5 and 14			Divisions 8.c and 9.a			Total		
	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch
1969	4800		4800	47404		47404	739175		739175	7		7	42526		42526	833912		833912
1970	3900		3900	72822		72822	322451		322451	163		163	70172		70172	469508		469508
1971	10200		10200	89745		89745	243673		243673	358		358	32942		32942	376918		376918
1972	13000		13000	130280		130280	188599		188599	88		88	29262		29262	361229		361229
1973	52200		52200	144807		144807	326519		326519	21600		21600	25967		25967	571093		571093
1974	64100		64100	207665		207665	298391		298391	6800		6800	30630		30630	607586		607586
1975	64800		64800	395995		395995	263062		263062	34700		34700	25457		25457	784014		784014
1976	67800		67800	420920		420920	305709		305709	10500		10500	23306		23306	828235		828235
1977	74800		74800	259100		259100	259531		259531	1400		1400	25416		25416	620247		620247
1978	151700	15100	166800	355500	35500	391000	148817		148817	4200		4200	25909		25909	686126	50600	736726
1979	203300	20300	223600	398000	39800	437800	152323	500	152823	7000		7000	21932		21932	782555	60600	843155
1980	218700	6000	224700	386100	15600	401700	87931		87931	8300		8300	12280		12280	713311	21600	734911
1981	335100	2500	337600	274300	39800	314100	64172	3216	67388	18700		18700	16688		16688	708960	45516	754476

Year	Subarea 6		Subarea 7 and Divisions 8.abde				Subareas 3 and 4		Subareas 1 2 5 and 14		Divisions 8.c and 9.a		Total			
1982	340400	4100	344500	257800	20800	278600	35033	450	35483	37600	37600	21076	21076	691909	25350	717259
1983	320500	2300	322800	235000	9000	244000	40889	96	40985	49000	49000	14853	14853	660242	11396	671638
1984	306100	1600	307700	161400	10500	171900	43696	202	43898	98222	98222	20208	20208	629626	12302	641928
1985	388140	2735	390875	75043	1800	76843	46790	3656	50446	78000	78000	18111	18111	606084	8191	614275
1986	104100		104100	128499		128499	236309	7431	243740	101000	101000	24789	24789	594697	7431	602128

Table 8.4.1.1. NE Atlantic Mackerel. ICES estimated catches by area (t). Discards not estimated prior to 1978 (data submitted by Working Group members). Continued.

Year	Subarea 6			Subarea 7 and Divisions 8.abde			Subareas 3 and 4			Subareas 1 2 5 and 14			Divisions 8.c and 9.a			Total		
	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch
1987	183700		183700	100300		100300	290829	10789	301618	47000		47000	22187		22187	644016	10789	654805
1988	115600	3100	118700	75600	2700	78300	308550	29766	338316	120404		120404	24772		24772	644926	35566	680492
1989	121300	2600	123900	72900	2300	75200	279410	2190	281600	90488		90488	18321		18321	582419	7090	589509
1990	114800	5800	120600	56300	5500	61800	300800	4300	305100	118700		118700	21311		21311	611911	15600	627511
1991	109500	10700	120200	50500	12800	63300	358700	7200	365900	97800		97800	20683		20683	637183	30700	667883
1992	141906	9620	151526	72153	12400	84553	364184	2980	367164	139062		139062	18046		18046	735351	25000	760351
1993	133497	2670	136167	99828	12790	112618	387838	2720	390558	165973		165973	19720		19720	806856	18180	825036
1994	134338	1390	135728	113088	2830	115918	471247	1150	472397	72309		72309	25043		25043	816025	5370	821395
1995	145626	74	145700	117883	6917	124800	321474	730	322204	135496		135496	27600		27600	748079	7721	755800
1996	129895	255	130150	73351	9773	83124	211451	1387	212838	103376		103376	34123		34123	552196	11415	563611
1997	65044	2240	67284	114719	13817	128536	226680	2807	229487	103598		103598	40708		40708	550749	18864	569613
1998	110141	71	110212	105181	3206	108387	264947	4735	269682	134219		134219	44164		44164	658652	8012	666664
1999	116362		116362	94290		94290	313014		313014	72848		72848	43796		43796	640311		640311

Year	Subarea 6			Subarea 7 and Divisions 8.abde			Subareas 3 and 4			Subareas 1 2 5 and 14			Divisions 8.c and 9.a			Total		
2000	187595	1	187595	115566	1918	117484	285567	165	304898	92557		92557	36074		36074	736524	2084	738608
2001	143142	83	143142	142890	1081	143971	327200	24	339971	67097		67097	43198		43198	736274	1188	737462
2002	136847	12931	149778	102484	2260	104744	375708	8583	394878	73929		73929	49576		49576	749131	23774	772905
2003	135690	1399	137089	90356	5712	96068	354109	11785	365894	53883		53883	25823	531	26354	659831	19427	679288
2004	134033	1705	134738	103703	5991	109694	306040	11329	317369	62913	9	62922	34840	928	35769	640529	19962	660491
2005	79960	8201	88162	90278	12158	102436	249741	4633	254374	54129		54129	49618	796	50414	523726	25788	549514

Table 8.4.1.1. NE Atlantic Mackerel. ICES estimated catches by area (t). Discards not estimated prior to 1978 (data submitted by Working Group members). Continued.

YEAR	SUBAREA 6			SUBAREA 7 AND DIVISIONS 8.ABDE			SUBAREAS 3 AND 4			SUBAREAS 1 2 5 AND 14			DIVISIONS 8.C AND 9.A			TOTAL		
	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch	Ldg	Disc	Catch
2006	88077	6081	94158	66209	8642	74851	200929	8263	209192	46716		46716	52751	3607	56358	454587	26594	481181
2007	110788	2450	113238	71235	7727	78962	253013	4195	257208	72891		72891	62834	1072	63906	570762	15444	586206
2008	76358	21889	98247	73954	5462	79416	227252	8862	236113	148669	112	148781	59859	750	60609	586090	37075	623165
2009	135468	3927	139395	88287	2921	91208	226928	8120	235049	163604		163604	107747	966	108713	722035	15934	737969
2010	106732	2904	109636	104128	4614	108741	246818	883	247700	355725	5	355729	49068	4640	53708	862470	13045	875515
2011	160756	1836	162592	51098	5317	56415	301746	1906	303652	398132	28	398160	24036	1807	25843	935767	10894	946661
2012	121115	952	122067	65728	9701	75429	218400	1089	219489	449325	1	449326	24941	3431	28372	879510	15174	894684
2013	132062	273	132335	49871	1652	51523	260921	337	261258	465714	15	465729	19733	2455	22188	928433	4732	933165
2014	180068	340	180408	93709	1402	95111	383887	334	384221	684082	91	684173	46257	4284	50541	1388003	6451	1394454
2015	134728	30	134757	98563	3155	101718	295877	34	295911	632493	78	632571	36899	7133	44033	1198560	10431	1208990
2016	206326	200	206526	37300	1927	39227	248041	570	248611	563440	54	563494	32987	3220	36207	1088094	5971	1094066
2017	225959	151	226110	21128	1992	23119	269404	400	269804	603806	62	603869	32815	227	33042	1153112	2832	1155944

Table 8.4.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in Subareas 1, 2, 5 and 14, 1984–2017 (Data submitted by Working Group members).

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992
Denmark	11787	7610	1653	3133	4265	6433	6800	1098	251
Estonia									216
Faroe Islands	137				22	1247	3100	5793	3347
France		16				11		23	6
Germany Fed. Rep.			99		380				
Germany Dem. Rep.			16	292		2409			
Iceland									
Ireland									
Latvia									100
Lithuania									
Netherlands									
Norway	82005	61065	85400	25000	86400	68300	77200	76760	91900
Poland									
Sweden									
United Kingdom			2131	157	1413		400	514	802
USSR/Russia	4293	9405	11813	18604	27924	12088	28900	13361	42440
Misreported (Area 4.a)									
Misreported (Area 6.a)									
Misreported (Unknown)									
Unallocated									
Discards									
Total	98222	78096	101112	47186	120404	90488	118700	97819	139062

Table 8.4.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in Areas 1, 2, 5 and 14, 1984–2017. Continued.

Country	1993	1994	1995	1996	1997	1998	1999	2000
Denmark			4746	3198	37	2090	106	1375
Estonia		3302	1925	3741	4422	7356	3595	2673
Faroe Islands	1167	6258	9032	2965	5777	2716	3011	5546
France	6	5	5		270			
Germany								
Greenland				1				
Iceland				92	925	357		
Ireland							100	
Latvia	4700	1508	389	233				
Lithuania								2085
Netherlands				561			661	
Norway	100500	141114	93315	47992	41000	54477	53821	31778
Poland					22			
Sweden								
United Kingdom		1706	194	48	938	199	662	
Russia	49600	28041	44537	44545	50207	67201	51003	491001
Misreported (Area 4.a)		-109625	-18647			-177	-40011	
Misreported (Area 6.a)							-100	
Misreported (Unknown)								
Unallocated								
Discards								
Total	165973	72309	135496	103376	103598	134219	72848	92557

Table 8.4.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in Areas 1, 2, 5, and 14, 1984–2017. Continued.

Country	2001	2002	2003	2004	2005	2006	2007	2008
Denmark	7	1						
Estonia	219							
Faroe Islands	3272	4730		650	30		278	123
France				2	1			
Germany							7	
Greenland								
Iceland		53	122		363	4222	36706	112286
Ireland			495	471				
Latvia								
Lithuania								
Netherlands		569	44	34	2393		10	72
Norway	21971	22670	125481	10295	13244	8914	493	3474
Poland								
Sweden	8							
United Kingdom	54	665	692	2493				4
Russia	41566	45811	40026	49489	40491	33580	35408	32728
Misreported (Area 4.a)								
Misreported (Area 6.a)								
Misreported (Unknown)		-570		-553				
Unallocated			-44	32	-2393		-10	-18
Discards				9				112
Total	67097	73929	53883	62922	54129	46716	72891	148781

Table 8.4.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in Areas 1, 2, 5, and 14, 1984–2017. Continued.

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017
Denmark		4845	269		391	2345	4321	1	2
Estonia					13671		0		
Faroe Islands	2992	66312	121499	107198	142976	103896	76889	61901	66194
France			2		197	8	36		
Germany				107	74		2963	3499	4064
Greenland			621	74021	541481	875811	30351	36142	46388
Iceland	116160	121008	159263	149282	151103	172960	169333	170374	167366
Ireland			90			1725	6	2	
Latvia									
Lithuania						1082		1931	
Netherlands		90	178	5	1	5887	6996	8599	7671
Norway	3038	104858	43168	110741	33817	192322	204574	153228	167739
Poland									
Sweden				4	825	3310	740	730	1720
United Kingdom					2	5534	7851	5240	4601
Russia	414141	58613	73601	74587	80812	116433	128433	121614	138061
Misreported (Area 4.a)									
Misreported (Area 6.a)									
Misreported (Unknown)									
Unallocated									
Discards		5	28	1	151	911	78	54	62
Total	163604	355729	398160	449326	465729	684173	632571	563315	603869

Table 8.4.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Subarea 4 and Division 3.a), 1988-2017 (Data submitted by Working Group members).

Country	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	20	37		125	102	191	351	106
Denmark	32588	26831	29000	38834	41719	42502	47852	30891
Estonia					400			
Faroe Islands		2685	5900	5338		11408	11027	17883
France	1806	2200	1600	2362	956	1480	1570	1599
Germany Fed. Rep.	177	6312	3500	4173	4610	4940	1497	712
Iceland								
Ireland		8880	12800	13000	13136	13206	9032	5607
Latvia					211			
Lithuania								
Netherlands	2564	7343	13700	4591	6547	7770	3637	1275
Norway	59750	81400	74500	102350	115700	112700	114428	108890
Poland								
Romania							2903	
Sweden	1003	6601	6400	4227	5100	5934	7099	6285
United Kingdom	1002	38660	30800	36917	35137	41010	27479	21609
USSR (Russia from 1990)								
Misreported (Area 2.a)							109625	18647
Misreported (Area 6.a)	180000	92000	126000	130000	127000	146697	134765	106987
Misreported (Unknown)								
Unallocated	29630	6461	-3400	16758	13566			983
Discards	29776	2190	4300	7200	2980	2720	1150	730
Total	338316	281600	305100	365875	367164	390558	472397	322204

Table 8.4.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Sub-area 4 and Division 3.a), 1988-2017. Continued.

Country	1996	1997	1998	1999	2000	2001	2002
Belgium	62	114	125	177	146	97	22
Denmark	24057	21934	25326	29353	27720	21680	343751
Estonia							
Faroe Islands	13886	32882	4832	4370	10614	18751	12548
France	1316	1532	1908	2056	1588	1981	2152
Germany	542	213	423	473	78	4514	3902
Iceland				357			
Ireland	5280	280	145	11293	9956	10284	20715
Latvia							
Lithuania							
Netherlands	1996	951	1373	2819	2262	2441	11044
Norway	88444	96300	103700	106917	142320	158401	161621
Poland							
Romania							
Sweden	5307	4714	5146	5233	49941	5090	52321
United Kingdom	18545	19204	19755	32396	58282	52988	61781
Russia		3525	635	345	1672	1	
Misreported (Area 2.a)				40000			
Misreported (Area 6.a)	51781	73523	98432	59882	8591	39024	49918
Misreported (Unknown)							
Unallocated	236	1102	3147	17344	34761	24873	22985
Discards	1387	2807	4753		1912	24	8583
Total	212839	229487	269700	313015	304896	339970	394878

Table 8.4.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Subarea 4 and Division 3.a), 1988-2017. Continued.

Country	2003	2004	2005	2006	2007	2008	2009
Belgium	2	4	1	3	1	2	3
Denmark	275081	25665	232121	242191	252171	26716	23491
Estonia							
Faroe Islands	11754	11705	9739	12008	11818	7627	6648
France	1467	1538	1004	285	7549	490	1493
Germany	4859	4515	4442	2389	5383	4668	5158
Iceland							
Ireland	17145	18901	15605	4125	13337	11628	12901
Latvia							
Lithuania							
Netherlands	6784	6366	3915	4093	5973	1980	2039
Norway	150858	147068	106434	113079	131191	114102	118070
Poland			109				
Romania							
Sweden	4450	4437	3204	3209	38581	36641	73031
United Kingdom	67083	62932	37118	28628	46264	37055	47863
Russia			4				
Misreported (Area 2.a)							
Misreported (Area 6.a)	62928	23692	37911	8719		17280	1959
Misreported (Unknown)							
Unallocated	-730	-783	7043	171	2421	2039	-629
Discards	11785	11329	4633	8263	4195	8862	8120
Total	365894	317369	254374	209192	257208	236111	235049

Table 8.4.2.2. NE Atlantic Mackerel. ICES estimated catch (t) in the North Sea, Skagerrak and Kattegat (Subarea 4 and Division 3.a), 1988-2017. Continued.

COUNTRY	2010	2011	2012	2013	2014	2015	2016	2017
Belgium	27	21	39	62	56	38	99	107
Denmark	36552	32800	36492	31924	21340	35809	21696	27457
Estonia								
Faroe Islands	4639	543	432	25	42919	25672	18193	12915
France	686	1416	5736	1788	4912	7827	3448	5942
Germany	25621	52911	4560	5755	4979	6056	10172	11185
Iceland								
Ireland	14639	15810	20422	13523	45167	34167	24437	35957
Latvia								
Lithuania					8340		596	
Netherlands	1300	9881	6018	4863	24536	17547	11434	17401
Norway	129064	162878	64181	130056	85409	36344	55089	51960
Poland						24		0.721
Romania								
Sweden	34291	32481	4560	2081	1112	3190	2933	1981
United Kingdom	52563	69858	75959	70840	145119	129203	99945	104499
Russia	696			4				
Misreported (Area 2.a)								
Misreported (Area 6.a)								
Misreported (Unknown)								
Unallocated	660							
Discards	883	1906	1089	337	334	34	559	400
Total	247700	303652	219489	261258	384221	295911	248611	269804

Table 8.4.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas 6 and 7 and Divisions 8.a,b,d,e), 1985–2017 (Data submitted by Working Group members).

Country	1985	1986	1987	1988	1989	1990	1991	1992
Belgium								
Denmark	400	300	100		1000		1573	194
Estonia								
Faroe Islands	9900	1400	7100	2600	1100	1000		
France	7400	11200	11100	8900	12700	17400	4095	
Germany	11800	7700	13300	15900	16200	18100	10364	9109
Guernsey								
Ireland	91400	74500	89500	85800	61100	61500	17138	21952
Isle of Man								
Jersey								
Lithuania								
Netherlands	37000	58900	31700	26100	24000	24500	64827	76313
Norway	24300	21000	21600	17300	700		29156	32365
Poland								
Spain				1500	1400	400	4020	2764
United Kingdom	205900	156300	200700	208400	149100	162700	162588	196890
Misreported (Area 4.a)		-148000	-117000	-180000	-92000	-126000	-130000	-127000
Misreported (Unknown)								
Unallocated	75100	49299	26000	4700	18900	11500	-3802	1472
Discards	4500			5800	4900	11300	23550	22020
Total	467700	232599	284100	197000	199100	182400	183509	236079

Table 8.4.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas 6 and 7 and Divisions 8.a,b,d,e), 1985–2017 (Data submitted by Working Group members).

Country	1993	1994	1995	1996	1997	1998	1999	2000
Belgium								
Denmark		2239	1143	1271			552	82
Estonia			361					
Faroe Islands		4283	4284		24481	3681	4239	4863
France	2350	9998	10178	14347	19114	15927	14311	17857
Germany	8296	25011	23703	15685	15161	20989	19476	22901
Guernsey								
Ireland	23776	79996	72927	49033	52849	66505	48282	61277
Isle of Man								
Jersey								
Lithuania								
Netherlands	81773	40698	34514	34203	22749	28790	25141	30123
Norway	44600	2552			223			
Poland	600							
Spain	3162	4126	4509	2271	7842	3340	4120	4500
United Kingdom	215265	208656	190344	127612	128836	165994	127094	126620
Misreported (Area 4.a)	-146697	-134765	-106987	-51781	-73523	-98255	-59982	-3775
Misreported (Unknown)								
Unallocated		4632	28245	10603	4577	8351	21652	31564
Discards	15660	4220	6991	10028	16057	3277		1920
Total	248785	251646	270212	213272	196110	218599	204885	297932

Table 8.4.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas 6 and 7 and Divisions 8.a,b,d,e), 1985–2017. Continued.

Country	2001	2002	2003	2004	2005	2006	2007	2008
Belgium				1				
Denmark	835		113				6	10
Estonia								
Faroe Islands	2161	2490	2260	674		59	1333	3539
France	18975	19726	21213	18549	15182	14625	12434	14944
Germany	20793	22630	19200	18730	14598	14219	12831	10834
Guernsey						10		
Ireland	60168	51457	49715	41730	30082	36539	35923	33132
Isle of Man								
Jersey					9	8	6	7
Lithuania						95	7	
Netherlands	33654	21831	23640	21132	18819	20064	18261	17920
Norway							7	3948
Poland					461	1368	978	
Russia								
Spain	4063	3483			4795	4048	2772	7327
United Kingdom	139589	131599	167246	149346	115586	67187	87424	768821
Misreported (Area 4.a)	-39024	-43339	-62928	-23139	-37911	-8719		-17280
Misreported (Unknown)								
Unallocated	37952	27558	5587	9714	13412	4783	10042	-952
Discards	1164	15191	7111	7696	20359	14723	10177	27351
Total	280553	252620	233157	244432	190597	169009	192201	177662

Table 8.4.2.3. NE Atlantic Mackerel. ICES estimated catch (t) in the Western area (Sub-areas 6 and 7 and Divisions 8.a,b,d,e), 1985–2017. Continued.

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017
Belgium	1	2					14	44	21
Denmark		48	2889	8	903	18538	6741	19443	12569
Estonia									
Faroe Islands	4421	36	8			3421	5851	13173	20559
France	16464	10301	11304	14448	12438	16627	17820	16634	16925
Germany	17545	16493	18792	14277	15102	23478	19238	9740	9608
Guernsey			10	5	9	9	4		
Ireland	48155	43355	45696	42627	42988	56286	54571	52087	48957
Isle of Man		14	11	11	8	3		8	2
Jersey	8	6	7	8	8	7	3	3	0.003
Lithuania			23			176	554	13	
Netherlands	20900	21699	18336	19794	16295	16242	15264	17896	18694
Norway	121	30	2019	1101	734		1313	1035	2657
Poland									
Russia		1						30	
Spain	8462	6532	1257	773	635	1796	951	1253	786
United Kingdom	109147	107840	111103	93775	92957	137195	110932	112268	116308
Misreported (Area 4.a)	-1959								
Misreported (Unknown)									
Unallocated	490	4503	399	16	-144		34		
Discards	6848	7518	7153	10654	2105	1742	3185	2126	2142
Total	230603	218377	219007	197496	183857	275519	236475	245754	249229

Table 8.4.2.4. NE Atlantic Mackerel. ICES estimated catch (t) in Divisions 8.c and 9.a, 1977–2017 (Data submitted by Working Group members).

Country	Div	1977	1978	1979	1980	1981	1982	1983	1984	1985
France	8.c									
Poland	9.a	8								
Portugal	9.a	1743	1555	1071	1929	3108	3018	2239	2250	4178
Spain	8.c	19852	18543	15013	11316	12834	15621	10390	13852	11810
Spain	9.a	2935	6221	6280	2719	2111	2437	2224	4206	2123
USSR	9.a	2879	189	111						
Total	9.a	7565	7965	7462	4648	5219	5455	4463	6456	6301
Total		27417	26508	22475	15964	18053	21076	14853	20308	18111

Country	Div	1986	1987	1988	1989	1990	1991	1992	1993	1994
France	8.c									
Poland	9.a									
Portugal	9.a	6419	5714	4388	3112	3819	2789	3576	2015	2158
Spain	8.c	16533	15982	16844	13446	16086	16940	12043	16675	21246
Spain	9.a	1837	491	3540	1763	1406	1051	2427	1027	1741
USSR	9.a									
Total	9.a	8256	6205	7928	4875	5225	3840	6003	3042	3899
Total		24789	22187	24772	18321	21311	20780	18046	19719	25045

Country	Div	1995	1996	1997	1998	1999	2000	2001	2002	2003
France	8.c									226
Poland	9.a									
Portugal	9.a	2893	3023	2080	2897	2002	2253	3119	2934	2749
Spain	8.c	23631	28386	35015	36174	37631	30061	38205	38703	17384
Spain	9.a	1025	2714	3613	5093	4164	3760	1874	7938	5464
Discards	8.c									531
Discards	9.a	3918	5737	5693	7990	6165	6013			
Total	9.a	27549	34123	40708	44164	43796	36074	4993	10873	8213
Total								43198	49575	26354

Table 8.4.2.4. NE Atlantic Mackerel. ICES estimated catch (t) in Divisions 8.c and 9.a, 1977–2017 (Data submitted by Working Group members). Continued.

Country	Div	2004	2005	2006	2007	2008	2009	2010	2011	2012
France	8.c	177	151	43	55	168	383	392	44	283
Poland	9.a									
Portugal	9.a	2289	1509	2620	2605	2381	1753	2363	962	824
Spain	8.c			43063	53401	50455	91043	38858	14709	17768
Spain	9.a			7025	6773	6855	14569	7347	2759	845
Discards	8.c	928	391	3606	156	73	725	4408	563	2187
Discards	9.a		405	1	916	677	241	232	1245	1244
Unallocated	8.c	28429	42851						4691	4144
Unallocated	9.a	3946	5107					108	871	1076
Total	9.a	6234	7021	9646	10293	9913	16562	10049	5836	3989
Total		35768	50414	56358	63906	60609	108713	53708	25843	28372

Country	Div	2013	2014	2015	2016	2017
France	8.c	220	171	21	106	83
Portugal	9.a	254	618	1456	619	634
Spain	8.c	14617	33783	29726	26553	30893
Spain	9.a	1162	2227	3853	2229	1206
Discards	8.c	1428	2821	4724	2469	84
Discards	9.a	1027	1463	2409	751	143
Unallocated	8.c	-573	8795	11	1357	
Unallocated	9.a	4053	662	1831	2123	
Total	9.a	6497	4308	9550	5722	1983
Total		22188	45570	44033	36207	33042

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers (‘000s) -at-age by area for 2017.

Quarters 1-4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	6469.5	1.2	166.3	22.5	1.2	1.1	0.1	16153.1	59.3
2	4144.3	2.4	332.5	51.0	1.9	1.0	0.3	47117.9	1966.2
3	184206.6	40.7	1342.7	278.4	8.3	10.9	1.6	144879.1	5758.8
4	137156.9	56.4	1360.5	196.7	0.6	4.7	1.7	93088.2	1235.3
5	130056.2	104.1	1511.4	224.5	2.4	8.8	1.4	96425.7	1163.5
6	207130.8	274.1	1374.7	284.7	6.2	12.3	1.5	100433.4	1241.8
7	192363.7	193.2	930.2	269.3	6.2	8.1	1.1	81246.2	1142.2
8	98036.7	95.1	250.1	186.5	3.5	5.8	0.6	51452.8	935.5
9	69092.1	50.1	483.4	104.0	2.0	2.9	0.3	31025.3	428.7
10	52518.2	19.8	591.1	98.1	2.0	2.0	0.4	25330.3	550.1
11	21175.0	1.0	143.3	28.2	0.6	0.6	0.1	9160.7	44.2
12	13075.8	1.0	143.3	23.0	0.1	0.1	0.1	5059.8	138.8
13	5163.8			16.3	0.1		0.1	1819.4	129.2
14	1652.8			10.7	0.1	0.1		844.7	105.8
15+	1328.8			0.8				220.1	5.4
Catch	461313.5	404.3	3636.5	686.0	12.4	22.8	3.5	263824.6	4723.4
SOP	461303.9	404.3	3636.5	686.3	12.4	22.8	3.6	263661.4	4725.4
SOP%	100%	100%	100%	100%	100%	100%	98%	100%	100%
AGE	**4.c**	**5.a**	**5.b**	**6.a**	**6.b**	**7.a**	**7.b**	**7.c**	**7.d**
0				36.1					
1	22.3		29.6	1896.2		0.1	30.3	20.3	395.9
2	516.6	908.6	128.2	4510.6	47.2	0.9	182.6	6.6	5676.2
3	436.5	8545.6	3134.2	46897.1	106.3	2.8	1378.1	3.3	5653.7
4	107.2	20461.0	2819.6	58059.9	39.7	2.3	770.4	1.4	1499.6
5	207.1	39384.5	3956.7	85304.6	0.9	4.5	2813.3	2.7	2376.4
6	135.8	49629.6	5602.4	105243.8	1.0	4.0	3360.9	5.2	1637.2
7	98.1	32370.6	4854.3	94518.4	0.7	5.5	2314.0	6.4	883.3
8	61.0	19226.1	3360.7	72337.6	0.4	2.5	2933.7	3.2	719.1
9	58.1	15585.2	1941.0	59501.7	0.3	3.5	2509.9	4.7	470.2
10	48.3	7674.4	1771.6	44873.8	0.2	3.1	1219.3	2.3	316.5
11	22.7	2953.6	222.5	23383.1	0.1	1.6	722.1	1.4	105.8
12	4.5	1420.9	424.4	11126.9		0.4	113.2		44.2
13	2.6	4.9	325.3	4280.6		0.1	65.0		17.0
14	2.1		269.6	1803.1		0.0	17.3		6.9
15+	1.2			600.7		0.0	0.0		12.6
Catch	531.6	87734.0	11343.6	226056.0	53.6	10.5	6420.5	17.8	6082.3
SOP	528.0	87738.8	11343.3	226102.9	54.9	10.5	6421.6	17.8	6033.4
SOP%	101%	100%	100%	100%	97%	100%	100%	100%	101%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarters 1-4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0	0.0	0.0	0.0	0.0	0.0	0.0	10111.7	17053.3
1	237.5	36.2	71.0	58.8	352.4	0.0	2086.3	6006.8
2	332.5	246.3	17.4	17.4	100.1	0.1	1808.5	3365.2
3	835.7	1273.6	3.7	9.1	214.9	0.1	1375.5	2963.7
4	360.5	868.3	1.1	2.9	193.8	0.04	632.4	1239.8
5	236.9	319.0	1.3	8.1	488.7	0.05	669.0	2277.2
6	194.6	147.3	1.8	7.6	897.5	0.04	673.1	2187.7
7	150.0	79.8	1.6	4.4	902.2	0.04	485.5	1411.7
8	161.4	51.4	1.2	6.7	687.0	0.01	278.8	726.4
9	130.9	39.1	1.1	5.3	622.2	0.02	154.5	401.7
10	108.8	20.4	0.5	2.8	281.0	0.01	95.9	150.9
11	147.5	18.1	0.3	3.0	194.8	0.01	16.6	38.4
12	49.0	6.6	0.1	0.6	93.0	0.00	29.8	7.3
13	63.9	8.8	0.1	0.7	69.8	0.0	0.9	2.1
14	32.0	4.4	0.0	0.3	26.5	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Catch	956.0	678.7	22.5	34.8	1817.3	0.2	2149.6	4853.5
SOP	956.7	678.6	22.5	34.8	1817.3	0.2	2154.2	4863.2
SOP%	100%	100%	100%	100%	100%	98%	100%	100%

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	329.63	0.0	59.5	435.9	279.8	0.0	0.0	28306.0
1	2702.36	1032.4	47.8	1319.9	1370.4	13.5	2853.7	43457.9
2	4991.5	1605.4	18.5	346.3	1019.5	38.7	8236.9	87739.1
3	8591.24	1919.1	18.8	811.0	1055.6	170.5	36373.9	458301.2
4	5192.66	2098.1	10.9	338.9	462.5	107.8	23407.2	351779.0
5	11664.52	5844.9	43.8	93.4	403.8	47.9	11215.3	396862.3
6	13062.37	6765.4	38.2	66.0	356.3	7.0	2816.8	503601.1
7	10188.69	5306.6	42.5	65.8	243.5	0.2	920.3	431014.2
8	6487.7	3208.7	15.1	47.2	146.5	0.0	530.5	261959.5
9	3844.51	1899.4	21.9	32.8	91.5	0.0	441.8	188949.9
10	1444.85	694.8	14.3	51.8	38.7	0.0	217.0	138143.1
11	446.91	265.3	8.5	4.7	14.5	0.0	85.9	59210.9
12	154.2	40.6	0.2	19.2	4.8	0.0	40.4	32022.0
13	94.33	53.5	0.1	0.0	3.0	0.0	0.0	12121.5
14	0	0.0	0.0	0.0	0.0	0.0	0.0	4776.4
15+	0	0.0	0.0	0.0	0.0	0.0	0.0	2169.6
Catch	20769.4	10289.9	75.9	776.6	1206.1	173.6	39263.1	1155943.8
SOP	20767.8	10289.5	75.9	776.6	1206.2	173.5	39263.9	1155785.1
SOP%	100%	100%	100%	100%	100%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 1

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1								3.8	
2								36.1	
3	0.6			1.3			0.1	4832.1	0.1
4	0.6			0.8				2996.4	
5	1.3			0.7				2655.8	0.1
6	1.9			1.1			0.1	4409.7	0.1
7	1.5			1.5			0.1	5380.1	0.1
8	1.0			1.2			0.1	4235.3	0.1
9	0.7			0.5				1846.4	
10	0.5			0.7				2557.5	
11	0.2							81.2	
12	0.1			0.2				680.3	
13	0.1			0.2				661.7	
14				0.2				547.6	
15+								0.0	
Catch	3.74			2.85			0.13	10717.97	0.13
SOP	3.74			2.87			0.13	10720.48	0.13
SOP%	100%			99%			102%	100%	99%

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0				35.9					
1				1871.0			30.2	20.3	92.2
2	0.7		0.1	4255.7			170.2	4.9	73.7
3	7.1	0.1	2156.5	46521.3		0.6	1292.3	1.0	571.0
4	4.3	0.3	1347.8	57870.8		0.8	726.9	0.8	337.4
5	7.1	0.5	1078.3	83936.6		1.5	2645.6	1.9	560.4
6	6.3	0.6	1886.9	104111.4		2.1	3178.4	4.7	516.8
7	5.5	0.4	2426.0	92769.9		2.6	2184.3	6.2	447.9
8	3.6	0.2	1940.8	71779.2		1.7	2750.0	3.2	296.4
9	2.7	0.1	808.7	58446.8		1.5	2365.1	4.6	213.5
10	1.2	0.1	1186.0	44031.6		1.6	1144.4	2.3	102.3
11	0.1		0.0	22776.0		0.7	630.3	1.3	10.9
12	0.2		323.5	11049.4		0.4	90.7		20.1
13	0.1		323.5	4214.6		0.1	38.0		11.2
14	0.0		269.6	1769.9		0.0	4.3		1.2
15+	0.0		0.0	598.3		0.0	0.0		0.0
Catch	13.1	1.0	4765.1	223122.1		5.1	5974.1	15.6	1082.3
SOP	13.1	1.0	4765.3	223167.9		5.1	5973.9	15.6	1082.6
SOP%	100%	99%	100%	100%		100%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 1

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							1811.5	4297.5
1	208.7	10.1	71.0	58.8	352.4		776.3	4083.8
2	66.0	52.8	16.2	13.8	91.1		363.7	2585.9
3	146.3	649.2	1.3	3.9	190.6		331.8	2363.1
4	93.0	464.2	0.1	1.4	181.7		132.9	904.0
5	85.4	137.5	0.1	5.7	461.6		267.9	1833.3
6	75.2	53.0	0.1	5.6	859.5	0.020	248.0	1716.4
7	44.0	21.7	0.1	3.0	836.3	0.030	147.4	1037.8
8	57.5	9.7	0.1	5.3	623.3	0.010	70.1	503.5
9	45.6	10.7	0.1	4.4	584.7	0.020	36.9	266.4
10	25.3	2.8	0.0	2.2	257.5	0.010	12.8	92.5
11	14.5	0.6	0.0	1.4	96.5	0.010	3.2	23.2
12	1.2				56.4		0.3	2.4
13	0.4				22.7		0.2	1.3
14	0.3				3.2		0.0	0.0
15+	0.0						0.0	0.0
Catch	228.5	281.5	18.4	26.1	1570.7	0.04	509.2	3464.5
SOP	228.6	281.5	18.4	26.1	1570.8	0.04	510.1	3470.5
SOP%	100%	100%	100%	100%	100%	93%	100%	100%

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	0	0	5.53	0	0			6150.4
1	1560.4	1026.0	25.0	66.9	0.4			10257.2
2	3533.4	1501.7	12.9	87.1	25.1			12891.2
3	4900.4	1685.8	17.3	154.6	164.1			65992.4
4	2974.0	1828.4	10.1	132.1	118.9			70127.6
5	6847.1	5110.5	22.8	12.6	194.5			105868.6
6	7487.7	5906.1	25.3	15.1	161.4			130673.6
7	5445.8	4603.0	18.5	35.2	69.3			115488.0
8	3203.8	2785.9	11.0	23.6	26.0			88332.2
9	1820.3	1620.0	6.2	18.9	12.2			68117.0
10	670.5	580.8	2.5	40.6	4.7			50720.1
11	172.5	188.1	0.7	2.7	1.6			24005.7
12	50.4	36.7	0.2	19.2	1.0			12332.8
13	12.3	15.0	0.1		0.4			5301.8
14			0.0					2596.3
15+								598.4
Catch	11357.5	8906.9	39.9	191.0	216.7			272514.0
SOP	11357.2	8906.9	39.9	191.0	216.7			272586.7
SOP%	100%	100%	100%	100%	100%			100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 2

