WORKING GROUP ON WIDELY DISTRIBUTED STOCKS (WGWIDE)

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

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

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Editors

Gudmundur J. Óskarsson

Authors

Magne Aldrin • Guillaume Bal • Benoit Berges • Esther Beukhof • Höskuldur Björnsson • Thomas Brunel • Finlay Burns • Andrew Campbell • Neil Campbell • Pablo Carrera • Gersom Costas • Laurent Dubroca • Afra Egan • Sólva Eliasen • Patricia Goncalves • Åge Højnes • Eydna í Homrum • Jan Arge Jacobsen • Teunis Jansen • Gitte Høj Jensen • Alexander Krysov • Gwladys Lambert • Richard Nash • Leif Nøttestad • Brendan O´Hea • Anna H. Olafsdottir • Alessandro Orio • Gudmundur J. Óskarsson • Martin Pastoors • Alexander Pronyuk • Lisa Readdy • Are Salthaug • Sonia Sanchez • Aril Slotte • Claus Sparrevohn • Erling Kåre Stenevik • Nikolay Timoshenko • Jens Ulleweit • Dmitry Vasilyev • Sindre Vatnehol • Morten Vinther

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8 Northeast Atlantic Mackerel

8.1 ICES Advice and International Management Applicable to 2018

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 (EU, NO and FO) agreed on a Management Strategy for 2014 to 2018. In November 2018, the agreement from 2014 was extended for two more years until 2020. However, the total declared quotas for 2015 to 2019 all exceed the TAC advised by ICES. An overview of the declared quotas and transfers for 2019, as available to WGWIDE, is given in the text table below. Total removals of mackerel are expected to be approximately 835 000 t in 2019, exceeding the ICES advice for 2019 by about 65 000 t.

Estimation of 2019 catch	Tonnes	Reference
EU quota	324 195	European Council Regulation2019/124
Norwegian quota	146 832	NEAFC HOD 19/02
Inter-annual quota transfer 2018->2019 (NO)	-5 601	NEAFC HOD 19/02
Russian quota	108 840	Federal agencey for Fisheries, Russia
Inter-annual quota transfer 2018->2019 (RU)	6 152	Federal agencey for Fisheries, Russia
Discards	2 890	Previous years estimate
Icelandic quota	131 307	Icelandic regulation No. 605/2019
Faroese quota	82 339	Faroese regulation No. 176/2018
Greenland expected catch [1]	38 000	Ministry of Fisheries, Hunting and Agriculture in Greenland
Total expected catch (incl. discard) [2,3]	834 954	

[1] [1] Greenland quota for 2019 = 70 411 t.

[2] No guesstimates of banking from 2019 to 2020

[3] Quotas refer to claims by each party for 2019

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.

8.2 The Fishery

8.2.1 Fleet Composition in 2018

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 2018

The northern summer fishery in Subareas 2, 5 and 14 continued in 2018. 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 international waters. This fleet targets herring and blue whiting in addition to mackerel. In the third and fourth quarter of 2018 the Russian vessels took the vast majority of 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 2.a in 2018. In 2017 the majority of the Icelandic catch was taken in 5.a in waters south and south-east of Iceland. Catches were also taken to the east and west of Iceland.

In 2018, Iceland and Greenland targeted mackerel in Division 14.b, with 6% of the total catch coming from this area. Catches from Greenland have increased in 2018 to almost 63 kt from 46 kt in 2017 and 30 kt in 2016 but are still lower than the 78 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.

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.

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.

As a result of this expansion, 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, and reached the biggest catch by this fleet to date in 2014, with a catch of 78 kt.

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.

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 2018 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, 2017b) 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 *de minimis* exemptions for mackerel caught in bottom-trawl fisheries in the North Western Waters (EC 2018/2034) and in the North Sea (EC 2018/2035).

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

Year	WG Total Catch (t)	% catch covered by sampling programme*	No. Samples	No. Measured	No. Aged
2016	1094066	89	2200	149216	21456
2017	1155944	87	2183	151548	24104
2018	1026437	83	1858	139590	20703

Overall sampling effort in 2018 was similar to previous years with 83% 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 2018 sampling levels for countries with a WG catch of greater than 100 t are shown below.

Country	Official catch	% WG catch covered by sampling programme	No. Samples	No. Measured	No. Aged
Belgium	168	0%	0	0	0
Denmark	30708	95%	6	449	450
Faroe Islands	81079	99%	15	871	921
France	21471	0%	0	0	0
Germany	19883	34%	84	716	17233
Greenland	63024	0%	0	0	0
Iceland	168330	98%	78	1910	3400
Ireland	66747	100%	42	1593	8254
Netherlands	30392	83%	28	775	2242
Norway	187207	92%	71	2345	2345
Poland	4057	0%	0	0	0
Portugal	4565	19%	148	492	7187
Russia	118255	95%	145	1342	36468
Sweden	3987	0%	0	0	0
Spain	35173	87%	1161	7200	35379
UK (England & Wales)	20729	4%	47	1910	5234
UK (Northern Ireland)	14873	41%	1	53	203
UK (Scotland)	155380	99%	32	1047	4285

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. Greenland, with a WG catch of 63 kt did not provide any sampling information. Sweden and Poland did not supply sampling information in 2018. Portugal sampled landings from 9.a only. 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 83% and 34% respectively) is designed to provide complete coverage for the freezer trawlers operating under these national flags and also those of England and France. 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	No Aged
2.a	316662	316662	216	39528	3508
3.a	552	552	2	50	50
4.a	338056	338056	121	8908	3805
4.b	2660	2660	4	340	161
4.c	838	838	0	0	0
5.a	65103	65103	31	1270	747
5.b	11034	11034	3	158	149
6.a	157275	157275	99	22006	1921
7.b	10130	10130	10	1824	256
7.d	5406	5406	3	192	154
7.e	1131	1131	14	1442	942
7.f	365	365	33	3792	968
7.g	159	159	0	0	0
7.h	209	209	0	0	0
7.j	8283	8283	10	1349	277
8.a	5966	5966	1	1	1
8.b	5002	5015	210	4414	303
8.c	22884	22884	401	10450	3122
8.c.E	8370	8749	186	16054	2320
8.d	113	113	2	2	2

Division	Official Catch (t)	WG Catch (t)	No. Samples	No. Measured	No Aged
9.a	855	855	148	7187	492
9.a.N	1881	1881	361	4458	1452
14.a	107	107	0	0	0
14.b	62834	62834	3	176	73

In general, areas with insufficient sampling have relatively low levels of catch. The exception is Division 7.d from which 5.5 kt (mainly French) was caught which was not sampled.

8.4 Catch Data

8.4.1 ICES Catch Estimates

The total ICES estimated catch for 2018 was 1 026 437 t, a decrease of 129 507 t on the estimated catch in 2017. Catches increased substantially from 2006—2010 and have averaged 1 081 kt since from 2011.

The combined 2018 TAC, arising from agreements and autonomous quotas, amounts to 998 000 t). The ICES catch estimate (1 026 437 t) represents an overshoot of this. The combined fishable TAC for 2019, as best ascertained by the Working Group (see Section 8.1), amounts to 834 954 t.

Catches reported for 2018 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

Country	Official Log Book	Other Sources	Discard Information
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 2018, discard data for mackerel were provided by The Netherlands, France, Germany, Ireland, Spain, Portugal, Greenland, Denmark, England, Scotland and Sweden. Total discards amounted to 2 890 t from the southern area. The German, French, 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 2018, Norway accounted for the greatest proportion (18%) followed by Scotland (15%), Iceland (16%), Russia (12%) and Faroe (8%). In the absence of an international agreement, Greenland, Iceland and Russia declared unilateral quotas in 2018. Russia and Iceland both had catches over 100 kt with Faroes catching 81 kt. Greenlandic catches increased to almost 63 kt. Scotland had catch in excess of 100 kt and Ireland caught almost 67 kt. The Netherlands, Spain and Denmark had catches of around 30 kt while Germany, France and England had catches of the order of 20 kt.

In 2018, catches in the northern areas (Subareas 2, 5, 14) amounted to 455 740 t (see Table 8.4.2.1), a decrease of 148 129 t on the 2017 catch. Icelandic, Norwegian and Russian catches were all over 100 kt. Catches from Division 2.a accounted for 31% of the total catch in 2018, a decrease from 40% in 2017. Almost all the Russian catch in 2018 was taken in Division 2.a. 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 2018 amounted to 342 147 t, an increase of 72 343 t from 2017. 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) decreased slightly to 194 180 t with most of the traditional fishing nations catching less mackerel in 2018 than 2017. The 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 34 369 t represents an increase from 2017. 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	2005	46	6	25	23
1991	38	5	25	32	2006	41	5	18	36
1992	34	5	24	37	2007	34	5	21	40
1993	29	7	25	39	2008	34	4	35	27
1994	32	6	28	34	2009	38	11	31	20
1995	37	8	27	28	2010	26	5	54	15
1996	37	8	32	23	2011	22	7	54	17
1997	34	11	33	22	2012	22	6	48	24
1998	38	12	24	27	2013	19	5	52	24
1999	36	9	28	27	2014	20	4	46	30
2000	41	4	21	33	2015	20	5	44	31
2001	40	6	23	30	2016	23	4	44	29
2002	37	5	29	28	2017	24	3	45	28
2003	36	5	22	37	2018	20	3	40	37
2004	37	6	28	29					

The quarterly distribution of catch in 2018 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 2018 (200 408 t – 20%)

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 2018 (34 125 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 2018. 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 (412 146 t – 40%)

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 (379 758 t – 37%)

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 2018 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 1 026 437 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, Faroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. There remain gaps in the age sampling of catches, notably from France (length samples were provided), Sweden, Poland and Greenland.

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.

As in previous years almost 80% of the catch in numbers in 2018 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 2018 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 2018 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. The range of lengths recorded in 2018 for 0 group mackerel (162 mm-254 mm) are higher than those in 2017 (131 mm-212 mm).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 2018 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 2018 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 2018 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 2019 egg survey for the southern and western components and the 2017 egg survey for the North Sea component). Mean weights-at-age in 2018 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 in 2018 were calculated from samples of the commercial catches collected from Divisions 4.a and 4.b in the second quarter of 2017. 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 components and in the stock in 2018 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 5 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			0.085	0.063
2	0.200	0.206	0.142	0.191
3	0.303	0.253	0.291	0.266
4	0.294	0.281	0.285	0.283
5	0.328	0.308	0.326	0.314
6	0.352	0.322	0.334	0.327
7	0.366	0.343	0.347	0.346
8	0.395	0.363	0.356	0.364
9	0.389	0.392	0.379	0.389
10	0.447	0.419	0.409	0.419
11	0.441	0.448	0.403	0.437
12+	0.465	0.490	0.490	0.488
Component Weighting	8.5%	68.1%	23.4%	
Number of fish sampled	98	658	736	

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 2018 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 2018 maturity ogives for the three components and for the mackerel stock are shown in the text table below.

A trend towards earlier maturation (increasing proportion mature at age 2) has been observed from the around 2008 to 2015. A change in the opposite direction has been observed since then and the proportion of fish mature at age in 2018 are now markedly lower that in the previous years, at levels comparable with the one observed at the end of the 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	0.09
2	0.37	0.44	0.54	0.46
3	1	0.92	0.70	0.88
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	8.5%	68.1%	23.4%	

8.6 Fishery Independent Data

8.6.1 International Mackerel Egg Survey

The ICES Triennial Mackerel and Horse Mackerel Egg Survey for 2019 was carried out during January - August. Final results will be presented at the WGMEGS meeting in April 2020. The results have been used in the assessment for mackerel since 1977. Since 2004 and subsequent to demands for up-to-date data for the assessment, WGMEGS aims to provide a preliminary estimate of NEA mackerel biomass and western horse mackerel egg production in time for the assessment meetings within the same calendar year as the survey.

WGMEGS presents the preliminary results of the 2019 mackerel and horse mackerel egg survey provided for WGWIDE in August 2019. The final survey results will be available during the next WGMEGS meeting in April 2020. This is due to the extremely large numbers of plankton and fecundity samples to be analysed following the surveys as well as the tight deadline set by WGWIDE for delivering these estimates. A working document (O' Hea *et al*., 2019) with the preliminary results of the survey was presented to WGWIDE members on time.

The 2019 survey plan was split into 6 sampling periods. Maximum deployment of effort in the Western area was during periods three, four, five and six (ICES, 2018c). Historically these periods would have coincided with the expected peak spawning of both mackerel and horse mackerel. In recent years mackerel peak spawning has been taken place during periods 3 and 5. Due to the expansion of the spawning area which has been observed since 2007, the emphasis was even more focused on full area coverage and delineation of the spawning boundaries.

Analyses of the plankton and fecundity samples were carried out according to the sampling protocols as described in the ICES Survey Protocols SISP 5 and SISP 6 (ICES, 2019b, ICES, 2019c).

8.6.1.1 Data analysis for mackerel annual egg production

Egg counts were converted to stage 1 egg production, using data on the volume of water filtered. These values were then converted to egg production/day/m^2 using the development equations and water temperature at 20 m depth. Arithmetic means were used where more than one sample per rectangle per period was collected. Daily egg production values were interpolated into unsampled rectangles according to procedures described in the above report. Plots of the distribution of egg production for the western area are presented in Figures 8.6.1.1-8.6.1.6. Interpolated values are highlighted in red. The area coverage is described in detail in the working document from O' Hea *et al*. (2019) presented to WGWIDE.

Figure 8.6.1.7 presents the egg production curve for the western area for the 2019 survey, along with those for the previous surveys for comparison. 2010 provided an unusually large spawning event early in the spawning season, 2013 yielded an even larger spawning event indicating that spawning was probably taking place well before the nominal start date of 10th February (day 42). In 2016 the first survey commenced on February 5th which is five days prior to the nominal start date. The pattern in 2019 followed that of 2016 with no early peak spawning being recorded. This year however, peak spawning was found to have taken place in period 4, rather than period 5 as the case in 2016. Unlike 2016 when concern was expressed that survey coverage may have underestimated the total egg production estimate, area coverage in 2019 was much better. The expansion observed in western and north-western areas during periods 5 and 6 in 2016 was once again reported during 2019. However, egg numbers were not as large as in 2016 (Figures 8.6.1.4-5). During these periods it was not possible to fully delineate the northern and north-western boundaries. However, an analysis provided significant evidence that while some spawning has been missed the loss of egg abundance is not sufficiently large to significantly impact the SSB estimate.

The nominal end of spawning date of the 31st July is the same as was used during previous survey years and the shape of the egg production curve for 2019 does not suggest that the chosen end date needs to be altered. The provisional total annual egg production (TAEP) for the western area in 2019 was calculated as 1.22 * 10^{15}. This is a 20% reduction on the 2016 TAEP estimate which was 1.55 * 10^{15}.

Figure 8.6.1.8 shows the egg production curve for the southern area for the 2019 survey, along with those for previous surveys for comparison. The start date for spawning in the southern area was the 23rd January). The Portuguese period 1 survey in division 9.a was pushed back by around 1 week. The result being that the survey dates aligned more closely to period 2. It was subsequently re-classified within period 2 and survey period 1 was removed. Sampling in the Cantabrian Sea, where the majority of spawning occurs within the Southern area, commenced 6 days later than in 2016 on the 14th March. The same end of spawning date of the 17th July was used again this year and the spawning curve suggests that there is no reason for this to change. As in 2016 the survey periods were not completely contiguous, and this has been accounted for. The provisional total annual egg production (TAEP) for the southern area in 2019 was calculated as 4.19 * 10^{14}. This is a 54% increase on the 2016 TAEP estimate which was 2.25 * 10^{14}.

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

Year	Western TAEP	Southern TAEP
2019	$1.22 * 10^{15}$	$4.19 * 10^{14}$
2016	$1.55 * 10^{15}$	$2.25 * 10^{14}$
2013	$2.20 * 10^{15}$	$5.06 * 10^{14}$
2010	$1.92 * 10^{15}$	$4.59 * 10^{14}$
2007	$1.42 * 10^{15}$	$3.48 * 10^{14}$
2004	$1.36 * 10^{15}$	$1.38 * 10^{14}$
2001	$1.35 * 10^{15}$	$3.18 * 10^{14}$
1998	$1.54 * 10^{15}$	$4.79 * 10^{14}$

Total annual eggs production (TAEP) for both the western and southern components combined in 2019 is $1.63 * 10^{15}$. This is a decrease in production of 9% compared to 2016 (Figure 8.6.1.9).

8.6.1.2 Mackerel fecundity and atresia estimation

Estimates of fecundity are given as preliminary realised fecundity which is the potential fecundity minus the atresia rate (for details see O' Hea *et al.*, 2019). The analysis of potential fecundity is carried out by four different participating institutes. Preliminary results are based on a limited number (34) of samples from period 2 and 3. This number of samples have been lower than in 2016, when 66 samples were available for the preliminary potential fecundity. The preliminary relative potential fecundity in 2019 is 1224 oocytes/gram female slightly higher than preliminary estimate in 2016 (1215 oocytes/gram female). Due to time constraints no samples were analysed for atresia at the time of WGWIDE. For the preliminary estimation of the realised fecundity the mean atresia rate based on the last six survey years (6%) was used. This resulted in a preliminary realised fecundity estimate for 2019 of 1 142 oocytes/gram female fish.

8.6.1.3 Quality and reliability of the 2019 egg survey

The 2019 survey shows a good spatial and temporal coverage in each of the sampling periods.

The previous surveys in 2010 and 2013 have been dominated by the issue of early peak of western mackerel spawning and its close proximity to the nominal start date. Both the 2013 and 2016 surveys were determined to address this issue with the result that sampling in the western area during these years commenced 2 weeks earlier than the preceding survey in an effort to capture the start of spawning. The pattern in 2019 followed that of 2016 with no early peak spawning being recorded. This year, however, peak spawning for western component was found to have taken place in period 4 which in regard to its temporal position has been early that of 2016 (Figure 8.6.1.7). The bulk of the spawning activity reported during historical surveys resulted from several egg production hotspots on and around the continental shelf edge and usually around the Celtic Sea and Porcupine Bank region. During 2019, high levels of egg production were recorded close to the 200 m contour line in Cantabrian Sea, Bay of Biscay, Porcupine Bank and from Cape Wrath to Shetland. (Figures 8.6.1.2-8.6.1.5). As it was noted in 2016, a low to moderate egg production at westwards and northwards of North of 54°N was found. Although it was not possible to fully delineate the boundary in this region during periods 5 and 6. It was accepted that this north and north-westerly unaccounted egg production would contribute only a small proportion of the TAEP in the western area. WGMEGS is confident that this survey accurately reflects the spawning patterns and that the survey has been successful in capturing the bulk of spawning activity. Further analysis of the quality and reliability of the survey will be done by WGMEGS in April 2020.

8.6.1.4 Mackerel biomass estimates

Based on the total annual egg production (TAEP) for the western and southern component, a preliminary realized fecundity estimate of 1 142 oocytes/gr female, a sex ratio of 1:1 and a raising factor of 1.08, the preliminary total spawning stock biomass (SSB) was estimated as shown below:

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

Where

F′ = realized fecundity,

s = 2 for a given sex ratio of 1:1,

cf = 1.08 (fixed raising factor to convert pre-spawning to spawning fish)

Giving

- 2.301 million tonnes for western component (2016: 3.077).
- 0.792 million tonnes for southern component (2016: 0.447).
- 3.092 million tonnes for western and southern components combined (2016: 3.524)

8.6.2 Demersal trawl surveys in October – March (IBTS Q4 and Q1)

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 NEA mackerel Stock Annex.

The data were compiled from several bottom trawl surveys conducted between October and March from 1998—2019 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), although several of the surveys use different names. 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, 2013b). 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.

All surveys in 2018 Q4 and 2019 Q1 were conducted according to standards. Figure 8.6.2.1 provides an overview of the distribution and number of samples.

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.

Results

The index of survivors in the first autumn-winter (recruitment index) was updated with data from surveys in 2018 Q4 and 2019 Q1. Parameter estimates and standard errors in the final model are listed in Table 8.6.2.1. The modelled average recruitment index (squared CPUE) surfaces were mapped in Figure 8.6.2.2. The timeseries of spatially integrated recruitment index values is used in the assessment as a relative abundance index of mackerel at age 0 (recruits). All annual index values were estimated to be slightly higher than during the previous model fit in IBPNEAMac (ICES, 2019a), but with the same interannual pattern ($p< 0.001$, $r = 0.9986$). This increase does not affect the stock assessment because it is used in the assessment as a relative abundance index. The estimated index value for the 2018 year class is above average (Figure 8.6.2.3).

Discussion

The combined demersal surveys have incomplete 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 NS-IBTS in Q1 should be extended to include the south-western Norwegian shelf and shelf edge in proximity to the Norwegian trench.

Finally, WGWIDE encourage studies of vertical distribution and catchability of age-0 mackerel in the Q4 and Q1 surveys, to evaluate if it is comparable in all areas (see acoustic information in Jansen *et al.*, 2015).

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

The IESSNS was successfully conducted in the summer of 2019 (Figure 8.6.3.1). Six vessels sampled 309 predetermined surface trawl stations during the period from June 28 to August 5 which covered an area of 3.2 mill. km^2, 2.9 mill. km^2 excluding the North Sea, which was similar coverage to 2018 (Nøttestad *et al.*, 2019). At each surface trawl station, a standardized trawl (Multpelt 832) is employed for 30-min according to a standardize operation protocol which is designed to catch mackerel. Additionally, abundance of herring and blue whiting was measured using acoustic methods, excluding the North Sea, and backscatter was 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 the future. The IESSNS 2019 cruise report is available as a working document to the current report (Nøttestad *et al*., 2019) and a detailed survey description is in the mackerel Stock Annex.

IESSNS provides an annual age-segregated index for mackerel abundance for age classes 1-14+ in Nordic Seas since 2010 and in the North Sea since 2018 (ICES, 2019a). In the current chapter, the North Sea mackerel data are reported separately from longer time series available from the Nordic Sea area. In Nordic Seas, total stock abundance (numbers) was estimated 26.4 billion and biomass was estimated 11.5 million tons which is compared to 2018 an increase of 56% and 85%, respectively (Table 8.6.3.1 and Figure 8.6.3.2a). Estimate stock abundance (billions) in 2019 is the second highest for the timeseries (Figure 8.6.3.2b), and in similar range as estimates for the period from 2013 to 2017 (Nøttestad *et al*., 2019). Catch curve analysis of cohort numbers for the period from 2010 to 2019 displays "a dip" for all age classes in 2018 (Figure 8.6.3.3), indicating annual effects in the survey (Nøttestad *et al*., 2019).

The most abundant year classes were 2011, 2010 and 2016 respectively presenting 14.8%, 14.5% and 14.4% of the total stock in numbers (Figure 8.6.3.4a, b). These cohorts were also abundant in 2018. Internal consistency of year classes is highly variable with correlation values ranging from 0.13 to 0.93 (Figure 8.6.3.5). There was a significant ($p < 0.05$) internal consistency for ages 1 to 5 years ($0.83 < r < 0.93$), it was not significant but fairly good for ages 6 to 7 and for ages 8 to 12 ($0.58 < r < 0.81$), and it was poor between ages 5 and 6 ($r = 0.31$) and ages 7 and 8 ($r = 0.13$) (Figure 8.6.3.5). Compared to 2018, internal consistency was similar for most ages except there was a noticeable decline for ages 5 - 6 and ages 7 - 8. It is worth noting that the internal consistency plots have seven data points each, hence one data point can have large influence on the correlation.

Mackerel density, per predetermined surface trawl station, ranged from 0 to 52 tonnes/km^2 with the highest densities recorded in the northern Norwegian Sea, south-east of Iceland, between Iceland and the Faroe Island, as well as south west of the Faroe Islands (Nøttestad *et al*., 2019). Mackerel geographical distribution began shifting eastward in 2018 compared to the period from 2010 to 2017 (Figure 8.6.3.6b). This eastward distributional shift continued in 2019 with limited amount of mackerel caught westward of longitude 27°W (Figure 8.6.3.6a) (Nøttestad *et al*., 2019). For comparison, the westward boundary of mackerel was at longitude 43°W in 2014 which is the year with the largest geographical distribution range.

For age classes 3-11, which are included in stock assessment (ICES, 2019a), increased in numbers was 98% compared to 56% for all age classes. This discrepancy is caused by age classes 1 and 2 being 70% lower in 2019 compared to 2018. The record high numbers of age 1 in 2018 resulted in below medium number at age 2 in 2019, and age 1 numbers in 2019 were among the lowest recorded (Figure 8.6.3.4a). The IESSNS is considered not cover the complete distribution range of youngest two-year classes, hence they are excluded from the assessment. However, the internal consistency between ages 1 - 3 suggests abundance at ages 1 and 2 gives an indication of year class size prior to recruitment into the survey at age 3 (Figure 8.6.3.5).

The North Sea (southward of latitude 60 °N) was included in the IESSNS for the second time in July 2019 with 38 predetermined surface trawl stations were sampled and survey area covering 0.28 mill. km^2 (Figure 8.6.3.6a). The mackerel abundance index was 1.0 billion and the biomass index was 0.2 million ton which was a decrease of 53% and 42% compared to 2018, respectively (Figure 8.6.3.6b) (Nøttestad *et al*., 2019).

8.6.4 Tag Recapture data

Steel-tags

The Institute of Marine Research in Bergen (IMR) has conducted tagging experiments on mackerel on annual basis since 1968, both in the North Sea and to the west of Ireland during the spawning season May–June. Information from steel-tagged mackerel tagged west of Ireland and British Isles was introduced in the mackerel assessment during ICES WKPELA 2014 (ICES, 2014), and data from release years 1980-2004, and recapture years 1986-2006 has been used in the update assessments after this. The steel tag experiments continued to 2009, with recaptures to 2010, but this part of the data was at the time considered less representative and was excluded.

What is used in the SAM stock assessment is a table of data showing numbers of steel tagged fish per year class in each release year, and the corresponding numbers scanned and recaptured of the same year classes in all years after release. The steel tag data and the corresponding trends in the data in terms of index of total biomass and year class abundance by year is described in (Tenningen *et al.*, 2011).

The steel tag methodology involved a whole lot of manual processes, demanding a lot of effort and reducing the possibility to scan larger proportions of the landings. The tags were recovered at metal detector/deflector gate systems installed at plants processing mackerel for human consumption. This system demanded external personnel to stay at the plants supervising the systems during processing. Among the typical 50 fish deflected, the hired personnel had to find the tagged fish with a hand-hold detector and send the fish to IMR for further analysis. It was decided in the end to go for a change in methodology to radio-frequency identification (RFID), which would allow for more automatic processes and increased proportion of scanned landings.

RFID tags

The RFID tagging project on NEA mackerel was initiated in 2011 by IMR, and the data was used in update assessments after the ICES WKWIDE2017 benchmark meeting (ICES, 2017b). The data format was the same as for steel tags, but the time series were treated with a different scaling parameter in the assessment.

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 tag itself is passive but information to the reader is released as it passes an electric field in the antenna system, and information is automatically updated in an IMR database. When tagging and releasing the fish, information is also synced to the IMR database regularly over internet.

There is a web-based software solution and database that is used to track the different scanning systems at the factories, 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). The development of the tagging data time series is dependent on the work from each country's research institutes, fisheries authorities or the industry it 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, undertake quality assurance of the data and other analyses of the trends in the data outside of the assessment model.

The RFID tagging technology is clearly a more cost-effective than the old steel tag technology. We are now scanning about 10 times more biomass than during the period with steel tags. An overview of the RFID tagging data in terms of numbers tagged, biomass scanned, and numbers recaptured is given in Tables 8.6.4.1-3, and geographical distributions of data in Figure 8.6.4.1.

During the period 2011— 1th September 2019 as many as 408 325 mackerel have been tagged with RFID (Table 8.6.4.1). This includes an experiment off the Norwegian Coast on young mackerel in September 2011 as well as five experiments carried out in August in Iceland 2015-2019, none of which are 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 4 490 RFID-tagged mackerel recaptured up to 1th September 2019 came from 23 European factories processing mackerel for human consumption (Table 8.6.4.3). 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 3 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. The working document from Slotte (2019) presented to WGWIDE, describes potential problems with some of the factories that has led to the exclusion of the data for use in assessment, the data from factories used in the 2019 assessment is marked in Tables 8.6.4.2-3.

During ICES WGWIDE 2018 (ICES, 2018d) meeting bias issues were described for RFID tag data, in addition to potential weighting issues of the tag data inside the model. After the intermediate benchmark meeting ICES IBPNEAMac 2019 (ICES, 2019a), these issues were overcome by using a subset of data for release years (exclude 2011-2012), recapture years (only use recaptures from year 1 and 2 after release) and age groups (exclude youngest fish ages 2-4, use ages 5-11). This is now the subset of data to be used in update assessments, and it is illustrated in Tables 8.6.4.1-3 where subset data currently used are marked.

Figure 8.6.4.2 shows the relative distributions of year classes tagged per year and scanned/recaptured year 1 and 2 after release for the subset years used in current update assessment. The figure illustrates the problem that the tagged/recaptured fish are skewed towards older fish than scanned. Especially the large year classes 2010-2011 were tagged in low numbers at ages 2-4 compared with the scanned numbers. However, for the latest release used in the assessment (2017), it seems that this tendency is less pronounced.

During ICES WGWIDE 2018 (ICES, 2018d) the RFID tag data had high weight, and the SSB trend in the assessment showed a clear tendency to decrease from 2011-2016. This was also consistent with the observed trend in the data from various abundance index data from the RFID tag-recapture time series explored during ICES IBPNEAMac 2019 (ICES, 2019a). However, by using the current subset data this changed the trend in the RFID tag data significantly, which is demonstrated by comparing the index of abundance from RFID data using all data and the subset data (Figure 8.6.4.3). Here it is also obvious that adding one more year of release and recapture data results in increases abundance in release years 2011-2012, as well as a very clear downward trend to 2017. On the other hand, adding one more release year and recapture year in the subset data lifts the index in 2016 to same level as in 2017. The subset data indicate a weak increase in abundance from 2013-2017, rather than a decrease.

Estimates of year class abundance for the subset of RFID tag-recapture data used in the current assessment also show differences in year class levels and trends over time that seems reasonable with no clear year effects, and with a year class development following a total mortality of approximately Z=0.4 (Figure 8.6.4.4). These estimates of year class trends and trends in aggregated abundance over ages should be continued to be explored in next update assessments, as this is format that is easier to evaluate than the actual raw data used in the SAM model.

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 NEA mackerel has been observed in catches in the Norwegian Sea during the combined survey in May during the International Ecosystem survey in the Norwegian Sea (IESNS) targeting herring and blue whiting (Rybakov *et al*., 2016; 2017). The spatial distribution pattern of mackerel was reduced in 2019 compared to 2017 and 2018 (Rybakov *et al*., 2017; ICES, 2018b; Salthaug *et al*., 2019). Mackerel was caught within a more limited area and in fewer trawl stations of the Norwegian Sea in May 2019 compared to May 2017 and 2018 (Rybakov *et al*., 2017; ICES, 2018b; Salthaug *et al*., 2019). In 2019, the northernmost mackerel catch was at 66°N and the westernmost catch was at 2°W, whereas in 2018, the northernmost mackerel catch was at 70°N and the westernmost catch was similar at 2°W. Mackerel of age 3 dominated followed by age 5 in 2019, whereas there was found much less 1-year olds compared to last year (Salthaug *et al*., 2019).

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 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) (Salthaug *et al*., 2019).

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

The northern Spanish waters (8.c and 9.a.N) were surveyed in PELACUS 0319 on board RV Miguel Oliver from 27th March till 19th April, using the methodology of the previous surveys.

The bulk of the mackerel 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 905 thousand tonnes, corresponding to 2 549 million fish were estimated, which represent an important increase from the 2018 estimates (557 thousand tonnes). Bigger fish (mainly age group 7) occurred in the westernmost part, while age group 5 in the rest of the area. (Figure 8.6.5.2.2, Tables 8.6.5.2.12).

Although biomass was higher, spawning area was lower than the one derived last year (246 positive egg stations of 367 this year; 364 of 373 in 2018), but probably due to the increase of the adult abundance, egg density was higher than that calculated last year (mean of 397 eggs per stations, corresponding to 36.21 eggs/m^3 this year and 248 egg per station -24 eggs/m^3- in 2018). It should be also noted the almost lack of spawning activity of mackerel in both Porcupine and the slope in 8.a (48ºN), with only a 7% and 33% of the stations being positives for mackerel eggs with an average of 20.67 and 2.29 egg counts/station corresponding to 2.29 and 0.2 eggs/m^3 respectively. On the contrary, in 8.b (45ºN) the spawning activity was really high, with 82% of the station being positives for mackerel eggs with the highest egg production too (1 181 eggs/station corresponding to 95.91 eggs/m^3) (Figure 8.6.5.2.3).

8.7 Stock Assessment

8.7.1 SAM assessment

8.7.1.1 Update assessment in 2019

During the 2019 interbenchmark process (ICES IBPNEAMac 2019; ICES, 2019a), a number of changes have been accepted for the NEA mackerel assessment. After identifying a number of potential biases in the RFID dataset, the decision was made to use a sub-set of the available data:

- Only fish recaptured 1 or 2 years after release are now used, in order to avoid the potential bias linked to tag loss or longer term post-tagging mortality.
- Fish tagged at a young age (4 and younger) are excluded from the data base, as they correspond to not fully mature ages, and therefore only a subcomponent of these age classes may be present on the spawning grounds were the tagging survey is carried out.
- The first 2 years of recapture in the tagging program are also excluded, as the volume of the catch scanned was much lower in these first years of the RFID program, and the catches only originates from a limited geographical area.

In addition to this, the SAM model configuration was modified in order to treat the young fish (ages 0 and 1) differently from the older fish. While in the previous assessment, there was one common observation variance parameter and one common F random walk variance parameter for all ages, the new assessment now estimates separate parameters for age 0, age 1 and for older ages.

The interbenchmark process was conducted using the data available for WGWIDE2018 (ICES, 2018d). The WGWIDE2019 assessment was therefore the first update assessment carried out with the new methodology. The update assessment was carried out by fitting the state-space assessment model SAM (Nielsen and Berg, 2014) using the R library *stockassessment* (downloadable at install_github("fishfollower/SAM/stockassessment")) and adopting the configuration described in the Stock Annex. The assessment is also available on the webpage stockassessment.org (assessment named MackWGWIDE2019v02).

The assessment model is fitted to catch-at-age data for ages 0 to 12 (plus group) for the period 1980 to 2018 (with a strong down-weighting of the catches for the period 1980-1999) and three surveys: (1) the SSB estimates from the triennial Mackerel Egg survey (every three years in the period 1992-2019); (2) the recruitment index from the western Europe bottom trawl IBTS Q1 and Q4 surveys (1998-2018); and (3) the abundance estimates for ages 3 to 11 from the IESSNS survey (2010, 2012-2019). 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 2014 and 2018 (age 5 and older at release) 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 benchmark assessment were:

- update of the recruitment index until 2018.
- Addition of the preliminary 2019 SSB estimate from the egg survey
- Addition of the 2019 survey data in the IESSNS indices.
- Addition of the 2018 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 2018

Input parameters and configurations are summarized in Table 8.7.1.1.1. The input data are given in Tables 8.7.1.1.2 to 8.7.1.1.9. 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_steel.dat and tag_RFID.dat).

8.7.1.2 Model diagnostics

Parameter estimates

The estimated parameters and their uncertainty estimates are shown in Table 8.7.1.2.1 and Figure 8.7.1.2.1. The model now estimates different observation standard deviations for young fish and for older fish. Reflecting the suspected high uncertainty in the catches of age 0 fish (mainly discards), the model gives a very poor fit to this data (large observation standard deviation). The standard deviation of the observation errors on catches of age 1 is lower, indicating a better fit. For the age 2 and older, the fit to the catch data is very good, with a very low observation standard deviation.

The observation standard deviations for the egg survey 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 compared to the catches. The IESSNS age 3 is a very poorly fitted in the assessment (high observation standard deviation). Overdispersion of the tag recaptures has the same meaning as the observation standard deviations, but is not directly comparable.

The catchability of the egg survey is 1.23, 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 0.86 for age 3 to 2.14 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 mortality estimate is higher for the steel tags (around 40%) than for the RFID tags (around 13%).

The process error standard deviation (ages 1-11) is moderate as well as the standard deviation of the F random walks.

The catchability parameters for the egg survey, recruitment index and post tagging survival appear to be estimated more precisely than other parameters (Table 8.7.1.2.1). The catchability for the IESSNS have a slightly higher standard deviation, except for the catchability of the IESSNS at age 3 which has a much higher standard deviation. Uncertainty on the observation standard deviations is larger for the egg survey, the IESSNS age 3 and for the recruitment index than for the other observations. Uncertainty on the overdispersion of the RFID tag data is high. The standard deviation on the estimate of process error is low, and the standard deviations for the estimates of F random walk variances of age 0 and 1 are both very high.

The estimated AR1 error correlation structure for the observations from the IESSNS survey age 3 to 11 has a high correlation between the errors of adjacent ages (r=0.73), then decreasing exponentially with age difference (Figure 8.7.1.2.2.). 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 correlations between parameter estimates (Figure 8.7.1.2.3):

- Catchabilities are positively correlated (especially for the IESSNS age 4 to 11), and negatively correlated to the survival rate for the RFID tags. This simply represents the fact that all scaling parameters are linked, which is to be expected.
- The observation variance for the IESSNS age 4-11 is positively correlated to the autocorrelation in the errors for these observation. This implies that when the model estimates highly correlated errors between age-groups, the survey is considered more noisy.

Residuals

The "one step ahead" (uncorrelated) residuals for the catches did not show any temporal pattern (Figure 8.7.1.2.4) 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 are of a similar size for all ages, indicating that the model configuration with respect to the decoupling of the observation variances for the catches is appropriate.

The residuals for the egg survey show a strong temporal pattern with large positive residuals for the period 2007-2010-2013, followed by large negative residuals in 2016 and 2019. This pattern reflects the fact that the model, based on all the information available, does not follow the recent trend present in the egg survey (with an historical low estimate for 2019) and considers those two last years as large negative observation errors. The strong increase in the observation variance for this survey (see Section 8.7.1.4.2) indicating a poorer fit with the egg survey is related to these two observations which point towards a very different direction as the other observations.

Residuals for the IESSNS indices show an alternation of positive, negative and positive residuals again in the years 2017-2018-2019, which reflect the fact that there is probably a negative year effect in 2018 in this survey. Residuals for the rest of the period year are more balanced.

Residuals to the recruitment index show no particular pattern, and appear to be relatively randomly distributed.

Finally, inspection of the residuals for the tag recaptures (Figure 8.7.1.2.5) did not show any specific pattern for the RFID data. For the steel tags, there is a tendency to have more positive residuals at the end of the period which could indicate that using a constant survival rate for this dataset may not be appropriate.

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 8.7.1.2.6).

The run without the RFID recaptures and the run without the recruitment index failed to converge. Making a small change in the model configuration (grouping the F random walk variance of age 1 with the one of the older ages, which did not have a noticeable effect on the stock trajectories for the run using all data source), it was possible to achieve converge for the run without RFID data, but not for the run without the recruitment index. It has therefore not been possible to assess the influence of this index on the assessment.

All leave out one runs showed parallel trajectories in SSB and F_{bar}. Removing the IESSNS resulted in lower SSB estimates and higher F_{bar} 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. In both cases, the estimated stock trajectories are well within the confidence interval of the assessment using all data sources. The final assessment seems to make a trade-off between the information coming from the IESSNS which leads to a more optimistic perception of the stock, and the information from the egg survey which suggests a more pessimistic perception of the stock. The run leaving out the RFID data gave a perception of the SSB very similar to the assessment using all data, and slightly higher fishing mortality over the last decade. This is a contrasting situation compared to the 2018 WGWIDE assessment, in which the RFID had a very strong influence on the assessment, and is the consequence of the changes made during the interbenchmark process and listed above. A closer inspection of the run without the RFID data (Figure 8.7.1.2.7) indicates that, although the inclusion of the RFID does not modify sensibly the

SSB trajectory, it does slightly reduce the uncertainty on the SSB estimates (slightly wider confidence bounds without the RFID data).

8.7.1.3 State of the Stock

The stock summary is presented in Figure 8.7.1.3.1 and Table 8.7.1.3.1. The stock numbers-at-age and fishing mortality-at-age are presented in Tables 8.7.1.3.2-3. The spawning stock biomass is estimated to have increase almost continuously from just above 2 million tonnes in the late 1990s and early 2000s to 5.2 million tonnes in 2014 and subsequently declined continuously to reach a level just above 4.3 million tonnes in 2018. The fishing mortality has declined from levels between F_{pa} (0.37) and F_{lim} (0.46) in the mid-2000s to levels just above F_{MSY} in 2018. The recruitment time series from the assessment shows a clear increasing trend since the late 1990s with a succession of large year classes (2002, 2005-2006, 2011 and 2016-2017). There is insufficient information to estimate accurately the size of the 2018 year class, estimate is very high but highly uncertain.

There is some indication of changes in the selectivity of the fishery over the last 30 years (Figure 8.7.1.3.2.). In the 1990s, the fishery seems to have had a steeper selection pattern (more rapid increase in fishing mortality with age). Between the end of the 1990s and the end of the 2000s, the selection pattern became less steep (decreasing selection on the ages2-5). After 2008, the pattern changed again towards a steeper selection pattern.

8.7.1.4 Additional exploratory runs

8.7.1.4.1 Excluding the 2018 estimates from the IESSNS survey

The residual plot for the IESSNS survey suggests a negative year effect in 2018 which is also visible in the survey index (Figure 8.6.3.3). A year effect in a survey corresponds to an anomaly in the catchability of the survey in a given year, that be caused by a range of different factors (poor weather, stock geographic distribution, fish behaviour ...). The reasons for this particular 2018 year effect have not been fully investigated yet. Nonetheless, it seemed worthwhile exploring the effect of removing this particular year from the IESSNS index used in the assessment.

This was done during WGWIDE and was found to make little difference in the outcome of the assessment. There was barely any difference in model parameters when the 2018 IESSNS index was removed (except a small reduction of the observation error variance for the age 3 in the IESSNS). This had no noticeable consequences for the estimated stock trajectories (Figure 8.7.1.4.1.1).

The SAM mackerel assessment includes a correlation structure for the errors in the IESSNS, which effectively means that the model is designed to cope with year effects in that survey (which correspond to errors correlated across age-classes). This results in more accurate estimates of model parameters (no bias due to invalid assumption that the errors are independently distributed). Amongst those parameters, the observation variance for the IESSNS survey are estimated at higher values once the correlation structure is used (ICES, 2017b), reflecting decreasing weight of this survey. A consequence is that the model is rather insensitive to the exclusion a single year of data, as already found in 2018 WGWIDE (ICES, 2018d), and confirmed by this analysis.

8.7.1.4.2 Excluding the 2016 and 2019 estimates from the egg survey index

Since 2010, the survey showed a very large expansion of the spawning area to the Northeast (into the Norwegian Sea), the North (south of Iceland) and West (on Hatton bank, see Figure 8.6.1.4). In 2016 and 2019, the survey could not cover the full extension of the spawning, probably leading to an underestimation of the total annual egg production. The areas that could not be covered are assumed to contain only low density of eggs and the conclusion of the MEGS group was that the bias on the SSB index should be rather small. Still, given the strong residual pattern found for this survey in the assessment (with 2 large negative residuals for 2016 and 2019), it seemed worthwhile investigating the sensitivity of the assessment to these 2 specific survey points.

The mackerel assessment run without the 2016 and 2019 egg survey estimates showed a much better overall fit to the egg survey index (strong decrease in the observation variance, Figure 8.7.1.4.2.1). However, a temporal pattern still remained in the residuals (Figure 8.7.1.4.2.2), which indicates that the assessment still did not completely match the temporal development in the egg survey index. The stock trajectories are slightly modified by the removal of these 2 years in the egg survey (upwards for SSB and downwards for F_{bar}, Figure 8.7.1.4.2.3). The difference on the final assessment year estimates is +10% for SSB and -7% for F_{bar}, but much smaller for the earlier years.

Considering the magnitude of the residuals for 2016 and 2019 - reflecting the discrepancy between the recent trend in the assessed SSB and the trend in the egg index - these two data only have a small overall effect on stock trajectories. This reflects the behaviour of the SAM model which automatically weights the data sources. In this case, the egg survey has been down-weighted as the new information became more contradictory with the rest of the assessment.

