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1

2 Blue whiting (*Micromesistius poutassou*) in subareas 27.1–9, 12, and 14 (Northeast Atlantic)

Blue whiting (*Micromesistius poutassou*) is a small pelagic gadoid that is widely distributed in the eastern part of the North Atlantic. The highest concentrations are found along the edge of the continental shelf in areas west of the British Isles and on the Rockall Bank plateau where it occurs in large schools at depths ranging between 300 and 600 meters but is also present in almost all other management areas between the Barents Sea and the Strait of Gibraltar and west to the Irminger Sea. Blue whiting reaches maturity at 2–7 years of age. Adults undertake long annual migrations from the feeding grounds to the spawning grounds. Most of the spawning takes place between March and April, along the shelf edge and banks west of the British Isles. Juveniles are abundant in many areas, with the main nursery area believed to be the Norwegian Sea. See the Stock Annex for further details on stock biology.

2.1 ICES advice in 2018

ICES notes that fishing mortality has increased from a historical low in 2011 to above F_{MSY} since 2014. Spawning-stock biomass increased after 2010 and peaked in 2017. SSB is currently above $MSY B_{trigger}$. Recruitment in 2018 is estimated to be low for the third year in a row, following high recruitment in 2014–15.

ICES advised that when the MSY approach is applied, catches in 2019 should be no more than 1 143 629 tonnes.

2.2 The fishery in 2018

The total catch in 2018 was 1711 kt. The main fisheries on blue whiting were targeting spawning and post-spawning fish (Figures 2.2.1 and 2.2.2). Most of the catches (88%) were taken in the first two quarters of the year and the largest part of this west of the British Isles and east, south and west of the Faroes. Smaller quantities were taken along the coast of Spain and Portugal. The fishery in the latter half of the year was concentrated in the central Norwegian Sea and east of the Faroes. The multinational fleet currently targeting blue whiting consists of several types of vessels from 16 countries. The bulk of the catch is caught with large pelagic trawlers, some with capacity to process or freeze on board. The remainder is caught by RSW vessels.

2.3 Input to the assessment

At the Inter-Benchmark Protocol on Blue Whiting (IBPBLW 2016) it was decided to use preliminary within year catch-at-age data in the assessment to get additional information to the within year IBWSS result. In most recent years around 90% of the annual catches of the age 3+ fish are taken in the first half year, which makes it reasonable to estimate the total annual catch-at-age from reported first semester data. The catch data sections in this report give first a comprehensive description of the 2018 data as reported to ICES and then a section including a brief description of the 2019 preliminary catch data.

2.3.1 Officially reported catch data

Official catches in 2018 were estimated to 1 711 477 tonnes based on data provided by WGWIDE members. Data provided as catch by rectangle represented more than 99% of the total WG catch in 2018. Total catch by country for the period 1988 to 2018 is presented in Table 2.3.1.1 and in Figure 2.3.1.1.

The spatial and temporal distribution of catches in 2018 (Figure 2.2.1, 2.2.2 and Table 2.3.1.2, 2.3.1.3), is quite similar to the distribution in previous years. The majority of catches is coming from the spawning area. The 2018 catches have largest contribution from ICES area 27.5.b, 27.6.a and 27.7.c (Figures 2.3.1.1 to 2.3.1.7). The temporal allocation of catches has been relatively stable in recent years (Figure 2.3.1.4). In the first two quarters, catches are taken over a broad area, with the highest catches in 27.5.b, 27.6.a, 27.6.b, 27.7.c and 27.7.k, while later in the year catches is mainly taken further north in area 27.2.a and in the North Sea (27.4.a) (Figure 2.3.1.6 and 2.3.1.7 and Table 2.3.1.3). The proportion of catches originating from the Northern areas has been decreasing from 2014 to 2016, in 2017 and 2018 an increase of 8% and 1% was observed, respectively.

Discards of blue whiting are small. Most of the blue whiting caught in directed fisheries are used for reduction to fish meal and fish oil. However, some discarding occurs in the fisheries for human consumption and as bycatch in fisheries directed towards other species.

Reports on discarding from fisheries which catch blue whiting were available from the Netherlands for the years 2002–2007 and 2012–2014. A study carried out to examine discarding in the Dutch fleet found that blue whiting made a minor contribution to the total pelagic discards when compared with the main species mackerel, horse mackerel and herring.

The blue whiting discards data produced by Portuguese vessels operating with bottom otter trawl within the Portuguese reaches of ICES Division 27.9.a is available since 2004. The discards data are from two fisheries: the crustacean fishery and the demersal fishery. The blue whiting estimates of discards in the crustacean fishery for the period of 2004–2011 ranged between 23% and 40% (in weight). For the same period the frequency of occurrence in the demersal fishery was around zero for the most of the years, in the years were it was significant (2004, 2006, 2010) was ranging between 43% and 38% (in weight). In 2018, discards were 40% of the total catches for blue whiting in the Portuguese coast (Table 2.3.1.5). The total catch from Portugal is less than a half percentage of the total international catches.

Information on discards was available for Spanish fleets since 2006. Blue whiting is a bycatch in several bottom-trawl mixed fisheries. The estimates of discards in these mixed fisheries in 2006 ranged between 23% and 99% (in weight) as most of the catch is discarded and only last day catch may be retained for marketing fresh. The catch rates of blue whiting in these fisheries are however low. In the directed fishery for blue whiting for human consumption with pair trawls, discards were estimated to be 11% (in weight) in 2015 (Table 2.3.1.5). Spanish catches are around 2% of the international catches.

In general, discards are assumed to be small in the blue whiting directed fishery. Discard data are provided by the Denmark, France, Portugal, Spain, UK (England and Wales) and UK (Scotland), to the working group. The discards constituted 0.25% of the total catches, 4309 tonnes.

The total estimated catches (tonnes) inside and outside the NEAFC regulatory area by country were reported on Table 2.3.1.6. The catches inside the NEAFC RA represent 10% of the total catches of blue whiting in 2018.

2.3.1.1 Sampling intensity

Sampling intensity for blue whiting with detailed information on the number of samples, number of fish measured, and number of fish aged by country and quarter is given in Table 2.3.1.1.1 and are presented and described by year, country and area (Table 2.3.1.1.2, 2.3.1.1.3 and 2.3.1.1.4). In total 2003 length samples, 1565 age samples, were collected from the fisheries in 2018, 131779 fish were measured and 1565 were aged. The percentage of catches covered by the sampling program was 87% in 2018. The most intensive sampling took place in the area 27.4.a, 27.5.b, 27.6.a, 27.7.k, 27.8.b, 27.8.c and 27.9.a. No sampling was carried out by Greenland, Poland, Sweden and the UK (England, Wales, Northern Ireland) representing together 3% of the total catches. The sampled and estimated catch-at-age data are shown on Figure 2.3.1.1.1.

Sampling intensity for age and weight of blue whiting are made in proportion to landings according to CR 1639/2001 and apply to EU member states. The Fisheries Regulation 1639/2001, requires EU Member States to take a minimum of one sample for every 1000 tonnes landed in their country. Various national sampling programs are in force.

2.3.1.2 Age compositions

The age-length key for the sampled catches on ICES area 27.6.a (as an example) is presented by quarter and country (Figure 2.3.1.2.1). The mean length (mm) by ages reveals that age classifications do present some differences between countries.

The InterCatch program was used to calculate the total international catch-at-age, and to document how it was done.

2.3.2 Preliminary 2019 catch data (Quarters 1 and 2)

The preliminary catches for 2019, quarters 1 and 2, and the expected whole 2019 catches as reported by the WGWIDE members (Table 2.3.2.3).

The spatial distribution of these 2019 preliminary catches is similar to the distribution in 2018. The majority of catches are coming from the areas 27.5.b, 27.6.a, 27.6.b, 27.7.c and 27.7.k (Figure 2.3.2.1 and Table 2.3.2.2).

Sampling intensity for blue whiting from the preliminary catches by area and quarter with detailed information on the number of samples, number of fish measured, and number of fish aged is presented in Table 2.3.2.2.

A comparison of the preliminary and the final catch for 2017 and 2018 (Table 2.3.2.4) shows a good agreement (i.e. max 0.3 % deviation).

WGWIDE estimated the expected total catch for 2019 from the sum of declared national quotas, corrected for expected national uptake and transfer of these quotas (Table 2.3.2.3).

The estimation of catch at age and mean weight at age followed the method described in the (2019 updated) Stock Annex.

2.3.3 Catch-at-age

Catch-at-age numbers are presented in Table 2.3.3.1. Catch proportions at age are plotted in Figure 2.3.3.1. Strong year classes that dominated the catches can be clearly seen in the early 1980s, 1990 and the late 1990s. In recent years, the age compositions are dominated by the younger ages (ages 3-5) with the 2014 year class contributing most.

Catch curves for the international catch-at-age dataset (Figure 2.3.3.2) indicate a consistent decline in catch number by cohort in years with rather high landings (and probably similar high

effort). The catch curves for year classes 2010-2011 show a consistent decline in the stock numbers with an estimated total mortality ($Z=F+M$) around 0.6-0.7 for the ages fully recruited to the fisheries.

2.3.4 Weight at age

Table 2.3.4.1 and Figure 2.3.4.1 show the mean weight-at-age for the total catch during 1983–2019 used in the stock assessment. Mean weight at age for ages 3–9 reached a minimum around 2007, followed by an increase until 2010–2012, and a decrease in the recent years, even though mean weights for ages 2-5 have shown an increase since 2017.

The weight-at-age for the stock is assumed the same as the weight-at-age for the catch.

2.3.5 Maturity and natural mortality

Blue whiting natural mortality and proportion of maturation-at-age are shown in Table 2.3.5.1. See the Stock Annex for further details.

2.3.6 Information from the fishing industry

No new information available.

2.3.7 Fisheries independent data

Data from the International Blue Whiting spawning stock survey are used by the stock assessment model, while recruitment indices from several other surveys are used to qualitatively adjust the most recent recruitment estimate by the assessment model and to guide the recruitments used in the forecast.

2.3.7.1 International Blue Whiting spawning stock survey

The Stock annex gives an overview of the surveys available for the blue whiting. The International Blue Whiting Spawning Stock Survey (IBWSS) is however the only survey used as input to the assessment model. The cruise report from IBWSS in spring 2019 is available as a working document to this report. The survey group considers that the 2019 estimate of abundance as robust.

The updated survey time-series (2004-2019) show variable internal consistency (Figure 2.3.7.1.1. B) for the main age groups.

The distribution of acoustic backscattering densities for blue whiting for the last 4 years is shown in Figure 2.3.7.1.2. The bulk of the mature stock was located from the north Porcupine to the Hebrides core area in a corridor close to the shelf edge. This is comparable to what was observed in 2018.

The abundance estimate of blue whiting for IBWSS are presented in Table 2.3.7.1.1. In comparison to the results in 2018, there is a small increase in the observed stock biomass (+4%) and in stock numbers (+9%).

The stock biomass within the survey area was dominated by 4, 5 and 6-year-old fish, contributing 82% of total-stock biomass. The age structure of the 2019 estimate is consistent with the age structure from the 2018 estimate.

Length and age distributions for the period 2015 to 2019 are given in Figure 2.3.7.1.3.

Survey indices, (ages 1-8years 2004-2019) as applied in the stock assessment are shown in Table 2.3.7.1.1.

2.3.7.2 Other surveys

The Stock Annex provides information and time-series from surveys covering parts of the stock area. A brief survey description and survey results are provided below.

The International ecosystem survey in the Nordic Seas (IESNS) in May which is aimed at observing the pelagic ecosystem with particular focus on Norwegian spring-spawning herring and blue whiting (mainly immature fish) in the Norwegian Sea (Table 2.3.7.2.1).

Norwegian bottom-trawl survey in the Barents Sea (BS-NoRu-Q1(Btr)) in February-March where blue whiting are regularly caught as a bycatch species. This survey gives the first reliable indication of year-class strength of blue whiting. 1 group is defined in this survey as less than 19 cm (Table 2.3.7.2.2).

Icelandic bottom-trawl surveys on the shelf and slope area around Iceland. Blue whiting is caught as bycatch species and 1-group is defined as greater than 15 cm and less than 22 cm in March (Table 2.3.7.2.3).

Faroese bottom-trawl survey on the Faroe plateau in spring where blue whiting is caught as bycatch species. 1 group is defined in this survey as less than 23 cm in March (Table 2.3.7.2.4).

The International Survey in Nordic Seas and adjacent waters in July-August (IESSNS). Blue whiting are from 2016 included as a main target species in this survey and methods are changed to sample blue whiting. This was a recommendation from WGWISE 2015 to try to have one more time-series for blue whiting. The time-series is currently too short for assessment purposes.

2.4 Stock assessment

The presented assessment in this report follows the recommendations from the Inter-Benchmark Protocol of Blue Whiting (IBPBLW) convened by correspondence from 10 March to 10 May 2016 (ICES, 2016a) to use the SAM model.

The configuration of the SAM model (see the Stock Annex for details) includes the same settings as agreed during IBPBLW 2016, but due to a new version of SAM, the actual values have changed in 2017. The new SAM version begins with 0 for parameters, while the old version begins with 1. The Stock Annex has been updated accordingly.

For a model as SAM, Berg and Nielsen (2016) pointed out that the so-called "One Step Ahead" (OSA) residuals should be used for diagnostic purposes. The OSA residuals (Figure 2.4.1) show a quite random distribution of residuals. There might be an indication of "years effect" (too low index) for the IBWSS 2015 observations. The strong 2014 year class gives all positive residuals for IBWSS.

The estimated parameters from the SAM model from this year's assessment and from previous years (retrospective analysis) are shown in Table 2.4.1. There are only a very few abrupt changes in the estimated parameters over the time-series presented. Observation noises for the IBWSS increase in 2019 for the youngest (ages 1-2) and oldest ages (7-8). The lowest observation noise has in all years been from catches ages 3-8.

The process error residuals ("Joint sample residuals") (Figure 2.4.2) are reasonable randomly distributed, except in the terminal year where process error on N is mainly positive and process error on F is mainly negative for the dominating year classes in the fishery. Process noise SAM is implemented as a "process mortality, Z "; these deviations in mortalities are shown in Figure 2.4.3. The deviations in mortality (plus or minus mortality) seems fairly randomly distributed

without very pronounced clusters. Process noise presented as number of fish (Figure 2.4.4) shows similarly no alarming patterns.

The correlation matrix between ages for the catches and survey indices (Figure 2.4.5) show a modest observation correlation for the younger ages and a stronger correlation for the older ages. This difference is more distinct for catches, probably because it includes older ages (1-10+) than the survey data (ages 1-8).

Figure 2.4.6 presents exploitation pattern for the whole time-series. There are no abrupt changes in the exploitation pattern from 2010 to 2019, even though the landings in 2011 were just 19% of the landings in 2010, which might have given a different fishing practice. The estimated rather stable exploitation pattern might be influenced by the use of correlated random walks for F at age with a high estimated correlation coefficient ($\rho = 0.93$, Table 2.4.1).

The retrospective analysis (Figure 2.4.7) shows an unstable assessment with substantial downward revision of SSB in the 2015 assessment (due to the 2015 low survey indices) followed by an increase in 2016. The addition of 2019 data gives an upward revisions of SSB and downward revision of F . The use of “preliminary” catches (here in the retrospective analysis it is actually the final catches that are used for the period before 2018). Mohn’s ρ by year and as the average value over the last five years are presented in (Table 2.4.2). Even though the annual values might be high (reflecting large changes from one year to the next) the average Mohn’s ρ is rather low indicating no serious bias.

Stock summary results with added 95% confidence limits (Figure 2.4.8 and Table 2.4.5) show a decrease in fishing mortality in the period 2004–2011, followed by a steep increase in F up to 2015 and a decrease in F in 2016-2019. Recruitment increased from low recruitments in 2006–2009 to a historically high recruitment in 2015. This is followed by a lower recruitment in 2016 and a much lower recruitments in 2017-2019. SSB has increased in the period 2010-2018, followed by a large reduction. SSB in 2020 is 4325386 tonne and above MSY B_{trigger} .

2.4.1 Alternative model runs

The assessment models TISVPA and XSA were run for a better screening of potential errors in input and for comparison with the SAM results. All three models gave a similar result with respect SSB dynamics (Figure 2.4.1.1), even though the absolute values differ between models. For F , SAM estimates a reduction since 2016, XSA an increase and TISVPA a rather constant F since 2016.

All three models show a low recruitment in the most recent years. The XSA configuration uses a stock size dependent catchability for the youngest ages. SAM and TISVPA assume a stock size independent catchability. This difference might explain the higher XSA estimate of recruitment in the last two years.

2.5 Final assessment

Following the recommendations from Inter-Benchmark Protocol on Blue Whiting (IBPBLW 2016) the SAM model is used for the final assessment. The model settings can be found in the Stock annex. Alternative model runs give similar results.

Input data are catch numbers-at-age (Table 2.3.3.1), mean weight-at-age in the stock and in the catch (Table 2.3.4.1) and natural mortality and proportion mature in Table 2.3.5.1. Applied survey data are presented in Table 2.3.7.1.1.

The model was run for the period 1981–2019, with catch data up to 2018 and preliminary catch data for the first semester of 2019 raised to expected annual catches, and survey data from March–April, 2004–2019. SSB 1st January in 2020 is estimated from survivors and estimated recruits (for 2020 estimated outside the model, see short-term forecast section). 11% of age group 1 is assumed mature, thus recruitment influences the size of SSB. The key results are presented in Tables 2.4.3–2.4.4 and summarized in Table 2.4.5 and Figure 2.4.8. Residuals of the model fit are shown in Figures 2.4.1 and 2.4.2.

2.6 State of the Stock

F has increased from a historic low at 0.052 in 2011 to 0.488 in 2015 followed by a decrease in F to 0.335 in 2019. F has been above F_{MSY} (0.32) since 2014. SSB increased from 2010 (2.71 million tonnes) to 2018 (6.32 million tonnes), followed by a decline to 2020 (4.32 million tonnes). SSB has been above B_{pa} (2.25 million tonnes) since 1997.

Recruitment (age 1 fish) was high in 2014–2016 followed by recruitments in the very low end of the historical recruitments. The lower recruitment in combination with a high F in recent years have resulted in a decline in SSB.

2.7 Biological reference points

In spring of 2016, the Inter-Benchmark Protocol on Blue Whiting (IBPBLW 2016) delegated the task of re-evaluating biological reference points of the stock to the ICES Workshop on Blue Whiting Long Term Management Strategy Evaluation (WKBWMSE) (ICES 2016b). During the WGWISE meeting 2017, WKBWMSE concluded to keep B_{lim} and B_{pa} unchanged but revised F_{lim} , F_{pa} , and F_{MSY} (See Table below). The table below summaries the currently used reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	2.25 million t	B_{pa}	ICES (2013a, 2013b, 2016b)
	F_{MSY}	0.32	Stochastic simulations with segmented regression stock–recruitment relationship	ICES (2016b)
Precautionary approach	B_{lim}	1.50 million t	Approximately B_{loss}	ICES (2013a, 2013b, 2016b)
	B_{pa}	2.25 million t	$B_{lim} \exp(1.645 \times \sigma)$, with $\sigma = 0.246$	ICES (2013a, 2013b, 2016b)
	F_{lim}	0.88	Equilibrium scenarios with stochastic recruitment: F value corresponding to 50% probability of ($SSB < B_{lim}$)	ICES (2016b)
	F_{pa}	0.53	Based on F_{lim} and assessment uncertainties. $F_{lim} \exp(-1.645 \times \sigma)$, with $\sigma = 0.299$	ICES (2016b)

2.8 References

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

ICES.2013b. NEAFC request on additional management plan evaluation for blue whiting. Special request, Advice October 2013. *In* Report of the ICES Advisory Committee, 2013. ICES Advice 2013, Book 9, Section 9.3.3.7.

ICES. 2016a. Report of the Inter-Benchmark Protocol for Blue Whiting (IBPBLW), 10 March–10 May 2016, By correspondence. ICES CM 2016/ACOM:36. 118 pp.

ICES. 2016b. Report of the Workshop on Blue Whiting Long Term Management Strategy Evaluation (WKBWMS), 30 August 2016 ICES HQ, Copenhagen, Denmark. ICES CM 2016/ACOM:53

2.9 Short-term forecast

2.9.1 Recruitment estimates

The benchmark WKPELA in February 2012 concluded that the available survey indices should be used in a qualitative way to estimate recruitment, rather than using them in a strict quantitative model framework. The WGWISE has followed this recommendation and investigated several survey time-series indices with the potential to give quantitative or semi-quantitative information of blue whiting recruitment. The investigated survey series were standardized by dividing with their mean and are shown in Figure 2.8.1.1.