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	56.3			1.2				6.4	18.5
2	77.2			0.0				55.1	1759.6
3	12817.9			86.5	0.4	0.01	0.3	323.1	3977.8
4	9812.6			52.4	0.2	0.01	0.2	104.7	794.1
5	5319.6			54.2	0.2	0.02	0.2	270.6	863.9
6	6074.7			95.3	0.3	0.03	0.3	524.9	1024.3
7	7487.9			116.4	0.4	0.03	0.4	569.9	1046.3
8	1727.3			86.4	0.4	0.01	0.3	387.0	893.5
9	1034.2			47.4	0.1	0.02	0.1	314.1	406.0
10	636.8			55.0	0.2	0.01	0.2	239.9	534.9
11	275.1			12.2		0.02		110.7	39.7
12	398.8			15.3	0.1	0.00	0.1	70.0	136.6
13	11.4			14.1	0.1	0.00	0.1	43.0	128.0
14	4.1			9.9	0.1	0.00		13.1	104.8
15+	1.0			0.6		0.00		12.9	5.2
Catch	15594.0			238.8	0.9	0.1	0.7	1334.4	3714.6
SOP	15594.6			238.9	0.9	0.1	0.7	1333.8	3714.9
SOP%	100%			100%	100%	108%	99%	100%	100%
AGE	**4.c**	**5.a**	**5.b**	**6.a**	**6.b**	**7.a**	**7.b**	**7.c**	**7.d**
0				0.2					0.0
1	10.6			2.2					43.1
2	229.8	23.9	25.8	217.9	0.1	0.2	12.0	1.6	913.6
3	200.0	157.5	241.3	224.7	0.1	0.7	84.6	2.2	770.3
4	50.1	330.8	159.8	169.3	0.0	0.5	42.6	0.6	174.5
5	111.2	647.5	307.1	1308.3	0.04	0.3	166.5	0.8	297.0
6	74.8	764.5	390.3	1014.9	0.03	0.2	181.3	0.5	182.1
7	72.1	455.6	209.8	1593.2	0.01	0.2	116.3	0.2	77.6
8	35.1	251.8	107.8	461.5	0.00	0.2	170.7	0.1	70.5
9	42.6	153.6	82.2	999.3	0.00	0.2	140.3		48.1
10	36.2	75.3	46.0	785.8	0.00	0.2	70.6		39.8
11	17.8	19.6	16.5	482.6	0.00		58.4		19.1
12	2.9	12.8	9.2	34.3	0.00		10.0		4.1
13	2.1		1.5	11.2	0.00		10.4		1.1
14	1.8			5.7	0.00		4.6		1.1
15+	0.5			2.4	0.00		0.0		2.1
Catch	276.7	1222.0	670.3	2485.8	0.1	0.7	382.0	2.1	800.8
SOP	274.7	1222.0	670.4	2487.5	0.1	0.7	382.8	2.1	792.6
SOP%	101%	100%	100%	100%	100%	100%	100%	100%	101%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 2

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0	0.0	0.0	0.0	0.0	0.0	0.0	1082.6	3639.6
1	0.0	0.2	0.0	0.0	0.0	0.0	457.3	1545.1
2	43.2	5.4	0.6	3.5	6.4	0.1	63.5	141.5
3	104.6	27.4	1.1	5.1	18.2	0.1	106.2	178.9
4	42.3	17.1	0.5	1.5	9.9	0.0	104.6	148.7
5	49.1	9.3	1.1	2.5	27.1	0.0	299.8	395.2
6	40.8	8.0	1.5	2.0	38.0	0.0	349.3	440.6
7	19.8	3.2	1.3	1.0	65.6	0.0	299.2	358.7
8	25.7	5.4	1.0	0.9	63.4	0.0	183.8	214.1
9	20.4	4.6	0.9	0.8	37.4	0.0	117.6	135.3
10	11.0	5.7	0.4	0.4	23.4	0.0	44.6	51.1
11	6.3	0.1	0.2	0.2	97.5	0.0	13.4	15.2
12	0.3	0.0	0.1	0.0	36.3	0.0	1.4	1.6
13	0.1	0.0	0.0	0.0	46.7	0.0	0.8	0.9
14	0.1	0.0	0.0	0.0	23.1	0.0	0.0	0.0
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Catch	112.0	22.1	3.1	6.2	242.2	0.1	596.7	815.5
SOP	112.0	22.1	3.1	6.2	242.2	0.1	600.2	818.6
SOP%	100%	100%	100%	100%	100%	102%	99%	100%
Age	**8.c**	**8.c.E**	**8.d**	**9.a**	**9.a.N**	**14.a**	**14.b**	**All**
0	0.0	0.0	54.0	0.0	0.0		0.0	4776.4
1	1025.8	2.2	22.7	863.2	59.7		6.0	4120.5
2	1335.2	52.6	5.5	43.4	377.3		17.2	5412.3
3	3522.2	165.4	1.5	333.1	353.1		75.7	23780.1
4	2165.3	243.2	0.8	107.3	94.0		47.8	14675.3
5	4806.9	729.2	21.0	56.4	147.7		21.3	15913.8
6	5570.1	856.7	13.0	46.4	178.8		3.1	17876.8
7	4740.2	702.5	24.1	28.3	167.6		0.1	18157.8
8	3282.6	421.8	4.2	23.5	119.5		0.0	8538.2
9	2024.2	279.4	15.7	13.9	79.3		0.0	5997.5
10	773.8	111.3	11.7	11.3	34.0		0.0	3599.8
11	274.4	77.2	7.8	2.0	12.8		0.0	1558.6
12	103.7	3.8	0.0	0.0	3.8		0.0	845.0
13	82.1	38.5	0.0	0.0	2.6		0.0	394.6
14	0.0	0.0	0.0	0.0	0.0		0.0	168.4
15+	0.0	0.0	0.0	0.0	0.0		0.0	24.6
Catch	9289.1	1338.4	36.0	272.9	437.2		77.0	39972.4
SOP	9289.3	1338.5	36.0	272.9	437.1		77.0	39971.2
SOP%	100%	100%	100%	100%	100%		100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 3

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	940.1			17.4	1.2	1.0	0.1	730.6	30.4
2	3076.3			40.3	1.9	0.9	0.2	1249.7	171.7
3	139839.6	31.3	35.6	150.7	7.8	9.7	1.1	4961.8	1657.7
4	115443.9	47.0	53.4	110.1	0.4	4.2	1.3	1571.0	395.3
5	107814.9	94.0	106.8	131.0	2.2	7.8	1.0	1899.1	262.8
6	170535.3	266.4	302.6	147.5	5.9	11.0	1.0	2730.8	192.5
7	155562.2	188.0	213.6	120.4	5.7	7.2	0.6	2482.0	83.0
8	75970.7	94.0	106.8	79.1	3.1	5.2	0.3	1754.1	37.2
9	51287.8	47.0	53.4	45.9	1.8	2.6	0.2	1405.0	19.7
10	37407.1	15.7	17.8	35.0	1.8	1.8	0.1	1176.3	13.5
11	14848.1			13.4	0.6	0.5	0.1	507.1	3.8
12	9157.3			6.4		0.1		280.9	2.0
13	4390.8			1.7		0.0		65.4	1.1
14	1470.4			0.5		0.1		15.7	1.0
15+	1127.5			0.2				19.2	0.2
Catch	369931.2	381.3	433.2	350.7	11.5	20.3	2.3	7734.3	911.4
SOP	369913.5	381.3	433.2	350.8	11.5	20.3	2.4	7735.0	912.8
SOP%	100%	100%	100%	100%	100%	100%	96%	100%	100%
AGE	**4.c**	**5.a**	**5.b**	**6.a**	**6.b**	**7.a**	**7.b**	**7.c**	**7.d**
0									
1	10.4						0.1		124.2
2	230.8	883.7	57.7	1.4	47.1	0.7	0.3	0.06	2530.6
3	192.9	8372.0	546.0	0.4	106.0	1.1	1.1	0.14	2174.9
4	45.2	20121.7	1311.8	0.3	39.6	0.9	0.9	0.05	492.7
5	73.4	38720.3	2524.1	6.6	0.8	2.6	1.0	0.00	799.8
6	45.3	48843.8	3184.0	4.1	1.0	1.5	1.1	0.00	489.2
7	17.5	31904.1	2079.8	7.7	0.6	2.7	9.9	0.01	179.0
8	18.2	18969.4	1236.6	1.4	0.4	0.5	9.6		186.8
9	10.5	15428.0	1005.7	5.1	0.3	1.8	3.3		108.4
10	8.8	7596.8	495.2	3.8	0.2	1.3	3.2		90.4
11	4.0	2933.3	191.2	2.5	0.1	0.9	24.2		40.9
12	1.1	1407.6	91.8				9.1		10.8
13	0.3	4.8	0.3				12.1		2.5
14	0.2						6.0		2.5
15+	0.5								5.7
Catch	200.1	86476.0	5637.2	11.1	53.4	4.4	47.2	0.1	2187.0
SOP	198.7	86476.7	5637.3	11.1	54.7	4.4	47.2	0.1	2164.3
SOP%	101%	100%	100%	100%	98%	100%	100%	104%	101%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 3

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							4520.1	2833.5
1	4.9	0.5				0.00	69.5	39.2
2	69.9	31.6	0.5		2.6	0.00	457.7	128.8
3	183.3	159.8	1.2		5.9	0.00	656.6	141.3
4	92.3	132.2	0.5		2.2	0.01	304.5	67.0
5	38.4	56.1	0.0		0.0	0.00	83.2	18.3
6	23.5	26.6	0.0		0.0	0.00	65.4	12.4
7	39.0	15.8	0.1	0.1	0.3	0.00	35.2	6.5
8	35.0	10.9	0.04	0.1	0.3	0.00	22.8	3.9
9	14.7	7.6	0.01	0.0	0.1	0.00	0.0	0.0
10	14.0	3.1	0.0	0.0	0.1	0.00	37.3	4.4
11	68.4	3.4	0.1	0.3	0.7	0.00	0.0	0.0
12	25.7	1.3		0.1	0.3	0.00	27.8	2.7
13	34.2	1.7		0.1	0.3	0.00	0.0	0.0
14	17.1	0.9		0.1	0.2	0.00	0.0	0.0
15+	0.0	0.0		0.0	0.0	0.00	0.0	0.0
Catch	241.4	117.4	0.8	0.6	4.2	0.004	602.6	168.6
SOP	241.5	117.4	0.8	0.6	4.2	0.004	602.4	168.5
SOP%	100%	100%	100%	99%	100%	100%	100%	100%
Age	**8.c**	**8.c.E**	**8.d**	**9.a**	**9.a.N**	**14.a**	**14.b**	**All**
0	10.8			280.3	245.0			7889.6
1	32.8			264.0	163.8	13.5	2847.7	5291.3
2	44.6	1.88	0.01	143.1	152.5	38.7	8219.7	17584.8
3	94.3	3.87	0.06	208.3	252.2	170.5	36298.3	196265.5
4	35.5	2.03	0.02	48.6	126.7	107.8	23359.4	163918.4
5	8.8	0.52	0.01	17.4	40.5	47.9	11194.0	163953.4
6	3.9	0.25	0.01		9.3	7.0	2813.7	229724.9
7	2.3	0.09	0.01		4.7	0.2	920.2	193888.3
8	1.2	0.05			0.8		530.5	99078.8
9	0.0	0.00					441.8	69890.5
10	0.5	0.04					217.0	47145.2
11	0.0						85.9	18729.3
12	0.1						40.4	11065.4
13								4515.4
14								1514.7
15+								1153.3
Catch	57.7	2.6	0.04	197.4	199.9	173.6	39186.1	515345.6
SOP	57.7	2.6	0.04	197.4	200.1	173.5	39187.1	515307.4
SOP%	100%	100%	97%	100%	100%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	5473.0	1.2	166.3	4.0		0.1	0.0	15412.2	10.5
2	990.8	2.4	332.5	10.6	0.01	0.1	0.1	45777.0	34.9
3	31548.4	9.4	1307.1	39.9	0.05	1.2	0.1	134762.0	123.2
4	11899.9	9.4	1307.1	33.4	0.01	0.5	0.2	88416.1	45.8
5	16920.4	10.1	1404.6	38.7	0.02	0.9	0.2	91600.2	36.9
6	30519.0	7.7	1072.1	40.8	0.04	1.3	0.1	92768.0	24.9
7	29312.1	5.2	716.6	31.1	0.03	0.9	0.1	72814.2	12.9
8	20337.7	1.0	143.3	19.9	0.02	0.6	0.1	45076.5	4.8
9	16769.4	3.1	430.0	10.2	0.01	0.3	0.03	27459.9	3.0
10	14473.8	4.1	573.3	7.4	0.01	0.2	0.02	21356.7	1.7
11	6051.6	1.0	143.3	2.6		0.1	0.01	8461.7	0.7
12	3519.6	1.0	143.3	1.1				4028.6	0.3
13	761.6			0.3				1049.2	0.1
14	178.3			0.1				268.3	0.0
15+	200.4							187.9	0.1
Catch	75784.6	23.0	3203.3	93.7	0.1	2.4	0.4	244037.9	97.3
SOP	75784.7	23.0	3203.2	93.8	0.1	2.5	0.4	243858.9	97.6
SOP%	100%	100%	100%	100%	97%	100%	99%	100%	100%
AGE	**4.c**	**5.a**	**5.b**	**6.a**	**6.b**	**7.a**	**7.b**	**7.c**	**7.d**
0									
1	1.27		29.62	22.92		0.02	0.01		136.39
2	55.37	0.92	44.64	35.58		0.08	0.02		2158.27
3	36.38	16	190.44	150.76		0.3	0.09		2137.51
4	7.62	8.19	0.19	19.46		0.17	0.07		494.93
5	15.41	16.18	47.29	53.19		0.14	0.08		719.08
6	9.33	20.67	141.2	113.42		0.14	0.09		449.15
7	2.98	10.49	138.72	147.6		0.09	3.51		178.78
8	4.12	4.73	75.45	95.5		0.06	3.49		165.42
9	2.36	3.48	44.44	50.62		0.03	1.17		100.2
10	2.07	2.16	44.43	52.63		0.02	1.16		83.99
11	0.94	0.65	14.82	122.02		0	9.2		34.94
12	0.25	0.45		43.17		0	3.45		9.08
13	0.06	0.11		54.86		0	4.6		2.12
14	0.06			27.43		0	2.3		2.12
15+	0.13					0	0		4.79
Catch	41.7	35.0	270.9	437.0		0.3	17.2		2012.2
SOP	41.6	35.0	270.9	437.0		0.3	17.2		1993.9
SOP%	100%	100%	100%	100%		100%	100%		101%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2017 (cont.).

Quarter 4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							2697.5	6282.8
1	23.9	25.4	0.01				783.2	338.7
2	153.5	156.5	0.01		0.06		923.6	509.0
3	401.6	437.2	0.1	0.1	0.14		280.9	280.5
4	133.0	254.8	0.1	0.0	0.05		90.6	120.1
5	64.0	116.1	0.1	0.0	0.00		18.1	30.4
6	55.0	59.7	0.1	0.0	0.00		10.4	18.3
7	47.2	39.1	0.1	0.4	0.03		3.8	8.8
8	43.2	25.4	0.1	0.4	0.03		2.1	4.9
9	50.3	16.2	0.03	0.1	0.01		0.0	0.0
10	58.5	8.9	0.02	0.1	0.01		1.2	2.9
11	58.4	14.1	0.02	1.1	0.07		0.0	0.0
12	21.9	5.3	0.01	0.4	0.03		0.3	0.6
13	29.2	7.0	0.01	0.5	0.04		0.0	0.0
14	14.6	3.5	0.00	0.3	0.02		0.0	0.0
15+							0.0	0.0
Catch	374.1	257.7	0.2	2.0	0.2		441.2	404.9
SOP	374.6	257.7	0.2	2.0	0.2		441.0	405.2
SOP%	100%	100%	98%	100%	95%		100%	100%
Age	**8.c**	**8.c.E**	**8.d**	**9.a**	**9.a.N**	**14.a**	**14.b**	**All**
0	318.9	0.0		155.7	34.8			9489.6
1	83.5	4.2		125.9	1146.5			23788.8
2	78.3	49.2		72.8	464.6			51850.8
3	74.4	64.0		115.1	286.2			172263.1
4	17.9	24.5		50.9	122.9			103057.7
5	1.7	4.7		7.0	21.1			111126.5
6	0.7	2.4		4.5	6.8			125325.8
7	0.4	1.0		2.3	1.9			103480.1
8	0.1	1.0		0.1	0.3			66010.3
9	0.0	0.0						44944.8
10	0.1	2.7						36678.0
11								14917.2
12								7778.8
13								1909.7
14								497.1
15+								393.3
Catch	65.0	42.0		115.3	352.4			328111.6
SOP	65.1	42.0		115.3	352.4			327929.8
SOP%	100%	100%		100%	100%			100%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1%.

Quarters 1-4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	1%	0%	2%	1%	3%	2%	2%	2%	0%
2	0%	0%	4%	3%	5%	2%	3%	7%	13%
3	16%	5%	16%	16%	24%	19%	17%	21%	39%
4	12%	7%	16%	11%	2%	8%	19%	13%	8%
5	12%	12%	18%	13%	7%	15%	15%	14%	8%
6	18%	33%	16%	16%	18%	21%	16%	14%	8%
7	17%	23%	11%	15%	18%	14%	12%	12%	8%
8	9%	11%	3%	10%	10%	10%	7%	7%	6%
9	6%	6%	6%	6%	6%	5%	4%	4%	3%
10	5%	2%	7%	5%	6%	3%	4%	4%	4%
11	2%	0%	2%	2%	2%	1%	1%	1%	0%
12	1%	0%	2%	1%	0%	0%	1%	1%	1%
13	0%			1%	0%	0%	1%	0%	1%
14	0%			1%	0%	0%	0%	0%	1%
15+	0%								

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	1%		0%	0%	0%	0%	0%	35%	2%
2	30%	0%	0%	1%	24%	3%	1%	11%	29%
3	25%	4%	11%	8%	54%	9%	7%	6%	29%
4	6%	10%	10%	9%	20%	7%	4%	2%	8%
5	12%	20%	14%	14%	0%	14%	15%	5%	12%
6	8%	25%	19%	17%	1%	13%	18%	9%	8%
7	6%	16%	17%	15%	0%	18%	13%	11%	4%
8	4%	10%	12%	12%	0%	8%	16%	6%	4%
9	3%	8%	7%	10%	0%	11%	14%	8%	2%
10	3%	4%	6%	7%	0%	10%	7%	4%	2%
11	1%	1%	1%	4%	0%	5%	4%	2%	1%
12	0%	1%	1%	2%	0%	1%	1%	0%	0%
13	0%	0%	1%	1%	0%	0%	0%	0%	0%
14	0%		1%	0%	0%	0%	0%	0%	0%
15+	0%			0%		0%			0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarters 1-4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							55%	45%
1	8%	1%	70%	46%	7%	0%	11%	16%
2	11%	8%	17%	14%	2%	20%	10%	9%
3	27%	41%	4%	7%	4%	30%	7%	8%
4	12%	28%	1%	2%	4%	9%	3%	3%
5	8%	10%	1%	6%	10%	11%	4%	6%
6	6%	5%	2%	6%	18%	9%	4%	6%
7	5%	3%	2%	3%	18%	9%	3%	4%
8	5%	2%	1%	5%	13%	2%	2%	2%
9	4%	1%	1%	4%	12%	5%	1%	1%
10	4%	1%	0%	2%	5%	2%	1%	0%
11	5%	1%	0%	2%	4%	2%	0%	0%
12	2%	0%	0%	0%	2%	0%	0%	0%
13	2%	0%	0%	1%	1%			
14	1%	0%		0%	1%			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	0%		17%	12%	5%			1%
1	4%	3%	14%	36%	25%	3%	3%	1%
2	7%	5%	5%	10%	19%	10%	9%	3%
3	12%	6%	6%	22%	19%	44%	42%	15%
4	8%	7%	3%	9%	8%	28%	27%	12%
5	17%	19%	13%	3%	7%	12%	13%	13%
6	19%	22%	11%	2%	6%	2%	3%	17%
7	15%	17%	12%	2%	4%	0%	1%	14%
8	9%	10%	4%	1%	3%		1%	9%
9	6%	6%	6%	1%	2%		1%	6%
10	2%	2%	4%	1%	1%		0%	5%
11	1%	1%	3%	0%	0%		0%	2%
12	0%	0%	0%	1%	0%			1%
13	0%	0%			0%			0%
14	0%	0%						0%
15+		0%						0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 1

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	0%								
2	0%						0%	0%	0%
3	7%			16%			16%	16%	16%
4	7%			10%			11%	10%	11%
5	15%			8%			8%	9%	13%
6	22%			14%			13%	14%	16%
7	18%			18%			18%	17%	16%
8	11%			14%			13%	14%	13%
9	8%			6%			5%	6%	5%
10	6%			9%			8%	8%	5%
11	2%			0%			0%	0%	0%
12	2%			2%			3%	2%	3%
13	1%			2%			3%	2%	3%
14	0%			2%			3%	2%	
15+	0%			0%					

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1				0%		0%	0%	40%	3%
2	2%	1%		1%		0%	1%	10%	2%
3	18%	5%	16%	8%		4%	7%	2%	18%
4	11%	11%	10%	10%		6%	4%	2%	10%
5	18%	22%	8%	14%		11%	15%	4%	17%
6	16%	26%	14%	17%		15%	18%	9%	16%
7	14%	16%	18%	15%		19%	13%	12%	14%
8	9%	9%	14%	12%		13%	16%	6%	9%
9	7%	5%	6%	10%		11%	14%	9%	7%
10	3%	3%	9%	7%		12%	7%	4%	3%
11	0%	1%	0%	4%		5%	4%	3%	0%
12	1%	0%	2%	2%		3%	1%		1%
13	0%		2%	1%		1%	0%		0%
14			2%	0%		0%			
15+				0%		0%			

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 1

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							43%	22%
1	24%	1%	80%	56%	8%		18%	21%
2	8%	4%	18%	13%	2%		9%	13%
3	17%	46%	1%	4%	4%		8%	12%
4	11%	33%	0%	1%	4%		3%	5%
5	10%	10%	0%	5%	10%		6%	9%
6	9%	4%	0%	5%	19%	20%	6%	9%
7	5%	2%	0%	3%	18%	30%	4%	5%
8	7%	1%	0%	5%	13%	10%	2%	3%
9	5%	1%	0%	4%	13%	20%	1%	1%
10	3%	0%	0%	2%	6%	10%	0%	0%
11	2%			1%	2%	10%	0%	0%
12	0%				1%			
13					0%			
14					0%			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0			3%					1%
1	4%	4%	16%	11%	0%			1%
2	9%	6%	8%	14%	3%			2%
3	13%	6%	11%	25%	21%			9%
4	8%	7%	6%	22%	15%			9%
5	18%	19%	14%	2%	25%			14%
6	19%	22%	16%	2%	21%			17%
7	14%	17%	12%	6%	9%			15%
8	8%	10%	7%	4%	3%			11%
9	5%	6%	4%	3%	2%			9%
10	2%	2%	2%	7%	1%			7%
11	0%	1%	0%	0%	0%			3%
12	0%	0%	0%	3%	0%			2%
13		0%						1%
14								0%
15+								0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 2

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	0%			0%				0%	0%
2	0%			0%				2%	15%
3	28%			13%	16%	6%	15%	11%	34%
4	21%			8%	10%	6%	9%	3%	7%
5	12%			8%	8%	13%	8%	9%	7%
6	13%			15%	14%	19%	14%	17%	9%
7	16%			18%	17%	19%	18%	19%	9%
8	4%			13%	14%	6%	13%	13%	8%
9	2%			7%	6%	13%	6%	10%	3%
10	1%			9%	9%	6%	8%	8%	5%
11	1%			2%	0%	13%	1%	4%	0%
12	1%			2%	2%		2%	2%	1%
13				2%	2%		2%	1%	1%
14				2%	2%		2%	0%	1%
15+				0%	0%			0%	

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	1%					0%			2%
2	26%	1%	2%	3%	27%	6%	1%	27%	35%
3	23%	5%	15%	3%	37%	29%	8%	36%	29%
4	6%	11%	10%	2%	10%	18%	4%	10%	7%
5	13%	22%	19%	18%	13%	12%	16%	13%	11%
6	8%	26%	24%	14%	9%	9%	17%	9%	7%
7	8%	16%	13%	22%	3%	6%	11%	3%	3%
8	4%	9%	7%	6%	1%	6%	16%	1%	3%
9	5%	5%	5%	14%	0%	6%	13%	1%	2%
10	4%	3%	3%	11%	0%	7%	7%	0%	2%
11	2%	1%	1%	7%		1%	5%	0%	1%
12	0%	0%	1%	0%			1%		0%
13	0%		0%	0%			1%		
14	0%			0%			0%		
15+	0%						0%		0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 2

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							35%	50%
1		0%					15%	21%
2	12%	6%	7%	20%	1%	28%	2%	2%
3	29%	32%	13%	29%	4%	38%	3%	2%
4	12%	20%	6%	8%	2%	9%	3%	2%
5	13%	11%	12%	14%	5%	13%	10%	5%
6	11%	9%	17%	11%	8%	9%	11%	6%
7	5%	4%	15%	5%	13%	3%	10%	5%
8	7%	6%	12%	5%	13%		6%	3%
9	6%	5%	11%	4%	8%		4%	2%
10	3%	7%	5%	2%	5%		1%	1%
11	2%	0%	2%	1%	20%		0%	0%
12	0%		1%	0%	7%			
13			0%		9%			
14			0%		5%			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0			30%					4%
1	3%	0%	12%	56%	4%		3%	3%
2	4%	1%	3%	3%	23%		10%	4%
3	12%	4%	1%	22%	22%		44%	19%
4	7%	7%	0%	7%	6%		28%	12%
5	16%	20%	12%	4%	9%		12%	13%
6	19%	23%	7%	3%	11%		2%	14%
7	16%	19%	13%	2%	10%		0%	14%
8	11%	11%	2%	2%	7%		0%	7%
9	7%	8%	9%	1%	5%			5%
10	3%	3%	6%	1%	2%			3%
11	1%	2%	4%	0%	1%			1%
12	0%	0%			0%			1%
13	0%	1%			0%			0%
14								0%
15+								0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 3

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	0%			2%	4%	2%	2%	4%	1%
2	0%			4%	6%	2%	4%	6%	6%
3	16%	4%	4%	17%	24%	19%	18%	24%	58%
4	13%	6%	6%	12%	1%	8%	22%	8%	14%
5	12%	12%	12%	15%	7%	15%	17%	9%	9%
6	19%	34%	34%	16%	18%	21%	17%	13%	7%
7	18%	24%	24%	13%	18%	14%	10%	12%	3%
8	9%	12%	12%	9%	10%	10%	4%	8%	1%
9	6%	6%	6%	5%	6%	5%	3%	7%	1%
10	4%	2%	2%	4%	6%	3%	2%	6%	0%
11	2%			1%	2%	1%	1%	2%	0%
12	1%			1%		0%		1%	0%
13	0%			0%		0%		0%	
14	0%			0%		0%		0%	
15+	0%							0%	

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	2%			0%			0%		2%
2	35%	0%	0%	4%	24%	5%	0%	19%	35%
3	29%	4%	4%	1%	54%	8%	1%	45%	30%
4	7%	10%	10%	1%	20%	7%	1%	16%	7%
5	11%	20%	20%	20%	0%	18%	1%		11%
6	7%	25%	25%	12%	0%	11%	1%		7%
7	3%	16%	16%	23%	0%	19%	12%	3%	2%
8	3%	10%	10%	4%	0%	4%	12%	3%	3%
9	2%	8%	8%	15%	0%	13%	4%	0%	1%
10	1%	4%	4%	11%	0%	9%	4%	0%	1%
11	1%	2%	2%	8%		6%	30%	6%	1%
12	0%	1%	1%				11%	3%	0%
13							15%	3%	0%
14							7%		0%
15+	0%								0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 3

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							72%	87%
1	1%	0%					1%	1%
2	11%	7%	21%	2%	20%		7%	4%
3	28%	35%	49%	3%	46%	24%	10%	4%
4	14%	29%	19%	1%	17%	55%	5%	2%
5	6%	12%	1%	1%	0%	20%	1%	1%
6	4%	6%	1%	1%	0%		1%	0%
7	6%	3%	2%	11%	2%		1%	0%
8	5%	2%	2%	11%	2%		0%	0%
9	2%	2%	0%	4%	1%			
10	2%	1%	0%	4%	1%		1%	0%
11	10%	1%	2%	29%	5%			
12	4%	0%	1%	11%	2%		0%	0%
13	5%	0%	1%	14%	3%			
14	3%	0%	0%	7%	1%			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	5%			29%	25%			1%
1	14%	0%	8%	27%	16%	3%	3%	0%
2	19%	22%	8%	15%	15%	10%	9%	1%
3	40%	44%	46%	22%	25%	44%	42%	16%
4	15%	23%	15%	5%	13%	28%	27%	13%
5	4%	6%	8%	2%	4%	12%	13%	13%
6	2%	3%	8%		1%	2%	3%	19%
7	1%	1%	8%		0%		1%	16%
8	1%	1%			0%		1%	8%
9	0%	0%					1%	6%
10	0%	0%					0%	4%
11							0%	2%
12	0%							1%
13								0%
14								0%
15+								0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	3%	2%	2%	2%	5%	2%	1%	2%	3%
2	1%	4%	4%	4%	5%	2%	7%	7%	12%
3	17%	17%	17%	17%	24%	19%	15%	21%	41%
4	6%	17%	17%	14%	5%	8%	21%	14%	15%
5	9%	18%	18%	16%	10%	15%	17%	14%	12%
6	16%	14%	14%	17%	19%	21%	14%	14%	8%
7	16%	9%	9%	13%	14%	14%	12%	11%	4%
8	11%	2%	2%	8%	10%	10%	7%	7%	2%
9	9%	6%	6%	4%	5%	5%	3%	4%	1%
10	8%	7%	7%	3%	5%	4%	2%	3%	1%
11	3%	2%	2%	1%		1%	1%	1%	0%
12	2%	2%	2%	0%		0%		1%	0%
13	0%			0%				0%	0%
14	0%			0%		0%		0%	
15+	0%								

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0						0%			
1			4%	2%		2%			2%
2	40%	1%	6%	4%		8%	0%		32%
3	26%	19%	25%	15%		29%	0%		32%
4	6%	10%		2%		16%	0%		7%
5	11%	19%	6%	5%		13%	0%		11%
6	7%	25%	18%	11%		13%	0%		7%
7	2%	12%	18%	15%		9%	12%		3%
8	3%	6%	10%	10%		6%	12%		2%
9	2%	4%	6%	5%		3%	4%		2%
10	1%	3%	6%	5%		2%	4%		1%
11	1%	1%	2%	12%			31%		1%
12	0%	1%	0%	4%			12%		0%
13		0%		6%			16%		
14				3%			8%		
15+	0%								0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2017. Zeros represent values <1% (cont.).

Quarter 4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							56%	83%
1	2%	2%	2%				16%	4%
2	13%	13%	2%	1%	12%		19%	7%
3	35%	37%	17%	3%	29%		6%	4%
4	12%	22%	8%	1%	10%		2%	2%
5	6%	10%	14%				0%	0%
6	5%	5%	19%				0%	0%
7	4%	3%	14%	12%	6%		0%	0%
8	4%	2%	10%	12%	6%			0%
9	4%	1%	5%	4%	2%			
10	5%	1%	3%	4%	2%			
11	5%	1%	3%	31%	14%			
12	2%	0%	2%	12%	6%			
13	3%	1%	2%	15%	8%			
14	1%	0%	0%	7%	4%			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	55%			29%	2%			1%
1	14%	3%		24%	55%			3%
2	14%	32%		14%	22%			6%
3	13%	42%		22%	14%			20%
4	3%	16%		10%	6%			12%
5	0%	3%		1%	1%			13%
6	0%	2%		1%	0%			14%
7	0%	1%		0%	0%			12%
8		1%						8%
9								5%
10		2%						4%
11								2%
12								1%
13								0%
14								0%
15+								0%

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017.