8.7.1.5 Quality of the assessment

Parametric uncertainty

Large confidence intervals are associated with the SSB in the years before 1992 (Figure 8.7.1.3.1 and Figure 8.7.1.5.1). This results from the absence of information from the egg survey index, the down-weighting 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 2018 is estimated with a precision of +/- 24% (Figure 8.7.1.3.1 and Table 8.7.1.3.1). There is generally also a corresponding large uncertainty on the fishing mortality, especially before 1995. The estimate of F_{bar4-8} in 2018 has a precision of +/- 27%. The uncertainty on the recruitment is high for the years before 1998 (precision of on average +/- 45%). The precision improves for the years for which the recruitment index is available (+/- 30%) except for the most recent recruitments (+/- 40%).

Model instability

The retrospective analysis was carried out for 3 retro years, by fitting the assessment using the 2019 data, removing successively 1 year of data (Figure 8.7.1.5.2). There is a systematic retrospective pattern found in the SSB (which is revised upwards with each new year of data) and the opposite for F_{bar}. However, given that the RFID series in now composed for only 5 years of recapture data, retrospective instability is to be expected (and retrospective runs removing 4 or more years would be meaningless as only 1 recapture year or none would be available for model fitting).

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 8.7.1.5.3) shows indications of some pattern across time and ages. There is a predominance of positive deviations in the recent years for age-classes 5 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 8.7.1.5.4). 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 (19911994 and 2004 and 2006). For the years between 2008 and 2016, the biomass cumulated process error remains positive, and large (reaching in 2013 almost the weight of the catches). 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 since 2016 is lower than in the previous year's assessment.

8.7.2 Exploratory assessments

8.7.2.1 Muppet model

Alternative model runs were done with the Muppet model that is a traditional separable catch at age model without any random effects. The model can use tagging data in the objective function and correlation of residuals in age disaggregated survey indices is modelled. The results are described in the working document from Björnsson (2019) presented to WGWIDE, but summarized shortly here.

The data used for tuning are the same as in the adopted assessment (i.e egg survey, pelagic survey, recruitment index and RFID tagging data).

The model setup before 2000 is based on using the catch in numbers data but estimate a scaling factor (1 number on the catches). This scaling factor is supposed to reflect average misreporting. For comparison the adopted assessment does not use the catch data before 2000 and the assessment is only based on tagging data where the level of misreporting depends on estimated tagging mortality.

The estimated "misreporting parameter" in the Muppet model depends on the selection pattern and is higher when selection is estimated separately for the early period.

Other differences between the Muppet and SAM model are:

- The recruitment model in Muppet is similar as if Beverton and Holt or Ricker were used in SAM (RTC3 type model).
- Constraints in fishing mortality (random walk) not implemented.

Different setup of the Muppet model lead to widely different results (Figure 8.7.2.1.1). The same setup as used in the adopted assessment leads to larger estimated stock compared to the adopted assessment. The preferred setup here is thought to use all the tagging data and implement tagloss. This setup leads to smaller stock compared to using limited subset of the tagging data as done in the adopted assessment. As shown in the IBPNEAMac report (ICES, 2019a) observed and predicted tagging data fit reasonably well with this model setup in Muppet.

Recruitment estimates from the Muppet model are very different from those in the assessment model (Figure 8.7.2.1.2) where large part of the recruitment is generated by subsequent deviations in M.

To summarize, the model does not lead to ”one correct result“, something that would be expected when tuning the model with as disparate and contradictory data as the data for NEA mackerel.

8.8 Short term forecast

The short-term forecast provides estimates of SSB and catch in 2020 and 2021, given assumption of the current year's (also called intermediate year) catch and a range of management options for the catch in 2020.

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 (2019) 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 (2018) was considered too uncertain to be used directly, because this year class has not yet fully recruited into the fishery. The last recruitment estimate is therefore replaced by predictions from the RCT3 software (Shepherd, 1997). The RCT3 software evaluates the historical performance of the IBTS recruitment index, by performing a linear regression between the index and the SAM estimates over the period 1998 to 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 weighting calculated by RCT3 was 85 % (recruitment index) and 15 % (time tapered geometric mean), which leads to an expected recruitment of 7 259 millions.

8.8.3 Short term forecast

A deterministic short-term forecast was calculated using FLR (www.flr-project.org). 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 2020.

Assuming catches for 2019 of 834 954 kt, F was estimated at 0.21 (below F_{MSY}) and SSB at 4.39 Mt (above B_{pa}) in spring 2019. If catches in 2020 equal the catch in 2019, F is expected to increase to 0.21 (above F_{lim}) in 2020 with a corresponding increase in SSB to 4.54 Mt in spring 2020. Assuming an F of 0.21 again in 2021, the SSB will remain at a similar level (4.47 Mt) in spring 2020.

Following the MSY approach, exploitation in 2020 shall be at F_{MSY} (0.23), this is equivalent to catches of 922 kt and an increase in SSB to 4.53 Mt in spring 2020 (3 % increase). During the subsequent year, SSB is predicted decrease with 3 % to 4.39 Mt in spring 2020.

8.9 Biological Reference Points

An Interbenchmark Workshop on the assessment of northeast Atlantic mackerel (IBPNEA-Mac) was conducted during 20182019 (ICES, 2019a) 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 2003; B_{loss} = 1 990 000 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} = 0.46.

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 $\sigma = 0.14$ (the estimate of uncertainty associated with spawning biomass in the terminal year in the assessment, 2017, as estimated in the 2019 intermediate benchmark assessment); B_{pa} = 2 500 000 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} .F_{pa} is the estimate of fishing mortality which is designed to ensure that the true F is above F_{lim} with a 95% probability. Its value is calculated based on F_{lim}, whilst taking the assessment uncertainty in F into consideration: F_{lim} * exp(1.645 σ) where σ = 0.14 was the estimated standard deviation of ln(F) in the final assessment year (2017), this leads to F_{pa} = 0.37.

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, 2017a), long term equilibrium simulations indicated that F=0.23 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 $B_{trigger}$ were below B_{pa}. Following the ICES procedure MSY $B_{trigger}$ was set equal to $B_{pa,}$ 2 500 000 t.

Updated ICES reference points for NEA mackerel			
Type		Value	Technical basis
MSY approach	MSY $B_{trigger}$	2.50 million tonnes	B_{pa} [1]
	F_{MSY}	0.23	Stochastic simulations [1]
Precautionary approach	B_{lim}	1.99 million tonnes	B_{loss} from 2019 interbenchmark assessment (2003) [1]
	B_{pa}	2.50 million tonnes	$B_{lim} \times \exp(1.654 \times \sigma)$, $\sigma_{SSB} = 0.14$ [1]
	F_{lim}	0.46	F that, on average, leads to B_{lim} [1]
	F_{pa}	0.37	$F_{lim} \times \exp(1.654 \times \sigma)$, $\sigma_F = 0.14$ [1]

[1] **20182019 benchmark assessment (ICES, 2019a)**

8.10 Comparison with previous assessment and forecast

The last available assessment used for providing advice was carried out in 2019 during the IBPNEAMac. The new 2019 WGWIDE assessment gives a slightly different perception of the recent development of the stock (Figure 8.10.1). The SSB trajectory since 2014 has been rescaled slightly upwards, while the estimated F_{bar} has been rescaled downwards. The estimated recruitment time series are very similar.

The differences in the 2017 TSB and SSB estimates between the previous and the present assessments are moderate, of 8.3 and 6.9% respectively. The upward revision of the 2017 fishing mortality estimate is larger, of -16%.

	TSB 2017	SSB 2017	Fbar4-8 2017
Values			
2019 IBPNEAMac	5329214	4387307	0.287
2019 WGWIDE	5773203	4692164	0.241
% difference	8.3%	6.9%	-16.0%

The addition of a new year of data has slightly modified the relative weight of the different data sources: the estimated observation standard deviation has increased (although not significantly) both for the IESSNS survey and for the egg survey. This decreasing influence of the 2 surveys on the assessment may be related to the increasing conflict between these two series, the IESSNS indicating record high biomass in 2019 (Figure 8.6.3.2a) while the egg survey index is at its lowest. These changes in the weight of the different data sources can partly explain the revision of stock trajectories. As a result of this change in perception of the stock, small differences are found in the estimated catchabilities for the surveys.

The uncertainty on the parameter estimates has decreased for some parameters (standard deviations of the F random walk for age 0, and the observation variance for the catches age 2-12, Figure 8.10.2), but increased for others (recruitment variance, and catchability of the IESSNS for ages 4-8). The uncertainty on SSB and $F_{bar4\text{-}8}$ in this year's assessment is in general larger than for the inter-benchmark assessment, especially for the period 2005-2015 (Figure 8.10.3).

The prediction of the mackerel catch for 2018 used for the short-term forecast in the advice given after the interbenchmark was very close to the actual 2018 catch reported for WGIWIDE 2019 and used in the present assessment (text table below). The new assessment produced an estimate of the SSB in 2018 which was just 2.2% lower than the 2019 IBPNEAMac forecast prediction (ICES, 2019a). The fishing mortality F_{bar4-8} for 2018 estimated at the WGWIDE 2019 is 14.2% lower than the value estimated by the short term forecast in the previous assessment. Most of this discrepancy is explained by the revision of the perception of F_{bar4-8} described above.

	Catch (2018)	SSB (2018)	F_{bar4-8} (2018)
2019 IBPNEAMac forecast	1 000 559 t	4 186 496 t	0.28
2019 WGWIDE assessment	1 026 424 t	4 279 185 t	0.24
% difference	2.6%	2.2%	-14.3%

8.11 Management Considerations

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

The 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, 5.b (EU), 2.a (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%, in 2015 at 60% and at 24% in 2018 and 2019.

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, 2016; Nøttestad *et al*., 2018). This northerly shift in spawning and recruitment pattern of NEA mackerel seem to have continued also in 2017 (Nøttestad *et al*., 2018), but has reversed in 2018 (Figure 8.6.2.2).
The recruitment index indicates high recruitment in 2016, 2017 and 2018. For the two first year classes, this is confirmed by the IESSNS, where 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). In 2019 on the other hand, the incoming 2018-year class was one of the lowest in the entire IESSNS time series (Nøttestad *et al*., 2019). This may reflect the more south-western distribution of the recruits from the 2018 year class as it was observed in the IBTS-surveys.

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.

The growth (mean weights per age group) have slightly increased during the last 34 years for several age groups (ICES, 2018c; ICES, 2019a). However, this does not include the 0-year olds which supports the finding of high abundance at age 0 (Figure 8.5.2.1.).

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*., 2016), a slight decrease in distribution area of mackerel in the Nordic Seas was observed in 2017 and 2018 with 2.8 million square kilometres (Nøttestad *et al*., 2017; ICES, 2018a). The mackerel distribution slightly increased to 2.9 million km^2 in 2019 (Nøttestad *et al*., 2019). The mackerel was more patchily distributed within the survey area in 2019 and 2017 than in 2018. Mackerel had a more eastern distribution in 2019 and 2018 than in 20142017 (ICES, 2018a; Nøttestad *et al*., 2019). This difference in distribution primarily consists of a marked biomass decline in the west, and particularly in Greenland waters but also in Icelandic waters. Geographical distribution of the 2016 cohort at age 0 and 1 extended more to the north than normally, including latitude 6071°N along the coast and offshore areas of Norway based on various survey data and fishing data (Nøttestad *et a*l., 2018).

Spatial mackerel distribution related to environmental conditions

Ólafsdóttir *et al*. (2018) analysed the IESSNS data from 2007 to 2016 with the following results: 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. 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. 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. 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 2019 IESSNS a marked change in the spatial distribution of mackerel was observed with lower densities of mackerel in the western distribution areas (East Greenland and Iceland) as compared to 2017 (see Figures 8.6.3.6a and b). It is not clear what causes this distributional shift, but the SST were 1-2°C higher in the western and south-western areas as compared to a 20 years mean (19992009), and substantially lower zooplankton concentrations in Icelandic and Greenland waters in 2019 than 2018, might partly explain such changes (ICES, 2018a, Nøttestad *et al*., 2019).

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 developed by Bachiller *et al*. (2018) estimated 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 and 2019 (ICES, 2018a, Nøttestad *et al*., 2019). This is similar as seen in previous years (Nøttestad *et al*., 2016; 2017). A change was seen in the northern Norwegian Sea in 2019 where we had some overlap between mackerel and herring (mainly 2013- and 2016- year classes) (Nøttestad *et al*., 2019). There was, on the other hand, practically no overlap between NEA mackerel and NSSH in the central and northern part of the Norwegian Sea in 2018 and previous years, mainly because of very limited amounts of herring in this area (ICES, 2018a).

There seem to be rather limited spatial overlap between marine mammals and mackerel during summers in the Nordic Seas (Nøttestad *et al*., 2019; Løviknes, 2019). There is spatial overlap between killer whales and mackerel in the Norwegian Sea, and killer whales are actively hunting for mackerel schools close to the surface during summer (Nøttestad *et al*., 2014). 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) and 2018 (Bjørdal, 2019), 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; Boge, 2019). Additionally, the new situation of numerous 0- and 1-group mackerel in Norwegian coastal waters in 2018 (Bjørdal, 2019), 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) (Bjørdal, 2019). Although much fewer 1-groups of NEA mackerel was found along the coast in Norway during the IESSNS 2019 (Nøttestad *et al*., 2019), the Atlantic bluefin tuna are still indeed targeting schools of 1-group mackerel during their intense feeding migration in Norwegian waters.

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8.14 Tables

Table 8.2.1. 2018 Mackerel fleet composition of major mackerel catching nations.

Country	Len (m)	Engine power (hp)	Gear	Storage	No vessels
Denmark	57-88	407710469	Trawl	Tank	8
Faroe Islands	64-75	34605920 kw	Purse Seine/Trawl	RSW	2
	76-84	39208000 kw	Purse Seine/Trawl	RSW	4
	84	6005kw	Trawl	Freezer	1
	55-79	36007680 kw	Trawl/Pair trawl	RSW	5
	36-49	10291800 kw	Trawl	Clondyking	2
France		110529	Pair Trawl		56
		442400	Trawl		654
		6525	Nets		447
		7294	Lines		257
		22662	Other gears		245
Germany	90-140	380012000	Single Midwater Trawl	Freezer	4
Greenland	65 - 84	3 0029 517	Trawl	RSW, Freezer	14
	85 - 121	6 6899 517	Trawl	RSW, Freezer	9
Iceland	51-60	25024079	Single Midwater Trawl	RSW, Freezer	6
	61-70	20007507	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	7
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

Country	Len (m)	Engine power (hp)	Gear	Storage	No vessels
	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	24
	24-40	191-876	Trawl	Dryhold	78
	40-	353	Trawl	Dryhold	2
	0-10	34-44	Purse Seine	Dryhold	1
	10-12	20-106	Purse Seine	Dryhold	11
	12-18	21-245	Purse Seine	Dryhold	97
	18-24	70-397	Purse Seine	Dryhold	100
	24-40	140-809	Purse Seine	Dryhold	94
	0-10	3-74	Artisanal	Dryhold	306
	10-12	12-118	Artisanal	Dryhold	207
	12-18	18-239	Artisanal	Dryhold	206
	18-24	59-368	Artisanal	Dryhold	42
	24-40	129-368	Artisanal	Dryhold	12

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 (6, 7, 8.a-b,d,e, 5.b (EC), 2.a (nonEC), 12, 14), a certain quantity may be taken from 4.a 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.	

Technical measure	National/International level	Specification	Note
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.	There are de minimis exemptions for mackerel caught in bottom-trawl fisheries in the North Western Waters (EC 2018/2034) and in the North Sea (EC 2018/2035).

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
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

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		
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

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		
1999	116362		116362	94290		94290	313014		313014	72848		72848	43796		43796	640311		640311
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
2018	157239	90	157329	35240	1611	36851	341527	620	342147	455689	51	455740	33851	518	34369	1023547	2890	1026437

Table 8.4.2.1. NE Atlantic Mackerel. ICES estimated catch (t) in Subareas 1, 2, 5 and 14, 1984 – 2018 (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 – 2018. 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 – 2018. 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 – 2018. Continued.

Country	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Denmark		4845	269		391	2345	4321	1	2	289
Estonia					13671		0			
Faroe Islands	2992	66312	121499	107198	142976	103896	76889	61901	66194	52061
France			2		197	8	36			733
Germany				107	74		2963	3499	4064	577
Greenland			621	74021	541481	875811	30351	36142	46388	62973
Iceland	116160	121008	159263	149282	151103	172960	169333	170374	167366	168330
Ireland			90			1725	6	2		
Latvia										
Lithuania						1082		1931		
Netherlands		90	178	5	1	5887	6996	8599	7671	2697
Norway	3038	104858	43168	110741	33817	192322	204574	153228	167739	46853
Poland										2
Sweden				4	825	3310	740	730	1720	910
United King-dom					2	5534	7851	5240	4601	2009
Russia	414141	58613	73601	74587	80812	116433	128433	121614	138061	118255
Misreported (Area 4.a)										
Misreported (Area 6.a)										
Misreported (Unknown)										
Unallocated										
Discards		5	28	1	151	911	78	54	62	51
Total	163604	355729	398160	449326	465729	684173	632571	563315	603869	455740

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), 1988-2018 (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), 1988-2018. 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), 1988-2018. 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), 19882018. Continued.

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	27	21	39	62	56	38	99	107	110
Denmark	36552	32800	36492	31924	21340	35809	21696	27457	22207
Estonia									
Faroe Islands	4639	543	432	25	42919	25672	18193	12915	15475
France	686	1416	5736	1788	4912	7827	3448	5942	6714
Germany	25621	52911	4560	5755	4979	6056	10172	11185	12091
Iceland									
Ireland	14639	15810	20422	13523	45167	34167	24437	35957	24567
Latvia									
Lithuania					8340		596		
Netherlands	1300	9881	6018	4863	24536	17547	11434	17401	13844
Norway	129064	162878	64181	130056	85409	36344	55089	51960	135715
Poland						24		0.721	4041
Romania									
Sweden	34291	32481	4560	2081	1112	3190	2933	1981	3056
United Kingdom	52563	69858	75959	70840	145119	129203	99945	104499	103707
Russia	696			4					
Misreported (Area 2.a)									
Misreported (Area 6.a)									
Misreported (Unknown)									
Unallocated	660								
Discards	883	1906	1089	337	334	34	559	400	620
Total	247700	303652	219489	261258	384221	295911	248611	269804	342147

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 – 2018 (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 – 2018 (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 – 2018 Continued.

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009
Belgium				1					1
Denmark	835		113				6	10	
Estonia									
Faroe Islands	2161	2490	2260	674		59	1333	3539	4421
France	18975	19726	21213	18549	15182	14625	12434	14944	16464
Germany	20793	22630	19200	18730	14598	14219	12831	10834	17545
Guernsey						10			
Ireland	60168	51457	49715	41730	30082	36539	35923	33132	48155
Isle of Man									
Jersey					9	8	6	7	8
Lithuania						95	7		
Netherlands	33654	21831	23640	21132	18819	20064	18261	17920	20900
Norway							7	3948	121
Poland					461	1368	978		
Russia									
Spain	4063	3483			4795	4048	2772	7327	8462
United Kingdom	139589	131599	167246	149346	115586	67187	87424	768821	109147
Misreported (Area 4.a)	-39024	-43339	-62928	-23139	-37911	-8719		-17280	-1959
Misreported (Unknown)									
Unallocated	37952	27558	5587	9714	13412	4783	10042	-952	490
Discards	1164	15191	7111	7696	20359	14723	10177	27351	6848
Total	280553	252620	233157	244432	190597	169009	192201	177662	230603

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 – 2018. Continued.

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	2					14	44	21	58
Denmark	48	2889	8	903	18538	6741	19443	12569	8194
Estonia									
Faroe Islands	36	8			3421	5851	13173	20559	13543
France	10301	11304	14448	12438	16627	17820	16634	16925	13974
Germany	16493	18792	14277	15102	23478	19238	9740	9608	7214
Guernsey		10	5	9	9	4			12
Ireland	43355	45696	42627	42988	56286	54571	52087	48957	42181
Isle of Man	14	11	11	8	3		8	2	3
Jersey	6	7	8	8	7	3	3	0.003	3
Lithuania		23			176	554	13		
Netherlands	21699	18336	19794	16295	16242	15264	17896	18694	13851
Norway	30	2019	1101	734		1313	1035	2657	4639
Poland									14
Russia	1						30		
Spain	6532	1257	773	635	1796	951	1253	786	4471
United Kingdom	107840	111103	93775	92957	137195	110932	112268	116308	84309
Misreported (Area 4.a)									
Misreported (Unknown)									
Unallocated	4503	399	16	-144		34			13
Discards	7518	7153	10654	2105	1742	3185	2126	2142	1701
Total	218377	219007	197496	183857	275519	236475	245754	249229	194180

Table 8.4.2.4. NE Atlantic Mackerel. ICES estimated catch (t) in Divisions 8.c and 9.a, 1977 – 2018 (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 – 2018 (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	2018
France	8.c	220	171	21	106	83	50
Portugal	8.c						3709
Portugal	9.a	254	618	1456	619	634	855
Spain	8.c	14617	33783	29726	26553	30893	27250
Spain	9.a	1162	2227	3853	2229	1206	1687
Discards	8.c	1428	2821	4724	2469	84	324
Discards	9.a	1027	1463	2409	751	143	194
Unallocated	8.c	-573	8795	11	1357		300
Unallocated	9.a	4053	662	1831	2123		
Total	9.a	6497	4308	9550	5722	1983	2736
Total		22188	45570	44033	36207	33042	34369

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers (‘000s) -at-age by area for 2018. Quarters 1-4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0	0	0	0	0	0	1267.7	0	3.07	0
1	4386.0	10.9	1.4	2.5	3.2	10822.8	364.2	96.7	0.0
2	43760.5	121.7	5.7	9.9	9.6	129923.4	3729.0	1055.1	1032.6
3	44149.5	43.8	4.9	8.3	3.1	53002.8	1700.4	450.3	3861.1
4	107902.8	235.6	7.3	12.3	3.9	136104.0	1990.2	578.9	18635.2
5	79566.3	108.9	3.9	6.3	2.6	79734.7	490.4	142.9	18278.4
6	73573.6	163.8	4.2	7.2	1.7	87574.7	221.6	113.0	24607.9
7	113671.1	208.9	2.3	3.9	0.6	142174.1	204.2	129.9	29419.7
8	96157.4	200.0	1.4	2.3	0.2	89309.3	67.9	91.8	24110.9
9	62313.7	108.1	1.2	2.1	0.2	45940.9	40.6	52.9	13139.8
10	54456.9	81.2	0.8	1.2	0.1	37487.6	34.6	36.8	8057.2
11	25324.4	61.2	0.8	1.2	0.1	25135.7	26.6	15.2	5255.1
12	13830.9	27.3	0.1	0.1	0.0	12045.6	8.4	9.8	1878.3
13	3966.2	8.3	0.0	0.0	0.0	3546.8	3.2	0.5	446.0
14	1953.6	10.9	0.1	0.1	0.0	2081.0	4.2	0.6	0.0
15+	569.1	5.2	0.0	0.0	0.0	1317.1	2.3	0.0	0.0
Catch	316662	552	12	20	8	338056	2660	838	65103
SOP	316681	551	12	20	8	338092	2664	839	65103
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0	0	0	0	0	1.29	120.3	682.6	48.3	0
1	0.5	108.8	0.1	6.0	0.3	18.7	2457.4	942.3	818.2
2	9809.0	19829.2	8.8	10.8	1949.3	29.2	3509.7	1273.7	808.8
3	625.2	20276.8	14.8	6.3	930.1	10.3	1515.6	327.1	124.0
4	4512.6	72579.1	35.5	9.5	5401.6	19.0	1751.2	460.6	140.0
5	1509.7	50059.3	38.5	9.6	2821.1	13.3	1744.0	293.3	42.2
6	1765.8	64007.3	38.5	6.5	3387.6	18.2	1613.5	295.2	16.3
7	3425.9	80083.2	0.9	4.4	4699.5	23.2	1329.9	180.6	0.1
8	3885.5	55339.0	1.0	2.2	5405.1	17.6	587.3	90.3	0.0
9	1477.1	37197.7	0.4	3.6	1686.5	12.5	996.5	182.0	0.1
10	2374.7	17448.5	0.6	1.8	1976.5	5.1	361.3	60.4	0.0
11	800.3	11976.9	0.2	0.1	909.1	3.7	216.9	94.8	0
12	846.3	6797.4	0.2	0.0	267.2	1.1	76.3	33.4	0
13	197.5	1005.9	0.1	0.0	58.3	0.3	34.1	14.9	0
14	0.1	318.1	0.0	0.0	3.5	0.2	34.1	14.9	0
15+	196.1	43.8	0.1	0.0	49.2	0.0	0.0	0.0	0
Catch	11034	157275	54	20	10130	51	5406	1131	365
SOP	11033	157285	54	20	10132	51	5442	1131	365
SOP%	100%	100%	100%	100%	100%	100%	99%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2018 (cont.). Q 1-4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0	0.0	3.9	153.6	5.2	2235.0	1442.2	305.9	584.1
1	192.0	11.9	378.4	0.6	5808.4	1263.5	14909.6	1950.4
2	280.8	182.7	522.3	1.1	3500.8	2146.2	8791.3	311.0
3	47.7	77.0	536.2	0.5	1188.0	813.4	4179.3	539.1
4	75.1	175.8	3885.9	1.1	3177.7	2396.1	8518.4	2983.2
5	53.6	80.0	2208.3	0.9	1320.2	1215.6	4676.6	2293.9
6	34.8	57.6	4070.3	1.3	2145.6	1987.0	7338.3	3713.4
7	12.4	53.2	3149.6	1.7	2665.6	2512.9	9654.1	4940.7
8	7.0	22.3	2073.4	1.3	2026.5	1934.0	7592.3	3825.9
9	11.1	42.8	3080.7	0.9	1587.5	1465.2	7074.5	3092.3
10	5.4	12.4	1009.5	0.4	764.4	701.9	3709.7	1467.7
11	0.3	33.4	1992.7	0.3	503.7	462.3	2679.1	957.7
12	0.1	11.7	701.3	0.1	165.9	151.6	942.6	321.4
13	0.0	5.2	296.1	0.0	30.9	29.9	243.6	70.9
14	0.0	5.1	289.1	0.0	6.4	6.0	37.1	13.1
15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Catch	159	209	8283	3	5966	5015	22884	8749
SOP	159	210	8287	3	5961	5009	22865	8748
SOP%	100%	99%	100%	100%	100%	100%	100%	100%

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	25.2	0.1	2574.3	0.0	0.0	9452.8
1	31.5	878.7	642.1	0.0	0.0	46106.9
2	20.4	1016.3	4774.9	0.8	473.5	238898.0
3	9.8	368.6	1006.1	3.0	1752.4	137575.2
4	38.3	255.5	714.8	9.6	5628.9	378239.8
5	27.2	124.5	140.3	18.2	10664.5	257688.9
6	45.6	99.7	197.5	31.3	18398.1	295536.9
7	61.4	48.1	448.2	45.6	26766.8	425922.4
8	49.2	57.9	210.5	41.8	24560.1	317671.2
9	41.5	65.5	108.0	32.0	18769.2	198527.0
10	20.3	17.9	87.9	18.0	10580.8	140781.4
11	13.7	23.1	35.5	11.1	6527.6	83062.8
12	4.6	0.0	24.0	5.8	3407.9	41559.6
13	0.8	0.0	4.3	3.6	2099.6	12066.8
14	0.2	0.0	0.0	0.0	0.0	4778.2
15+	0.0	0.0	0.0	0.0	0.0	2182.7
Catch	113	855	1881	107	62834	1026437
SOP	113	855	1880	107	62835	1026482
SOP%	100%	100%	100%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2018 (cont.). Q1

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	0.060					0.150	0.000	0.030	
2	0.770	1.850			0.020	13.810	0.050	1.030	
3	0.110	0.430	0.030	0.010	0.020	6.080	0.360	0.320	
4	1.830	7.700	0.070	0.030	0.060	53.520	0.840	2.250	
5	0.640	2.920	0.080	0.030	0.040	25.190	0.930	0.980	
6	0.780	5.780	0.080	0.030	0.050	41.880	0.930	1.710	
7	2.040	6.890			0.040	46.990	0.010	2.400	
8	1.780	7.420			0.040	46.790	0.010	2.310	
9	0.840	4.650			0.020	30.160	0.010	1.210	
10	0.770	2.630			0.010	16.510	0.010	0.890	
11	0.510	1.700			0.010	11.180	0.010	0.270	
12	0.230	0.480				3.420	0.010	0.290	
13	0.110	0.090				0.650	0.000	0.010	
14	0.050	0.040				0.290	0.000	0.020	
15+	0.030	0.000				0.040	0.000	0.000	
Catch	4.687	15.422	0.109	0.038	0.116	108.285	1.283	5.067	
SOP	4.683	15.302	0.105	0.041	0.114	107.636	1.280	5.068	
SOP%	100%	101%	103%	94%	102%	101%	100%	100%	

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0							97.1		
1		106.9	0.1	1.0	0.0	7.7	349.6	206.3	143.1
2		19700.5	5.3	1.2	423.0	15.2	499.2	352.4	145.4
3		20230.2	0.3	0.2	307.6	3.9	233.4	101.1	19.2
4		71798.3	0.9	0.2	4199.4	9.6	447.4	216.1	17.8
5		49646.2	0.1	0.1	2340.5	3.4	309.0	104.4	5.9
6		63295.3	0.03	0.02	3326.3	2.7	448.2	153.6	0.9
7		79380.2			4463.7	2.8	262.4	79.9	
8		54826.6			5310.4	2.0	133.3	46.5	
9		36832.0			1654.5	1.6	272.3	109.7	
10		17171.0			1941.1	0.8	68.0	29.8	
11		11774.0			893.8	1.2	215.0	94.8	
12		6646.3			262.7	0.5	75.7	33.4	
13		939.9			57.4	0.2	33.8	14.9	
14		316.3			3.5	0.2	33.8	14.9	
15+		33.6			48.3	0.0	0.0	0.0	
Catch		155792	1	0.49	9109	12	1139	433	56
SOP		155800	1	0.49	9111	12	1175	434	56
SOP%		100%	100%	100%	100%	100%	97%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers (‘000s) -at-age by area for 2018 (cont.). Q1

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					677.1	244.6	0.0	0.0
1		10.3	228.2	0.0	1780.8	687.8	13158.0	1445.5
2	0.01	181.0	309.1	0.3	1422.0	1564.7	8192.3	279.6
3	0.02	75.8	474.1	0.1	484.3	564.7	3412.8	440.6
4	0.2	171.6	3703.0	0.3	1271.4	1570.7	5492.0	2404.2
5	0.1	74.7	2026.6	0.1	505.4	716.8	2249.4	1825.7
6	0.1	50.7	3853.9	0.1	812.9	1156.0	3415.1	2945.5
7	0.2	44.8	2959.9	0.1	988.7	1418.9	4562.1	3907.6
8	0.1	16.2	1946.2	0.0	739.7	1072.1	3530.2	3021.2
9	0.1	37.8	2935.1	0.1	532.5	727.9	3425.3	2397.3
10	0.04	10.3	951.1	0.0	251.8	336.4	1785.0	1120.2
11	0.02	32.6	1949.0	0.1	162.0	214.8	1345.2	727.7
12	0.01	11.5	687.0	0.02	52.1	67.7	470.2	241.5
13		5.1	290.5	0.01	11.0	16.0	153.1	54.8
14		5.1	284.3	0.01	1.9	2.5	18.0	9.9
15+						0.0	0.0	0.0
Catch	0	195	7793	0	2204	2877	13146	6859
SOP	0	196	7796	0	2205	2878	13126	6859
SOP%	100%	99%	100%	99%	100%	100%	100%	100%

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	5.9					1024.7
1	24.4	164.2	279.9			18594.2
2	12.5	175.3	2329.1			35625.4
3	4.5	182.0	22.6			26564.8
4	15.5	96.9	57.7			91539.7
5	8.3	33.7	10.5			59891.7
6	13.5	20.7	21.3			79568.1
7	17.6	25.4	30.9			98203.5
8	13.5	12.9	7.8			70736.9
9	11.2	24.9	3.5			49002.5
10	5.4	8.2	0.9			23700.9
11	3.6	13.6	0.9			17441.9
12	1.3	0.0	0.3			8554.4
13	0.3	0.0	0.0			1577.9
14	0.1	0.0	0.0			690.7
15+	0.0	0.0	0.0			82.0
Catch	36	259	361			200408
SOP	36	259	360			200425
SOP%	100%	100%	100%			100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2018 (cont.). Q2

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	160.2	2.1	0.0	1.1	2.5	55.0	209.7	50.9	0.0
2	331.5	43.5	0.0	4.2	6.6	916.0	2698.7	718.6	0.1
3	1544.9	7.6	0.0	3.4	0.7	115.4	1111.7	289.7	0.3
4	1314.7	119.3	0.1	5.2	0.9	1104.8	1313.3	384.2	1.5
5	1937.6	41.2	0.1	2.6	0.4	419.2	267.1	83.5	1.4
6	785.5	78.2	0.1	3.0	0.4	397.1	99.3	65.1	1.9
7	2083.3	113.1	0.1	1.7	0.2	1026.3	111.2	94.6	2.3
8	1981.5	113.8	0.1	1.0	0.1	760.5	31.2	76.2	1.9
9	1868.7	66.8	0.0	0.9	0.1	394.7	26.6	39.8	1.0
10	1658.2	40.8	0.1	0.5	0.0	315.2	14.6	29.3	0.6
11	619.5	27.5	0.1	0.5	0.0	294.2	13.0	9.0	0.4
12	294.2	9.3	0.0	0.1		119.8	2.2	9.5	0.2
13	81.5	2.4	0.0	0.0		38.6	1.1	0.4	0.0
14	18.7	1.0	0.0	0.0		17.4	0.4	0.6	
15+	2.2	0.4	0.0	0.0		14.7	0.3		
Catch	6269.5	247.0	0.4	8.5	2.9	2338.1	1688.1	554.3	5.1
SOP	6269.2	246.4	0.3	8.5	2.9	2339.4	1690.2	554.5	5.1
SOP%	100%	100%	102%	100%	101%	100%	100%	100%	100%

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0									
1	0.0	0.2		1.2	0.2	3.4	0.0	7.3	3.9
2	339.3	74.8		1.7	1514.7	3.2	0.4	13.6	5.6
3	31.5	16.0		0.3	617.5	1.8	105.1	16.7	0.9
4	203.2	510.2		0.5	1186.8	8.9	316.2	49.1	1.4
5	99.2	280.2		0.4	473.1	9.8	524.9	83.0	0.9
6	124.3	516.6		0.3	55.3	15.4	421.0	70.8	0.5
7	193.8	513.9		0.0	226.6	20.3	420.2	54.8	0.1
8	195.8	373.9		0.0	85.3	15.6	210.2	27.4	0.0
9	84.8	270.0		0.0	29.0	10.8	420.5	54.8	0.1
10	102.4	208.0		0.0	31.9	4.3	209.9	27.4	0.0
11	41.1	149.8			13.8	2.5	1.2		
12	33.9	113.1			4.0	0.7	0.4		
13	7.9	50.4			0.9	0.2	0.2		
14		1.4			0.0	0.0	0.2		
15+	6.7	7.8			0.8				
Catch	547.3	1052.4		1.0	998.6	30.3	982.0	145.8	2.8
SOP	547	1053		1.01	999	30	982	146	3
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 2018 (cont.). Q2

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					1553.5	218.6		
1	191.95	1.3	142.1	0.3	4027.6	571.1	1734.4	504.9
2	280.74	1.4	203.3	0.3	2073.9	294.6	563.9	22.4
3	45.28	0.9	48.4	0.1	677.1	148.7	693.9	97.2
4	67.3	3.8	128.0	0.8	1760.7	573.6	3007.2	577.4
5	41.8	4.7	133.5	0.8	685.4	379.9	2419.5	467.5
6	24.9	6.5	150.6	1.2	1117.3	635.1	3918.3	766.8
7	2.1	7.9	145.2	1.6	1385.9	844.5	5086.2	1031.7
8	1.5	5.8	102.9	1.2	1053.5	672.5	4060.7	803.6
9	1.3	4.6	91.7	0.8	864.7	563.2	3646.5	694.1
10	0.59	1.9	39.4	0.4	421.6	281.1	1924.7	347.1
11	0.20	0.9	13.5	0.2	280.8	190.4	1333.9	229.7
12	0.07	0.2	3.8	0.06	93.9	63.4	472.3	79.8
13	0.01	0.1	0.8	0.02	16.3	10.6	90.5	16.1
14		0.0	0.1		3.7	2.6	19.1	3.3
15+								
Catch	136	13	345	3	3270	1566	9666	1870
SOP	136	13	346	3	3268	1560	9666	1869
SOP%	100%	100%	100%	100%	100%	100%	100%	100%

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	2.7					1774.8
1	7.0	590.8	54.2			8323.0
2	3.8	99.7	1837.5		7.5	12061.6
3	4.0	62.8	407.7		27.9	6077.4
4	20.0	96.6	576.0		89.6	13420.8
5	17.8	70.9	113.1		169.7	8729.1
6	30.1	72.5	165.8		292.8	9816.7
7	41.3	18.1	404.6		426.0	14257.4
8	33.7	43.9	199.6		390.9	11244.2
9	28.1	37.0	95.1		298.7	9594.4
10	13.7	9.7	87.0		168.4	5938.8
11	9.3	9.5	34.6		103.9	3379.4
12	3.0		23.4		54.2	1381.7
13	0.5		4.2		33.4	356.1
14	0.1					68.6
15+						32.9
Catch	70	315	998		1000	34125
SOP	70	315	997		1000	34120
SOP%	101%	100%	100%		100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers (‘000s) -at-age by area for 2018 (cont.). Q3

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58	0.00
1	3278.19	7.44	1.41	1.41	0.54	262.62	133.62	29.66	0.00
2	35269.91	67.08	5.48	5.41	2.15	4033.56	938.53	263.25	1030.57
3	40631.16	28.70	4.58	4.45	1.56	561.89	532.02	119.05	3853.53
4	93793.82	96.81	6.83	6.71	1.89	4553.67	607.42	139.45	18598.50
5	71557.17	57.43	3.47	3.34	1.36	1806.20	188.07	35.87	18242.40
6	66290.32	70.58	3.94	3.92	0.81	1645.94	102.02	24.33	24559.52
7	93461.43	82.77	2.13	2.15	0.25	3928.67	53.23	16.90	29361.86
8	80607.56	74.40	1.25	1.28	0.07	2940.16	23.76	6.18	24063.45
9	52814.30	34.08	1.15	1.18	0.05	1509.23	13.12	6.15	13113.97
10	44715.46	36.34	0.68	0.70	0.02	1245.84	13.57	3.09	8041.33
11	19799.06	30.91	0.68	0.70	0.02	1161.77	13.30	3.09	5244.78
12	11555.35	17.27	0.06	0.06	0.00	487.30	6.11	0.00	1874.63
13	2973.58	5.72	0.02	0.02	0.00	161.19	2.08	0.00	445.11
14	1680.19	9.80	0.04	0.04	0.00	97.77	3.80	0.00	0.00
15+	389.50	4.77	0.02	0.02	0.00	71.02	1.93	0.00	0.00
Catch	270554	265	11	11	3	9545	843	192	64975
SOP	270575	265	11	11	3	9546	844	192	64975
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0	0	0	0	0	1.29	106.4300	378.0	23.780	0
1	0.5	0.2	0.0	3.7	0.1	7.1	1360.4	468.0	213.6
2	100.3	4.6	3.5	7.7	0.8	10.3	1942.5	472.7	276.0
3	10.7	1.5	14.5	5.7	0.5	4.5	736.0	73.7	36.0
4	48.7	36.1	34.6	8.5	6.1	0.5	565.8	63.1	44.2
5	20.3	20.7	38.5	8.9	3.4	0.1	468.9	46.7	16.8
6	19.4	36.8	38.51	5.85	4.8	0.0	385.3	35.7	10.2
7	39.6	31.3	0.900	4.00	6.4	0.0	323.0	24.9	0.000
8	44.1	18.8	1.0	1.83	7.6	0.0	110.0	9.2	0.000
9	19.8	16.7	0.4	3.36	2.4	0.0	101.0	11.0	0.000
10	28.5	13.2	0.6	1.65	2.8	0.0	6.4	2.7	0.000
11	9.7	12.0	0.2	0.02	1.2	0.0	0.0	0.0	
12	9.3	8.5	0.2	0.00	0.4	0.0	0.0	0.0	
13	2.2	4.5	0.1	0.00	0.1	0.0	0.0	0.0	
14	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	
15+	2.0	0.7	0.1	0.00	0.1	0.0	0.0	0.0	
Catch	127	67	53	18.06	13	8	1898	268	120
SOP	127	67	53	18.09	13	8	1898	268	121
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2018 (cont.). Q3

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0	0.00	3.9	84.8	5.2	0.0	332.4	5.5	169.2
1	0.00	0.3	5.7	0.4	0.0	1.6	2.9	0.0
2	0.00	0.4	8.1	0.5	1.6	104.3	23.0	2.8
3	0.01	0.2	13.5	0.2	13.6	35.4	55.4	0.5
4	0.0	0.2	54.5	0.0	80.4	86.6	15.9	0.8
5	0.1	0.3	47.8	0.0	79.3	39.8	6.5	0.3
6	0.1	0.3	65.3	0.0	134.9	65.9	4.4	0.5
7	0.1	0.3	44.2	0.0	186.0	84.0	5.1	0.7
8	0.0	0.1	24.2	0.0	153.0	64.4	1.3	0.5
9	0.1	0.3	53.7	0.0	128.0	57.6	2.4	0.4
10	0.02	0.1	18.9	0.0	62.2	28.0	0.0	0.2
11	0.00	0.0	30.0	0.0	42.5	18.9	0.0	0.1
12	0.00	0.0	10.6	0.00	13.9	6.6	0.1	0.0
13	0.00	0.0	4.7	0.00	2.2	1.1	0.0	0.0
14	0.00	0.0	4.7	0.00	0.6	0.3	0.0	0.0
15+	0.00	0.000	0.0000	0.00	0.0000	0.0	0.0	0.0
Catch	0	1	138	0	311	191	35	6
SOP	0	1	138	0	308	191	35	6
SOP%	102%	100%	100%	99%	101%	100%	100%	100%

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	0.0	0.1	1290.5	0.0	0.0	2402.7
1	0.0	86.9	276.7	0.0	0.0	6142.7
2	0.0	627.4	518.6	0.8	466.0	46187.6
3	0.1	93.1	305.8	3.0	1724.5	48865.4
4	0.0	43.1	48.5	9.6	5539.3	124491.5
5	0.0	0.3	15.2	18.2	10494.8	103222.3
6	0.0	3.2	9.7	31.3	18105.3	111658.9
7	0.0	3.3	11.7	45.6	26340.8	154061.2
8	0.0	0.0	2.7	41.8	24169.2	132367.9
9	0.0	3.6	8.7	32.0	18470.5	86404.9
10	0.0	0.0	0.0	18.0	10412.4	64652.6
11	0.0	0.0	0.0	11.1	6423.7	32803.8
12	0.0	0.0	0.2	5.8	3353.7	17350.0
13	0.0	0.0	0.0	3.6	2066.2	5672.3
14	0.0	0.0	0.0	0.0	0.0	1797.3
15+	0.0	0.0	0.0	0.0	0.0	470.1
Catch	0	215	335	107	61834	412146
SOP	0	215	335	107	61835	412163
SOP%	125%	100%	100%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2018 (cont.). Q4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0	0.0	0.0	0.0	0.0	0.0	1267.7	0.0	1.5	0.0
1	947.5	1.4	0.0	0.1	0.1	10505.0	20.9	16.0	0.0
2	8158.3	9.3	0.2	0.3	0.8	124960.0	91.8	72.3	2.0
3	1973.3	7.0	0.3	0.4	0.9	52319.5	56.3	41.3	7.3
4	12792.5	11.8	0.3	0.4	1.0	130392.0	68.7	53.0	35.2
5	6070.9	7.4	0.2	0.3	0.8	77484.1	34.3	22.5	34.5
6	6497.0	9.3	0.1	0.2	0.4	85489.7	19.3	21.9	46.5
7	18124.4	6.1	0.0	0.1	0.1	137172.2	39.7	16.0	55.6
8	13566.6	4.3	0.0	0.0	0.0	85561.9	13.0	7.2	45.6
9	7629.9	2.5	0.0	0.0	0.0	44006.9	0.9	5.7	24.8
10	8082.5	1.4	0.0	0.0	0.0	35910.0	6.4	3.6	15.2
11	4905.3	1.1	0.0	0.0	0.0	23668.6	0.4	2.9	9.9
12	1981.1	0.2	0.0	0.0	0.0	11435.1	0.1	0.0	3.6
13	911.0	0.1	0.0	0.0	0.0	3346.3	0.1	0.0	0.8
14	254.6	0.0	0.0	0.0	0.0	1965.6	0.0	0.0	0.0
15+	177.3	0.0	0.0	0.0	0.0	1231.3	0.0	0.0	0.0
Catch	39834	24	0	1	2	326065	128	87	123
SOP	39834	24	0	1	2	326107	128	87	123
SOP%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0	0	0		0	0	13.8	207.5	24.510	0
1	0.0	1.5		0.2	0.0	0.49	747.5	260.7	457.6
2	9369.4	49.3		0.2	10.8	0.50	1067.6	435.0	381.7
3	583.0	29.1		0.0	4.5	0.06	441.1	135.6	67.9
4	4260.7	234.5		0.4	9.4	0.11	421.8	132.3	76.7
5	1390.3	112.2		0.1	4.0	0.04	441.2	59.1	18.6
6	1622.1	158.5		0.25	1.2	0.07	359.1	35.2	4.6
7	3192.6	157.8		0.34	2.7	0.08	324.4	20.9	
8	3645.5	119.7		0.36	1.8	0.05	133.9	7.1	
9	1372.5	78.9		0.23	0.7	0.06	202.7	6.5	
10	2243.8	56.4		0.13	0.7	0.03	77.0	0.4	
11	749.5	41.2		0.08	0.3	0.02	0.7	0.0	
12	803.1	29.5		0.02	0.1	0.01	0.2	0.0	
13	187.4	11.1		0.00	0.0	0.00	0.1	0.0	
14	0.0	0.3		0.00	0.0	0.00	0.1	0.0	
15+	187.4	1.6		0.00	0.0	0.00	0.0	0.0	
Catch	10359	364		0.78	9	1	1386	284	185
SOP	10359	367		0.77	9	1	1386	284	185
SOP%	100%	99%		101%	100%	103%	100%	100%	100%

Table 8.4.3.1. NE Atlantic Mackerel. Catch numbers ('000s) -at-age by area for 2018 (cont.). Q4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0	0.02	0.02	68.8		4.4	646.7	300.4	414.9
1	0.00	0.00	2.48		0.0	2.9	14.4	0.0
2	0.02	0.00	1.89		3.2	182.7	12.1	6.2
3	2.34	0.06	0.13		13.0	64.7	17.2	0.8
4	7.6	0.17	0.38		65.2	165.2	3.3	0.8
5	11.7	0.29	0.28		50.1	79.1	1.2	0.4
6	9.8	0.23	0.41		80.5	130.0	0.5	0.6
7	10.1	0.23	0.26		105.1	165.4	0.7	0.8
8	5.3	0.12	0.13		80.4	125.0	0.2	0.6
9	9.6	0.23	0.28		62.3	116.6	0.3	0.4
10	4.78	0.12	0.10		28.9	56.5	0.0	0.2
11	0.10	0.00	0.16		18.5	38.1	0.0	0.1
12	0.04	0.00	0.05		6.1	13.8	0.0	0.0
13	0.00	0.00	0.02		1.3	2.3	0.0	0.0
14	0.00	0.00	0.02		0.3	0.6	0.0	0.0
15+								
Catch	23	1	7		181	381	37	14
SOP	23	1	7		181	381	37	14
SOP%	100%	100%	99%		100%	100%	100%	100%

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	16.6	0.0	1283.8			4250.6
1	0.1	36.8	31.3			13047.0
2	4.0	114.0	89.8			145023.3
3	1.3	30.6	270.1			56067.6
4	2.7	19.0	32.6			148787.9
5	1.2	19.6	1.5			85845.9
6	2.0	3.2	0.6			94493.3
7	2.6	1.4	1.0			159400.3
8	2.0	1.1	0.4			103322.3
9	2.3		0.8			53525.2
10	1.1		0.0			46489.2
11	0.8		0.0			29437.8
12	0.3		0.0			14273.4
13	0.0		0.0			4460.6
14	0.0		0.0			2221.6
15+			0.0			1597.7
Catch	7	65	188			379758
SOP	7	65	188			379804
SOP%	100%	100%	100%			100%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1%.