The International Ecosystem Survey in the Nordic Seas (IESNS) only partially covers the known distribution of recruitment from this stock. The 1–group (2018 year class) and the 2–group (2017 year class) indices from the survey in 2019 were approximately at the median and below the median of the historical range, respectively.

The International Blue Whiting Spawning Stock Survey (IBWSS) is not designed to give a representative estimate of the abundance of immature blue whiting. However, the 1–group indices appear to be fairly consistent with corresponding indices from older ages. The 1–group (2018 year class) index from the survey in 2019 was the slightly above the middle of the historic range. The 2–group in 2019 (2017 year class) was in the lower end in the time-series.

The Norwegian bottom-trawl survey in the Barents Sea (BS-NoRu-Q1(Btr)) in February–March 2018, showed that 1–group blue whiting was above the median in the time series (Table 2.3.7.2.2). However, the index in 2019 is low compared to the strong year-classes observed earlier. This index should be used as a presence/absence index, in the way that when blue whiting is present in the Barents Sea, this is usually a sign of a strong year class, as all known strong year classes have been strong also in the Barents Sea.

The 1–group estimate in 2019 (2018 year class) from the Icelandic bottom-trawl survey showed a decrease compared to 2018 and was the lowest observed in the time-series.

The 1–group estimate in 2019 (2018 year class) from the Faroese Plateau spring bottom-trawl survey was the lowest observed in the time-series.

In conclusion, the indices from available survey time-series indicate that the 2017 year class is in the low end and it corresponds to the SAM assessment results. The 2018 year classes estimated from surveys are also in the low end, which also is the result of the SAM assessment where it is in the lower end. It was therefore decided not to change the SAM estimate of the 2017 and 2018 year classes.

No information is available for the 2019 and 2020 year classes and the geometric mean of the full time-series (1981–2018) was used for these year classes (14.8 billion at age 1 in 2019) (Table 2.8.1.1).

2.9.2 Short-term forecast

As decided at WGWIDE 2014, a deterministic version of the SAM forecast was applied. Details about specific implementation can be found in the Stock Annex.

2.9.2.1 Input

Table 2.8.2.1 lists the input data for the short-term predictions. Mean weight at age in the stock and mean weight in the catch are the same, and are calculated as three year averages (2017–2019) in accordance with the 2019 updated Stock Annex. Selection (exploitation pattern) is based on F in the most recent year. The proportion mature for this stock is assumed constant over the years and values are copied from the assessment input.

Recruitment (age 1) in 2018 and 2019 are assumed as estimated by the SAM model, as additional survey information was not conflicting this result. Recruitment in 2020 and 2021 are assumed at the long-term average (geometric mean for the full time-series, minus the last year (1981-2018)).

As the assessment uses preliminary catches for 2019 an estimate of stock size exist for the 1 January 2020. The normal use of an “intermediate year” calculation is not relevant in this case. F in the “intermediate year” (2019) is as calculated by the assessment model. Catches in 2019 is the (model input) preliminary catches (1444301 tonnes). Intermediate year assumptions are summarised in Tables 2.8.2.1.1 and 2.8.2.1.2

2.9.2.2 Output

A range of predicted catch and SSB options from the deterministic short-term forecast used for advice are presented in Table 2.8.2.2.1.

Following the ICES MSY framework implies fishing mortality to be at $F_{MSY} = 0.32$ which will give a TAC in 2020 at 1161615 tonnes. This corresponds to a 1.6 % increase compared to the ICES advice last year, and 19.6% reduction compared to the preliminary estimate of catches in 2019. SSB is predicted to decrease by 20.6 %, if the advised catches are taken.

2.10 Comparison with previous assessment and forecast

Comparison of the final assessment results from the last 5 years is presented in Figure 2.9.1. The last three assessments, with the inclusion of the preliminary catches in 2016, had previously shown a tendency for overestimating SSB and underestimating F . This was partly because the previous assessments used a three years average of the mean weights at age for the preliminary catch data in previous year. Due to a decreasing trend in mean weight for the main age classes in the fishery, these values were an overestimate compared to the final mean weights obtained in the following year. This gave a tendency to overestimate SSB and underestimate F .

For 2019, the preliminary mean weights as observed were used in the assessment. This has partly removed the previously observed bias in SSB and F . The upward revision in SSB and downward revision in F this year are however mainly due to a higher than expected survey indices, mainly for the large 2014 year-class.

2.11 Quality considerations

Based on the confidence interval produced by the assessment model SAM there is a moderate to high uncertainty of the absolute estimate of F and SSB and the recruiting year classes (Figure 2.4.8). The retrospective analysis (Figure 2.4.7), the comparison of SSB and F estimated by three different assessment programs TISVPA, XSA and SAM (Figure 2.4.1.1) and the comparison of

the 2015-2019 assessments (Figure 2.9.1) suggest a consistent assessment for the last three years (with inclusion of preliminary catch data). The preliminary 2016-2018 catches in weight correspond well with the final catch statistics (Table 2.3.2.4).

There are several sources of uncertainty: age reading, stock identity, and survey indices. As there is only one survey (IBWSS) that covers the spawning stock, the quality of the survey influences the assessment result considerably. The Inter-Benchmark Protocol on Blue Whiting (IBPBLW 2016) introduced a configuration of the SAM model that includes the use of estimated correlation for catch and survey observations. This handles the “year effects” in the survey observation in a better way than assuming an uncorrelated variance structure as usually applied in assessment models. However, biased survey indices will still give a biased stock estimate with the new SAM configuration.

During the WGWISE 2017 (ICES 2017), a comparison between the mean length-at-age, by quarter and ICES division was made. This comparison reveals a considerable lower mean length-at-age from the Faroese catch-at-age data. The 2018 catch-at-age from Faroese Islands, provided for this year assessment, were based on the age reading guidelines from the last workshop on blue whiting ageing (WKARBLUE2) and no significant deviations of the mean length-at-age have been found (Figure 2.3.1.2.1). The Faroese catch-at-age data from the previous years are under revision and the assessment will be updated, when the data become available.

Utilization of preliminary catch data provides the assessment with information for the most recent year in addition to the survey information. This should give a less biased assessment, as potential biased survey data in the final year are supplemented by additional catch data.

2.12 Management considerations

The assessment estimates a low 2018 year class, which is confirmed by a series of surveys not used in the assessment model. This low recruitment in combination with low 2016-2017 year classes will result in a decrease in stock size, and a reduction in fishing opportunities when the 2016 - 2018 year classes are fully selected in the fishery.

2.13 Ecosystem considerations

An extensive overview of ecosystem considerations relevant for blue whiting can be found in the stock annex.

2.14 Regulations and their effects

There is an agreed long-term management strategy agreed by the European Union, the Faroe Islands, Iceland and Norway. However there is no agreement between the Coastal States EU, Norway, Iceland and the Faroe Island on the share of the blue whiting TAC.

WGWISE members estimate the total expected catch to be around 1.444 million tonnes in 2019, whereas the TAC advice for 2019, according to the long-term management strategy was ≤ 1,143,629 tonnes.

2.14.1 Management plans and evaluations

A response to NEAFC request to ICES to evaluate a long-term management strategy for the fisheries on the blue whiting ICES WKBWMSE was established in the fall of 2015. The ICES Advice

September 2016, “NEAFC request to ICES to evaluate a long-term management strategy for the fisheries on the blue whiting (*Micromesistius poutassou*) stock” concluded that:

- That the harvest control rule (HCR) proposed for the Long-Term Management Strategy (LTMS) for blue whiting, as described in the request, is precautionary given the ICES estimates of Blim (1.5 million t), Bpa (2.25 million t), and FMSY (0.32).
- The HCR was found to be precautionary both with and without the 20% TAC change limits above Bpa. However, the 20% TAC change limits can lead to the TAC being lowered significantly if the stock is estimated to be below Bpa, while also limiting how quickly the TAC can increase once the stock is estimated to have recovered above Bpa.
- The evaluation found that including a 10% interannual quota flexibility (‘banking and borrowing’) in the LTMS had an insignificant effect on the performance of the HCR.

2.15 Recommendations

The WGWIDE expert group analysed the mean length at age by area and by quarter of the data submitted from the different institutes/member states and differences have been identified in the data from the northern and southern areas. Due to the impact that biased age classifications could have on the blue whiting stock assessment, an inter-calibration exercise and a workshop is needed to review the age criteria used on this species. The impact of these uncertainties on age reading on the stock assessment results and uncertainties should be investigated.

2.16 Tables

Table 2.3.1.1. Blue whiting. ICES estimated catches (tonnes) by country for the period 1988–2018.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2003
Denmark	18941	26630	27052	15538	34356	41053	20456	12439	52101	26270	61523	82935
Estonia					6156	1033	4342	7754	10982	5678	6320	
Faroese	79831	75083	48686	10563	13436	16506	24342	26009	24671	28546	71218	329895
France		2191				1195		720	6442	12446	7984	14149
Germany	5546	5417	1699	349	1332	100	2	6313	6876	4724	17969	22803
Iceland		4977						369	302	10464	68681	501493
Ireland	4646	2014			781		3	222	1709	25785	45635	22580
Japan					918	1742	2574					
Latvia					10742	10626	2582					
Lithuania						2046						
Netherlands	800	2078	7750	17369	11036	18482	21076	26775	17669	24469	27957	48303
Norway	233314	301342	310938	137610	181622	211489	229643	339837	394950	347311	560568	834540
Poland	10											
Portugal	5979	3557	2864	2813	4928	1236	1350	2285	3561	2439	1900	2651
Spain	24847	30108	29490	29180	23794	31020	28118	25379	21538	27683	27490	13825
Sweden ***	1229	3062	1503	1000	2058	2867	3675	13000	4000	4568	9299	65532
UK (England + Wales)****												
UK (Northern Ireland)												
UK (Scotland)	5183	8056	6019	3876	6867	2284	4470	10583	14326	33398	92383	27382
USSR / Russia *	177521	162932	125609	151226	177000	139000	116781	107220	86855	118656	130042	355319
Greenland***												
Unallocated												
TOTAL	557847	627447	561610	369524	475026	480679	459414	578905	645982	672437	1128969	2321406

* From 1992 only Russia.

** Reported to the EU but not to the ICES WGNPBW. (Landings of 19,467 tonnes).

*** Estimates from Sweden and Greenland: are not included in the Catch at Age Number.

**** From 2012.

Table 2.3.1.1. (continued). Blue whiting. ICES estimated catches (tonnes) by country for the period 1988–2018.

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Denmark	89 500	41 450	54 663	48 659	18 134	248	140	165	340	2 167	35 256	45 178	39 395	60 868	87 348
Estonia	**														
Faroes	322 322	266 799	321 013	317 859	225 003	58 354	49979	16405	43290	85 768	224 700	282 502	282 416	356 501	349 838
France		8 046	18 009	16 638	11 723	8 831	7839	4337	9799	8 978	10 410	9 659	10 345	13 369	16 784
Germany	15 293	22 823	36 437	34 404	25 259	5 044	9108	278	6239	11 418	24 487	24 107	20 025	45 555	47 708
Iceland	379 643	265 516	309 508	236 538	159 307	120 202	87942	5887	63056	104 918	182 879	214 870	186 914	228 934	292 944
Ireland	75 393	73 488	54 910	31 132	22 852	8 776	8324	1195	7557	13 205	21 466	24 785	27 657	43 238	49 903
Lithuania			4 635	9 812	5 338						4 717		1 129	5 300	
Netherlands	95 311	147 783	102 711	79 875	78 684	35 686	33762	4595	26526	51 635	38 524	56 397	58 148	81 156	121 864
Norway	957 684	738 490	642 451	539 587	418 289	225 995	194317	20539	118832	196 246	399 520	489 439	310 412	399 363	438 426
Poland														15 889	12 152
Portugal	3 937	5 190	5 323	3 897	4 220	2 043	1482	603	1955	2 056	2 150	2 547	2 586	2 046	2 497
Spain	15 612	17 643	15 173	13 557	14 342	20 637	12891	2416	6726	15 274	32065	29 206	31 952	28 920	24 718
Sweden	19 083	2 960	101	464	4	3	50	1	4	199	2	32	42	90	16
UK (England + Wales)	2 593	7 356	10 035	12 926	14 147	6 176	2475	27	1590	4 100	11	131	1374+	3 447	1 864
UK (Northern Ireland)										1 232	2 205	1 119			4 508
UK (Scotland)	57 028	104 539	72 106	43 540	38 150	173	5496	1331	6305	8 166	24 630	30 508	37 173	64 724	66 682
Russia	346 762	332 226	329 100	236 369	225 163	149 650	112553	45841	88303	120 674	152 256	185 763	173 655	188 449	170 892
Greenland										2 133				20 212	23 333
Unallocated									3 499						
TOTAL	2380161	2034309	1976176	1625255	1260615	641818	526357	103620	384021	628169	1155279	1396244	1 181 850	1 558 061	1 711 477

** Reported to the EU but not to the ICES WGNPBW (Landings of 19,467 tonnes).

+ data from 2016 updated in the 2018.

Table 2.3.1.2. Blue whiting. ICES estimated catches (tonnes) by country and area for 2018.

ICES Div.	Denmark	Faroe Islands	France	Germany	Greenland	Iceland	Ireland	Netherlands	Norway	Poland	Portugal	Russia	Spain	Sweden*	UK (England + Wales)	UK (Northern Ireland)	UK (Scotland)	Total
27.2.a	27	30484	546	10377	2171	43232		6789	2106	104		39058		0	24			134917
27.3.a	41													15				57
27.4.																	56	56
27.4.a	7	7019	124	1037	1468	7244		1751	22763	86		1854						43353
27.4.b	14								5						0			19
27.5.a					199	8085												8284
27.5.b	1222	192299	1999	3543	16328	186887		2842	1820	6488		84620	14					498062
27.6.a	23441	50340	8212	25725	3164	23060	10184	65446	198503	5475		15760	672		1836		12469	444288
27.6.b	7134	14061	1631	298		8290	9117	6702	98671			6092	10			1324	16153	169483
27.7.b	2011		21	1637			753	3					4				371	4801
27.7.c	53451	43655	3885	5090		11244	29846	29919	99347			11751	91			3184	37611	329075
27.7.d			0															0
27.7.e			23												2			25
27.7.f															0			0
27.7.g			2				1						1		1			4
27.7.h			10				1						23		1			34
27.7.j			28	1				375					368				21	793
27.7.k		11980				4653		8035	15212			11757	11					51648
27.8.a			277				0						2					279
27.8.b			26					1					158		1			186
27.8.c			0										18934					18934
27.8.d			0				1						15					15
27.9.a											2497		4417					6915
27.12.b						249												249
27.14.a					3													3
Total	87348	349838	16784	47708	23333	292944	49903	121864	438426	12152	2497	170892	24718	16	1864	4508	66682	1711477

*only landings.

Table 2.3.1.3. Blue whiting. ICES estimated catches (tonnes) by quarter and area for 2018

Area	Quarter 1	Quarter 2	Quarter 3	Quarter 4	2018*	Total
27.2.a	373	49294	46937	38314		134917
27.3.a		25	32			57
27.4					56	56
27.4.a	14	15891	12183	15265		43353
27.4.b	0	14	5	0		19
27.5.a		3068	3812	1404		8284
27.5.b	63607	375061	3	59391		498062
27.6.a	82165	345772	7	16322	22	444288
27.6.b	164263	5121	7	3	89	169483
27.7.b	4026	773	2			4801
27.7.c	322229	6779	60	6		329075
27.7.d	0					0
27.7.e	0	6	17	2		25
27.7.f			0			0
27.7.g		1	2	1		4
27.7.h	8	17	7	1		34
27.7.j	164	324	267	38		793
27.7.k	47491	4147	9	1		51648
27.8.a	79	91	106	3		279
27.8.b	49	50	33	54		186
27.8.c	5096	7057	4149	2633		18934
27.8.d		0	9	6		15
27.9.a	896	2487	1701	1830		6915
27.12.b				249		249
27.14.a			3			3
Total	690461	815979	69349	135521	167	1711477

Discards data from UK(Scotland) were provided by year, due to sampling intensity.

Table 2.3.1.4. Blue whiting. ICES estimated catches (tonnes) from the main fisheries 1988–2018 by area.

Area	Norwegian Sea fishery (SAs1+2;Divs.5.a,14a-b)	Fishery in the spawning area (SA 12.; Divs. 5.b, 6.a-b, 7.a-c)	Directed- and mixed fisheries in the North Sea (SA4; Div.3.a)	Total northern areas	Total southern areas (SAs8+9;Divs.7.d-k)	Grand total
1988	55829	426037	45143	527009	30838	557847
1989	42615	475179	75958	593752	33695	627447
1990	2106	463495	63192	528793	32817	561610
1991	78703	218946	39872	337521	32003	369524
1992	62312	318018	65974	446367	28722	475026
1993	43240	347101	58082	448423	32256	480679
1994	22674	378704	28563	429941	29473	459414
1995	23733	423504	104004	551241	27664	578905
1996	23447	478077	119359	620883	25099	645982
1997	62570	514654	65091	642315	30122	672437
1998	177494	827194	94881	1099569	29400	1128969
1999	179639	943578	106609	1229826	26402	1256228
2000	284666	989131	114477	1388274	24654	1412928
2001	591583	1045100	118523	1755206	24964	1780170
2002	541467	846602	145652	1533721	23071	1556792
2003	931508	1211621	158180	2301309	20097	2321406
2004	921349	1232534	138593	2292476	85093	2377569
2005	405577	1465735	128033	1999345	27608	2026953
2006	404362	1428208	105239	1937809	28331	1966140
2007	172709	1360882	61105	1594695	17634	1612330
2008	68352	1111292	36061	1215704	30761	1246465
2009	46629	533996	22387	603012	32627	635639
2010	36214	441521	17545	495280	28552	523832
2011	20599	72279	7524	100401	3191	103592
2012	24391	324545	5678	354614	29402	384016*
2013	31759	481356	8749	521864	103973	625837**
2014	45580	885483	28596	959659	195620	1155279
2015	150828	895684	44661	1091173	305071	1396244
2016	59744	905087	55774	1020604	162583	1183187
2017	136565	1284105	45474	1466144	91917	1558061
2018	143204	1445957	43484	1632646	78831	1711477

* Data from UK(England + Wales) not included (2004-2007).

** Data from UK(England + Wales) and Sweden not included (2008-2011).

Table 2.3.1.5. Blue whiting. ICES estimates(tonnes) of catches, landings and discards by country for 2018.

	Catches	BMS landings	Landings	Discards	% discards
Denmark	87348		87308	40	0.05
Faroe Islands	349838		349838		
France	16784		16409	375	2.23
Germany	47708		47708		
Greenland	23333		23333		
Iceland	292944		292944		
Ireland	49903		49903	0	
Netherlands	121864		121864		
Norway	438426		438426		
Poland	12152		12152		
Portugal	2497		1497	1000	40.05
Russia	170892		170892		
Spain	24718		21993	2725	11.02
Sweden*	16		16		
UK (England)	1864	16	1845	3	0.15
UK(Northern Ireland)	4508		4508		
UK(Scotland)	66682		66515	167	0.25
Total	1711477	16	1707152	4309	0.25

*only

landings.

Table 2.3.1.6. Blue whiting. ICES estimated catches (tonnes) inside and outside NEAFC regulatory area for 2018 by country.

	Catches inside NEAFC RA	Catches outside NEAFC RA	Total catches
Denmark	1228	86120	87348
Faroe Islands	5426	344412	349838
France	670	16114	16784
Germany	4425	43283	47708
Greenland	104	23229	23333
Iceland	27458	265486	292944
Ireland	0	49903	49903
Netherlands	5218	116646	121864
Norway	67651	370776	438426
Poland	91	12062	12152
Portugal	0	2497	2497
Russia	64113	106778	170892
Spain	15	24704	24718
Sweden*	0.02	15	16
UK (England + Wales)**	0	1864	1864
UK(Northern Ireland)	0	4508	4508
UK(Scotland)	0.733	66681	66682
Total in 2018	176399	1535078	1711477

* only landings.

** those values are assumed.

Table 2.3.1.1.1. Blue whiting. ICES estimated catches (tonnes), the percentage of catch covered by the sampling programme, No. of age samples, No. of fish measured and No. of fish aged for 2000-2018.