Quarters 1-4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	291	335	335	284	280	282	292	288	282
2	328	335	335	323	311	321	320	317	313
3	324	345	331	326	327	334	328	328	316
4	328	355	355	346	344	352	350	348	341
5	345	362	366	351	347	357	356	353	344
6	353	370	372	357	346	360	364	360	351
7	357	386	376	361	353	368	367	365	354
8	367	396	379	373	365	378	383	374	368
9	374	391	386	375	370	381	375	377	368
10	379	403	395	383	381	385	384	380	385
11	384	395	395	383	390	389	385	386	393
12	389	395	395	386	383	393	382	390	382
13	393			385	382	410	381	392	381
14	398			366	360	386	362	371	361
15+	408			409				411	412

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0				165		165			
1	271		280	274		242	298	298	278
2	311	338	327	291	335	291	304	341	311
3	317	338	313	313	335	297	316	356	317
4	334	348	342	340	335	317	321	371	335
5	342	354	350	348	357	345	344	362	343
6	348	358	355	353	360	350	346	375	351
7	359	364	357	360	366	359	362	383	365
8	365	373	370	369	374	368	368	381	369
9	377	376	372	379	376	382	373	392	376
10	384	382	385	382	382	388	379	394	378
11	396	387	387	385	387	389	371	405	397
12	393	393	383	391	393	391	392	404	399
13	388	420	380	393	420	390	407	410	395
14	373		360	406		385	416	419	406
15+	413			399		381			413

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarters 1-4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							137	136
1	295	231	298	298	298	0	215	190
2	299	268	342	343	338	348	304	303
3	310	291	349	349	320	367	334	328
4	318	305	347	346	336	377	349	346
5	339	317	357	353	347	384	357	354
6	347	325	356	351	352	388	364	359
7	368	334	364	370	362	390	373	369
8	371	352	375	369	375	390	382	379
9	380	351	377	372	377	396	389	386
10	388	386	382	380	383	397	398	390
11	401	405	384	385	391	409	402	400
12	408	408	391	408	394	445	427	417
13	410	410	408	410	409		438	437
14	420	420	416	420	418			
15+	413							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	181		131	189	212			138
1	257	263	185	219	256	352	352	269
2	296	299	299	313	292	336	336	315
3	321	327	319	333	324	357	357	327
4	345	347	345	364	343	372	371	340
5	355	354	352	371	351	383	381	350
6	361	361	357	371	357	400	380	355
7	371	372	363	390	372	422	367	360
8	380	379	377	389	382		374	370
9	385	386	385	394	388		376	376
10	389	390	394	400	393		382	381
11	403	407	395	408	403		387	385
12	414	416	405	393	412		394	390
13	433	436	418		440			393
14			372					394
15+								406

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 1

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	237					215		224	249
2	334							308	307
3	333			304		310	304	304	306
4	344			336		334	336	336	338
5	351			340		340	340	342	348
6	357			349		351	349	349	354
7	362			351		355	351	352	358
8	372			369		366	369	369	373
9	375			367		367	367	368	375
10	382			388		375	388	387	388
11	386					373		386	392
12	389			380		383	380	380	382
13	395			380		380	380	380	381
14	399			360		420	360	360	360
15+	408							408	

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0				165		165			
1	249			274		239	298	298	298
2	306	334	349	290		295	304	339	317
3	308	341	304	313		310	316	333	308
4	340	345	336	340		337	322	366	340
5	354	352	340	348		346	344	352	354
6	361	356	349	353		351	346	373	360
7	369	360	351	360		360	361	383	369
8	384	373	369	369		368	368	380	383
9	383	372	367	378		380	373	392	383
10	391	381	388	382		382	379	393	390
11	398	385	445	384		382	369	405	395
12	393	378	380	391		391	389	400	392
13	385		380	392		390	407	411	386
14	372		360	406		385	405	405	369
15+				399		381			

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 1

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							129	129
1	297	257	298	298	298		174	188
2	326	279	342	341	338		302	302
3	304	296	359	328	317		325	326
4	310	303	365	317	336	395	344	345
5	335	312	360	343	347	355	352	353
6	342	316	355	343	352	380	357	358
7	357	326	361	362	361	385	367	367
8	366	347	375	366	374	383	378	378
9	370	350	378	371	377	394	384	384
10	378	417	382	377	381	395	388	387
11	370	367	380	367	377	408	399	399
12	394	405	386	405	386		411	410
13	401	405	407	405	407		435	435
14	372		405		405			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0			151					130
1	268	263	197	192	269			232
2	294	298	295	296	308			296
3	320	327	319	323	327			313
4	346	347	345	362	339			340
5	354	354	354	373	345			348
6	360	361	359	372	348			353
7	369	371	369	394	361			361
8	379	379	378	391	377			370
9	384	385	384	393	386			378
10	388	390	387	400	390			382
11	398	402	396	410	408			384
12	411	416	405	393	417			390
13	427	440	418		429			391
14			372					391
15+								399

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 2

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	230			218		215	215	250	264
2	282			311				311	313
3	315			307	304	310	304	325	315
4	313			336	336	334	336	339	336
5	329			342	340	340	340	348	338
6	338			351	349	351	349	356	347
7	348			354	351	355	351	363	352
8	355			369	369	366	368	371	367
9	364			369	367	367	367	376	368
10	374			385	388	375	386	382	385
11	383			379		373	373	386	394
12	380			383	380	383	380	390	382
13	423			382	380	380	380	394	381
14	436			365	360	420	362	389	361
15+	408			408				408	412

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	269			268		235			269
2	311	334	334	315	349	271	305	349	311
3	316	341	332	309	369	290	317	369	318
4	333	345	348	339	380	304	318	380	333
5	343	352	353	350	387	330	344	387	340
6	348	356	359	352	393	345	344	392	346
7	357	360	363	359	405	349	364	403	360
8	366	373	371	373	423	349	369	417	360
9	379	372	376	384	433	380	374	417	372
10	388	381	380	392	437	382	381	417	375
11	395	385	384	394	445	395	371	419	396
12	388	378	396	391	445		401	445	404
13	384		420	395			406		409
14	367			377			420		407
15+	413			397					413

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 2

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0								
1	254	235					173	172
2	338	270	347	348	341	349	323	308
3	332	291	354	365	337	369	340	333
4	329	304	354	374	339	380	352	348
5	355	327	357	374	349	387	358	356
6	356	344	356	374	351	393	365	363
7	368	343	363	382	379	405	376	374
8	368	348	374	374	384	423	384	383
9	372	378	377	378	381	433	391	390
10	379	379	381	383	397	437	395	394
11	368	367	375	375	404	445	403	402
12	399	406	386	411	407	445	407	407
13	402	405	407	405	410		439	439
14	372		405		420			
15+	413							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0								
1	238	262	172	210	239		352	201
2	299	307	310	318	295		336	308
3	322	332	322	325	315		357	317
4	345	348	338	358	336		372	323
5	355	355	351	362	353		383	344
6	362	362	352	371	363		400	352
7	374	374	358	387	377		422	360
8	382	380	375	386	384			373
9	386	390	385	395	388			379
10	390	394	395	400	393			386
11	405	419	395	405	402			394
12	416	412	419	405	410			388
13	434	435			441			405
14								376
15+								408

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 3

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	248			288	280	282	294	293	291
2	329			322	311	321	319	311	317
3	323	350	350	334	328	334	334	325	320
4	328	355	355	350	350	352	353	341	350
5	345	362	362	354	348	357	359	348	361
6	353	370	370	360	346	360	369	356	372
7	356	387	387	367	353	368	378	362	376
8	367	397	397	376	365	378	402	368	381
9	374	392	392	379	370	381	382	373	378
10	379	405	405	380	380	385	380	378	382
11	384			386	390	390	390	383	391
12	389			392	398	394		387	389
13	393			402	408	415		391	387
14	399			389		385		396	370
15+	408			410				410	413

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	272			284		235	284		270
2	311	338	338	316	335	298	325	335	311
3	317	338	338	335	335	295	335	335	318
4	334	348	348	351	335	308	350	335	333
5	339	354	354	351	354	346	354		340
6	346	358	358	352	358	349	361		346
7	362	364	364	359	364	357	393	395	361
8	360	373	373	375	373	371	394	395	360
9	370	376	376	385	376	384	394	395	370
10	371	382	382	395	382	395	413	415	371
11	396	387	387	395	387	395	406	406	397
12	404	393	393	396	393		408	408	405
13	414	420	420	411	420		410	410	415
14	415			385			420	420	415
15+	413								413

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 3

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							141	141
1	280	235	284				276	273
2	285	266	335	349	335	335	324	317
3	306	295	335	369	335	335	340	339
4	317	308	336	380	335	335	350	351
5	327	320	354	387			371	370
6	339	327	361	393			382	379
7	376	334	380	395	395		378	379
8	382	350	388	395	395		385	385
9	383	345	388	395	395			
10	402	385	400	415	415		405	405
11	406	406	406	406	406			
12	408	408	408	408	408		429	428
13	410	410	410	410	410			
14	420	420	420	420	420			
15+	413							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	196			192	211			145
1	260	271	289	244	252	352	352	312
2	313	335	305	324	309	336	336	328
3	331	340	323	347	333	357	357	330
4	343	352	341	367	349	372	371	337
5	368	366	352	397	362	383	381	350
6	381	381	359		371	400	380	355
7	381	395	359		376	422	367	358
8	387	394	376		385		374	369
9			375				376	375
10	400	395					382	380
11							387	385
12	415	415					394	390
13								393
14								399
15+								408

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	299	335	335	285	283	282	288	288	289
2	328	335	335	324	312	321	325	317	312
3	328	330	330	335	329	334	336	329	323
4	339	355	355	351	353	352	351	348	346
5	350	367	367	355	354	357	355	354	354
6	356	372	372	361	353	360	364	360	364
7	362	373	373	368	358	368	370	366	367
8	368	365	365	379	371	378	383	374	372
9	373	385	385	382	372	381	382	377	375
10	379	395	395	382	380	385	379	379	375
11	383	395	395	388	390	390	387	386	391
12	388	395	395	395		394	398	392	396
13	392			410		415	408	400	405
14	395			385		385		392	408
15+	410			410				411	413

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	269		280	286		247	284		274
2	312	341	310	313		269	324		310
3	316	332	328	328		300	335		318
4	332	347	340	355		320	351		333
5	337	354	347	354		343	354		340
6	344	359	346	349		355	361		347
7	361	362	352	366		362	394		360
8	357	370	364	377		373	395		360
9	369	375	370	379		373	395		371
10	371	379	380	391		383	415		372
11	397	383	390	405		390	406		397
12	405	395		408		394	408		405
13	415	420		410		415	410		415
14	415			420		385	420		415
15+	413								413

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2017 (cont.).

Quarter 4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							141	141
1	274	220	283				274	274
2	282	264	325	335	335		294	301
3	308	284	334	335	335		329	335
4	321	307	351	335	335		350	352
5	339	320	357				368	369
6	351	330	361				373	376
7	371	338	371	395	395		379	379
8	371	355	380	395	395		386	386
9	390	347	383	395	395			
10	390	381	388	415	415		404	404
11	406	406	401	406	406			
12	408	408	406	408	408		419	419
13	410	410	410	410	410			
14	420	420	414	420	420			
15+	413.00							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	181			184	225			143
1	264	286		248	258			288
2	295	324		309	283			316
3	317	335		348	325			329
4	327	348		376	345			347
5	368	367		368	363			353
6	375	376		371	368			359
7	377	381		362	376			365
8	385	385		385	385			372
9								376
10	404	405						380
11								385
12		415						390
13								397
14								396
15+								410

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2017. Zeros represent values <1%. Handline Fleet. UKE=UK England and Wales.

	UKE lines							
	7.e				7.f			
Length cm	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
15								
16								
17								
18								0%
19								0%
20								0%
21	0%		0%					0%
22	0%			0%	0%			1%
23	0%		0%	1%	0%	0%	0%	1%
24	0%		0%	2%	0%	1%	2%	1%
25	0%		3%	6%	1%	2%	4%	8%
26	3%	1%	13%	11%	2%	5%	3%	14%
27	5%	5%	13%	17%	4%	8%	7%	13%
28	8%	20%	7%	14%	11%	8%	6%	6%
29	20%	33%	9%	4%	30%	15%	14%	7%
30	35%	22%	12%	2%	29%	13%	20%	10%
31	16%	10%	14%	4%	13%	8%	21%	15%
32	8%	4%	13%	6%	5%	6%	10%	11%
33	3%	1%	6%	6%	2%	6%	8%	6%
34	1%	1%	3%	5%	1%	9%	3%	2%
35	0%	1%	3%	3%	0%	6%	1%	1%
36	0%	1%	1%	5%	0%	4%	0%	1%
37	0%	0%	1%	5%	0%	4%	0%	0%
38	0%	0%	1%	2%	0%	2%	0%	0%
39	0%	0%	0%	3%		1%		0%
40	0%	0%	0%	2%	0%	1%	0%	
41	0%		0%	0%				
42	0%	0%		1%		0%		
43	0%	0%	0%	1%				
44								
45								
46								
47								

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2017. Zeros represent values <1% (cont.). Southern Fleets. ES=Spain.

	ES Purse Seine				ES Trawl				ES Artisanal			
Length cm	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
12												
13												
14												
15												
16												
17												
18					0%							
19					0%	0%	4%					
20					0%	0%	13%					
21					0%	0%	20%					
22				3%	0%	0%	8%	2%				
23				2%		0%	2%	3%				
24			0%	10%		0%	1%	11%				
25		0%	4%	23%		1%	1%	18%				
26		1%	9%	20%	2%	0%	2%	10%			1%	
27		2%	7%	9%	6%	1%	1%	14%			2%	
28	0%	6%	3%	2%	9%	2%	1%	6%			2%	
29	0%	11%	1%	3%	6%	3%	2%	8%	0%		5%	2%
30	0%	9%	3%	6%	11%	7%	7%	7%	0%		5%	5%
31	1%	3%	7%	5%	11%	10%	10%	5%	0%	0%	19%	16%
32	2%	3%	6%	8%	5%	11%	7%	6%	1%	0%	32%	35%
33	7%	5%	8%	4%	3%	11%	4%	2%	5%	3%	14%	20%
34	18%	9%	14%	2%	10%	10%	4%	2%	17%	12%	10%	9%
35	23%	12%	24%	2%	12%	10%	5%	2%	21%	16%	6%	7%
36	18%	12%	9%	3%	10%	9%	5%	3%	18%	18%	3%	7%
37	14%	11%	4%		7%	10%	3%	2%	17%	20%		
38	10%	7%	0%		3%	9%	1%	0%	12%	16%		
39	4%	4%	0%		2%	2%	0%		6%	9%		
40	2%	3%			0%	1%			2%	4%		
41	0%	1%			0%	1%			1%	1%		
42	0%	0%			0%	1%			0%	1%		
43	0%	0%			0%	0%			0%	0%		
44		0%								0%		
45						0%						
46												
47												
49												

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2017. Zeros represent values <1% (cont.). Southern Fleets (cont.). BQ=Basque, PT=Portugal.

	BQ Purse Seine				BQ Artisanal				BQ Trawl			PT All			
LENG TH CM	Q1	Q2	Q 3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q4	Q1	Q2	Q3	Q4
11															
12															
13															
14															
15															
16															
17															
18															
19															
20									0%						
21															
22															
23									0%						3%
24					1%				1%						13%
25		0%			2%				3%	0%				0%	11%
26				3%	1%				3%	0%			0%	0%	9%
27				1%	1%				7%	0%			0%	0%	1%
28				2%	0%				10%	1%		5%	1%	0%	2%
29	0%			1%	0%				22%	4%	13%	4%	1%	1%	2%
30	0%	1%		5%	0%				22%	5%	7%	6%	5%	1%	2%
31	0%	1%		8%	0%	0%			21%	5%	20%	11%	8%	6%	2%
32	2%	4%		15%	2%	2%	19%		7%	2%	13%	7%	15%	17%	5%
33	7%	9%		27%	5%	4%	18%	50%	2%	1%	27%	6%	12%	17%	8%
34	15%	17%		17%	13%	13%	26%	50%	1%	1%	7%	5%	7%	17%	8%
35	19%	21%		11%	17%	22%	24%			2%		4%	15%	17%	9%
36	21%	15%		5%	18%	21%	13%			2%	7%	7%	10%	10%	6%
37	15%	13%		2%	17%	17%				3%		9%	5%	4%	8%
38	11%	11%		3%	12%	12%				13%		13%	7%	4%	8%
39	5%	5%			6%	5%				8%		12%	6%	1%	3%
40	2%	2%			2%	3%				18%	7%	6%	4%	1%	1%

	BQ Purse Seine				BQ Artisanal				BQ Trawl			PT All			
LENGTH CM	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q4	Q1	Q2	Q3	Q4
41	1%	1%			1%	1%				18%		3%	2%	0%	0%
42	0%	0%			0%	0%				0%		1%	0%	2%	0%
43	0%				0%	0%				18%		1%	0%		
44	0%				0%							0%			
45															0%
46															
47															
49															

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2017. Zeros represent values <1% (cont.). Pelagic Trawl Fleets. IE=Ireland, UKS=UK Scotland, IS=Iceland, DK=Denmark.

	IE			UKS		IS			DK
	4.a	6.a	7.b	4.a	6.a	2.a, 5.a, 14.b			4.a
Length cm	Q4	Q1	Q1	Q4	Q1	Q2	Q3	Q4	Q4
15									
16		0%							
17									
18									
19									
20		0%							
21									
22					0%				
23		0%							
24	0%	0%			0%				
25	0%								
26				0%			0%		
27	1%	0%		0%	0%		0		
28	1%	0%		1%	0%		0%		
29	1%	0%	0%	1%	1%		0%	0%	0%
30	0%	1%	1%	1%	2%	0%	0%	1%	3%
31	2%	2%	1%	3%	2%	1%	3%	6%	3%
32	6%	1%	2%	8%	3%	5%	5%	8%	3%
33	10%	6%	6%	10%	12%	17%	13%	15%	5%
34	12%	18%	16%	18%	20%	27%	24%	24%	15%
35	21%	19%	20%	21%	18%	22%	21%	20%	20%
36	19%	15%	16%	17%	14%	13%	16%	14%	15%
37	13%	15%	18%	11%	15%	9%	11%	7%	11%
38	9%	12%	12%	7%	8%	4%	5%	3%	12%
39	4%	7%	5%	3%	3%	1%	2%	2%	7%
40	1%	3%	2%	1%	1%	0%	1%	0%	3%
41	1%	1%	1%	0%	0%		0%	0%	1%
42	0%	0%	0%	0%	0%				0%
43	0%	0%	0%		0%		0%		0%
44				0%	0%				0%
45									

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2017. Zeros represent values <1% (cont.). Freezer Trawlers. NL=The Netherlands, DE=Germany, RU= Russia.

	NL				DE				RU	
	2.A,4.A,4.B,6.A,7.B,7.C				6.A	4.A	2.A	7.B	2.A	2.A
LENGTH CM	Q1	Q2	Q3	Q4	Q1	Q3	Q4	Q1	Q3	Q4
15										
16					0%					
17					1%					
18					1%					
19					0%					
20					0%					
21					0%	0%	0%		0%	
22					0%	0%	0%			0%
23					0%	0%	0%		0%	0%
24					0%	0%	0%			0%
25					0%	0%	0%		0%	0%
26	1%		0%		0%	0%	0%			0%
27			0%		1%	0%	0%	0%	0%	0%
28	1%		0%		2%	1%	1%	1%	0%	0%
29	3%		2%		3%	5%	5%	3%	0%	0%
30	8%		2%		3%	24%	24%	3%	5%	1%
31	6%	0.04	6%	2%	2%	28%	28%	4%	22%	10%
32	2%	0%	6%	9%	5%	12%	12%	4%	19%	21%
33	6%	4%	4%	9%	14%	10%	10%	13%	10%	15%
34	14%	12%	7%	8%	17%	8%	8%	22%	16%	17%
35	18%	28%	15%	16%	15%	5%	5%	16%	15%	18%
36	13%	8%	14%	18%	14%	3%	3%	16%	7%	10%
37	10%	8%	9%	19%	12%	1%	1%	12%	3%	4%
38	10%	24%	15%	8%	6%	0%	0%	4%	1%	2%
39	5%	4%	10%	7%	2%	0%	0%	2%	1%	1%
40	1%	8%	7%	4%	1%	0%	0%	1%	0%	0%
41	2%		2%		0%	0%	0%	0%	0%	0%
42	1%		0%		0%	0%	0%	0%	0%	0%
43	0%		0%		0%				0%	0%
44									0%	
45									0%	0%
46										
47										
48										

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017.

Quarters 1-4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	220	318	318	188	171	176	199	199	191
2	333	316	316	282	246	272	278	270	269
3	327	380	306	289	290	309	300	302	259
4	348	407	386	351	343	368	375	365	330
5	392	430	424	368	355	384	391	380	345
6	418	464	442	389	352	397	415	402	363
7	434	527	465	404	376	429	424	421	366
8	466	542	462	446	422	467	486	454	412
9	489	533	494	457	442	481	445	468	416
10	510	593	581	484	487	497	481	483	475
11	528	612	612	494	532	514	503	506	534
12	549	542	542	493	467	531	459	520	463
13	572			482	459	606	455	526	457
14	604			406	376	497	384	431	383
15+	639			634				614	611

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0				27		27			
1	175		170	192		111	187	187	179
2	262	369	318	193	276	177	212	272	260
3	276	370	256	232	276	214	237	314	272
4	320	400	352	310	277	261	250	361	314
5	331	419	388	332	416	304	314	342	338
6	345	433	399	350	432	318	317	383	357
7	353	454	399	371	454	332	363	417	392
8	396	485	439	407	486	376	391	403	414
9	401	494	454	440	495	401	406	429	434
10	451	516	490	455	516	444	424	464	449
11	432	539	537	464	539	400	402	504	522
12	514	563	478	491	564	476	476	527	526
13	485	671	452	504	670	470	550	588	513
14	434		376	546		449	664	708	574
15+	602			530		434			602

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarters 1-4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							17	17
1	185	97	187	187	187		79	49
2	208	150	274	275	267	289	201	196
3	238	190	300	301	237	338	267	250
4	256	218	306	302	280	369	306	298
5	308	247	338	331	312	389	329	318
6	330	270	338	330	323	408	349	334
7	414	299	363	399	356	432	378	365
8	431	356	405	402	405	426	407	398
9	453	356	412	411	410	439	431	421
10	472	460	429	434	429	473	462	435
11	553	572	456	476	491	516	478	471
12	608	611	476	605	501	594	583	539
13	616	617	566	615	584		630	623
14	716	719	665	719	692			
15+	602							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	47		15	54	74			18
1	120	124	46	81	127	431	431	178
2	178	189	181	260	182	369	369	266
3	228	251	226	307	243	422	422	312
4	283	300	283	397	289	481	479	356
5	305	322	302	421	298	532	523	377
6	320	341	310	405	311	577	516	397
7	350	375	322	473	354	644	477	415
8	374	397	363	464	381		501	444
9	387	422	377	483	397		510	466
10	400	437	442	510	412		532	484
11	444	501	374	539	443		554	497
12	482	535	474	483	473		581	523
13	549	621	528		574			537
14			424					535
15+								606

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 1

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	188					67		77	106
2	358							206	199
3	345			215		232	215	215	211
4	382			300		298	300	299	296
5	403			312		316	312	315	326
6	422			339		353	339	341	347
7	443			348		365	348	351	361
8	475			409		403	409	410	419
9	491			400		406	400	405	419
10	517			479		437	479	477	475
11	538					430		452	456
12	552			450		471	450	452	456
13	581			450		457	450	451	453
14	599			376		643	376	378	378
15+	641							641	

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0				27		27			
1	106			193		96	187	187	187
2	196	358	289	192		190	212	267	219
3	205	376	215	232		220	236	259	206
4	290	386	300	310		291	251	357	290
5	336	406	312	332		316	314	321	335
6	358	420	339	350		332	317	380	357
7	381	431	348	372		363	361	416	380
8	438	475	409	407		389	389	402	437
9	437	469	400	441		432	404	429	437
10	471	502	479	455		440	423	463	469
11	458	515	594	465		439	392	503	457
12	474	492	450	491		476	452	475	474
13	460		450	502		470	522	528	464
14	423		376	544		448	507	507	412
15+				530		434			

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 1

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							14	14
1	186	128	187	187	187		36	46
2	245	158	274	272	266		193	194
3	209	187	315	259	233		244	245
4	224	202	336	242	280	442	291	293
5	291	221	333	314	312	337	312	315
6	310	231	327	313	323	401	328	330
7	358	252	348	373	349	425	358	359
8	390	311	399	386	397	408	393	394
9	404	337	408	403	407	433	415	415
10	429	569	422	423	422	469	426	426
11	397	387	418	388	411	515	467	466
12	500	541	434	541	435		515	511
13	534	541	517	541	518		615	615
14	424		507		507			
15+								

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0			21					14
1	134	124	58	52	134			105
2	175	186	176	200	201			189
3	225	249	224	262	239			230
4	283	300	284	375	266			306
5	304	321	304	409	280			328
6	318	341	319	406	289			346
7	344	374	346	487	321			369
8	369	397	373	473	365			405
9	384	420	388	480	391			436
10	397	435	405	510	404			454
11	428	481	434	549	462			462
12	471	536	474	483	490			487
13	528	637	528		532			493
14			424					491
15+								530

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 2

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	125			86		67	67	182	166
2	226			261				262	269
3	301			231	215	232	216	312	255
4	292			304	300	298	300	351	308
5	335			329	312	316	312	389	324
6	371			361	339	353	341	420	346
7	397			372	348	365	350	446	357
8	426			421	409	403	408	471	409
9	428			431	400	406	401	496	413
10	486			483	479	437	475	518	475
11	505			478		430	430	542	536
12	537			475	450	471	452	555	462
13	684			468	450	457	451	569	456
14	737			400	376	643	386	542	382
15+	641			641				641	611

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0				27					
1	173			163		100			173
2	259	358	334	198	289	153	214	289	261
3	275	376	341	217	342	191	239	342	280
4	317	386	390	301	374	219	244	374	321
5	325	406	411	306	393	276	314	393	337
6	335	420	430	311	412	314	315	412	354
7	334	431	445	318	452	308	378	450	390
8	389	475	473	378	515	326	403	498	396
9	389	469	492	385	549	410	420	502	421
10	453	502	510	450	565	428	436	519	441
11	403	515	524	382	594	369	407	538	499
12	491	492	574	483	594		524	594	566
13	467		690	510			546		585
14	405			440			713		578
15+	602			519					602

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 2

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							14	14
1	123	100					34	34
2	267	154	286	288	275	289	243	209
3	257	192	310	334	276	342	281	264
4	250	220	317	361	287	374	313	304
5	328	273	334	370	321	393	331	324
6	336	318	333	376	324	412	351	345
7	380	315	356	410	446	452	385	381
8	390	327	397	403	486	515	411	408
9	406	423	408	417	463	549	436	433
10	424	423	423	437	497	565	449	446
11	392	388	407	412	568	594	480	479
12	516	543	437	549	603	594	499	501
13	537	541	518	541	616		634	634
14	424		507		718			
15+	602							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0			14					14
1	97	122	34	68	97		431	62
2	183	207	193	248	176		369	234
3	230	262	237	264	214		422	279
4	281	304	277	360	261		481	296
5	306	323	300	372	302		532	327
6	324	345	292	400	327		577	352
7	357	384	303	459	366		644	378
8	379	403	338	456	385			405
9	390	435	373	488	397			412
10	402	451	450	509	413			456
11	453	549	369	527	440			460
12	487	522	549	450	468			519
13	552	615			580			537
14								463
15+								619

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 3

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	161			196	171	177	202	216	202
2	344			281	246	272	275	262	269
3	333	403	403	316	293	309	324	296	268
4	353	411	411	368	372	368	389	344	371
5	397	431	431	380	359	384	406	367	409
6	423	465	465	402	353	397	440	393	447
7	439	529	529	428	378	429	474	418	463
8	474	544	544	465	423	467	584	438	482
9	499	536	536	478	446	482	482	459	464
10	519	596	596	486	488	497	488	479	478
11	538			505	532	517	533	500	520
12	561			531	554	533		517	504
13	578			580	605	634		536	486
14	610			513		494		553	422
15+	643			615				614	604

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	177			181		113	181		174
2	263	369	369	204	276	185	283	276	261
3	280	369	369	318	276	225	316	276	280
4	325	401	401	369	277	256	367	276	322
5	339	419	419	305	419	298	381		339
6	359	433	433	300	433	292	402		357
7	412	454	454	307	454	302	518	527	409
8	403	485	485	353	485	338	557	562	398
9	435	495	495	375	495	373	581	590	432
10	441	516	516	451	516	450	568	573	438
11	535	539	539	370	539	369	578	578	537
12	569	564	564	545	564		611	611	571
13	612	670	670	618	670		617	617	613
14	613			494			719	719	613
15+	602								602

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 3

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							19	19
1	186	113	181				148	143
2	194	164	276	289	276	276	244	228
3	239	226	277	342	276	276	283	279
4	266	256	281	374	276	276	310	313
5	297	286	381	394			373	368
6	329	308	402	412			411	399
7	462	327	473	525	527		395	396
8	505	379	522	562	562		417	418
9	522	370	534	590	590			
10	533	492	535	573	573		490	489
11	578	578	576	578	578			
12	611	611	609	611	611		588	584
13	617	617	617	617	617			
14	719	719	717	719	719			
15+	602							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	60			57	72			22
1	134	137	200	111	123	431	431	311
2	230	269	232	300	223	369	369	331
3	268	282	287	372	273	422	422	348
4	298	316	337	448	314	481	479	377
5	364	357	360	582	346	532	523	410
6	401	407	375		373	577	516	426
7	402	451	412		386	644	477	442
8	420	450	418		413		501	476
9			429				510	497
10	464	453					532	517
11							554	537
12	514	530					581	560
13								578
14								611
15+								642

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 4

Age	2.a	2.a.1	2.a.2	3.a	3.b	3.c	3.d	4.a	4.b
0									
1	231	318	318	184	177	177	191	198	200
2	307	316	316	284	250	272	290	271	261
3	311	303	303	318	300	309	326	305	286
4	351	385	385	370	389	368	376	367	357
5	381	423	423	383	384	384	389	382	381
6	401	436	436	406	377	397	420	405	412
7	420	446	446	432	396	429	441	426	436
8	440	401	401	475	448	467	497	458	443
9	462	489	489	486	450	482	488	472	451
10	487	580	580	490	488	497	484	483	461
11	504	612	612	509	533	517	508	506	521
12	519	542	542	542		533	554	532	545
13	538			611		634	605	571	586
14	554			496		494		528	589
15+	616			616				612	603

AGE	4.c	5.a	5.b	6.a	6.b	7.a	7.b	7.c	7.d
0									
1	173		170	186		125	181		179
2	267	370	243	253		156	283		260
3	278	341	292	293		222	318		279
4	320	391	314	385		269	369		321
5	335	414	355	382		336	381		340
6	354	433	351	362		378	402		357
7	409	442	375	422		405	525		407
8	396	473	420	481		447	561		398
9	433	492	444	489		448	588		434
10	439	508	488	524		483	572		442
11	537	525	533	575		516	578		537
12	571	575		608		533	611		571
13	613	686		617		634	617		613
14	613			719		494	719		613
15+	602								602

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2017 (cont.).

Quarter 4

Age	7.e	7.f	7.g	7.h	7.j	7.k	8.a	8.b
0							19	19
1	174	85	177				142	142
2	183	144	274	276	276		180	195
3	242	181	308	276	276		254	269
4	272	227	364	276	276		310	314
5	322	256	386				360	364
6	351	282	400				378	387
7	441	312	438	527	527		397	397
8	450	369	478	562	562		419	419
9	497	343	490	590	590			
10	484	438	504	573	573		486	486
11	578	578	560	578	578			
12	611	611	597	611	611		548	548
13	617	617	618	617	617			
14	719	719	683	719	719			
15+	602							

Age	8.c	8.c.E	8.d	9.a	9.a.N	14.a	14.b	All
0	46			49	87			21
1	141	163		119	129			199
2	194	244		260	173			267
3	237	269		376	254			305
4	260	302		481	305			365
5	363	360		439	349			382
6	383	388		450	364			404
7	389	403		413	385			424
8	415	418		413	413			453
9								469
10	477	490						486
11								507
12		530						527
13								560
14								556
15+								614

Table 8.6.1.1.1 International mackerel and horse mackerel egg survey: Periods and area assignments for vessels by week for the 2019 survey. Area assignments and dates are provisional.

		Area							
week	Starts	Portugal, Cadiz & Galicia	Cantabrian Sea	Bay of Biscay	Celtic Sea	North west Ireland	West of Scotland	Northern Area	Period
3	13-Jan-19	PO1 (DEPM)							1
4	20-Jan-19	PO1 (DEPM)							1
5	27-Jan-19	PO1 (DEPM)		IRL1	IRL1				2
6	03-feb-19	PO1 (DEPM)		IRL1	IRL1				2
7	10-feb-19	PO1 (DEPM)		IRL1	IRL1				2
8	17-feb-19	PO1 (DEPM)				SCO (IBTS)	SCO (IBTS)		2
9	24-feb-19					SCO (IBTS)	SCO (IBTS)		2
10	03-mar-19								3
11	10-mar-19		IEO1			SCO2	SCO2		3
12	17-mar-19		IEO1	AZTI1	GER1	SCO2	SCO2		3
13	24-mar-19		IEO1	AZTI1	GER1	GER1			3
14	31-mar-19		IEO1	AZTI1	GER1	GER1			3
15	07-Apr-19		IEO2	IEO2 AZTI1	GER2	GER2			4
16	14-Apr-19		IEO2	IEO2	GER2	GER2	DEN	DEN	4
17	21-Apr-19		IEO2	IEO2	GER2	DEN	DEN	DEN	4
18	28-Apr -19		IEO2	IEO2					4
19	05-may-19		AZTI2 (DEPM)	AZTI2 (DEPM)	NED1	SCO3	SCO3	ICE	5
20	12-may-19		AZTI2 (DEPM)	AZTI2 (DEPM)	NED1	SCO3	SCO3	ICE	5
21	19-may-19		AZTI2 (DEPM)	AZTI2 (DEPM)	NED1	SCO3	SCO3	FAR	5
22	26-may-19		AZTI2 (DEPM)	AZTI2 (DEPM)				FAR	5
23	02-jun-19			NED2	NED2			FAR	5
24	09-jun-19			NED2	NED2	IRL2	IRL2	NOR	6
25	16-jun-19			NED2	NED2	IRL2	IRL2	NOR	6
26	23-jun-19					IRL2	IRL2	NOR	6
27	30-jun-19								6
28	07-jul-19				SCO3	SCO4	SCO4		7
29	14 –Jul-19				SCO3	SCO4	SCO4		7
30	21-jul-19				SCO3	SCO4	SCO4		7
31	28-jul-19								7

Table 8.6.3.1. Abundance index, mean weight-at-age, and biomass index for mackerel from the IESSNS in 2007 and from 2010 to 2018.

	2007			2010			2011			2012		
AGE	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)
1	1.33	133	0.18	0.03	133	0	0.21	133	0.03	0.5	112	0.06
2	1.86	233	0.43	2.8	212	0.59	0.26	278	0.07	4.99	188	0.94
3	0.9	323	0.29	1.52	290	0.44	0.87	318	0.28	1.22	286	0.35
4	0.24	390	0.09	4.02	353	1.42	1.11	371	0.41	2.11	347	0.73
5	1	472	0.47	3.06	388	1.19	1.64	412	0.67	1.82	397	0.72
6	0.16	532	0.09	1.35	438	0.59	1.22	440	0.54	2.42	414	1
7	0.06	536	0.03	0.53	512	0.27	0.57	502	0.29	1.64	437	0.72
8	0.04	585	0.02	0.39	527	0.2	0.28	537	0.15	0.65	458	0.3
9	0.03	591	0.02	0.2	548	0.11	0.12	564	0.07	0.34	488	0.17
10	0.01	640	0.01	0.05	580	0.03	0.07	541	0.04	0.12	523	0.06
11	0.01	727	0.01	0.03	645	0.02	0.06	570	0.03	0.07	514	0.03
12	0	656	0	0.02	683	0.01	0.02	632	0.01	0.02	615	0.01
13	0.01	685	0.01	0.01	665	0.01	0.01	622	0.01	0.01	509	0
14+	0	671	0	0.01	596	0	0	612	0	0.01	677	0
TOTAL	5.65	512	1.64	13.99	469	4.89	6.42	467	2.69	15.91	426	5.09

	2013			2014			2015			2016		
AGE	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)
1	0.06	96	0.01	0.01	228	0	1.2	128	0.15	<0.01	95	<0.01
2	7.78	184	1.43	0.58	275	0.16	0.83	290	0.24	4.98	231	1.15
3	8.99	259	2.32	7.8	288	2.24	2.41	333	0.8	1.37	324	0.45
4	2.14	326	0.7	5.14	335	1.72	5.77	342	1.97	2.64	360	0.95
5	2.91	374	1.09	2.61	402	1.05	4.56	386	1.76	5.24	371	1.95
6	2.87	399	1.15	2.62	433	1.14	1.94	449	0.87	4.37	394	1.72
7	2.68	428	1.15	2.67	459	1.23	1.83	463	0.85	1.89	440	0.83
8	1.27	445	0.56	1.69	477	0.8	1.04	479	0.5	1.66	458	0.76
9	0.45	486	0.22	0.74	488	0.36	0.62	488	0.3	1.11	479	0.53
10	0.19	523	0.1	0.36	533	0.19	0.32	505	0.16	0.75	488	0.37
11	0.16	499	0.08	0.09	603	0.05	0.08	559	0.04	0.45	494	0.22
12	0.04	547	0.02	0.05	544	0.03	0.07	568	0.04	0.2	523	0.1
13	0.01	677	0.01	0.02	537	0.01	0.04	583	0.02	0.07	511	0.04
14+	0.02	607	0.01	0	569	0	0.02	466	0.01	0.07	664	0.04
TOTAL	29.57	418	8.85	24.37	441	8.98	20.72	431	7.72	24.81	367	9.11

Table 8.6.3.1. Abundance index , mean weight-at-age, and biomass index for mackerel from the IESSNS in 2007 and from 2010 to 2018. Cont.

	2017			2018		
AGE	Number (billions)	W (g)	Biom. t (million)	Number (billions)	W (g)	Biom. t (million)
1	0.86	86	0.07	2.18	67	0.15
2	0.12	292	0.03	2.5	229	0.57
3	3.56	330	1.18	0.5	330	0.16
4	1.95	373	0.73	2.38	390	0.93
5	3.32	431	1.43	1.2	420	0.5
6	4.68	437	2.04	1.41	449	0.63
7	4.65	462	2.15	2.33	458	1.07
8	1.75	487	0.86	1.79	477	0.85
9	1.94	536	1.04	1.05	486	0.51
10	0.63	534	0.33	0.5	515	0.26
11	0.51	542	0.28	0.56	534	0.3
12	0.12	574	0.07	0.29	543	0.16
13	0.08	589	0.05	0.14	575	0.08
14+	0.04	626	0.03	0.09	643	0.05
TOTAL	24.22	425	10.29	16.92	368	6.22

Table 8.6.4.1. Numbers of RFID tagged and recaptured (by 31.08.2018) mackerel by tagging experiment. In the 2018 tagging survey off Ireland-Hebrides a proportion of the tagged mackerel were handled in the old way (marked * in the table), with manual jigging, and released directly to the sea at starboard side. This was to test whether differences in survival rates between the steel tag time series and the RFID tag time series is due to handling.

Year	Period	Area	N-Released	N-Recaptured
2011	May-June	Ireland-Hebrides	18645	133
2011	Sep	Norwegian west coast	31253	144
2012	May-June	Ireland-Hebrides	32137	276
2013	May-June	Ireland-Hebrides	22792	328
2014	May-June	Ireland-Hebrides	55185	885
2015	May-June	Ireland-Hebrides	43910	561
2015	August	Iceland	806	11
2016	May-June	Ireland-Hebrides	43959	537
2016	August	Iceland	4884	119
2017	May-June	Ireland-Hebrides	56082	286
2017	August	Iceland	3891	43
2018	May-June	Ireland-Hebrides	35336	13
2018*	May-June	Ireland-Hebrides	4661	1
Total			353541	3337

Table 8.6.4.2. Numbers of recaptured mackerel with RFID tags by factory and recapture year.