Quarters 14

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0						0%		0%	
1	1%	1%	4%	4%	13%	1%	4%	3%	
2	6%	9%	17%	17%	38%	15%	42%	38%	1%
3	6%	3%	14%	14%	13%	6%	19%	16%	3%
4	15%	17%	22%	21%	15%	16%	22%	21%	13%
5	11%	8%	11%	11%	10%	9%	6%	5%	12%
6	10%	12%	12%	12%	7%	10%	2%	4%	17%
7	16%	15%	7%	7%	2%	17%	2%	5%	20%
8	13%	14%	4%	4%	1%	10%	1%	3%	16%
9	9%	8%	4%	4%	1%	5%	0%	2%	9%
10	8%	6%	2%	2%	0%	4%	0%	1%	5%
11	3%	4%	2%	2%	0%	3%	0%	1%	4%
12	2%	2%	0%	0%		1%	0%	0%	1%
13	1%	1%	0%	0%		0%	0%	0%	0%
14	0%	1%	0%	0%		0%	0%	0%	
15+	0%	0%				0%	0%		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0					0%	41%	4%	1%	
1	0%	0%	0%	10%	0%	6%	15%	22%	42%
2	31%	5%	6%	18%	7%	10%	21%	30%	41%
3	2%	5%	11%	10%	3%	4%	9%	8%	6%
4	14%	17%	25%	16%	18%	7%	10%	11%	7%
5	5%	11%	28%	16%	10%	5%	10%	7%	2%
6	6%	15%	28%	11%	11%	6%	10%	7%	1%
7	11%	18%	1%	7%	16%	8%	8%	4%	0%
8	12%	13%	1%	4%	18%	6%	3%	2%	0%
9	5%	9%	0%	6%	6%	4%	6%	4%	0%
10	8%	4%	0%	3%	7%	2%	2%	1%	0%
11	3%	3%	0%	0%	3%	1%	1%	2%	
12	3%	2%	0%	0%	1%	0%	0%	1%	
13	1%	0%	0%	0%	0%	0%	0%	0%	
14	0%	0%	0%	0%	0%	0%	0%	0%	
15+	1%	0%	0%	0%	0%	0%	0%	0%	

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarters 14

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0		1%	1%	34%	8%	8%	0%	2%
1	27%	2%	2%	4%	21%	7%	18%	7%
2	39%	24%	2%	7%	13%	12%	11%	1%
3	7%	10%	2%	3%	4%	4%	5%	2%
4	10%	23%	16%	7%	12%	13%	11%	11%
5	7%	10%	9%	6%	5%	7%	6%	8%
6	5%	7%	17%	8%	8%	11%	9%	14%
7	2%	7%	13%	11%	10%	14%	12%	18%
8	1%	3%	9%	8%	7%	10%	9%	14%
9	2%	6%	13%	6%	6%	8%	9%	11%
10	1%	2%	4%	2%	3%	4%	5%	5%
11	0%	4%	8%	2%	2%	2%	3%	4%
12	0%	2%	3%	1%	1%	1%	1%	1%
13	0%	1%	1%	0%	0%	0%	0%	0%
14	0%	1%	1%	0%	0%	0%	0%	0%
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	6%	0%	23%			0%
1	8%	30%	6%			2%
2	5%	34%	44%	0%	0%	9%
3	3%	12%	9%	1%	1%	5%
4	10%	9%	7%	4%	4%	15%
5	7%	4%	1%	8%	8%	10%
6	12%	3%	2%	14%	14%	11%
7	16%	2%	4%	21%	21%	16%
8	13%	2%	2%	19%	19%	12%
9	11%	2%	1%	14%	14%	8%
10	5%	1%	1%	8%	8%	5%
11	4%	1%	0%	5%	5%	3%
12	1%		0%	3%	3%	2%
13	0%		0%	2%	2%	0%
14	0%					0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 1

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	1%	0%			0%	0%		0%	
2	7%	4%			6%	5%	2%	8%	
3	1%	1%	12%	10%	6%	2%	11%	2%	
4	17%	18%	27%	30%	19%	18%	26%	16%	
5	6%	7%	31%	30%	13%	8%	29%	7%	
6	7%	14%	31%	30%	16%	14%	29%	12%	
7	19%	16%			13%	16%	0%	17%	
8	17%	17%			13%	16%	0%	17%	
9	8%	11%			6%	10%	0%	9%	
10	7%	6%			3%	6%	0%	6%	
11	5%	4%			3%	4%	0%	2%	
12	2%	1%				1%	0%	2%	
13	1%	0%				0%	0%	0%	
14	0%	0%				0%	0%	0%	
15+	0%					0%	0%	0%	

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0							3%		
1		0%	2%	37%	0%	15%	10%	13%	43%
2		5%	79%	44%	2%	29%	14%	23%	44%
3		5%	5%	8%	1%	8%	7%	6%	6%
4		17%	13%	8%	17%	19%	13%	14%	5%
5		11%	1%	3%	9%	7%	9%	7%	2%
6		15%	0%	1%	13%	5%	13%	10%	0%
7		18%			18%	5%	8%	5%	
8		13%			21%	4%	4%	3%	
9		9%			7%	3%	8%	7%	
10		4%			8%	2%	2%	2%	
11		3%			4%	2%	6%	6%	
12		2%			1%	1%	2%	2%	
13		0%			0%	0%	1%	1%	
14		0%			0%	0%	1%	1%	
15+		0%			0%	0%	0%	0%	

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 1

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					7%	2%		
1		1%	1%		18%	7%	26%	7%
2	1%	25%	1%	24%	15%	15%	16%	1%
3	2%	10%	2%	11%	5%	5%	7%	2%
4	18%	24%	16%	24%	13%	15%	11%	12%
5	8%	10%	9%	11%	5%	7%	4%	9%
6	14%	7%	17%	7%	8%	11%	7%	14%
7	20%	6%	13%	6%	10%	14%	9%	19%
8	14%	2%	9%	2%	8%	10%	7%	15%
9	12%	5%	13%	5%	5%	7%	7%	12%
10	5%	1%	4%	2%	3%	3%	3%	5%
11	2%	4%	9%	5%	2%	2%	3%	3%
12	1%	2%	3%	2%	1%	1%	1%	1%
13		1%	1%	1%	0%	0%	0%	0%
14		1%	1%	1%	0%	0%	0%	0%
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	4%					0%
1	18%	22%	10%			3%
2	9%	23%	84%			6%
3	3%	24%	1%			5%
4	11%	13%	2%			16%
5	6%	4%	0%			10%
6	10%	3%	1%			14%
7	13%	3%	1%			17%
8	10%	2%	0%			12%
9	8%	3%	0%			8%
10	4%	1%	0%			4%
11	3%	2%	0%			3%
12	1%		0%			1%
13	0%					0%
14	0%					0%
15+	0%					0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 2

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	1%	0%	0%	4%	21%	1%	4%	3%	0%
2	2%	7%	3%	17%	56%	15%	46%	39%	1%
3	11%	1%	1%	14%	6%	2%	19%	16%	3%
4	9%	18%	15%	21%	7%	18%	22%	21%	13%
5	13%	6%	9%	11%	3%	7%	5%	5%	12%
6	5%	12%	8%	12%	3%	7%	2%	4%	17%
7	14%	17%	12%	7%	1%	17%	2%	5%	20%
8	13%	17%	15%	4%	1%	13%	1%	4%	16%
9	13%	10%	5%	4%	1%	7%	0%	2%	9%
10	11%	6%	9%	2%	0%	5%	0%	2%	5%
11	4%	4%	9%	2%		5%	0%	0%	4%
12	2%	1%	5%	0%		2%	0%	1%	1%
13	1%	0%	1%	0%		1%	0%	0%	0%
14	0%	0%	4%	0%		0%	0%	0%	
15+	0%	0%	1%	0%		0%	0%		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0									
1	0%	0%		26%	0%	3%	0%	2%	29%
2	23%	2%		38%	36%	3%	0%	3%	42%
3	2%	1%		6%	15%	2%	4%	4%	7%
4	14%	17%		11%	28%	9%	12%	12%	10%
5	7%	9%		10%	11%	10%	20%	21%	7%
6	8%	17%		8%	1%	16%	16%	17%	4%
7	13%	17%		1%	5%	21%	16%	14%	1%
8	13%	12%		0%	2%	16%	8%	7%	0%
9	6%	9%		1%	1%	11%	16%	14%	1%
10	7%	7%		0%	1%	4%	8%	7%	0%
11	3%	5%		0%	0%	3%	0%		
12	2%	4%		0%	0%	1%	0%		
13	1%	2%		0%	0%	0%	0%		
14	0%	0%		0%	0%	0%	0%		
15+	0%	0%		0%	0%	0%			

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 2

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					10%	4%		
1	29%	3%	12%	3%	25%	10%	6%	9%
2	43%	3%	17%	4%	13%	5%	2%	0%
3	7%	2%	4%	2%	4%	3%	2%	2%
4	10%	9%	11%	10%	11%	11%	10%	10%
5	6%	12%	11%	10%	4%	7%	8%	8%
6	4%	16%	13%	15%	7%	12%	14%	14%
7	0%	20%	12%	21%	9%	15%	18%	18%
8	0%	15%	9%	16%	7%	12%	14%	14%
9	0%	11%	8%	11%	5%	10%	13%	12%
10	0%	5%	3%	5%	3%	5%	7%	6%
11	0%	2%	1%	3%	2%	3%	5%	4%
12	0%	1%	0%	1%	1%	1%	2%	1%
13	0%	0%	0%	0%	0%	0%	0%	0%
14		0%	0%		0%	0%	0%	0%
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	1%					2%
1	3%	53%	1%			8%
2	2%	9%	46%		0%	11%
3	2%	6%	10%		1%	6%
4	9%	9%	14%		4%	13%
5	8%	6%	3%		8%	8%
6	14%	7%	4%		14%	9%
7	19%	2%	10%		21%	13%
8	16%	4%	5%		19%	11%
9	13%	3%	2%		14%	9%
10	6%	1%	2%		8%	6%
11	4%	1%	1%		5%	3%
12	1%		1%		3%	1%
13	0%		0%		2%	0%
14	0%					0%
15+						0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 3

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0								0%	
1	1%	1%	4%	4%	6%	1%	5%	5%	
2	6%	11%	17%	17%	25%	16%	36%	41%	1%
3	7%	5%	14%	14%	18%	2%	20%	18%	3%
4	15%	16%	22%	21%	22%	19%	23%	22%	13%
5	12%	9%	11%	11%	16%	7%	7%	6%	12%
6	11%	11%	12%	12%	9%	7%	4%	4%	17%
7	15%	13%	7%	7%	3%	16%	2%	3%	20%
8	13%	12%	4%	4%	1%	12%	1%	1%	16%
9	9%	5%	4%	4%	1%	6%	0%	1%	9%
10	7%	6%	2%	2%	0%	5%	1%	0%	5%
11	3%	5%	2%	2%	0%	5%	1%	0%	4%
12	2%	3%	0%	0%	0%	2%	0%		1%
13	0%	1%	0%	0%	0%	1%	0%		0%
14	0%	2%	0%	0%	0%	0%	0%		
15+	0%	1%	0%	0%	0%	0%	0%		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0					3%	83%	6%	2%	
1	0%	0%	0%	7%	0%	5%	21%	38%	36%
2	28%	2%	3%	15%	2%	8%	30%	38%	46%
3	3%	1%	11%	11%	1%	3%	12%	6%	6%
4	14%	18%	26%	17%	16%	0%	9%	5%	7%
5	6%	10%	29%	17%	9%	0%	7%	4%	3%
6	5%	18%	29%	11%	13%	0%	6%	3%	2%
7	11%	15%	1%	8%	17%	0%	5%	2%	
8	12%	9%	1%	4%	20%	0%	2%	1%	
9	6%	8%	0%	7%	6%	0%	2%	1%	
10	8%	6%	0%	3%	7%	0%	0%	0%	
11	3%	6%	0%	0%	3%				
12	3%	4%	0%	0%	1%				
13	1%	2%	0%	0%	0%				
14	0%	0%		0%					
15+	1%	0%	0%		0%				

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 3

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0		61%	18%	83%		36%	4%	96%
1		4%	1%	6%		0%	2%	0%
2		6%	2%	8%	0%	11%	19%	2%
3	3%	4%	3%	4%	2%	4%	45%	0%
4	13%	3%	12%	0%	9%	9%	13%	0%
5	20%	5%	10%		9%	4%	5%	0%
6	17%	4%	14%		15%	7%	4%	0%
7	17%	4%	9%		21%	9%	4%	0%
8	7%	2%	5%		17%	7%	1%	0%
9	17%	4%	11%		14%	6%	2%	0%
10	7%	2%	4%		7%	3%		0%
11			6%		5%	2%		0%
12			2%		2%	1%	0%	0%
13			1%		0%	0%		0%
14			1%		0%	0%		
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0		0%	52%			0%
1		10%	11%			1%
2	13%	73%	21%	0%	0%	5%
3	63%	11%	12%	1%	1%	5%
4	13%	5%	2%	4%	4%	13%
5	13%	0%	1%	8%	8%	11%
6		0%	0%	14%	14%	12%
7		0%	0%	21%	21%	16%
8			0%	19%	19%	14%
9		0%	0%	14%	14%	9%
10				8%	8%	7%
11				5%	5%	3%
12			0%	3%	3%	2%
13				2%	2%	1%
14						0%
15+						0%

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0						0%		1%	
1	1%	2%	3%	3%	3%	1%	6%	6%	
2	9%	15%	18%	18%	18%	15%	26%	27%	1%
3	2%	11%	21%	21%	21%	6%	16%	16%	3%
4	14%	19%	25%	25%	25%	16%	20%	20%	13%
5	7%	12%	19%	19%	19%	9%	10%	9%	12%
6	7%	15%	11%	10%	10%	10%	5%	8%	17%
7	20%	10%	2%	3%	3%	17%	11%	6%	20%
8	15%	7%	1%	1%	0%	10%	4%	3%	16%
9	8%	4%				5%	0%	2%	9%
10	9%	2%				4%	2%	1%	5%
11	5%	2%				3%	0%	1%	4%
12	2%	0%				1%	0%		1%
13	1%	0%				0%	0%		0%
14	0%	0%				0%	0%		
15+	0%	0%				0%	0%		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0						90%	5%	2%	
1	0%	0%		6%		3%	17%	23%	45%
2	32%	5%		10%	30%	3%	24%	39%	38%
3	2%	3%		2%	12%	0%	10%	12%	7%
4	14%	22%		16%	26%	1%	10%	12%	8%
5	5%	10%		5%	11%	0%	10%	5%	2%
6	5%	15%		11%	3%	0%	8%	3%	0%
7	11%	15%		15%	7%	1%	7%	2%	
8	12%	11%		15%	5%	0%	3%	1%	
9	5%	7%		10%	2%	0%	5%	1%	
10	8%	5%		6%	2%	0%	2%	0%	
11	3%	4%		3%	1%	0%	0%		
12	3%	3%		1%	0%	0%	0%		
13	1%	1%		0%	0%		0%		
14		0%		0%			0%		
15+	1%	0%			0%				

Table 8.4.3.2. NE Atlantic Mackerel. Percentage catch numbers-at-age by area for 2018. Zeros represent values <1% (cont.).

Quarter 4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0	0%	1%	91%		1%	36%	86%	97%
1	0%	0%	3%		0%	0%	4%	
2	0%	0%	3%		1%	10%	3%	1%
3	4%	4%	0%		2%	4%	5%	0%
4	12%	12%	1%		13%	9%	1%	0%
5	19%	20%	0%		10%	4%	0%	0%
6	16%	16%	1%		15%	7%	0%	0%
7	16%	16%	0%		20%	9%	0%	0%
8	9%	8%	0%		15%	7%	0%	0%
9	16%	16%	0%		12%	7%	0%	0%
10	8%	8%	0%		6%	3%		0%
11	0%		0%		4%	2%		0%
12	0%		0%		1%	1%	0%	0%
13			0%		0%	0%		
14			0%		0%	0%		
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	45%		75%			0%
1	0%	16%	2%			1%
2	11%	51%	5%			15%
3	3%	14%	16%			6%
4	7%	8%	2%			15%
5	3%	9%	0%			9%
6	5%	1%	0%			10%
7	7%	1%	0%			17%
8	5%	0%	0%			11%
9	6%		0%			6%
10	3%					5%
11	2%					3%
12	1%		0%			1%
13	0%					0%
14	0%					0%
15+	0%					0%

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018.

Quarters 1-4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0						225		254	
1	262	295	298	298	290	295	280	284	
2	309	306	315	315	295	313	305	304	343
3	315	337	330	329	340	343	320	316	345
4	341	341	334	332	350	347	342	338	347
5	349	356	351	349	365	360	352	346	358
6	358	360	347	345	364	362	362	353	360
7	360	365	359	358	374	367	375	365	363
8	366	370	365	365	370	372	372	368	365
9	369	378	368	368	372	379	371	379	375
10	373	385	374	373	374	384	384	384	376
11	383	384	373	373	373	386	380	381	380
12	389	396	393	393	401	387	392	391	384
13	390	395	390	390	397	391	390	405	394
14	392	388	385	385	388	395	386	410	
15+	397	410	410	410	410	402	409		

AGE	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0					170	175	254	254	
1	251	291	217	277	246	251	298	280	260
2	303	285	284	299	289	274	316	300	300
3	333	326	336	338	324	320	330	321	314
4	340	337	353	350	338	339	346	333	320
5	352	351	368	362	351	356	354	350	340
6	352	356	377	369	361	360	369	363	364
7	354	361	354	374	365	363	375	371	373
8	361	368	361	375	368	366	389	376	375
9	367	377	367	382	378	373	386	377	383
10	372	384	372	394	379	378	393	390	395
11	387	387	387	386	390	383	386	386	
12	380	393	380	407	396	389	390	390	
13	370	396	370	405	404	389	385	385	
14	400	397	409	405	385	386	385	385	
15+	390	404	390		421	421			

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarters 1-4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0		171	191	170	151	162	226	164
1	284	243	257	255	175	178	240	164
2	296	288	284	279	284	285	294	295
3	313	323	323	325	313	316	343	340
4	330	332	335	342	334	337	341	343
5	350	346	353	357	357	358	363	360
6	364	359	358	360	360	360	365	362
7	369	353	362	363	364	364	369	366
8	373	365	367	366	368	368	372	369
9	381	372	373	373	380	378	381	376
10	393	384	384	378	382	381	387	382
11	393	386	387	383	387	387	390	386
12	400	390	391	388	393	392	395	392
13	405	385	385	389	395	395	408	398
14	385	385	385	388	395	395	395	395
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	162	220	210			191
1	195	268	249			248
2	286	309	278	350	350	307
3	327	358	313	354	354	330
4	341	367	331	356	356	343
5	360	375	369	365	365	354
6	363	385	366	366	366	360
7	367	393	379	370	370	364
8	370	399	390	373	373	369
9	380	391	386	379	379	375
10	383	402	411	384	384	379
11	387	396	389	383	383	385
12	392		397	386	386	389
13	394		395	407	407	394
14	395					393
15+						400

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 1

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	300	300			288	301	280	277	
2	318	280			293	286	304	287	
3	335	309	337	337	338	320	335	311	
4	343	336	354	354	344	338	354	333	
5	353	355	369	369	364	356	369	353	
6	360	360	378	378	367	361	377	354	
7	367	363			364	363	359	361	
8	373	370			370	370	365	367	
9	378	377			377	376	370	380	
10	383	386			386	385	384	385	
11	388	386			386	386	378	387	
12	392	407				404	393	391	
13	396	406				403	390	405	
14	400	409				405	385	410	
15+	410					406	410		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0							254		
1		292	217	280		242	298	283	278
2		285	276	293	289	279	316	301	288
3		326	300	312	328	316	329	319	308
4		337	311	324	341	331	341	330	323
5		351	312	337	354	347	354	348	337
6		356	335	359	361	358	365	358	361
7		361			366	357	371	365	
8		368			368	367	384	365	
9		377			378	374	382	371	
10		384			379	382	385	385	
11		387			390	387	386	386	
12		393			396	392	390	390	
13		397			404	387	385	385	
14		397			385	385	385	385	
15+		406			421	421			

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 1

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					151	151		
1		242	242		176	180	236	164
2	301	288	277	289	284	285	292	294
3	326	323	323	323	312	314	342	340
4	336	331	335	331	334	335	338	343
5	353	346	353	345	356	357	364	360
6	355	358	357	358	359	359	365	362
7	359	351	362	351	363	363	369	366
8	368	365	367	365	367	366	373	368
9	376	371	373	371	378	377	383	376
10	383	385	384	385	380	379	389	381
11	393	386	387	386	387	387	392	386
12	400	390	391	390	393	393	396	391
13		385	385	385	397	398	414	398
14		385	385	385	395	395	395	395
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	151					161
1	200	259	237			225
2	286	346	261			286
3	322	364	329			328
4	337	359	333			337
5	359	381	359			352
6	362	376	355			357
7	366	389	356			362
8	369	410	368			368
9	378	394	378			377
10	383	400	382			383
11	388	396	385			388
12	393		386			393
13	402		395			396
14	395					391
15+						415

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 2

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	249	299	291	298	290	300	281	279	
2	301	298	315	316	291	314	304	303	343
3	305	319	347	328	324	329	316	314	345
4	332	336	346	331	329	340	339	338	347
5	342	353	357	347	343	349	344	346	358
6	351	358	357	344	341	356	358	356	360
7	354	364	357	358	355	363	374	365	363
8	363	370	365	365	360	369	369	367	365
9	365	377	370	368	362	375	372	380	375
10	368	385	384	373	370	379	377	385	376
11	380	387	378	373	370	384	381	386	380
12	389	401	393	393		388	388	391	384
13	393	401	390	390		392	389	405	394
14	399	403	385	385		396	393	410	
15+	410	411	410	410		406	407		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0									
1	254	244		284	240	240	280	287	284
2	303	285		297	289	273	301	303	296
3	337	312		314	322	342	325	324	313
4	342	335		330	329	348	345	343	329
5	355	351		352	339	360	355	356	350
6	356	357		365	361	361	365	365	365
7	357	362		373	347	364	372	373	373
8	362	367		375	368	366	375	375	375
9	370	377		383	378	373	382	383	383
10	373	384		395	379	377	395	395	395
11	385	389			390	382	386		
12	381	387			396	388	390		
13	374	386			405	391	385		
14	404	409			395	392	385		
15+	390	395			421	421			

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 2

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					151	151		
1	284	244	279	241	175	175	269	164
2	296	278	296	287	284	287	315	314
3	312	337	321	341	312	326	346	344
4	329	347	339	347	334	341	347	344
5	349	359	356	359	357	360	362	360
6	364	361	362	361	360	363	365	363
7	360	365	365	364	365	367	368	367
8	368	366	367	366	368	370	372	370
9	377	375	376	374	381	380	379	378
10	385	380	384	378	382	383	385	384
11	394	381	383	382	388	387	389	387
12	400	387	389	388	393	392	393	392
13	405	390	391	391	394	392	397	395
14		395	395		395	395	395	395
15+								

Age	**8.d**	**9.a**	**9.a.N**	**14.a**	**14.b**	**All**
0	150					151
1	176	270	238			211
2	289	329	298		350	298
3	338	363	305		354	318
4	345	373	329		356	339
5	361	373	369		365	353
6	364	387	368		366	362
7	367	400	381		370	365
8	370	396	391		373	369
9	380	388	386		379	376
10	383	403	412		384	380
11	387	396	389		383	386
12	392		397		386	391
13	389		395		407	394
14	395					397
15+						401

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 3

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0								254	
1	254	294	298	298	290	298	278	287	
2	309	311	315	316	302	312	307	305	343
3	314	342	329	328	343	333	327	318	345
4	341	347	332	331	354	340	346	338	347
5	348	359	349	347	368	350	360	345	358
6	358	362	345	344	370	358	364	350	360
7	359	366	358	358	380	364	377	368	363
8	365	370	365	365	375	369	366	371	365
9	368	379	368	368	376	375	370	372	375
10	372	385	373	373	373	380	381	373	376
11	382	382	373	373	372	383	378	373	380
12	389	393	393	393	393	389	393		384
13	388	392	390	390	390	392	390		394
14	390	386	385	385	385	392	385		
15+	392	410	410	410	410	407	410		

Age	**5.b**	**6.a**	**6.b**	**7.a**	**7.b**	**7.c**	**7.d**	**7.e**	**7.f**
0					170	170	254	254	
1	247	298	217	276	265	265	298	281	273
2	303	304	296	301	286	269	316	291	299
3	321	323	337	341	326	315	331	316	313
4	339	337	354	353	341	321	349	339	320
5	349	350	369	363	354	344	353	351	347
6	351	358	377	370	361	365	375	372	365
7	354	362	354	375	366	349	381	379	373
8	361	367	361	376	368	375	416	405	375
9	366	376	367	383	378	383	402	394	383
10	371	383	372	395	379	395	395	395	395
11	386	390	388	386	390				
12	381	387	380	407	396				
13	372	385	370	407	405				
14	399	396		409					
15+	390	395	390		421				

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 3

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0		170	170	170		168	173	164
1		265	265	265		279	264	285
2		268	268	268	338	285	302	278
3	325	318	322	315	348	314	328	301
4	345	343	338	315	347	336	355	332
5	355	355	354		361	358	378	359
6	365	365	361		364	362	374	361
7	373	373	367		367	366	372	365
8	375	375	368		370	369	375	368
9	383	383	375		380	381	391	375
10	395	395	388		383	383		381
11			386		387	388		386
12			390		392	392	415	391
13			385		389	392		395
14			385		395	395		395
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0		220	218			209
1		262	262			269
2	306	298	279	350	350	310
3	327	352	311	354	354	319
4	353	376	344	356	356	342
5	377	410	375	365	365	352
6		381	371	366	366	360
7		381	368	370	370	362
8			375	373	373	367
9		400	400	379	379	372
10				384	384	374
11				383	383	382
12			415	386	386	388
13				407	407	396
14						390
15+						395

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0						225		254	
1	294	294	288	288	288	294	282	294	
2	313	312	309	309	309	313	308	310	343
3	344	340	346	346	346	343	344	326	345
4	346	347	359	359	359	347	355	337	347
5	356	360	370	370	370	360	369	350	358
6	361	364	376	376	376	363	370	350	360
7	366	372	390	390	390	367	372	365	363
8	372	378	390	390	390	372	388	375	365
9	374	385	400	400	400	379	375	372	375
10	381	386				384	403	379	376
11	386	387				386	382	373	380
12	390	398				387	388		384
13	394	404				391	389		394
14	400	389				395	396		
15+	409	410				402	406		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0						210	254	254	
1	295	289		253		252	298	276	248
2	303	296		296	289	261	316	311	305
3	333	328		315	322	352	331	324	316
4	340	338		333	331	361	348	330	319
5	351	350		352	342	364	354	345	334
6	351	358		358	361	365	371	370	362
7	354	362		363	354	365	377	381	
8	361	369		370	368	371	393	416	
9	367	379		377	379	385	388	402	
10	372	386		386	380	385	395	395	
11	388	387		386	390	389	386		
12	380	392		407	396	393	390		
13	370	387		407	405		385		
14		410		409			385		
15+	390	395			421				

Table 8.5.1.1. NE Atlantic Mackerel. Mean length (mm) -at-age by area for 2018 (cont.).

Quarter 4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0	217	217	217		166	168	227	164
1	248	248	248		285	280	242	
2	311	257	257		324	285	277	276
3	325	325	345		342	316	325	290
4	344	345	345		343	336	344	334
5	355	355	355		359	359	376	359
6	364	365	361		361	362	374	361
7	371	373	367		365	366	369	365
8	374	375	368		368	369	379	368
9	382	383	375		376	382	390	375
10	394	395	388		381	384		381
11	394		386		386	388		386
12	400		390		391	392	415	391
13	405		385		395	394		395
14			385		395	395		
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	168		202			205
1	274	291	257			292
2	285	302	301			312
3	312	334	326			343
4	335	350	335			347
5	359	374	379			359
6	364	402	370			362
7	368	413	367			367
8	372	424	375			372
9	388		396			378
10	386					383
11	389					386
12	393		415			387
13	393					391
14	395					396
15+						401

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2018. 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				0%			0%	
18				0%			1%	0%
19				1%			3%	2%
20			0%	3%			2%	9%
21			0%	4%			0%	14%
22			0%	1%	0%	1%	0%	4%
23			1%	1%	0%	0%	0%	0%
24	1%		6%	0%	1%	5%	1%	0%
25	8%	1%	20%	0%	19%	5%	4%	1%
26	13%	4%	24%	2%	26%	10%	8%	2%
27	11%	3%	22%	8%	18%	10%	14%	7%
28	10%	7%	11%	10%	8%	20%	20%	14%
29	15%	8%	8%	20%	8%	17%	25%	20%
30	18%	7%	3%	22%	10%	8%	11%	17%
31	15%	4%	0%	17%	5%	7%	5%	6%
32	7%	9%	3%	7%	2%	6%	3%	3%
33	2%	12%	0%	1%	1%	5%	2%	1%
34	1%	12%	1%	1%	0%	2%	1%	0%
35	0%	16%	0%	1%	0%	1%	1%	0%
36	0%	10%	0%		0%	1%	0%	0%
37	0%	4%	0%			1%	0%	0%
38	0%	3%	0%			1%	0%	
39							0%	
40							0%	

	UKE lines							
	7.e				7.f			
Length cm	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
41							0%	
42								
43								
44								
45								

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2018. Zeros represent values <1% (cont.). Southern Fleets. ES=Spain.

	ES All fleets			
length cm	Q1	Q2	Q3	Q4
16				
17				1%
18			1%	4%
19			2%	19%
20	0%		5%	25%
21	4%		17%	11%
22	9%		19%	9%
23	6%		8%	7%
24	3%		1%	2%
25	5%	0%	4%	0%
26	8%	0%	9%	0%
27	4%	0%	7%	0%
28	3%	1%	3%	0%
29	1%	4%	4%	1%
30	2%	3%	5%	1%
31	2%	1%	4%	3%
32	3%	2%	3%	7%

	ES All fleets			
length cm	Q1	Q2	Q3	Q4
33	3%	4%	1%	6%
34	5%	10%	2%	2%
35	9%	15%	2%	0%
36	10%	18%	2%	0%
37	8%	17%	1%	0%
38	6%	14%	1%	0%
39	4%	7%	0%	0%
40	2%	3%	0%	
41	1%	1%	0%	
42	0%	0%	0%	
43	0%	0%		
44	0%	0%		
45	0%	0%		
46		0%		
47		0%		
48				

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2018. Zeros represent values <1% (cont.). Southern Fleets (cont.). BQ=Basque

	BQ Purse Seine				BQ Artisanal		BQ Trawl	
length cm	Q1	Q2	Q3	Q4	Q1	Q2	Q1	Q2
20								
21								
22								
23							1%	
24							1%	
25							1%	
26							4%	

	BQ Purse Seine				BQ Artisanal		BQ Trawl	
length cm	Q1	Q2	Q3	Q4	Q1	Q2	Q1	Q2
27							15%	
28					0%		12%	
29					0%		11%	
30	0%				0%		6%	
31	1%	1%			1%	0%	4%	
32	2%	1%		2%	2%	1%	4%	1%
33	6%	6%		6%	4%	4%	4%	3%
34	12%	14%		12%	9%	10%	5%	9%
35	22%	21%	33%	21%	18%	17%	7%	19%
36	25%	19%	39%	25%	24%	23%	8%	25%
37	17%	18%	28%	17%	22%	21%	7%	20%
38	9%	11%		10%	11%	13%	6%	12%
39	5%	6%		5%	6%	7%	2%	7%
40	1%	1%		1%	2%	2%	1%	4%
41	1%	1%			1%	1%		1%
42	0%	0%			0%	0%		1%
43	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 2018. Zeros represent values <1% (cont.). Southern Fleets (cont.). PT=Portugal.

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

	PT All			
length cm	**Q1**	**Q2**	**Q3**	**Q4**
47				
49				

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2018. Zeros represent values <1% (cont.). Pelagic Trawl Fleets. IE=Ireland, UKS=UK Scotland, IS=Iceland

	IE				**UKS**		**IS**		
	4.a	6.a	7.b	7.j	4.a	6.a	2.a	5.a	14.b
Length cm	Q4	Q1	Q1	Q1	Q4	Q1	Q3	Q3	Q3
15									
16									
17									
18									
19									
20									
21									
22									
23									
24		0%				0%			
25		0%				1%			
26	0%	1%				1%			
27	1%	1%			0%	1%			
28	1%	1%			1%	1%	0%		
29	2%	1%			2%	1%	1%		
30	4%	1%	0%	0%	3%	1%	1%		
31	2%	1%	0%	1%	4%	3%	2%	0%	
32	3%	5%	2%	5%	4%	6%	2%	0%	
33	4%	8%	6%	10%	7%	10%	6%	2%	1%
34	8%	10%	12%	15%	12%	17%	12%	8%	1%
35	15%	18%	22%	23%	17%	21%	19%	22%	10%

	IE				UKS		IS		
	4.a	6.a	7.b	7.j	4.a	6.a	2.a	5.a	14.b
Length cm	Q4	Q1	Q1	Q1	Q4	Q1	Q3	Q3	Q3
36	22%	19%	24%	21%	19%	17%	24%	26%	20%
37	18%	14%	15%	11%	16%	11%	17%	21%	23%
38	11%	10%	11%	7%	8%	8%	9%	12%	25%
39	7%	6%	5%	5%	5%	2%	4%	4%	14%
40	2%	2%	2%	1%	2%	1%	2%	2%	3%
41	1%	1%	1%	0%	0%	0%	1%	1%	2%
42	0%	0%	0%		0%	0%	0%	0%	1%
43	0%	0%				0%	0%		
44	0%	0%							
45		0%							
46		0%							

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2018. Zeros represent values <1% (cont.). Pelagic Trawl Fleets. DK=Denmark, RU=Russia

	DK			RU	
	4.a	4.b	6.a	2.a	2.a
length cm	Q4	Q4	Q4	Q3	Q4
15					
16					
17					
18					
19					
20					
21					
22				0%	
23				0%	0%
24				0%	0%
25				0%	0%

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

Table 8.5.1.2. NE Atlantic Mackerel. Percentage length composition in catches by country and fleet in 2018. Zeros represent values <1% (cont.). Freezer Trawlers. NL=The Netherlands, DE=Germany,

	NL				**DE**	
	2.a,4.a,4.b,6.a,7.b,7.c				6.a	4.a
length cm	Q1	Q2	Q3	Q4	Q1	Q3
15						
16						
17						
18						
19						
20					0%	
21					0%	
22					0%	
23					0%	
24					0%	
25					1%	
26				0%	1%	0%
27	1%		2%	0%	1%	5%
28	3%		8%	5%	1%	12%
29	1%		15%	8%	1%	11%
30	3%	1%	13%	10%	1%	7%
31	3%	1%	10%	13%	2%	9%
32	9%	4%	12%	1%	4%	14%
33	16%	6%	14%	7%	7%	13%
34	22%	16%	11%	1%	14%	12%
35	16%	19%	4%	4%	20%	8%
36	11%	21%	5%	15%	17%	6%
37	7%	11%	3%	18%	14%	2%
38	4%	10%	3%	11%	9%	1%
39	2%	6%	1%	4%	4%	0%
40	2%	3%	0%	4%	2%	

	NL				DE	
	2.a,4.a,4.b,6.a,7.b,7.c				6.a	4.a
length cm	Q1	Q2	Q3	Q4	Q1	Q3
41	0%	1%	0%	0%	0%	
42	0%	0%			0%	
43	0%				0%	
44					0%	

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018

Quarters 1-4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0						87		110	
1	156	225	237	238	217	220	188	200	
2	283	240	280	281	226	256	248	245	377
3	310	330	326	323	355	348	293	279	385
4	392	333	343	338	389	363	350	332	390
5	418	389	398	392	440	407	397	368	423
6	452	391	384	379	439	413	435	382	430
7	454	409	430	428	465	435	449	409	440
8	476	430	456	454	461	452	467	419	446
9	493	452	467	465	465	480	474	470	477
10	506	494	494	489	476	503	527	487	484
11	544	500	491	488	477	510	511	490	496
12	572	563	578	578	563	514	560	507	510
13	583	563	565	565	555	533	555	587	546
14	579	551	547	547	548	558	548	611	
15+	608	644	646	646	646	586	640		

AGE	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0					37	41	110	110	
1	131	211	65	160	110	117	205	165	135
2	234	173	177	211	161	148	253	209	208
3	321	270	301	337	245	241	295	261	244
4	343	297	362	367	291	276	338	289	260
5	384	344	433	396	326	314	359	336	322
6	383	361	448	403	356	323	409	366	403
7	392	377	391	405	369	329	432	392	386
8	417	402	416	429	379	338	505	432	428
9	442	436	441	423	412	360	462	410	420
10	459	461	458	455	415	375	451	445	455
11	527	475	527	454	451	395	423	423	
12	493	501	493	547	475	428	476	476	
13	452	525	451	529	502	406	390	390	
14	579	529	551	526	396	399	396	396	
15+	537	559	537		576	576			

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarters 1-4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0		37	55	37	21	28	88	28
1	162	103	123	125	35	38	105	28
2	187	159	164	162	160	162	195	183
3	225	242	243	252	219	226	314	284
4	266	271	278	290	267	272	284	290
5	324	301	320	319	326	327	335	338
6	361	329	331	324	335	334	337	345
7	375	317	343	336	347	346	345	356
8	410	360	370	345	358	355	354	364
9	417	380	387	365	397	388	381	390
10	451	427	431	385	402	397	396	409
11	464	421	425	407	420	415	408	423
12	490	474	476	442	438	433	416	441
13	509	390	393	431	449	446	461	468
14	396	396	396	430	445	440	416	453
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	28	81	71			55
1	53	160	115			133
2	165	252	154	406	406	246
3	248	388	230	421	421	319
4	278	415	254	427	427	354
5	324	442	349	457	457	396
6	333	471	338	461	461	410
7	343	502	374	474	474	426
8	350	521	405	485	485	446
9	381	491	398	507	507	469
10	391	527	472	523	523	491
11	402	507	399	522	522	507
12	418		423	532	532	528
13	431		416	615	615	556
14	427					551
15+						587

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 1

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	238	230			205	233	190	183	
2	291	152			196	171	246	188	
3	350	220	303	303	327	252	301	249	
4	371	283	367	367	325	293	367	293	
5	407	345	434	434	406	360	434	357	
6	434	358	449	449	399	367	449	361	
7	455	367			371	371	444	388	
8	479	392			392	395	474	408	
9	503	416			417	420	490	465	
10	524	453			453	456	542	485	
11	545	456			455	461	520	493	
12	566	550			550	540	578	507	
13	582	542			541	539	565	587	
14	600	552			551	546	547	611	
15+	651	636				606	646		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0							110		
1		211	65	152		101	205	158	148
2		173	153	181	161	149	253	196	169
3		270	206	224	258	225	279	238	214
4		297	232	252	298	265	314	268	250
5		344	233	288	334	303	349	308	289
6		361	303	354	356	335	388	331	365
7		377			372	337	405	342	
8		403			379	374	477	367	
9		436			412	390	465	382	
10		461			415	423	435	435	
11		476			451	428	423	423	
12		502			475	473	476	476	
13		535			502	400	390	390	
14		528			396	396	396	396	
15+		606			576	576			

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 1

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					21	21		
1		101	101		36	40	97	28
2	188	159	149	161	161	161	192	181
3	249	242	243	243	218	222	318	282
4	277	270	277	271	267	270	279	289
5	325	300	319	300	326	328	341	338
6	332	330	330	330	334	334	337	345
7	343	314	342	314	347	346	348	356
8	374	367	371	367	358	356	357	364
9	401	382	387	382	395	390	391	388
10	427	435	432	435	402	400	403	407
11	462	423	426	423	425	424	417	422
12	489	475	477	476	444	445	420	440
13		390	393	390	460	465	482	472
14		396	396	396	451	451	416	453
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	21					30
1	58	145	95			88
2	165	342	124			175
3	239	394	248			275
4	273	382	254			294
5	331	455	316			342
6	339	434	305			357
7	351	479	308			373
8	360	560	340			395
9	390	499	367			426
10	404	520	379			448
11	419	506	387			460
12	436		388			492
13	472		416			494
14	443					458
15+						588

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 2

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0									
1	126	235	212	239	218	233	191	187	
2	264	212	299	282	218	265	246	242	377
3	280	273	375	321	309	317	279	273	385
4	372	296	407	334	326	342	339	329	390
5	399	348	441	388	372	372	369	359	423
6	432	359	442	376	365	396	419	374	430
7	441	382	445	427	416	422	440	398	440
8	467	404	474	454	435	444	456	408	446
9	482	429	491	465	442	465	472	465	477
10	492	464	542	489	477	485	495	485	484
11	540	474	520	488	477	503	509	493	496
12	575	547	578	578		522	526	507	510
13	625	552	565	565		539	542	587	546
14	582	565	547	547		555	553	611	
15+	651	636	646	646		606	613		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0									
1	138	107		164	99	99	190	168	162
2	235	171		190	161	144	229	201	187
3	341	233		227	239	276	263	258	224
4	354	270		266	266	288	318	311	263
5	403	315		328	287	318	343	346	321
6	407	317		366	355	320	353	357	365
7	411	348		386	313	328	386	386	386
8	426	374		428	379	334	428	428	428
9	456	405		420	411	355	420	420	420
10	464	416		455	416	365	455	455	455
11	517	414			451	379	423		
12	496	413			474	398	476		
13	465	379			508	412	391		
14	591	602			416	411	396		
15+	537	404			576	576			

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 2

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0					21	21		
1	162	104	156	102	35	35	163	28
2	187	153	187	184	160	165	244	225
3	223	271	242	277	217	245	301	294
4	261	292	282	299	266	277	293	293
5	319	325	328	322	326	323	328	339
6	365	326	338	324	336	332	336	348
7	345	333	341	337	349	342	341	359
8	376	339	351	344	360	351	352	368
9	403	365	380	363	403	381	373	396
10	430	382	404	383	405	390	389	416
11	464	376	386	402	422	402	399	426
12	490	394	409	431	439	418	411	444
13	510	406	415	454	447	419	425	455
14		416	416		446	427	416	453
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	21					21
1	36	164	100			84
2	169	297	183		406	207
3	268	389	198		421	266
4	283	425	246		427	304
5	321	423	342		457	351
6	329	475	339		461	354
7	338	522	378		474	373
8	345	505	407		485	392
9	374	476	389		507	413
10	383	532	473		523	437
11	393	508	399		522	446
12	408		422		532	469
13	402		416		615	499
14	417					509
15+						547

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 3

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0								110	
1	137	222	238	239	215	229	183	208	
2	288	258	281	282	242	259	254	249	377
3	309	343	324	321	365	330	314	284	385
4	394	379	338	334	405	346	369	338	390
5	419	417	393	388	449	379	426	374	423
6	454	425	379	376	458	404	448	396	430
7	456	446	428	427	487	425	461	440	440
8	478	472	454	454	495	448	466	480	446
9	495	499	465	465	492	469	478	486	477
10	505	530	489	489	487	490	526	486	484
11	548	525	488	488	486	505	514	486	496
12	577	572	578	578	578	528	573		510
13	588	567	565	565	565	542	562		546
14	578	549	547	547	547	552	548		
15+	596	645	646	646	646	615	644		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0					37	37	110	110	
1	123	239	65	162	142	142	205	167	157
2	234	224	213	221	159	149	253	191	206
3	303	277	303	348	258	241	303	261	240
4	344	265	365	380	299	254	360	323	260
5	387	303	433	401	334	303	380	366	348
6	387	306	449	408	356	353	477	448	409
7	398	328	391	408	372	319	498	478	386
8	422	347	416	436	379	428	656	599	428
9	451	377	441	423	412	420	610	530	420
10	464	386	458	455	416	455	455	455	455
11	529	402	527	455	452				
12	500	392	493	550	475				
13	468	374	451	541	509				
14	578	510		551					
15+	537	404	537		576				

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 3

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0		37	37	37		31	39	28
1		142	142	142		152	143	160
2		148	148	148	263	162	222	149
3	263	247	249	241	288	221	276	195
4	318	314	292	241	286	269	353	263
5	343	343	325		320	325	422	334
6	353	353	338		329	335	410	341
7	386	386	357		338	347	402	352
8	428	428	388		345	356	411	361
9	420	420	395		373	396	473	386
10	455	455	442		382	400		405
11			423		392	413		421
12			476		407	430	561	440
13			390		400	430		459
14			396		416	438		453
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0		81	79			70
1		144	138			161
2	224	223	168	406	406	282
3	273	393	236	421	421	318
4	346	481	322	427	427	393
5	419	639	415	457	457	422
6	407	499	399	461	461	449
7		500	389	474	474	455
8			411	485	485	473
9		588	502	507	507	494
10				523	523	505
11				522	522	533
12			561	532	532	559
13				615	615	593
14						576
15+						599

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 4

Age	2.a	3.a	3.b	3.c	3.d	4.a	4.b	4.c	5.a
0						87		110	
1	226	223	205	205	205	220	191	224	
2	262	259	254	254	254	256	248	259	377
3	359	346	373	373	373	348	363	310	385
4	374	369	419	419	419	364	402	343	390
5	413	411	456	456	456	408	456	392	423
6	432	423	478	478	478	413	451	392	430
7	447	452	516	516	516	435	461	443	440
8	468	479	558	558	558	453	495	484	446
9	481	509	574	574	574	480	480	486	477
10	509	513				503	602	510	484
11	529	523				510	505	486	496
12	545	560				514	522		510
13	564	590				532	542		546
14	587	556				558	555		
15+	635	642				584	606		

Age	5.b	6.a	6.b	7.a	7.b	7.c	7.d	7.e	7.f
0						71	110	110	
1	225	203		130		122	205	168	120
2	234	193		199	161	134	253	240	225
3	321	266		249	240	342	300	279	254
4	342	278		275	270	363	349	298	262
5	383	315		332	295	372	364	348	308
6	382	334		350	356	374	426	451	402
7	391	357		366	336	376	447	499	
8	416	384		391	381	372	531	656	
9	441	419		416	414	423	472	610	
10	458	439		453	419	418	455	455	
11	527	433		455	452	432	423		
12	493	442		550	475	446	476		
13	451	393		541	509	449	390		
14		581		551		453	396		
15+	537	404			576				

Table 8.5.2.1. NE Atlantic Mackerel. Mean weight (g) -at-age by area for 2018 (cont.).