Year	Catch (tonnes)	% catch covered by sampling programme	No. Age samples	No. Measured	No. Aged
2000	1412928	*	1136	125162	13685
2001	1780170	*	985	173553	17995
2002	1556792	*	1037	116895	19202
2003	2321406	*	1596	188770	26207
2004	2377569	*	1774	181235	27835
2005	2026953	*	1833	217937	32184
2006	1966140	*	1715	190533	27014
2007	1610090	87	1399	167652	23495
2008	1246465	90	927	113749	21844
2009	635639	88	705	79500	18142
2010	524751	87	584	82851	16323
2011	103591	85	697	84651	12614
2012	373937	80	1143	173206	15745
2013	625837	96	915	111079	14633
2014	1155279	89	912	111316	39738
2015	1396244	94	1570	102367	29821
2016	1183187	89	1092	120329	13793
2017	1558061	91	1779	147297	15828
2018	1711477	87	1565	131779	16426

Table 2.3.1.1.2. Blue whiting. ICES estimated catches (tonnes), the percentage of catch covered by the sampling programme (catch-at-age numbers), No. of length samples, No. of age samples, No. of fish measured, No. of fish aged, No. of fish aged by 1000 tonnes and No. of fish measured by 1000 tonnes by country for 2018.

Country	Catch (ton)	% catch covered by sampling programme	No. Length samples	No. Age samples	No. Measured	No. Aged	No Aged/ 1000 tonnes	No Measured/ 1000 tonnes
Denmark	87348	86	27	27	1135	1135	13	13
Faroe Islands	349838	90	18	18	1837	1756	5	5
France	16784	0	314	0	7167	0	0	427
Germany	47708	8	3	3	205	133	3	4
Greenland	23333	0	0	0	0	0	0	0
Iceland	292944	97	90	90	1961	2250	8	7
Ireland	49903	98	15	15	3498	1511	30	70
Netherlands	121864	86	71	71	16323	1744	14	134
Norway	438426	100	222	222	9660	2078	5	22
Poland	12152	0	0	0	0	0	0	0
Portugal	2497	100	59	59	3760	531	213	1506
Russia	170892	86	183	183	51117	1750	10	299
Spain	24718	95	867	867	30221	3080	125	1223
Sweden*	16	0	0	0	0	0	0	0
UK (England + Wales)	1863.7	0	5	0	82	0	0	44
UK(Northern Ireland)	4508	0	0	0	0	0	0	0
UK(Scotland)	66682	78	129	10	4813	458	7	72
Total	1711477	87	2003	1565	131779	16426	10	77

only landings.

Table 2.3.1.1.3. Blue whiting. ICES estimated catches (tonnes), No. of Age samples, No. of fish measured and No. of fish aged by country and quarter for 2018.

	Catch (tonnes)	No. Age samples	No. Length Measured	No. Aged
Denmark				
1	60288	12	445	445
2	27038	14	671	671
3	17	0	0	0
4	5	1	19	19
Total	87348	27	1135	1135
Faroe Islands				
1	132791	7	768	694
2	174913	8	765	762
3	3364	0	0	0
4	38770	3	304	300
Total	349838	18	1837	1756
France				
1	4030	0	2380	0
2	8004	0	2025	0
3	574	0	547	0
4	4176	0	2215	0
Total	16784	0	7167	0
Germany				
1	8381	0	0	0
2	30809	0	0	0
3	4933	3	205	133
4	3585	0	0	0
Total	47708	3	205	133
Greenland				
2	14763	0	0	0
3	107	0	0	0
4	8462	0	0	0
Total	23333	0	0	0
Iceland				
1	29146	13	309	325
2	194904	50	1091	1250
3	28519	10	214	250
4	40375	17	347	425
Total	292944	90	1961	2250
Ireland				
1	43746	13	3023	1308
2	6156	2	475	203
4	1	0	0	0
Total	49903	15	3498	1511
Netherlands				
1	41283	50	10923	1229
2	72350	21	5400	515
3	4502	0	0	0
4	3729	0	0	0
Total	121864	71	16323	1744

Table 2.3.1.1.3. (continued) Blue whiting. ICES estimated catches (tonnes), No. of Age samples, No. of fish measured and No. of fish aged by country and quarter for 2018.

	Catch (tonnes)	No. Age samples	No. Length Measured	No. Aged
Norway				
1	258673	41	1913	1017
2	163910	100	4097	726
3	12821	74	3337	335
4	3023	7	313	0
Total	438426	222	9660	2078
Poland				
4	12152	0	0	0
Total	12152	0	0	0
Portugal				
1	350	9	565	89
2	649	15	1280	125
3	910	24	1315	145
4	588	11	600	172
Total	2497	59	3760	531
Russia				
1	43886	65	15476	569
2	101891	74	22228	938
3	8455	32	9642	195
4	16660	12	3771	48
Total	170892	183	51117	1750
Spain				
1	5906	172	5182	626
2	9714	269	8779	626
3	5129	175	7706	914
4	3970	251	8554	914
Total	24718	867	30221	3080
Sweden*				
3	15.5	0	0	0
4	0.025	0	0	0
Total	16	0	0	0
UK (England + Wales)				
1	0	0	0	0
2	1837	0	44	0
3	2	0	38	0
4	24	0	0	0
Total	1864	0	82	0
UK (Northern Ireland)				
1	4508	0	0	0
Total	4508	0	0	0
UK (Scotland)				
1	57474	10	1864	458
2	9041	0	0	0
2018**	167	0	2949	0
Total	66682	10	4813	458
Total Geral	1711477	1565	131779	16426

* only landings.

** Discards data from UK(Scotland) were provided by year, due to sampling intensity.

Table 2.3.1.1.4. Blue whiting. ICES estimated catches (tonnes), the percentage of catch covered by the sampling programme, No. of length samples, No. of age samples, No. of fish measured, No. of fish aged, No. of fish aged by 1000 tonnes and No. of fish measured by 1000 tonnes by ICES division for 2018.

ICES Division	Catch (ton)	No. Length samples	No. Age samples	No. Measured	No. Aged	No Aged/ 1000 tonnes	No Measured/ 1000 tonnes
27.2.a	134917	103	98	15162	1006	7	112
27.3.a	57	0	0	0	0	0	0
27.4	56	74	0	686	0	0	12308
27.4.a	43353	188	144	6666	703	16	154
27.4.b	19	0	0	0	0	0	0
27.5.a	8284	1	1	19	25	3	2
27.5.b	498062	151	139	25167	3147	6	51
27.6.a	444288	271	96	19870	3143	7	45
27.6.b	169483	46	34	6065	1028	6	36
27.7.b	4801	0	0	0	0	0	0
27.7.c	329075	105	84	14813	2979	9	45
27.7.d	0	0	0	0	0	0	0
27.7.e	25	0	0	0	0	0	0
27.7.f	0	0	0	0	0	0	0
27.7.g	4	2	0	44	0	0	11881
27.7.h	34	15	0	78	0	0	2296
27.7.j	793	0	0	0	0	0	0
27.7.k	51648	43	43	8543	784	15	165
27.8.a	279	32	0	409	0	0	1467
27.8.b	186	193	147	1374	0	0	7406
27.8.c	18934	421	421	21646	1540	81	1143
27.8.d	15	0	0	0	0	0	0
27.9.a	6915	358	358	11237	2071	300	1625
27.12.b	249	0	0	0	0	0	0
27.14.a	3	0	0	0	0	0	0
TOTAL	1711477	2003	1565	131779	16426	10	77

Table 2.3.2.1. Blue whiting. ICES estimated preliminary catches (tonnes) in 2019 by quarter and area. Data submitted to InterCatch.

ICES div.	Quarter 1	Quarter 2	2019*	Total
27.2.a	447	13193		13641
27.3.a	0	0		0
27.4			129	129
27.4.a	232	4224		4455
27.4.b	0			0
27.5.a	8	5		13
27.5.b	45466	289865		335331
27.6.a	59671	234102	4	293776
27.6.b	67972	1848	77	69897
27.7.b	280	1959		2239
27.7.c	415686	13133		428818
27.7.g		0		0
27.7.h		17		17
27.7.j	0	2		3
27.7.k	102995			102995
27.8.a	1			1
27.8.b	11			11
27.9.a	203	260		464
27.12	51			51
Total	693023	558608	209	1251841

* Data assign for 2019 were provided by year, due to sampling intensity.

Table 2.3.2.2. Blue whiting. ICES estimated preliminary catches (tonnes), the percentage of catch covered by the sampling programme, No. of samples, No. of fish measured, No. of fish aged, No. of fish aged by 1000 tonnes and No. of fish measured by 1000 tonnes by ICES division for 2019 preliminary data (quarters 1 and 2). Data submitted to InterCatch.

ICES div.	Catch (ton)	No. samples	No. Measured	No. Aged
27.4	129	0	0	0
27.2.a	13641	0	0	0
27.2.a.2	0	0	0	0
27.3.a	0	0	0	0
27.4.a	4455	0	0	0
27.4.b	0	0	0	0
27.5.a	13	0	0	0
27.5.b	334158	47	4658	1362
27.5.b.1	535	0	0	0
27.5.b.2	638	0	0	0
27.6.a	293776	25	2682	1634
27.6.b	48693	23	5394	923
27.6.b.2	21204	5	1118	374
27.7.b	2239	0	0	0
27.7.c	352501	95	21802	1793
27.7.c.2	76317	31	3999	1927
27.7.g	0	0	0	0
27.7.h	17	0	0	0
27.7.j	3	0	0	0
27.7.j.2	0	0	0	0
27.7.k	92381	19	4565	965
27.7.k.2	10614	6	1027	437
27.8.a	1	0	0	0
27.8.b	11	0	0	0
27.9.a	464	5	249	192
27.12	51	0	0	0
Total	1251841	256	45494	9607

Table 2.3.2.3. Blue whiting. ICES estimates of catches (tonnes) in 2019, based on (initial) declared quotas and expected uptake estimated by WGWIDE.

Country	Prelim Q1-Q2 catch	Expected remaining catch or total year catch	Total catch
Denmark	68,290	0	68,290
Faroe Islands	306,282	18,626	324,908
Germany	0	31,979	31,979
Greenland	0	19,692	19,692
France	0	13,327	13,327
Iceland	224,870	1,857	226,727
Ireland	35,961	0	35,961
The Netherlands	54,725	34,456	89,181
Norway	333,171	23,100	356,271
Poland	11,304	0	11,304
Portugal	464	2,000	2,464
Russia	162,735	33,265	196,000
United Kingdom	59,961	209	60,170
Spain	0	8,000	8,000
Sweden	0	27	27
Total	1,257,762	186,539	1,444,301
EU	230,704	89,998	320,703
Non-EU	1,027,058	76,848	1,103,906
Best estimate of catches in 2019			1,444,301

Table 2.3.2.4. Blue whiting. Comparison of preliminary and final catches (tonnes).

Year	Preliminary	Final	Deviation %*
2016	1147000	1180786	2.9
2017	1559437	1555069	-0.3
2018	1712874	1709856	-0.2
2019	1444301		

* (final-preliminary)/final*100

Table 2.3.3.1. Blue whiting. Catch-at-age numbers (thousands) by year. Discards included since 2014. Values for 2019 are preliminary.

Year Age	1	2	3	4	5	6	7	8	9	10+
1981	258000	348000	681000	334000	548000	559000	466000	634000	578000	1460000
1982	148000	274000	326000	548000	264000	276000	266000	272000	284000	673000
1983	2283000	567000	270000	286000	299000	304000	287000	286000	225000	334000
1984	2291000	2331000	455000	260000	285000	445000	262000	193000	154000	255000
1985	1305000	2044000	1933000	303000	188000	321000	257000	174000	93000	259000
1986	650000	816000	1862000	1717000	393000	187000	201000	198000	174000	398000
1987	838000	578000	728000	1897000	726000	137000	105000	123000	103000	195000
1988	425000	721000	614000	683000	1303000	618000	84000	53000	33000	50000
1989	865000	718000	1340000	791000	837000	708000	139000	50000	25000	38000
1990	1611000	703000	672000	753000	520000	577000	299000	78000	27000	95000
1991	266686	1024468	513959	301627	363204	258038	159153	49431	5060	9570
1992	407730	653838	1641714	569094	217386	154044	109580	79663	31987	11706
1993	263184	305180	621085	1571236	411367	191241	107005	64769	38118	17476
1994	306951	107935	367962	389264	1221919	281120	174256	90429	79014	30614
1995	296100	353949	421560	465358	615994	800201	253818	159797	59670	41811
1996	1893453	534221	632361	537280	323324	497458	663133	232420	98415	82521
1997	2131494	1519327	904074	577676	295671	251642	282056	406910	104320	169235
1998	1656926	4181175	3541231	1044897	383658	322777	303058	264105	212452	85513
1999	788200	1549100	5820800	3460600	412800	207200	151200	153100	68800	140500
2000	1814851	1192657	3465739	5014862	1550063	513663	213057	151429	58277	139791
2001	4363690	4486315	2962163	3806520	2592933	585666	170020	97032	76624	66410

Year Age	1	2	3	4	5	6	7	8	9	10+
2002	1821053	3232244	3291844	2242722	1824047	1647122	344403	168848	102576	142743
2003	3742841	4073497	8378955	4824590	2035096	1117179	400022	121280	19701	27493
2004	2156261	4426323	6723748	6697923	3044943	1276412	649885	249097	75415	36805
2005	1427277	1518938	5083550	5871414	4450171	1419089	518304	249443	100374	55226
2006	412961	939865	4206005	6150696	3833536	1718775	506198	181181	67573	36688
2007	167027	306898	1795021	4210891	3867367	2353478	935541	320529	130202	88573
2008	408790	179211	545429	2917190	3262956	1919264	736051	315671	113086	126637
2009	61125	156156	231958	594624	1596095	1156999	592090	251529	88615	48908
2010	349637	222975	160101	208279	646380	992214	702569	256604	70487	43693
2011	162997	101810	63954	53863	69717	116396	120359	55470	25943	12542
2012	239667	351845	663155	141854	106883	203419	363779	356785	212492	157947
2013	228175	508122	848597	896966	462714	224066	321310	397536	344285	383601
2014	588717	584084	2312953	2019373	1272862	416523	386396	462339	526141	662747
2015	2944849	2852384	2427329	2465286	1518235	707533	329882	258743	239164	450046
2016	1239331	3518677	2933271	1874011	1367844	756824	339851	185368	131039	288635
2017	401947	1999011	7864694	4063916	1509651	777185	263007	110351	63945	149369
2018	418781	541041	3572357	7340084	2983975	1022883	424206	150753	90387	163289
2019	62481	204969	1574606	3595548	4765543	1503323	451127	144760	43247	83582

Table 2.3.4.1. Blue whiting. Individual mean weight (kg) at age in the catch. Preliminary values for 2019.

Year Age	1	2	3	4	5	6	7	8	9	10+
1981	0.052	0.065	0.103	0.125	0.141	0.155	0.170	0.178	0.187	0.213
1982	0.045	0.072	0.111	0.143	0.156	0.177	0.195	0.200	0.204	0.231
1983	0.046	0.074	0.118	0.140	0.153	0.176	0.195	0.200	0.204	0.228
1984	0.035	0.078	0.089	0.132	0.153	0.161	0.175	0.189	0.186	0.206
1985	0.038	0.074	0.097	0.114	0.157	0.177	0.199	0.208	0.218	0.237
1986	0.040	0.073	0.108	0.130	0.165	0.199	0.209	0.243	0.246	0.257
1987	0.048	0.086	0.106	0.124	0.147	0.177	0.208	0.221	0.222	0.254
1988	0.053	0.076	0.097	0.128	0.142	0.157	0.179	0.199	0.222	0.260
1989	0.059	0.079	0.103	0.126	0.148	0.158	0.171	0.203	0.224	0.253
1990	0.045	0.070	0.106	0.123	0.147	0.168	0.175	0.214	0.217	0.256
1991	0.055	0.091	0.107	0.136	0.174	0.190	0.206	0.230	0.232	0.266
1992	0.057	0.083	0.119	0.140	0.167	0.193	0.226	0.235	0.284	0.294
1993	0.066	0.082	0.109	0.137	0.163	0.177	0.200	0.217	0.225	0.281
1994	0.061	0.087	0.108	0.137	0.164	0.189	0.207	0.217	0.247	0.254
1995	0.064	0.091	0.118	0.143	0.154	0.167	0.203	0.206	0.236	0.256
1996	0.041	0.080	0.102	0.116	0.147	0.170	0.214	0.230	0.238	0.279
1997	0.047	0.072	0.102	0.121	0.140	0.166	0.177	0.183	0.203	0.232
1998	0.048	0.072	0.094	0.125	0.149	0.178	0.183	0.188	0.221	0.248
1999	0.063	0.078	0.088	0.109	0.142	0.170	0.199	0.193	0.192	0.245
2000	0.057	0.075	0.086	0.104	0.133	0.156	0.179	0.187	0.232	0.241
2001	0.050	0.078	0.094	0.108	0.129	0.163	0.186	0.193	0.231	0.243
2002	0.054	0.074	0.093	0.115	0.132	0.155	0.173	0.233	0.224	0.262
2003	0.049	0.075	0.098	0.108	0.131	0.148	0.168	0.193	0.232	0.258
2004	0.042	0.066	0.089	0.102	0.123	0.146	0.160	0.173	0.209	0.347
2005	0.039	0.068	0.084	0.099	0.113	0.137	0.156	0.166	0.195	0.217
2006	0.049	0.072	0.089	0.105	0.122	0.138	0.163	0.190	0.212	0.328
2007	0.050	0.064	0.091	0.103	0.115	0.130	0.146	0.169	0.182	0.249
2008	0.055	0.075	0.100	0.106	0.120	0.133	0.146	0.160	0.193	0.209
2009	0.056	0.085	0.105	0.119	0.124	0.138	0.149	0.179	0.214	0.251

Table 2.3.7.1.1. Blue whiting. Time-series of StoX abundance estimates of blue whiting (millions) by age in the IBWSS. Total biomass in last column (1000 t). Shaded values (ages 1-8; years 2004-2019) are used as input to the assessment

Year	Age										TSB
	1	2	3	4	5	6	7	8	9	10+	
2004	1 097	5 538	13 062	15 134	5 119	1 086	994	593	164		3 505
2005	2 129	1 413	5 601	7 780	8 500	2 925	632	280	129	23	2 513
2006	2 512	2 222	10 858	11 677	4 713	2 717	923	352	198	31	3 512
2007	468	706	5 241	11 244	8 437	3 155	1 110	456	123	58	3 274
2008	337	523	1 451	6 642	6 722	3 869	1 715	1 028	269	284	2 639
2009	275	329	360	1 292	3 739	3 457	1 636	587	250	162	1 599
2010*											
2011	312	1 361	1 135	930	1 043	1 712	2 170	2 422	1 298	250	1 826
2012	1 141	1 818	6 464	1 022	596	1 420	2 231	1 785	1 256	1 022	2 355
2013	586	1 346	6 183	7 197	2 933	1 280	1 306	1 396	927	1 670	3 107
2014	4 183	1 491	5 239	8 420	10 202	2 754	772	577	899	1 585	3 337
2015	3 255	4 565	1 888	3 630	1 792	465	173	108	206	247	1 403
2016	2 745	7 893	10 164	6 274	4 687	1 539	413	133	235	256	2 873
2017	275	2 180	15 939	10 196	3 621	1 711	900	75	66	144	3 135
2018	836	628	6 615	21 490	7 692	2 187	755	188	72	144	4 035
2019	1 129	1 169	3 468	9 590	16 979	3 434	484	513	99	144	4 198

*Survey discarded.

Table 2.3.7.2.1. Blue whiting. Estimated abundance of 1 and 2 year old blue whiting from the International Norwegian Sea ecosystem survey, 2003–2018.

Year\Age	Age 1	Age 2
2003*	16127	9317
2004*	17792	11020
2005*	19933	7908
2006*	2512	5504
2007*	592	213
2008	25	17
2009	7	8
2010	0	280
2011	1613	0
2012	9476	3265
2013	454	6544
2014	3893	2048
2015	8563	2796
2016	4223	8089
2017	1236	2087
2018	441	1491
2019	3157	215

*Using the old TS-value. To compare the results all values were divided by approximately 3.1.

Table 2.3.7.2.2. Blue whiting. 1-group indices of blue whiting from the Norwegian winter survey (late January-early March) in the Barents Sea. (Blue whiting < 19 cm in total body length which most likely belong to 1-group.)