Factory	2012	2013	2014	2015	2016	2017	2018	Total
DK01 Sæby	0	0	8	11	0	0	0	19
FO01 Vardin Pelagic	0	0	15	37	23	13	0	88
GB01 Denholm Coldstore	0	0	0	10	10	28	25	73
GB01 Denholm Factory	0	0	25	64	79	119	31	318
GB02 Lunar Freezing Peterhead	0	0	33	51	60	42	20	206
GB03 Lunar Freezing Fraserburgh	0	0	0	9	16	7	5	37
GB04 Pelagia Shetland	0	0	25	130	162	157	53	527
GB05 Northbay Pelagic	0	0	0	0	0	0	23	23
IC01 Vopnafjord	0	0	24	61	81	73	37	276
IC02 Neskaupstad	0	0	0	19	93	58	23	193
IC03 Höfn	0	0	0	1	0	1	0	2
NO01 Pelagia Egersund Seafood	12	25	19	7	1	0	53	117
NO02 Skude Fryseri	6	9	21	19	27	55	16	153
NO03 Pelagia Austevoll	1	1	7	5	1	0	3	18
NO04 Pelagia Florø	6	19	33	22	18	0	0	98
NO05 Pelagia Måløy	6	19	21	46	42	89	7	230
NO06 Pelagia Selje	19	35	38	77	59	102	24	354
NO07 Pelagia Liavågen	10	13	34	34	30	102	0	223
NO08 Brødrene Sperre	7	18	21	66	117	85	30	344
NO09 Lofoten Viking	0	0	0	0	0	0	7	7
NO14 Nils Sperre	0	0	0	0	0	0	30	30
NO16 Vikomar	0	0	0	0	0	0	1	1
All factories summed	67	139	324	669	819	931	388	**3337**

Table 8.6.4.3. Abundance index in billions individuals ages 4-12 per release years 2011-2016. The index is based on RFID tagging experiments and data from scanned catches and recaptures the two first years after a relase year (yearsout=1-2). The index is already scaled down to the 10% survival estimated by SAM.

					Age				
Year	4	5	6	7	8	9	10	11	12
2011	3,236171	2,813887	2,017941	0,635952	0,322985	0,137462	0,036253	0,041593	0,064976
2012	3,484761	3,284821	2,956715	1,741262	0,572768	0,361678	0,128663	0,056303	0,036048
2013	1,974994	2,161885	1,956662	1,423692	0,709068	0,246734	0,141168	0,040904	0,009638
2014	3,206810	1,412106	1,636556	1,360554	0,890053	0,437290	0,191334	0,077791	0,037645
2015	2,696358	2,484074	1,350807	1,331608	1,065801	0,835234	0,400878	0,219851	0,061100
2016	0,890211	1,764716	1,618460	0,741481	0,727085	0,506326	0,355878	0,176446	0,048090

Table 8.6.5.2.1. Biomass, abundance, mean length and mean weight at age of mackerel from the Spanish spring acoustics surveys (PELACUS) from 2001 to 2018.

	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

Table 8.6.5.2.1. Biomass, abundance, mean length and mean weight at age of mackerel from the Spanish spring acoustics surveys (PELACUS) from 2001 to 2018 (cont.).

	2007				2008				2009			
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	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

Table 8.6.5.2.1. Biomass, abundance, mean length and mean weight at age of mackerel from the Spanish spring acoustics surveys (PELACUS) from 2001 to 2018 (cont.).

	2013				**2014**				**2015**			
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	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
	2016				**2017**				**2018**			
1	12.61	22.4	74.0	1.0	170.5	21.9	67.2	12.4		22.72	81.99	5.3
2	73.54	28.0	144.1	11.2	12.4	27.8	141.3	1.9		27.46	142.93	5.1
3	26.62	30.9	193.1	5.3	91.4	62.8	234.2	22.6		33.56	256.69	10.1
4	54.98	34.5	268.2	14.8	115.6	64.8	283.1	34.5		35.73	309.38	30.9
5	230.22	35.7	297.7	68.9	438.3	65.4	298.2	137.2		35.99	315.99	124.3
6	406.48	36.4	315.3	128.9	421.2	36.1	316.4	139.9		36.52	329.78	143.6
7	318.08	37.3	337.3	107.8	278.3	37.1	344.8	100.7		37.33	351.83	116.2
8	271.41	37.8	353.4	96.2	128.7	38.1	374.3	50.4		38.04	371.91	58.1
9	102.70	38.3	365.1	37.6	84.4	38.2	377.0	33.2		38.12	374.13	41.8
10	50.36	38.4	367.8	18.6	21.8	38.4	384.1	8.7		38.30	379.46	10.8
11	13.83	38.9	383.8	5.3	11.8	40.1	439.1	5.4		40.10	434.16	7.0
12	5.31	39.4	398.6	2.1	2.7	39.5	418.0	1.2		41.64	484.65	3.4
13		-	-	-								
14	-	-		-								
15+	´-	-	-	-								
TOTAL	1566.14	36.3	311.7	497.7	1777.0	34.7	280.4	548.2		36.10	318.83	556.53

Table 8.6.5.2.2. Mackerel abundance and biomass by ICES sub-divisions from Spanish spring acoustic surveys (PELACUS) from 2001 to 2018.

	ICES 9.a-N		ICES 8.c-W		8.c-EW		8.c-EE		TOTAL	
	Abund. (10^9)	Biomass (kt)	Abund. (10^9)	Biomass (kt)	Abund. (10^9)	Biomass (kt)	Abund. (10^9)	Biomass (kt)	Abund. (10^9)	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*	0.02	2.4	0.03	3.0			2.75	803	2.80	808.4
2015*	0.21	73.6	0.3	7.4			1.36	410	1.57	483.3
2016*	0.00	0.2	0.09	13.7			1.48	484	1.57	498
2017*	.17	14.7	.36	119.0			1.25	415	1.78	548.7
2018*	0.10	27.8	0.01	031			1.55	528*	1.64	556.5

*** Without split between 8.c-EW and 8.c-EE.**

Table 8.7.1.1. 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 -2017		Yes
Catch-at-age in numbers	1980 -2017	0-12+	Yes
Weight-at-age in the commercial catch	1980 – 2017	0-12+	Yes
Weight-at-age of the spawning stock at spawning time.	1980 – 2018	0-12+	Yes
Proportion of natural mortality before spawning	1980 -2018	0-12+	Yes
Proportion of fishing mortality before spawning	1980 -2018	0-12+	Yes
Proportion mature-at-age	1980 -2018	0-12+	Yes
Natural mortality	1980 -2018	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, 2013,2016.	Not applicable (gives SSB)
Survey (abundance index)	IBTS Recruitment index (log transformed)	1998-2015	Age 0
Survey (abundance index)	International Ecosystem Summer Survey in the Nordic Seas (IESSNS)	2010, 2012-2018	Ages 3-11
Tagging/recapture	Norwegian tagging program	Steal tags : 1980 (release year)-2006 (recapture years) RFID tags : 2011 (release year) 2017 (recapture year)	Ages 2 and older (age at release)

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 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 0/0/0/3/4/5/6/7/8/9/10/10/0	No catchability parameter for the catches One catchability parameter estimated for the egg One catchability parameter estimated for the recruitment index One catchability parameter for each age group estimated for the IESSNS (age 3 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 0/0/0/3/4/4/4/4/4/4/4/0	Same observation variance for all ages in the catches One observation variance for the egg survey One observation variance for the recruitment index 2 observation variances for the IESSNS (age 3 and ages 4 and older)
Stock recruitment model	0	No stock-recruiment model
Correlation structure	"ID", "ID", "ID", "AR"	Auto-regressive correlation structure for the IESSNS index, independent observations assumed for the other data sources

Table 8.7.1.2. NE Atlantic Mackerel. CATCH IN NUMBER

Units : thousands

age \ year	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 \ year	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 \ year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	11553	12426	75651	19302	25886	17615	23453	30429	23872	11325	62100	6732
1	31421	46840	149425	88439	59899	36514	78605	62708	66196	47020	43173	104019
2	453133	135648	173646	190857	167748	113574	137101	115346	200167	235411	137788	124411
3	529753	668588	159455	220575	399086	455113	303928	322725	214043	399751	669949	248852
4	147973	293579	470063	215655	284660	616963	739221	469953	415884	370551	829399	579835
5	258177	120538	195594	455131	260314	319465	611729	654395	456404	442597	564508	646894
6	145899	121477	97061	203492	255675	224848	284788	488713	511270	429324	549985	450344
7	89856	63612	73510	77859	124382	194326	143039	244210	323835	336701	503300	415107
8	65669	38763	33399	59652	57297	73171	102072	113012	142948	188910	339538	355997
9	40443	23947	18961	30494	32343	29738	45841	53363	69551	112765	141344	205691
10	35654	18612	13987	16039	19482	14989	21222	25046	30619	45938	63614	107685
11	16430	7955	8334	11416	6798	7470	6255	12311	11603	18928	21294	26939
12	19509	10669	10186	12801	9581	5003	8523	10775	11678	17857	13136	22700

age \ year	2016	2017
0	716	28306
1	45199	43458
2	203753	87739
3	257293	458301
4	424843	351779
5	589549	396862
6	532890	503601
7	340155	431014
8	269962	261959
9	170373	188950
10	94778	138143
11	33896	59211
12	24420	51090

Table 8.7.1.3. NE Atlantic Mackerel. WEIGHTS AT AGE IN THE CATCH

Units : Kg

age \ year	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

age \ year	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

age \ year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0	0.051	0.104	0.048	0.029	0.089	0.091	0.043	0.051	0.035	0.018
1	0.105	0.153	0.118	0.113	0.123	0.173	0.127	0.154	0.158	0.178
2	0.222	0.213	0.221	0.231	0.187	0.234	0.232	0.242	0.240	0.266
3	0.292	0.283	0.291	0.282	0.285	0.277	0.282	0.294	0.297	0.312
4	0.370	0.331	0.331	0.334	0.340	0.336	0.324	0.320	0.329	0.356
5	0.418	0.389	0.365	0.368	0.375	0.360	0.362	0.351	0.356	0.377
6	0.444	0.424	0.418	0.411	0.401	0.386	0.395	0.392	0.383	0.397
7	0.497	0.450	0.471	0.451	0.431	0.406	0.422	0.420	0.411	0.415
8	0.551	0.497	0.487	0.494	0.469	0.431	0.444	0.443	0.438	0.444
9	0.571	0.538	0.515	0.540	0.503	0.454	0.468	0.465	0.453	0.466
10	0.620	0.586	0.573	0.580	0.537	0.472	0.482	0.489	0.479	0.484
11	0.595	0.599	0.604	0.611	0.538	0.493	0.523	0.522	0.499	0.497
12	0.662	0.630	0.630	0.664	0.585	0.554	0.583	0.560	0.520	0.531

Table 8.7.1.4. NE Atlantic Mackerel. WEIGHTS AT AGE IN THE STOCK

Units : Kg

age \ year	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	0.125	0.123	0.122	0.122	0.119	0.123	0.115	0.076	0.111	0.114	0.096	0.174	0.130	0.145
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	0.487	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 \ year	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	0.116	0.097	0.084	0.083	0.087	0.093	0.113	0.109	0.112	0.112	0.106	0.108	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	0.164	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	0.236	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	0.291	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	0.333	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	0.400	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	0.413	0.451
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	0.437	0.452
9	0.496	0.511	0.513	0.505	0.475	0.489	0.464	0.484	0.458	0.490	0.506	0.547	0.455	0.508
10	0.550	0.517	0.508	0.511	0.530	0.508	0.489	0.521	0.511	0.488	0.519	0.538	0.469	0.527
11	0.592	0.560	0.538	0.546	0.500	0.545	0.514	0.535	0.523	0.521	0.579	0.509	0.531	0.533
12	0.604	0.602	0.573	0.585	0.547	0.576	0.551	0.574	0.557	0.540	0.588	0.603	0.566	0.586

age \ year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.133	0.107	0.096	0.080	0.089	0.076	0.107	0.078	0.059	0.058
2	0.160	0.162	0.161	0.175	0.155	0.144	0.165	0.207	0.184	0.204
3	0.207	0.214	0.201	0.223	0.216	0.179	0.199	0.247	0.239	0.237
4	0.260	0.268	0.249	0.274	0.255	0.249	0.238	0.254	0.283	0.278
5	0.346	0.295	0.297	0.332	0.288	0.281	0.291	0.288	0.299	0.308
6	0.354	0.351	0.342	0.369	0.312	0.318	0.321	0.336	0.336	0.308
7	0.393	0.386	0.389	0.389	0.360	0.341	0.341	0.350	0.364	0.338
8	0.448	0.437	0.411	0.430	0.390	0.374	0.387	0.381	0.382	0.377
9	0.452	0.461	0.442	0.452	0.453	0.414	0.416	0.412	0.403	0.394
10	0.478	0.517	0.491	0.495	0.498	0.441	0.466	0.447	0.427	0.426
11	0.487	0.548	0.535	0.518	0.503	0.500	0.472	0.485	0.442	0.430
12	0.511	0.559	0.573	0.525	0.557	0.520	0.517	0.549	0.470	0.494

Table 8.7.1.5. NE Atlantic Mackerel. NATURAL MORTALITY

Units : NA

year

age	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

year

age	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

year

age	2014	2015	2016	2017
0	0.15	0.15	0.15	0.15
1	0.15	0.15	0.15	0.15
2	0.15	0.15	0.15	0.15
3	0.15	0.15	0.15	0.15
4	0.15	0.15	0.15	0.15
5	0.15	0.15	0.15	0.15
6	0.15	0.15	0.15	0.15
7	0.15	0.15	0.15	0.15
8	0.15	0.15	0.15	0.15
9	0.15	0.15	0.15	0.15
10	0.15	0.15	0.15	0.15
11	0.15	0.15	0.15	0.15
12	0.15	0.15	0.15	0.15

Table 8.7.1.6. NE Atlantic Mackerel. PROPORTION MATURE

age \ year	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	0.093	0.097	0.097	0.098	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103
2	0.521	0.497	0.498	0.485	0.467	0.516	0.522	0.352	0.360	0.372	0.392	0.435	0.520	0.534
3	0.872	0.837	0.857	0.863	0.853	0.885	0.926	0.922	0.901	0.915	0.909	0.912	0.928	0.934
4	0.949	0.934	0.930	0.940	0.938	0.940	0.983	0.994	0.989	0.994	0.996	0.991	0.996	0.996
5	0.972	0.976	0.969	0.972	0.966	0.966	0.965	0.997	0.994	0.996	0.998	0.996	0.997	0.997
6	0.984	0.984	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.996	0.994	0.994
7	0.990	0.987	0.985	0.984	0.975	0.976	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	0.999	0.999	0.999	0.999	0.999	0.991	0.992	0.991	0.993	0.995	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

age \ year	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	0.103	0.103	0.103	0.097	0.097	0.097	0.104	0.104	0.104	0.107	0.107	0.107	0.095	0.095
2	0.621	0.599	0.586	0.621	0.688	0.669	0.692	0.675	0.710	0.690	0.761	0.616	0.589	0.546
3	0.938	0.931	0.936	0.880	0.886	0.876	0.909	0.909	0.937	0.940	0.962	0.959	0.928	0.921
4	0.994	0.993	1.000	0.993	0.994	0.989	0.989	0.987	0.992	0.988	0.993	0.993	0.994	0.994
5	0.997	0.994	1.000	0.998	0.999	0.999	0.998	0.998	1.000	1.000	0.999	0.999	1.000	1.000
6	0.993	0.987	0.994	0.999	0.999	0.999	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1.000
7	0.999	0.999	0.999	1.000	1.000	1.000	1.000	0.999	1.000	0.999	0.999	0.999	1.000	1.000
8	1.000	1.000	1.000	0.994	0.995	0.996	0.997	0.997	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

age \ year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.095	0.096	0.096	0.096	0.094	0.092	0.092	0.104	0.103	0.101
2	0.524	0.541	0.667	0.655	0.604	0.683	0.675	0.763	0.755	0.749
3	0.917	0.919	0.930	0.927	0.926	0.921	0.916	0.944	0.941	0.936
4	0.999	0.999	0.999	0.999	0.999	0.998	0.999	0.998	0.998	0.998
5	0.999	1.000	1.000	1.000	0.999	1.000	1.000	0.999	0.999	1.000
6	1.000	1.000	0.999	0.999	0.999	0.999	0.999	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.999
8	1.000	1.000	1.000	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	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
11	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

Table 8.7.1.7. NE Atlantic Mackerel. FRACTION OF HARVEST BEFORE SPAWNING

	year													
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	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.253	0.285	0.316	0.318
4	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.253	0.285	0.316	0.318
5	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
6	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
7	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
8	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
9	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
10	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
11	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439
12	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.392	0.403	0.414	0.439

	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	0.201	0.216	0.231	0.230	0.229	0.229
2	0.252	0.287	0.250	0.212	0.175	0.179	0.183	0.187	0.201	0.216	0.231	0.230	0.229	0.229
3	0.321	0.323	0.328	0.334	0.339	0.364	0.390	0.415	0.408	0.400	0.393	0.375	0.357	0.338
4	0.321	0.323	0.328	0.334	0.339	0.364	0.390	0.415	0.408	0.400	0.393	0.375	0.357	0.338
5	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
6	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
7	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
8	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
9	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
10	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
11	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336
12	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420	0.434	0.402	0.368	0.336

	year									
age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.197	0.165	0.133	0.126	0.119	0.111	0.137	0.164	0.191	0.191
2	0.197	0.165	0.133	0.126	0.119	0.111	0.137	0.164	0.191	0.191
3	0.305	0.270	0.237	0.183	0.129	0.075	0.121	0.168	0.214	0.214
4	0.305	0.270	0.237	0.183	0.129	0.075	0.121	0.168	0.214	0.214
5	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
6	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
7	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
8	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
9	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
10	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
11	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169
12	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183	0.169	0.169

Table 8.7.1.8. NE Atlantic Mackerel. FRACTION OF NATURAL MORTALITY BEFORE SPAWNING

	year													
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	2015	2016	2017
0	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
1	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
2	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
3	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
4	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
5	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
6	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
7	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
8	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
9	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
10	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
11	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343
12	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311	0.343	0.343

Table 8.7.1.9. NE Atlantic Mackerel. SURVEY INDICES

```
Some random text
103
SSB-egg-based-survey

1992     2018
1        1        0        0
-1       -1
1        3874476.93
1        -1
1        -1
1        3766378.516
1        -1
1        -1
1        4198626.531
1        -1
1        -1
1        3233833.244
1        -1
1        -1
1        3106808.703
1        -1
1        -1
1        3782966.707
1        -1
1        -1
1        4810751.571
1        -1
1        -1
1        4831948.353
1        -1
1        -1
1        3524054.85
1        -1
1        -1
R-idx(sqrt transf)

1998     2017
1        1        0        0
0        0
1        0.015720899
1        0.017996206
1        0.012743674
1        0.022164525
1        0.023618634
1        0.013230785
1        0.024607411
1        0.038156211
1        0.037598707
1        0.020352249
1        0.018292615
1        0.015170405
1        0.027764032
1        0.036979005
1        0.02420564
1        0.023257095
1        0.025778066
1        0.023169671
1        -1
1        -1
Swept-idx
2010     2018
1        1        0.58     0.75
3        11
1        1617005  4035646  3059146  1591100  691936   413253   198106   65803    24747
1        -1       -1       -1       -1       -1       -1       -1       -1       -1
1        1283247  2383260  2164365  2850847  1783942  740361   299490   149282   84344
1        9201746  2456618  3073772  3218990  2540444  1087937  377406   144695   146826
1        7034162  4896456  2659443  2630617  2768227  1910160  849010   379745   95304
1        2539963  6409324  4802298  1795564  1628872  1254859  727691   270562   72410
1        1374705  2635033  5243607  4368491  1893026  1658839  1107866  754993   450100
1        3562908  1953609  3318099  4680603  4653944  1754954  1944991  626406   507546
1        496595   2384310  1200541  1408582  2330520  1787503  1049868  499295   557573
```

Table 8.7.2.1. NE Atlantic Mackerel. SAM parameter estimates for the 2018 update.

	estimate	std. dev	confidence interval lower bound	confidence interval upper bound
observation standard deviations				
Catches	0.18	0.15	0.14	0.25
Egg survey	0.20	0.29	0.11	0.37
Recruitment index	0.36	0.23	0.23	0.56
IESSNS age 3	0.68	0.27	0.40	1.15
IESSNS ages 4-11	0.40	0.20	0.27	0.59
Recapture overdispersion steal tags	1.21	0.27	1.36	1.12
Recapture overdispersion RFID tags	1.16	0.63	1.55	1.04
random walk standard deviation				
F	0.25	0.15	0.18	0.33
N@age0	0.78	0.15	0.58	1.06
process error standard deviation				
N@age1-12+	0.17	0.13	0.13	0.21
catchabilities				
egg survey	1.37	0.08	1.16	1.61
recruitment index	0.00	0.12	0.00	0.00
IESSNS age 3	1.00	0.27	0.58	1.71
IESSNS age 4	1.49	0.18	1.04	2.14
IESSNS age 5	1.99	0.18	1.39	2.85
IESSNS age 6	2.35	0.18	1.63	3.38
IESSNS age 7	2.69	0.18	1.87	3.87
IESSNS age 8	2.57	0.18	1.77	3.71
IESSNS age 9	2.56	0.18	1.77	3.70
IESSNS ages 10-11	2.18	0.18	1.52	3.12
post tagging survival steal tags	0.39	0.10	0.34	0.43
post tagging survival RFID tags	0.10	0.08	0.09	0.12

Table 8.7.3.1. NE Atlantic Mackerel. STOCK SUMMARY. Low = lower limit and High = higher limit of 95% confidence interval.

YEAR	RECRUITMENT (AGE 0)	HIGH	LOW	SSB	HIGH	LOW	TOTAL CATCH	F (AGES 4-8)	HIGH	LOW
	THOUSANDS			TONNES			TONNES	PER YEAR		
1980	7750521	16984113	3536869	4017907	8457837	1908712	734950	0.171	0.34	0.087
1981	6406269	12337825	3326379	3639690	6906887	1917990	754045	0.171	0.32	0.091
1982	1976069	4143932	942305	3651751	6260529	2130057	716987	0.172	0.31	0.095
1983	1571022	3517044	701756	3969695	6114088	2577404	672283	0.173	0.30	0.099
1984	5911986	11635802	3003796	4194238	6089443	2888873	641928	0.174	0.29	0.104
1985	3856995	7251430	2051514	4034958	5635108	2889188	614371	0.179	0.29	0.110
1986	3835380	6929670	2122776	3661554	4952706	2707000	602201	0.186	0.29	0.118
1987	5394520	9378868	3102810	3689032	4948576	2750075	654992	0.195	0.30	0.127
1988	3362579	5796405	1950681	3609380	4717758	2761401	680491	0.20	0.30	0.138
1989	3601083	6225603	2082979	3334286	4254397	2613169	585920	0.22	0.32	0.153
1990	2584288	4615319	1447038	3390278	4220794	2723181	626107	0.25	0.35	0.174
1991	3243249	5537959	1899375	3226020	3954919	2631459	675665	0.28	0.39	0.20
1992	3886031	6639093	2274594	2890322	3483688	2398022	760690	0.31	0.43	0.23
1993	3045153	5191337	1786237	2526363	3023607	2110892	824568	0.35	0.47	0.26
1994	2888409	4882393	1708774	2202704	2619309	1852360	819087	0.36	0.49	0.27
1995	2425238	4122421	1426778	2198832	2596179	1862300	756277	0.34	0.44	0.26
1996	3468432	6357582	1892232	2092064	2458667	1780123	563472	0.29	0.38	0.23
1997	2676317	4716590	1518612	2078029	2412438	1789976	573029	0.27	0.35	0.21
1998	3246924	5010572	2104054	2109062	2458101	1809586	666316	0.27	0.35	0.21
1999	3753406	5630541	2502079	2253952	2610229	1946305	640309	0.30	0.37	0.24
2000	2588498	3794164	1765955	2181219	2482469	1916526	738606	0.33	0.39	0.29
2001	5132275	7328207	3594365	2059605	2327376	1822643	737463	0.39	0.45	0.33
2002	8708579	12577632	6029700	1885840	2146182	1657079	771422	0.43	0.50	0.37
2003	2992952	4284375	2090798	1910203	2198387	1659796	679287	0.46	0.54	0.39
2004	3936957	5726238	2706774	2410549	2831564	2052132	660491	0.42	0.49	0.36

YEAR	RECRUITMENT (AGE 0)	HIGH	LOW	SSB	HIGH	LOW	TOTAL CATCH	F (AGES 4-8)	HIGH	LOW
	THOUSANDS			TONNES			TONNES	PER YEAR		
2005	6300180	9244002	4293840	2269837	2705129	1904590	549514	0.32	0.38	0.27
2006	11464574	16692197	7874126	2215900	2618927	1874894	481181	0.29	0.34	0.25
2007	5374061	7823457	3691531	2417312	2820632	2071663	586206	0.33	0.39	0.28
2008	5604311	8168336	3845128	2986019	3534299	2522795	623165	0.32	0.38	0.27
2009	5200071	7550819	3581167	3634054	4324811	3053624	737969	0.29	0.34	0.25
2010	6683926	9631467	4638427	4025533	4732936	3423862	875515	0.28	0.34	0.24
2011	7483547	10773616	5198207	4794839	5605302	4101560	946661	0.28	0.33	0.24
2012	4793523	6980496	3291723	4388467	5125670	3757293	892353	0.26	0.32	0.22
2013	3220460	4867764	2130621	4097288	4816614	3485388	931732	0.29	0.35	0.24
2014	8120609	12377522	5327746	4130139	4869649	3502932	1393000	0.33	0.40	0.27
2015	2588980	4292931	1561361	3962603	4726385	3322248	1208990	0.34	0.42	0.28
2016	784490	1514562	406338	3527235	4358303	2854640	1094066	0.34	0.43	0.26
2017	5267776*			3081442	4048464	2345404	1155944	0.38	0.52	0.28
2018	3977184**			2353927***						

*** Time-tapered weighted mean of recruitment estimates for 1990-2016.**

**** Geometric mean 1990–2016.**

***** Estimated value from the forecast.**

Table 8.7.3.2. NE Atlantic Mackerel. ESTIMATED POPULATION ABUNDANCE

Units : Thousands

age \ year	1980	1981	1982	1983	1984	1985	1986	1987	1988
0	7750521	6406269	1976069	1571022	5911986	3856995	3835380	5394520	3362579
1	4653503	6674218	5704000	1616192	1251155	5420373	3217029	3214005	4790054
2	1994678	3851943	5596469	4948040	1288926	972292	4842709	2622680	2635582
3	859737	1618606	3202496	4822696	4516385	1006458	755269	4369121	2102982
4	1436702	677785	1255507	2669203	4073668	3961881	807785	568199	3770464
5	3133512	1086645	502708	900550	2047940	3175475	3039200	652426	394514
6	2510612	2319913	814036	382695	652194	1561824	2343384	2157767	523863
7	863764	1795418	1654449	581517	279837	470366	1093914	1620849	1453406
8	331686	616978	1282244	1179309	411693	205305	328654	786281	1123879
9	893401	236932	440339	915906	839983	294981	148484	228410	559979
10	254857	638392	169181	314231	654130	597984	212258	105041	157144
11	370675	182078	455649	120858	224335	466509	423241	149601	73519
12	720141	779558	686085	813009	664842	633036	776749	837345	681914

age \ year	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	3601083	2584288	3243249	3886031	3045153	2888409	2425238	3468432	2676317
1	2791294	3116740	2146980	2776509	3371213	2574073	2473456	2018977	3033938
2	4151447	2263634	2630428	1741654	2320685	2853235	2120474	2063911	1638484
3	2267428	3809144	1986829	2416739	1482507	1901314	2351623	2087839	1886939
4	1648739	1800686	2923925	1458623	1936356	1048497	1395745	1761690	1728231
5	2885724	1094092	1239644	1838572	946709	1315821	667912	947183	1183072
6	280542	1993896	803823	946094	1156693	598254	934839	486344	700631
7	411136	188509	1271565	511140	595837	667257	364148	563023	323875
8	1060679	309038	123601	745711	311527	325256	282228	208508	331667
9	779546	719709	216105	77710	403224	169709	159252	135522	141769
10	388105	513918	474639	135206	43802	198426	90147	81118	84077
11	105748	262315	324277	284713	77335	22471	103818	48353	44956
12	516017	416934	438303	459432	412102	261141	145339	134326	108136

age \ year	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	3246924	3753406	2588498	5132275	8708579	2992952	3936957	6300180	11464574
1	2230568	2717670	3214851	1656113	5540645	7640107	2374435	3434107	6745432
2	2589748	1811668	2225301	2598715	1156202	4778023	6322183	2163769	3206972
3	1235950	2399436	1606592	1718343	2288967	863689	3630261	4805540	1796105
4	1603085	1148736	1825073	1181814	1376087	1507762	725866	2007947	3141256
5	1442468	1246929	887036	1248500	872918	828969	939853	533921	1174809
6	843866	899401	858755	571109	792513	513453	441021	494521	374910
7	466220	596413	617614	568121	353005	384012	253679	230731	283550
8	253753	305369	371428	407934	323896	207701	173905	124998	134023
9	207980	177515	189592	233962	215643	170164	103054	84052	70411
10	97984	132390	114796	116459	121321	104783	77607	54332	49742
11	54502	64192	75161	69488	59571	58960	43288	31887	30210
12	101486	106159	114888	117007	101807	74253	52784	40653	38505

age \ year	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	5374061	5604311	5200071	6683926	7483547	4793523	3220460	8120609	2588980
1	8364901	5023296	4767259	5132389	6100878	6435719	3666510	2653561	5729227
2	5761560	6799560	4475215	4861233	4241194	5854904	5875273	2836051	2139734
3	2674246	4974795	5957253	4072078	4872581	3228525	5167586	5056793	2190824
4	1524897	2160727	4082726	4939563	3665559	3604041	2320908	3809943	3546703
5	2021532	1211576	1694921	2990105	3640896	2898278	2438039	1820046	2697023
6	756155	1134335	857849	1261783	2099677	2599148	2061105	1749681	1337925
7	252284	432420	656180	546902	858589	1388862	1516822	1486047	1268619
8	171286	161852	249913	348960	366556	552617	755650	1005593	1017669
9	87865	91768	100362	153527	193504	232924	321638	472405	684094
10	42040	51283	47692	65513	85207	115615	126056	204054	330069
11	30128	20710	27323	24875	40456	48998	70568	69010	105121
12	37494	30676	22847	30202	34270	41879	50179	53444	68892

age \ year	2016	2017	2018
0	784490	12549868	12549868
1	1945108	832500	10779246
2	4183158	1544466	685512
3	1581349	3327781	1156774
4	1786534	1275182	2501606
5	2338797	1337856	831220
6	1814684	1584788	788762
7	909373	1282719	965217
8	819252	622176	716721
9	557457	560140	389037
10	358043	339104	258445
11	174934	214525	221993
12	86911	155190	205492

Table 8.7.3.3. NE Atlantic Mackerel. ESTIMATED FISHING MORTALITY

year

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	0.010	0.010	0.010	0.010	0.010	0.011	0.010	0.010	0.011	0.011	0.011	0.011	0.011	0.011
1	0.036	0.036	0.036	0.036	0.036	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
2	0.054	0.053	0.053	0.052	0.052	0.052	0.051	0.051	0.050	0.050	0.051	0.051	0.052	0.053
3	0.086	0.086	0.085	0.085	0.086	0.088	0.091	0.094	0.098	0.102	0.107	0.112	0.116	0.121
4	0.148	0.148	0.149	0.149	0.150	0.154	0.160	0.173	0.184	0.201	0.215	0.229	0.234	0.234
5	0.149	0.150	0.150	0.153	0.155	0.158	0.163	0.166	0.175	0.184	0.190	0.199	0.216	0.224
6	0.185	0.186	0.188	0.190	0.195	0.202	0.209	0.217	0.222	0.243	0.265	0.284	0.302	0.319
7	0.186	0.186	0.186	0.185	0.186	0.190	0.198	0.209	0.221	0.240	0.278	0.339	0.409	0.479
8	0.186	0.186	0.186	0.185	0.186	0.190	0.198	0.209	0.221	0.240	0.278	0.339	0.409	0.479
9	0.186	0.186	0.186	0.185	0.186	0.190	0.198	0.209	0.221	0.240	0.278	0.339	0.409	0.479
10	0.186	0.186	0.186	0.185	0.186	0.190	0.198	0.209	0.221	0.240	0.278	0.339	0.409	0.479
11	0.186	0.186	0.186	0.185	0.186	0.190	0.198	0.209	0.221	0.240	0.278	0.339	0.409	0.479
12	0.186	0.186	0.186	0.185	0.186	0.190	0.198	0.209	0.221	0.240	0.278	0.339	0.409	0.479

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.011	0.011	0.011	0.011	0.011	0.012	0.012	0.007	0.007	0.005	0.004	0.003	0.005	0.004
1	0.035	0.035	0.035	0.035	0.034	0.034	0.033	0.030	0.034	0.026	0.017	0.016	0.019	0.013
2	0.054	0.055	0.057	0.060	0.062	0.065	0.069	0.068	0.068	0.068	0.073	0.066	0.055	0.039
3	0.124	0.124	0.125	0.128	0.136	0.154	0.177	0.165	0.169	0.142	0.159	0.146	0.109	0.096
4	0.233	0.224	0.215	0.203	0.207	0.223	0.254	0.281	0.289	0.251	0.229	0.193	0.180	0.166
5	0.222	0.223	0.231	0.249	0.278	0.306	0.357	0.338	0.367	0.368	0.343	0.279	0.240	0.265
6	0.318	0.311	0.296	0.290	0.291	0.313	0.357	0.438	0.443	0.464	0.425	0.350	0.329	0.332
7	0.520	0.463	0.362	0.294	0.290	0.320	0.353	0.437	0.523	0.611	0.549	0.387	0.353	0.456
8	0.520	0.463	0.362	0.294	0.290	0.320	0.353	0.437	0.523	0.611	0.549	0.387	0.353	0.456
9	0.520	0.463	0.362	0.294	0.290	0.320	0.353	0.437	0.523	0.611	0.549	0.387	0.353	0.456
10	0.520	0.463	0.362	0.294	0.290	0.320	0.353	0.437	0.523	0.611	0.549	0.387	0.353	0.456
11	0.520	0.463	0.362	0.294	0.290	0.320	0.353	0.437	0.523	0.611	0.549	0.387	0.353	0.456
12	0.520	0.463	0.362	0.294	0.290	0.320	0.353	0.437	0.523	0.611	0.549	0.387	0.353	0.456

year

age	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
0	0.005	0.004	0.004	0.004	0.005	0.004	0.005	0.003	0.002	0.002
1	0.012	0.010	0.013	0.012	0.012	0.014	0.017	0.021	0.028	0.044
2	0.030	0.029	0.031	0.032	0.037	0.044	0.052	0.059	0.057	0.061
3	0.090	0.086	0.082	0.078	0.081	0.095	0.131	0.139	0.166	0.164
4	0.160	0.169	0.167	0.154	0.154	0.189	0.227	0.219	0.267	0.308
5	0.252	0.233	0.235	0.218	0.211	0.237	0.304	0.297	0.309	0.343
6	0.307	0.307	0.282	0.278	0.263	0.275	0.345	0.379	0.361	0.389
7	0.443	0.370	0.366	0.374	0.347	0.382	0.384	0.415	0.369	0.437
8	0.443	0.370	0.366	0.374	0.347	0.382	0.384	0.415	0.369	0.437
9	0.443	0.370	0.366	0.374	0.347	0.382	0.384	0.415	0.369	0.437
10	0.443	0.370	0.366	0.374	0.347	0.382	0.384	0.415	0.369	0.437
11	0.443	0.370	0.366	0.374	0.347	0.382	0.384	0.415	0.369	0.437
12	0.443	0.370	0.366	0.374	0.347	0.382	0.384	0.415	0.369	0.437

Table 8.8.3.1. 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
2018								
0	3977184	0.15	0	0	0.332	0	0.002	0.035
1	4524562	0.15	0.10	0.182	0.332	0.065	0.031	0.163
2	685511.6	0.15	0.76	0.182	0.332	0.198	0.059	0.249
3	1156774	0.15	0.94	0.199	0.332	0.241	0.157	0.301
4	2501606	0.15	1	0.199	0.332	0.272	0.264	0.335
5	831220	0.15	1	0.174	0.332	0.298	0.316	0.361
6	788762	0.15	1	0.174	0.332	0.327	0.377	0.391
7	965217	0.15	1	0.174	0.332	0.351	0.407	0.415
8	716721	0.15	1	0.174	0.332	0.380	0.407	0.442
9	389037	0.15	1	0.174	0.332	0.403	0.407	0.461
10	258445	0.15	1	0.174	0.332	0.433	0.407	0.484
11	221993	0.15	1	0.174	0.332	0.452	0.407	0.506
12+	205492	0.15	1	0.174	0.332	0.504	0.407	0.537
2019								
0	3977184	0.15	0	0	0.332	0	0.002	0.035
1	-	0.15	0.10	0.182	0.332	0.065	0.031	0.163
2	-	0.15	0.76	0.182	0.332	0.198	0.059	0.249
3	-	0.15	0.94	0.199	0.332	0.241	0.157	0.301
4	-	0.15	1	0.199	0.332	0.272	0.264	0.335
5	-	0.15	1	0.174	0.332	0.298	0.316	0.361
6	-	0.15	1	0.174	0.332	0.327	0.377	0.391
7	-	0.15	1	0.174	0.332	0.351	0.407	0.415
8	-	0.15	1	0.174	0.332	0.380	0.407	0.442
9	-	0.15	1	0.174	0.332	0.403	0.407	0.461
10	-	0.15	1	0.174	0.332	0.433	0.407	0.484
11	-	0.15	1	0.174	0.332	0.452	0.407	0.506
12+	-	0.15	1	0.174	0.332	0.504	0.407	0.537
2020								
0	3977184	0.15	0	0	0.332	0	0.002	0.035
1	-	0.15	0.10	0.182	0.332	0.065	0.031	0.163
2	-	0.15	0.76	0.182	0.332	0.198	0.059	0.249
3	-	0.15	0.94	0.199	0.332	0.241	0.157	0.301
4	-	0.15	1	0.199	0.332	0.272	0.264	0.335
5	-	0.15	1	0.174	0.332	0.298	0.316	0.361
6	-	0.15	1	0.174	0.332	0.327	0.377	0.391
7	-	0.15	1	0.174	0.332	0.351	0.407	0.415
8	-	0.15	1	0.174	0.332	0.380	0.407	0.442
9	-	0.15	1	0.174	0.332	0.403	0.407	0.461

	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
10	-	0.15	1	0.174	0.332	0.433	0.407	0.484
11	-	0.15	1	0.174	0.332	0.452	0.407	0.506
12+	-	0.15	1	0.174	0.332	0.504	0.407	0.537

Table 8.8.3.2. NE Atlantic Mackerel. Short-term prediction: Multi-option table for 1 001 kt catch in 2018 and a range of F-values in 2019.