Quarter 4

Age	7.g	7.h	7.j	7.k	8.a	8.b	8.c	8.c.E
0	78	78	78		29	31	89	28
1	117	117	117		160	152	109	160
2	214	130	130		243	162	174	145
3	263	263	317		287	226	268	173
4	313	318	315		291	273	325	268
5	343	343	332		336	334	437	335
6	352	353	345		343	344	418	341
7	381	386	359		354	357	396	353
8	420	428	388		362	368	437	361
9	419	420	395		387	410	466	386
10	453	455	442		406	414		405
11	464		423		421	428		421
12	490		476		440	444	561	440
13	510		390		459	453		459
14			396		453	453		453
15+								

Age	8.d	9.a	9.a.N	14.a	14.b	All
0	31		63			66
1	145	206	131			214
2	161	233	217			254
3	218	338	270			347
4	270	384	292			364
5	336	484	428			408
6	351	598	396			414
7	365	657	385			436
8	377	714	411			453
9	430		488			479
10	422					502
11	433					513
12	446		561			517
13	449					535
14	453					562
15+						584

Table 8.6.2.1. Model parameter estimates and standard errors.

Symbol	Description	Unit	Estimate	Std.Error
T	Decorrelation time	year	2	0.4
H	Spatial decorrelation distance	km	486.3	97.81
WS	Log Wing spread	Nmi	-1.3	0.64
σ_N^2	Variance of the nugget effect	1	3.9	NA
σ_{xy}^2	Spatial variance parameter (year specific surfaces)	1	5.3	NA
$\sigma_x^{2\,2}$	Spatial variance parameter (intercept surface)	1	5.6	NA

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 2019.

	2007			2010			2011			2012		
AGE	Number (billions)	W (g)	Biom. t (mil-lion)	Num-ber (bil-lions)	W (g)	Biom. t (mil-lion)	Num-ber (bil-lions)	W (g)	Biom. t (mil-lion)	Num-ber (bil-lions)	W (g)	Biom. t (mil-lion)
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			2019		
AGE	Number (billions)	W (g)	Biom. t (million)	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	0.08	153	0.01
2	0.12	292	0.03	2.5	229	0.57	1.35	212	0.29
3	3.56	330	1.18	0.5	330	0.16	3.81	325	1.24
4	1.95	373	0.73	2.38	390	0.93	1.21	352	0.43
5	3.32	431	1.43	1.2	420	0.5	2.92	428	1.25
6	4.68	437	2.04	1.41	449	0.63	2.86	440	1.26
7	4.65	462	2.15	2.33	458	1.07	1.95	472	0.92
8	1.75	487	0.86	1.79	477	0.85	3.91	477	1.86
9	1.94	536	1.04	1.05	486	0.51	3.82	490	1.87
10	0.63	534	0.33	0.5	515	0.26	1.50	511	0.77
11	0.51	542	0.28	0.56	534	0.3	1.25	524	0.65
12	0.12	574	0.07	0.29	543	0.16	0.58	564	0.33
13	0.08	589	0.05	0.14	575	0.08	0.59	545	0.32
14+	0.04	626	0.03	0.09	643	0.05	0.57	579	0.32
TOTAL	24.22	425	10.29	16.92	368	6.22	26.40	436	11.52

Table 8.6.4.1. Overview of numbers released in the different RFID tagging experiments, and numbers recaptured per year (year 2019 show update per 1th September to demonstrate ongoing process). Recaptures from experiments and recapture years used in 2019 stock assessment, based on decisions in the ICES IBPNEAMac 2019 (ICES, 2019) is outlined and marked grey. However, note that these numbers also include recaptures from some factories excluded in the final estimation of tag table used in the stock assessment 2019 (see Slotte, 2019 -WD12- and Tables 8.6.4.2-3). Note also that during tagging off Ireland 2018 two experiments were carried out on same vessel, where the one named Ireland2018-2 was based on fishing and handling mackerel in the same way as with the older steel tag time series (manual jigging and release directly at starboard side, instead of automatic jigging and release through pipes at port side as in rest of RFID time series) for comparison of recapture rates.

Survey	N-Released	2012	2013	2014	2015	2016	2017	2018	2019	All years
Iceland2015	806	0	0	0	6	2	3	0	0	11
Iceland2016	4884	0	0	0	0	59	48	28	13	148
Iceland2017	3890	0	0	0	0	0	28	27	3	58
Iceland2018	1872	0	0	0	0	0	0	5	6	11
Iceland2019	3614	0	0	0	0	0	0	0	0	0
Ireland 2011	18645	27	24	31	24	17	5	9	6	143
Norway2011	31253	9	31	24	34	26	16	20	3	163
Ireland 2012	32136	31	57	60	67	34	21	12	2	284
Ireland2013	22792	0	26	**89**	**109**	61	31	21	7	344
Ireland2014	55184	0	0	112	**321**	**277**	139	91	19	959
Ireland2015	43905	0	0	0	117	**219**	**177**	93	30	636
Ireland2016	43956	0	0	0	0	124	**326**	**185**	70	705
Ireland2017	56073	0	0	0	0	0	137	**344**	114	595
Ireland2018	33475	0	0	0	0	0	0	180	120	300
Ireland2018-2	4661	0	0	0	0	0	0	24	18	42
Ireland2019	51179	0	0	0	0	0	0	0	91	91
All surveys	408325	67	138	316	678	819	931	1039	502	4490

Table 8.6.4.2. Overview of numbers of tons scanned for RFID tags per factory per year. The biomass scanned which is used in 2019 stock assessment, based on decisions in the ICES IBPNEAMac 2019 (ICES, 2019) and evaluation of efficiency of the scanners (WD 12), is outlined and marked grey.

Factory	2012	2013	2014	2015	2016	2017	2018	All years
FO01 Vardin Pelagic	0	0	**10460**	**11565**	**7895**	**4844**	0	34763
GB01 Denholm Coldstore	0	0	0	**4377**	**4710**	**5365**	**7806**	22258
GB01 Denholm Factory	0	0	**14939**	**17509**	**18840**	**17913**	**13609**	82811
GB02 Lunar Freezing Peterhead	0	0	**22586**	**17830**	**16473**	**9745**	**9857**	76491
GB03 Lunar Freezing Fraserburgh	0	0	0	8797	14282	12684	**9452**	45215
GB04 Pelagia Shetland	0	0	**21436**	**41117**	**40200**	**26935**	**25350**	155038
GB05 Northbay Pelagic	0	0	0	0	0	0	**15353**	15353
IC01 Vopnafjord	0	0	**18577**	**18772**	**21716**	**22935**	**18869**	100869
IC02 Neskaupstad	0	0	0	**6288**	**21887**	**19558**	**16757**	64490
NO01 Pelagia Egersund Seafood	20930	21442	36724	14375	15905	0	**48373**	157748
NO02 Skude Fryseri	7546	8250	**16719**	**14172**	**8671**	**16760**	3108	75226
NO03 Pelagia Austevoll	6405	6134	10314	4203	2216	0	**7293**	36564
NO04 Pelagia Florø	9986	12838	**17379**	**12592**	**7749**	0	0	60544
NO05 Pelagia Måløy	13344	14632	**13942**	**21051**	**15762**	**22405**	**13341**	114477
NO06 Pelagia Selje	17731	26878	**39525**	**41209**	**29897**	**35416**	**28972**	219629
NO07 Pelagia Liavågen	9442	10968	**22395**	**18144**	**13911**	**19989**	**12398**	107249
NO08 Brødrene Sperre	14425	15048	**20182**	**34307**	**36736**	**18814**	33960	173473
NO09 Lofoten Viking	0	0	0	0	0	0	3380	3380
NO14 Nils Sperre	0	0	0	0	0	0	**28304**	28304
NO15 Grøntvedt Pelagic	0	0	0	0	0	0	6411	6411
NO16 Vikomar	0	0	0	0	0	0	12512	12512
All factories	99808	116190	265178	286310	276850	233363	315105	1592805

Table 8.6.4.3. Overview of numbers of RFID tagged mackerel recaptured per factory per year. The number of recaptures used in 2019 stock assessment, based on decisions in the ICES IBPNEAMac 2019 (ICES 2019) and evaluation of efficiency of the scanners (WD 12), is outlined and marked grey. Note that two factories, DK01 Sæby and IC03 Höfn, are shown in this table, but not in Table 8.6.4.2 with biomass scanned, to demonstrate that they have had a few recaptures although not functioning properly.

Factory	2012	2013	2014	2015	2016	2017	2018	All years
DK01 Sæby	0	0	0	20	0	0	0	20
FO01 Vardin Pelagic	0	0	**15**	**37**	**23**	**13**	0	88
GB01 Denholm Coldstore	0	0	0	**10**	**10**	**28**	**40**	88
GB01 Denholm Factory	0	0	**25**	**64**	**79**	**119**	**58**	345
GB02 Lunar Freezing Peterhead	0	0	**33**	**51**	**60**	**42**	**42**	228
GB03 Lunar Freezing Fraserburgh	0	0	0	9	16	7	**27**	59
GB04 Pelagia Shetland	0	0	**25**	**130**	**162**	**157**	**108**	582
GB05 Northbay Pelagic	0	0	0	0	0	0	**57**	57
IC01 Vopnafjord	0	0	24	**61**	**81**	**73**	**63**	302
IC02 Neskaupstad	0	0	0	**19**	**93**	**58**	**39**	209
IC03 Höfn	0	0	0	1	0	1	1	3
NO01 Pelagia Egersund Seafood	12	25	19	7	1	0	**148**	212
NO02 Skude Fryseri	6	8	**21**	**19**	**27**	**55**	17	153
NO03 Pelagia Austevoll	1	1	7	5	1	0	**29**	44
NO04 Pelagia Florø	6	19	**33**	**22**	**18**	0	0	98
NO05 Pelagia Måløy	6	19	**21**	**46**	**42**	**89**	**42**	265
NO06 Pelagia Selje	19	35	**38**	**77**	**59**	**102**	**100**	430
NO07 Pelagia Liavågen	10	13	**34**	**34**	**30**	**102**	**50**	273
NO08 Brødrene Sperre	7	18	**21**	**66**	**117**	**85**	58	372
NO09 Lofoten Viking	0	0	0	0	0	0	10	10
NO14 Nils Sperre	0	0	0	0	0	0	**117**	117
NO15 Grøntvedt Pelagic	0	0	0	0	0	0	11	11
NO16 Vikomar	0	0	0	0	0	0	22	22
All factories	67	138	316	678	819	931	1039	3988

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 2019.

	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

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

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 2019 (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

AGE	2010 Number (millions)	L (cm)	W (g)	Bio-mass t ('000)	2011 Num-ber (mil-lions)	L (cm)	W (g)	Bio-mass t ('000)	2012 Num-ber (mil-lions)	L (cm)	W (g)	Bio-mass t ('000)
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
TO-TAL	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 2019 (cont.).

	2013				2014				2015			
AGE	Number (millions)	L (cm)	W (g)	Bio-mass t ('000)	Num-ber (mil-lions)	L (cm)	W (g)	Bio-mass t ('000)	Num-ber (mil-lions)	L (cm)	W (g)	Bio-mass 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
TO-TAL	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			
AGE	Number (millions)	L (cm)	W (g)	Bio-mass t ('000)	Num-ber (mil-lions)	L (cm)	W (g)	Bio-mass t ('000)	Num-ber (mil-lions)	L (cm)	W (g)	Bio-mass t ('000)
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+	´-	-	-	-								
TO-TAL	1566.14	36.3	311.7	497.7	1777.0	34.7	280.4	548.2		36.10	318.83	556.53

Table 8.6.5.2.1. Biomass, abundance, mean length and mean weight at age of mackerel from the Spanish spring acoustics surveys (PELACUS) from 2001 to 2019 (cont.).

	2019			
AGE	**Number (millions)**	**L (cm)**	**W (g)**	**Biomass t ('000)**
1	11	25.0	113.4	1
2	27	27.6	152.1	4
3	98	33.3	262.4	27
4	86	34.9	300.9	27
5	773	35.3	310.6	251
6	379	36.7	348.6	138
7	517	37.3	363.5	196
8	385	37.3	363.5	147
9	188	38.0	384.3	75
10	48	39.6	433.6	22
11	27	39.6	434.5	12
12	10	41.1	484.9	5
13				
14				
15+				
TOTAL	2549	36.3	338.0	905

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	0.36	119.0			1.25	415	1.78	548.7
2018*	0.10	27.8	0.01	031			1.55	528*	1.64	556.5
2019	0.03	4.8	0.38	145.1			2.1	755	2.55	905.0

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

Table 8.7.1.1.1. 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 -2018		Yes
Catch-at-age in numbers	1980 -2018	0-12+	Yes
Weight-at-age in the commercial catch	1980 – 2018	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 -2019	0-12+	Yes
Proportion of fishing mortality before spawning	1980 -2019	0-12+	Yes
Proportion mature-at-age	1980 -2019	0-12+	Yes
Natural mortality	1980 -2019	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, 2013,2016,2019.	Not applicable (gives SSB)
Survey (abundance index)	IBTS Recruitment index (log transformed)	1998-2018	Age 0
Survey (abundance index)	International Ecosystem Summer Survey in the Nordic Seas (IESSNS)	2010, 2012-2019	Ages 3-11
Tagging/recapture	Norwegian tagging program	Steal tags : 1980 (release year)- 2006 (recapture years) RFID tags : 2013 (release year) 2018 (recapture year)	Ages 5 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	No catchability parameter for the catches

	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	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	1/2/3/3/3/3/3/3/3/3/3/3/3	Separate F random walk variances for age 0, age 1 and a same variance for older ages
Coupling of log abundance random walk variances	1/2/2/2/2/2/2/2/2/2/2/2/2	Same variance used for the log abundance random walk of all ages except for the recruits (age 0)
Coupling of the observation variances	1/2/3/3/3/3/3/3/3/3/3/3/3 0/0/0/0/0/0/0/0/0/0/0/0/0 4/0/0/0/0/0/0/0/0/0/0/0/0 0/0/0/5/6/6/6/6/6/6/6/6/0	Separate observation variances for age 0 and 1 than for the older 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 8.7.1.1.2. NE Atlantic Mackerel. CATCH IN NUMBER

Units : thousands

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

age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	24246	10007	43447	19354	25368	14759	37956	36012	61127	67003
1	140534	58459	83583	128144	147315	81529	119852	144390	99352	73597
2	209848	212521	156292	210319	221489	340898	168882	186481	229767	132994
3	410751	206421	356209	266677	306979	340215	333365	238426	264566	223639

4	208146	375451	266591	398240	267420	275031	279182	378881	323186	261778
5	156742	188623	306143	244285	301346	186855	177667	246781	361945	281041
6	254015	129145	156070	255472	184925	197856	96303	135059	207619	244212
7	42549	197888	113899	149932	189847	142342	119831	84378	118388	159019
8	49698	51077	138458	97746	106108	113413	55812	66504	72745	86739
9	85447	43415	51208	121400	80054	69191	59801	39450	47353	50613
10	33041	70839	36612	38794	57622	42441	25803	26735	24386	30363
11	16587	29743	40956	29067	20407	37960	18353	13950	16551	17048
12	27905	52986	68205	68217	57551	39753	30648	24974	22932	32446

	year									
age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
0	36345	26034	70409	14744	11553	12426	75651	19302	25886	17615
1	102407	40315	222577	187997	31421	46840	149425	88439	59899	36514
2	142898	158943	70041	275661	453133	135648	173646	190857	167748	113574
3	275376	234186	367902	91075	529753	668588	159455	220575	399086	455113
4	390858	297206	350163	295777	147973	293579	470063	215655	284660	616963
5	295516	309937	262716	235052	258177	120538	195594	455131	260314	319465
6	241550	231804	237066	183036	145899	121477	97061	203492	255675	224848
7	175608	195250	151320	133595	89856	63612	73510	77859	124382	194326
8	106291	120241	118870	94168	65669	38763	33399	59652	57297	73171
9	52394	72205	79945	75701	40443	23947	18961	30494	32343	29738
10	31280	42529	43789	45951	35654	18612	13987	16039	19482	14989
11	18918	20546	21611	25797	16430	7955	8334	11416	6798	7470
12	34202	40706	40280	30890	19509	10669	10186	12801	9581	5003

	year								
age	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	23453	30429	23872	11325	62100	6732	716	28306	9453
1	78605	62708	66196	47020	43173	104019	45199	43458	46107
2	137101	115346	200167	235411	137788	124411	203753	87739	238898
3	303928	322725	214043	399751	669949	248852	257293	458301	137575
4	739221	469953	415884	370551	829399	579835	424843	351779	378240
5	611729	654395	456404	442597	564508	646894	589549	396862	257689
6	284788	488713	511270	429324	549985	450344	532890	503601	295537
7	143039	244210	323835	336701	503300	415107	340155	431014	425922
8	102072	113012	142948	188910	339538	355997	269962	261959	317671
9	45841	53363	69551	112765	141344	205691	170373	188950	198527
10	21222	25046	30619	45938	63614	107685	94778	138143	140781
11	6255	12311	11603	18928	21294	26939	33896	59211	83063
12	8523	10775	11678	17857	13136	22700	24420	51090	60587

Table 8.7.1.1.3. NE Atlantic Mackerel. WEIGHTS AT AGE IN THE CATCH

Units : Kg

	year											
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
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
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
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
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
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
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
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
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
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

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
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
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
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

year

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.051	0.061	0.046	0.072	0.058	0.076	0.065	0.062	0.063	0.069	0.052	0.081
1	0.167	0.134	0.136	0.143	0.143	0.143	0.157	0.176	0.135	0.172	0.160	0.170
2	0.239	0.240	0.255	0.234	0.226	0.230	0.227	0.235	0.227	0.224	0.256	0.267
3	0.333	0.317	0.339	0.333	0.313	0.295	0.310	0.306	0.306	0.305	0.307	0.336
4	0.397	0.376	0.390	0.390	0.377	0.359	0.354	0.361	0.363	0.376	0.368	0.385
5	0.460	0.436	0.448	0.452	0.425	0.415	0.408	0.404	0.427	0.424	0.424	0.438
6	0.495	0.483	0.512	0.501	0.484	0.453	0.452	0.452	0.463	0.474	0.461	0.477
7	0.532	0.527	0.543	0.539	0.518	0.481	0.462	0.500	0.501	0.496	0.512	0.522
8	0.555	0.548	0.590	0.577	0.551	0.524	0.518	0.536	0.534	0.540	0.536	0.572
9	0.597	0.583	0.583	0.594	0.576	0.553	0.550	0.569	0.567	0.577	0.580	0.612
10	0.651	0.595	0.627	0.606	0.596	0.577	0.573	0.586	0.586	0.603	0.600	0.631
11	0.663	0.647	0.678	0.631	0.603	0.591	0.591	0.607	0.594	0.611	0.629	0.648
12	0.669	0.679	0.713	0.672	0.670	0.636	0.631	0.687	0.644	0.666	0.665	0.715

year

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.067	0.048	0.038	0.089	0.051	0.104	0.048	0.029	0.089	0.091	0.043	0.051
1	0.156	0.151	0.071	0.120	0.105	0.153	0.118	0.113	0.123	0.173	0.127	0.154
2	0.263	0.268	0.197	0.215	0.222	0.213	0.221	0.231	0.187	0.234	0.232	0.242
3	0.323	0.306	0.307	0.292	0.292	0.283	0.291	0.282	0.285	0.277	0.282	0.294
4	0.400	0.366	0.357	0.372	0.370	0.331	0.331	0.334	0.340	0.336	0.324	0.320
5	0.419	0.434	0.428	0.408	0.418	0.389	0.365	0.368	0.375	0.360	0.362	0.351
6	0.485	0.440	0.479	0.456	0.444	0.424	0.418	0.411	0.401	0.386	0.395	0.392
7	0.519	0.496	0.494	0.512	0.497	0.450	0.471	0.451	0.431	0.406	0.422	0.420
8	0.554	0.539	0.543	0.534	0.551	0.497	0.487	0.494	0.469	0.431	0.444	0.443
9	0.573	0.556	0.584	0.573	0.571	0.538	0.515	0.540	0.503	0.454	0.468	0.465
10	0.595	0.583	0.625	0.571	0.620	0.586	0.573	0.580	0.537	0.472	0.482	0.489
11	0.630	0.632	0.636	0.585	0.595	0.599	0.604	0.611	0.538	0.493	0.523	0.522
12	0.684	0.655	0.689	0.666	0.662	0.630	0.630	0.664	0.585	0.554	0.583	0.560

year

age	2016	2017	2018
0	0.035	0.018	0.055
1	0.158	0.178	0.133
2	0.240	0.266	0.246
3	0.297	0.312	0.319
4	0.329	0.356	0.354
5	0.356	0.377	0.396
6	0.383	0.397	0.410
7	0.411	0.415	0.426
8	0.438	0.444	0.446
9	0.453	0.466	0.469
10	0.479	0.484	0.491
11	0.499	0.497	0.507
12	0.520	0.531	0.537

Table 8.7.1.1.4. NE Atlantic Mackerel. WEIGHTS AT AGE IN THE STOCK

Units : Kg

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
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
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
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
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
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
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
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
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
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
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
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
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
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

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.130	0.145	0.114	0.116	0.097	0.084	0.083	0.087	0.093	0.113	0.109	0.112
2	0.201	0.190	0.163	0.201	0.185	0.196	0.172	0.210	0.194	0.190	0.206	0.181
3	0.260	0.266	0.240	0.278	0.250	0.257	0.248	0.260	0.253	0.246	0.245	0.251
4	0.308	0.323	0.306	0.327	0.322	0.310	0.299	0.317	0.301	0.303	0.288	0.277
5	0.360	0.359	0.368	0.385	0.372	0.356	0.348	0.356	0.357	0.342	0.333	0.341
6	0.397	0.410	0.418	0.432	0.425	0.401	0.383	0.392	0.394	0.398	0.360	0.401
7	0.419	0.432	0.459	0.458	0.446	0.460	0.409	0.424	0.416	0.417	0.418	0.407
8	0.458	0.459	0.480	0.491	0.471	0.473	0.455	0.456	0.438	0.451	0.429	0.489
9	0.487	0.480	0.496	0.511	0.513	0.505	0.475	0.489	0.464	0.484	0.458	0.490
10	0.513	0.515	0.550	0.517	0.508	0.511	0.530	0.508	0.489	0.521	0.511	0.488
11	0.543	0.547	0.592	0.560	0.538	0.546	0.500	0.545	0.514	0.535	0.523	0.521
12	0.568	0.577	0.604	0.602	0.573	0.585	0.547	0.576	0.551	0.574	0.557	0.540

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.112	0.106	0.108	0.083	0.133	0.107	0.096	0.080	0.089	0.076	0.107	0.078
2	0.158	0.140	0.164	0.149	0.160	0.162	0.161	0.175	0.155	0.144	0.165	0.207
3	0.258	0.221	0.236	0.206	0.207	0.214	0.201	0.223	0.216	0.179	0.199	0.247
4	0.318	0.328	0.291	0.288	0.260	0.268	0.249	0.274	0.255	0.249	0.238	0.254
5	0.355	0.378	0.333	0.330	0.346	0.295	0.297	0.332	0.288	0.281	0.291	0.288
6	0.406	0.403	0.400	0.362	0.354	0.351	0.342	0.369	0.312	0.318	0.321	0.336
7	0.449	0.464	0.413	0.451	0.393	0.386	0.389	0.389	0.360	0.341	0.341	0.350
8	0.482	0.481	0.437	0.452	0.448	0.437	0.411	0.430	0.390	0.374	0.387	0.381
9	0.506	0.547	0.455	0.508	0.452	0.461	0.442	0.452	0.453	0.414	0.416	0.412
10	0.519	0.538	0.469	0.527	0.478	0.517	0.491	0.495	0.498	0.441	0.466	0.447
11	0.579	0.509	0.531	0.533	0.487	0.548	0.535	0.518	0.503	0.500	0.472	0.485
12	0.588	0.603	0.566	0.586	0.511	0.559	0.573	0.525	0.557	0.520	0.517	0.549

age	2016	2017	2018
0	0.000	0.000	0.000
1	0.059	0.058	0.063
2	0.183	0.204	0.191
3	0.240	0.237	0.266

4	0.282	0.278	0.283
5	0.299	0.308	0.314
6	0.335	0.308	0.327
7	0.364	0.338	0.346
8	0.382	0.377	0.364
9	0.403	0.394	0.389
10	0.427	0.426	0.419
11	0.441	0.430	0.437
12	0.469	0.494	0.488

Table 8.7.1.1.5. NE Atlantic Mackerel. NATURAL MORTALITY

Units : NA

age \ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
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
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
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
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
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
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
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
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
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
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
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
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
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

age \ year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
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
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
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
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
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
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
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
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
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
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
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
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
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

age \ year	2010	2011	2012	2013	2014	2015	2016	2017	2018
0	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
2	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
4	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
6	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

8	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
10	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
12	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Table 8.7.1.1.6. NE Atlantic Mackerel. PROPORTION MATURE

	year											
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.093	0.097	0.097	0.098	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102
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
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
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
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
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
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
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
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
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
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
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

	year											
age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.102	0.102	0.102	0.102	0.102	0.097	0.097	0.097	0.104	0.104	0.104	0.106
2	0.520	0.534	0.621	0.599	0.586	0.621	0.688	0.669	0.692	0.675	0.710	0.690
3	0.928	0.934	0.938	0.931	0.936	0.880	0.886	0.876	0.909	0.909	0.937	0.940
4	0.996	0.996	0.994	0.993	1.000	0.993	0.994	0.989	0.989	0.987	0.992	0.988
5	0.997	0.997	0.997	0.994	1.000	0.998	0.999	0.999	0.998	0.998	1.000	1.000
6	0.994	0.994	0.993	0.987	0.994	0.999	0.999	0.999	0.999	0.999	1.000	1.000
7	1.000	1.000	0.999	0.999	0.999	1.000	1.000	1.000	1.000	0.999	1.000	0.999
8	1.000	1.000	1.000	1.000	1.000	0.994	0.995	0.996	0.997	0.997	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
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
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
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

	year											
age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.106	0.106	0.095	0.095	0.095	0.096	0.096	0.096	0.094	0.092	0.092	0.104
2	0.761	0.616	0.589	0.546	0.524	0.541	0.667	0.655	0.604	0.683	0.675	0.763
3	0.962	0.959	0.928	0.921	0.917	0.919	0.930	0.927	0.926	0.921	0.916	0.944
4	0.993	0.993	0.994	0.994	0.999	0.999	0.999	0.999	0.999	0.998	0.999	0.998
5	0.999	0.999	1.000	1.000	0.999	1.000	1.000	1.000	0.999	1.000	1.000	0.999
6	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.999	0.999	1.000
7	0.999	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	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	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
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
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
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

age	2016	2017	2018
0	0.000	0.000	0.000
1	0.103	0.101	0.086
2	0.632	0.624	0.459
3	0.937	0.931	0.878
4	0.997	0.997	0.998
5	0.999	1.000	1.000
6	1.000	1.000	1.000
7	0.999	1.000	1.000
8	1.000	1.000	1.000
9	1.000	1.000	1.000
10	1.000	1.000	1.000
11	1.000	1.000	1.000
12	1.000	1.000	1.000

Table 8.7.1.1.7. NE Atlantic Mackerel. FRACTION OF HARVEST BEFORE SPAWNING

age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.177	0.179
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
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
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
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
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
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
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
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
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
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
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

age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.181	0.216	0.252	0.287	0.250	0.212	0.175	0.179	0.183	0.187	0.201	0.216
2	0.181	0.216	0.252	0.287	0.250	0.212	0.175	0.179	0.183	0.187	0.201	0.216
3	0.316	0.318	0.321	0.323	0.328	0.334	0.339	0.364	0.390	0.415	0.408	0.400
4	0.316	0.318	0.321	0.323	0.328	0.334	0.339	0.364	0.390	0.415	0.408	0.400
5	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
6	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
7	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
8	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
9	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
10	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
11	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420
12	0.414	0.439	0.464	0.489	0.492	0.494	0.497	0.462	0.425	0.390	0.405	0.420

age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.231	0.230	0.229	0.229	0.197	0.165	0.133	0.126	0.119	0.111	0.137	0.164
2	0.231	0.230	0.229	0.229	0.197	0.165	0.133	0.126	0.119	0.111	0.137	0.164

3	0.393	0.375	0.357	0.338	0.305	0.270	0.237	0.183	0.129	0.075	0.121	0.168
4	0.393	0.375	0.357	0.338	0.305	0.270	0.237	0.183	0.129	0.075	0.121	0.168
5	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
6	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
7	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
8	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
9	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
10	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
11	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183
12	0.434	0.402	0.368	0.336	0.305	0.272	0.241	0.232	0.223	0.214	0.199	0.183

	year		
age	2016	2017	2018
0	0.000	0.000	0.000
1	0.191	0.188	0.268
2	0.191	0.188	0.268
3	0.216	0.157	0.196
4	0.216	0.157	0.196
5	0.174	0.286	0.190
6	0.174	0.286	0.190
7	0.174	0.286	0.190
8	0.174	0.286	0.190
9	0.174	0.286	0.190
10	0.174	0.286	0.190
11	0.174	0.286	0.190
12	0.174	0.286	0.190

Table 8.7.1.1.8. NE Atlantic Mackerel. FRACTION OF NATURAL MORTALITY BEFORE SPAWNING

	year											
age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
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
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
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
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
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
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
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
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
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
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
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
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
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

	year											
age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
1	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
2	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
3	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
4	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
5	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
6	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
7	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355

8	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
9	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
10	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
11	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355
12	0.333	0.341	0.349	0.357	0.339	0.322	0.304	0.325	0.346	0.366	0.361	0.355

	year											
age	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
1	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
2	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
3	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
4	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
5	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
6	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
7	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
8	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
9	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
10	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
11	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311
12	0.350	0.346	0.342	0.339	0.311	0.283	0.255	0.252	0.249	0.246	0.278	0.311

	year		
age	2016	2017	2018
0	0.343	0.327	0.312
1	0.343	0.327	0.312
2	0.343	0.327	0.312
3	0.343	0.327	0.312
4	0.343	0.327	0.312
5	0.343	0.327	0.312
6	0.343	0.327	0.312
7	0.343	0.327	0.312
8	0.343	0.327	0.312
9	0.343	0.327	0.312
10	0.343	0.327	0.312
11	0.343	0.327	0.312
12	0.343	0.327	0.312

Table 8.7.1.1.9. NE Atlantic Mackerel. SURVEY INDICES

```
Some random text

103

SSB-egg-based-survey

1992            2019

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
1               3092415.70
R-idx(sqrt transf)

1998            2018

1               1               0               0

0               0

1               0.00537
1               0.008018
1               0.005652
1               0.008848
1               0.011184
1               0.005732
1               0.013097
1               0.016542
1               0.0152
1               0.00999
1               0.009151
1               0.006446
1               0.009707
1               0.016199
1               0.011892
1               0.013118
1               0.009979
1               0.010863
1               0.018963
1               0.019512
```

1 0.017155

Swept-idx

2010 2019

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			
1	3814661	1211770	2920591	2856932	1948653	3906891
	3824410	1499778	1248160			

Table 8.7.1.2.1. NE Atlantic Mackerel. SAM parameter estimates for the 2019 update.

	esti-mate	std.dev	confidence interval lower bound	confidence interval upper bound
observation standard deviations				
Catches age 0	0.97	0.19	0.66	1.42
Catches age 1	0.37	0.25	0.23	0.61
Catches age 2-12	0.11	0.17	0.08	0.15
Egg survey	0.32	0.26	0.19	0.54
Recruitment index	0.19	0.36	0.09	0.39
IESSNS age 3	0.62	0.26	0.37	1.06
IESSNS ages 4-11	0.34	0.15	0.25	0.46
Recapture overdispersion tags	1.23	0.25	1.37	1.14
random walk standard deviation				
F age 0	0.24	0.58	0.07	0.76
F age 1	0.17	0.48	0.07	0.45
F age 2+	0.12	0.20	0.08	0.17
N@age0	0.27	0.29	0.15	0.49
process error standard deviation				
N@age1-12+	0.20	0.09	0.17	0.24
catchabilities				
egg survey	1.23	0.11	0.98	1.55
recruitment index	0.00	0.11	0.00	0.00
IESSNS age 3	0.86	0.24	0.53	1.40
IESSNS age 4	1.27	0.16	0.92	1.75
IESSNS age 5	1.67	0.16	1.21	2.30
IESSNS age 6	2.00	0.16	1.45	2.78
IESSNS age 7	2.14	0.17	1.54	2.98
IESSNS age 8	2.04	0.17	1.46	2.85
IESSNS age 9	2.07	0.17	1.48	2.88
IESSNS ages 10-11	1.77	0.16	1.28	2.44

post tagging survival steal tags	0.40	0.11	0.35	0.45
post tagging survival RFID tags	0.13	0.11	0.11	0.16

Table 8.7.1.3.1. NE Atlantic Mackerel. STOCK SUMMARY. Low = lower limit and High = higher limit of 95% confidence interval.