Catch Rate		
Year	All	< 19 cm
1981	0.13	0
1982	0.17	0.01
1983	4.46	0.46
1984	6.97	2.47
1985	32.51	0.77
1986	17.51	0.89
1987	8.32	0.02
1988	6.38	0.97
1989	1.65	0.18
1990	17.81	16.37
1991	48.87	2.11
1992	30.05	0.06
1993	5.80	0.01
1994	3.02	0
1995	1.65	0.10
1996	9.88	5.81
1997	187.24	175.26
1998	7.14	0.21
1999	5.98	0.71
2000	129.23	120.90
2001	329.04	233.76
2002	102.63	9.69
2003	75.25	15.15
2004	124.01	36.74
2005	206.18	90.23
2006	269.2	3.52
2007	80.38	0.16

Catch Rate		
Year	All	< 19 cm
2008	17.97	0.04
2009	4.50	0.01
2010	3.30	0.08
2011	1.48	0.01
2012	127.71	125.93
2013	39.54	2.33
2014	31.48	24.97
2015	148.4	128.34
2016	86.99	11.31
2017	167.16	0.71
2018	9.19	0.03
2019	22.56	11.79

Table 2.3.7.2.3. Blue whiting. 1-group indices of blue whiting from the Icelandic bottom-trawl surveys, 1-group (< 22 cm in March).

Catch Rate	
Year	< 22 cm
1996	6.5
1997	3.4
1998	1.1
1999	6.3
2000	9
2001	5.2
2002	14.2
2003	15.4
2004	8.9
2005	8.3
2006	30.4
2007	3.9
2008	0.1
2009	1.6
2010	0.2
2011	10.8
2012	29.9
2013	11.7
2014	66.3
2015	43.8
2016	6.3
2017	1.8
2018	0.4
2019	0.1

Table 2.3.7.2.4. Blue whiting. 1-group indices of blue whiting from Faroese bottom-trawl surveys, 1-group (< 23 cm in March).

Catch Rate	
Year	< 23 cm
1994	1382
1995	1105
1996	4442
1997	1764
1998	360
1999	1330
2000	782
2001	3357
2002	3885
2003	929
2004	15163
2005	23750
2006	13364
2007	11509
2008	840
2009	3754
2010	824
2011	11406
2012	5345
2013	8855
2014	51313
2015	14444
2016	22485
2017	5286
2018	1948
2019	285

Table 2.4.1. Blue whiting. Parameter estimates, from final assessment (2019) and retrospective analysis (2015-2018).

Parameter Year	2015	2016	2017	2018	2019
Random walk variance					
-F Age 1-10	0.40	0.39	0.38	0.38	0.37
Process error					
-log(N) Age 1	0.58	0.60	0.63	0.61	0.61
--- Age 2-10	0.17	0.18	0.18	0.18	0.18
Observation variance					
-Catch Age 1	0.46	0.45	0.44	0.43	0.45
--- Age 2	0.30	0.28	0.29	0.28	0.31
--- Age 3-8	0.20	0.20	0.20	0.19	0.19
--- Age 9-10	0.40	0.40	0.40	0.40	0.39
-IBWSS Age 1	0.75	0.82	0.73	0.72	0.81
--- Age 2	0.31	0.32	0.30	0.32	0.38
--- Age 3	0.45	0.45	0.42	0.43	0.41
--- Age 4-6	0.45	0.42	0.39	0.38	0.37
--- Age 7-8	0.38	0.40	0.47	0.51	0.54
Survey catchability					
-IBWSS Age 1	0.06	0.06	0.07	0.06	0.07
--- Age 2	0.12	0.12	0.12	0.11	0.11
--- Age 3	0.37	0.38	0.38	0.38	0.36
--- Age 4	0.70	0.69	0.70	0.68	0.67
--- Age 5-8	0.91	0.89	0.90	0.87	0.86
Rho					
--	0.92	0.92	0.93	0.93	0.93

Table 2.4.2. Blue whiting. Mohn's rho by year and average over the last five years (n=5).

Year	R(age 1)	SSB	Fbar(3-7)
2014	-0.393	0.293	-0.274
2015	-0.347	-0.143	0.277
2016	0.197	0.034	-0.075
2017	-0.161	-0.133	0.214
2018	0.036	-0.140	0.152
rho.mean	-0.134	-0.018	0.059

Table 2.4.3. Blue whiting. Estimated fishing mortalities. Catch data for 2019 are preliminary.

Year Age	1	2	3	4	5	6	7	8	9	10+
1981	0.078	0.118	0.171	0.210	0.243	0.316	0.345	0.444	0.490	0.490
1982	0.067	0.102	0.147	0.181	0.206	0.268	0.291	0.371	0.406	0.406
1983	0.078	0.116	0.169	0.208	0.236	0.310	0.334	0.416	0.444	0.444
1984	0.096	0.142	0.211	0.263	0.302	0.394	0.415	0.505	0.527	0.527
1985	0.102	0.151	0.231	0.294	0.346	0.447	0.464	0.559	0.574	0.574
1986	0.114	0.169	0.269	0.359	0.434	0.555	0.574	0.692	0.706	0.706
1987	0.101	0.150	0.248	0.339	0.417	0.542	0.562	0.675	0.677	0.677
1988	0.098	0.148	0.253	0.349	0.441	0.580	0.591	0.695	0.676	0.676
1989	0.113	0.170	0.303	0.418	0.527	0.690	0.715	0.843	0.803	0.803
1990	0.105	0.158	0.291	0.406	0.511	0.668	0.717	0.854	0.817	0.817
1991	0.059	0.088	0.166	0.233	0.289	0.367	0.396	0.465	0.449	0.449
1992	0.048	0.072	0.139	0.194	0.232	0.284	0.310	0.368	0.361	0.361
1993	0.042	0.063	0.126	0.176	0.206	0.246	0.269	0.320	0.315	0.315
1994	0.037	0.055	0.115	0.162	0.187	0.221	0.244	0.295	0.289	0.289
1995	0.047	0.070	0.150	0.215	0.242	0.282	0.313	0.383	0.368	0.368
1996	0.056	0.085	0.186	0.271	0.296	0.345	0.382	0.474	0.451	0.451
1997	0.055	0.084	0.190	0.281	0.299	0.347	0.381	0.476	0.454	0.454
1998	0.070	0.110	0.252	0.382	0.405	0.468	0.506	0.628	0.590	0.590
1999	0.064	0.102	0.240	0.374	0.398	0.458	0.482	0.596	0.560	0.560

Year Age	1	2	3	4	5	6	7	8	9	10+
2000	0.074	0.118	0.282	0.450	0.499	0.576	0.588	0.706	0.666	0.666
2001	0.069	0.110	0.264	0.429	0.490	0.567	0.567	0.673	0.637	0.637
2002	0.064	0.103	0.251	0.418	0.502	0.594	0.595	0.701	0.665	0.665
2003	0.067	0.106	0.261	0.440	0.542	0.632	0.624	0.704	0.664	0.664
2004	0.068	0.107	0.268	0.459	0.588	0.686	0.682	0.744	0.702	0.702
2005	0.059	0.094	0.239	0.420	0.557	0.651	0.655	0.700	0.663	0.663
2006	0.051	0.081	0.209	0.373	0.510	0.599	0.607	0.637	0.603	0.603
2007	0.047	0.077	0.197	0.356	0.504	0.605	0.630	0.660	0.627	0.627
2008	0.041	0.067	0.171	0.307	0.442	0.531	0.565	0.590	0.569	0.569
2009	0.026	0.043	0.111	0.194	0.282	0.337	0.367	0.382	0.370	0.370
2010	0.019	0.031	0.079	0.134	0.194	0.231	0.254	0.258	0.252	0.252
2011	0.006	0.009	0.024	0.040	0.056	0.066	0.073	0.075	0.075	0.075
2012	0.012	0.020	0.052	0.084	0.119	0.139	0.158	0.165	0.165	0.165
2013	0.019	0.034	0.091	0.148	0.209	0.241	0.277	0.292	0.292	0.292
2014	0.036	0.064	0.180	0.292	0.406	0.467	0.537	0.571	0.568	0.568
2015	0.045	0.082	0.234	0.381	0.526	0.610	0.690	0.732	0.724	0.724
2016	0.038	0.069	0.201	0.329	0.455	0.538	0.607	0.640	0.633	0.633
2017	0.035	0.064	0.191	0.310	0.424	0.501	0.558	0.583	0.578	0.578
2018	0.034	0.062	0.189	0.307	0.418	0.497	0.557	0.579	0.576	0.576
2019	0.028	0.052	0.162	0.263	0.355	0.422	0.475	0.488	0.488	0.488

Table 2.4.4. Blue whiting. Estimated stock numbers-at-age (thousands). Preliminary catch data for 2019 have been used.

Year Age	1	2	3	4	5	6	7	8	9	10+
1981	3896876	3492597	4871007	2093891	2627921	2153014	1650416	1738083	1216486	2951678
1982	4630424	2917499	2528049	3301226	1598544	1512881	1303118	1015736	886131	1927262
1983	17678275	3689975	1882874	1834658	1928848	1225298	1017655	857480	626680	1262180
1984	17723928	14056528	2427175	1238806	1273828	1401313	819180	554020	484216	932256

Year Age	1	2	3	4	5	6	7	8	9	10+
198 5	9543383	1332060 5	9633102	1451713	753924	913924	750203	461578	268372	727320
198 6	7272374	6414112	9356762	5492602	937539	454417	472050	377560	232213	500050
198 7	9132926	5095624	4105139	6793112	2551160	395339	253474	237604	156824	293766
198 8	6437259	6908547	3541005	2890386	3688443	125249 7	198439	125507	99098	171218
198 9	8612583	4634745	5000149	2436690	2123685	167504 1	350727	102311	60197	115618
199 0	1874238 0	6071502	3108680	2744591	1483283	118278 6	559053	120505	33129	84570
199 1	8944058	1560713 3	4297830	1806968	1491047	868106	558493	188955	32441	45039
199 2	6715037	7285087	1250681 9	3315816	1270988	795566	486310	287451	101283	39141
199 3	5089008	5134499	5254883	9687193	2261655	980787	518006	283412	157318	74460
199 4	8033603	3536421	4046815	3408563	6881206	144101 6	762408	326991	206137	116946
199 5	9374009	5852874	3159661	2577279	2848615	374896 7	103546 9	540324	218570	184810
199 6	2773611 6	7129129	4070132	2398183	1566377	186617 7	223542 5	641166	304831	247248
199 7	4406548 2	2118697 8	5465815	2565642	1428114	107553 4	106425 3	121151 7	288089	332121
199 8	2694782 6	3698762 6	1626911 3	3483215	1384172	930528	781084	602526	614854	292253
199 9	2074196 0	2074026 1	2717928 3	1039348 8	1717461	779068	522937	409836	237132	426968
200 0	3874189 7	1563140 0	1654355 0	1568192 5	4319771	110519 3	471896	323231	154091	312783
200 1	5620409 2	3086839 6	1217326 7	1070796 4	7428567	169694 5	490394	226938	161246	178587
200 2	4911873 1	4556862 3	2030918 6	8322894	5478866	339865 8	694437	255236	102946	154501
200 3	5287385 3	3911270 7	3502553 3	1354530 4	5059887	297337 7	121400 3	348080	89487	106983
200 4	2980694 6	4200595 3	3002178 9	2091885 6	7277417	246282 6	131858 1	506050	152639	81125

Year Age	1	2	3	4	5	6	7	8	9	10+
2005	22383995	22907020	28674529	18110397	10790277	3251624	1115168	518475	194586	99714
2006	9029595	15894983	22513302	19372863	9487707	4479140	1364412	486872	220152	121600
2007	4912498	6134558	13271167	16017943	10370614	4702075	1840967	611444	230227	164203
2008	5795362	3509986	4413604	11107332	9224656	4942632	1867227	759340	237143	199906
2009	5717271	4044320	2450635	3754299	7000979	4756794	2210150	861048	326583	190172
2010	15629189	4941581	2398985	1897417	3408214	4382146	2856638	1217416	418810	269718
2011	19530150	13653303	3322078	1684645	1646850	2644032	2728079	1377509	825674	398698
2012	19666112	15578182	12565693	2335933	1213771	1640203	2350394	2133180	1091964	911564
2013	16561619	16449374	11666941	7481074	2257018	1109546	1388478	1649435	1360434	1393334
2014	37382298	13131769	13874711	8092127	4449641	1371109	940364	1004844	1026638	1508860
2015	64931228	32784290	10908640	8617890	4279090	1764228	745265	522430	485513	1068627
2016	36012234	58459167	21601034	7829243	4446954	1848161	717154	355683	223797	602550
2017	12772968	29542948	46531673	15623163	4732406	2228178	759299	290397	164278	383498
2018	9856549	10175002	23263586	31440843	9331101	2657503	997009	323802	148486	277502
2019	5466776	7044995	10228252	16037027	18749727	4968279	1315218	447418	138539	216660

Table 2.4.5. Blue whiting. Estimated recruitment in thousands, spawning-stock biomass (SSB) in tonnes, average fishing mortality for ages 3 to 7 (F_{BAR} 3-7) and total-stock biomass (TBS) in tonnes. Preliminary catch data for 2019 are included.

Year	R(age 1)	Low	High	SSB	Low	High	F _{bar} (3-7)	Low	High	TSB	Low	High
1981	3896876	2489342	6100263	2846619	2233607	3627870	0.257	0.186	0.356	3343500	2673113	4182014
1982	4630424	2936887	7300526	2304898	1828845	2904869	0.219	0.161	0.297	2771494	2238241	3431793
1983	17678275	11403660	27405360	1858580	1506437	2293040	0.251	0.188	0.337	2861615	2324804	3522379
1984	17723928	11541642	27217758	1744170	1437627	2116077	0.317	0.240	0.418	3046970	2452354	3785761
1985	9543383	6250679	14570604	2078674	1710733	2525752	0.356	0.273	0.465	3204588	2608905	3936282
1986	7272374	4790094	11041000	2263816	1866673	2745452	0.438	0.337	0.570	3104859	2566763	3755762
1987	9132926	6002314	13896362	1926457	1591061	2332555	0.421	0.323	0.549	2813755	2329199	3399115
1988	6437259	4223292	9811850	1635851	1362246	1964409	0.443	0.340	0.577	2427085	2016017	2921969
1989	8612583	5630452	13174180	1546980	1292158	1852055	0.531	0.409	0.688	2398767	1982599	2902292
1990	18742380	12073288	29095370	1360972	1126775	1643846	0.519	0.393	0.684	2504729	1995610	3143735
1991	8944058	5714284	13999334	1779798	1423554	2225191	0.290	0.213	0.396	3220186	2510433	4130600
1992	6715037	4336390	10398447	2458820	1941223	3114427	0.232	0.170	0.316	3523473	2786577	4455238
1993	5089008	3256529	7952642	2536460	2012814	3196336	0.205	0.150	0.278	3420502	2734553	4278517
1994	8033603	5173862	12474003	2529314	2029095	3152848	0.186	0.136	0.253	3412013	2763725	4212371
1995	9374009	6095731	14415341	2309839	1894920	2815609	0.240	0.180	0.321	3359104	2757252	4092328
1996	27736116	18077467	42555304	2208021	1829036	2665534	0.296	0.223	0.393	3715742	3015623	4578404

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
1997	44065482	28775928	67478857	2457528	2031284	2973214	0.300	0.227	0.396	5388585	4221497	6878330
1998	26947826	17716639	40988888	3643947	2968036	4473784	0.403	0.308	0.525	6757753	5379486	8489143
1999	20741960	13560362	31726948	4406105	3577162	5427141	0.390	0.298	0.511	7158771	5800381	8835283
2000	38741897	25326341	59263774	4222027	3496188	5098557	0.479	0.370	0.620	7437292	6046579	9147868
2001	56204092	36978866	85424468	4552790	3785445	5475682	0.463	0.357	0.601	8969231	7207515	11161559
2002	49118731	32310079	74671737	5408962	4487435	6519731	0.472	0.363	0.614	10363526	8352423	12858864
2003	52873853	35189022	79446489	6867451	5676958	8307598	0.500	0.390	0.641	11842067	9665842	14508259
2004	29806946	19758274	44966176	6783789	5666909	8120791	0.537	0.421	0.684	10443214	8667067	12583348
2005	22383995	14867884	33699701	6084043	5088722	7274042	0.504	0.392	0.648	8616632	7185805	10332363
2006	9029595	5935661	13736226	5934656	4943004	7125252	0.459	0.355	0.595	7801807	6498799	9366068
2007	4912498	3209526	7519066	4706700	3904871	5673177	0.458	0.350	0.600	5753500	4782808	6921199
2008	5795362	3738612	8983607	3619929	2959058	4428398	0.403	0.299	0.543	4441932	3646020	5411588
2009	5717271	3587927	9110325	2779726	2211779	3493512	0.258	0.186	0.358	3498267	2803095	4365843
2010	15629189	10039318	24331487	2713336	2115726	3479746	0.178	0.126	0.253	3799359	2990497	4827000
2011	19530150	12632711	30193579	2747257	2156219	3500305	0.052	0.035	0.077	4505291	3535106	5741736
2012	19666112	12933873	29902563	3477167	2797733	4321604	0.110	0.081	0.149	5176218	4155705	6447338
2013	16561619	10904850	25152773	3812909	3126908	4649409	0.193	0.145	0.257	5678694	4630818	6963687
2014	37382298	24357428	57372075	4050639	3357100	4887455	0.376	0.285	0.496	6714472	5444800	8280218

Year	R(age 1)	Low	High	SSB	Low	High	Fbar (3-7)	Low	High	TSB	Low	High
2015	64931228	41984711	100419038	4229586	3475339	5147528	0.488	0.374	0.637	8267016	6501844	10511410
2016	36012234	22678031	57186666	5017692	3981388	6323733	0.426	0.318	0.570	9341505	7181935	12150446
2017	12772968	7579852	21523998	6295525	4822504	8218476	0.397	0.286	0.550	9153979	6933676	12085268
2018	9856549	5319672	18262697	6315041	4620979	8630149	0.394	0.263	0.590	8213238	5977386	11285415
2019	5466776	2151558	13890231	5576649	3722192	8355027	0.335	0.197	0.570	6887458	4587618	10340241
2020				4325386*						5700362*		

*assuming long term GM(1981-2018) recruitment (14872450) and weight at age as average over 2017-2019

Table 2.4.6. Blue whiting. Model estimate of total catch weight (in tonnes) and Sum of Product of catch number and mean weight at age for ages 1-10+ (Observed catch). Preliminary catch data for 2019 are included.

Year	Estimate	Low	High	Observed catch
1981	787954	559923	1108852	922980
1982	542653	409706	718741	550643
1983	507233	389448	660641	553344
1984	556434	425583	727517	615569
1985	635872	494977	816872	678214
1986	760976	593813	975195	847145
1987	638147	498366	817134	654718
1988	569393	445099	728396	552264
1989	619196	487448	786552	630316
1990	554092	433229	708675	558128
1991	405970	312825	526849	364008
1992	436412	341704	557371	474592
1993	440682	343516	565330	475198
1994	427876	331807	551760	457696
1995	507164	399455	643915	505176
1996	596929	470197	757820	621104
1997	640252	499350	820912	639681
1998	1070793	829910	1381593	1131955
1999	1248963	964168	1617879	1261033
2000	1505625	1172188	1933911	1412449
2001	1546213	1203135	1987120	1771805
2002	1711828	1332093	2199814	1556955
2003	2194948	1716704	2806423	2365319
2004	2313302	1817118	2944976	2400795
2005	2014019	1585530	2558307	2018344
2006	1868076	1471476	2371571	1956239
2007	1564711	1230188	1990199	1612269
2008	1173138	915397	1503451	1251851

Year	Estimate	Low	High	Observed catch
2009	653482	508924	839100	634978
2010	472279	361420	617142	539539
2011	137370	100382	187988	103771
2012	326245	256616	414768	375692
2013	590657	463820	752177	613863
2014	1112707	868768	1425140	1147650
2015	1336495	1050650	1700108	1390656
2016	1232532	966207	1572266	1180786
2017	1473370	1154261	1880700	1555069
2018	1691316	1318577	2169423	1709856
2019	1465267	1121211	1914899	1444301

Table 2.8.1.1. Blue whiting. Input to short-term projection (median values for exploitation pattern and stock numbers).