2018			
TSB	**SSB**	**Fbar**	**Catch**
2977734	2353927	0,455	1000559

2019				2020		
TSB	**SSB**	**Fbar**	**Catch**	**TSB**	**SSB**	**Implied change in the catch**
2667210	2167164	0,00	0	3166783	2642785	-100%
-	2164240	0,01	19776	3149804	2623332	-98%
-	2161320	0,02	39374	3132980	2604087	-96%
-	2158405	0,03	58798	3116309	2585049	-94%
-	2155496	0,04	78048	3099789	2566214	-92%
-	2152591	0,05	97126	3083420	2547581	-90%
-	2149691	0,06	116034	3067199	2529148	-88%
-	2146796	0,07	134774	3051124	2510910	-87%
-	2143905	0,08	153347	3035196	2492867	-85%
-	2141020	0,09	171755	3019411	2475016	-83%
-	2138140	0,10	190001	3003769	2457355	-81%
-	2135264	0,11	208084	2988267	2439882	-79%
-	2132393	0,12	226007	2972906	2422593	-77%
-	2129527	0,13	243772	2957682	2405488	-76%
-	2126666	0,14	261380	2942596	2388563	-74%
-	2123810	0,15	278833	2927644	2371817	-72%
-	2120958	0,16	296132	2912827	2355248	-70%
-	2118112	0,17	313279	2898142	2338853	-69%
-	2115270	0,18	330275	2883589	2322630	-67%
-	2112433	0,19	347122	2869166	2306578	-65%
-	2109600	0,20	363822	2854871	2290695	-64%
-	2106773	0,21	380375	2840704	2274977	-62%
-	2103950	0,22	396784	2826663	2259424	-60%
-	2101132	0,23	413049	2812746	2244034	-59%
-	2098319	0,24	429172	2798953	2228804	-57%
-	2095510	0,25	445155	2785283	2213732	-56%
-	2092706	0,26	460999	2771733	2198818	-54%
-	2089907	0,27	476705	2758303	2184058	-52%
-	2087113	0,28	492275	2744992	2169451	-51%
-	2084323	0,29	507710	2731799	2154996	-49%
-	2081538	0,30	523012	2718721	2140690	-48%
-	2078758	0,31	538181	2705759	2126532	-46%
-	2075982	0,32	553219	2692910	2112520	-45%
-	2073211	0,33	568128	2680174	2098652	-43%
-	2070445	0,34	582908	2667550	2084926	-42%
-	2067683	0,35	597561	2655037	2071342	-40%
-	2064926	0,36	612089	2642632	2057896	-39%
-	2062174	0,37	626491	2630336	2044589	-37%
-	2059426	0,38	640771	2618147	2031417	-36%
-	2056683	0,39	654928	2606065	2018380	-35%
-	2053944	0,40	668965	2594087	2005475	-33%
-	2051210	0,41	682881	2582213	1992702	-32%
-	2048481	0,42	696680	2570442	1980058	-30%
-	2045756	0,43	710360	2558774	1967543	-29%
-	2043036	0,44	723925	2547206	1955154	-28%
-	2040320	0,45	737375	2535738	1942890	-26%
-	2037609	0,46	750710	2524368	1930751	-25%
-	2034903	0,47	763933	2513097	1918733	-24%

-	2032201	0,48	777044	2501922	1906836	-22%
-	2029503	0,49	790045	2490844	1895059	-21%
-	2026810	0,50	802936	2479860	1883400	-20%
-	2024122	0,51	815719	2468971	1871858	-18%
-	2021438	0,52	828394	2458174	1860431	-17%
-	2018758	0,53	840964	2447470	1849117	-16%
-	2016084	0,54	853427	2436857	1837917	-15%
-	2013413	0,55	865787	2426334	1826828	-13%
-	2010747	0,56	878044	2415901	1815849	-12%
-	2008086	0,57	890198	2405556	1804978	-11%
-	2005429	0,58	902251	2395299	1794216	-10%
-	2002776	0,59	914204	2385128	1783559	-9%
-	2000128	0,60	926058	2375044	1773008	-7%
-	1997484	0,61	937814	2365044	1762560	-6%
-	1994845	0,62	949472	2355129	1752215	-5%
-	1992210	0,63	961034	2345297	1741971	-4%
-	1989580	0,64	972501	2335548	1731828	-3%
-	1986954	0,65	983873	2325880	1721783	-2%
-	1984332	0,66	995152	2316293	1711837	-1%
-	1981715	0,67	1006338	2306786	1701987	1%
-	1979102	0,68	1017433	2297359	1692234	2%
-	1976494	0,69	1028436	2288010	1682574	3%
-	1973890	0,70	1039350	2278739	1673009	4%
-	1971290	0,71	1050175	2269545	1663535	5%
-	1968695	0,72	1060911	2260427	1654153	6%
-	1966104	0,73	1071561	2251384	1644861	7%
-	1963517	0,74	1082124	2242417	1635659	8%
-	1960934	0,75	1092601	2233523	1626545	9%
-	1958356	0,76	1102993	2224702	1617518	10%
-	1955783	0,77	1113302	2215954	1608577	11%
-	1953213	0,78	1123527	2207278	1599722	12%
-	1950648	0,79	1133670	2198673	1590951	13%
-	1948087	0,80	1143732	2190138	1582263	14%
-	1945531	0,81	1153712	2181673	1573657	15%
-	1942978	0,82	1163613	2173276	1565133	16%
-	1940430	0,83	1173435	2164949	1556689	17%
-	1937886	0,84	1183178	2156688	1548325	18%
-	1935347	0,85	1192843	2148495	1540040	19%
-	1932812	0,86	1202432	2140368	1531832	20%
-	1930281	0,87	1211944	2132307	1523701	21%
-	1927754	0,88	1221381	2124311	1515646	22%
-	1925231	0,89	1230744	2116379	1507667	23%
-	1922713	0,90	1240032	2108511	1499761	24%
-	1920199	0,91	1249247	2100706	1491929	25%
-	1917689	0,92	1258389	2092964	1484170	26%
-	1915183	0,93	1267460	2085283	1476482	27%
-	1912681	0,94	1276459	2077664	1468866	28%
-	1910184	0,95	1285388	2070106	1461319	28%
-	1907691	0,96	1294247	2062607	1453842	29%
-	1905201	0,97	1303037	2055168	1446433	30%
-	1902716	0,98	1311759	2047788	1439093	31%
-	1900236	0,99	1320412	2040467	1431819	32%
-	1897759	1,00	1328999	2033203	1424612	33%
-	1895286	1,01	1337519	2025996	1417470	34%
-	1892818	1,02	1345973	2018847	1410393	35%
-	1890354	1,03	1354362	2011753	1403379	35%
-	1887893	1,04	1362686	2004715	1396430	36%
-	1885437	1,05	1370946	1997731	1389543	37%

-	1882985	1,06	1379143	1990803	1382718	38%
-	1880537	1,07	1387277	1983928	1375954	39%
-	1878094	1,08	1395348	1977107	1369250	39%
-	1875654	1,09	1403358	1970338	1362607	40%

Table 8.8.3.3. NE Atlantic Mackerel. Short-term prediction: Management option table for 1 001 kt catch in 2018 and a range of catch options in 2019.

Rationale	Catch (2019)	Fbar (2019)	SSB (2019)	SSB (2020)	% SSb change	% catch change	% advice change
MSY AR	318403	0,173	2117257	2333959	10%	-68%	-42%
Catch(2019) = Zero	0	0,000	2167164	2642785	22%	-100%	-100%
Catch(2019) = 2018 catch -20%	800447	0,498	2027332	1885650	-7%	-20%	45%
Catch(2019) = 2018 catch	1000559	0,665	1983069	1707074	-14%	0%	82%
Catch(2019) = 2018 +20%	1200671	0,858	1933279	1533339	-21%	20%	118%
Fbar(2019) = 0.23	413049	0,230	2101132	2244034	7%	-59%	-25%
Fbar(2019) = 0.31 (Fpa)	538181	0,310	2078758	2126532	2%	-46%	-2%
Fbar(2019) = 0.43 (Flim)	710360	0,430	2045756	1967543	-4%	-29%	29%
Fbar(2019) = 0.21 (Fmsy)	380375	0,210	2106773	2274977	8%	-62%	-31%
Fbar(2019) = 0.26	460999	0,260	2092706	2198818	5%	-54%	-16%
Fbar(2019) = 0.27	476705	0,270	2089907	2184058	5%	-52%	-13%
Fbar(2019) = 0.28	492275	0,280	2087113	2169451	4%	-51%	-11%
SSB(2020) = MSY Btrigger = Bpa	78048	0,040	2155496	2566214	19%	-92%	-86%
SSB(2020) = Blim	737375	0,450	2040320	1942890	-5%	-26%	34%
Fbar(2019) = F2018	744410	0,455	2038892	1936484	-5%	-26%	35%
F = 0.20	363822	0,200	2109600	2290695	9%	-64%	-34%
F = 0.21	380375	0,210	2106773	2274977	8%	-62%	-31%
F = 0.22	396784	0,220	2103950	2259424	7%	-60%	-28%
F = 0.23	413049	0,230	2101132	2244034	7%	-59%	-25%
F = 0.24	429172	0,240	2098319	2228804	6%	-57%	-22%
F = 0.25	445155	0,250	2095510	2213732	6%	-56%	-19%
F = 0.26	460999	0,260	2092706	2198818	5%	-54%	-16%
F = 0.27	476705	0,270	2089907	2184058	5%	-52%	-13%
F = 0.28	492275	0,280	2087113	2169451	4%	-51%	-11%
F = 0.29	507710	0,290	2084323	2154996	3%	-49%	-8%

8.15 Figures

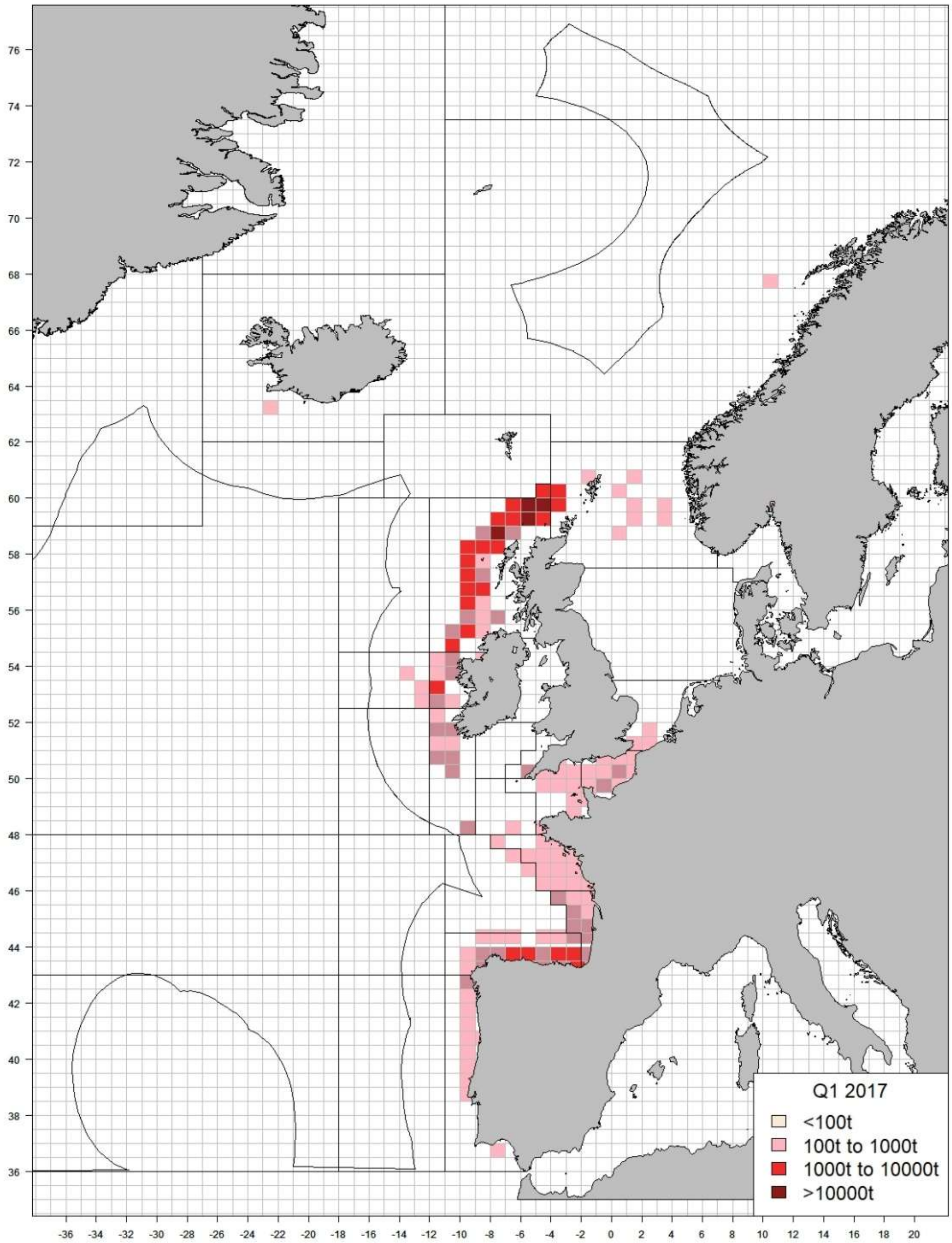

Figure 8.4.2.1. NE Atlantic Mackerel. Commercial catches in 2017, quarter 1.

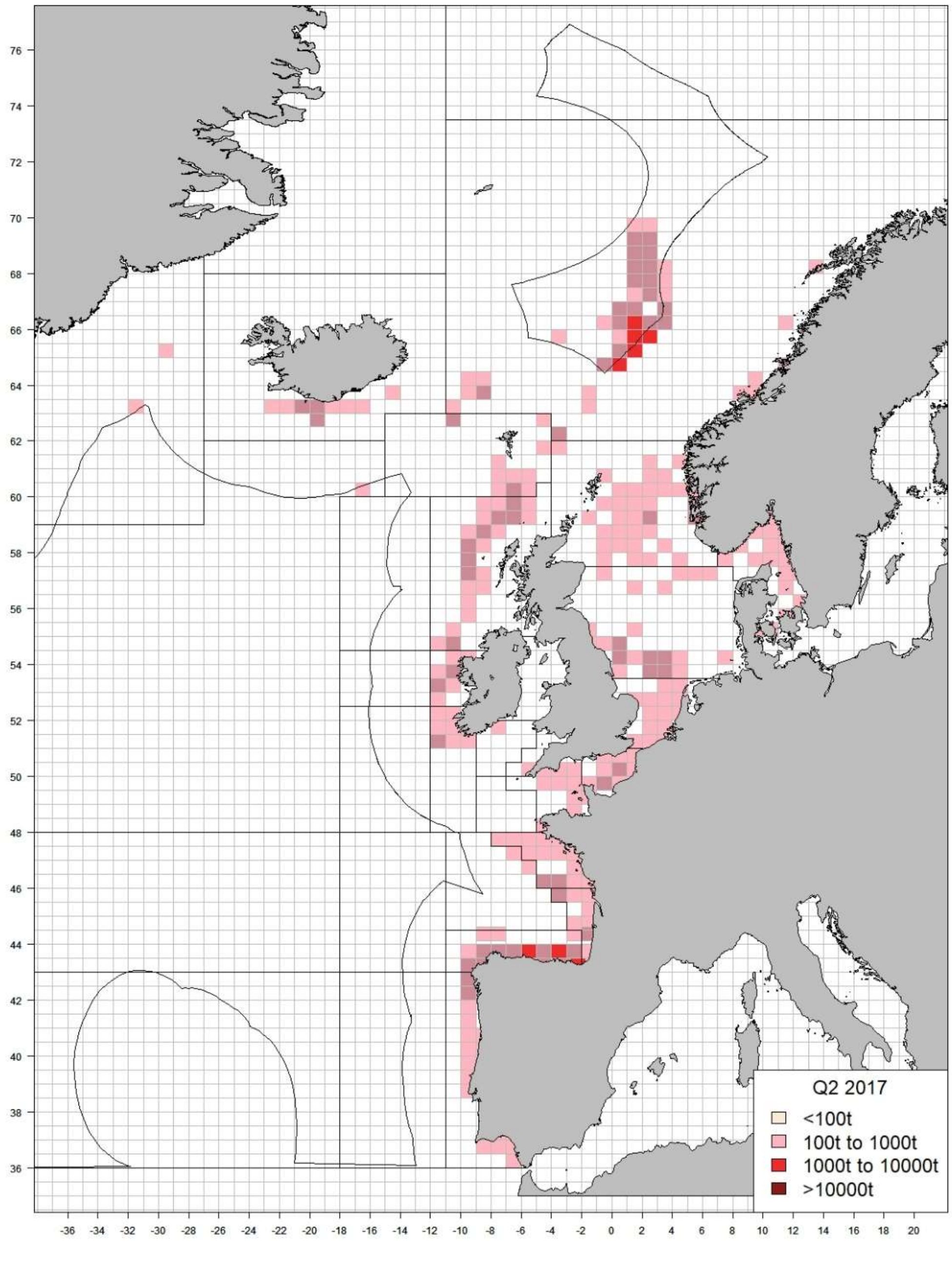

Figure 8.4.2.2. NE Atlantic Mackerel. Commercial catches in 2017, quarter 2.

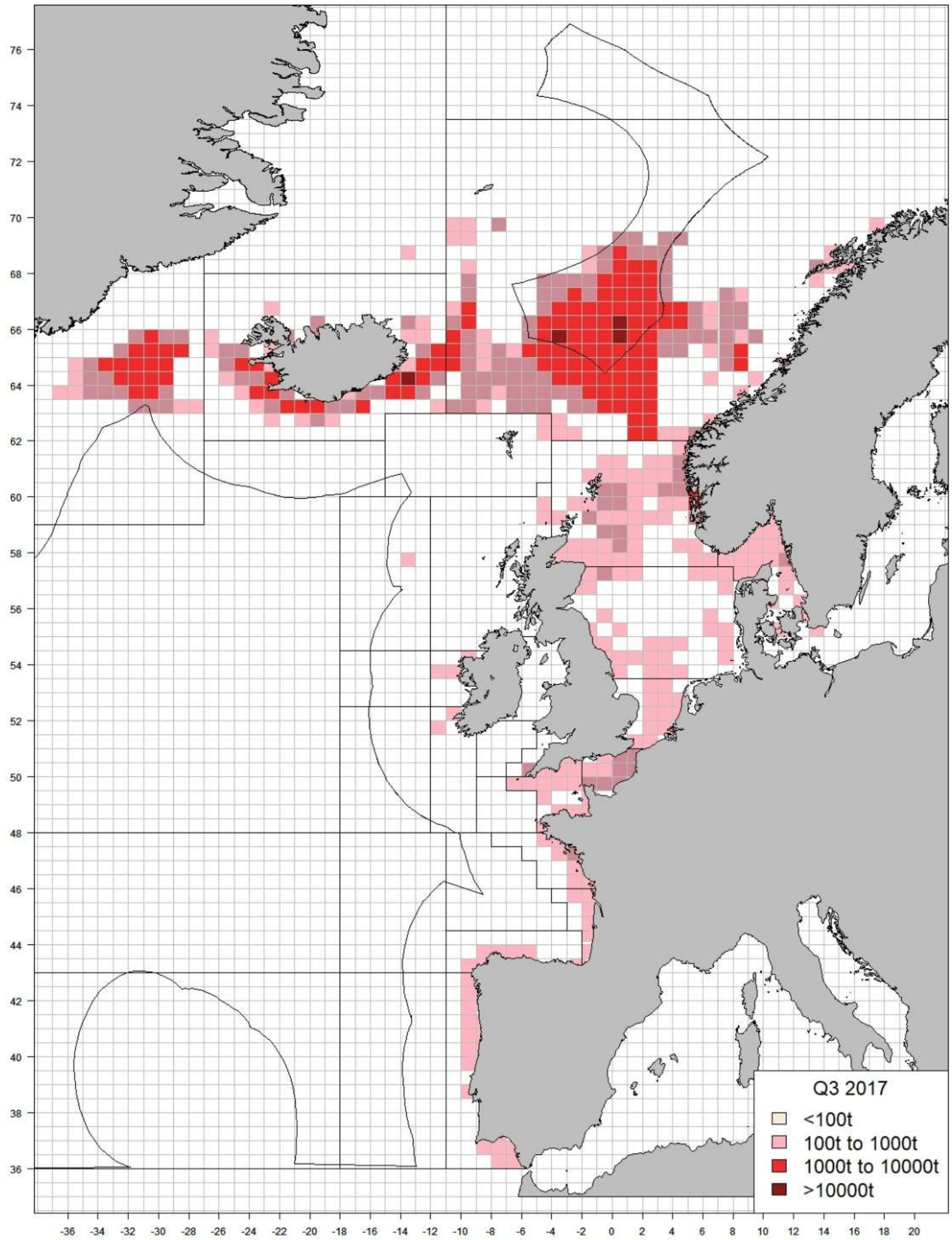

Figure 8.4.2.3. NE Atlantic Mackerel. Commercial catches in 2017, quarter 3.

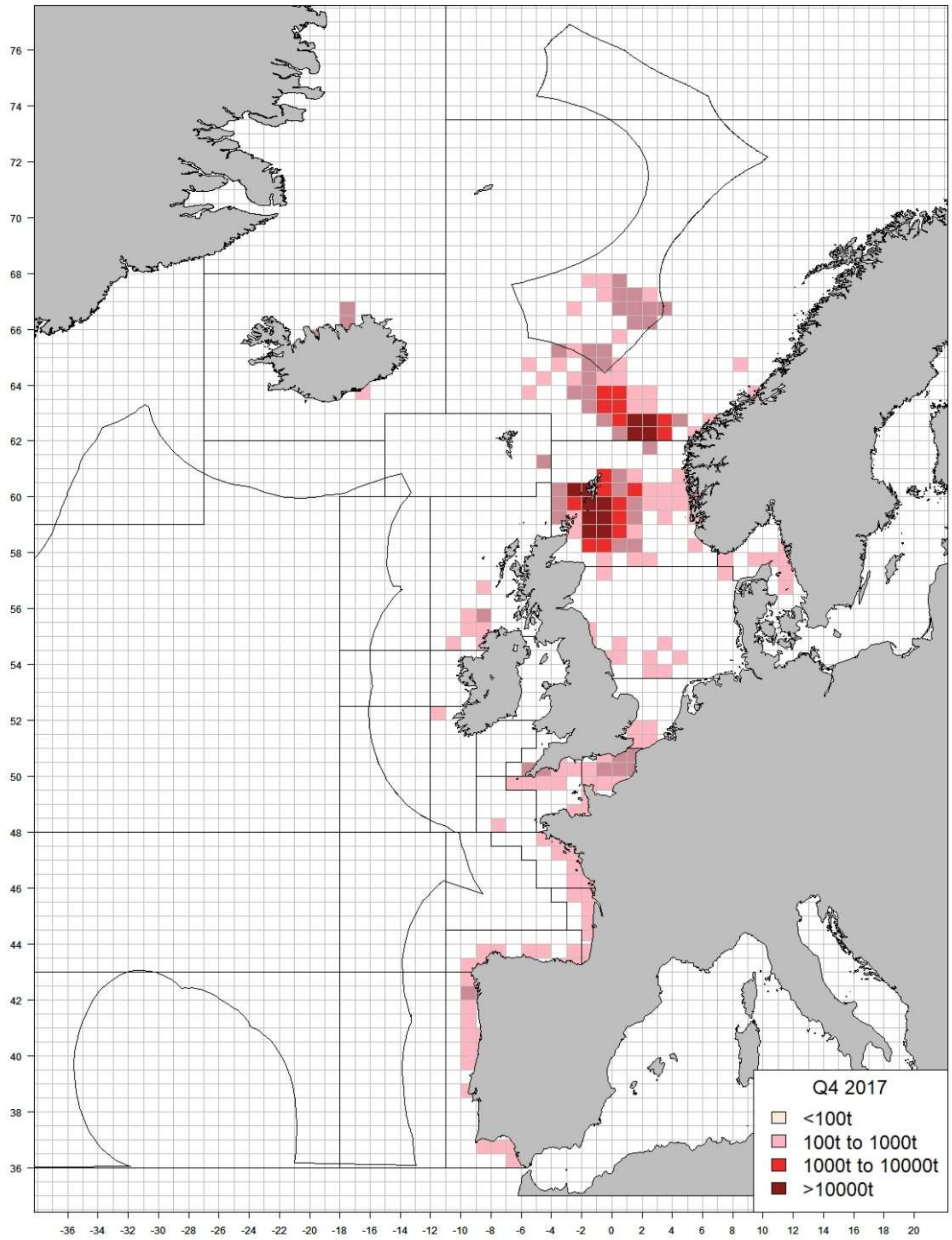

Figure 8.4.2.4. NE Atlantic Mackerel. Commercial catches in 2017, quarter 4.

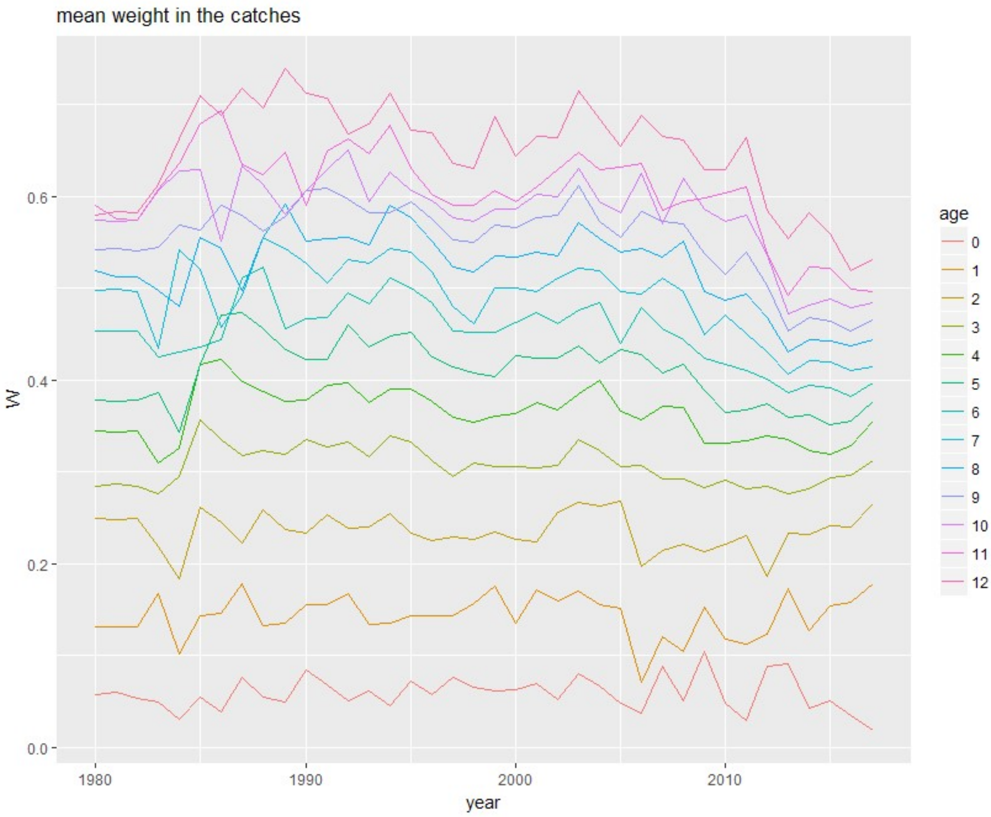

Figure 8.5.2.1. NE Atlantic mackerel. Weights-at-age in the catch.

Figure 8.5.2.2. NE Atlantic mackerel. Weights-at-age in the stock.

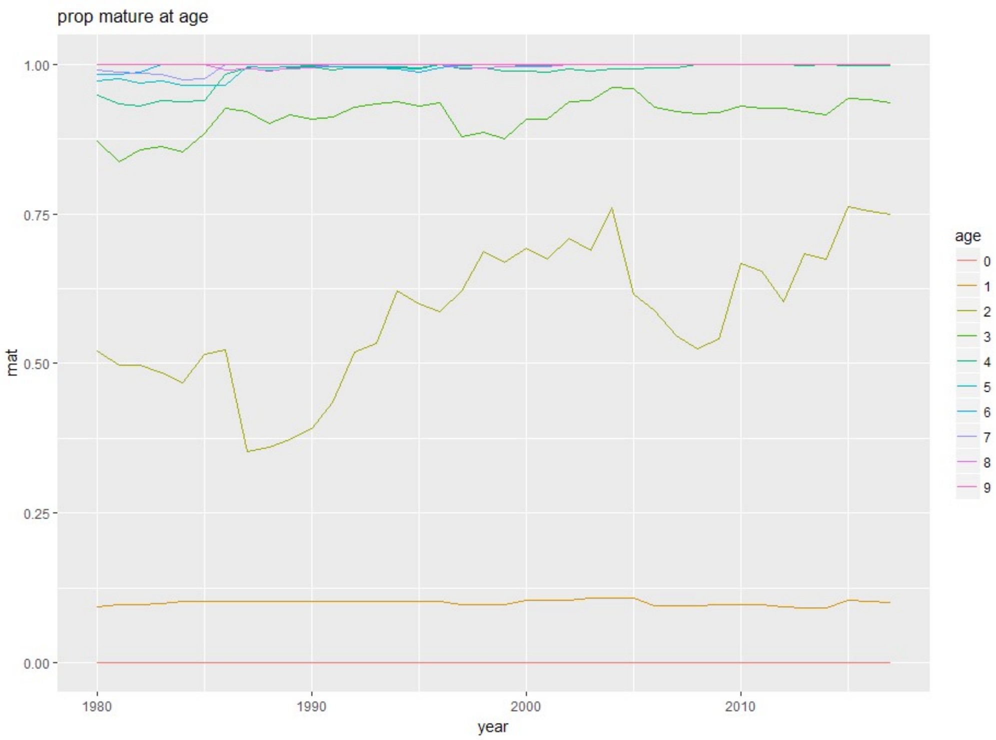

Figure 8.5.3.1. NE Atlantic mackerel. Proportion of mature fish at age.

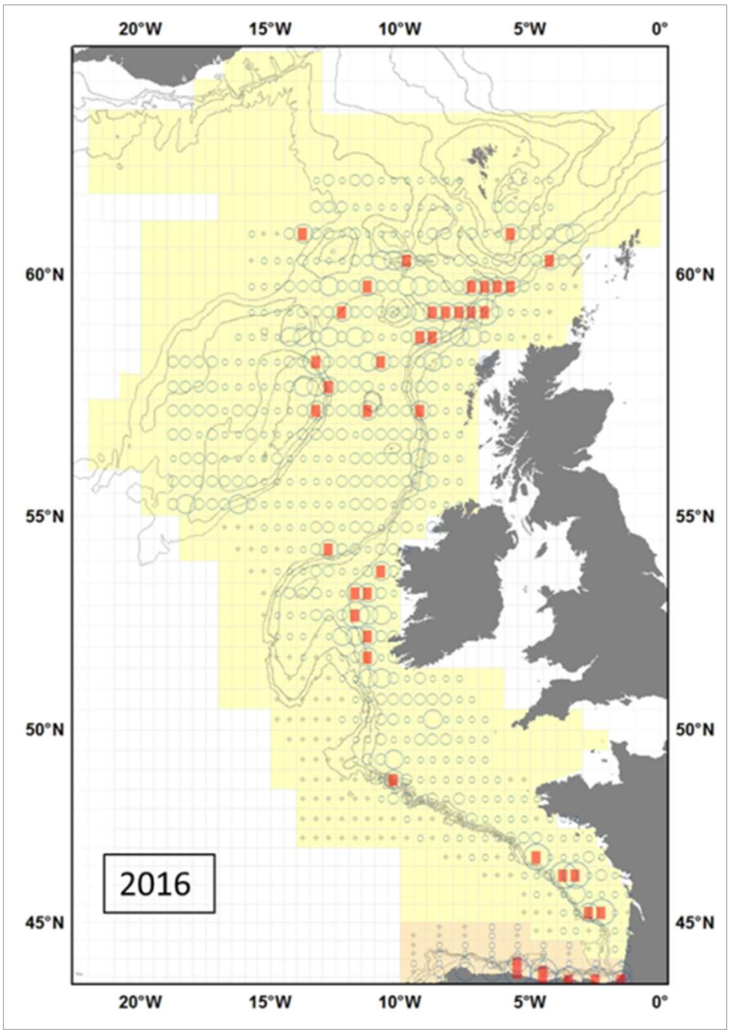

Figure 8.6.1.2.1.: Mean egg production (stage 1 eggs/m²/day) by half ICES rectangle for all Mackerel and Horse Mackerel Egg Surveys (MEGS) stations sampled in 2016. Egg production values are square root transformed. Crosses denote locations where sampling was undertaken but where no spawning was recorded. Area in yellow denotes the maximum geographical survey extent for the western survey area. Area/stations capturing 50% of spawning activity within that year are overlaid in red

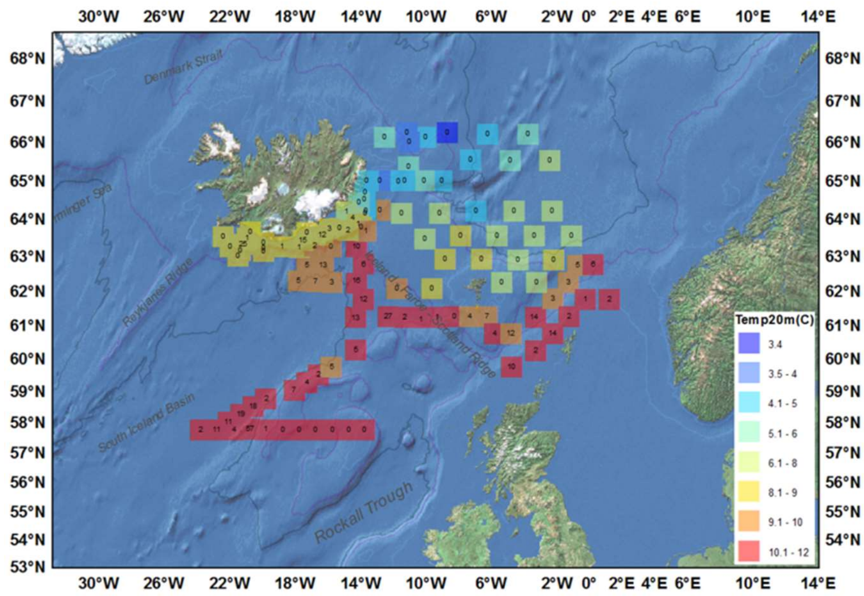

Figure 8.6.1.2.2: Mackerel stage 1 egg counts /m²/day, May/June 2017, for all relevant surveys and all stations. The coloured squares correspond to the observed temperature recorded at 20 m depth during the plankton deployments. The 200, 1000 and 2000m contours are included for reference.