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Total Catch tonnes	F Ages 4-8 per year	High	Low
1980	5811487	2993662	11281629	4133735	1978488	8636782	734950	0.225	0.149	0.341
1981	5081028	2931698	8806106	3619938	1955059	6702587	754045	0.225	0.151	0.335
1982	3613849	2041350	6397678	3493680	2105977	5795789	716987	0.226	0.154	0.330
1983	3372139	1876687	6059250	3731743	2507647	5553376	672283	0.227	0.158	0.325
1984	4359034	2642350	7191015	4010169	2874270	5594970	641928	0.228	0.162	0.322
1985	4140770	2570310	6670781	3978339	2973239	5323213	614371	0.231	0.167	0.320
1986	4128829	2615106	6518751	3562706	2718570	4668953	602201	0.235	0.173	0.320
1987	4388517	2797577	6884198	3528345	2695161	4619100	654992	0.240	0.179	0.321
1988	3762477	2436833	5809274	3473395	2718784	4437452	680491	0.246	0.187	0.323
1989	3573130	2312000	5522172	3257928	2592729	4093792	585920	0.254	0.197	0.329
1990	3214451	2046045	5050081	3327951	2692831	4112868	626107	0.265	0.208	0.337
1991	3346363	2174251	5150345	3226517	2637787	3946646	675665	0.277	0.220	0.348
1992	3456082	2244504	5321666	2968248	2448778	3597914	760690	0.290	0.233	0.362
1993	3112788	2034941	4761538	2648332	2199450	3188824	824568	0.302	0.244	0.374
1994	2943059	1928161	4492155	2329018	1947957	2784623	819087	0.310	0.252	0.380
1995	2792843	1818532	4289157	2303399	1941410	2732882	756277	0.310	0.256	0.376
1996	2994638	1932217	4641226	2185774	1848588	2584463	563472	0.306	0.256	0.365
1997	2926988	1936803	4423402	2148580	1839814	2509165	573029	0.304	0.257	0.360
1998	2977574	2171685	4082521	2118079	1810296	2478192	666316	0.310	0.264	0.364
1999	3528098	2547705	4885760	2302099	1973069	2685997	640309	0.322	0.276	0.374
2000	2952146	2112975	4124594	2283798	2001413	2606025	738606	0.336	0.294	0.383
2001	4749644	3452779	6533612	2172227	1907342	2473899	737463	0.363	0.315	0.419
2002	5646271	4025264	7920072	2066525	1792202	2382837	771422	0.386	0.330	0.451

Year	Recruitment Age 0 thousands	High	Low	SSB tonnes	High	Low	Total Catch tonnes	F Ages 4-8 per year	High	Low
2003	3696698	2502549	5460662	2001924	1734279	2310873	679287	0.400	0.337	0.476
2004	5397194	3828829	7607994	2623839	2236181	3078701	660491	0.375	0.318	0.442
2005	7070591	4816015	10380629	2356722	2003961	2771579	549514	0.315	0.272	0.365
2006	6866257	4799793	9822401	2154446	1833349	2531780	481181	0.296	0.256	0.344
2007	5176997	3756146	7135318	2282022	1954818	2663993	586206	0.324	0.280	0.376
2008	4658201	3364249	6449832	2651098	2237447	3141224	623165	0.317	0.272	0.368
2009	4188877	2840952	6176341	3272629	2755301	3887090	737969	0.294	0.252	0.344
2010	5507435	3939474	7699466	3650817	3094848	4306662	875515	0.288	0.245	0.338
2011	7152461	4951329	10332115	4115518	3480137	4866903	946661	0.286	0.241	0.338
2012	5944485	4300959	8216050	3780926	3174452	4503266	892353	0.270	0.225	0.325
2013	5795704	4157315	8079781	4185895	3493207	5015939	931732	0.273	0.226	0.330
2014	5807466	4177963	8072513	5229726	4368401	6260879	1393000	0.278	0.229	0.338
2015	5273724	3777291	7362995	5195560	4304180	6271543	1208990	0.265	0.215	0.325
2016	7454724	4935333	11260215	4896846	4021132	5963271	1094066	0.241	0.193	0.302
2017	8514386	5650073	12830766	4692164	3801919	5790867	1155944	0.241	0.191	0.305
2018	8417954	5641595	12560625	4279185	3368975	5435312	1026437	0.238	0.182	0.310

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

**** Geometric mean 1990–2016.**

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

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Table 8.7.1.3.2. NE Atlantic Mackerel. ESTIMATED POPULATION ABUNDANCE

Units : Thousands

year

age	1980	1981	1982	1983	1984	1985	1986	1987
0	5811487	5081028	3613849	3372139	4359034	4140770	4128829	4388517
1	5066727	5336916	4836475	2678222	2430810	4350004	3431733	3400436
2	2356914	4207417	4775209	4488699	1942279	1717024	4228815	2785062
3	971920	1900616	3509680	4414944	4431183	1366235	1220034	4105793
4	1667214	745535	1428708	2919746	3904993	4079146	1023220	837081
5	3532918	1227527	534141	981668	2204394	3127743	3167500	798035
6	2720078	2458671	871816	388128	669736	1619976	2258697	2167274
7	796744	1809490	1633840	583783	268768	459718	1072754	1506920
8	295072	543030	1235375	1113115	394745	190838	306700	750523
9	817621	201096	369765	843094	756721	271045	133121	203735
10	219293	557548	136989	251506	574522	513448	187494	90283
11	321051	149463	379660	93279	170967	390066	346585	126377
12	670122	676226	562212	639426	496779	452475	567162	611101

year

age	1988	1989	1990	1991	1992	1993	1994	1995
0	3762477	3573130	3214451	3346363	3456082	3112788	2943059	2792843
1	4227661	3033117	3129422	2538719	2880073	3168710	2592044	2507014
2	2746398	3976245	2392196	2673416	1960756	2421052	2834665	2103094
3	2197614	2369434	3922898	2125376	2540241	1623864	1980696	2397052
4	3742417	1693417	1845461	3033097	1519690	2021591	1095526	1427841
5	532325	2963250	1092446	1258271	1921266	987028	1382143	686011
6	603519	344106	1958216	775256	937460	1149156	587857	963596
7	1407812	457354	213861	1210712	471761	563756	643823	346178
8	1032219	1044471	341785	136533	727737	308354	336294	287197
9	523307	710921	707747	240048	88068	413582	183596	179611
10	134667	353719	460208	477409	154452	53056	221677	111076
11	60869	86834	234273	289782	300008	94909	30336	135809
12	491084	365448	296881	344108	403220	438340	326376	215920

year

age	1996	1997	1998	1999	2000	2001	2002	2003
0	2994638	2926988	2977574	3528098	2952146	4749644	5646271	3696698
1	2237518	2681714	2442259	2639368	3164303	1831918	5225586	6546657
2	2082761	1747234	2340997	1985763	2287288	2633917	1162604	4838263
3	2165772	1936746	1257137	2362967	1849592	1763267	2517487	798499
4	1811766	1783097	1634555	1259527	1840505	1314230	1545782	1564105
5	977367	1212140	1503291	1262108	1034238	1244403	985542	912708
6	494593	727191	859452	904037	857830	676977	802017	575099
7	571367	323932	478737	609850	613375	598927	411157	379253
8	216439	345325	261064	308331	371112	406402	345210	241512
9	141874	151886	210019	178440	188868	236538	227586	194314
10	95846	88654	101606	129476	111914	126110	127014	117130
11	64806	51494	54473	62675	69292	67734	62863	66410
12	213886	173268	142706	125678	120876	125587	111456	81303

year

age	2004	2005	2006	2007	2008	2009	2010	2011
0	5397194	7070591	6866257	5176997	4658201	4188877	5507435	7152461
1	2782018	4115431	6257389	5837497	4253706	4050708	3931871	5468140
2	6903746	2366385	3456976	4928830	4914299	3467381	3889809	3248914
3	3935453	5359600	1688164	2468583	4407270	4959973	3324633	3582565

```
  4   748161 1855893 3137021 1441641 1932829 3865976 4564342 2973954
  5   995776  530813 1013461 2037647 1201501 1553094 2895012 3260361
  6   474183  472969  366991  731893 1080211  875286 1202387 2022930
  7   265787  228543  275871  250053  412211  668360  543054  865890
  8   183896  132749  129095  180661  173670  255774  360937  392261
  9   116257   86043   71915   92813   99590  106161  162364  197104
  10   91785   61559   51620   46423   57232   51047   71441   89927
  11   47235   30896   31318   33550   21592   27854   24443   43745
  12   56812   39794   37692   38940   30660   19938   30667   37263
    year
age  2012    2013    2014    2015    2016    2017    2018    2019
  0  5944485 5795704 5807466 5273724 7454724 8514386 8417954 8417954
  1  6764044 4660042 4364061 5887265 3554837 6253009 6665681 7219298
  2  5483351 6641401 3731239 3369114 5208571 2251622 5663515 5558268
  3  2629623 5116627 6744045 2874181 2655377 4415613 1454336 4466194
  4  2877283 2339308 4850744 4459795 2616745 2057688 2837967 1065094
  5  2310697 2357877 2251610 3382451 3169647 2011058 1396565 1838158
  6  2243752 2017883 2105139 1747398 2503277 2421971 1311630 1155087
  7  1268941 1476690 1805233 1627215 1372480 2088658 1908878  766610
  8   559947  786322 1205200 1333183 1175988 1082969 1499558 1329015
  9   249717  374251  541573  850072  785497  924875  882297 1133087
  10  117817  153492  243436  407131  465747  569871  605599  565355
  11   49392   75314   83145  120934  200296  311841  407462  460681
  12   46190   63107   57208   89478  118166  226285  296018  460899

units:  NA
```

Table 8.7.1.3.3. NE Atlantic Mackerel. ESTIMATED FISHING MORTALITY

age	1980	1981	1982	1983	1984	1985	1986
0	0.0079637	0.0079821	0.0079918	0.0080282	0.0081053	0.0080973	0.0080419
1	0.0318048	0.0317035	0.0316022	0.0315436	0.0314226	0.0312491	0.0311197
2	0.0590627	0.0589670	0.0588420	0.0588308	0.0589727	0.0589586	0.0589003
3	0.1143646	0.1144215	0.1143559	0.1146084	0.1155079	0.1171984	0.1189421
4	0.1852804	0.1855727	0.1861833	0.1863764	0.1872804	0.1896991	0.1933297
5	0.2126300	0.2128668	0.2134704	0.2151041	0.2165622	0.2191039	0.2226244
6	0.2593009	0.2597709	0.2606091	0.2617647	0.2644178	0.2681483	0.2723270
7	0.2336101	0.2338513	0.2341282	0.2347044	0.2357387	0.2387384	0.2431078
8	0.2336101	0.2338513	0.2341282	0.2347044	0.2357387	0.2387384	0.2431078
9	0.2336101	0.2338513	0.2341282	0.2347044	0.2357387	0.2387384	0.2431078
10	0.2336101	0.2338513	0.2341282	0.2347044	0.2357387	0.2387384	0.2431078
11	0.2336101	0.2338513	0.2341282	0.2347044	0.2357387	0.2387384	0.2431078
12	0.2336101	0.2338513	0.2341282	0.2347044	0.2357387	0.2387384	0.2431078

age	1987	1988	1989	1990	1991	1992	1993
0	0.0079613	0.0079592	0.0079186	0.0078394	0.0077524	0.0077054	0.0076400
1	0.0310186	0.0309753	0.0309986	0.0310071	0.0309902	0.0309350	0.0308831
2	0.0590065	0.0590752	0.0592226	0.0595768	0.0600065	0.0606068	0.0612113
3	0.1203655	0.1226368	0.1250483	0.1276805	0.1304954	0.1330712	0.1360127
4	0.1984633	0.2025169	0.2084142	0.2134091	0.2183330	0.2220026	0.2247438
5	0.2262146	0.2317444	0.2364785	0.2409026	0.2464809	0.2544704	0.2603452
6	0.2773143	0.2825125	0.2923300	0.3016604	0.3105762	0.3186741	0.3257536
7	0.2487956	0.2561388	0.2672094	0.2836643	0.3049666	0.3276275	0.3496797
8	0.2487956	0.2561388	0.2672094	0.2836643	0.3049666	0.3276275	0.3496797
9	0.2487956	0.2561388	0.2672094	0.2836643	0.3049666	0.3276275	0.3496797
10	0.2487956	0.2561388	0.2672094	0.2836643	0.3049666	0.3276275	0.3496797
11	0.2487956	0.2561388	0.2672094	0.2836643	0.3049666	0.3276275	0.3496797
12	0.2487956	0.2561388	0.2672094	0.2836643	0.3049666	0.3276275	0.3496797

age	1994	1995	1996	1997	1998	1999	2000
0	0.0075786	0.0075085	0.0074455	0.0073612	0.0072515	0.0071007	0.0069145
1	0.0308493	0.0307299	0.0305944	0.0303518	0.0300827	0.0297624	0.0294683
2	0.0617987	0.0624223	0.0632962	0.0643490	0.0652014	0.0663590	0.0677509
3	0.1382657	0.1402508	0.1423662	0.1451665	0.1489544	0.1551726	0.1621972
4	0.2274085	0.2284119	0.2295167	0.2302798	0.2348751	0.2422538	0.2539412
5	0.2637545	0.2684914	0.2756808	0.2866376	0.3008093	0.3144050	0.3314492
6	0.3292134	0.3307539	0.3311059	0.3337611	0.3391175	0.3509724	0.3682325
7	0.3636306	0.3611378	0.3464510	0.3348470	0.3379247	0.3501930	0.3620875
8	0.3636306	0.3611378	0.3464510	0.3348470	0.3379247	0.3501930	0.3620875
9	0.3636306	0.3611378	0.3464510	0.3348470	0.3379247	0.3501930	0.3620875
10	0.3636306	0.3611378	0.3464510	0.3348470	0.3379247	0.3501930	0.3620875
11	0.3636306	0.3611378	0.3464510	0.3348470	0.3379247	0.3501930	0.3620875
12	0.3636306	0.3611378	0.3464510	0.3348470	0.3379247	0.3501930	0.3620875

age	2001	2002	2003	2004	2005	2006	2007
0	0.0064504	0.0060630	0.0054441	0.0049533	0.0047164	0.0047473	0.0045190
1	0.0280298	0.0274159	0.0239256	0.0197643	0.0181384	0.0181156	0.0166957
2	0.0670692	0.0665897	0.0654018	0.0666868	0.0611811	0.0535286	0.0447764
3	0.1572967	0.1573937	0.1435419	0.1458268	0.1348009	0.1149774	0.1062388
4	0.2619204	0.2587623	0.2364095	0.2233034	0.1983572	0.1842172	0.1784182