Age	Mean weight in the stock (kg)	Mean weight in the catch (kg)	Proportion maturity	Natural mortality	Exploitation pattern	Stock number(2020) (thousands)
Age 1	0.057	0.057	0.11	0.20	0.085	14872450
Age 2	0.087	0.087	0.40	0.20	0.156	4350212
Age 3	0.099	0.099	0.82	0.20	0.484	5474034
Age 4	0.110	0.110	0.86	0.20	0.784	7120291
Age 5	0.117	0.117	0.91	0.20	1.058	10095469
Age 6	0.129	0.129	0.94	0.20	1.258	10768766
Age 7	0.144	0.144	1.00	0.20	1.417	2668431
Age 8	0.164	0.164	1.00	0.20	1.456	669720
Age 9	0.176	0.176	1.00	0.20	1.455	224837
Age 10	0.252	0.252	1.00	0.20	1.455	178582

Table 2.8.2.1.2. Blue whiting. Deterministic forecast, intermediate year assumptions and recruitments.

Values	Value	Notes
F ages 3-7 (2019)	0.335	From the assessment (preliminary 2019 catches)
SSB (2020)	4325386	From forecast; in tonnes
R age 1 (2019)	5466776	From the assessment; in thousands
R age 1 (2020)	14872450	GM (1981–2018); in thousands
R age 1 (2021)	14872450	GM (1981–2018) ; in thousands
Total catch (2019)	1444301	Preliminary 2019 catches as estimated by the WG, based on declared quotas and expected uptake; in tonnes

Table 2.8.2.2.1. Blue whiting. Deterministic forecast(weights in tonnes).

Basis	Catch (2020)	F(2020)	SSB(2021)	% SSB change*	% Catch change**	% Advice change***
Long-term management strategy (F=FMSY)	1161615	0.320	3435240	-20.6	-19.6	1.6
MSY approach: FMSY	1161615	0.320	3435240	-20.6	-19.6	1.6
F = 0	0	0.000	4558202	5.4	-100.0	-100.0
Fpa	1738144	0.530	2887400	-33.2	20.3	52.0
Flim	2464861	0.880	2210394	-48.9	70.7	115.5
SSB (2021) = Blim	3258019	1.476	1499411	-65.3	125.6	184.9
SSB (2021) = Bpa	2421569	0.855	2250182	-48.0	67.7	111.7
SSB (2021) = MSY Btrigger	2421569	0.855	2250182	-48.0	67.7	111.7
F = F (2019)	1207680	0.335	3391192	-21.6	-16.4	5.6
SSB (2021) = SSB (2020)	239207	0.058	4325277	-0.0	-83.4	-79.1
Catch (2020) = Catch (2019)	1444788	0.418	3165186	-26.8	0.0	26.3
Catch (2020) = Catch (2019) -20 %	1155502	0.318	3441089	-20.4	-20.0	1.0
Catch (2020) = Advice (2019) -20 %	914820	0.242	3671942	-15.1	-36.7	-20.0
F = 0.05	208483	0.050	4355152	0.7	-85.6	-81.8
F = 0.1	406117	0.100	4163213	-3.7	-71.9	-64.5
F = 0.15	593517	0.150	3981748	-7.9	-58.9	-48.1
F = 0.16	629820	0.160	3946657	-8.8	-56.4	-44.9

Basis	Catch (2020)	F(2020)	SSB(2021)	% SSB change*	% Catch change**	% Advice change***
F = 0.17	665741	0.170	3911957	-9.6	-53.9	-41.8
F = 0.18	701285	0.180	3877642	-10.4	-51.4	-38.7
F = 0.19	736456	0.190	3843708	-11.1	-49.0	-35.6
F = 0.2	771258	0.200	3810150	-11.9	-46.6	-32.6
F = 0.21	805695	0.210	3776964	-12.7	-44.2	-29.5
F = 0.22	839773	0.220	3744145	-13.4	-41.9	-26.6
F = 0.23	873494	0.230	3711689	-14.2	-39.5	-23.6
F = 0.24	906863	0.240	3679593	-14.9	-37.2	-20.7
F = 0.25	939884	0.250	3647850	-15.7	-34.9	-17.8
F = 0.26	972561	0.260	3616459	-16.4	-32.7	-15.0
F = 0.27	1004898	0.270	3585413	-17.1	-30.4	-12.1
F = 0.28	1036898	0.280	3554710	-17.8	-28.2	-9.3
F = 0.29	1068567	0.290	3524345	-18.5	-26.0	-6.6
F = 0.3	1099906	0.300	3494315	-19.2	-23.8	-3.8
F = 0.31	1130921	0.310	3464614	-19.9	-21.7	-1.1
F = 0.32	1161615	0.320	3435240	-20.6	-19.6	1.6
F = 0.33	1191992	0.330	3406189	-21.3	-17.5	4.2
F = 0.34	1222054	0.340	3377457	-21.9	-15.4	6.9
F = 0.35	1251807	0.350	3349039	-22.6	-13.3	9.5
F = 0.45	1533028	0.450	3081403	-28.8	6.1	34.0
F = 0.5	1663178	0.500	2958178	-31.6	15.2	45.4

*) SSB 2021 relative to SSB 2020.

**) Catch 2020 relative to expected catch in 2019 (1444301 tonnes).

***) Catch 2020 relative to advice for 2019 (1143629 tonnes).

2.17 Figures

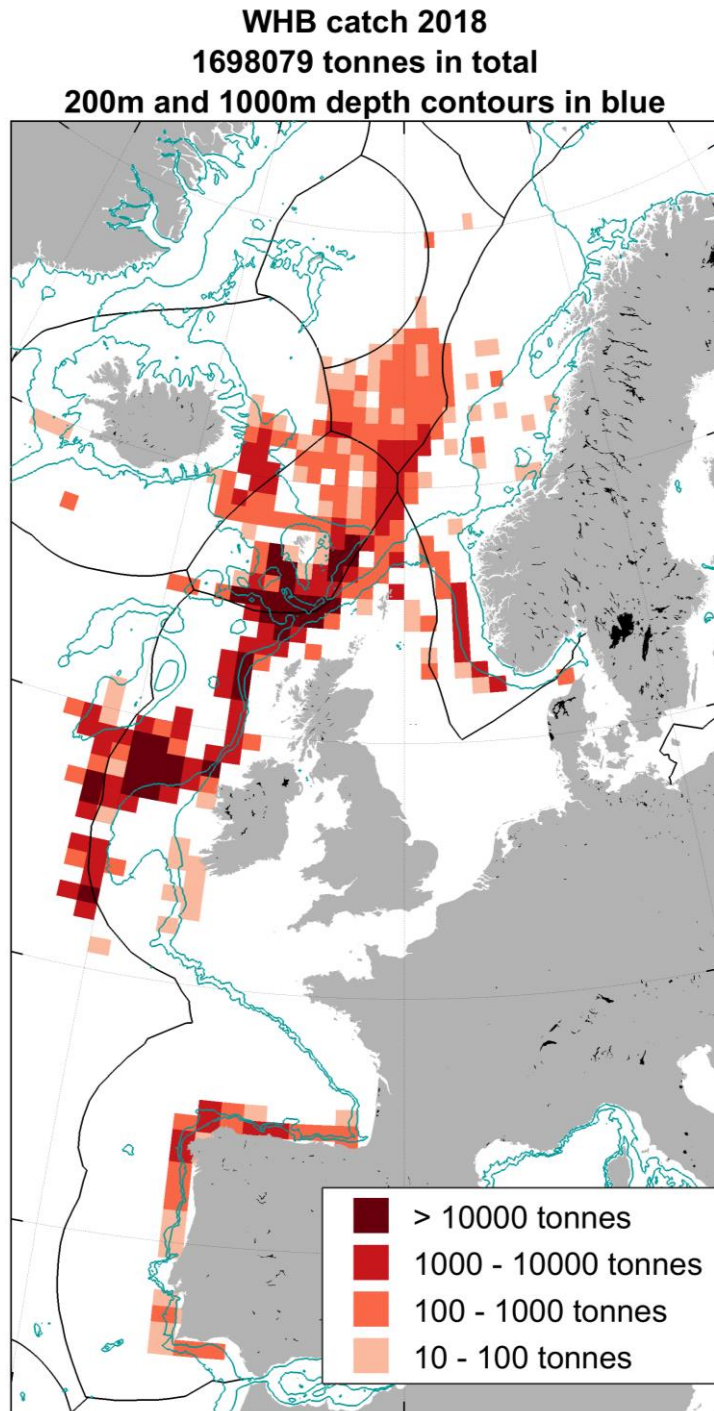


Figure 2.2.1. Blue whiting landings (ICES estimates) in 2018 by ICES rectangle. The 200 m and 1000 m depth contours are indicated in blue. The catches on the map constitute 98.8 % of the total landings.

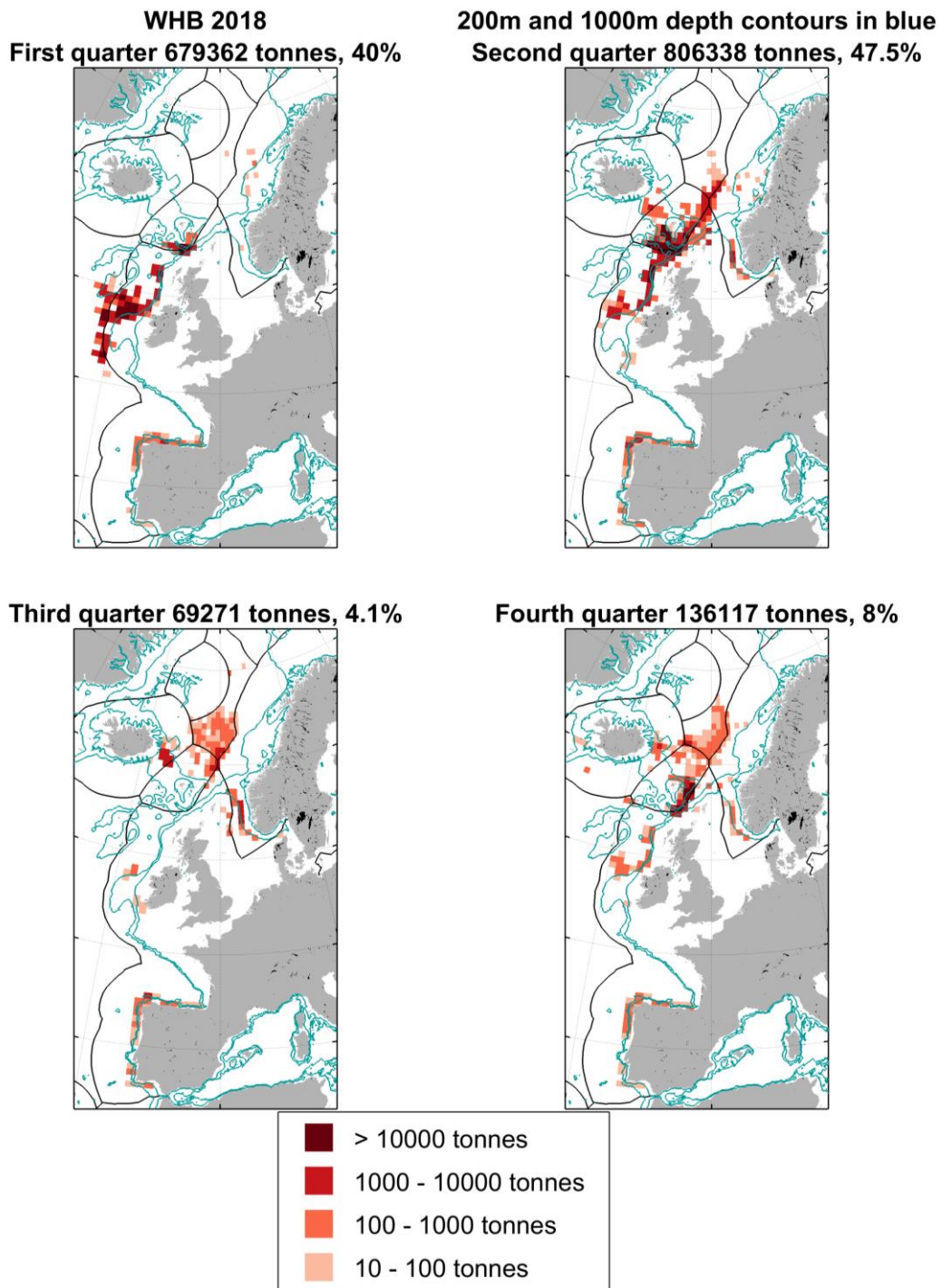


Figure 2.2.2. Blue whiting total catches per quarter (ICES estimates) 2018 by ICES rectangle. The 200 m and 1000 m depth contours are indicated in blue. The catches on the map constitute 99.6 % of the total landings.

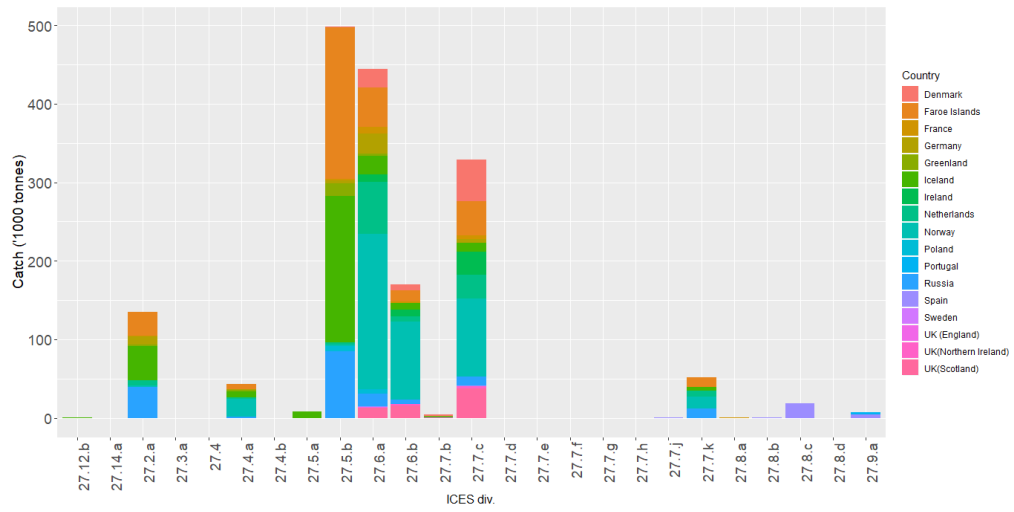
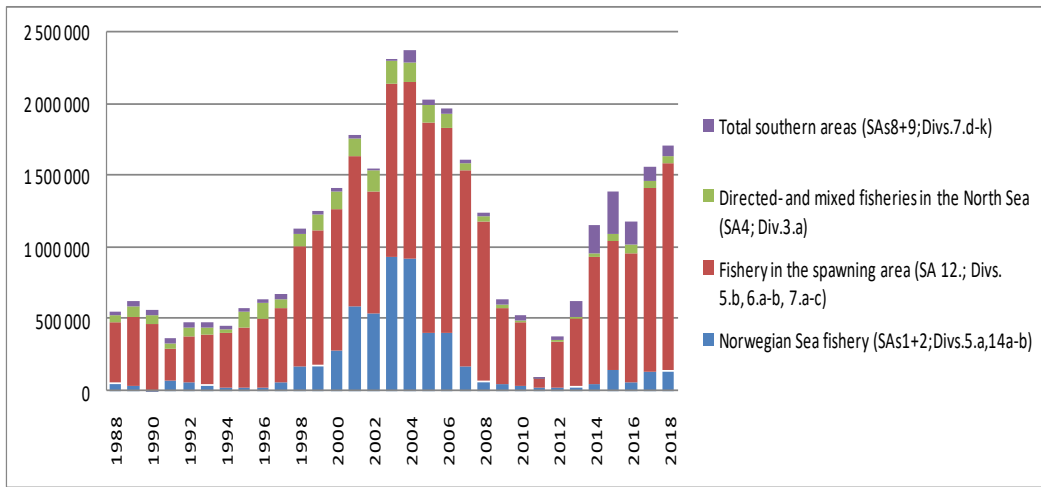


Figure 2.3.1.1. Blue whiting. ICES estimated catches ('1000 tonnes) in 2018 by ICES division and country.

A



B

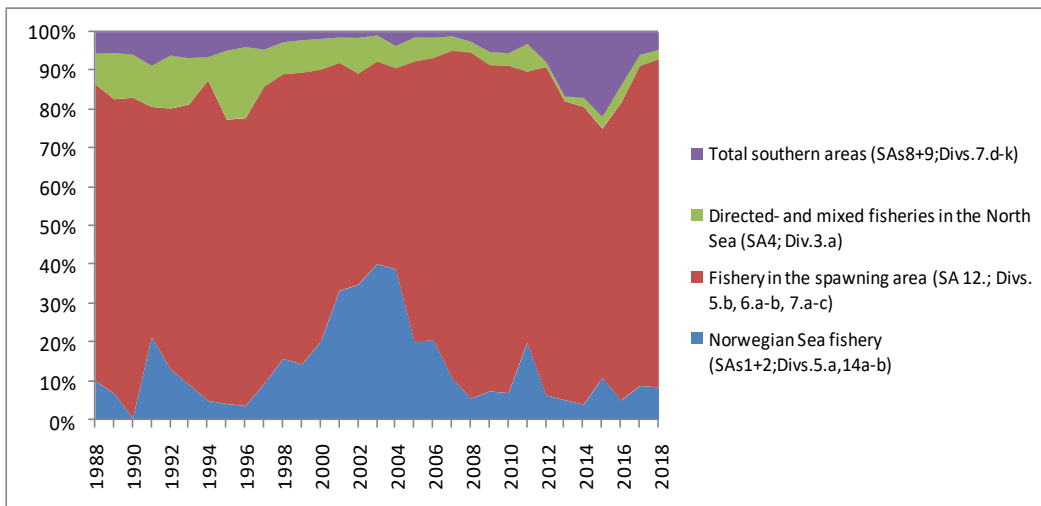


Figure 2.3.1.2. Blue whiting.(A) ICES estimated catches (tonnes) of blue whiting by fishery subareas from 1988-2018 and (B) the percentage contribution to the overall catch by fishery subarea over the same period.

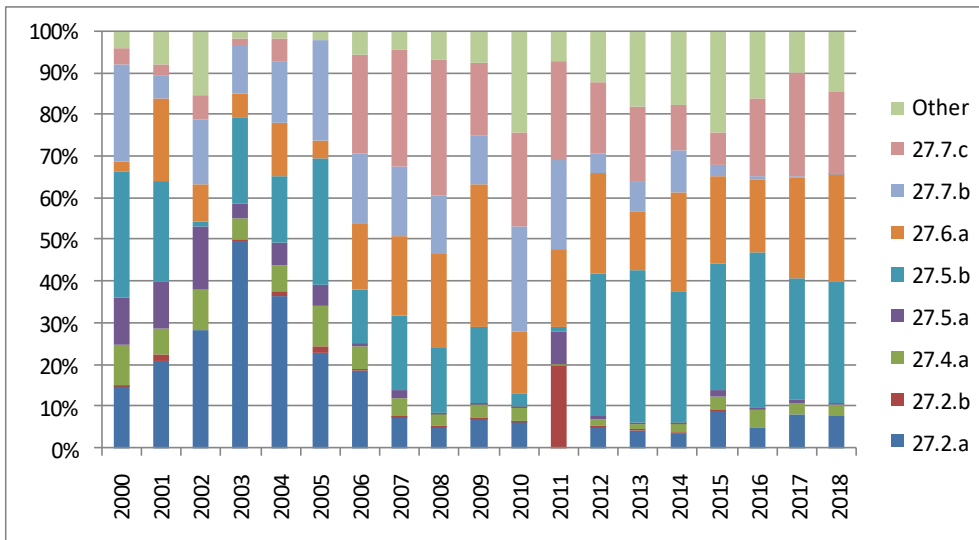


Figure 2.3.1.3. Blue whiting. Distribution of 2018 ICES estimated catches (in percentage) by ICES division area.