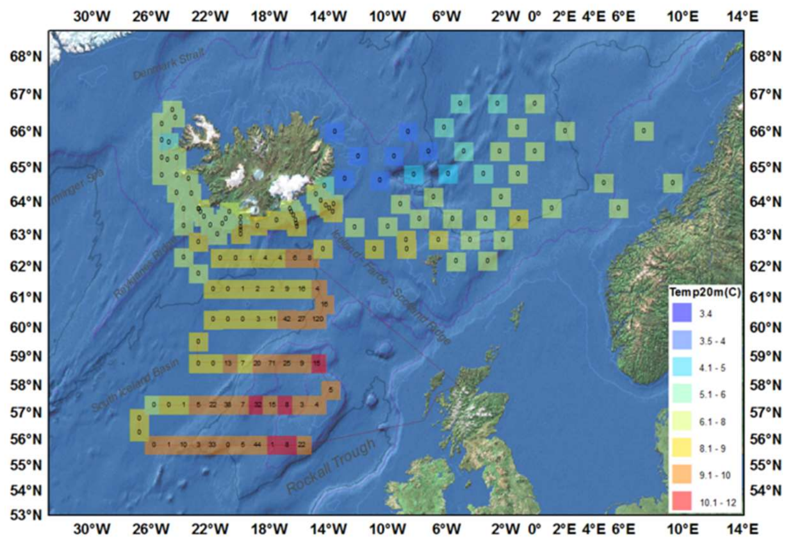

Figure 8.6.1.2.3: Mackerel stage 1 egg counts/m²/day 2018, for all surveys/stations sampled. The coloured squares represent the temperature in degrees Celsius at 20 m depth recorded during the plankton deployments.

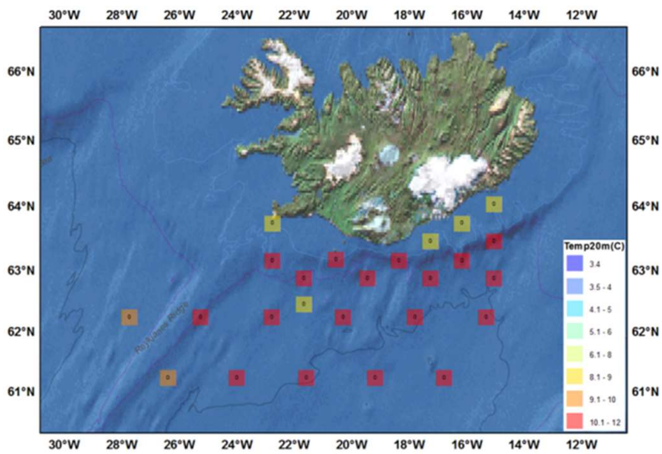

Figure 8.6.1.2.4: Results of analysed Icelandic Ecosystem surveys in the Nordic Seas in July-August (IESSNS) station results, July 2018. The coloured squares represent the temperature in degrees Celsius at 20 m depth recorded during the plankton deployments.

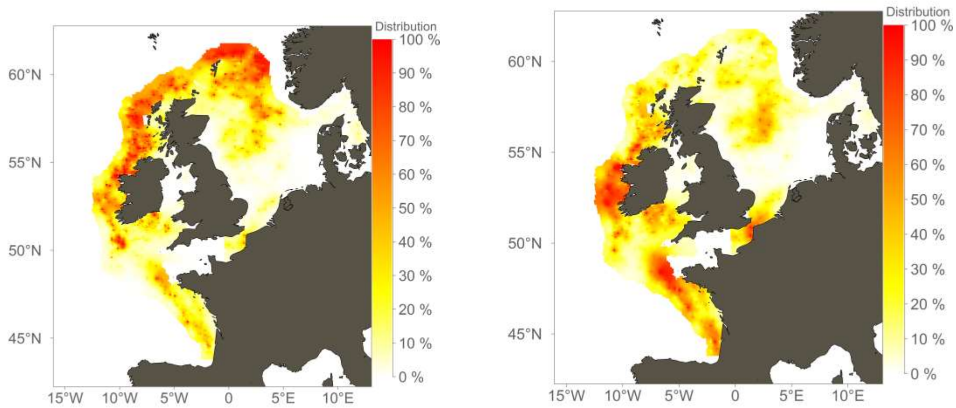

Figure 8.6.2.1. Distributions of modelled squared catch rates of mackerel at approximately 3-9 months of age in first and fourth quarter demersal trawl surveys. Left) average rates for cohorts from 1998-2015; and Right) 2015 cohort. See Jansen *et al.* (2015) for details.

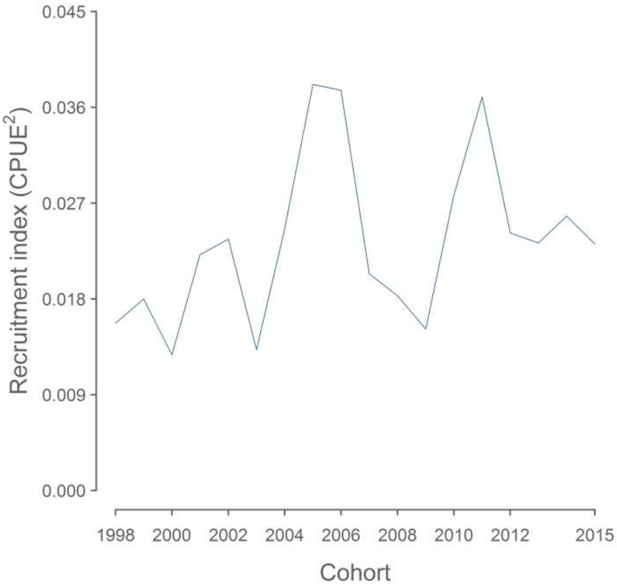

Figure 8.6.2.2. IBTS recruitment index derived from square root transformed CPUE. See Jansen *et al*. (2015) for details.

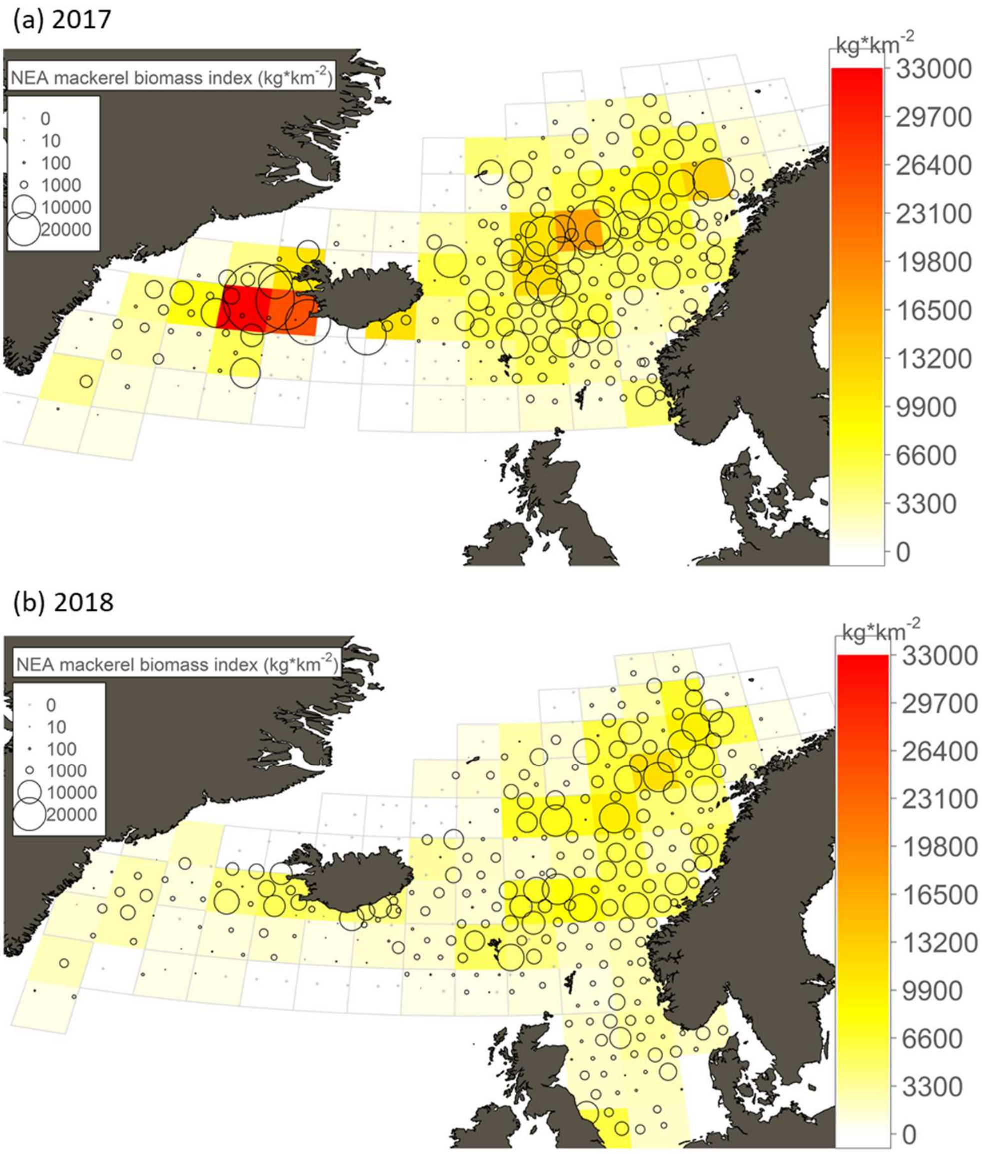

Figure 8.6.3.1. Mackerel catch rates from surface trawl hauls (circle size represents catch rate in kg/km²) overlaid on mean catch rate per standardized rectangle (1° lat. x 2° lon.) from the IESSNS survey in 2017 (a) and in 2018 (b).

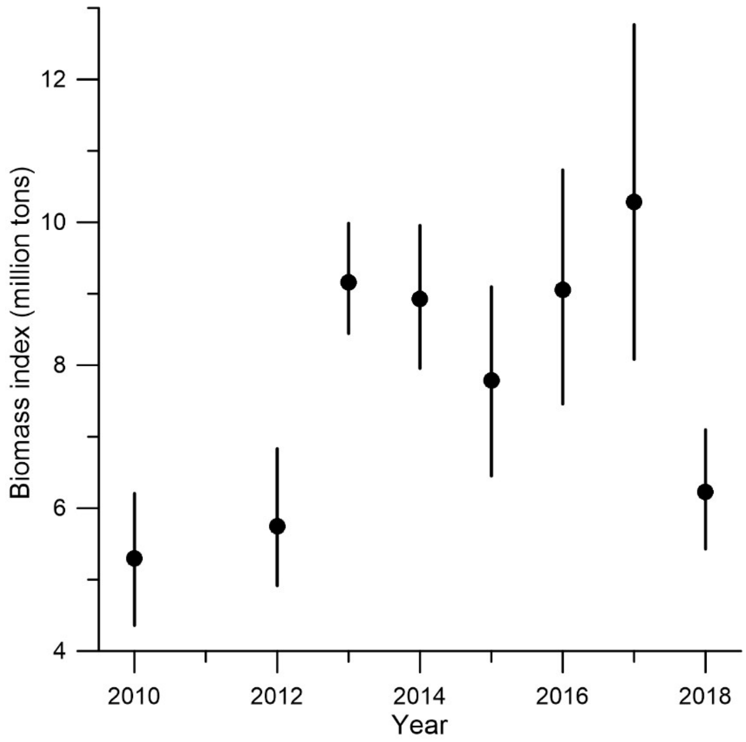

Figure 8.6.3.2. Estimated mackerel total stock biomass, with 90% CI, from the IESSNS for the years included in the assessment. North Sea is excluded from biomass index calculations in 2018.

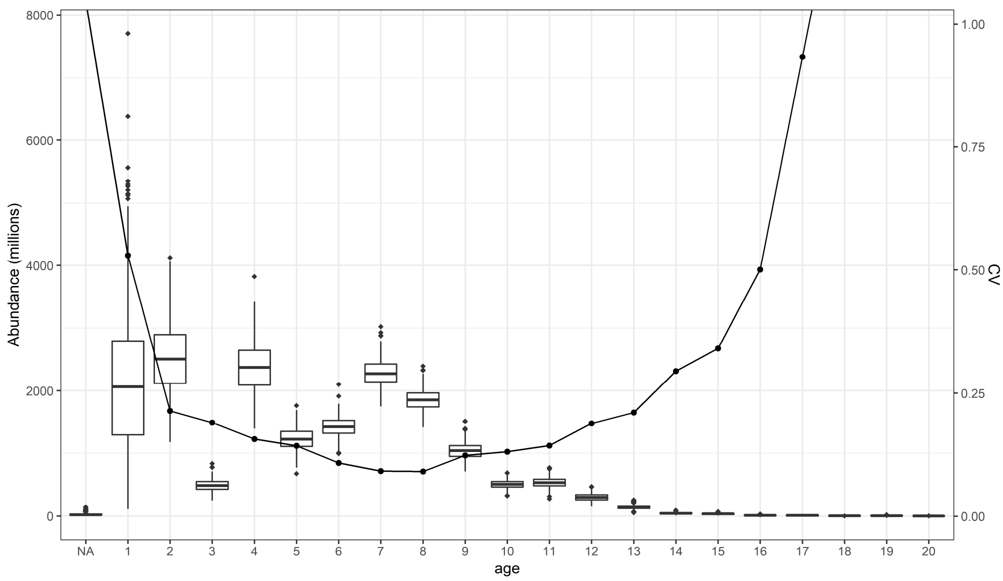

Figure 8.6.3.3. Mackerel numbers by age from the IESSNS survey in 2018, excluding North Sea. Boxplot of abundance and relative standard error (CV) obtained by bootstrapping with 500 replicates using the StoX software (http://www.imr.no/forskning/prosjekter/stox/nb-no).

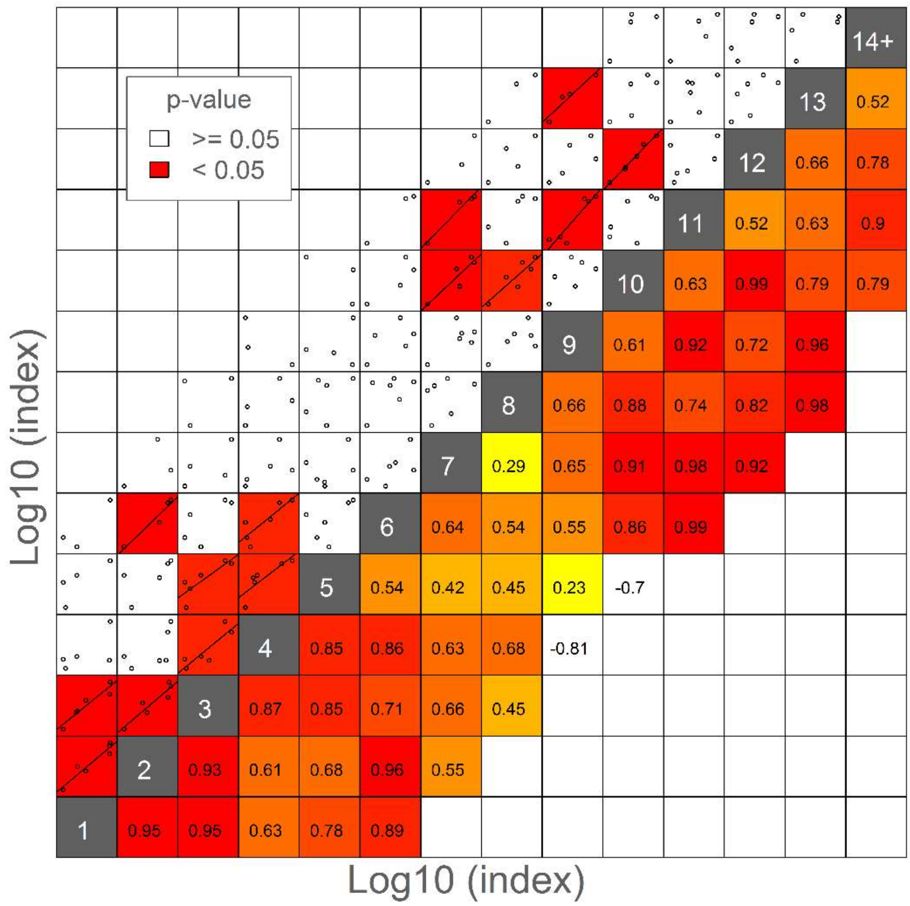

Figure 8.6.3.4. Internal consistency of the mackerel abundance index from the IESSNS surveys including data from 2012 to 2018, excluding North Sea in 2018. Ages indicated by white numbers in grey diagonal cells. Statistically significant positive correlations (*p<0.05*) are indicated by regression lines and red cells in upper left half. Corelation coefficients (r) are given in the lower right half.

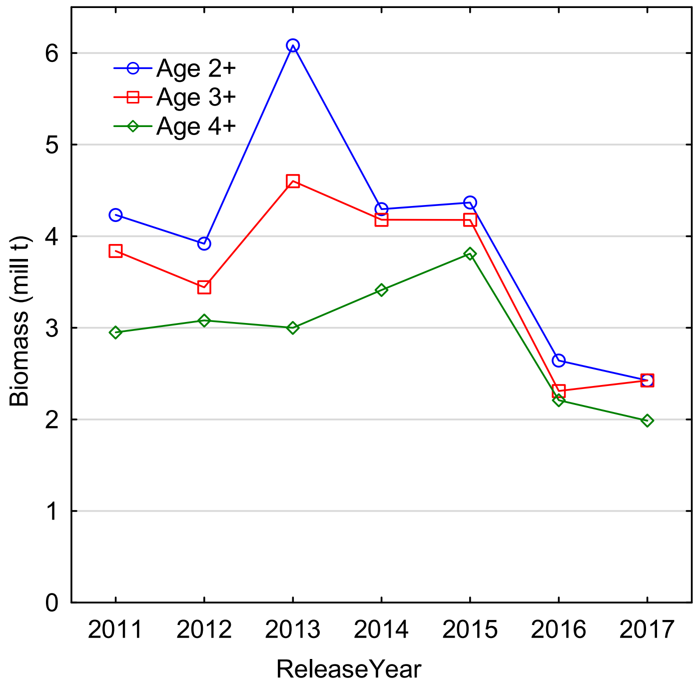

Figure 8.6.4.1. Biomass (mill t) estimates of mackerel at ages 2+, 3+ and 4+ based on RFID tagging data and recaptures at year 1 after release (YearsOut=1). Estimates are scaled to the 10% survival used in SAM. Estimates for release year 2017 is only based on landings in quarter 1 2018. Note that the mortality happening over the year is not taken into account in the estimation.

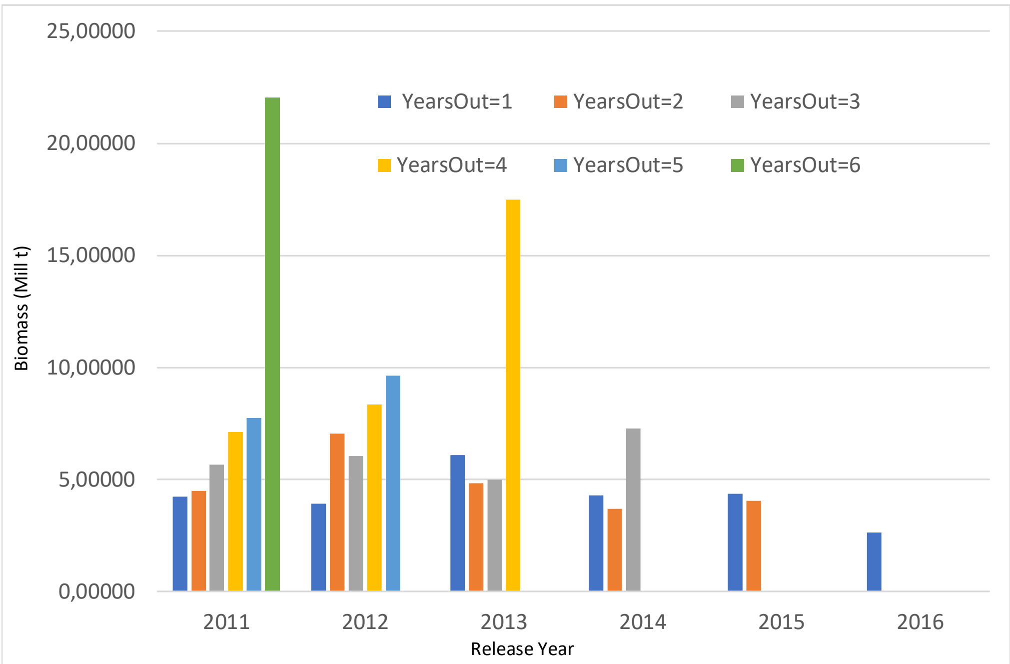

Figure 8.6.4.2. Biomass (mill t) estimates of Age 2+ mackerel based on RFID tagging data and recaptures at different numbers of years after release (YearsOut=1-6). Estimates are scaled to the 10% survival used in SAM. Note that the mortality happening over the year is not taken into account in the estimation.

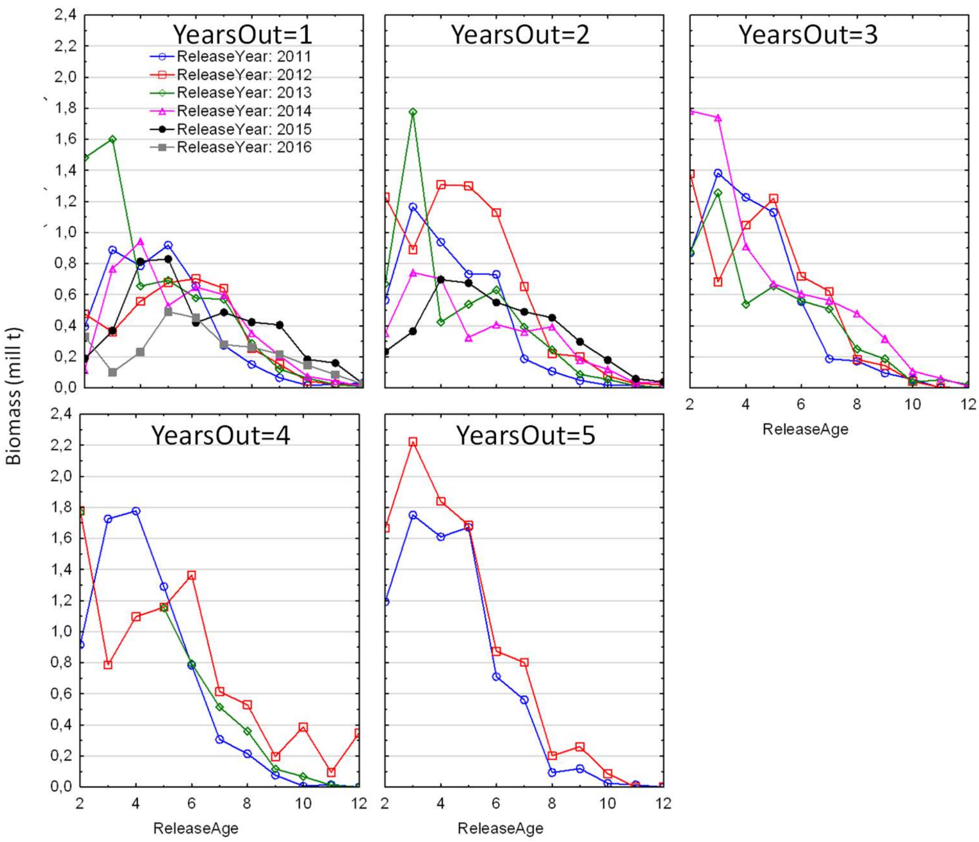

Figure 8.6.4.3. Biomass (mill t) estimates by age for the years 2011-2016 based on RFID tagging data and recaptures at different numbers of years after release (YearsOut=1-5). Estimates are scaled to 10% survival used in SAM. Note that the mortality happening over the year is not taken into account in the estimation.

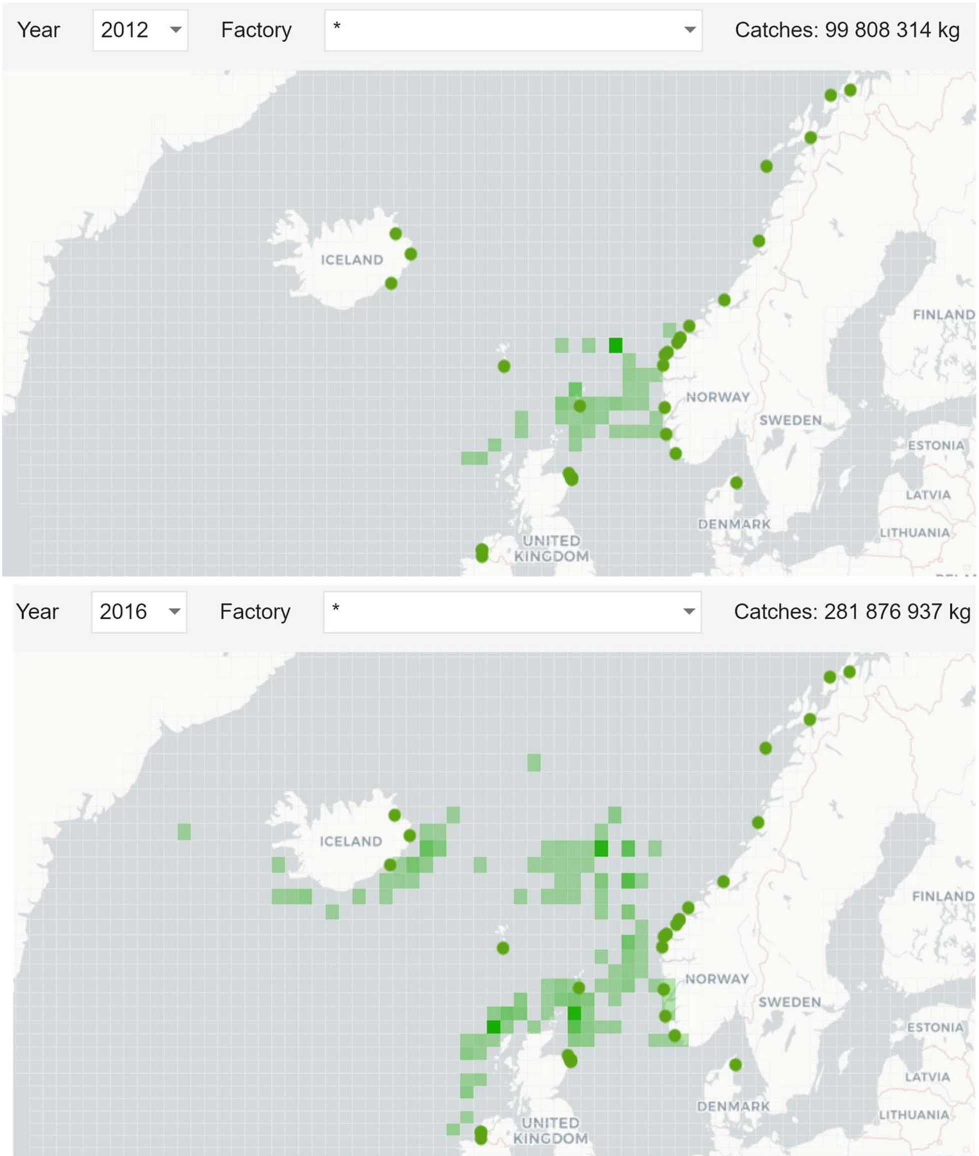

Figure 8.6.4.4. Illustration of the change in distribution of catches and biomass scanned for tags over the time series of RFID-tagging data. A marked change happened from 2014 onwards, when Icelandic, Faroese and Scottish factories installed RFID antenna systems. The pictures are from a map websolution (www.smartfishmap.hi.no) where it is given an overview of tagging experiments, scanned catches and recaptures, where it is possible to filter by year and factory, and where there also is a list of recaptures. All ICES rectangles with info are clickable for more info.

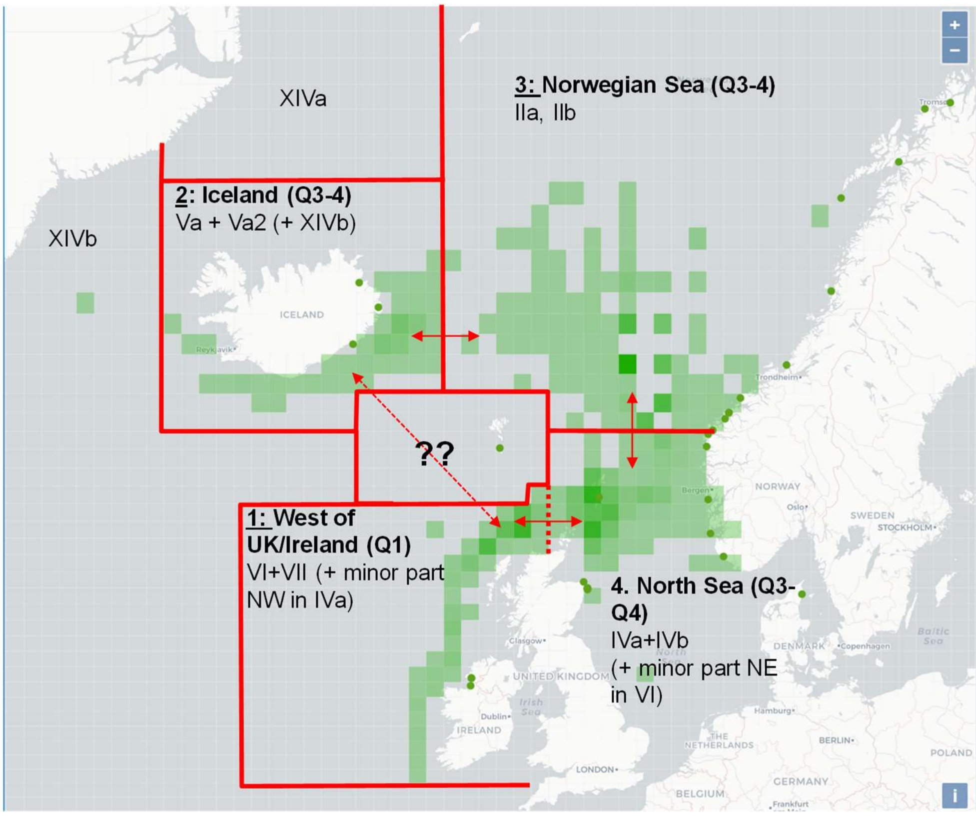

Figure 8.6.4.5. Suggestion of a possible split into 4 areas/seasons with scanned catches and recaptures handled, by area. Note that this also would imply that SAM would have to include mortality happening over the year for the tagging data. At present it is not taken into account whether recaptures are coming in quarter Q1, Q3 or Q4.

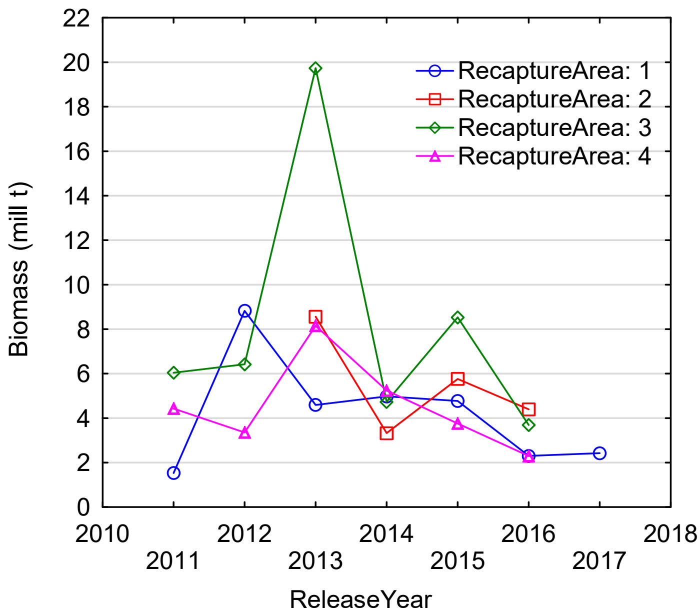

Figure 8.6.4.6. Biomass (mill t) estimates of mackerel at ages 2+ based on RFID tagging data and recaptures at year 1 after release (YearsOut=1), and based on recaptures in 4 different areas/seasons. Estimates are scaled to the 10% survival used in SAM. Estimates for release year 2017 is only based on landings in quarter 1 2018. Note that the mortality happening over the year is not taken into account in the estimation.