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  5  0.3234447 0.3281295 0.3233877 0.3124659 0.2823805 0.2593185 0.2658818
  6  0.4022376 0.4006351 0.4043449 0.3863956 0.3499205 0.3382625 0.3349733
  7  0.4135473 0.4709529 0.5185751 0.4759785 0.3725255 0.3500767 0.4215319
  8  0.4135473 0.4709529 0.5185751 0.4759785 0.3725255 0.3500767 0.4215319
  9  0.4135473 0.4709529 0.5185751 0.4759785 0.3725255 0.3500767 0.4215319
  10 0.4135473 0.4709529 0.5185751 0.4759785 0.3725255 0.3500767 0.4215319
  11 0.4135473 0.4709529 0.5185751 0.4759785 0.3725255 0.3500767 0.4215319
  12 0.4135473 0.4709529 0.5185751 0.4759785 0.3725255 0.3500767 0.4215319
    year
age  2008      2009      2010      2011      2012      2013      2014
  0  0.0043309 0.0040697 0.0038012 0.0035126 0.0031951 0.0028520 0.0025915
  1  0.0154370 0.0142991 0.0144289 0.0133007 0.0124674 0.0121304 0.0120714
  2  0.0397398 0.0378851 0.0385101 0.0390073 0.0395508 0.0395536 0.0404353
  3  0.1036988 0.1029883 0.1019253 0.0995995 0.0950419 0.0947216 0.1036332
  4  0.1776054 0.1835016 0.1855085 0.1825708 0.1772060 0.1824536 0.1853439
  5  0.2601412 0.2525970 0.2512682 0.2444012 0.2397071 0.2393082 0.2584703
  6  0.3134106 0.3106012 0.2974811 0.2935257 0.2833848 0.2772942 0.2972979
  7  0.4157745 0.3624106 0.3529844 0.3537624 0.3257843 0.3326300 0.3244693
  8  0.4157745 0.3624106 0.3529844 0.3537624 0.3257843 0.3326300 0.3244693
  9  0.4157745 0.3624106 0.3529844 0.3537624 0.3257843 0.3326300 0.3244693
  10 0.4157745 0.3624106 0.3529844 0.3537624 0.3257843 0.3326300 0.3244693
  11 0.4157745 0.3624106 0.3529844 0.3537624 0.3257843 0.3326300 0.3244693
  12 0.4157745 0.3624106 0.3529844 0.3537624 0.3257843 0.3326300 0.3244693
    year
age  2015      2016      2017      2018      2019
  0  0.0021519 0.0018347 0.0018630 0.0018175 0.0018175
  1  0.0123229 0.0114141 0.0101151 0.0095777 0.0095778
  2  0.0411522 0.0425606 0.0434984 0.0450707 0.0450748
  3  0.1029212 0.1085399 0.1125820 0.1100668 0.1100927
  4  0.1713103 0.1823056 0.1849752 0.1689698 0.1692441
  5  0.2376831 0.2287867 0.2301573 0.2255009 0.2266378
  6  0.2943613 0.2694109 0.2626977 0.2693035 0.2660935
  7  0.3098142 0.2626654 0.2642959 0.2630290 0.2595995
  8  0.3098142 0.2626654 0.2642959 0.2630290 0.2595995
  9  0.3098142 0.2626654 0.2642959 0.2630290 0.2595995
  10 0.3098142 0.2626654 0.2642959 0.2630290 0.2595995
  11 0.3098142 0.2626654 0.2642959 0.2630290 0.2595995
  12 0.3098142 0.2626654 0.2642959 0.2630290 0.2595995
```

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	Exploita-tion pat-tern	Weights in the catch
2019								
0	4486293	0.15	0.000	0.000	0.327	0.000	0.002	0.036
1	6236961	0.15	0.097	0.216	0.327	0.060	0.010	0.156
2	5558268	0.15	0.572	0.216	0.327	0.193	0.044	0.251
3	4466194	0.15	0.915	0.190	0.327	0.248	0.110	0.309
4	1065094	0.15	0.997	0.190	0.327	0.281	0.179	0.346
5	1838158	0.15	1.000	0.217	0.327	0.307	0.228	0.376
6	1155087	0.15	1.000	0.217	0.327	0.323	0.267	0.397
7	766610	0.15	1.000	0.217	0.327	0.349	0.263	0.417
8	1329015	0.15	1.000	0.217	0.327	0.374	0.263	0.443
9	1133087	0.15	1.000	0.217	0.327	0.395	0.263	0.463
10	565355	0.15	1.000	0.217	0.327	0.424	0.263	0.485
11	460681	0.15	1.000	0.217	0.327	0.436	0.263	0.501
12+	460899	0.15	1.000	0.217	0.327	0.484	0.263	0.529
2020								
0	4486293	0.15	0.000	0.000	0.327	0.000	0.002	0.036
1	-	0.15	0.097	0.216	0.327	0.060	0.010	0.156
2	-	0.15	0.572	0.216	0.327	0.193	0.044	0.251
3	-	0.15	0.915	0.190	0.327	0.248	0.110	0.309
4	-	0.15	0.997	0.190	0.327	0.281	0.179	0.346
5	-	0.15	1.000	0.217	0.327	0.307	0.228	0.376
6	-	0.15	1.000	0.217	0.327	0.323	0.267	0.397
7	-	0.15	1.000	0.217	0.327	0.349	0.263	0.417
8	-	0.15	1.000	0.217	0.327	0.374	0.263	0.443
9	-	0.15	1.000	0.217	0.327	0.395	0.263	0.463
10	-	0.15	1.000	0.217	0.327	0.424	0.263	0.485
11	-	0.15	1.000	0.217	0.327	0.436	0.263	0.501

	Stock Numbers	M	Maturity ogive	Prop of F before spw.	Prop of M before spw.	Weights in the stock	Exploita-tion pat-tern	Weights in the catch
12+	-	0.15	1.000	0.217	0.327	0.484	0.263	0.529
2021								
0	4486293	0.15	0.000	0.000	0.327	0.000	0.002	0.036
1	-	0.15	0.097	0.216	0.327	0.060	0.010	0.156
2	-	0.15	0.572	0.216	0.327	0.193	0.044	0.251
3	-	0.15	0.915	0.190	0.327	0.248	0.110	0.309
4	-	0.15	0.997	0.190	0.327	0.281	0.179	0.346
5	-	0.15	1.000	0.217	0.327	0.307	0.228	0.376
6	-	0.15	1.000	0.217	0.327	0.323	0.267	0.397
7	-	0.15	1.000	0.217	0.327	0.349	0.263	0.417
8	-	0.15	1.000	0.217	0.327	0.374	0.263	0.443
9	-	0.15	1.000	0.217	0.327	0.395	0.263	0.463
10	-	0.15	1.000	0.217	0.327	0.424	0.263	0.485
11	-	0.15	1.000	0.217	0.327	0.436	0.263	0.501
12+	-	0.15	1.000	0.217	0.327	0.484	0.263	0.529

Table 8.8.3.2. NE Atlantic Mackerel. Short-term prediction: Multi-option table for 834 954 t catch in 2019 and a range of F-values in 2020.

2019			
TSB	**SSB**	**F_{bar}**	**Catch**
5665055	4389601	0.206	834954

2020				2021		
TSB	**SSB**	**Fbar**	**Catch**	**TSB**	**SSB**	**Implied change in the catch**
5680185	4696388	0	0	6136310	5287640	-100.0%
-	4688846	0.01	43964	6099423	5243867	-94.7%
-	4681320	0.02	87553	6062857	5200562	-89.5%
-	4673808	0.03	130768	6026610	5157720	-84.3%
-	4666311	0.04	173614	5990679	5115335	-79.2%
-	4658828	0.05	216095	5955060	5073402	-74.1%
-	4651360	0.06	258214	5919751	5031915	-69.1%
-	4643907	0.07	299974	5884749	4990869	-64.1%
-	4636468	0.08	341379	5850050	4950259	-59.1%
-	4629044	0.09	382432	5815652	4910081	-54.2%
-	4621635	0.10	423136	5781552	4870328	-49.3%
-	4614240	0.11	463496	5747747	4830995	-44.5%
-	4606859	0.12	503514	5714234	4792079	-39.7%
-	4599493	0.13	543193	5681010	4753574	-34.9%
-	4592141	0.14	582537	5648072	4715475	-30.2%
-	4584803	0.15	621549	5615418	4677778	-25.6%
-	4577480	0.16	660233	5583045	4640477	-20.9%
-	4570172	0.17	698590	5550950	4603568	-16.3%
-	4562877	0.18	736624	5519131	4567047	-11.8%
-	4555597	0.19	774340	5487584	4530909	-7.3%
-	4548331	0.20	811738	5456308	4495149	-2.8%
-	4541079	0.21	848823	5425299	4459764	1.7%

2020				2021		
TSB	SSB	Fbar	Catch	TSB	SSB	Implied change in the catch
-	4519408	0.24	958226	5333853	4355808	14.8%
-	4512212	0.25	994086	5303889	4321876	19.1%
-	4505031	0.26	1029648	5274181	4288296	23.3%
-	4497864	0.27	1064913	5244725	4255066	27.5%
-	4490710	0.28	1099885	5215518	4222180	31.7%
-	4483571	0.29	1134566	5186560	4189634	35.9%
-	4476445	0.30	1168959	5157847	4157425	40.0%
-	4469333	0.31	1203068	5129377	4125550	44.1%
-	4462236	0.32	1236894	5101148	4094003	48.1%
-	4455151	0.33	1270440	5073157	4062781	52.2%
-	4448081	0.34	1303710	5045402	4031880	56.1%
-	4441025	0.35	1336704	5017881	4001297	60.1%
-	4433982	0.36	1369427	4990591	3971029	64.0%
-	4426953	0.37	1401881	4963531	3941070	67.9%
-	4419938	0.38	1434068	4936698	3911418	71.8%
-	4412936	0.39	1465991	4910091	3882070	75.6%
-	4405948	0.40	1497652	4883706	3853021	79.4%
-	4398973	0.41	1529053	4857541	3824268	83.1%
-	4392012	0.42	1560198	4831596	3795809	86.9%
-	4385065	0.43	1591089	4805867	3767639	90.6%
-	4378131	0.44	1621727	4780352	3739755	94.2%
-	4371210	0.45	1652115	4755050	3712153	97.9%
-	4364303	0.46	1682257	4729958	3684832	101.5%
-	4357410	0.47	1712153	4705075	3657787	105.1%
-	4350530	0.48	1741806	4680398	3631015	108.6%
-	4343663	0.49	1771219	4655926	3604513	112.1%
-	4336809	0.50	1800394	4631656	3578279	115.6%

2020				2021		
TSB	SSB	Fbar	Catch	TSB	SSB	Implied change in the catch
-	4309528	0.54	1914754	4536564	3475949	129.3%
-	4302741	0.55	1942771	4513279	3451005	132.7%
-	4295966	0.56	1970562	4490185	3426309	136.0%
-	4289205	0.57	1998130	4467281	3401860	139.3%
-	4282457	0.58	2025477	4444564	3377654	142.6%
-	4275723	0.59	2052605	4422033	3353690	145.8%
-	4269001	0.60	2079517	4399686	3329963	149.1%
-	4262292	0.61	2106213	4377522	3306472	152.3%
-	4255596	0.62	2132696	4355539	3283213	155.4%
-	4248913	0.63	2158969	4333734	3260185	158.6%
-	4242243	0.64	2185032	4312107	3237384	161.7%
-	4235586	0.65	2210889	4290656	3214808	164.8%
-	4228942	0.66	2236540	4269379	3192454	167.9%
-	4222311	0.67	2261988	4248274	3170320	170.9%
-	4215693	0.68	2287234	4227340	3148403	173.9%
-	4209087	0.69	2312281	4206575	3126701	176.9%
-	4202494	0.70	2337131	4185978	3105212	179.9%
-	4195914	0.71	2361784	4165546	3083932	182.9%
-	4189347	0.72	2386244	4145280	3062861	185.8%
-	4182792	0.73	2410511	4125176	3041994	188.7%
-	4176250	0.74	2434588	4105233	3021331	191.6%
-	4169720	0.75	2458476	4085451	3000868	194.4%
-	4163204	0.76	2482177	4065827	2980604	197.3%
-	4156699	0.77	2505693	4046360	2960537	200.1%
-	4150208	0.78	2529025	4027048	2940663	202.9%
-	4143728	0.79	2552176	4007890	2920981	205.7%
-	4137262	0.80	2575146	3988885	2901489	208.4%

2020				2021		
TSB	SSB	Fbar	Catch	TSB	SSB	Implied change in the catch
-	4130808	0.81	2597937	3970031	2882184	211.1%
-	4124366	0.82	2620552	3951327	2863066	213.9%
-	4117937	0.83	2642991	3932771	2844130	216.5%
-	4111520	0.84	2665257	3914363	2825376	219.2%
-	4105115	0.85	2687350	3896099	2806801	221.9%
-	4098723	0.86	2709273	3877981	2788404	224.5%
-	4092343	0.87	2731027	3860005	2770182	227.1%
-	4085975	0.88	2752614	3842170	2752133	229.7%