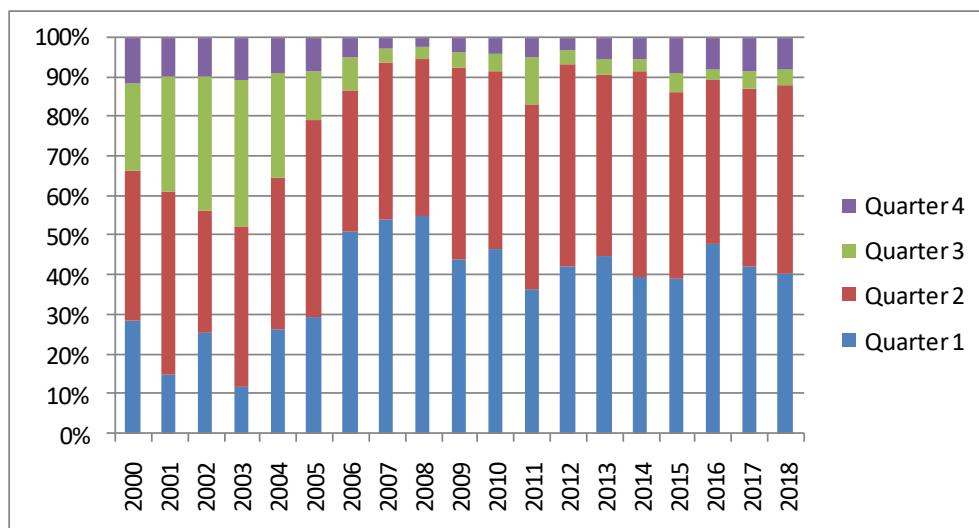


Figure 2.3.1.4. Blue whiting. Distribution of 2018 ICES estimated catches (in percentage) by quarter.

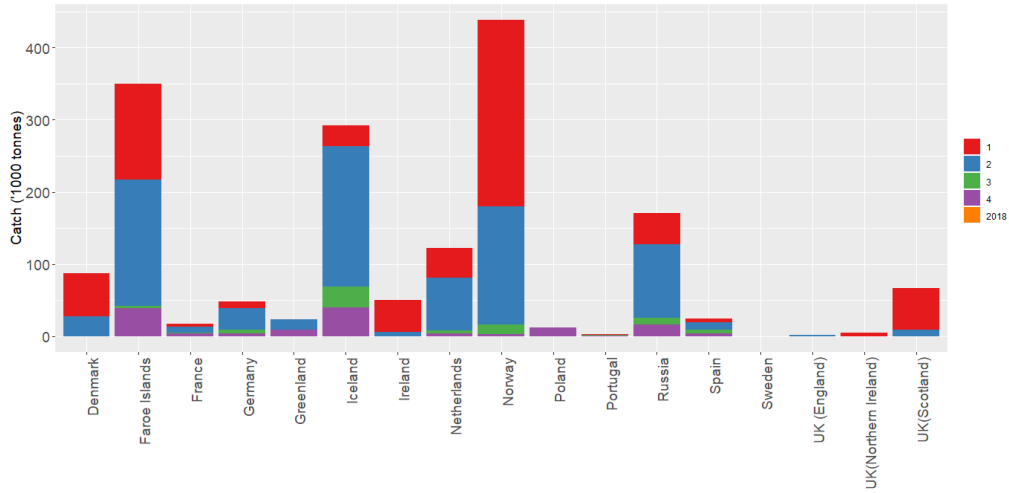


Figure 2.3.1.5. Blue whiting. Distribution of 2018 ICES estimated catches ('1000 tonnes) by country and by quarter. Discard data from UK (Scotland) were not assigned by quarter due to sampling intensity.

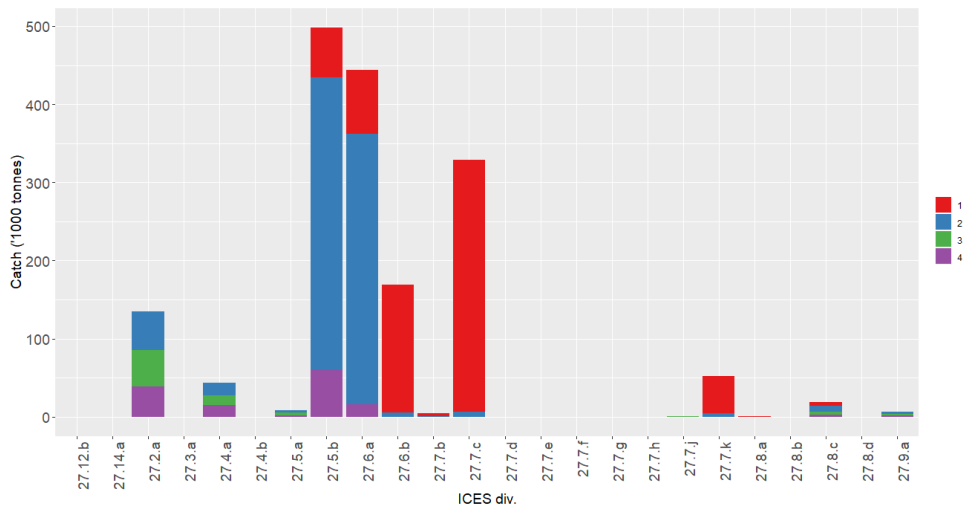


Figure 2.3.1.6. Blue whiting. Distribution of 2018 ICES estimated catches ('1000 tonnes) by ICES division and by quarter.

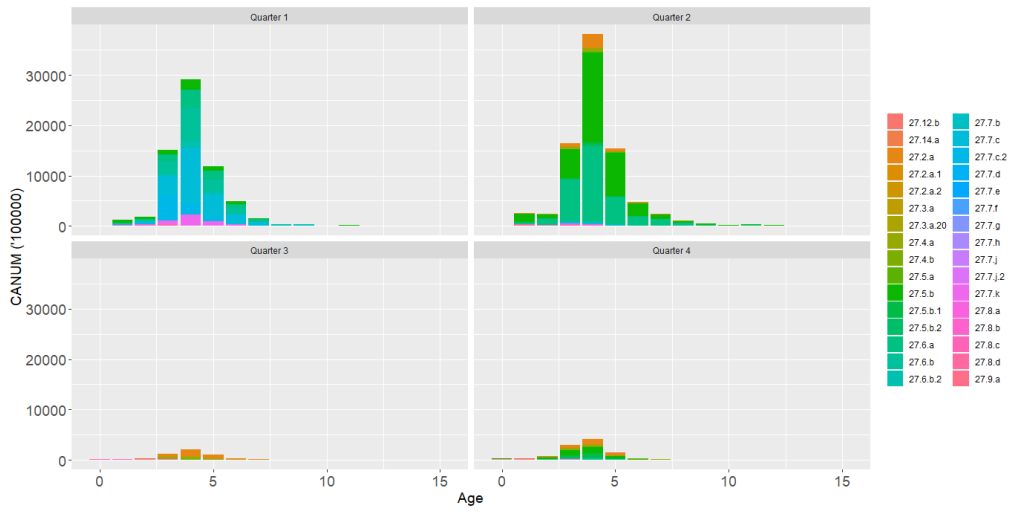


Figure 2.3.1.7. Blue whiting. Catch-at-age numbers (CANUM) distribution by quarter and ICES division for 2018.

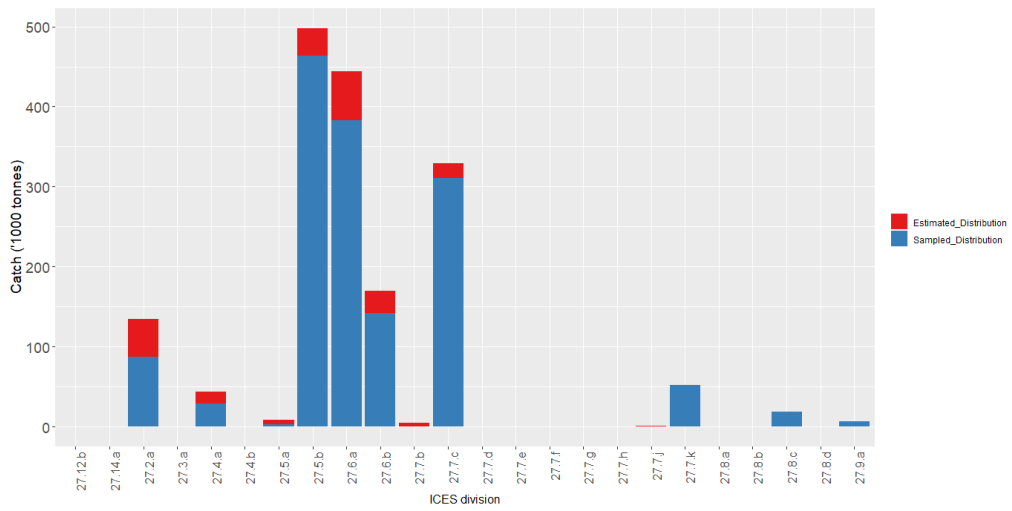


Figure 2.3.1.1.1. Blue whiting. 2018 ICES catches ('1000 tonnes) sampled and estimated by ICES division.

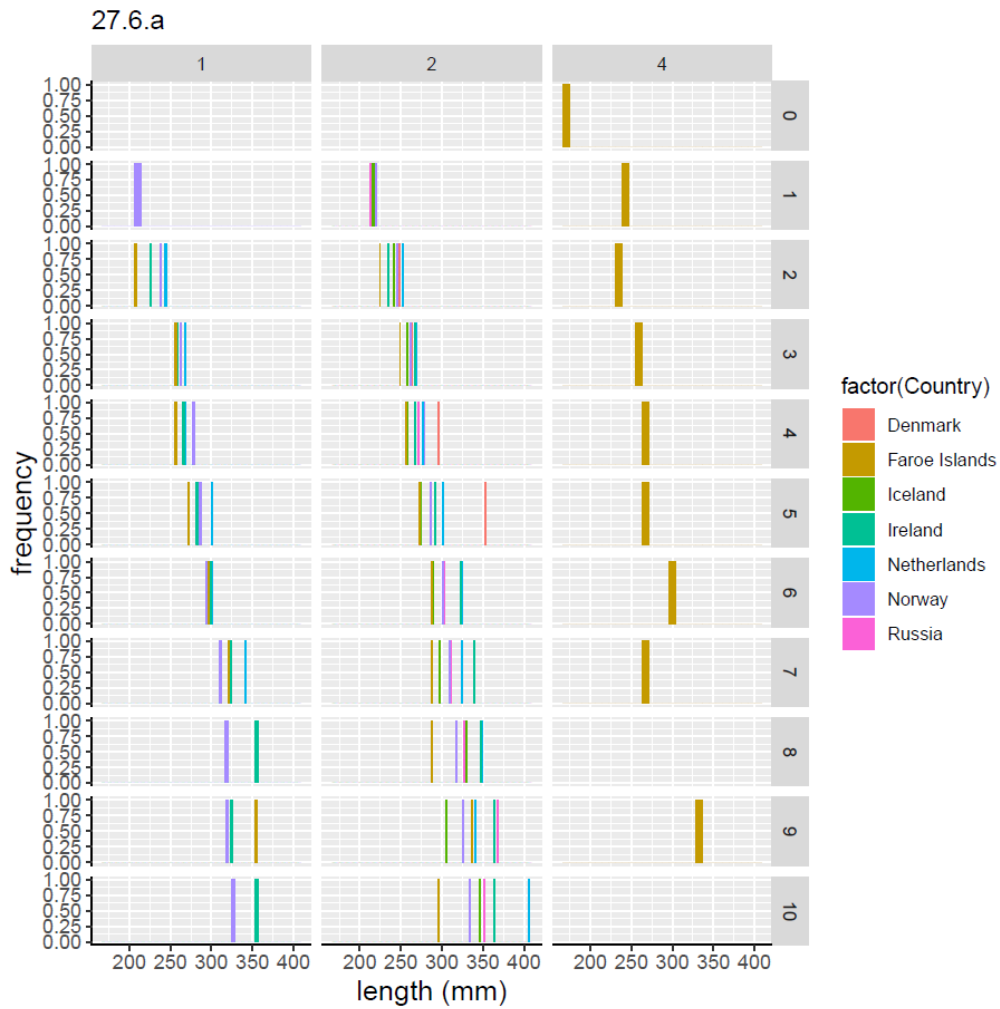


Figure 2.3.1.2.1. Blue whiting. Mean length (mm) by age (0-10 year), by quarter (1,2,4), by country for ICES division area 27.6.a. These data only comprises the 2018 ICES catch-at-age sampled estimates for ICES division 27.6.a.

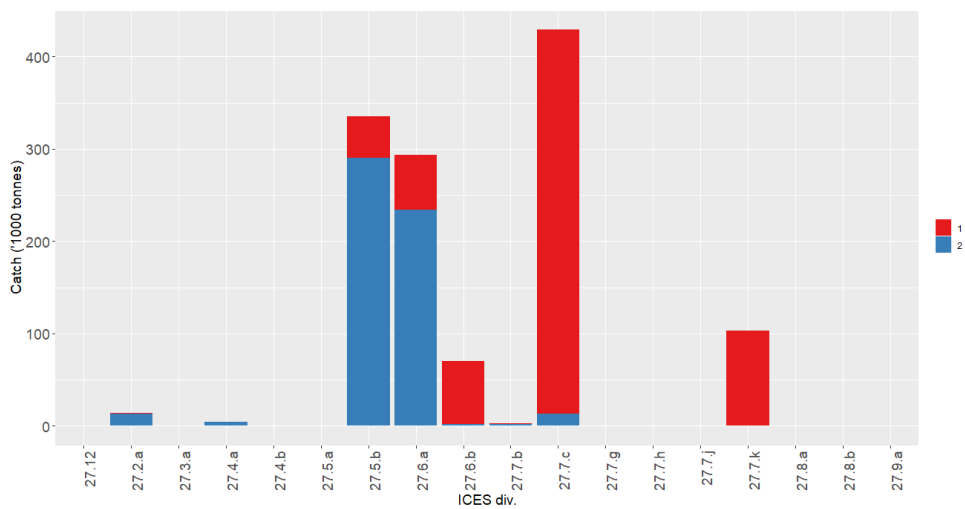


Figure 2.3.2.1. Blue whiting. Distribution of 2019 preliminary catches (tonnes) (1st semester) by ICES division and quarter.

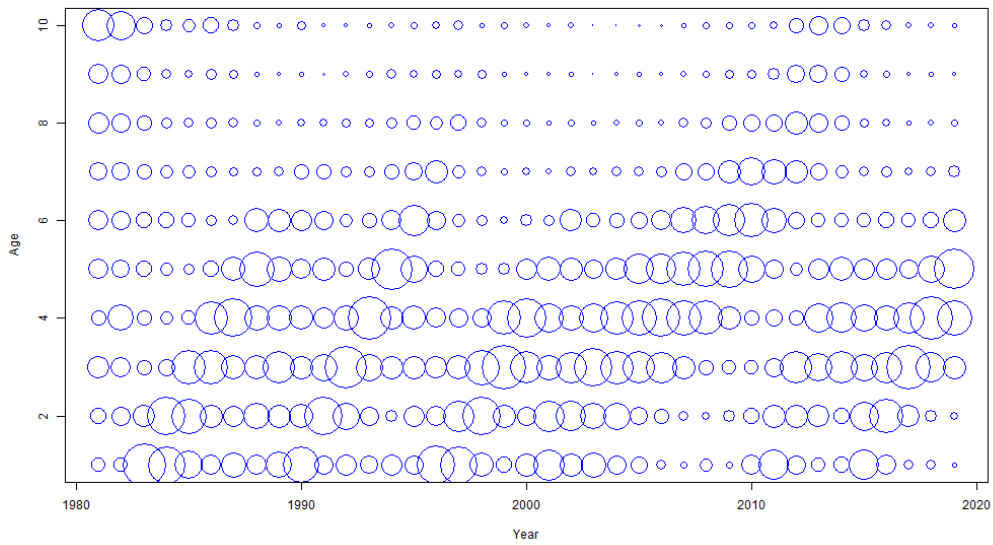


Figure 2.3.3.1. Blue whiting. Catch proportion at age, 1981-2018.9. Preliminary values for 2019.8 have been used.

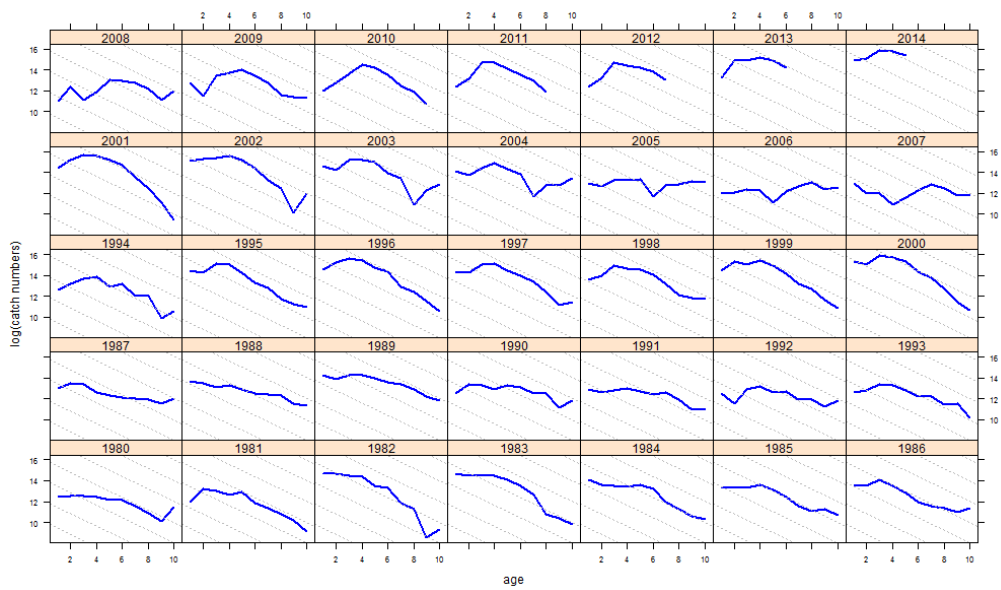


Figure 2.3.3.2. Blue whiting. Age disaggregated catch (numbers) plotted on log scale. The labels for each panel indicate year classes. The grey dotted lines correspond to $Z=0.6$. Preliminary catch-at-age for 2019 have been used.