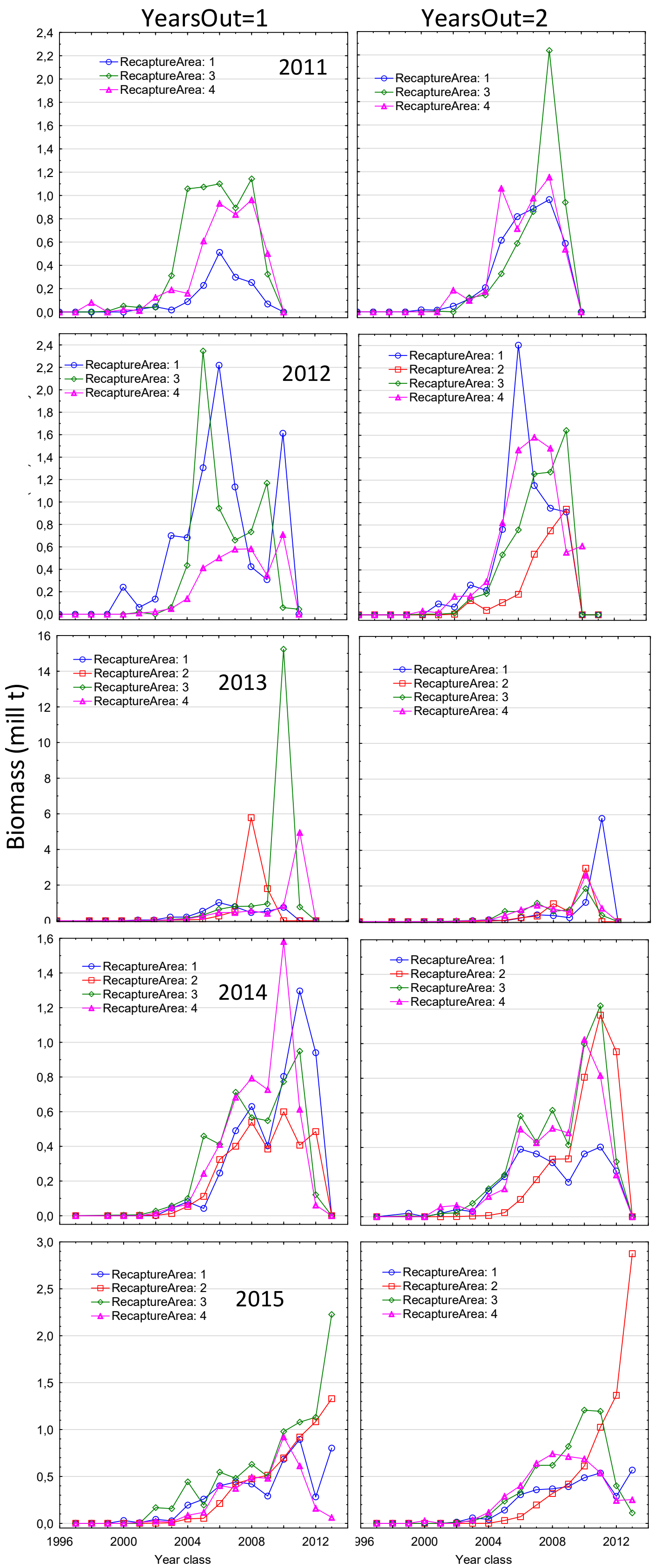

Figure 8.6.4.7. Biomass (mill t) estimates of mackerel by age in 2011-2015 based on RFID tagging data and recaptures at 1-2 years out after release (YearsOut=1-2), and based on recaptures in 4 different areas/seasons. Estimates are scaled to the 10% survival used in SAM. Note that the mortality happening over the year is not taken into account in the estimation.

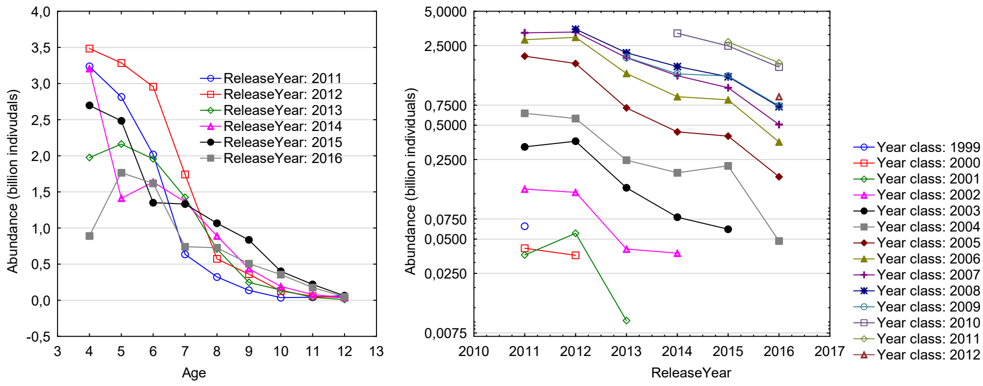

Figure 8.6.4.8. Left: Abundance index in billions individuals ages 4-12 per release years 2011-2016. Right: Year class trends in abundance (log scale) 2011-2016 from the index. The index is based on RFID tagging experiments 2011-2016, and data from scanned catches and recaptures in the two first years after a release year (yearsout=1-2).The index is already scaled down to the 10% survival estimated by SAM (see Table 8.6.4.3 for data).

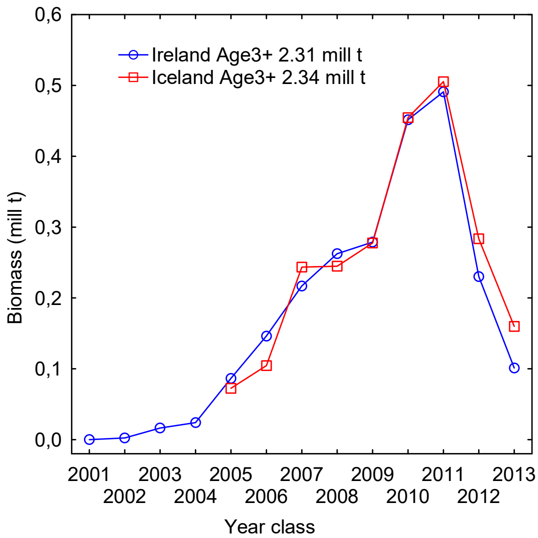

Figure 8.6.4.9. Biomass (mill t) estimates of mackerel by age (and total estimate) in 2016 based on RFID tagging off Ireland and Iceland and recaptures in 2017. Estimates are scaled to the 10% survival used in SAM. Note that the mortality happening over the year is not taken into account in the estimation.

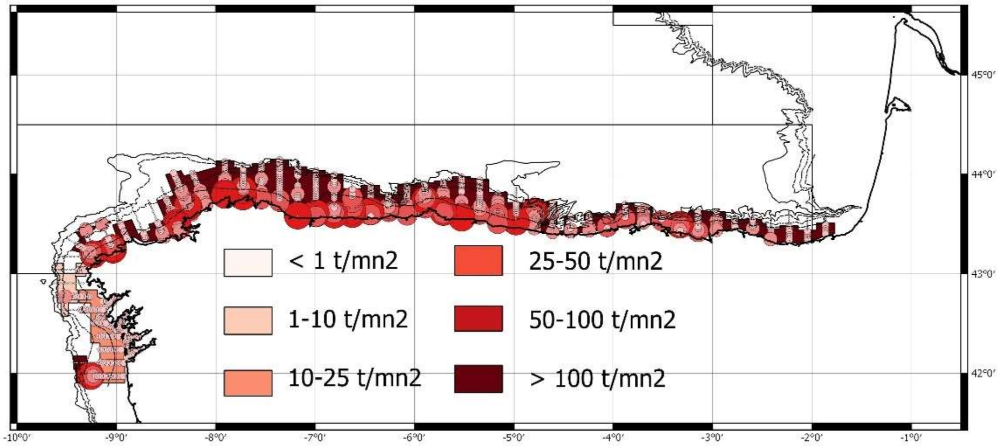

Figure 8.6.5.2.1. PELACUS 0318 mackerel density distribution. Polygons are drawn to encompass the backscattering energy, and polygon colour indicates the mean density expressed as tonnes per squared nautical mile (<1; 1-10; 10-25; 25-50; 50-100; and >100).

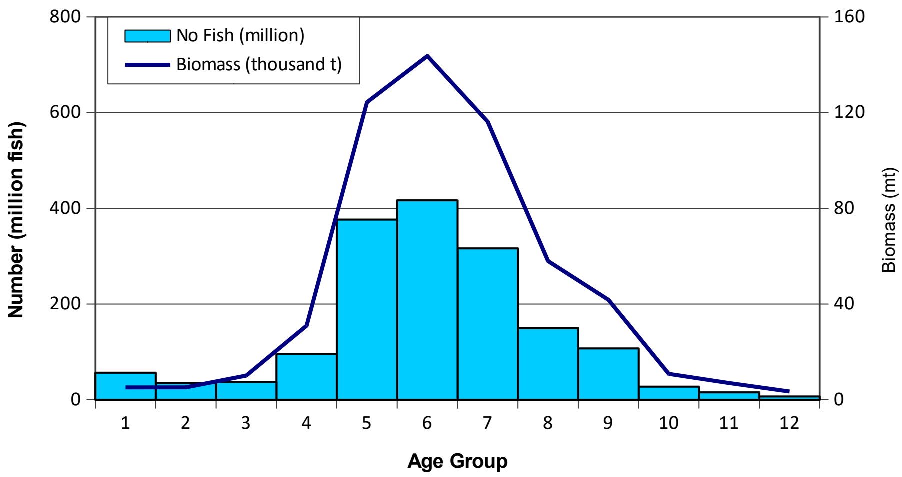

Figure 8.6.5.2.2: Mackerel abundance and biomass estimates by age group in ICES Divisions 8c. and 9.a during PELACUS 0318.

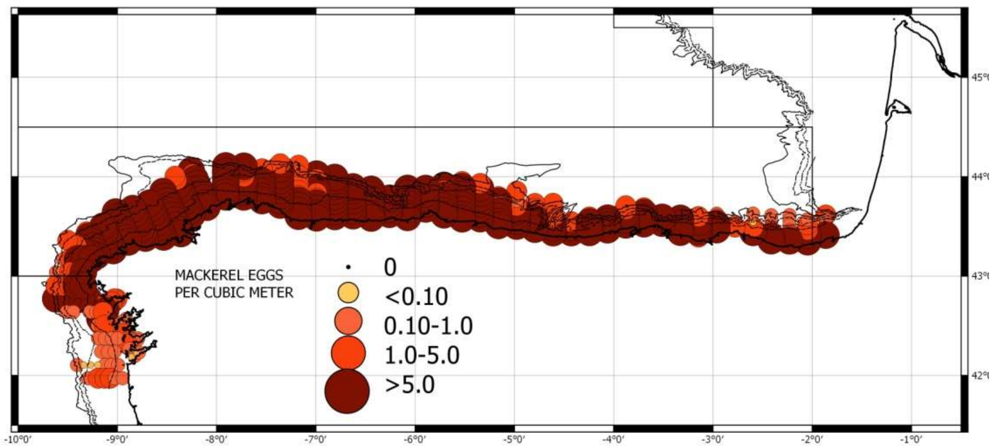

Figure 8.6.5.2.3: Mackerel subsurface egg distribution (no eggs/m^3) as recorded by CUFES during PELACUS 0318.

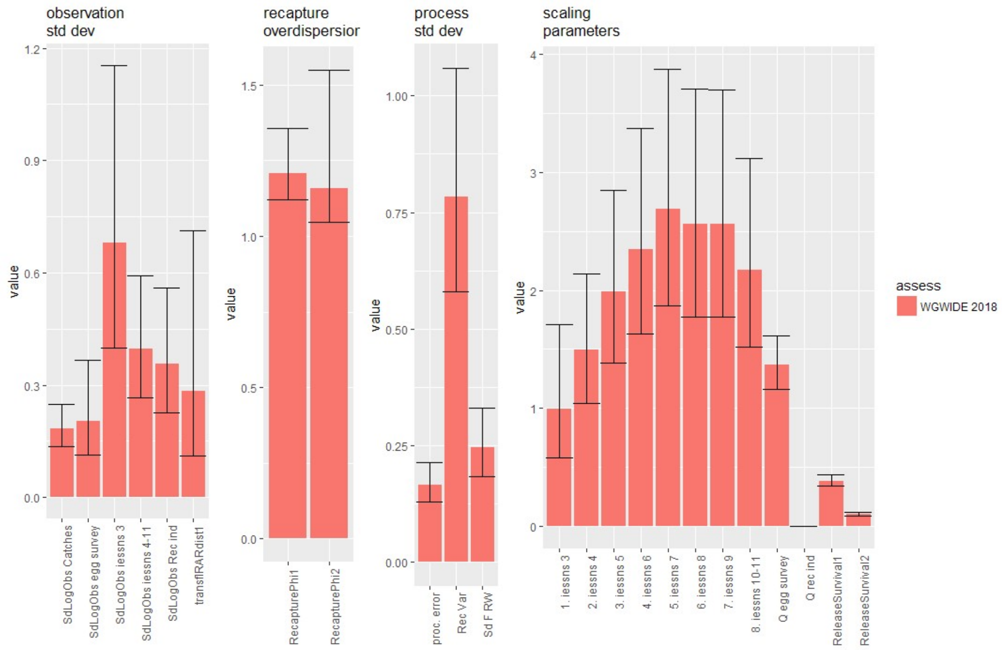

Figure 8.7.2.1. NE Atlantic mackerel. Parameter estimates from the SAM model (and associated confidence intervals) for the WGWIDE 2018 update assessment.

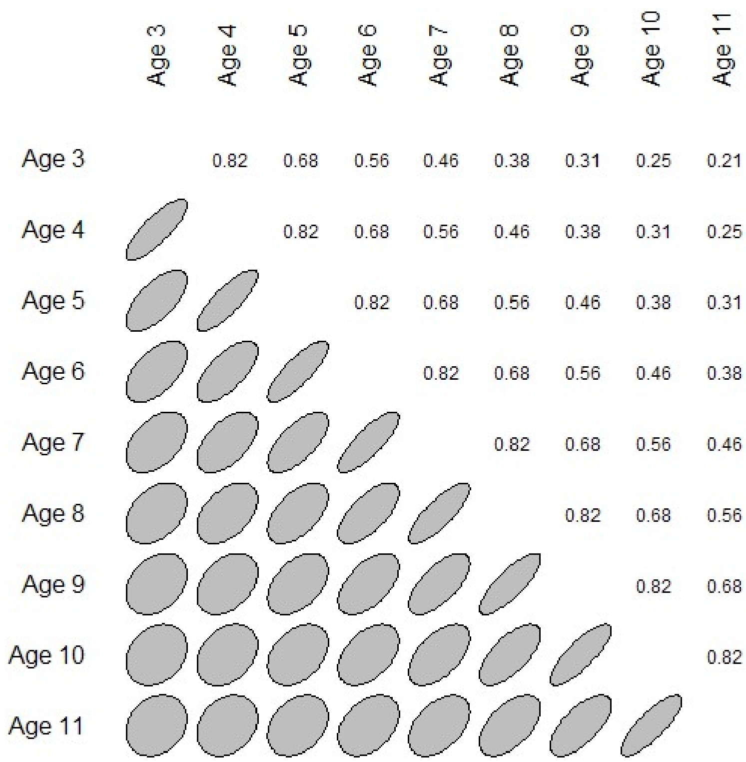

Figure 8.7.2.2. NE Atlantic mackerel. Estimated AR1 error correlation structure for the observations from the IESSNS survey age 3 to 11.

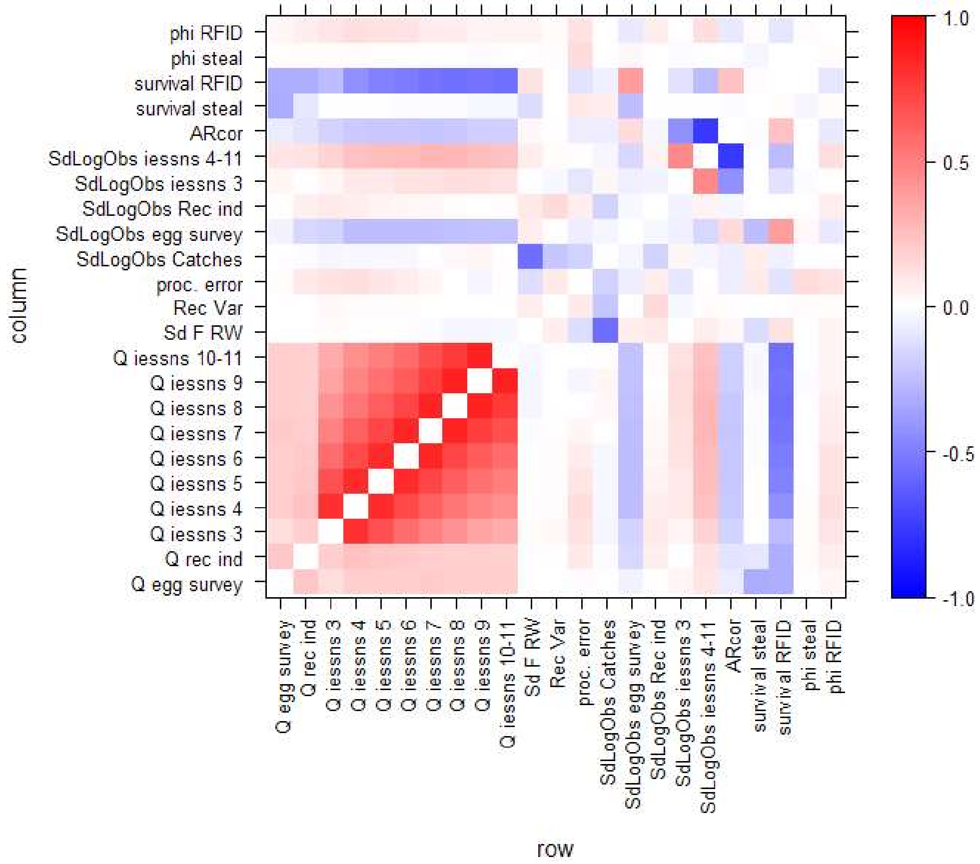

Figure 8.7.2.3. NE Atlantic mackerel. Correlation between parameter estimates from the SAM model for the WGWIDE 2018 update assessment.

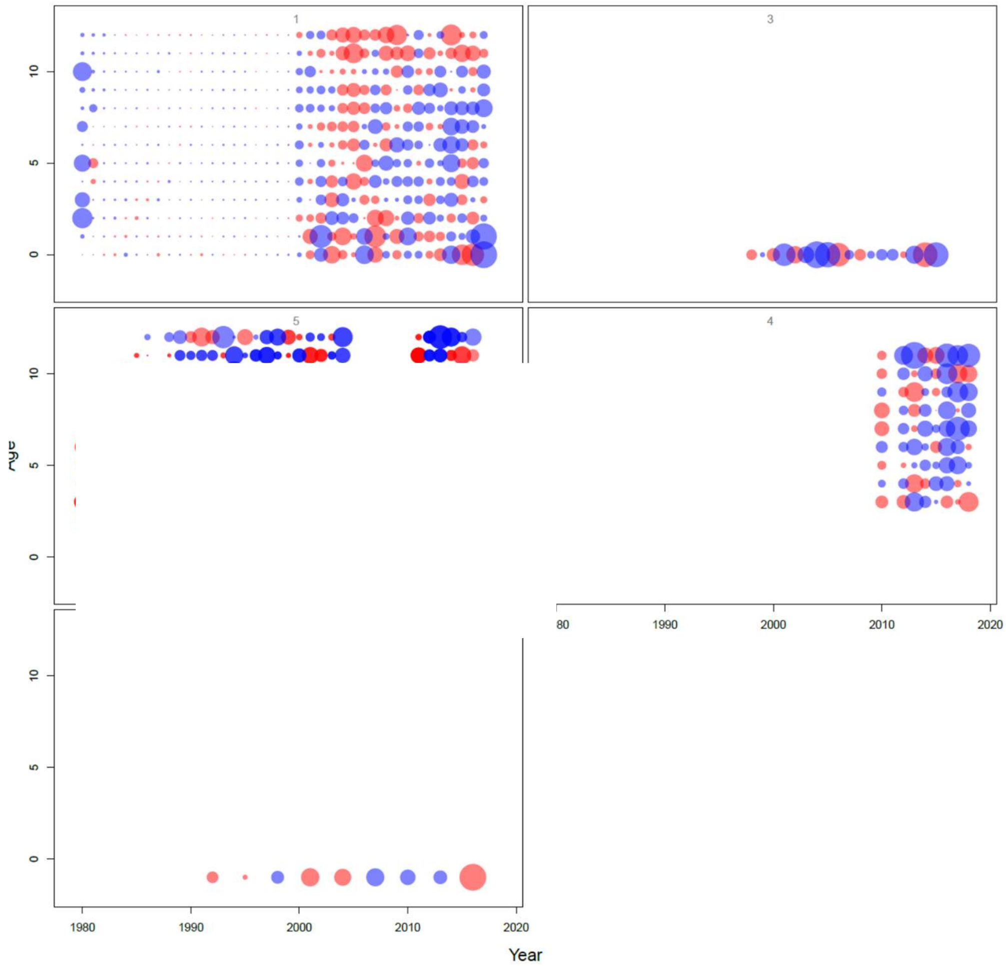

Figure 8.7.2.4. NE Atlantic mackerel. One Step Ahead Normalized residuals for the fit to the: (1) catch data (catch data prior to 2000 were not used to fit the model); (2) SSB estimates from egg survey; (3) recruitment index from the western Europe bottom trawl IBTS Q1 and Q4 surveys; and (4) abundance estimates at age from IESSNS survey. Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

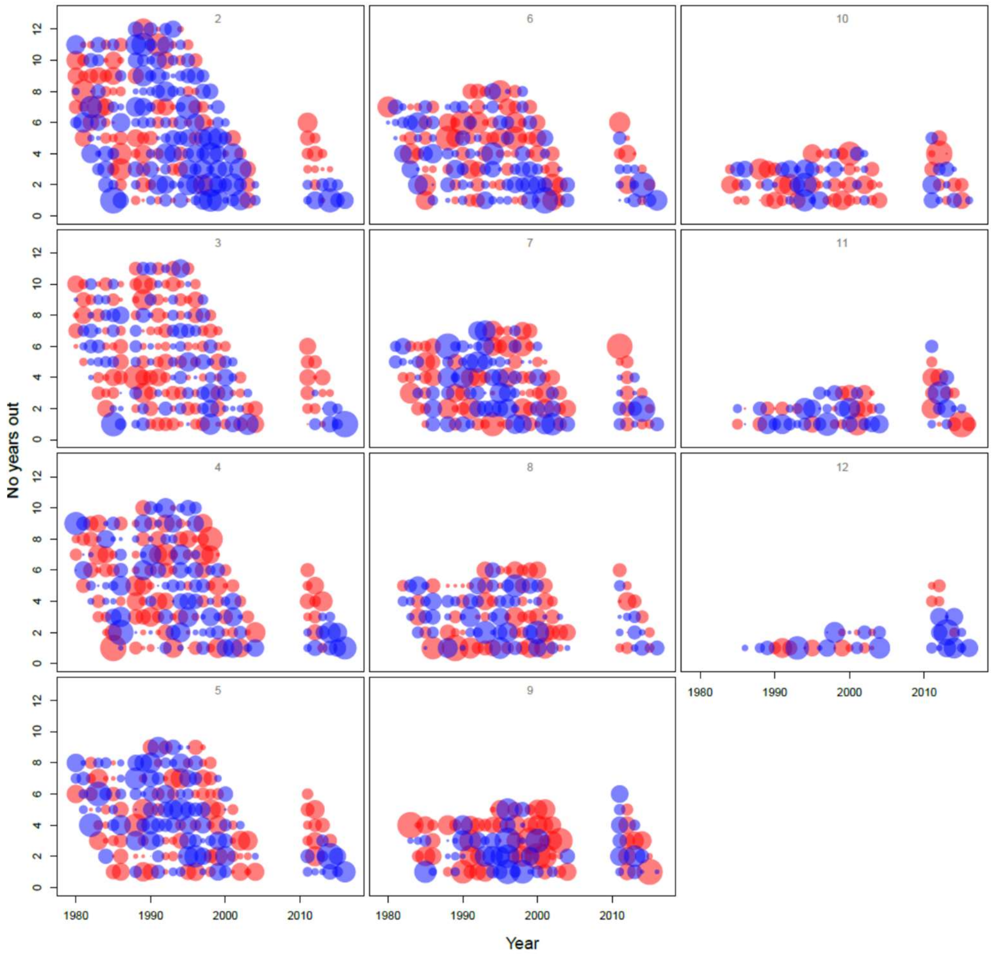

Figure 8.7.2.5. NE Atlantic mackerel. One step ahead residuals for the fit to the recaptures of tags in the final assessment. The x-axis represents the release year, and the y-axis is the number of years between tagging and recapture. Each panel correspond to a given age at release. Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

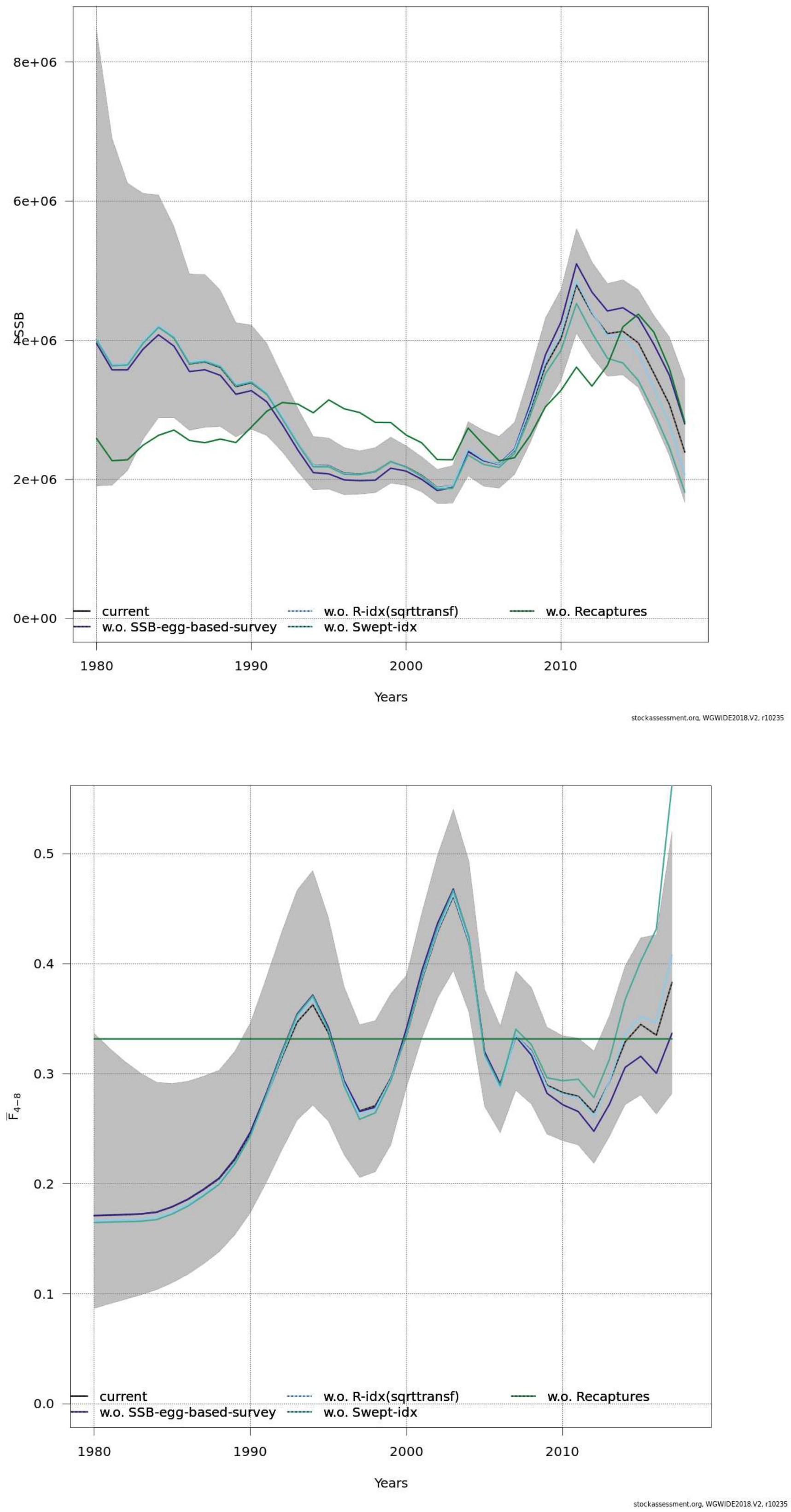

Figure 8.7.2.6. NE Atlantic mackerel. Leave one out assessment runs. SAM estimates of SSB and Fbar, for assessments runs leaving out one of the observation data sets. 2018 WGWIDE assessment (black) and current assessment leaving out: egg survey (purple), the recruitment index (light blue), IESSNS index (seagreen) and without tagging data (dark green).

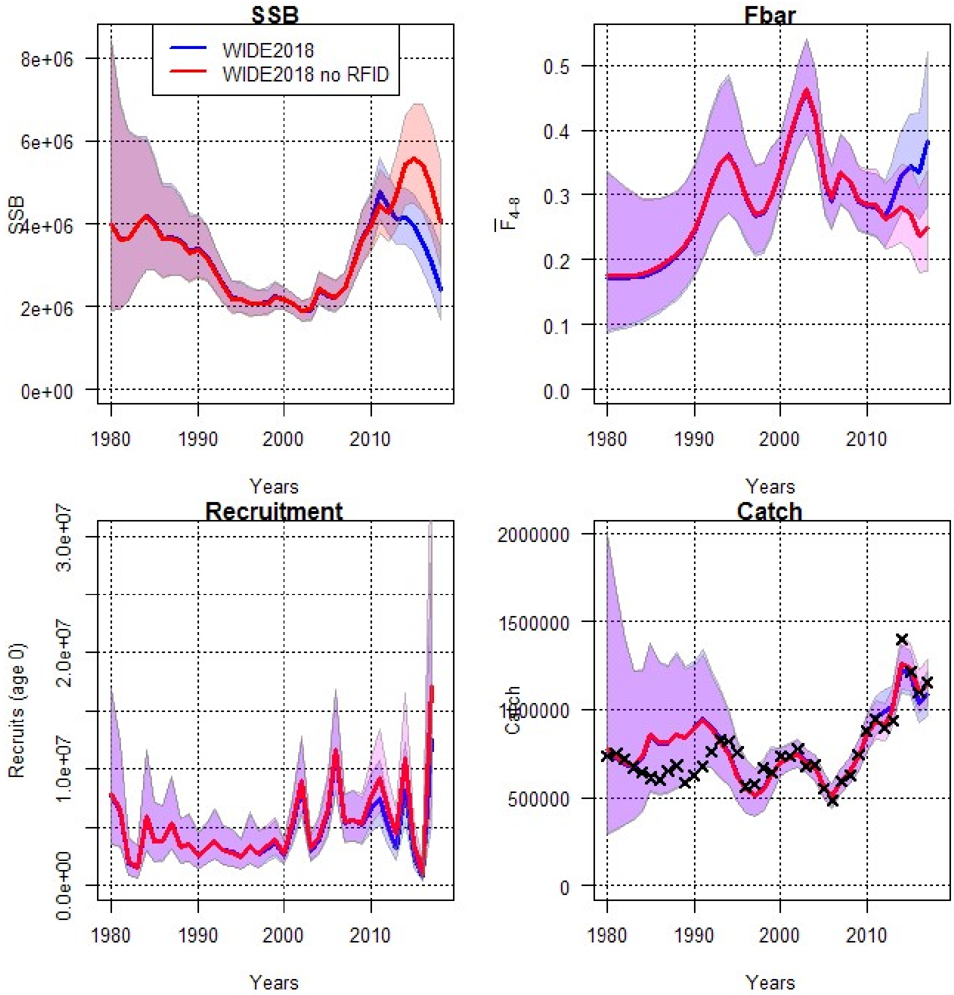

Figure 8.7.2.7. NE Atlantic mackerel. Leave one out assessment run excluding the RFID tagging data.Comparison of stock estimates from the 2018 WGWIDE assessment (blue) and the 2018 WGWIDE assessment without the 2017 RFID tagging data (red).

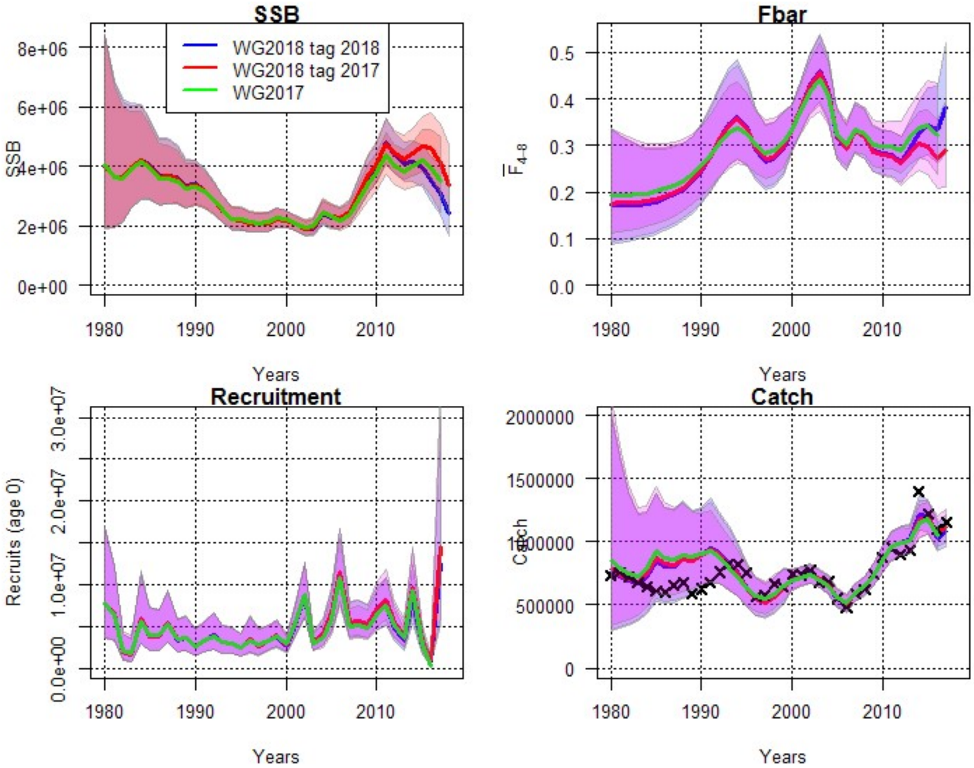

Figure 8.7.2.8. NE Atlantic mackerel. Influence of the latest year of data (recaptures from 2017) for the RFID tags on the output of the assessment. Comparison of stock estimates from the 2018 WGWIDE assessment (blue), the 2018 WGWIDE assessment without the 2017 recaptures (red) and the 2017 WGWIDE assessment (green).

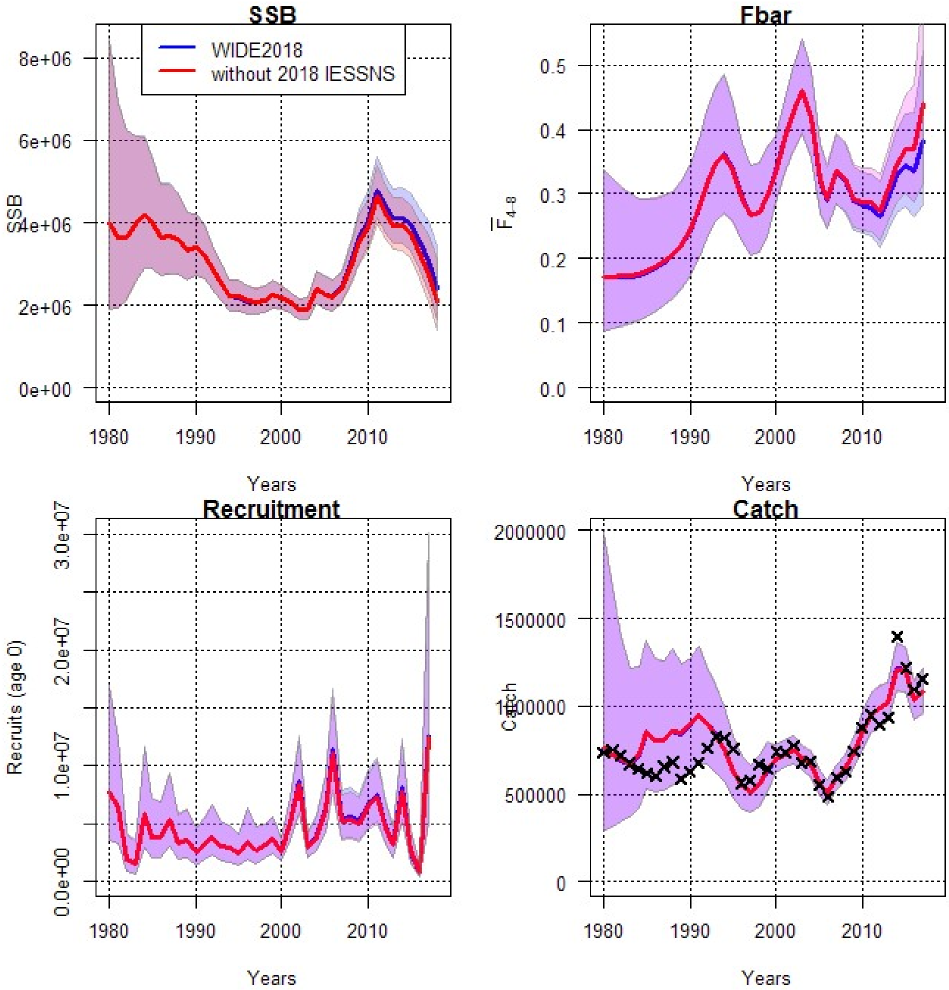

Figure 8.7.2.9. NE Atlantic mackerel. Influence of the latest year of data for the IESSNS survey on the output of the assessment. Comparison of stock estimates from the 2018 WGWIDE assessment (blue) and the 2018 WGWIDE assessment without the 2018 IESSNS index (red).