-	4079620	0.89	2774034	3824476	2734256	232.2%
-	4073277	0.90	2795290	3806921	2716549	234.8%
-	4066946	0.91	2816384	3789504	2699009	237.3%
-	4060627	0.92	2837315	3772223	2681636	239.8%
-	4054321	0.93	2858087	3755078	2664426	242.3%
-	4048026	0.94	2878701	3738066	2647378	244.8%
-	4041744	0.95	2899157	3721187	2630491	247.2%
-	4035474	0.96	2919457	3704440	2613763	249.7%
-	4029216	0.97	2939604	3687822	2597191	252.1%
-	4022969	0.98	2959597	3671334	2580775	254.5%
-	4016735	0.99	2979439	3654974	2564512	256.8%
-	4010513	1.00	2999131	3638740	2548401	259.2%
-	4004303	1.01	3018674	3622632	2532440	261.5%
-	3998105	1.02	3038070	3606649	2516627	263.9%
-	3991918	1.03	3057319	3590788	2500962	266.2%
-	3985744	1.04	3076424	3575050	2485441	268.5%
-	3979581	1.05	3095386	3559433	2470064	270.7%
-	3973430	1.06	3114205	3543936	2454829	273.0%
-	3967291	1.07	3132884	3528557	2439735	275.2%

2020				2021		
TSB	**SSB**	**Fbar**	**Catch**	**TSB**	**SSB**	**Implied change**
						in the catch
-	3961164	1.08	3151422	3513296	2424779	277.4%
-	3955049	1.09	3169823	3498152	2409961	279.6%

Table 8.8.3.3. NE Atlantic Mackerel. Short-term prediction: Management option table for 834 954 t catch in 2019 and a range of catch options in 2020.

Rationale	Catch (2020)	F_{bar} (2020)	SSB (2020)	SSB (2021)	% SSb change	% catch change	% advice change
MSY AR	922064	0.23	4526617	4390097	-3.0%	10.4%	19.7%
F = 0	0	0.00	4696388	5287640	12.6%	-100.0%	-100.0%
F = Fpa	1401881	0.37	4426953	3941070	-11.0%	67.9%	82.0%
F = Flim	1682257	0.46	4364303	3684832	-15.6%	101.5%	118.4%
SSB(2021) = MSY Btrigger = Bpa	3058502	1.03	3991537	2500000	-37.4%	266.3%	297.0%
SSB(2021) = Blim	3705781	1.42	3760134	1990000	-47.1%	343.8%	381.0%
F = F2019	835665	0.21	4543657	4472310	-1.6%	0.1%	8.5%
Catch(2020) = Catch(2019) −20%	667963	0.16	4576011	4633032	1.2%	-20.0%	-13.3%
Catch(2020) = Catch (2019)	834954	0.21	4543796	4472988	-1.6%	0.0%	8.4%
Catch(2020) = Catch(2019) +25%	1043693	0.26	4502182	4275053	-5.0%	25.0%	35.5%
F = 0.20	811738	0.20	4548331	4495149	-1.2%	-2.8%	5.4%
F = 0.21	848823	0.21	4541079	4459764	-1.8%	1.7%	10.2%
F = 0.22	885597	0.22	4533841	4424748	-2.4%	6.1%	15.0%
F = 0.24	958226	0.24	4519408	4355808	-3.6%	14.8%	24.4%
F = 0.25	994086	0.25	4512212	4321876	-4.2%	19.1%	29.0%
F = 0.26	1029648	0.26	4505031	4288296	-4.8%	23.3%	33.7%
F = 0.27	1064913	0.27	4497864	4255066	-5.4%	27.5%	38.2%
F = 0.28	1099885	0.28	4490710	4222180	-6.0%	31.7%	42.8%
F = 0.29	1134566	0.29	4483571	4189634	-6.6%	35.9%	47.3%

8.15 Figures

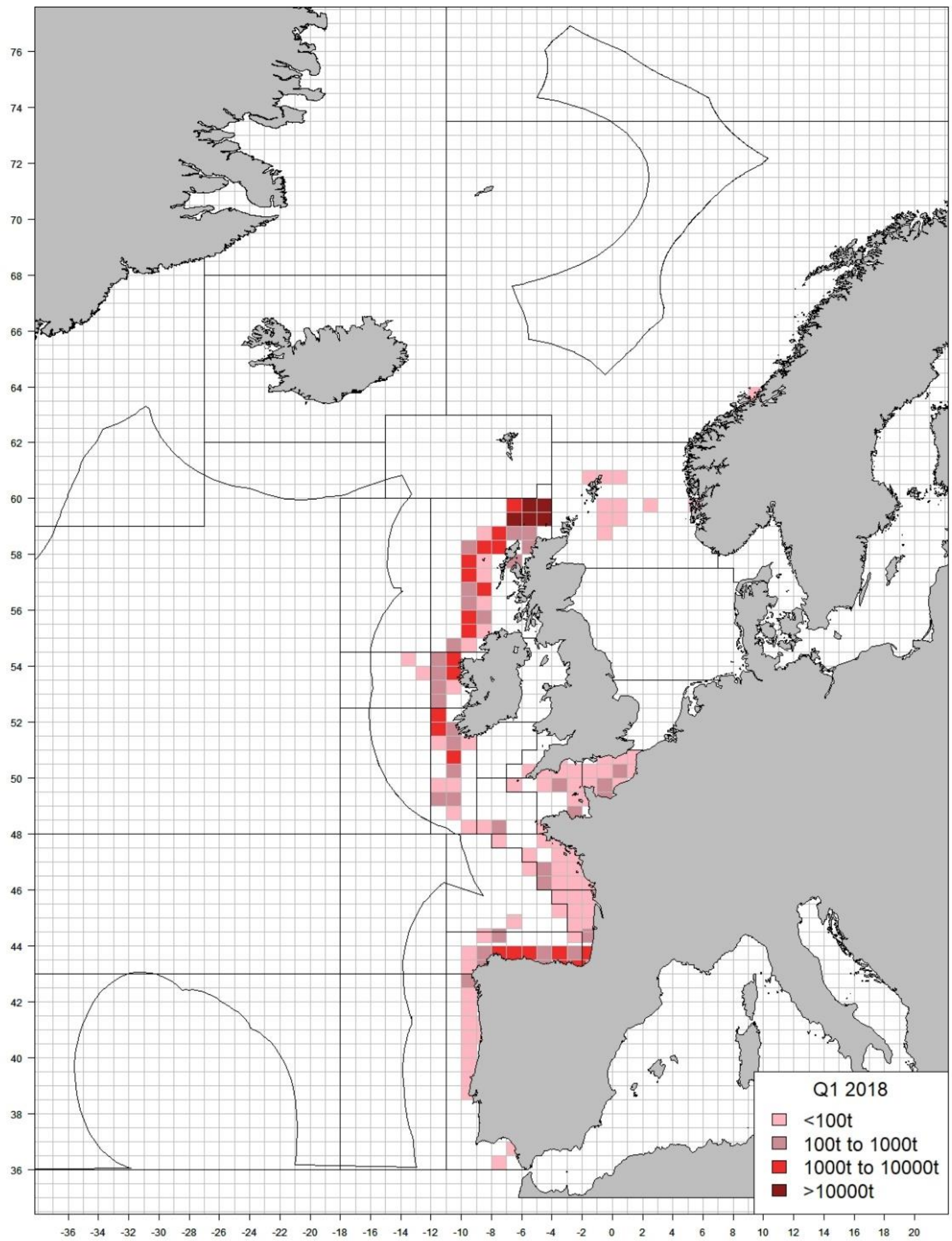


Figure 8.4.2.1. NE Atlantic Mackerel. Commercial catches in 2018, quarter 1.

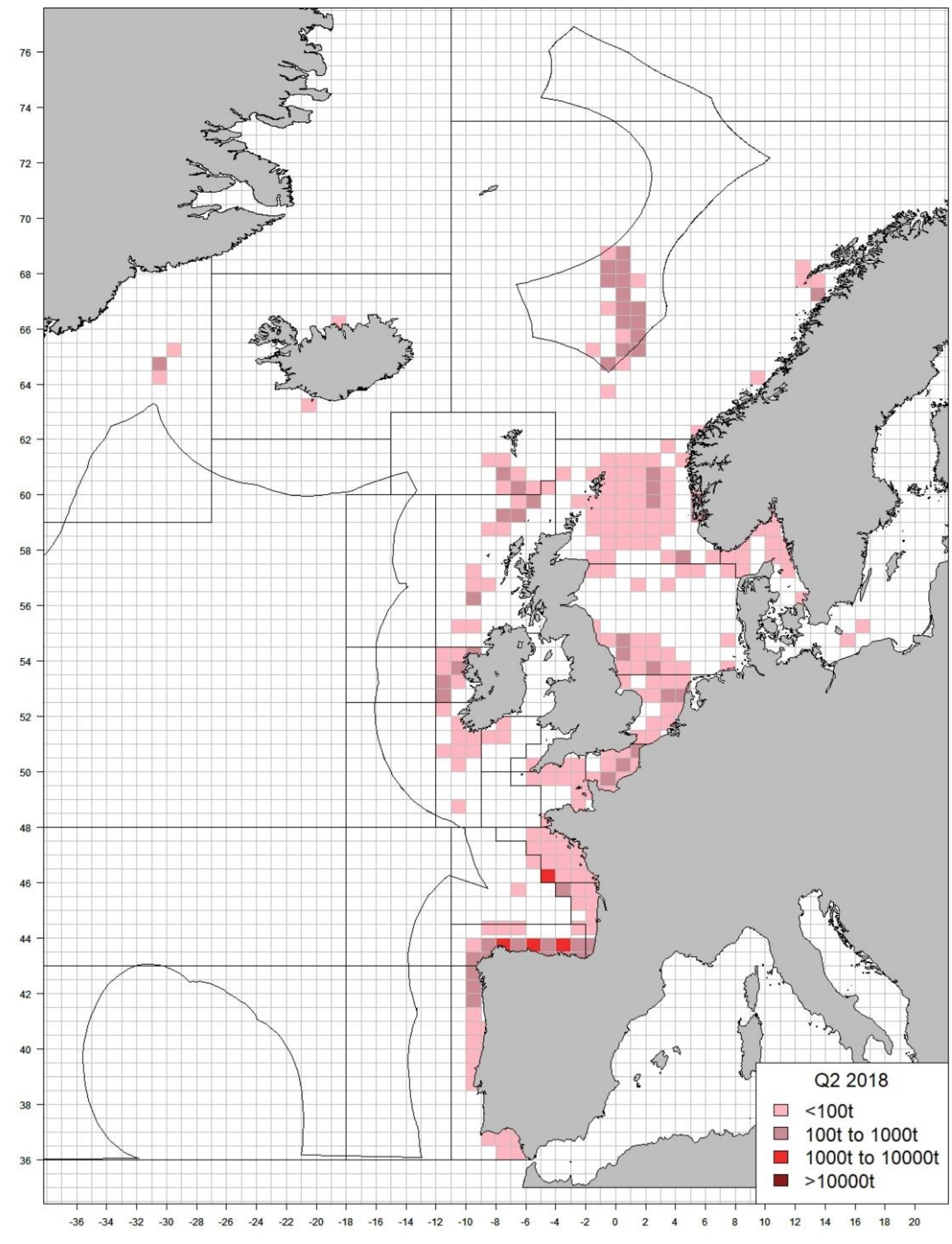


Figure 8.4.2.2. NE Atlantic Mackerel. Commercial catches in 2018, quarter 2.

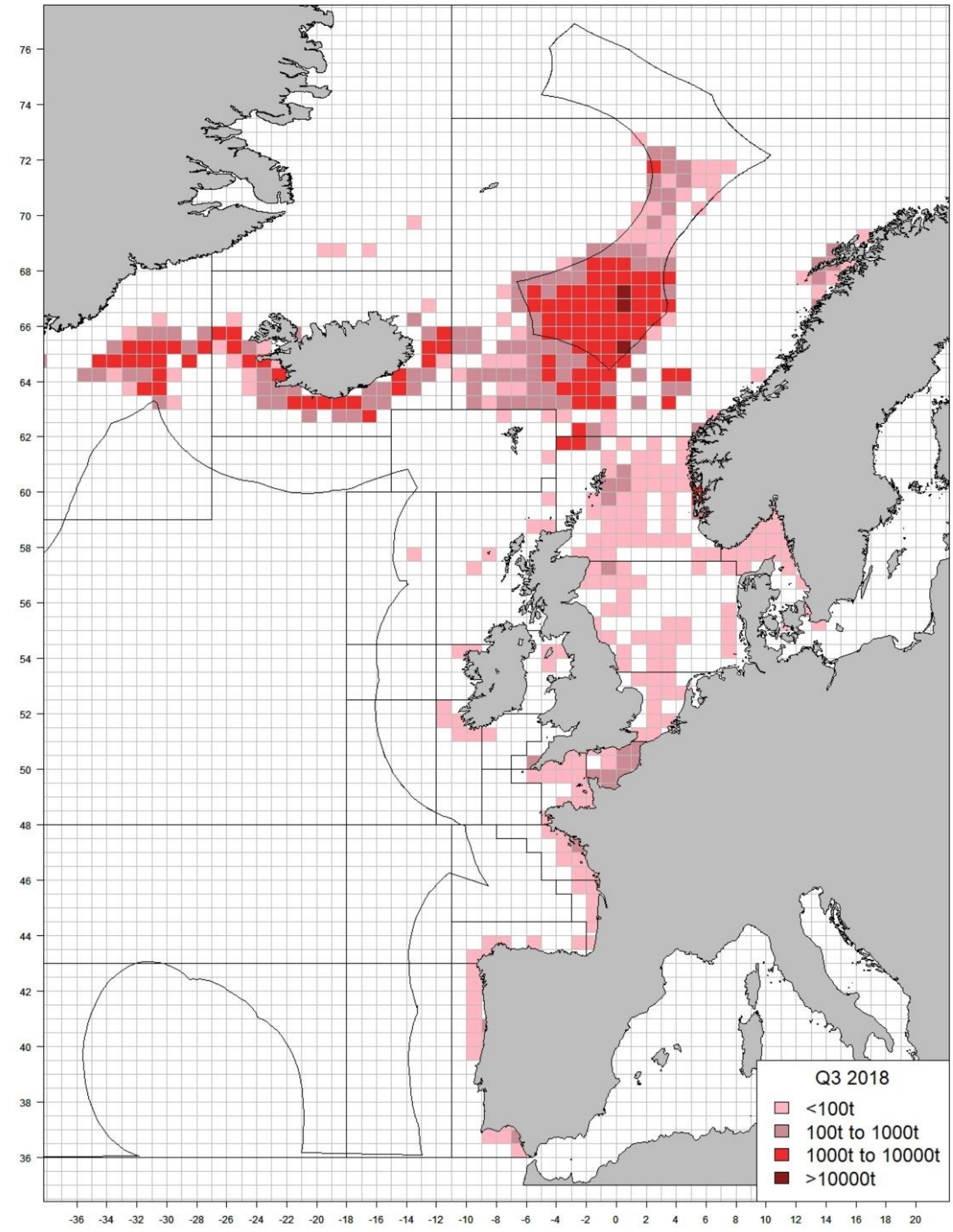


Figure 8.4.2.3. NE Atlantic Mackerel. Commercial catches in 2018, quarter 3.

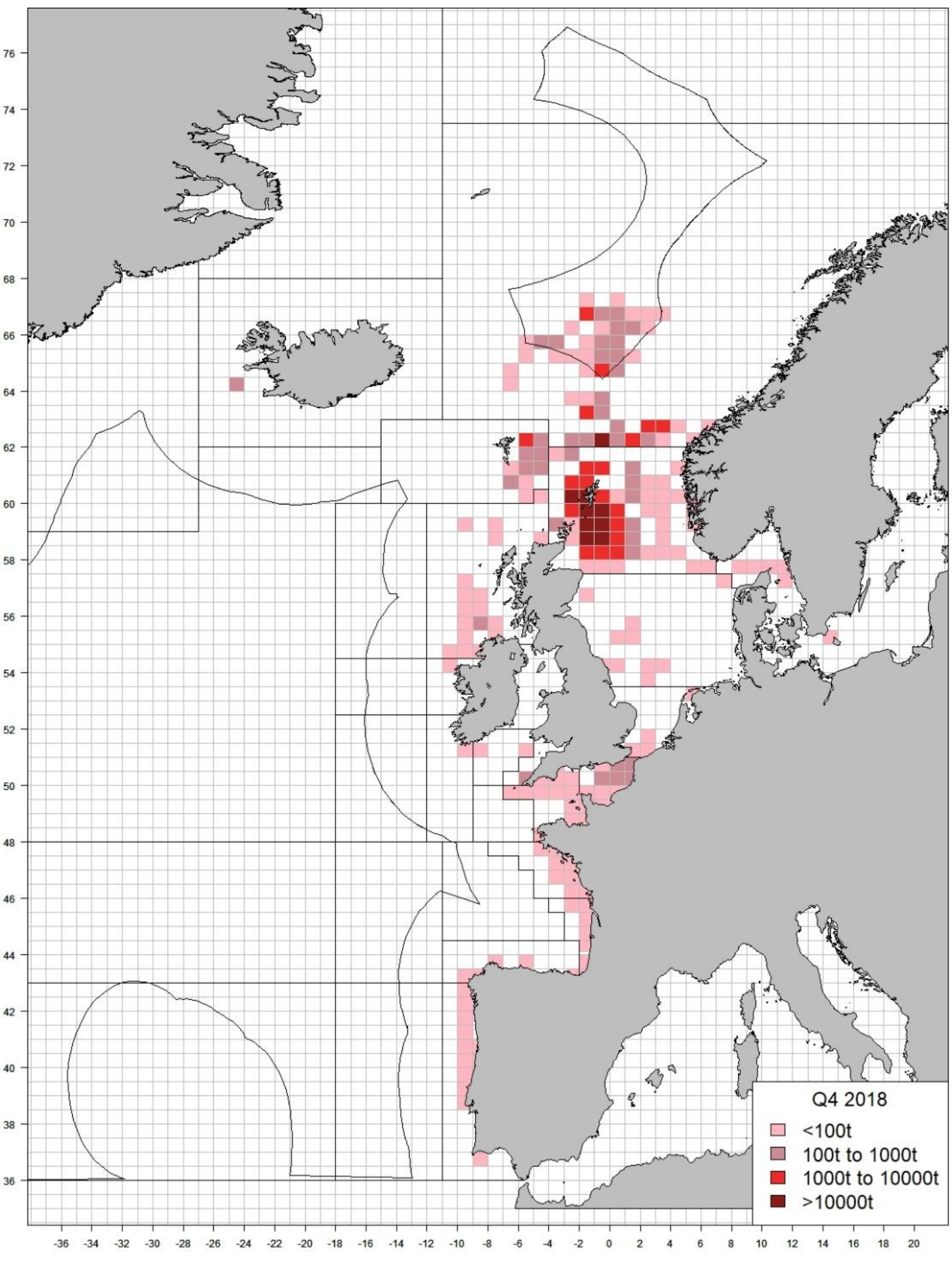


Figure 8.4.2.4. NE Atlantic Mackerel. Commercial catches in 2018, quarter 4.

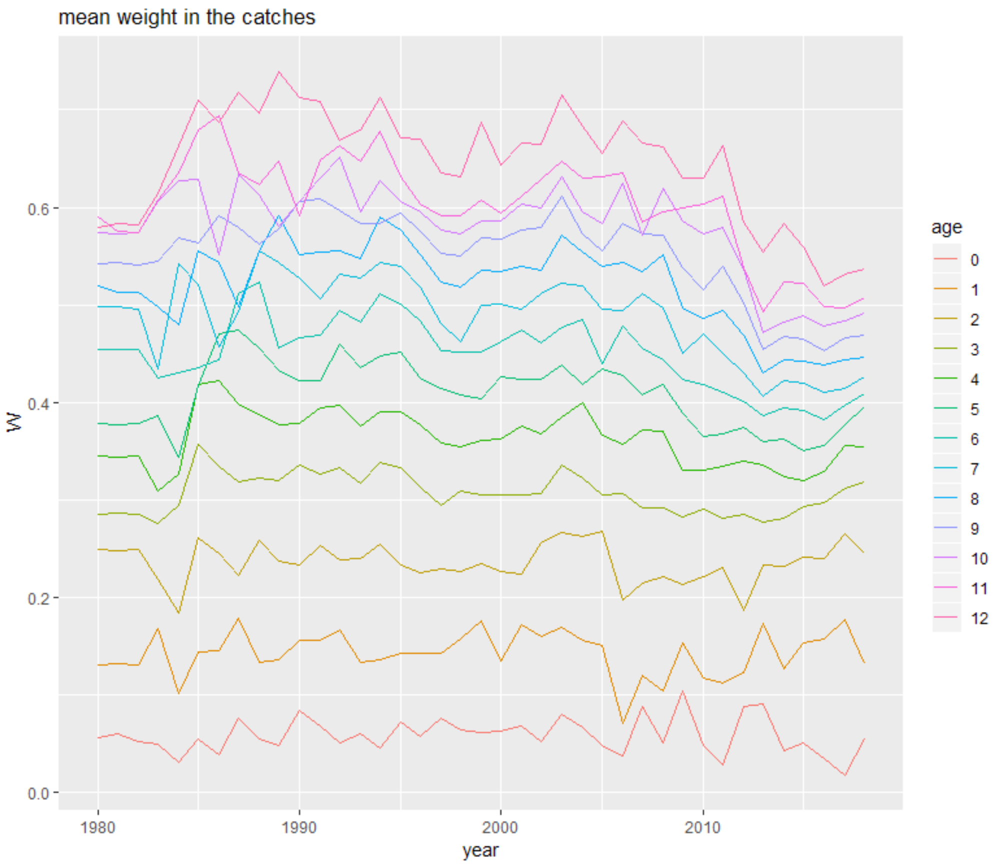


Figure 8.5.2.1. NE Atlantic mackerel. Weights-at-age in the catch.

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

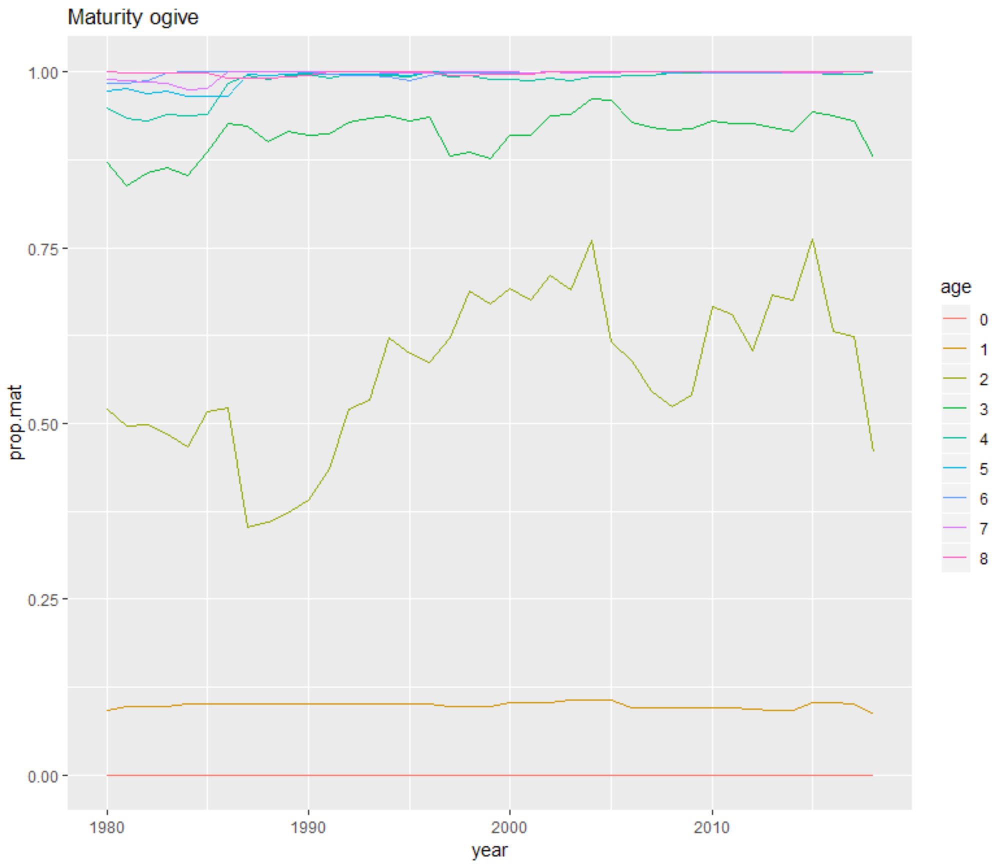


Figure 8.5.3.1. NE Atlantic mackerel. Proportion of mature fish at age.

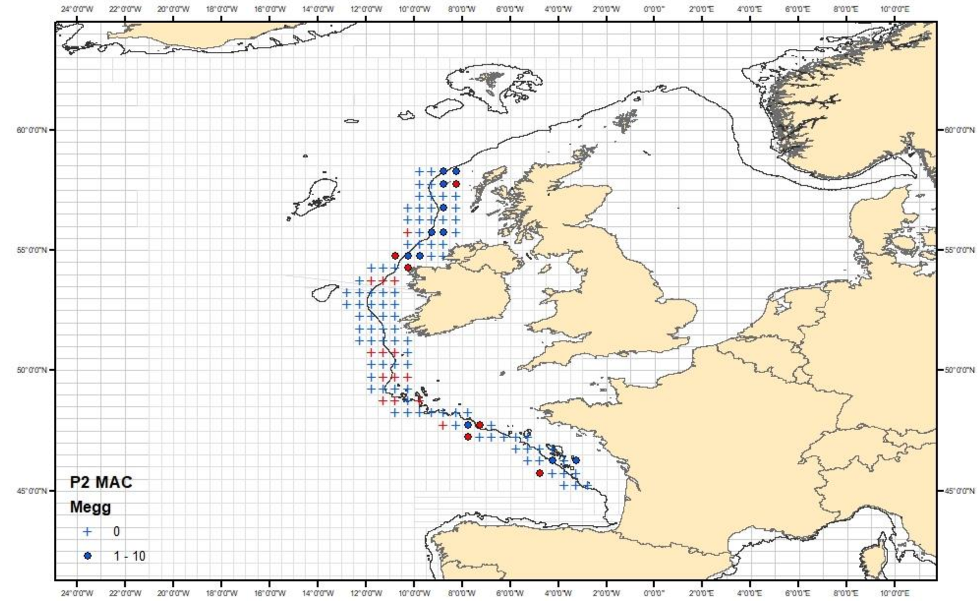


Figure 8.6.1.1. Mackerel egg production by half rectangle for period 2 (Feb 5th – Mar 3rd). Filled blue circles represent observed values, filled red circles represent interpolated values, blue crosses represent observed zeroes, red crosses interpolated zeroes.

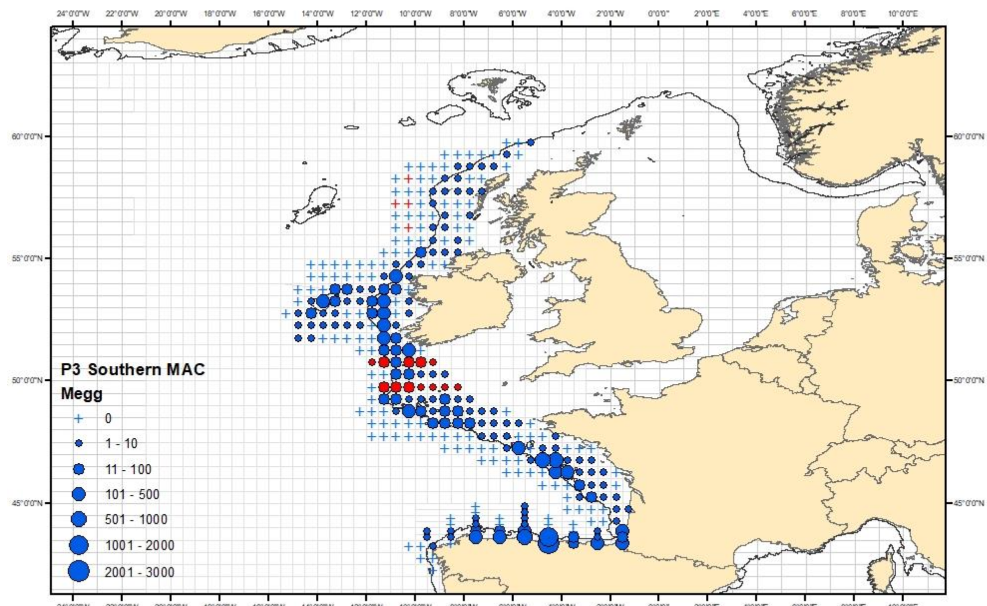


Figure 8.6.1.2. Mackerel egg production by half rectangle for period 3 (Mar 4th – Apr 12th). Filled blue circles represent observed values, filled red circles represent interpolated values, blue crosses represent observed zeroes, red crosses interpolated zeroes.

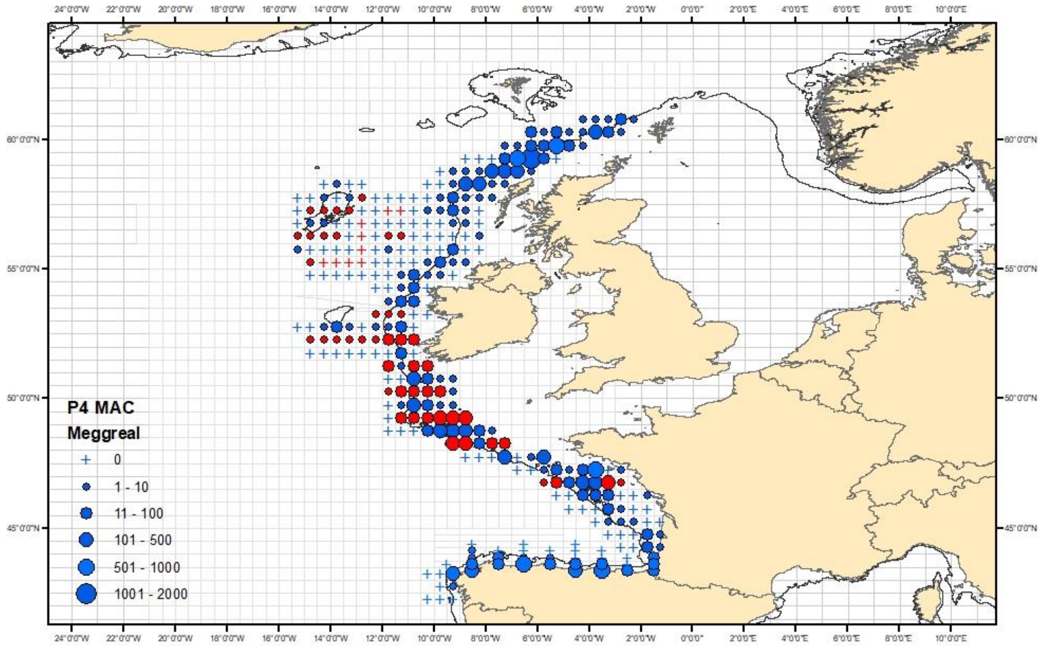


Figure 8.6.1.3. Mackerel egg production by half rectangle for period 4 (Apr 13th – May 3rd). Filled blue circles represent observed values, filled red circles represent interpolated values, blue crosses represent observed zeroes, red crosses interpolated zeroes.

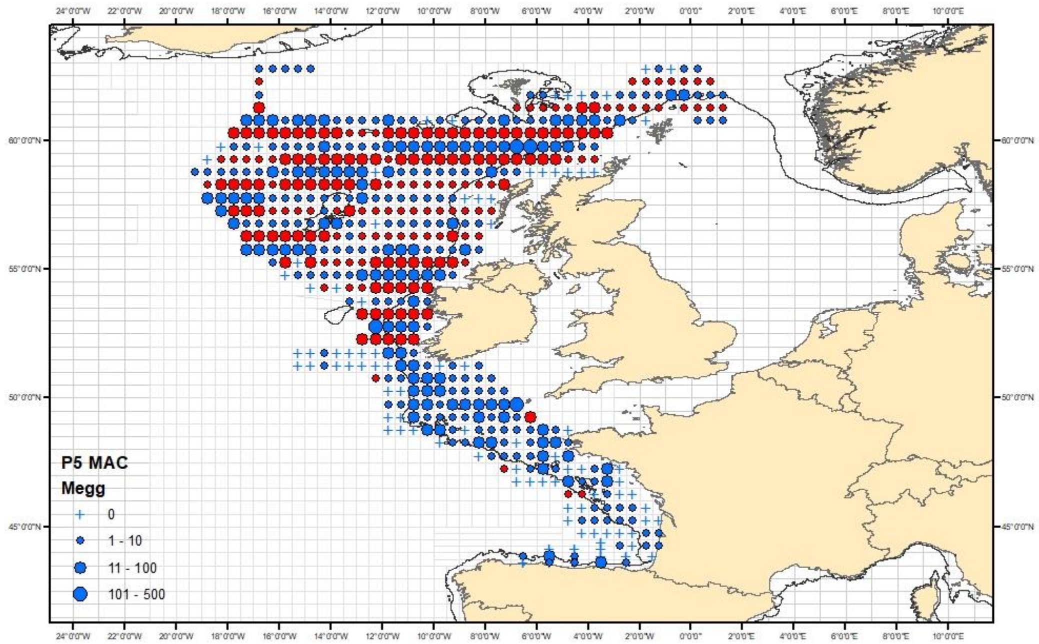


Figure 8.6.1.4. Mackerel egg production by half rectangle for period 5 (May 4th – June 5th). Filled blue circles represent observed values, filled red circles represent interpolated values, blue crosses represent observed zeroes, red crosses interpolated zeroes.

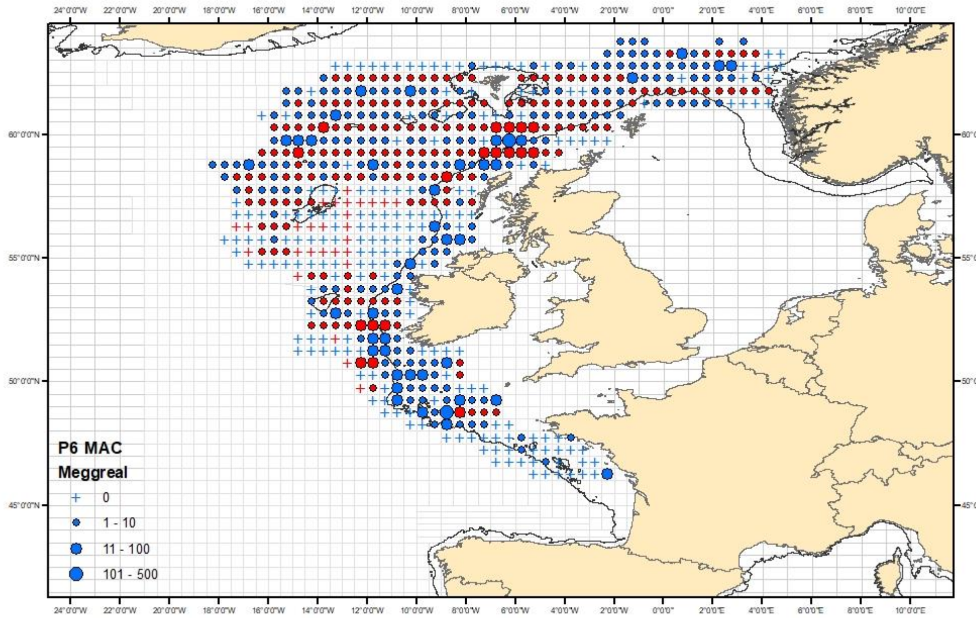


Figure 8.6.1.5. Mackerel egg production by half rectangle for period 6 (June 6th – 30th). Filled blue circles represent observed values, filled red circles represent interpolated values, blue crosses represent observed zeroes, red crosses interpolated zeroes.

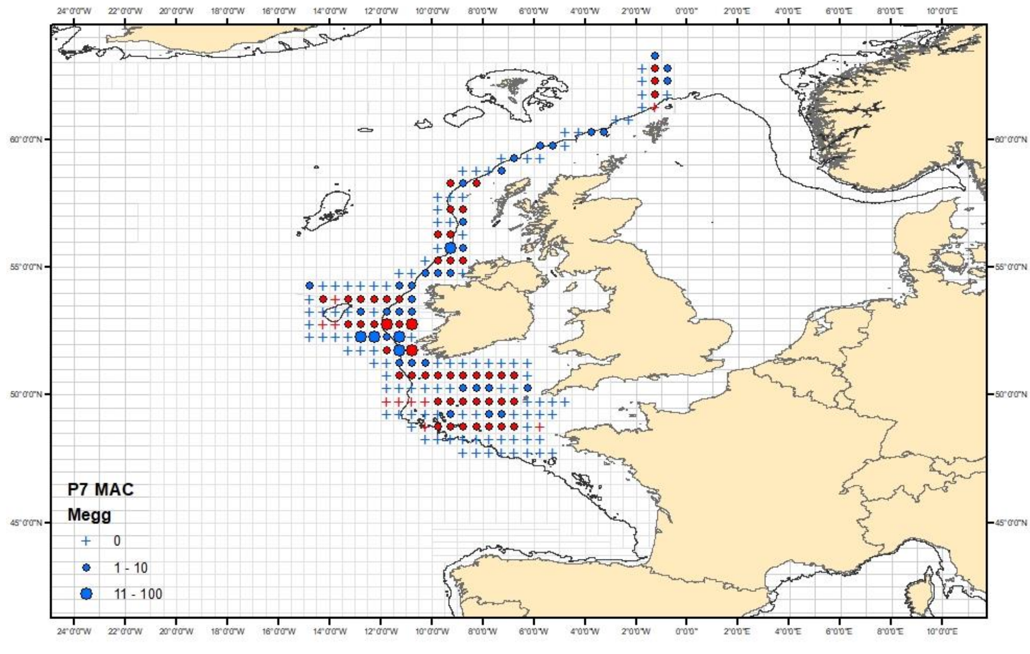


Figure 8.6.1.6. Mackerel egg production by half rectangle for period 7 (July 1st – 31st). Filled blue circles represent observed values, filled red circles represent interpolated values, blue crosses represent observed zeroes, red crosses interpolated zeroes.

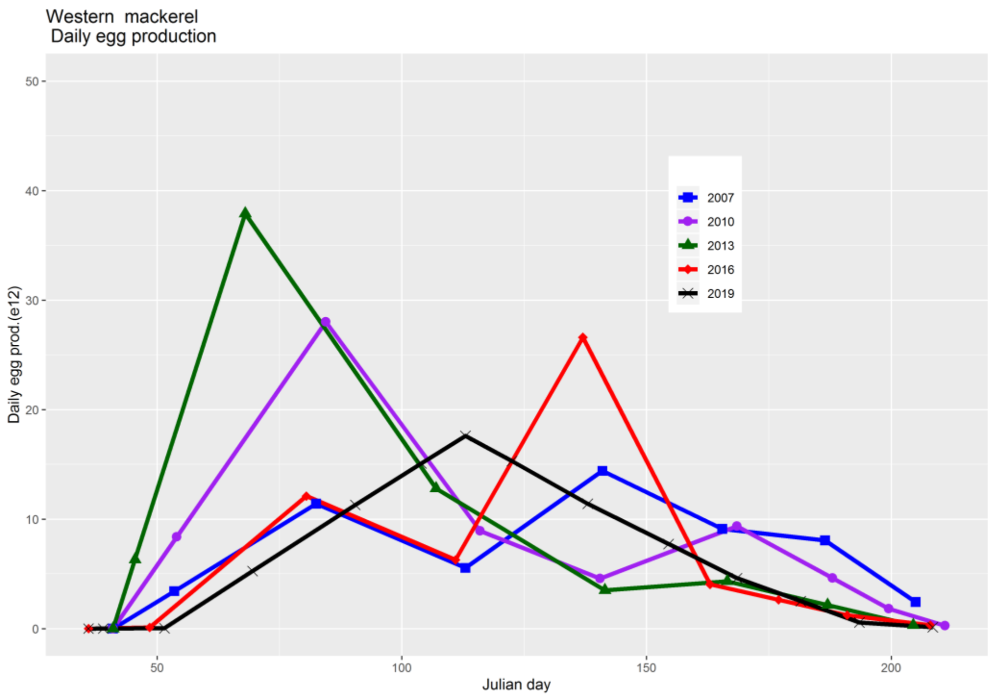


Figure 8.6.1.7. Provisional annual egg production curve for mackerel in the western spawning component. The curves for 2007, 2010 2013 and 2016 are included for comparison.

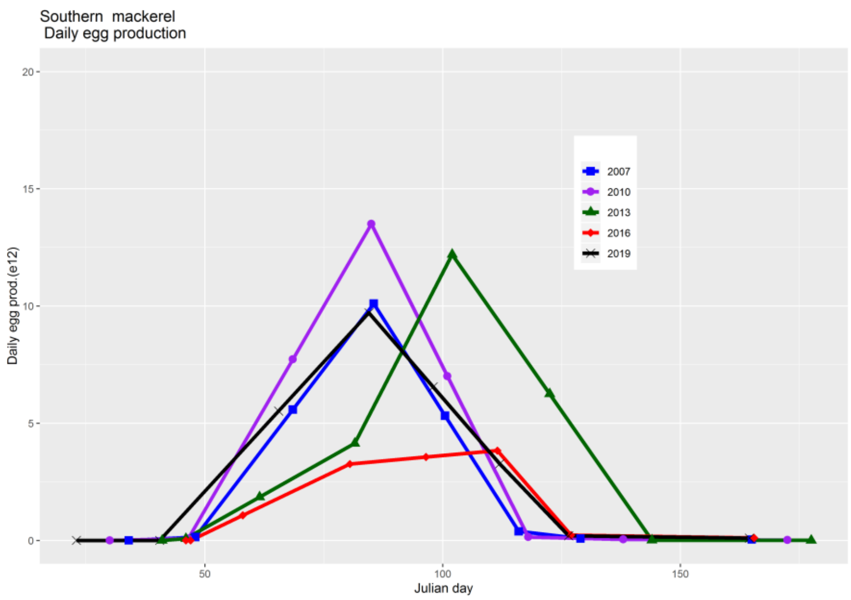


Figure 8.6.1.8. Provisional annual egg production curve for mackerel in the southern spawning component for 2019. The curves for 2007, 2010, 2013 and 2016 are included for comparison.

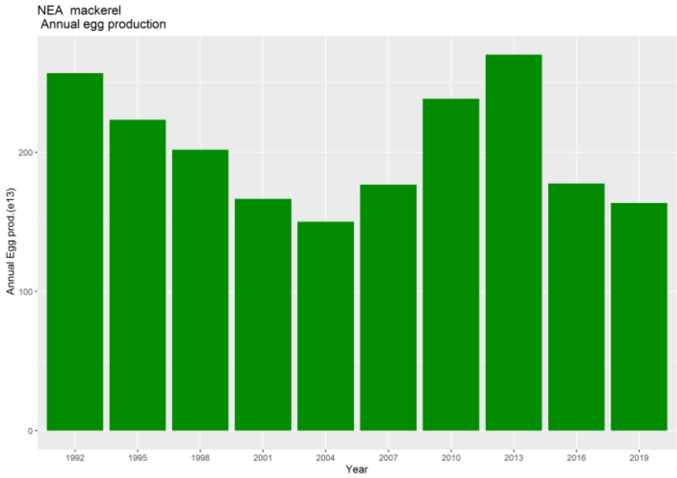


Figure 8.6.1.9. Combined mackerel TAEP estimates (*10[13]) - 1992 – 2019.

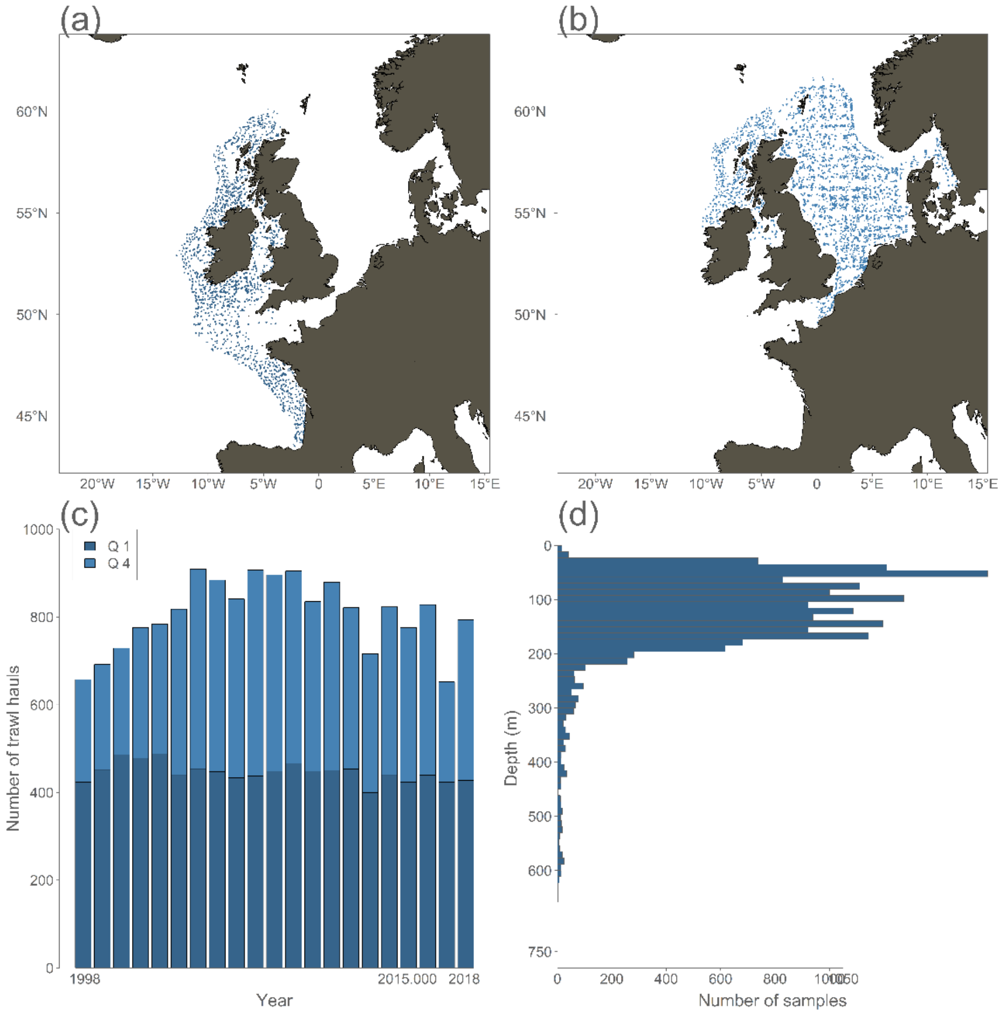


Figure 8.6.2.1. Demersal trawl survey data used to derive the abundance index of age-0 mackerel. (a) Trawl sample locations in the fourth quarter (Q4, October - November, blue dots); (b) trawl sample locations in the first quarter (Q1, January - March, light blue dots); (c) number of samples by year and quarter; and (d) depth.

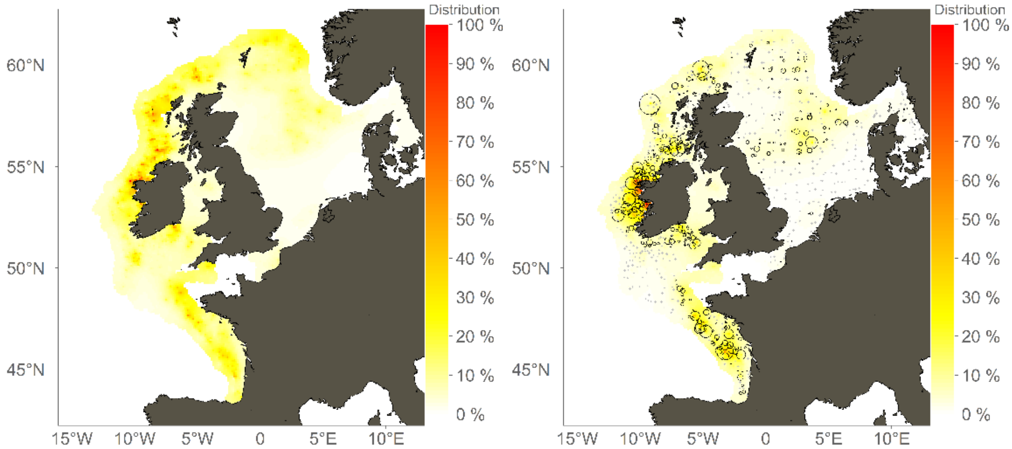


Figure 8.6.2.2. Spatial distribution of mackerel juveniles at age 0 in October to March. Left) average for cohorts from 19982018; and Right) 2018 cohort. Mackerel squared catch rates by trawl haul (circle areas represent catch rates in kg/km2) overlaid on modelled squared catch rates per 10 x 10 km rectangle. Each rectangle is coloured according to the expected squared catch rate in percent of the highest value for that year. See Jansen *et al.* (2015) for details.

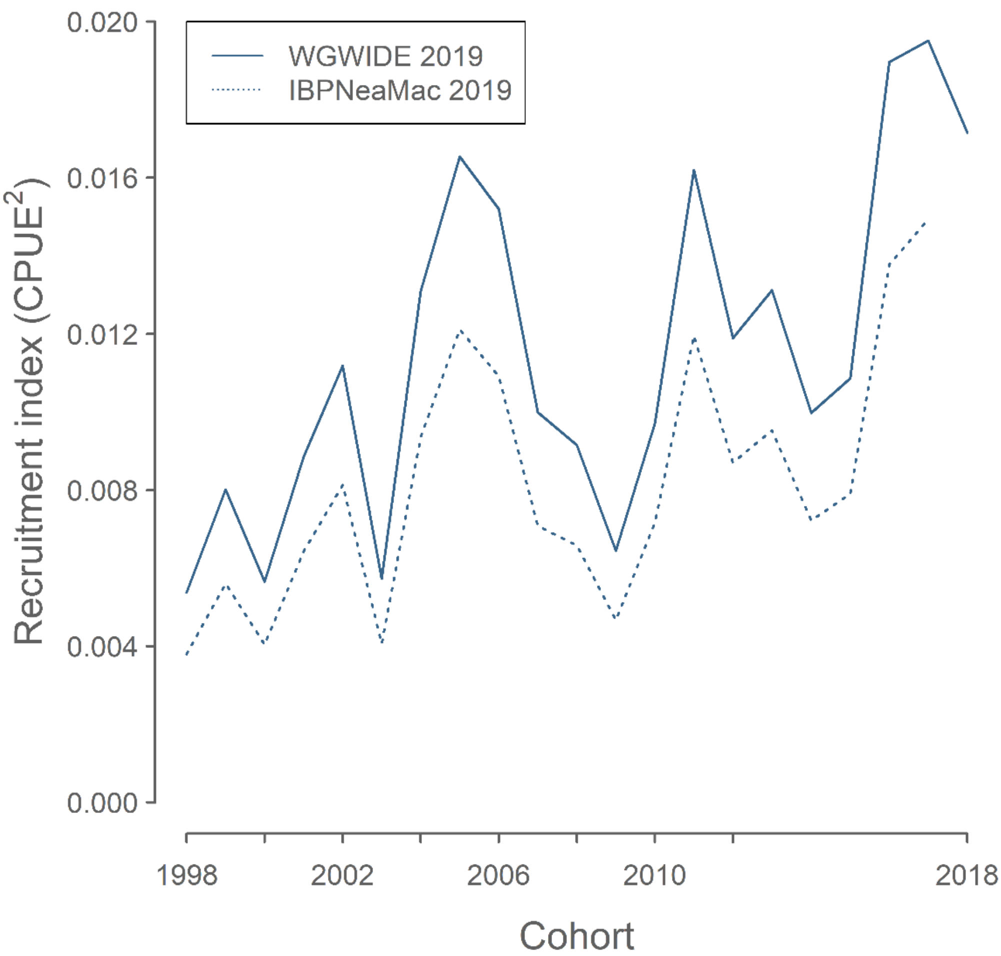


Figure 8.6.2.3. Index of mackerel juveniles at age 0 in October to March proxied by annual integration of square root of expected catch in demersal trawl surveys (Blue lines). See Jansen *et al.* (2015) for details.

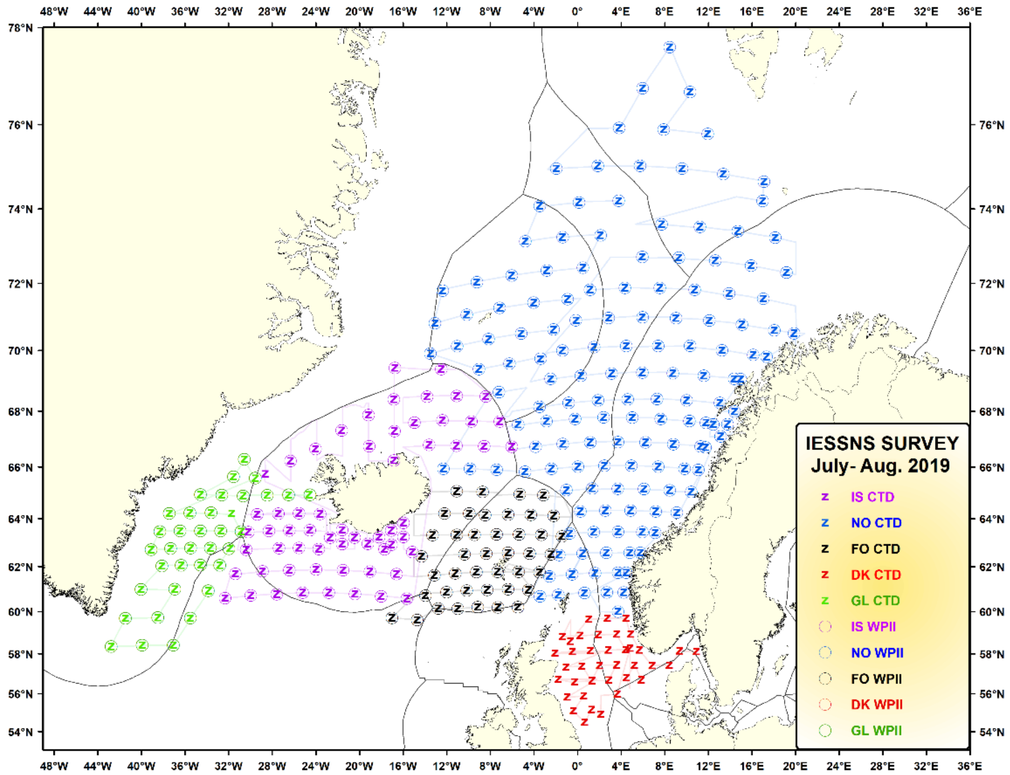


Figure 8.6.3.1. Fixed predetermined trawl stations (shown for CTD and WP2) included in the IESSNS 28th June – 5th August 2019. At each station a 30 min surface trawl haul, a CTD station (0-500 m) and WP2 plankton net samples (0-200 m depth) were performed. The colour codes, Árni Friðriksson (purple), Finnur Fríði (black), Kings Bay and Vendla (blue), Eros (green) and Ceton (red).

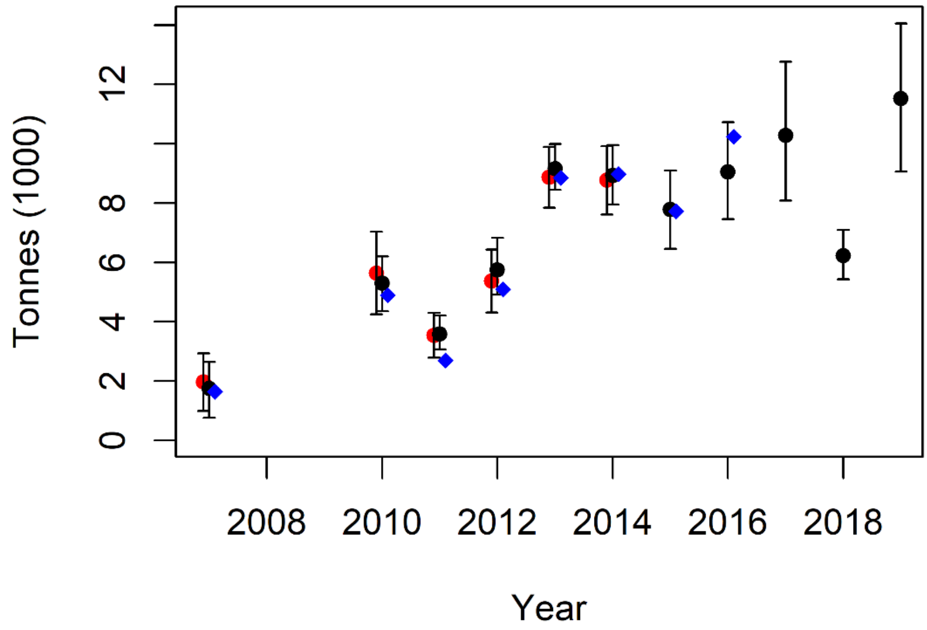


Figure 8.6.3.2a. Estimated total stock biomass (TSB) of mackerel from StoX (black dots), Nøttestad et al. (2016) (red dots) and IESSNS cruise reports (blue diamonds) 2007-2019. The error bars represent approximate 90 % confidence intervals.

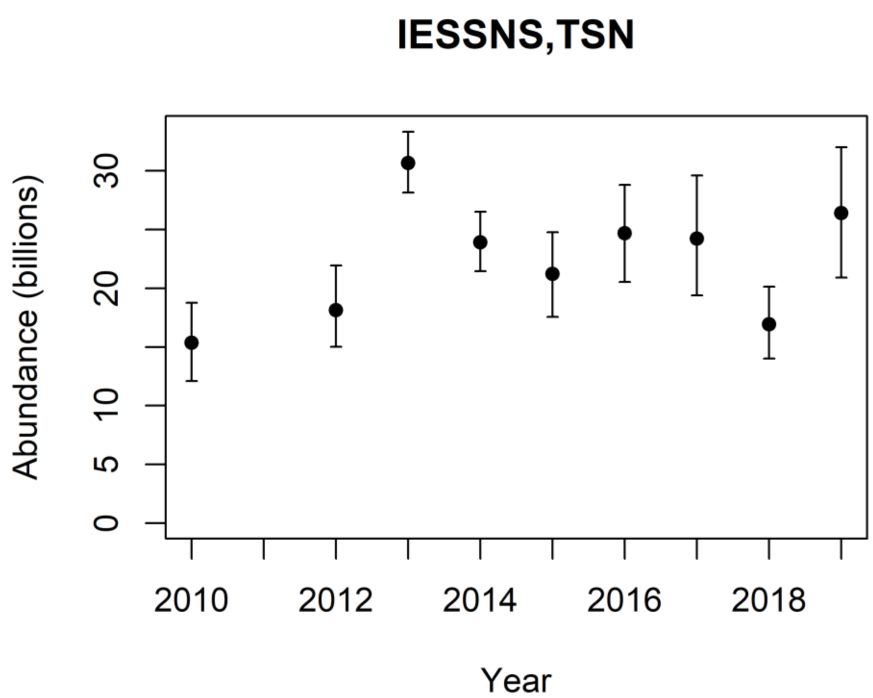


Figure 8.6.3.2b. Estimated total stock numbers (TSN) of mackerel from StoX (black dots) for the years 2010, 20122019. The error bars represent approximate 90 % confidence intervals

Figure 8.6.3.3. Catch curves. Each cohort is marked by a uniquely coloured line that connects the estimates indicated by the respective ages.

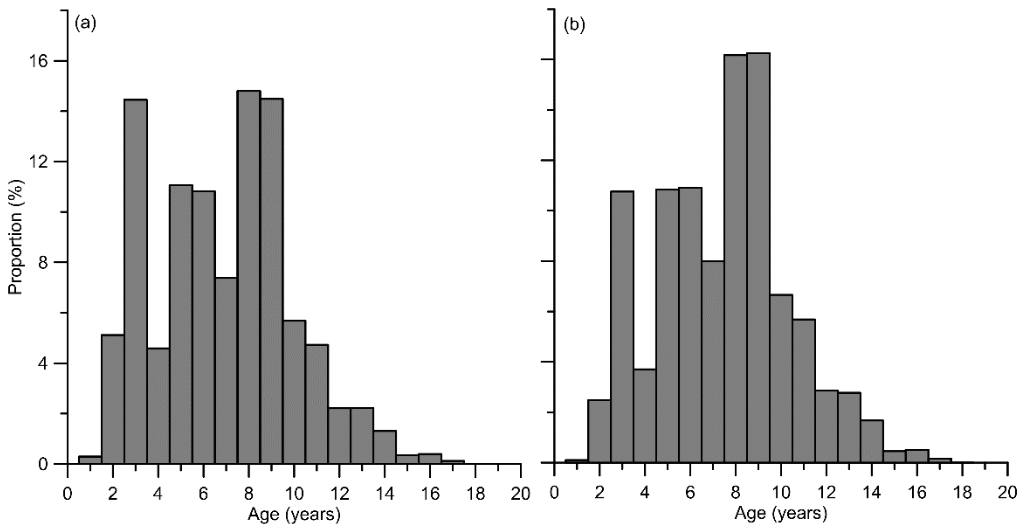


Figure 8.6.3.4a. Age distribution in proportion represented as a) % in numbers and b) % in biomass of Northeast Atlantic mackerel in 2019.

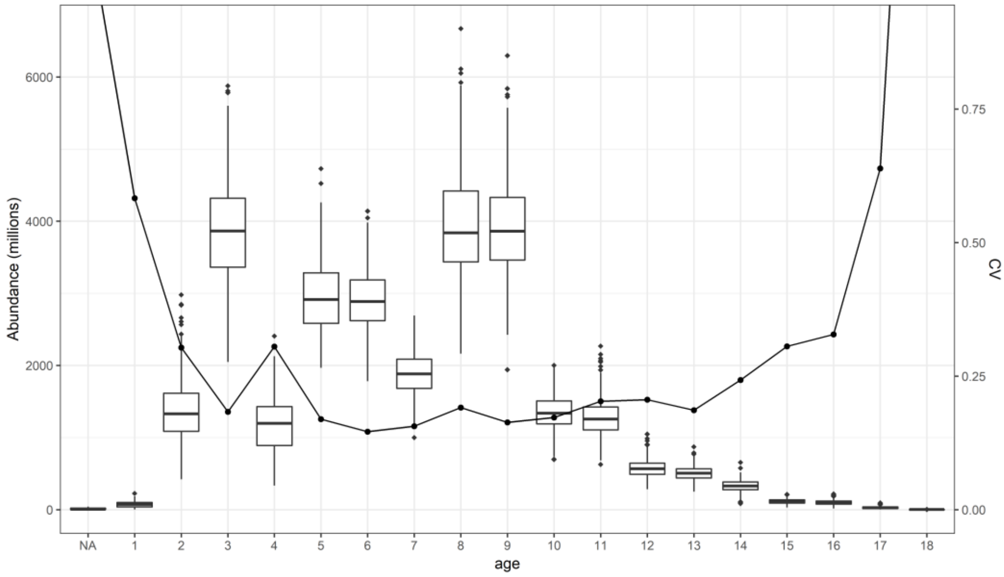


Figure 8.6.3.4b. Mackerel numbers by age from the IESSNS survey in 2019, excluding North Sea. Boxplot of abundance and relative standard error (CV) obtained by bootstrapping with 500 replicates using the StoX software (http://www.imr.no/forskning/prosjekter/stox/nb-no).

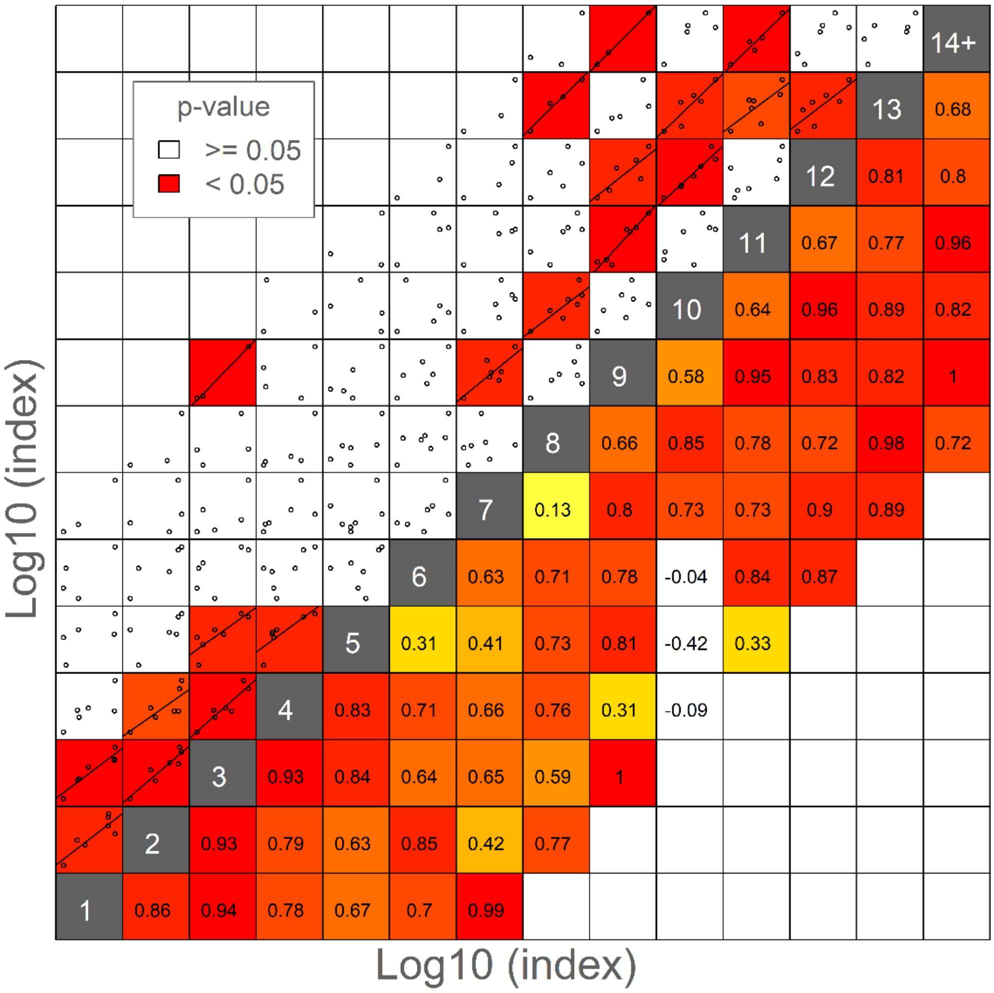


Figure 8.6.3.5. Internal consistency of the mackerel abundance index from the IESSNS surveys including data from 2012 to 2019, excluding North Sea in 2019. Ages indicated by white numbers in grey diagonal cells. Statistically significant positive correlations (*p<0.05*) are indicated by regression lines and red cells in upper left half. Correlation coefficients (r) are given in the lower right half.

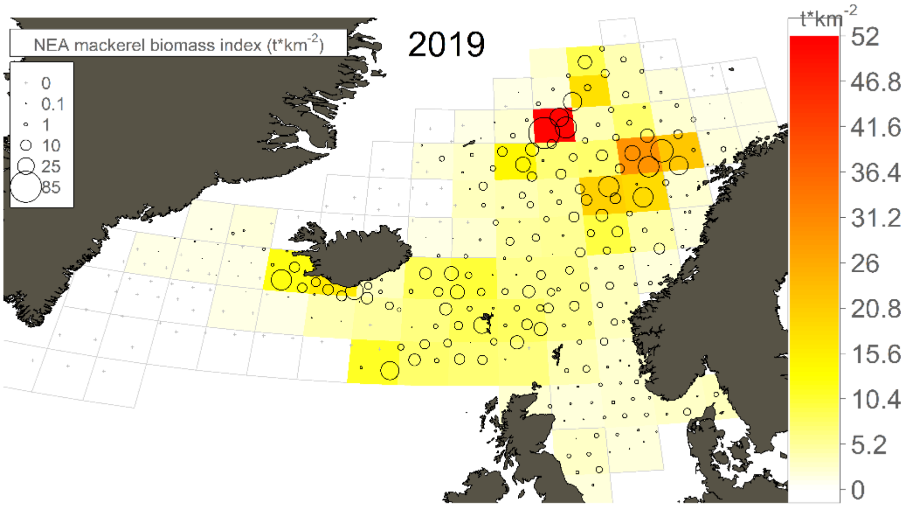