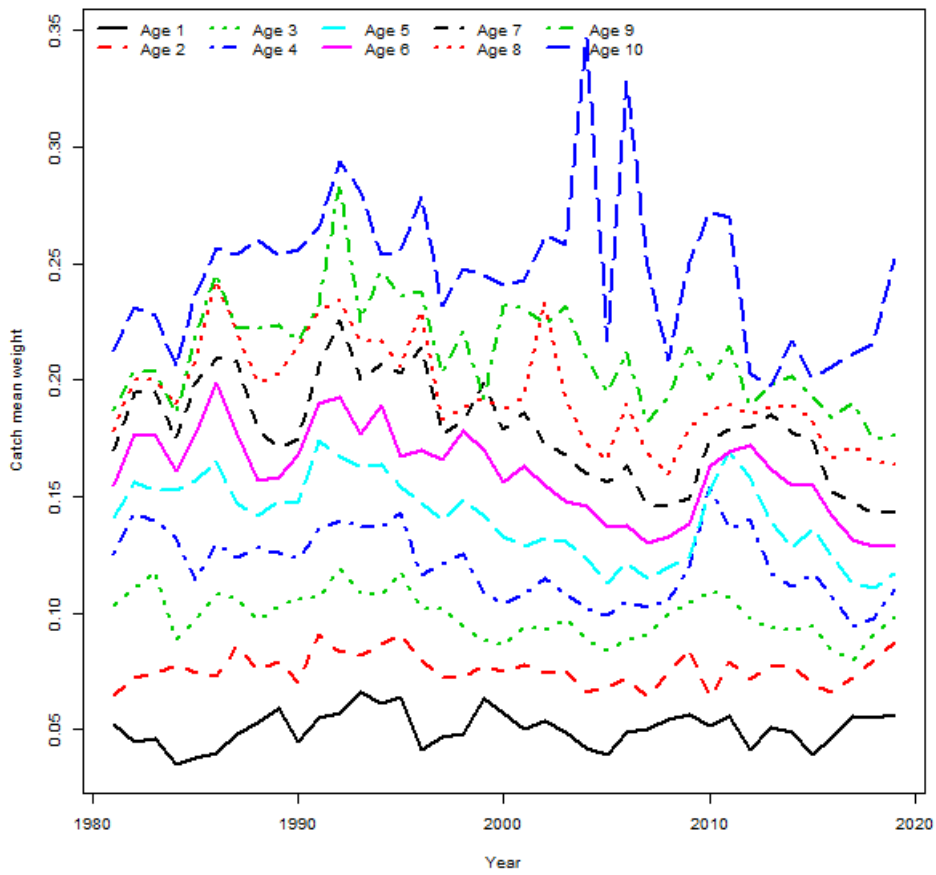
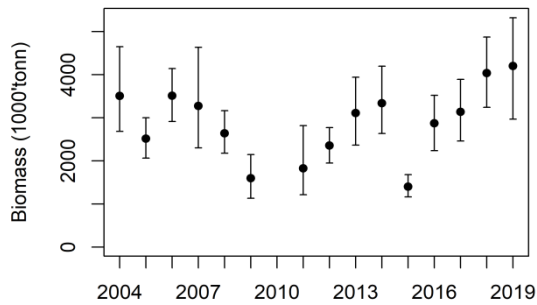


Figure 2.3.4.1. Blue whiting. Mean catch (and stock) weight (kg) at age by year. Preliminary values for 2019 have been used

A



B

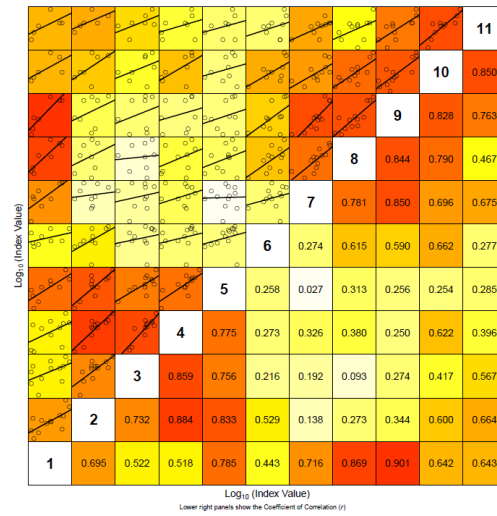
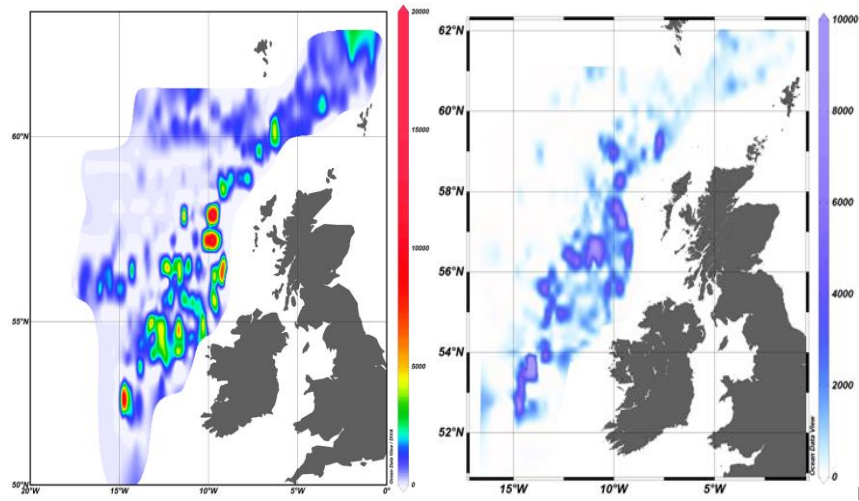
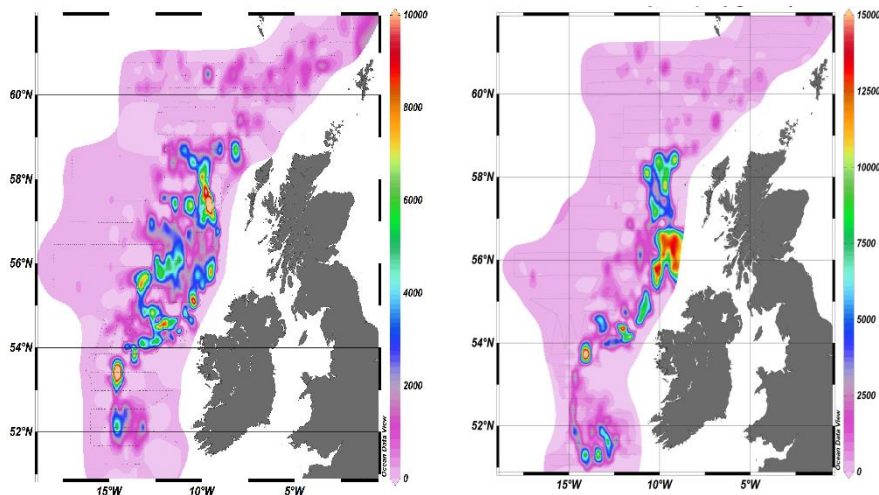


Figure 2.3.7.1.1. Blue whiting. (A) Estimate of total biomass from the International blue whiting spawning stock survey. The black dots and error bands are StoX estimates with 90 % confidence intervals. (B) Internal consistency within the International blue whiting spawning stock survey. The upper left part of the plots shows the relationship between log index-at-age within a cohort. Linear regression line shows the best fit to the log-transformed indices. The lower-right part of the plots shows the correlation coefficient (r) for the two ages plotted in that panel. The background colour of each panel is determined by the r value, where red equates to r=1 and white to r<0.



2016

2017



2018

2019

Figure 2.3.7.1.2. Map of blue whiting acoustic density (sA, m2/nm2) found during the spawning survey in spring 2016—2019.

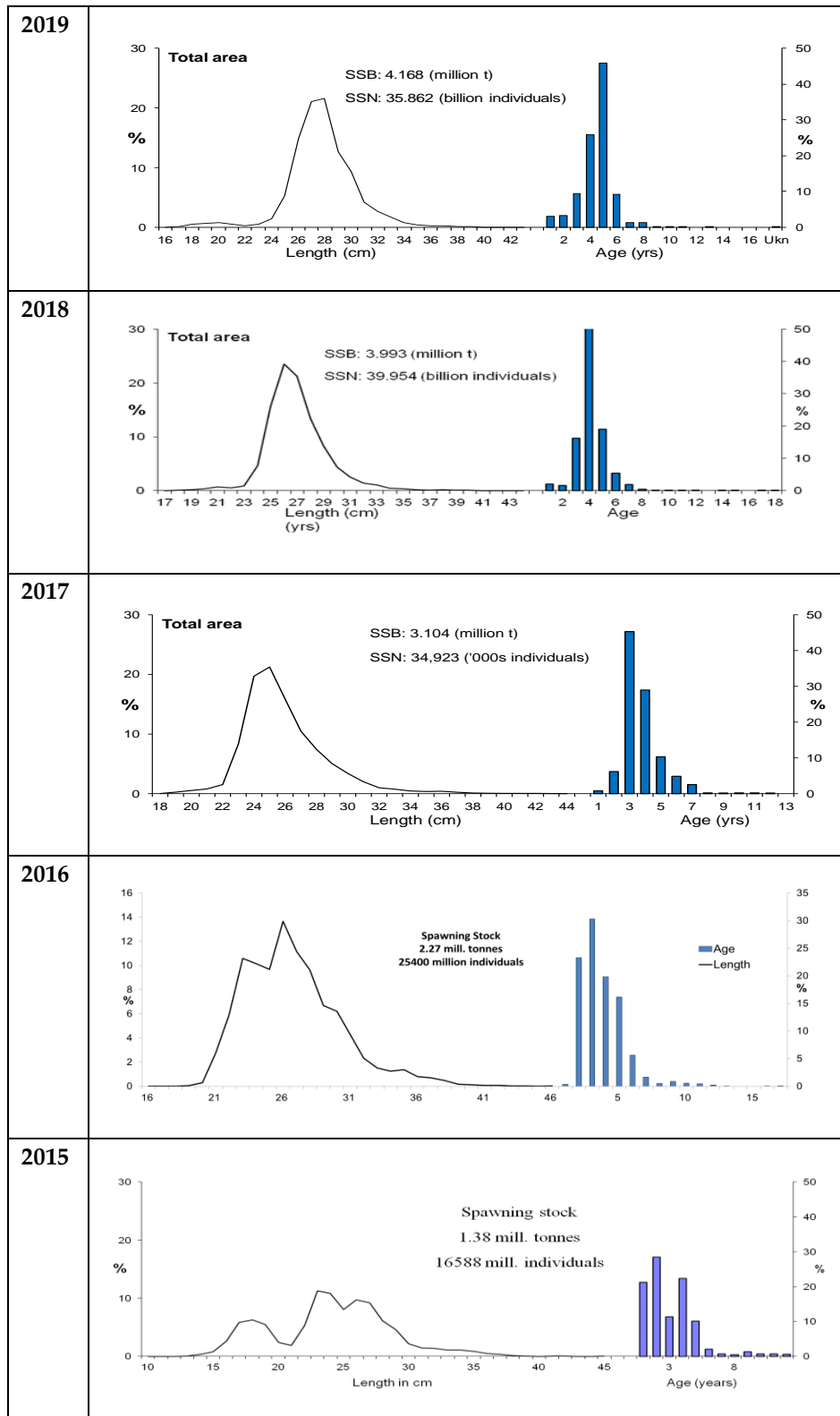


Figure 2.3.7.1.3. Blue whiting.Length (line) and age (bars) distribution of the blue whiting stock in the area to the west of the British Isles, spring 2015 (lower panel) to 2019 (upper panel).Spawning-stock biomass and numbers are given.

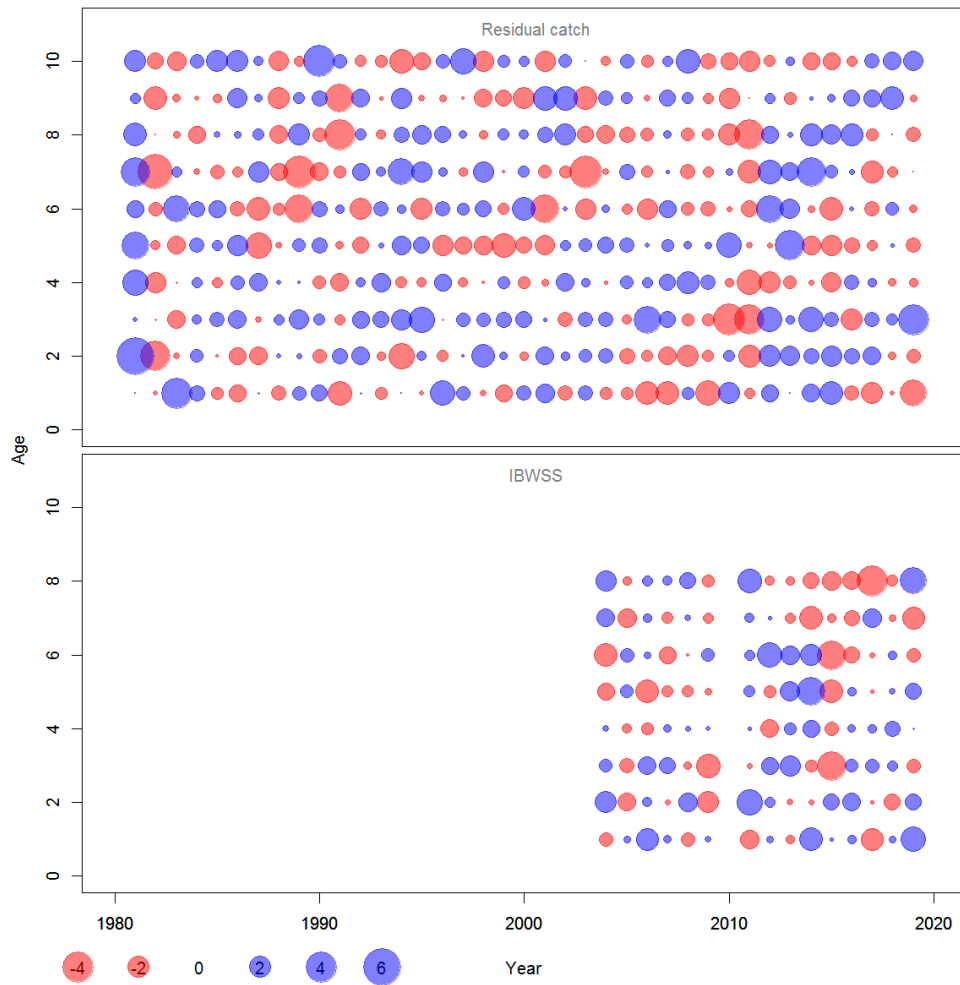


Figure 2.4.1. Blue Whiting, OSA (One Step Ahead) residuals (see Berg and Nielsen, 2016) from catch-at-age and the IBWSS survey. Red (lighter) bubbles show that the observed value is less than the expected value. Preliminary catch data for 2019 have been used.

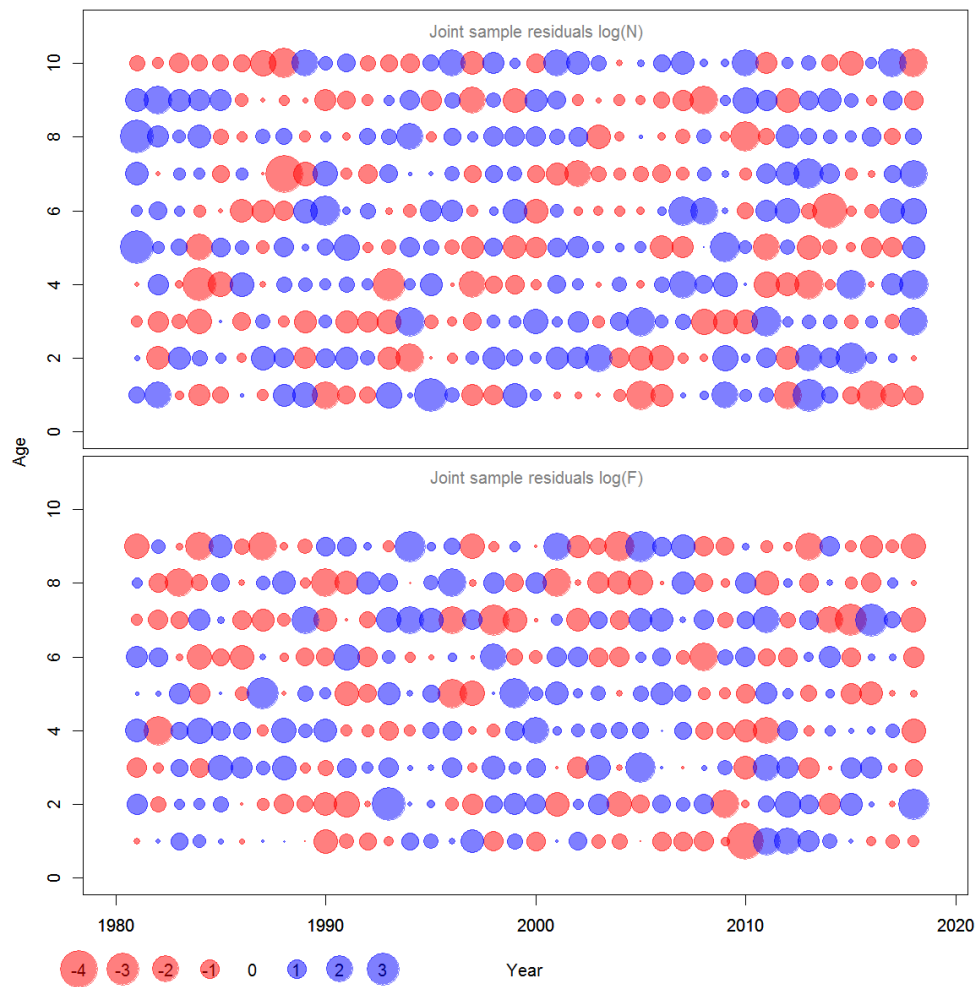


Figure 2.4.2. Blue whiting. Joint sample residuals (Process errors) for stock number and F at age. Red (lighter) bubbles show that the observed value is less than the expected value. Preliminary catch data for 2019 have been used.

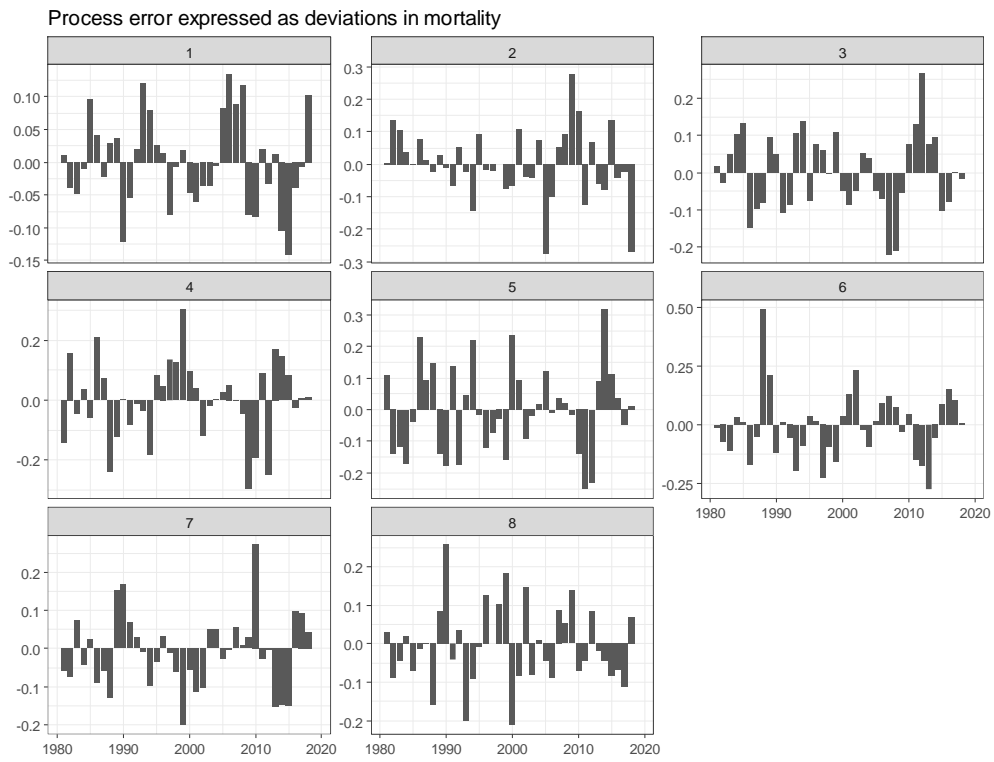


Figure 2.4.3. Blue whiting. Process errors expressed as deviation in instantaneous mortality at age by age and year.

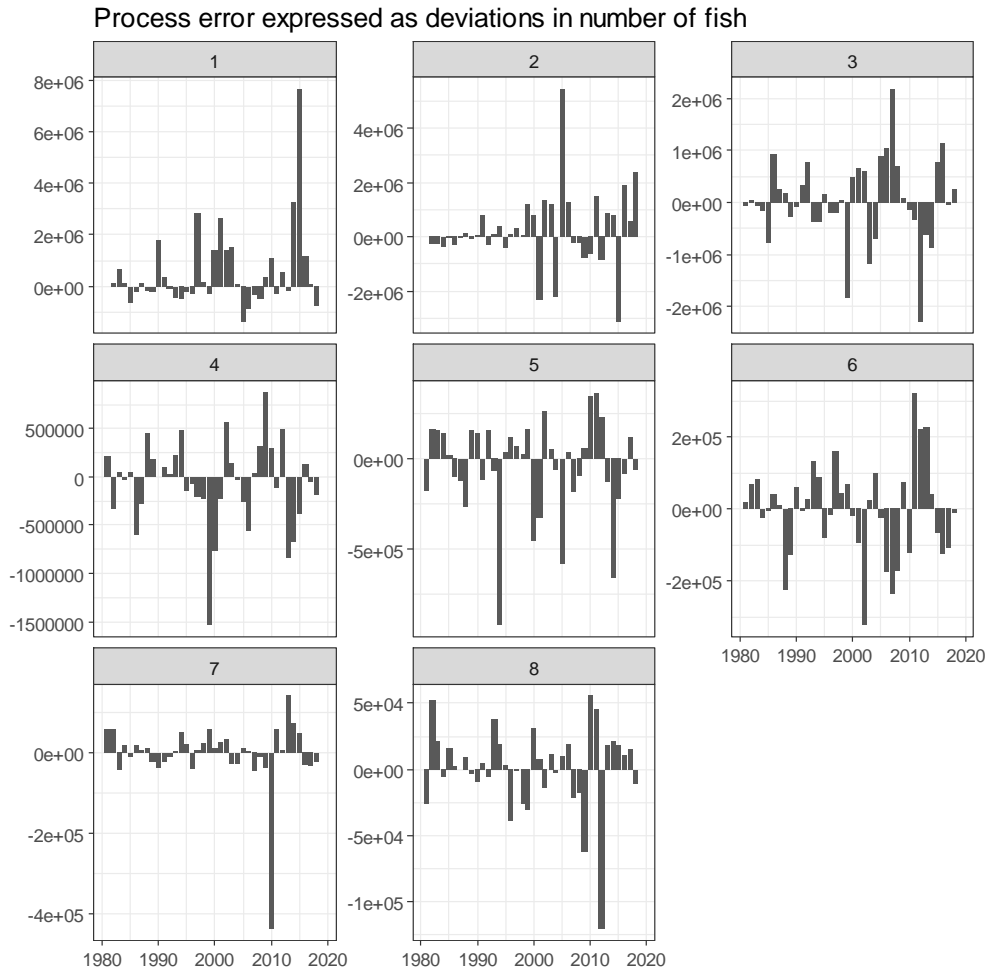


Figure 2.4.4. Blue whiting. Process errors expressed as deviation in instantaneous mortality at age by age and year.