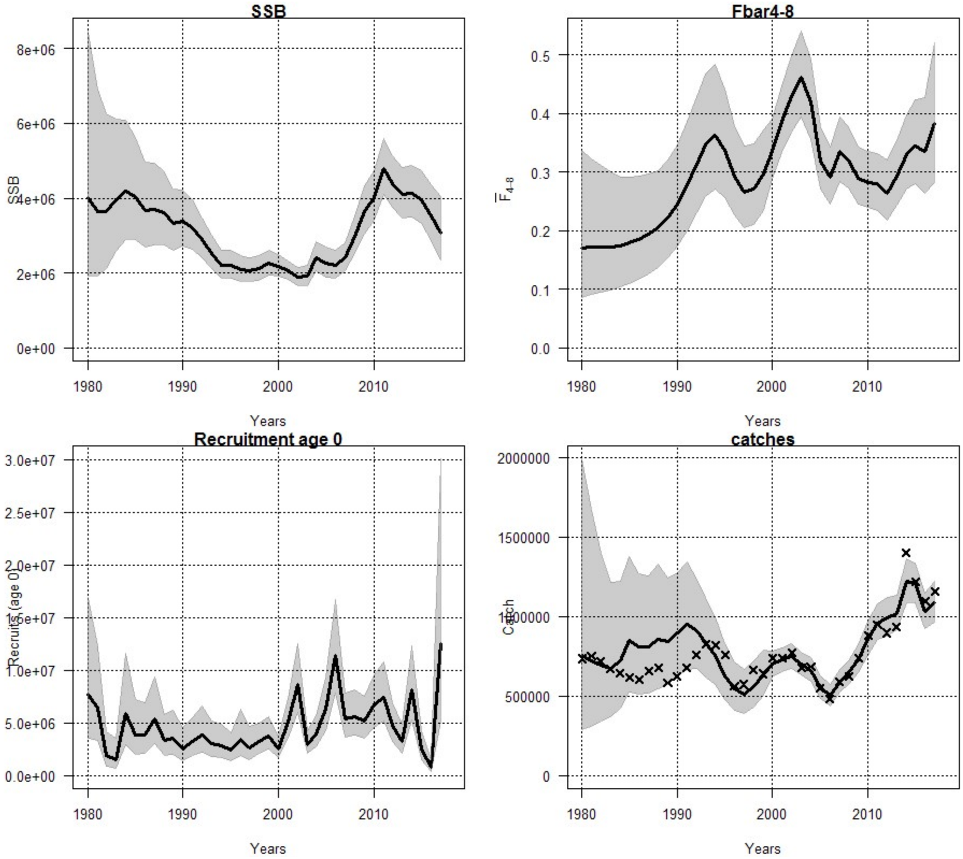

Figure 8.7.3.1. NE Atlantic mackerel. Perception of the NEA mackerel stock, showing the SSB, Fbar4-8 and recruitment (with 95% confidence intervals) from the SAM assessment.

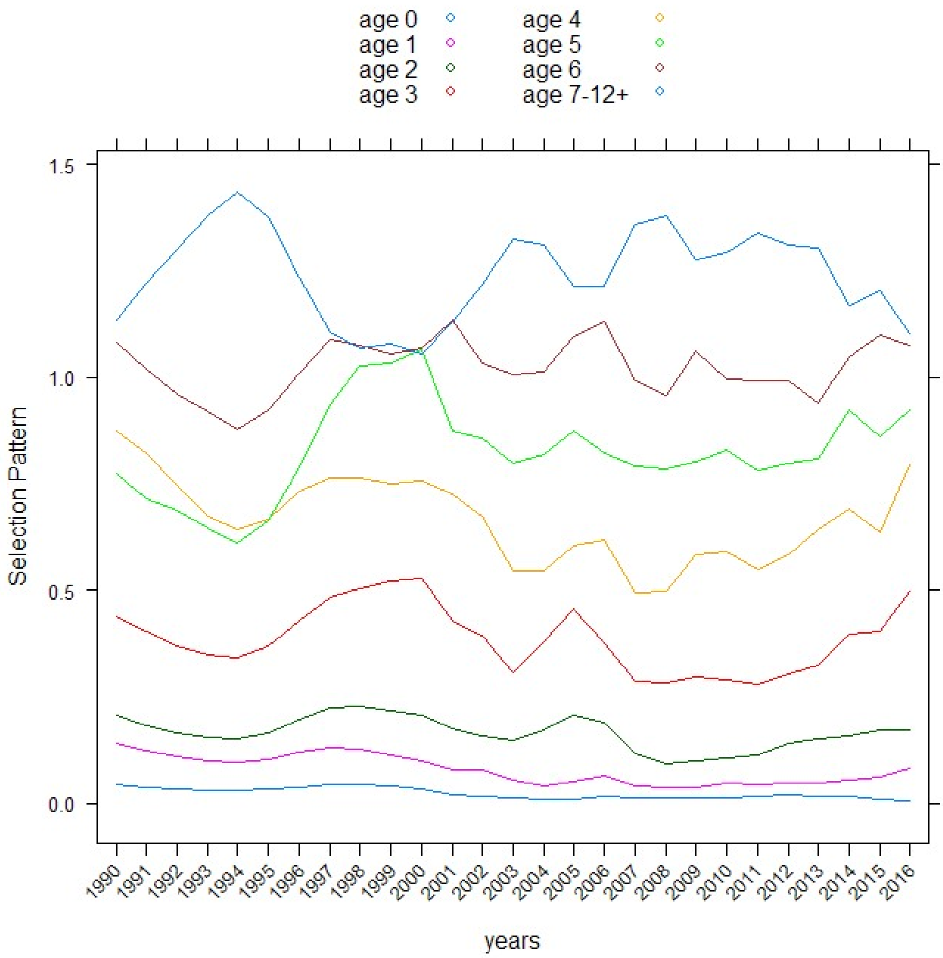

Figure 8.7.3.2. NE Atlantic mackerel. Estimated selectivity for the period 1990 to 2017, calculated as the ratio of the estimated fishing mortality-at-age and the Fbar4-8 value in the corresponding year.

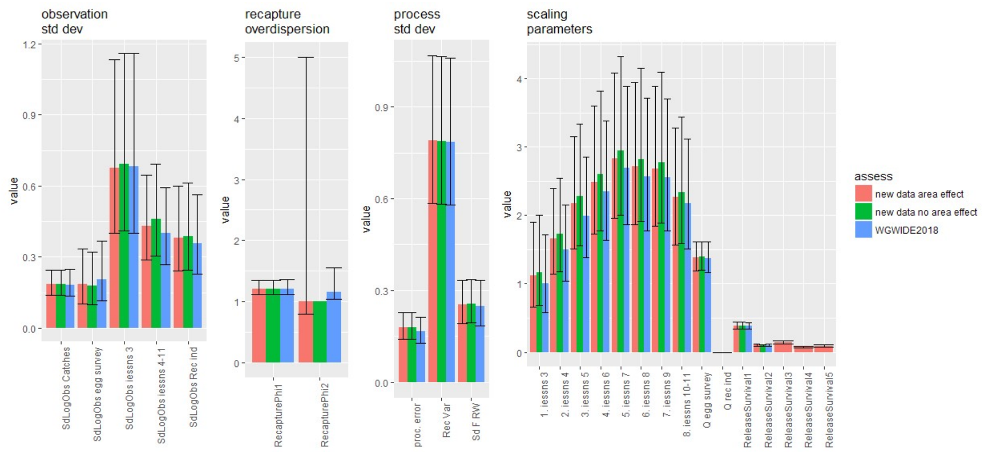

Figure 8.7.4.1.1. NE Atlantic mackerel. Comparison of estimated model parameters for the WGWIDE 2018 update assessment (blue), the assessment run with the same configuration on the RFID tag dataset structured by recapture area (green), and the assessment with survival rate for the RFID tag estimated for each area (red).

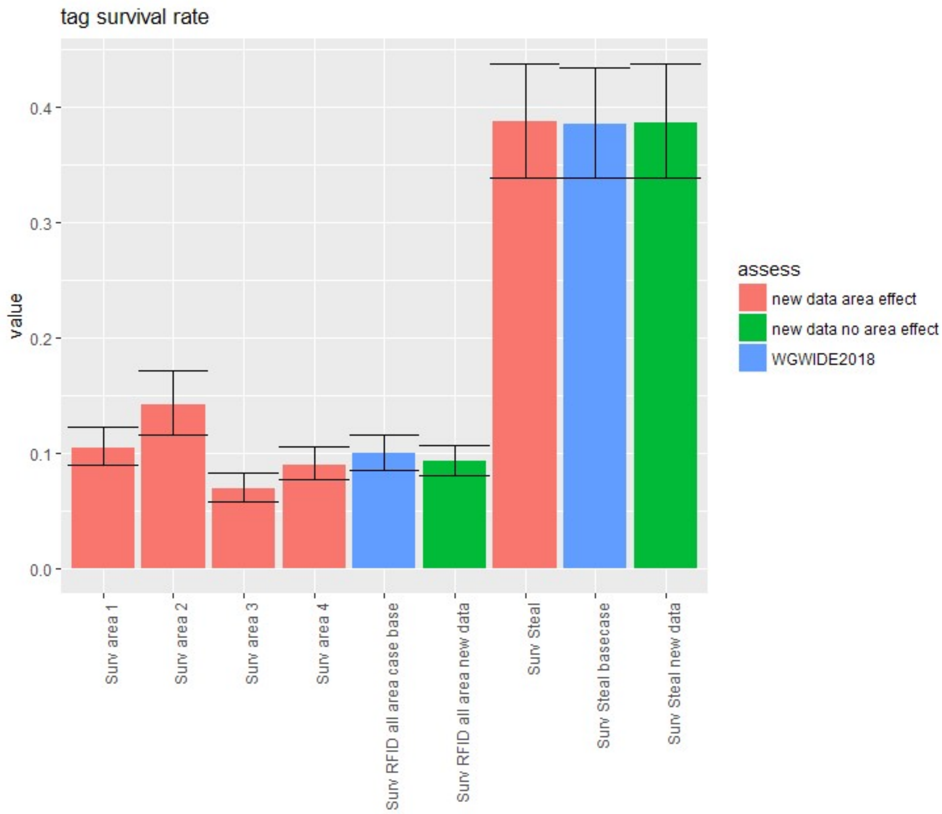

Figure 8.7.4.1.2. NE Atlantic mackerel. Comparison of estimated post release survival rates for the WGWIDE 2018 update assessment (blue), the assessment run with the same configuration on the RFID tag dataset structured by recapture area (green), and the assessment with survival rate for the RFID tag estimated for each area (red).

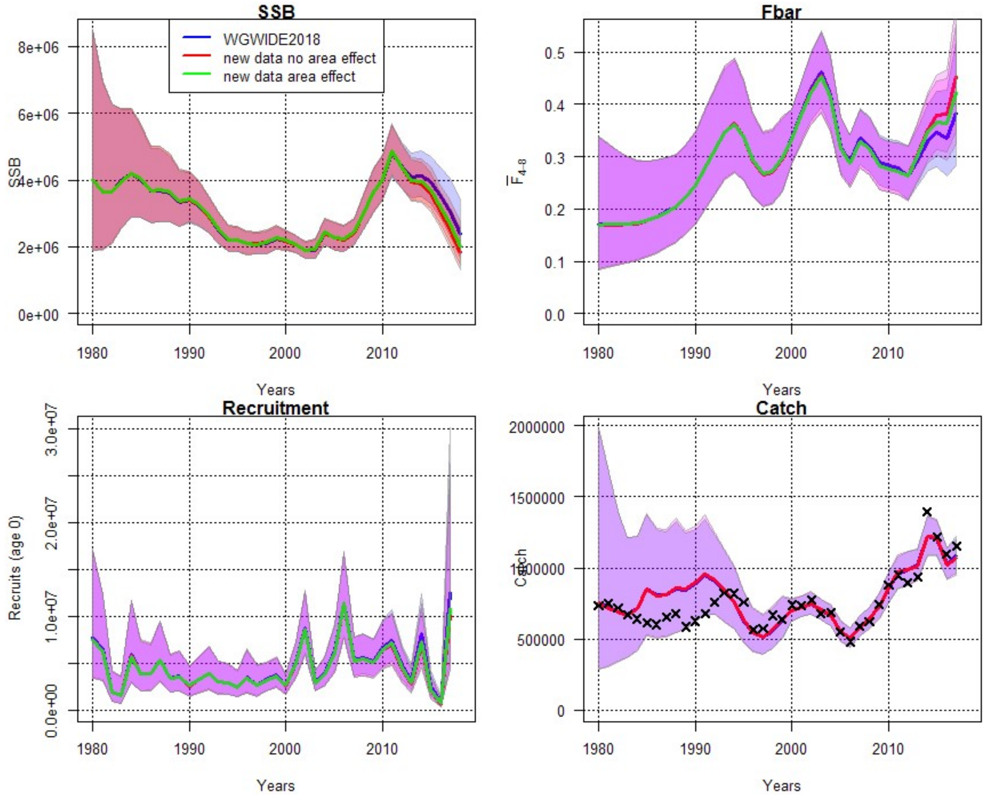

Figure 8.7.4.1.3. NE Atlantic mackerel. Comparison of the stock trajectories between the WGWIDE 2018 update assessment (blue), the assessment run with the same configuration on the RFID tag dataset structured by recapture area (red), and the assessment with survival rate for the RFID tag estimated for each area (green).

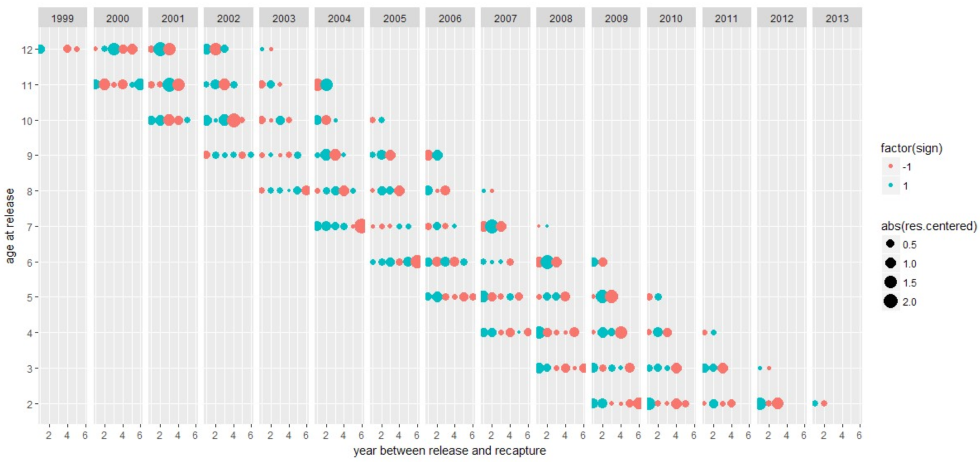

Figure 8.7.4.2.1. NE Atlantic mackerel. Residuals (OAS) for the RFID tags grouped by year-class and age at release and centred. The different panels correspond to different year-classes. Green circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

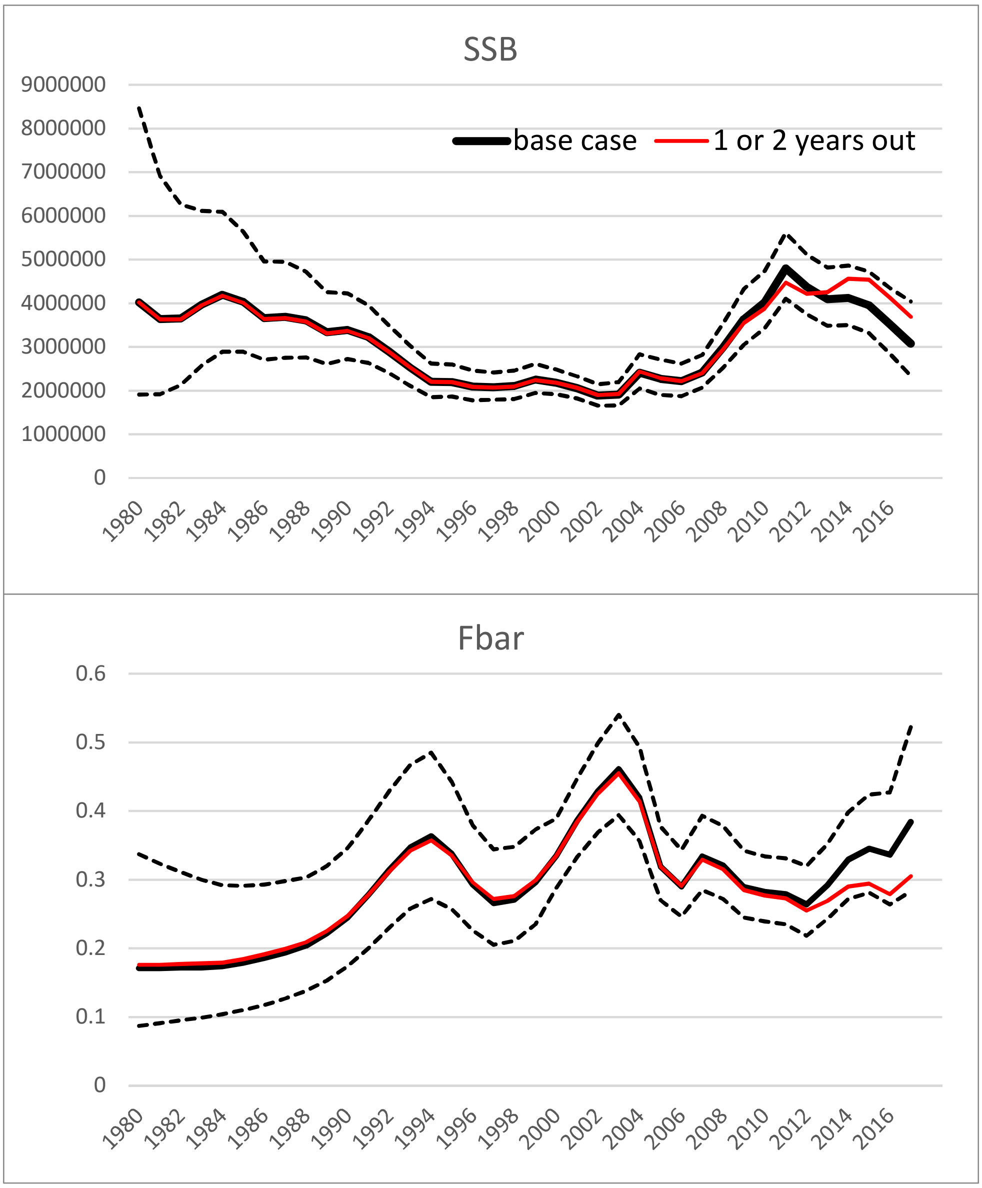

Figure 8.7.4.2.2. NE Atlantic mackerel. Comparison of the stock trajectories between the WGWIDE 2018 update assessment (black) and the same assessment using only the RFID tag data corresponding to the first 2 years of recapture after tagging (red).

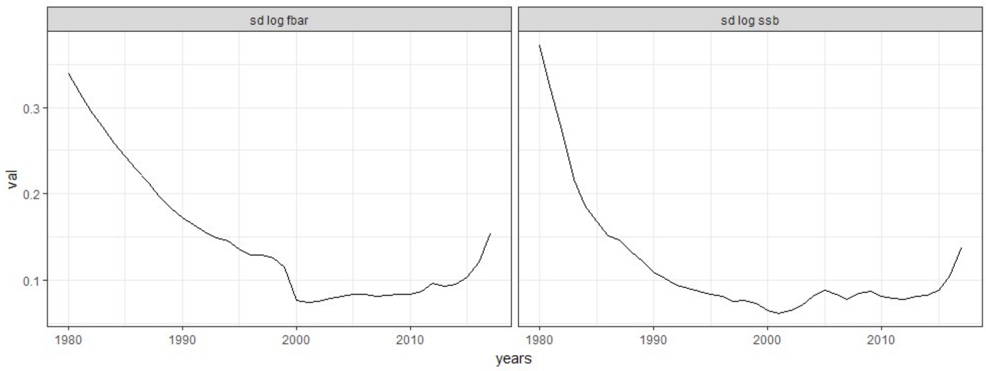

Figure 8.7.5.1. NE Atlantic mackerel. Uncertainty (standard deviation of the log values) of the estimates of SSB and Fbar from the SAM for the 2018 WGWIDE assessment.

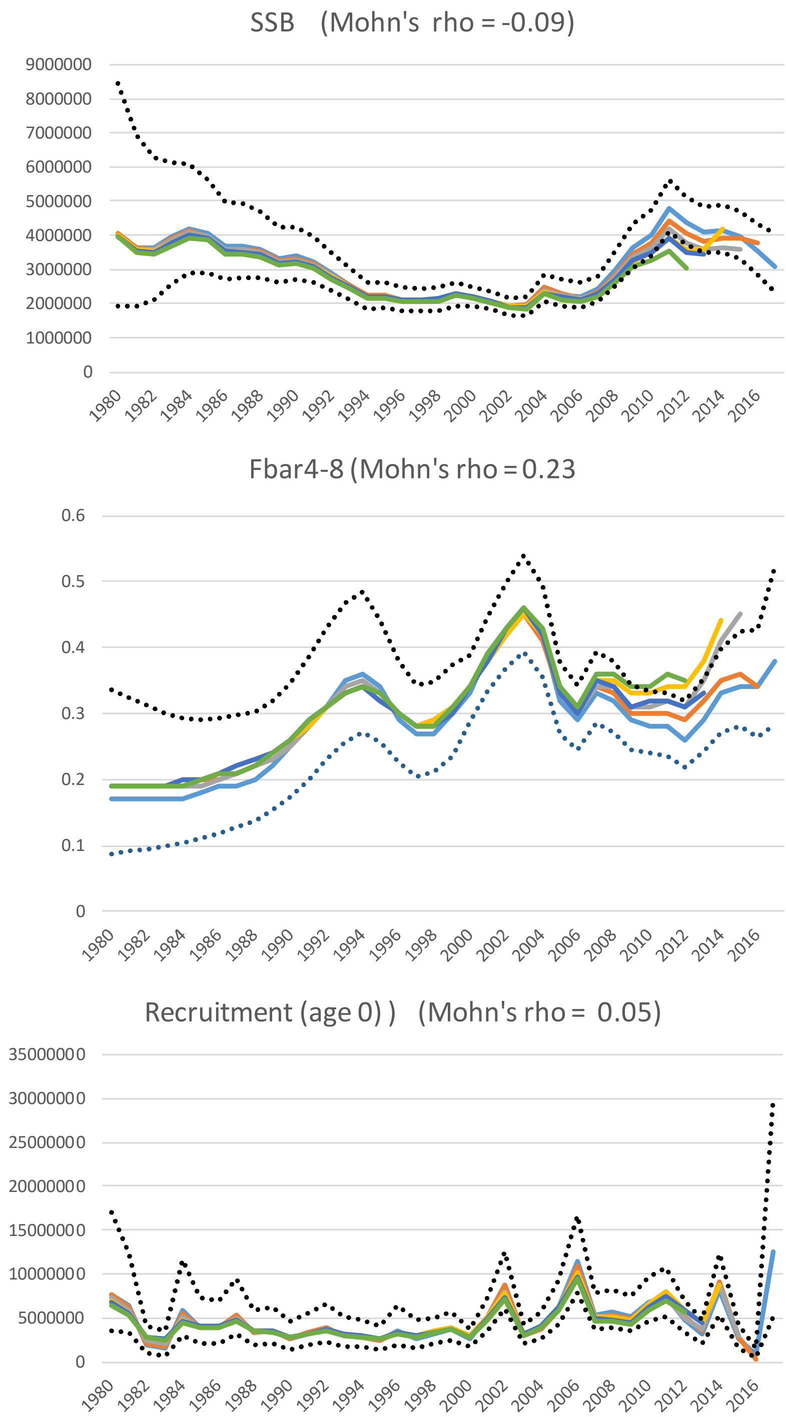

Figure 8.7.5.2. NE Atlantic mackerel. Analytical retrospective patterns (5 years back) of SSB, Fbar4-8 and recruitment from the WGWIDE 2018 update assessment.

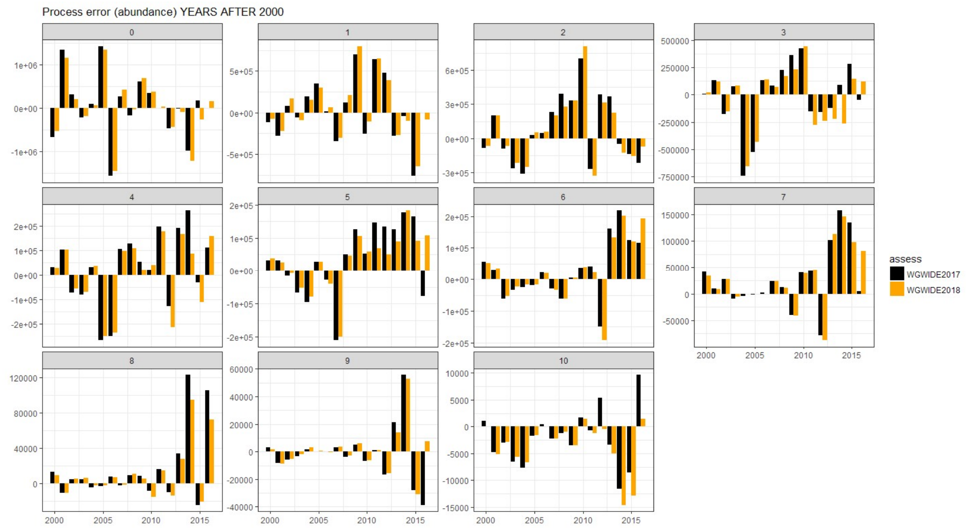

Figure 8.7.5.3. NE Atlantic mackerel. Process error expressed as annual deviations of abundances at age, for the 2018 WGWIDE assessment (orange) and from the 2017 WGWIDE assessment (black).

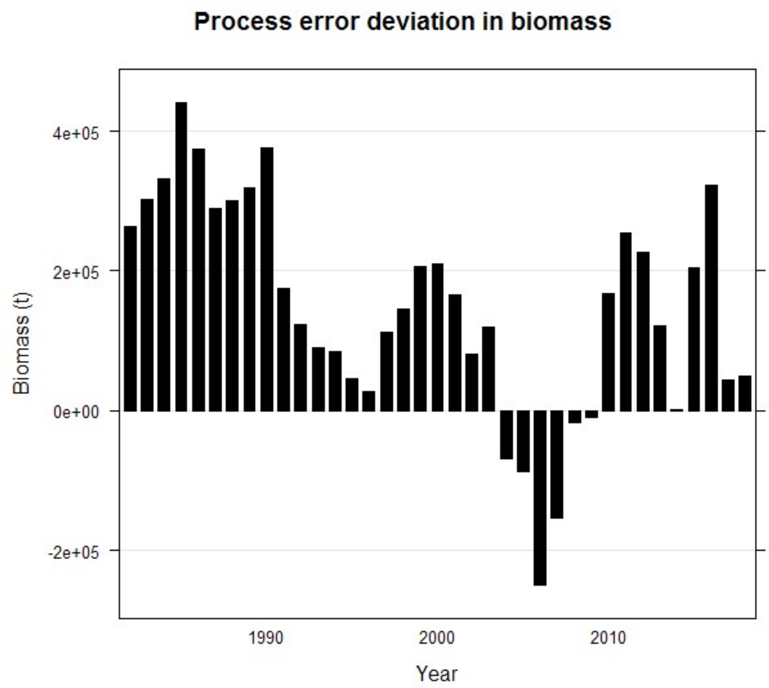

Figure 8.7.5.4. NE Atlantic mackerel. Model process error expressed in biomass cumulated across age-group for the 2018 WGWIDE assessment.

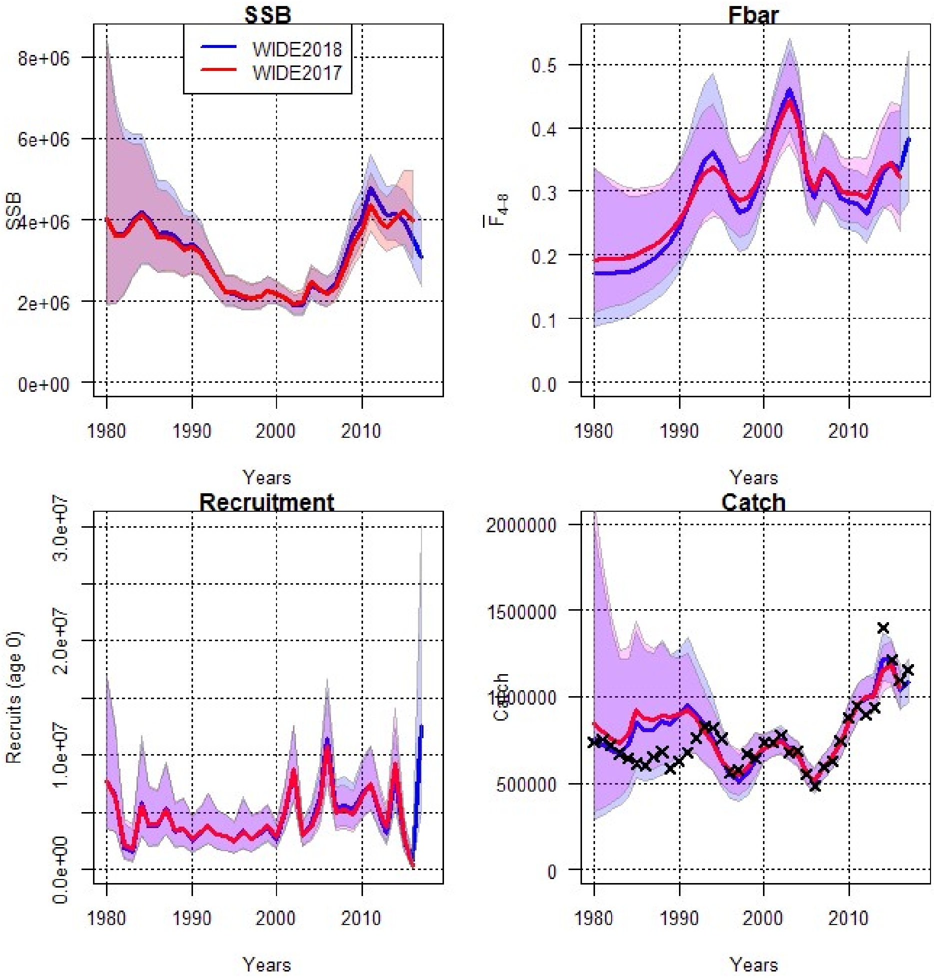

Figure 8.10.1. NE Atlantic mackerel. Comparison of the stock trajectories between the 2018 WGWIDE assessment (blue)and the 2017 assessment (red).

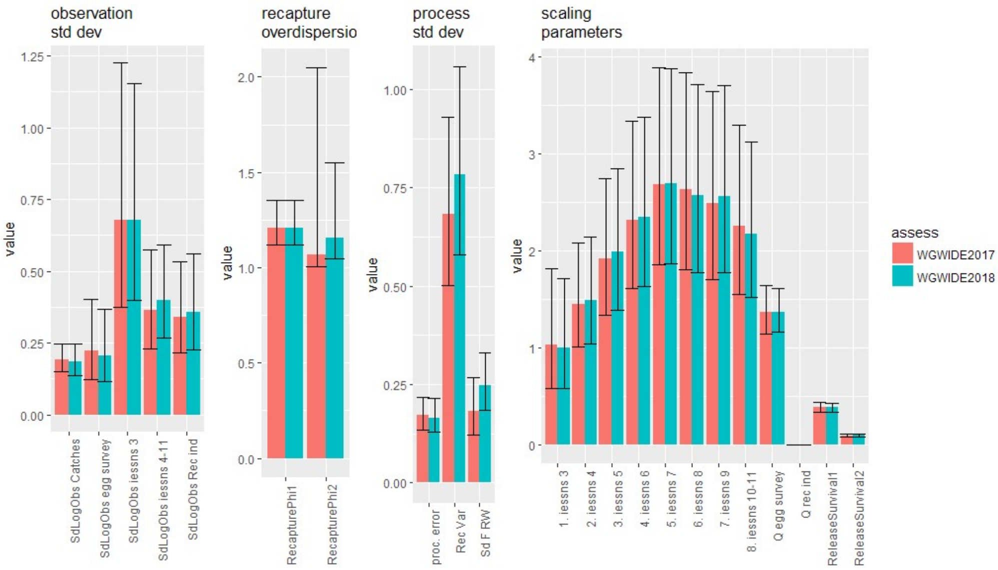

Figure 8.10.2. NE Atlantic mackerel. Comparison of model parameters and their uncertainty for the 2018 WGWIDE (green) and the 2017 WGWIDE assessment (red).

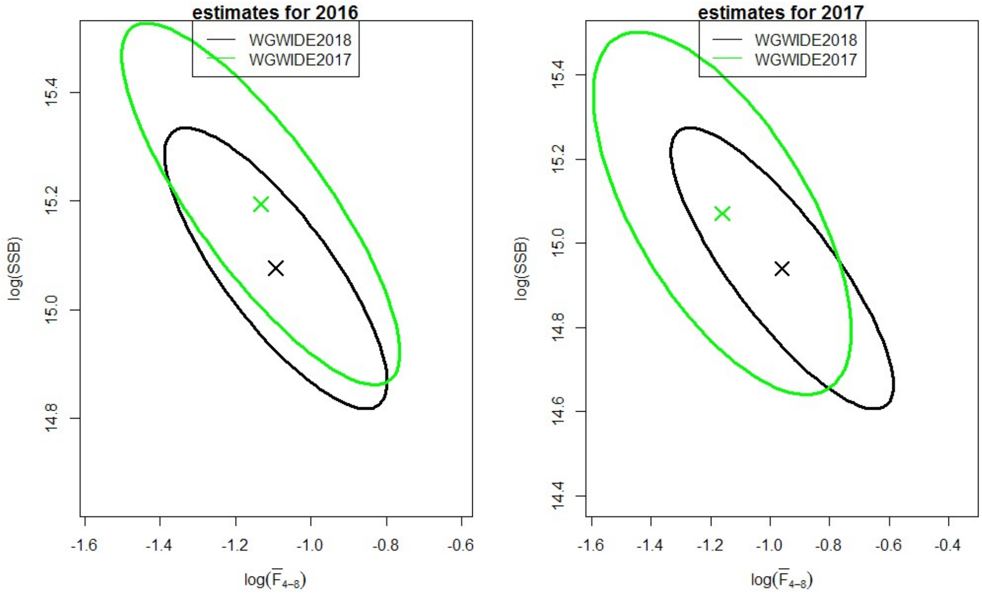

Figure 8.10.3. NE Atlantic mackerel. Comparison of the joint uncertainty on recent estimates of SSB and Fbar for the WGWIDE 2018 update assessment and last year's assessment.