Figure 8.6.3.6a. Mackerel catch rates from surface trawl hauls (circle size represents catch rate in kg/km2) overlaid on mean catch rate per standardized rectangle (1° lat. x 2° lon.) from the IESSNS survey in 2019.

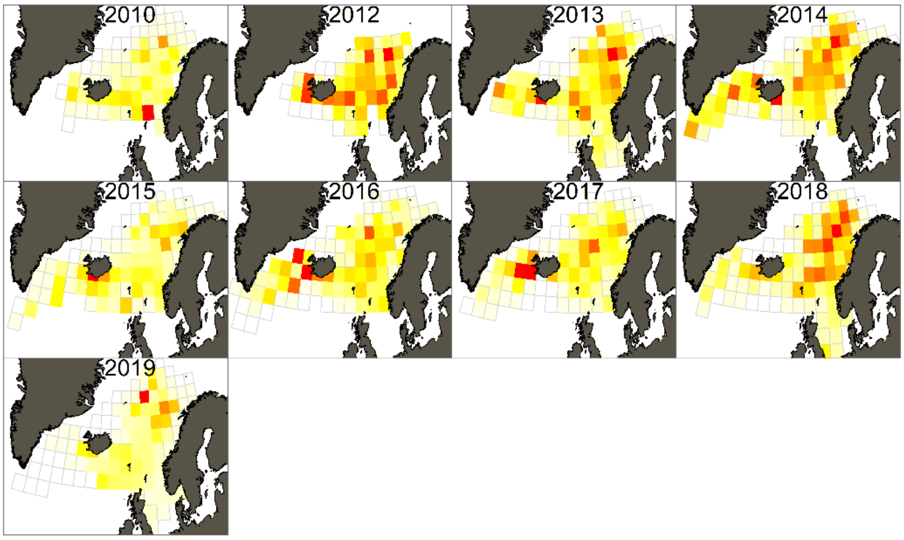


Figure 8.6.3.6b. Annual distribution of mackerel proxied by the relative distribution of mean mackerel catch rates per standardized rectangles (2° lat. x 4° lon.), from Multpelt 832 pelagic trawl hauls at predetermined surface trawl stations. Colour scale goes from white (= 0) to red (= maximum value for the given year).

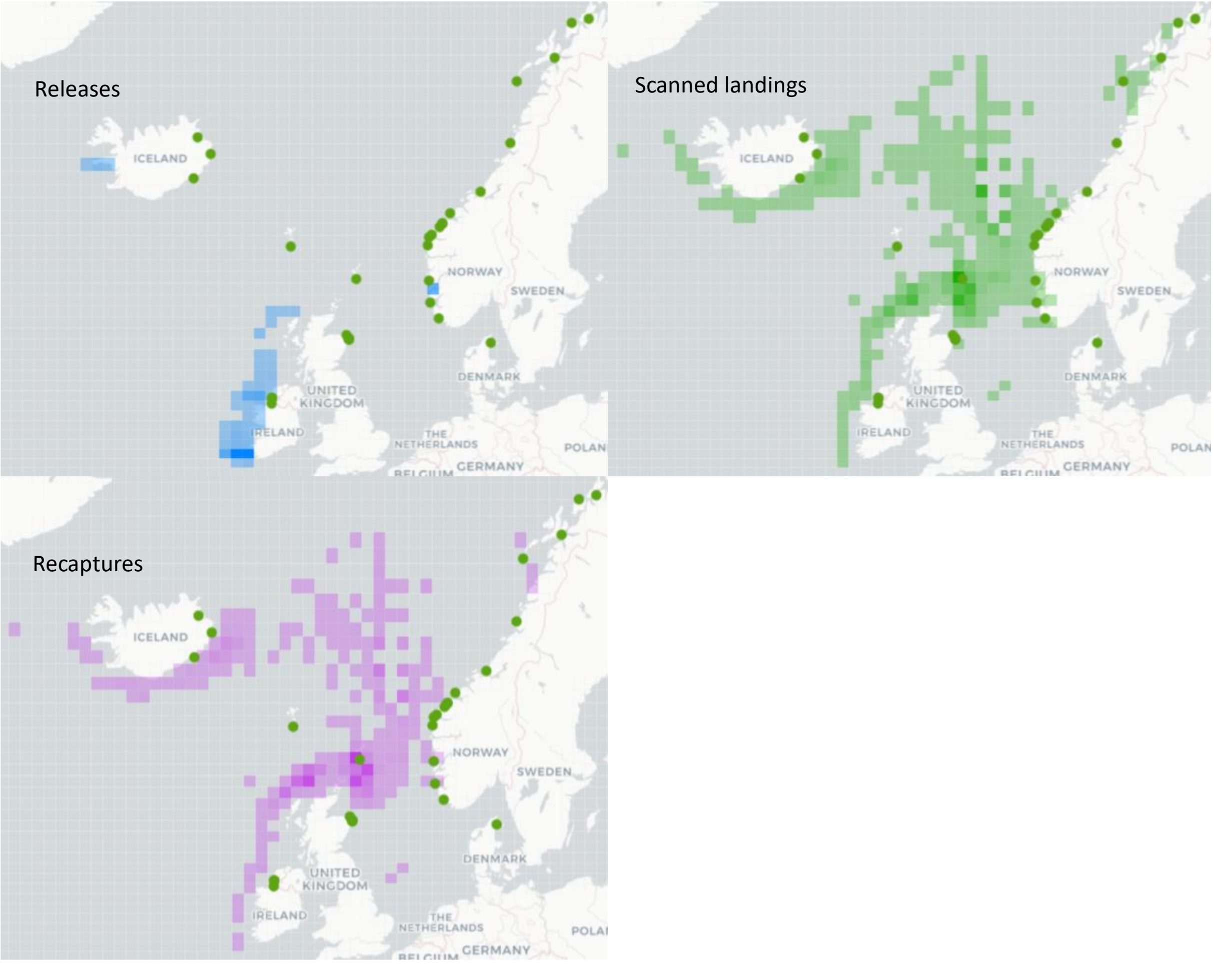


Figure 8.6.4.1. Distribution (per ICES rectangle) of RFID tagged mackerel (20112019), catch biomass scanned for RFID tagged mackerel (2012-2018) and corresponding numbers of recaptured mackerel (20122018). Darker colours mean higher density. Note that the maps give an overview of the total material, whereas details on actual data used on the stock assessment is given in Tables 8.4.6.13. Positions of factories with RFID scanners are shown as green dots on map (Irish scanners are not operational).

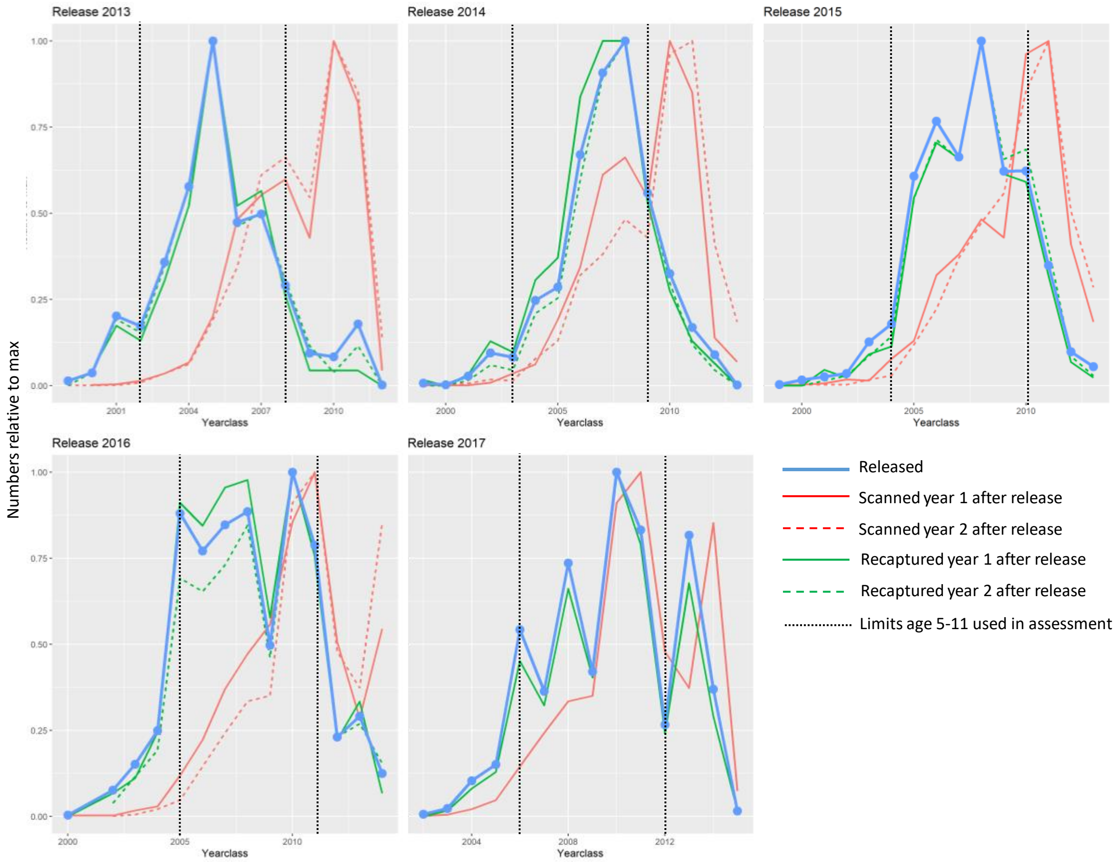


Figure 8.6.4.2. Overview of the relative year class distribution among RFID tagged mackerel per release year, compared with the numbers scanned and recaptured in year 1 and 2 after release of the same year classes. Only release years used in the mackerel assessment based on decisions in the ICES IBPNEAMac 2019 meeting (ICES, 2019a) are shown. Not that it was also decided to only use ages 511 in updated assessments, and limits for this age span is marked for each release year.

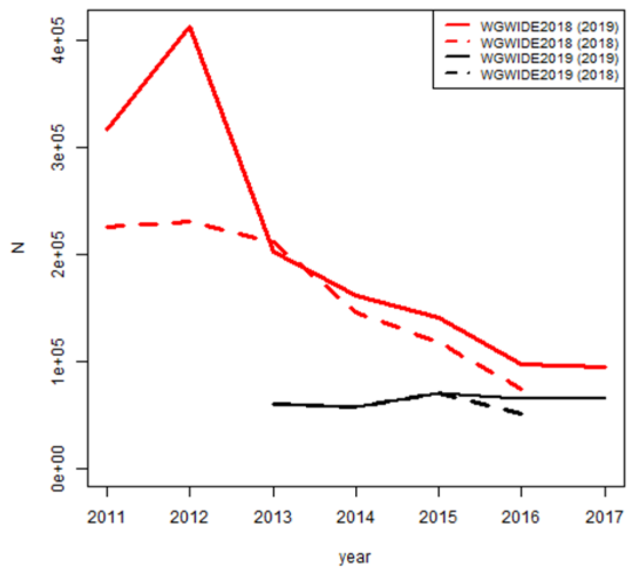


Figure 8.6.4.3. Trends in aggregated abundance index from RFID tag-recapture data. Comparison between the subset used in WGWIDE 2018 (release year 2011+, all recapture years, ages 211) versus the subset used in the updated WGWIDE 2019 assessment (release year 2013+, only recapture year 1 and 2 after release, ages 5-11), and the change using these subsets but the 2019 updated tag data set (updated with 2017 release data, and recaptures in 2018 from 2016 and 2017 releases). Method used is Chapman Lincoln-Peterson estimator described in IBPNEAMac 2019 report (ICES, 2019a).

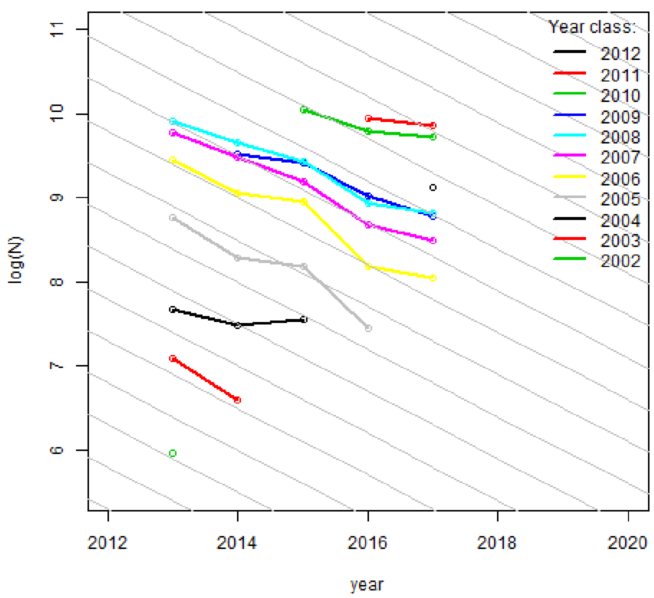


Figure 8.6.4.4. Trends in year class abundance from RFID tag-recapture data. Method used is Chapman Lincoln-Peterson estimator described in IBPNEAMac 2019 report (ICES, 2019a). Shown is only the subset data used in current assessment; release year 2013+, recapture year 1 and 2 after release and ages 5-11.

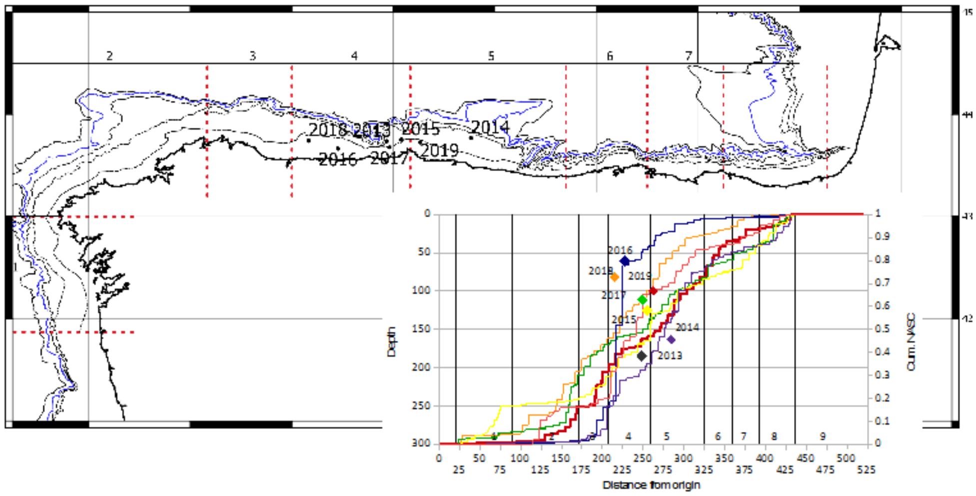


Figure 8.6.5.2.1. Centre of gravity for mackerel acoustic distribution from PELACUS 0313-19. The plot is showing the relative cumulative NASC distribution starting in the southern part and ending at the inner part of the Bay of Biscay.

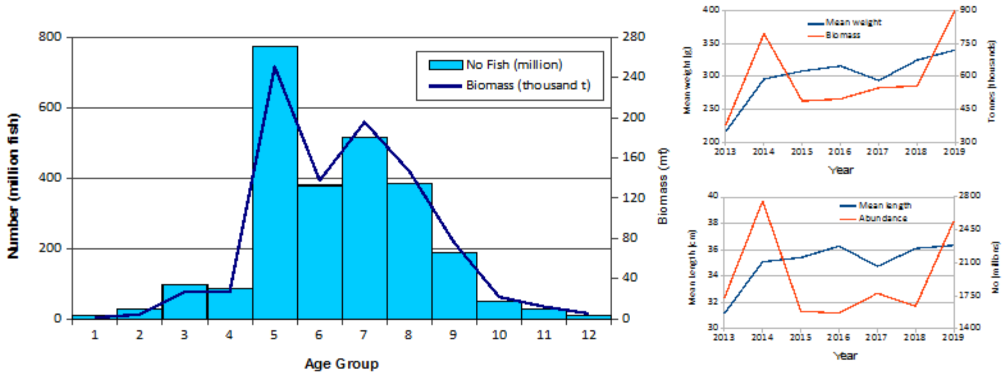


Figure 8.6.5.2.2: Mackerel abundance and biomass estimates by age group in ICES Divisions 8c. and 9.a during PELACUS 0319 (left). Upper right panel: mackerel mean weight (grams, blue line) and total biomass (thousand tonnes red line) estimated in PELACUS 201319; lower right: mackerel mean length (cm, blue line) and total abundance (million fish, red line) estimated in PELACUS 201319.

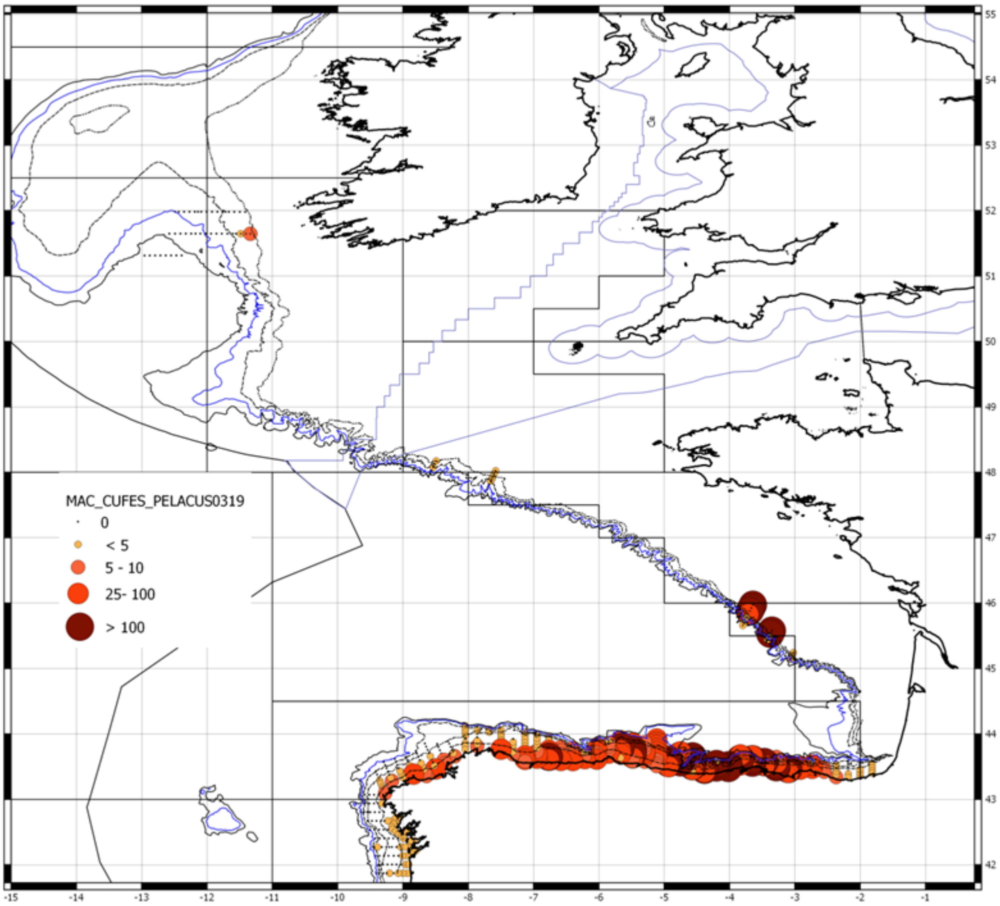


Figure 8.6.5.2.3: Mackerel subsurface egg distribution (no eggs/m³) as recorded by CUFES during PELACUS 0319.

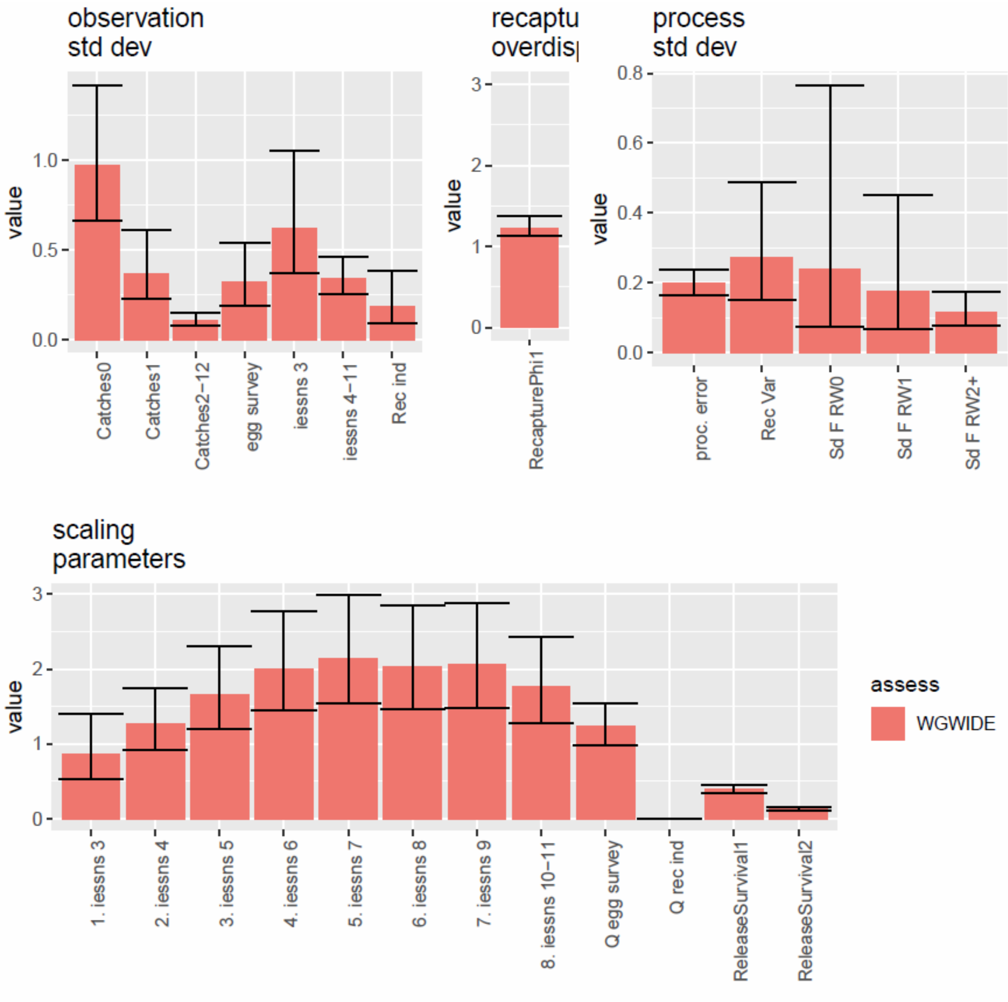


Figure 8.7.1.2.1. NE Atlantic mackerel. Parameter estimates from the SAM model (and associated confidence intervals) for the WGWIDE 2019 update assessment. top left: estimated standard deviation for the observation errors, top centre: estimated overdispersion for the errors on the tag recaptures, top right: standard deviation for the processes, bottom: survey catchabilities and post-release survival of tagged fish.

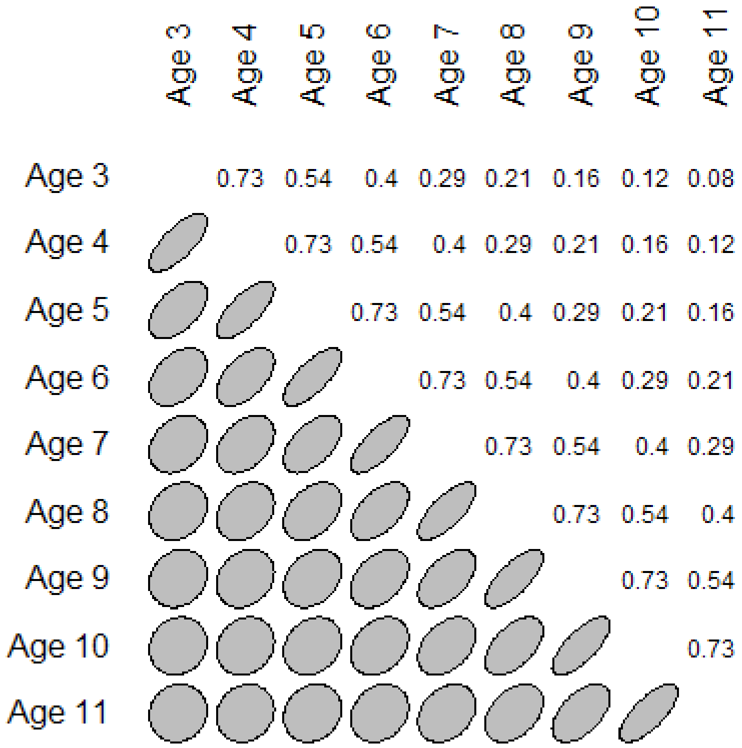


Figure 8.7.1.2.2. NE Atlantic mackerel. Estimated AR1 error correlation structure for the observations from the IESSNS survey age 3 to 11.

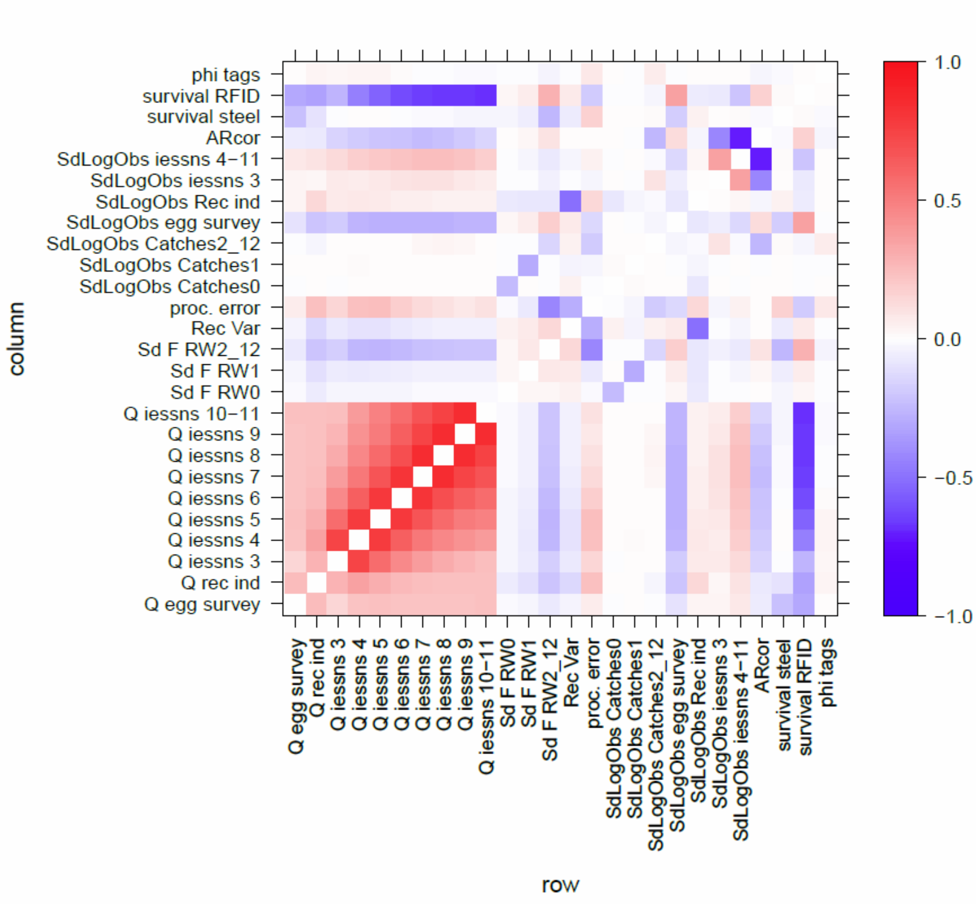


Figure 8.7.1.2.3. NE Atlantic mackerel. Correlation between parameter estimates from the SAM model for the WGWIDE 2018 update assessment

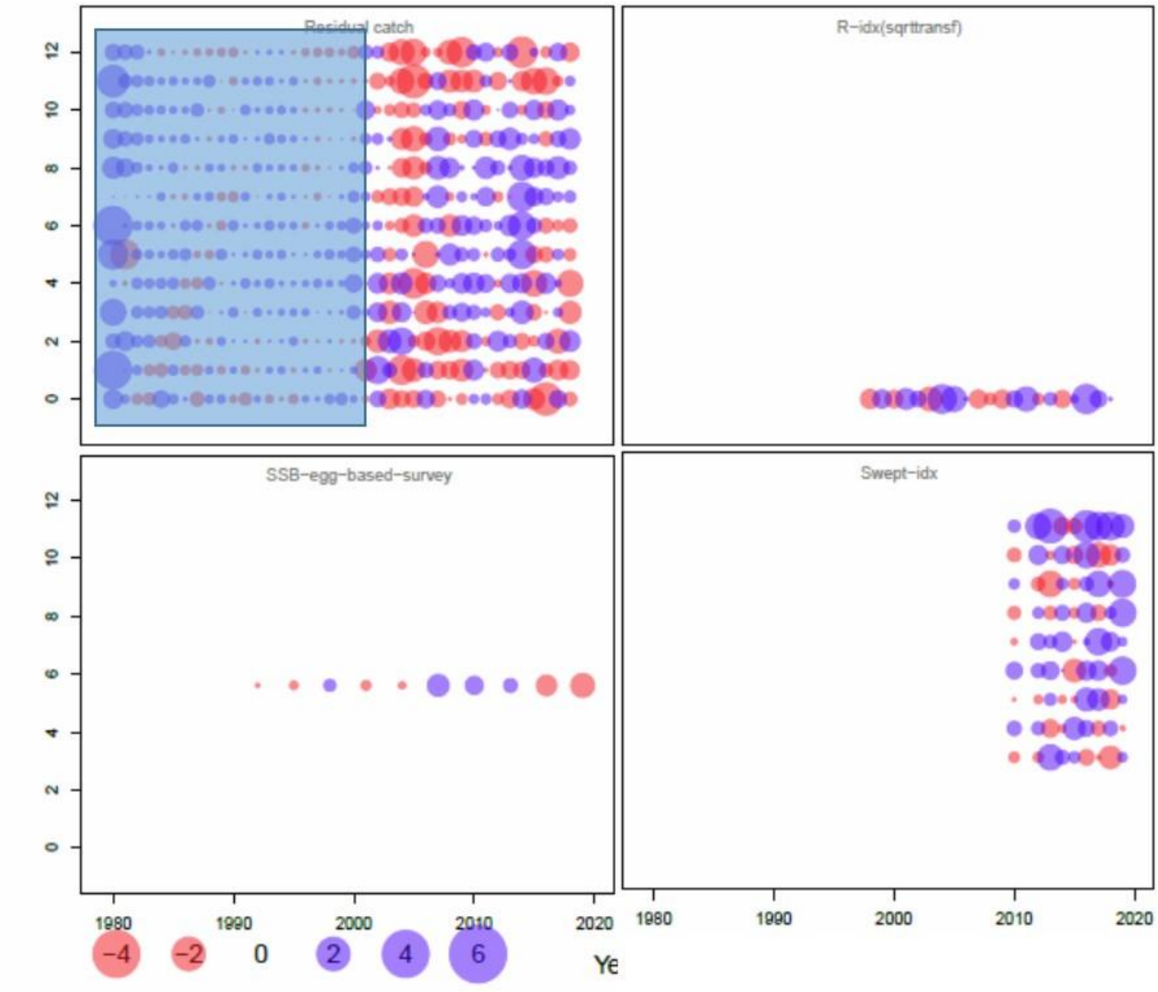


Figure 8.7.1.2.4. NE Atlantic mackerel. One Step Ahead Normalized residuals for the fit to the catch data (catch data prior to 2000 in blue rectangle were not used to fit the model). Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.

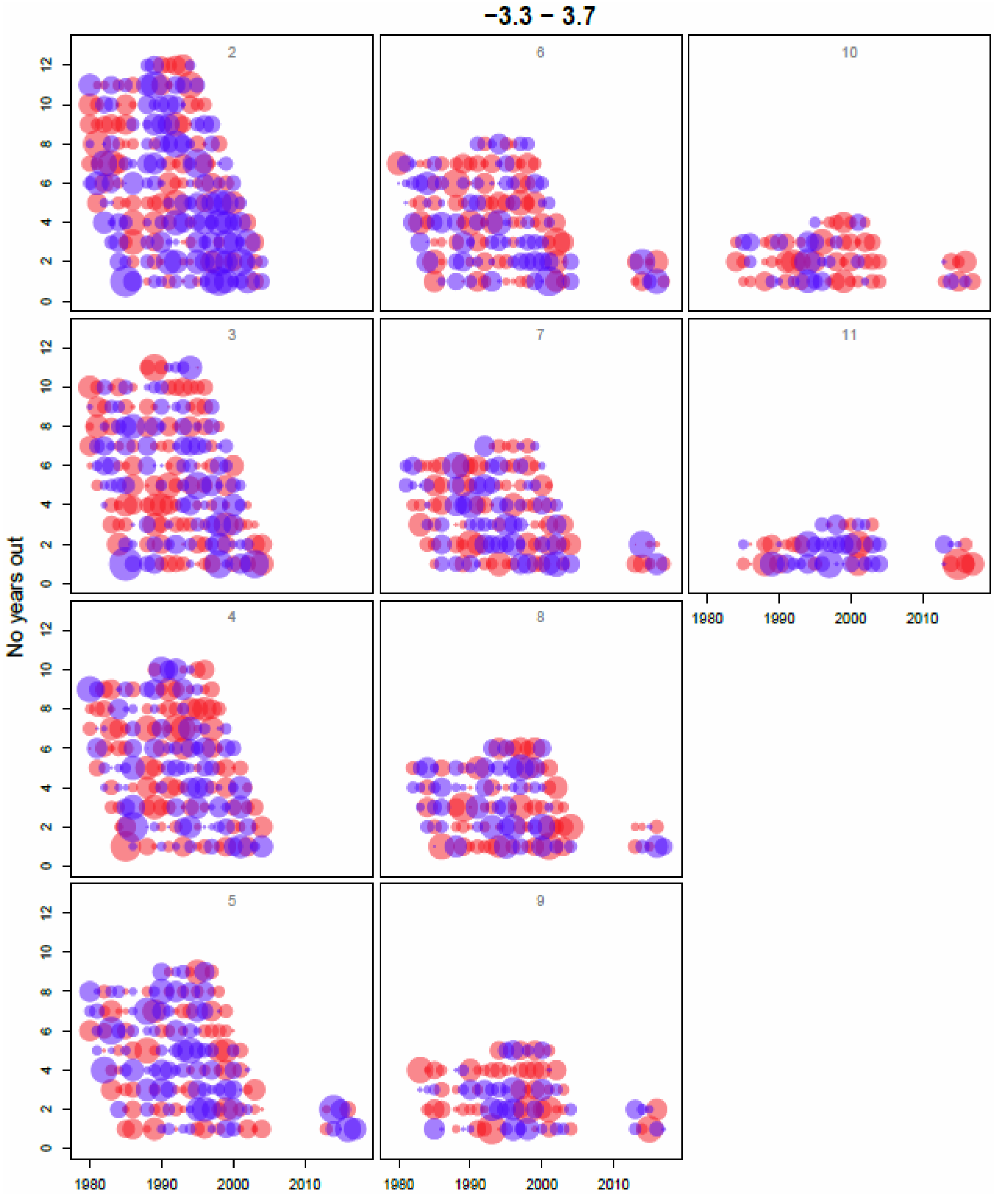
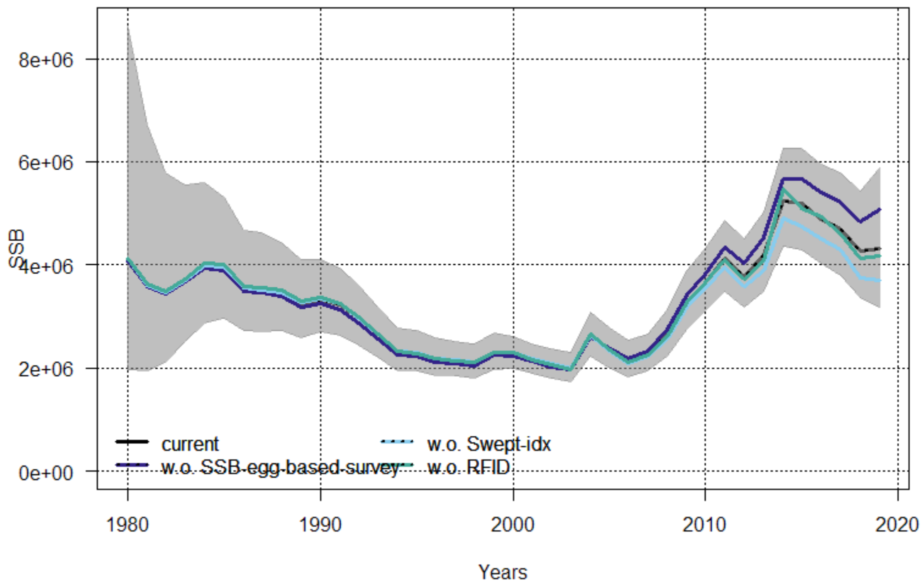


Figure8.7.1.2.5. NE Atlantic mackerel. One step ahead residuals for the fit to the recaptures of tags in the final assessment. The x-axis represents the release year, and the y-axis is the number of years between tagging and recapture. Each panel correspond to a given age at release. Blue circles indicate positive residuals (observation larger than predicted) and filled red circles indicate negative residuals.



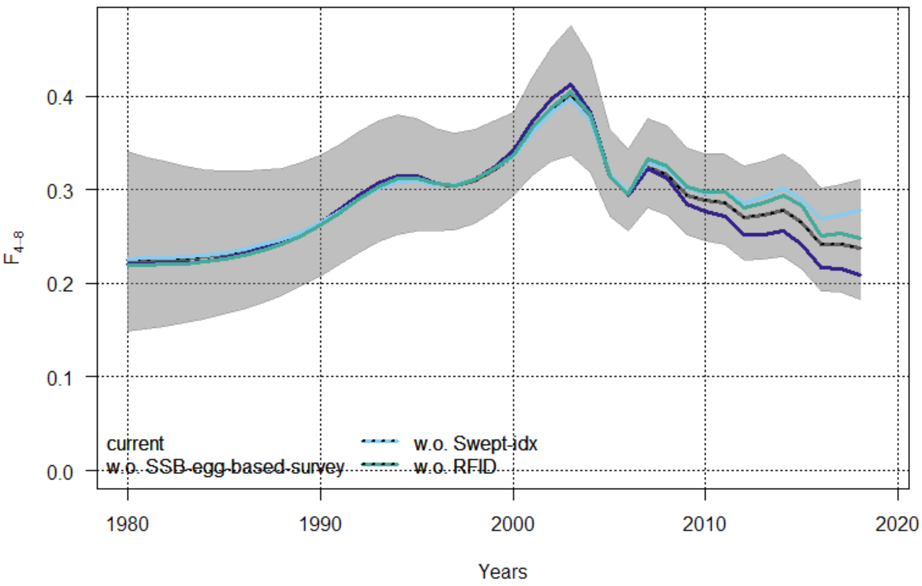


Figure 8.7.1.2.6. NE Atlantic mackerel. Leave one out assessment runs. SAM estimates of SSB and F_{bar}, for assessments runs leaving out one of the observation data sets.

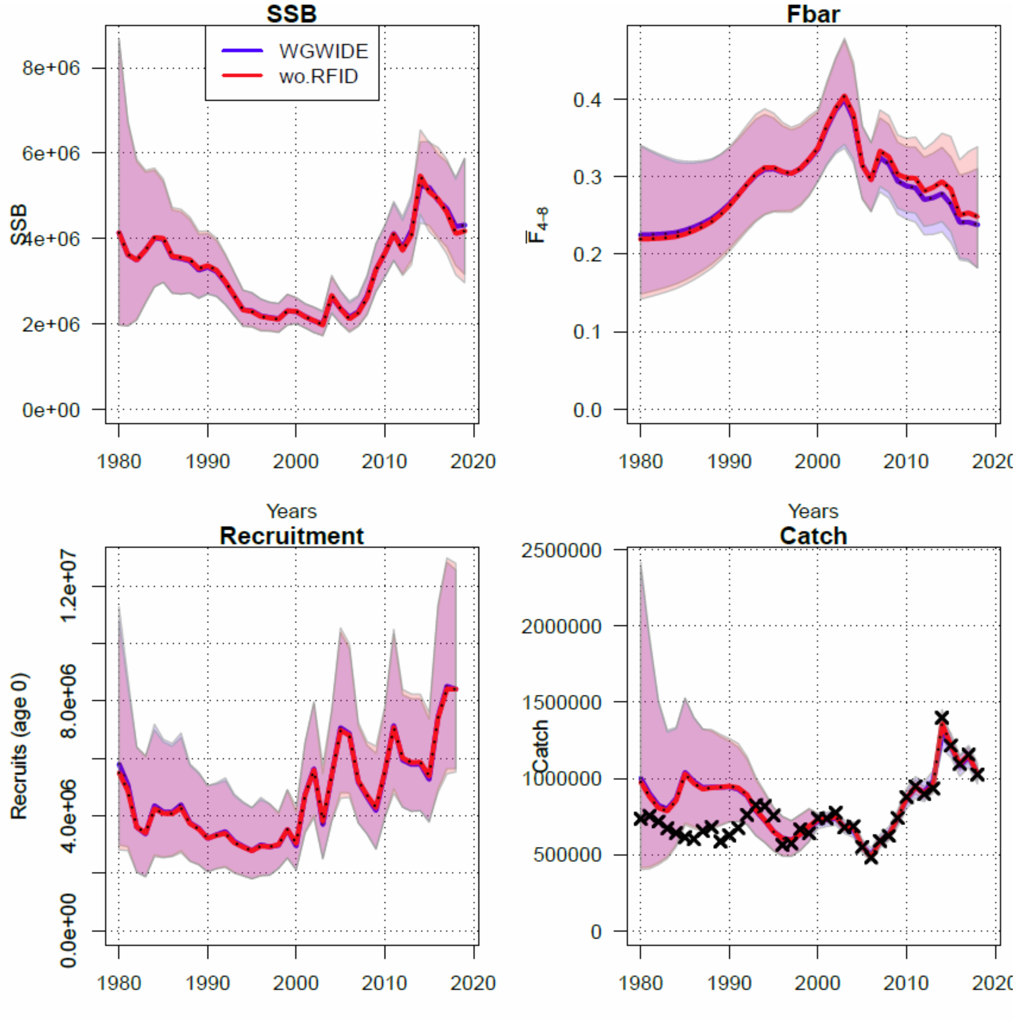


Figure 8.7.1.2.7. NE Atlantic mackerel. Leave one out assessment run excluding the RFID tagging data with confidence intervals for both runs (WGWIDE assessment in blue, run with RFID in red, overlap between both confidence intervals in purple).

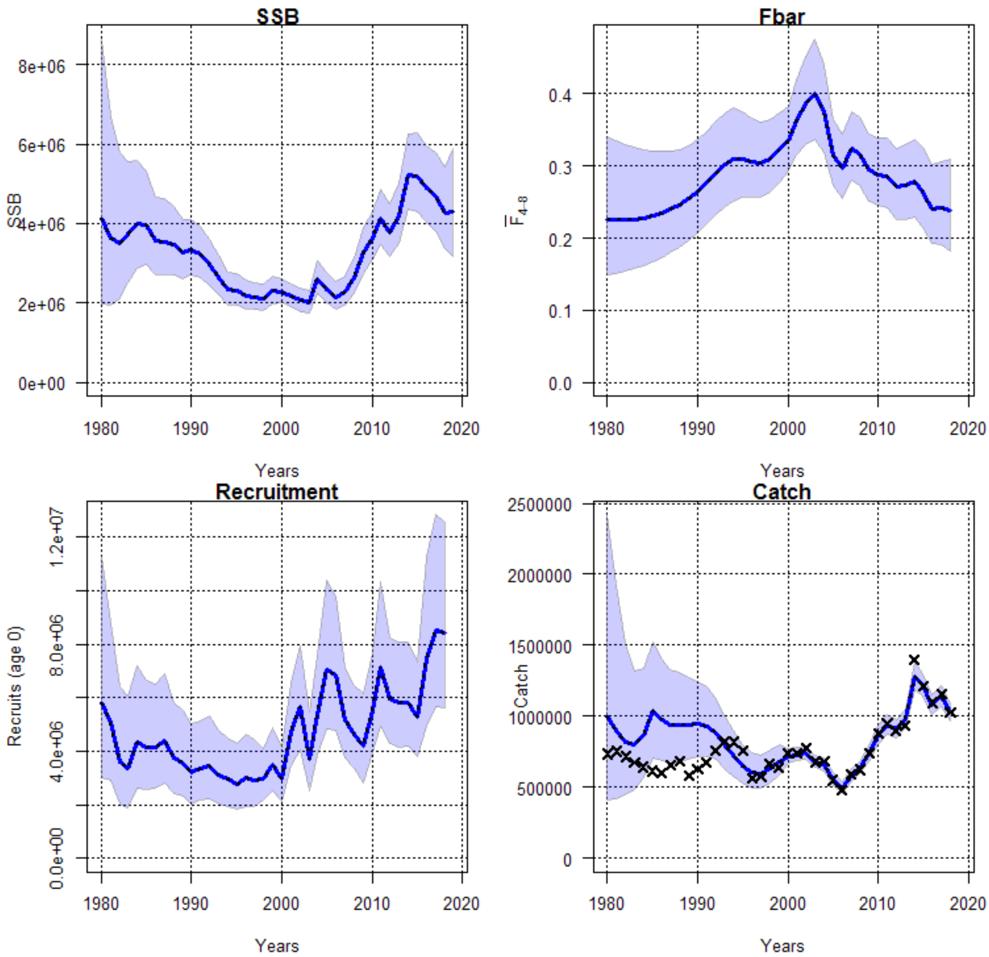


Figure 8.7.1.3.1. NE Atlantic mackerel. Perception of the NEA mackerel stock, showing the SSB, F_{bar}4-8 and recruitment (with 95% confidence intervals) from the SAM assessment.

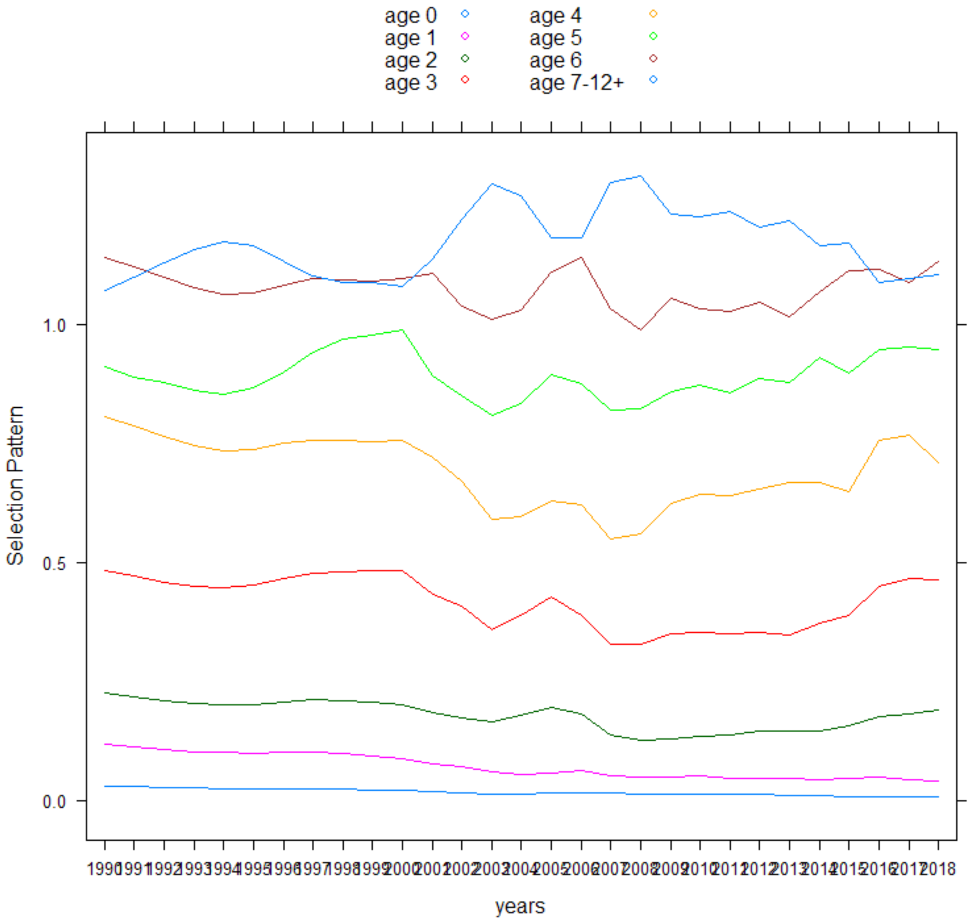


Figure 8.7.1.3.2. NE Atlantic mackerel. Estimated selectivity for the period 1990 to 2018, calculated as the ratio of the estimated fishing mortality-at-age and the F_{bar}48 value in the corresponding year.

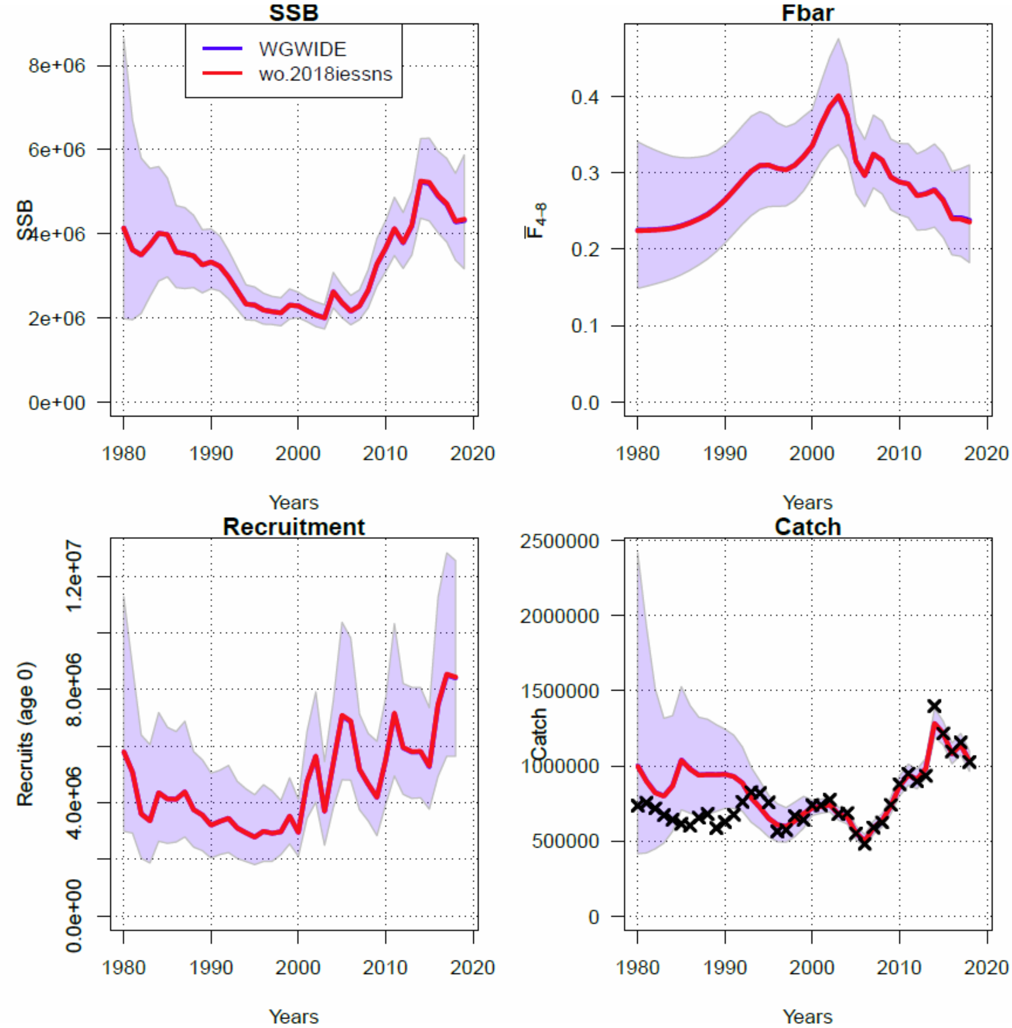


Figure 8.7.1.4.1.1. NE Atlantic mackerel. Influence of the 2018 IESSNS survey on the output of the assessment. Comparison of stock estimates from the 2019 WGWIDE assessment, the 2019 WGWIDE assessment without the 2018 IESSNS index.

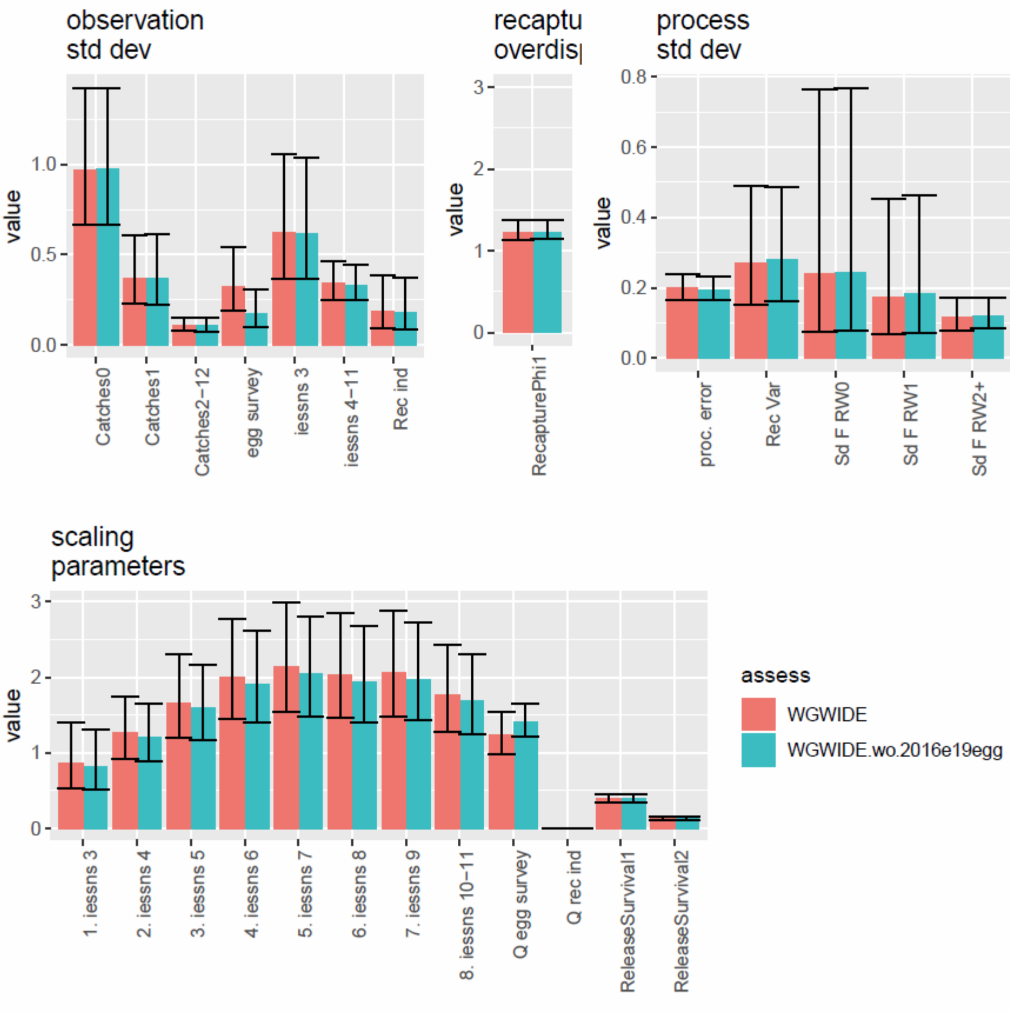


Figure 8.7.1.4.2.1. NE Atlantic mackerel. Comparison of estimated model parameters for the WGWIDE 2019 update assessment and the same assessment performed excluding the 2016 and 2019 egg survey indices.

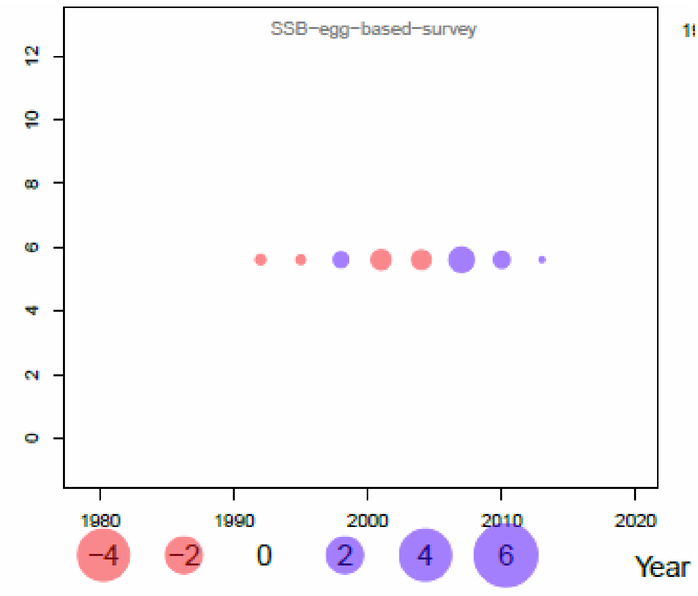


Figure 8.7.1.4.2.2. NE Atlantic mackerel. Residuals for the egg survey index in the assessment run excluding the 2016 and 2019 egg survey estimates.

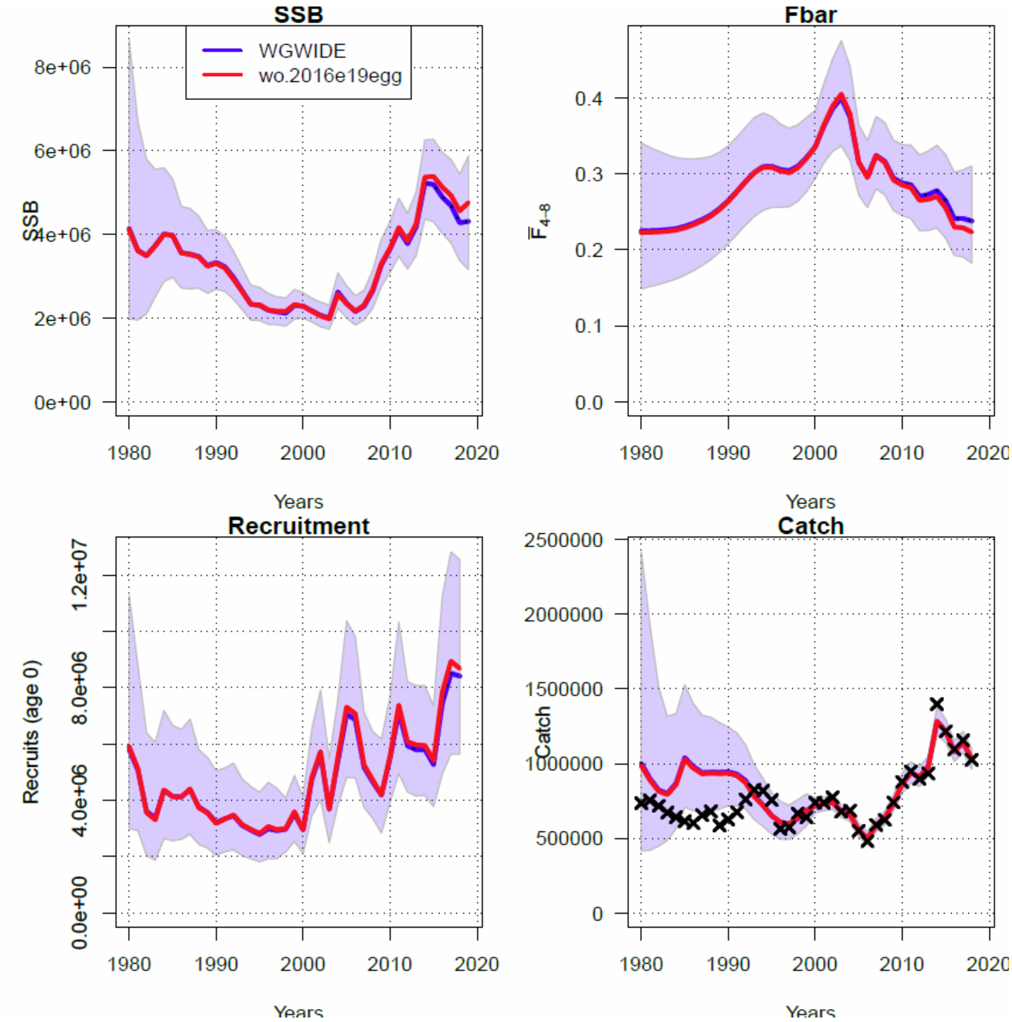


Figure 8.7.1.4.2.3. Influence of the 2016 and 2019 egg survey estimates on the output of the assessment. Comparison of stock estimates from the 2019 WGWIDE assessment, the 2019 WGWIDE assessment without the 2016 and 2019 egg indices.

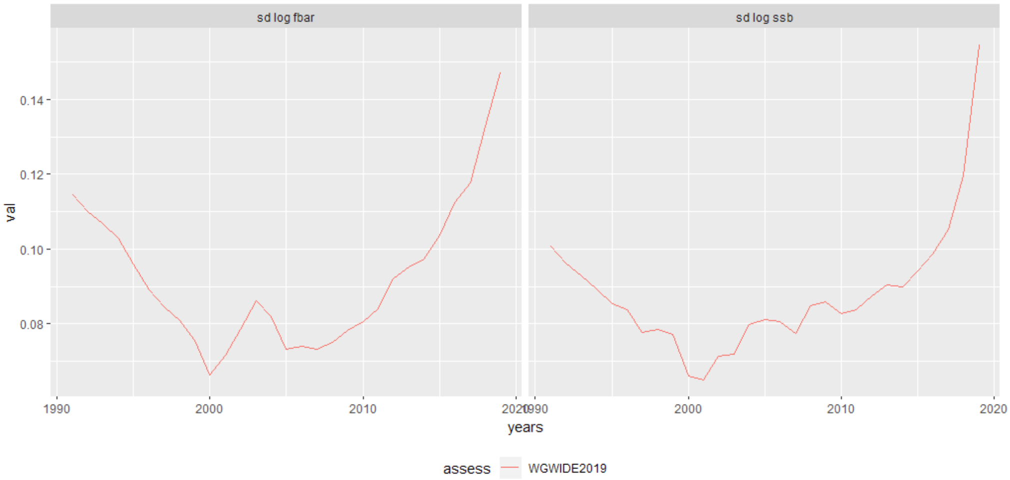


Figure 8.7.1.5.1. NE Atlantic mackerel. Uncertainty (standard deviation of the log values) of the estimates of SSB and F_{bar} from the SAM for the 2018 WGWIDE assessment.

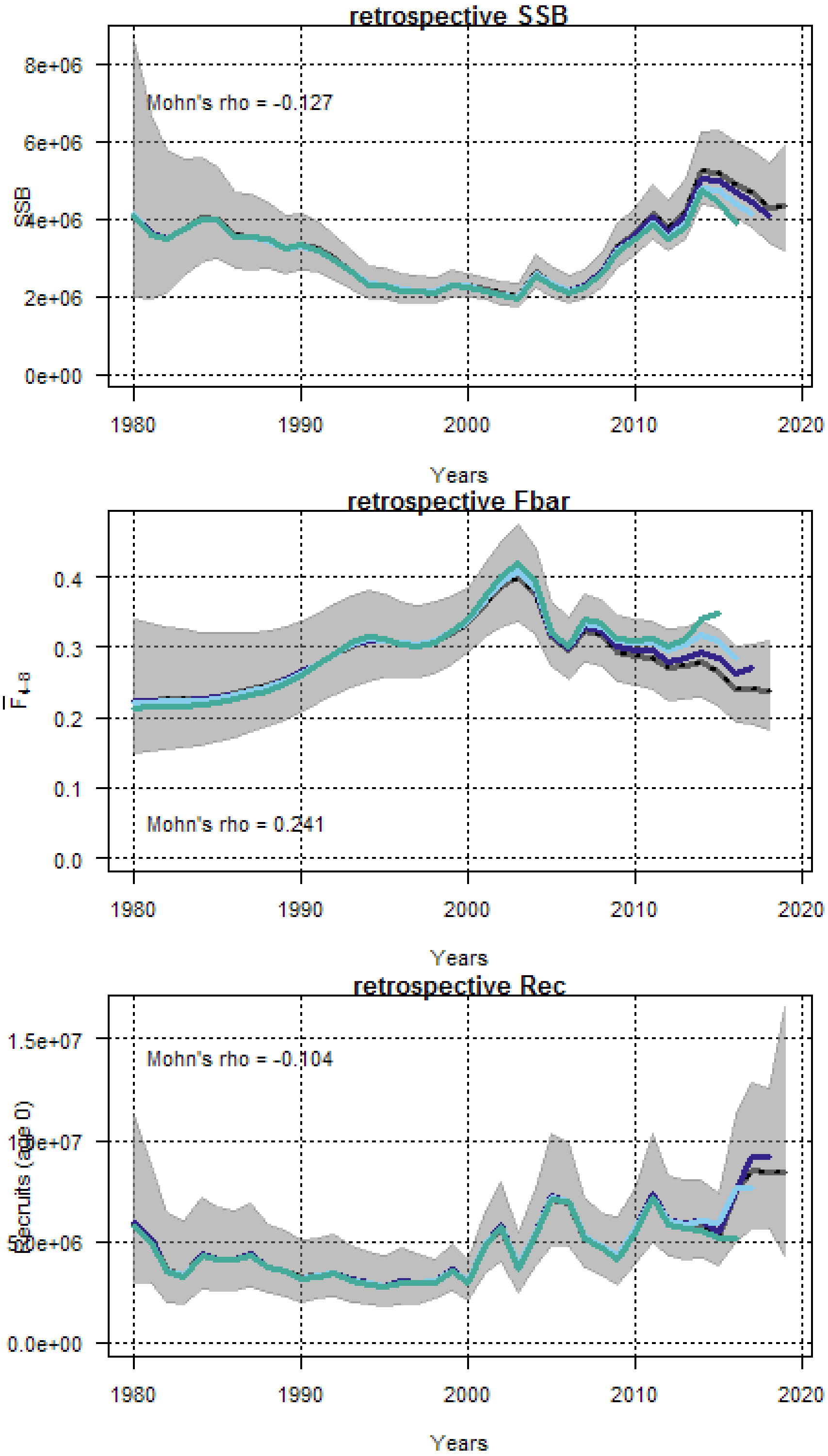


Figure 8.7.1.5.2. NE Atlantic mackerel. Analytical retrospective patterns (3 years back) of SSB, F_{bar}48 and recruitment from the WGWIDE 2018 update assessment.

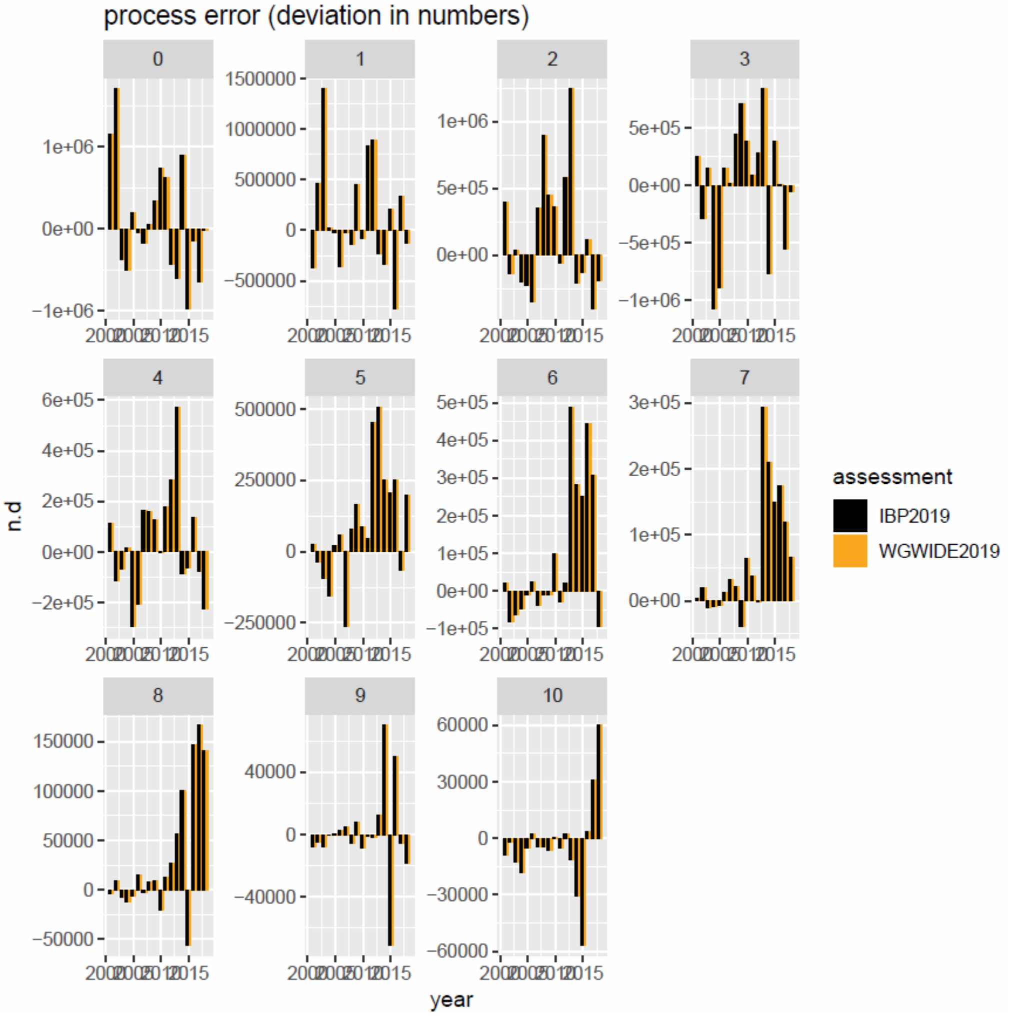


Figure 8.7.1.5.3. NE Atlantic mackerel. Process error expressed as annual deviations of abundances at age, for the 2019 WGWIDE assessment and from the 2019 interbenchmark assessment.

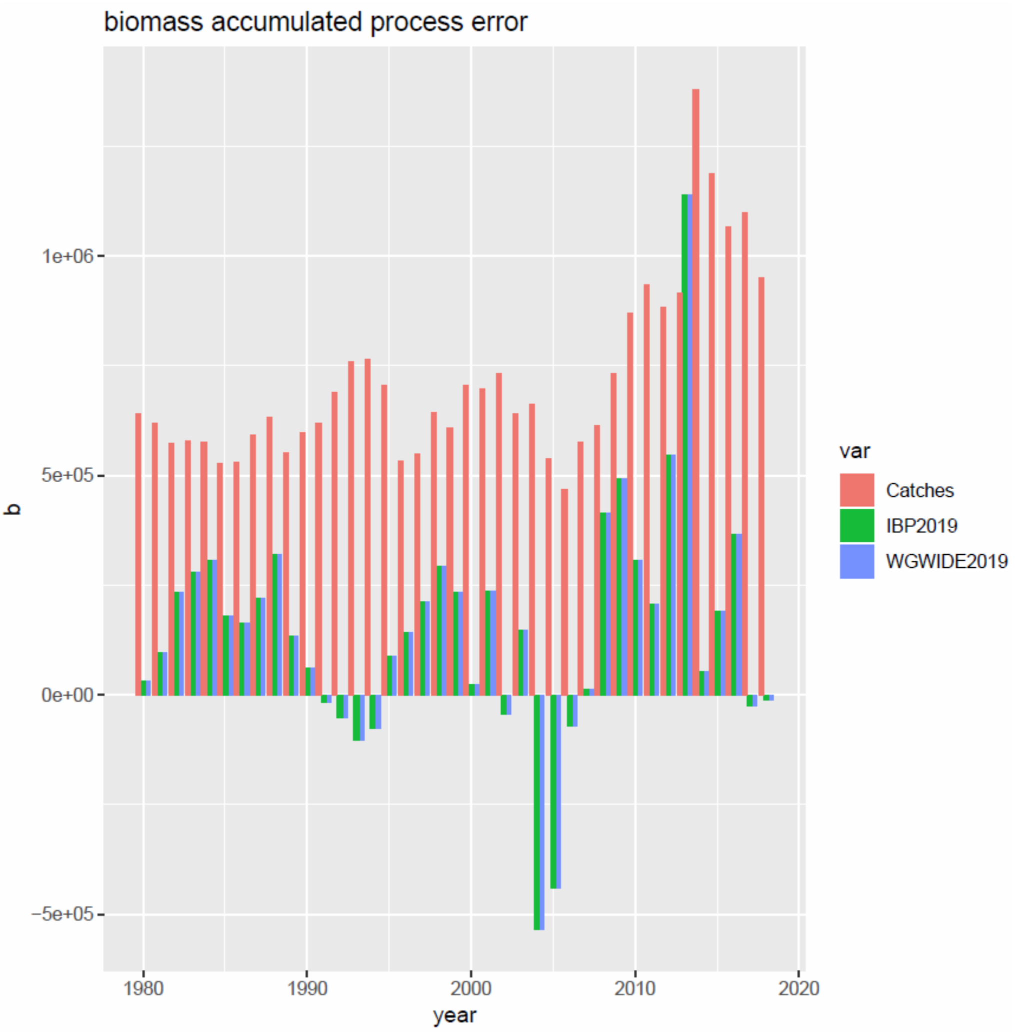


Figure 8.7.1.5.4. NE Atlantic mackerel. Model process error expressed in biomass cumulated across age-group for the 201 WGWIDE assessment and for the 2019 interbenchmark assessment.

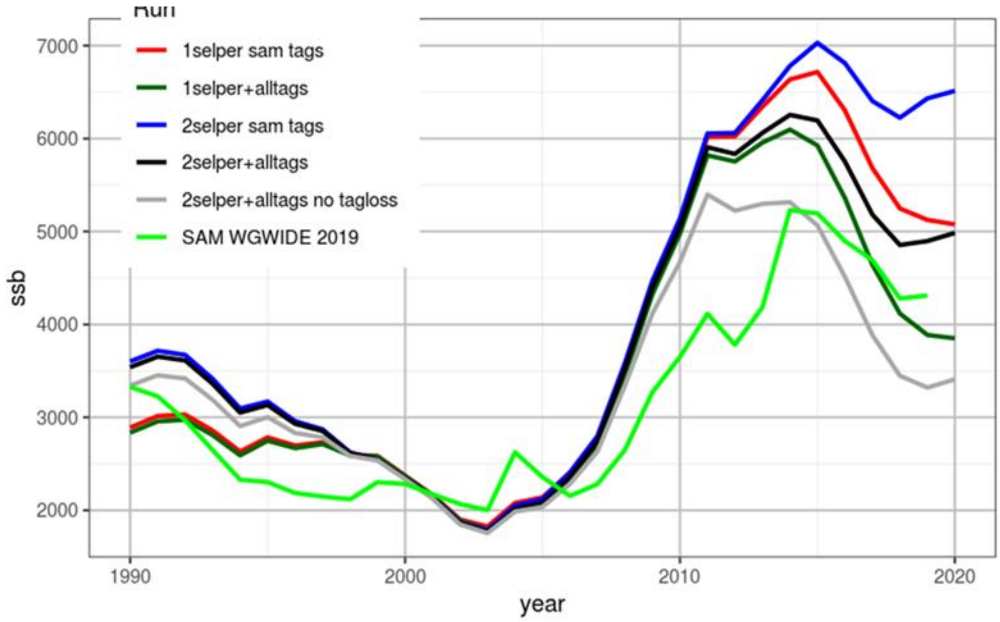


Figure 8.7.2.1.1. Development of spawning stock from different configurations of the Muppet model compared to the adopted SAM setup from WGWIDE 2019.

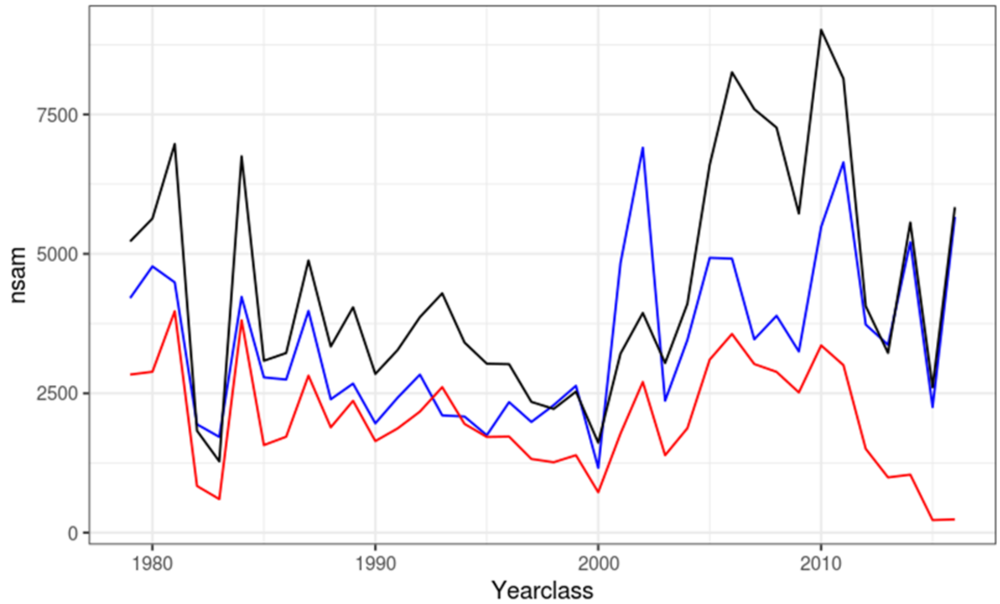


Figure 8.7.2.1.2. Estimated number of age 2 fish from SAM (blue), muppet (black) and catch of the year-class at age 2 to 11 (red).

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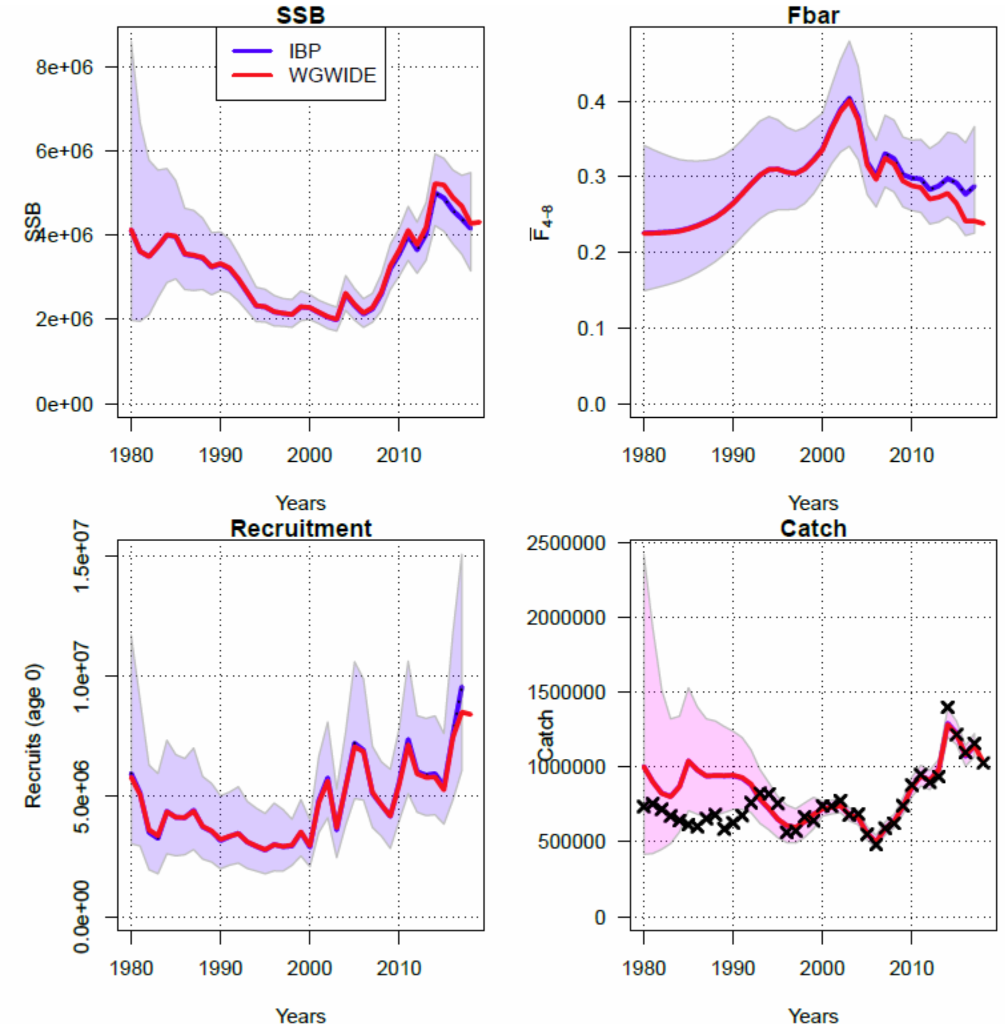

Figure 8.10.1. NE Atlantic mackerel. Comparison of the stock trajectories between the 2019 WGWIDE assessment and the 2019 IBPNEAMac (ICES, 2019a).

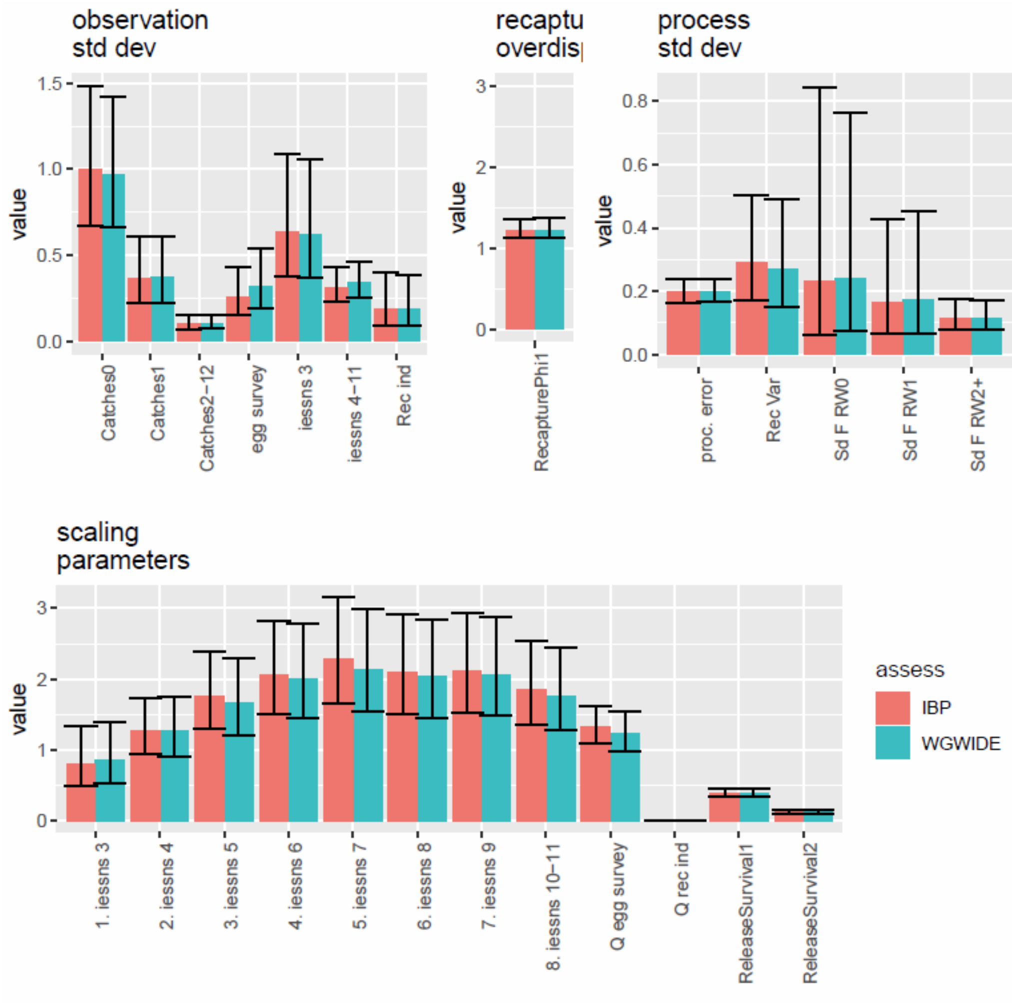

Figure 8.10.2. NE Atlantic mackerel. Comparison of model parameters and their uncertainty for the 2019 WGWIDE and the 2019 IBPNEAMac (ICES, 2019a).

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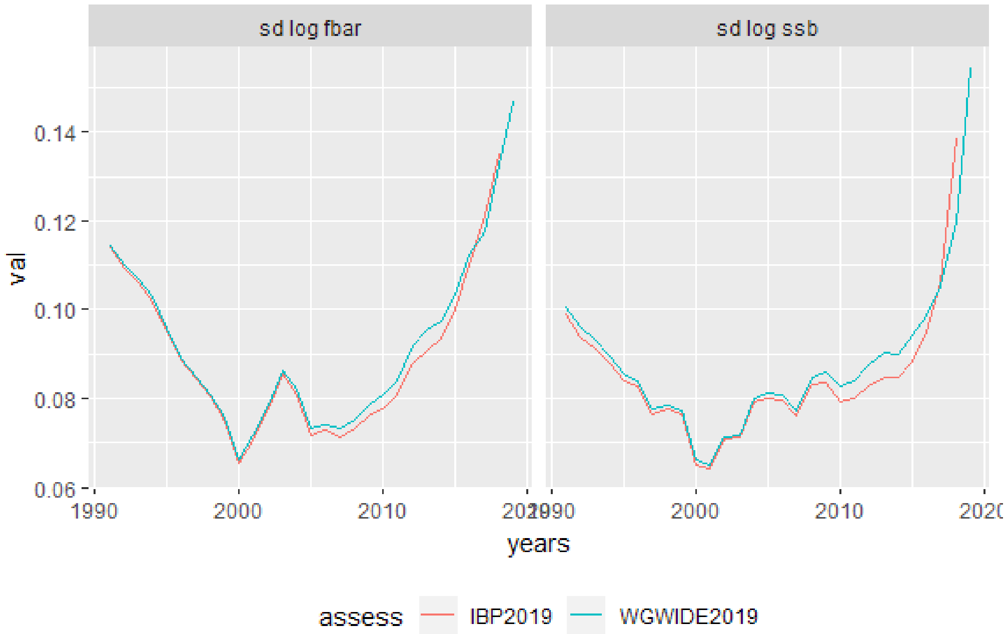

Figure 8.10.3. NE Atlantic mackerel. Comparison of the uncertainty on estimates of SSB and F_{bar} for the WGWIDE 2019 update assessment and the 2019 IBPNEAMac (ICES, 2019a).