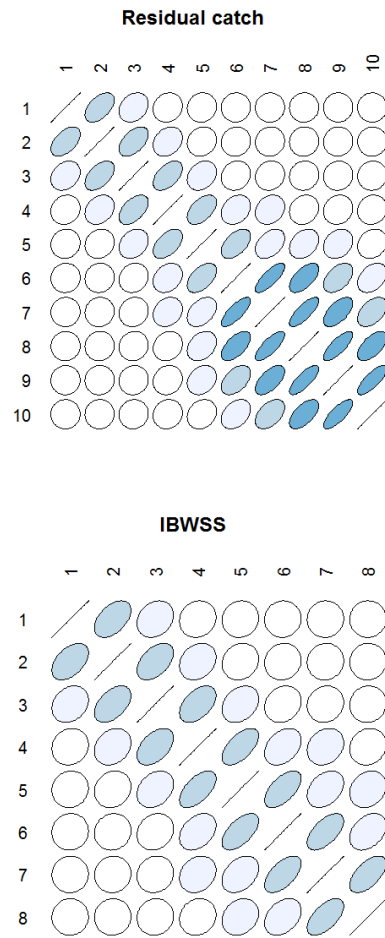


Figure 2.4.5. Blue whiting. The correlation matrix between ages for the catches and survey indices. Each ellipse represents the level curve of a bivariate normal distribution with the corresponding correlation. Hence, the sign of a correlation corresponds to the sign of the slope of the major ellipse axis. Increasingly darker shading is used for increasingly larger absolute correlations, while uncorrelated pairs of ages are depicted as circles with no shading.

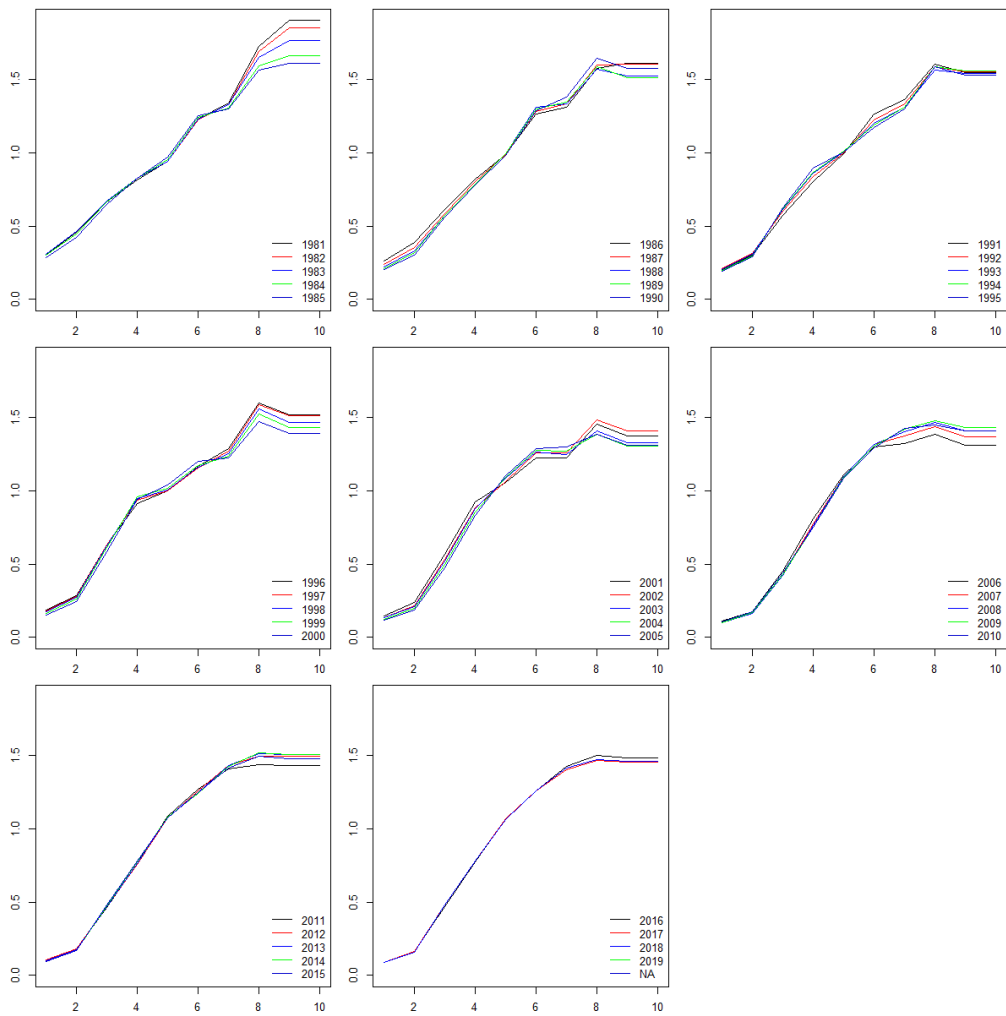


Figure 2.4.6. Blue whiting. Exploitation pattern by 5-years' time blocks. Values for 2019 are preliminary.

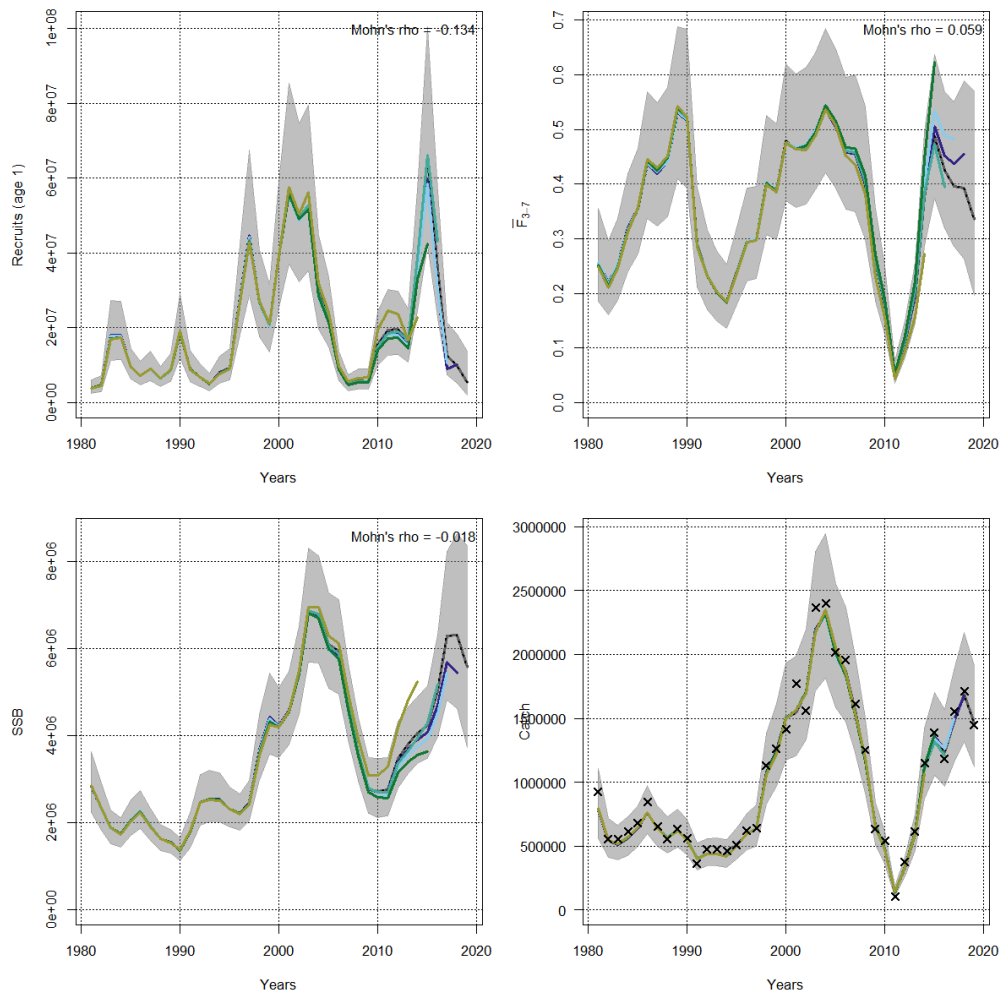


Figure 2.4.7. Blue whiting. Retrospective analysis of recruitment (age 1), SSB (tonnes), F and total catch using the SAM model. The 95% confidence interval is shown for the most recent assessment.

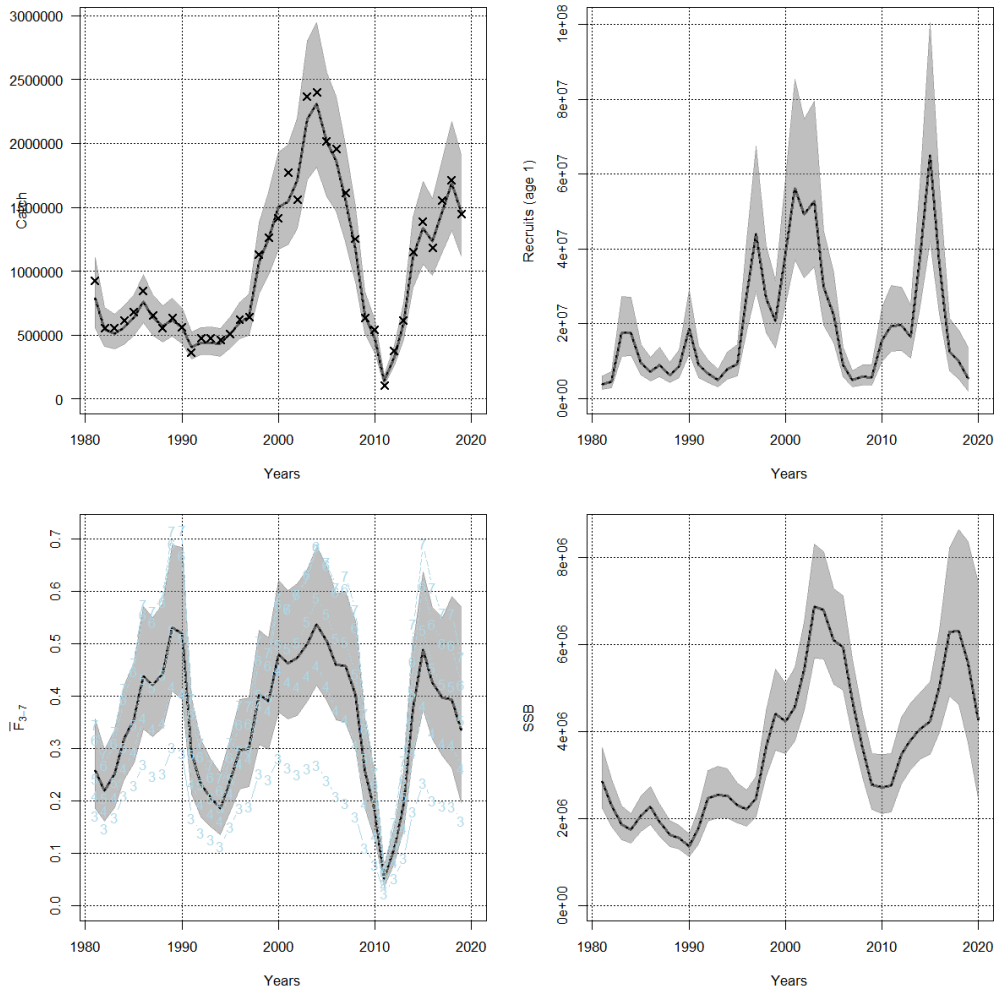


Figure 2.4.8. Blue whiting. SAM final run: Stock summary, total catches (tonnes), recruitment (age 1), F and SSB (tonnes). The graphs show the median value and the 95% confidence interval. The catch plot does also include the observed catches (x). Catches for 2019 are preliminary.

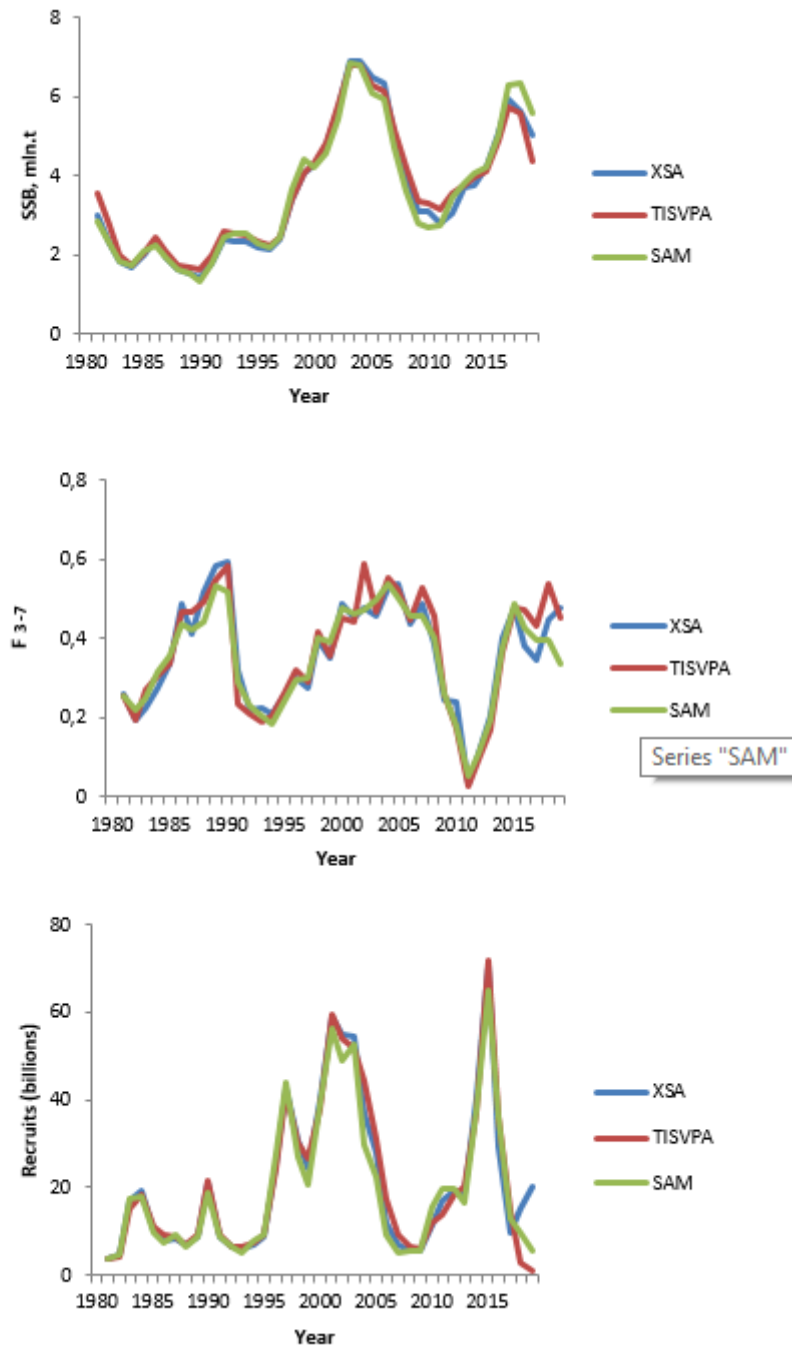


Figure 2.4.1.1. Blue whiting. Comparison of SSB, F and recruitment estimated by the assessment programs XSA, TISVPA and SAM. Catch values for 2019 are preliminary.

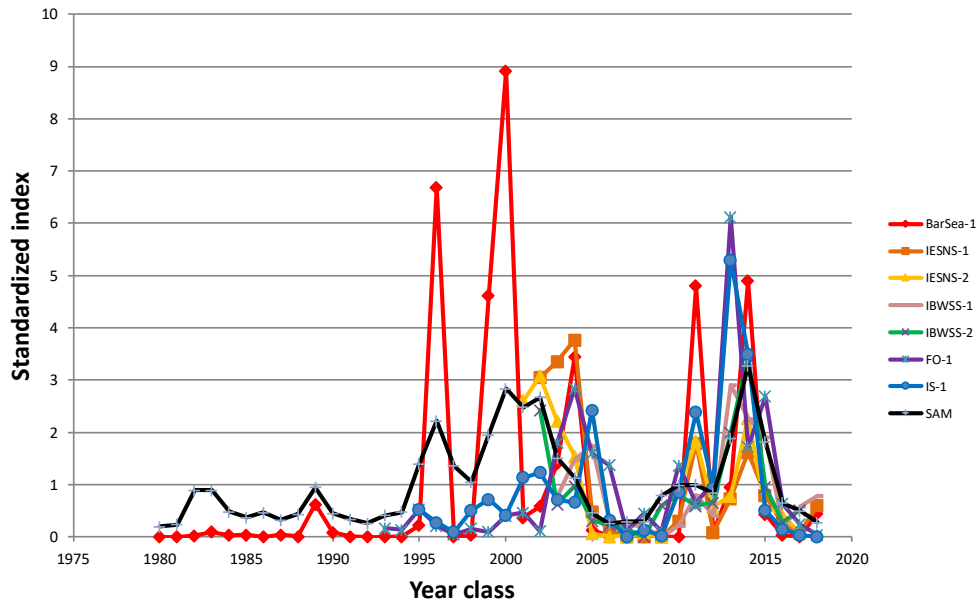


Figure 2.8.1.1. Blue whiting young fish indices from five different surveys and recruitment index from the assessment, standardized by dividing each series by their mean. BarSea - Norwegian bottom-trawl survey in the Barents Sea, IESNS: International Ecosystem Survey in the Nordic Seas in May (1 and 2 is the age groups), IBWSS: International Blue Whiting Spawning Stock survey (1 and 2 is the age groups), FO: the Faroese bottom-trawl surveys in spring, IS: the Icelandic bottom-trawl survey in spring, SAM: recruits from the assessment.

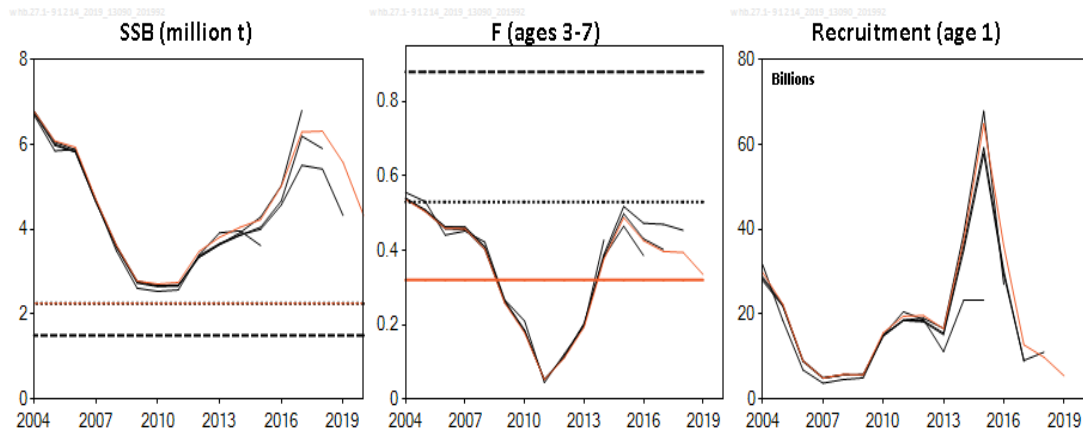


Figure 2.9.1. Blue whiting. Comparison of the 2015 - 2019 assessments.